The Uses, Meanings, and Values of Natural Objects:
University earth science objects and collections as material culture

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Table of Contents

List of Figures ............................................................................................................................. 6
Abstract ....................................................................................................................................... 9
Declaration ................................................................................................................................ 10
Copyright Statement ................................................................................................................ 10
Acknowledgements and Dedication .......................................................................................11
A note on the Author ................................................................................................................ 12

Chapter 1: Introduction ............................................................................................................ 13
  1.1. Set in stone? ............................................................................................................... 17
  1.2. A natural exclusion? ...................................................................................................19
  1.3. Matters of meaning: material culture ..........................................................................20
    1.3.1. On being interdisciplinary ................................................................................21
    1.3.2. Agency in museology ........................................................................................22
    1.3.3. Agency in science studies ...............................................................................23
  1.4. The geological tradition ..............................................................................................24
    1.4.1. Really real (really?)..........................................................................................25
    1.4.2. Objections to objective objects ........................................................................27
    1.4.3. Keeping for the future? ....................................................................................28
  1.5. Taken for granite?.......................................................................................................29
  1.6. Research outline .........................................................................................................31
    1.6.1. Preliminary groundwork...................................................................................32
    1.6.2. Selecting an appropriate approach and case studies .....................................33
    1.6.3. Empirical research: sources and methods ......................................................36
    1.6.4. Supplementary sources ...................................................................................43
    1.6.5. Knitting it all together: a brief account of the research process ......................46
    1.6.6. Thesis structure ...............................................................................................47

Chapter 2: The coming into being of earth science objects ................................................49
  2.1. Introduction ............................................................................................................... 50
2.2. The collecting context

2.2.1. Disciplinary factors
2.2.2. Personal factors
2.2.3. Institutional factors

2.3. The pragmatics of collecting

2.3.1. Selection
2.3.2. Removal
2.3.3. Inscription

2.4. The collecting process

2.4.1. The coming into being of research objects
2.4.2. The coming into being of teaching objects
2.4.3. Collecting for a purpose

2.5. Discussion

Chapter 3: The coming into being of collection items

3.1. Introduction
3.2. The contexts of collections

3.2.1. Collections and disciplines
3.2.2. Collections and institutions
3.2.3. Collections and people
3.2.4. The collection as a process

3.3. The pragmatics of creating collection items

3.3.1. Acquisition
3.3.2. Processing
3.3.3. Storing

3.4. Discussion

Chapter 4: The functions of university earth science objects and collections

4.1. Introduction
4.2. Teaching and Learning

4.2.1. Show and Tell
4.2.2. Surfaces to examine
4.2.3. Samples to test
4.2.4. Sets for interpretation
4.2.5. Objects for inspiration
Chapter 4: Research .............................................................. 131
4.3. Research ...................................................................................... 131
4.3.1. Observed objects ................................................................ 132
4.3.2. Amplified objects ................................................................ 135
4.3.3. Objects as materials .......................................................... 137
4.3.4. Objects as associations ..................................................... 138
4.4. Display .................................................................................. 140
4.4.1. The arrangement of displays ............................................. 141
4.4.2. The arrangement of objects ............................................... 144
4.4.3. The mediation of objects .................................................. 148
4.5. Discussion .......................................................................... 154

Chapter 5: The Mobility of Earth Science Objects and Collections ................. 159
5.1. Introduction ........................................................................ 159
5.2. Internal circulation of objects .............................................. 160
5.2.1. Museum Collections ...................................................... 160
5.2.2. Departmental Collections .............................................. 166
5.3. External movement ............................................................. 173
5.3.1. Temporary external circulation ........................................ 175
5.3.2. Permanent inward movement of material ...................... 176
5.3.3. Permanent outward movement of material ..................... 182
5.4. The circulation of proxies .................................................... 185
5.5. Discussion ........................................................................ 186

Chapter 6: Conclusions ................................................................................. 192
6.1. Introduction ........................................................................ 192
6.2. Paradoxical thinking .......................................................... 193
6.2.1. On enacting earth science objects ................................. 195
6.2.2. On being mindful .......................................................... 197
6.3. On getting the material culture treatment ......................... 200
6.3.1. Earth science objects as material culture ....................... 200
6.3.2. The cultures of the earth sciences ................................. 203
6.3.3. The cultures of collections ............................................ 204
Appendices ............................................................................................................................. 208

Appendix 1. Tables listing UK university earth science collections............................... 208
Appendix 2. Project outline and consent form ................................................................. 218
Appendix 3. Plans showing broad themes and questions to be addressed during interviews / observations at case study institutions .................................................. 221
Appendix 4. Samples of raw data from an interview transcript and field notes from observational research ................................................................. 231
Appendix 5. Summary of fieldwork ................................................................................ 233
Appendix 6. Background information about interviewees ............................................... 234

Bibliography .......................................................................................................................... 241

Websites ............................................................................................................................. 264
Interviews .......................................................................................................................... 265
Observations ....................................................................................................................... 266

Final word count: 90,166
List of Figures

Note: Unless otherwise stated, all photographs and diagrams are the author’s own.

Figure 1a: ‘Word Cloud’ generated by analysing the text from the four thematic chapters of this thesis. The font size is proportionate to the number of times each word occurs in the text. ............................................................................................................................................. 14

Figure 1b: Chrysotile specimen (2603) from the Harwood Mineral Collection (SEAES), showing fluffy asbestiform texture...................................................................................................... 18

Figure 1c: Table showing the categories used to group UK university earth science collections. ............................................................................................................................................. 34

Figure 1d: Six characteristics of case study research (based on: Denscombe 2007: 37). 36

Figure 1e: Table summarising the methods and sources that were originally identified for this research. ............................................................................................................................................. 37

Figure 1f: Table summarising interview-types (based on: Matthews and Ross 2010: 221; Richards and Morse 2007: 111) .......................................................................................... 38

Figure 1g: Table summarising four different approaches to observation (based on: Gold 1958; Matthews and Ross 2010: 257-8)........................................................................................... 41

Figure 1h: Table illustrating the variety of sources that were used for this research. ....... 44

Figure 1i: Diagram illustrating the relationships between and within case studies. .......... 46

Figure 2a: Suevite teaching specimens collected from the Reis Crater in Germany........... 65

Figure 2b: A sample of garnet peridotite (a piece of the earth’s mantle) collected by Dr Droop from Alpe Arami (Central Alps), during fieldwork (specimen TCL3). ................................. 69

Figure 2c: Samples sent back from field collecting in the Alps, showing bags marked with references. ............................................................................................................................................. 71

Figure 2d: A sample of the original sillimanite schist from the University of Leeds teaching collections. ........................................................................................................................... 74

Figure 2e: One of the three samples of sillimanite schist, collected by Bob Finch for the teaching sets at the University of Leeds. ............................................................................................................................................. 75

Figure 3a: Table showing collection ‘types’ at the case study institutions. ........................... 83

Figure 3b: Table explaining collection ‘types’ identified at the case study institutions........ 85

Figure 3c: Diagram illustrating the key events in the development of the collections at the University of Cambridge. ............................................................................................................................................. 93

Figure 3d: Entries in the Manchester Museum’s accessions register. ................................ 102

Figure 3e: Hand specimens of Andesite from the teaching collection at the University of Leeds. All of the specimens are numbered 12863. ................................................................. 104

Figure 3f: Thin sections from the teaching collection at the University of Leeds. All slides share the number of the corresponding hand specimen. ................................................................. 104

Figure 3g: Amber specimen (LL.15963) (photograph © Manchester Museum) .................. 105

Figure 3h: A piece of limestone (object) containing numerous fossil crinoid species (specimens) at the Sedgwick (arrows point to specimen numbers). .................................................. 106

Figure 3i: The Sedgwick’s full palaeontology store in the Brighton Building. ...................... 109
Figure 3j: The Sedgwick’s active store in the Brighton Building...............................109
Figure 3k: A drawer containing material from the Johnston-Lavis collection at UCL........110
Figure 3l: Teaching material stored in the teaching laboratory at UCL .........................112
Figure 4a: Table summarising teaching and learning provision at the case study institutions.120
Figure 4b: Trilobite with antlers (LL.12482) (© The Manchester Museum).....................122
Figure 4c: A set of sedimentary rocks used during ‘Understanding the Earth’ practical at LJMU
as surfaces to examine....................................................................................................123
Figure 4d: Haematite used as samples for testing during ‘Geological Materials’ practical at
Leeds. ................................................................................................................................126
Figure 4e: Metamorphic rocks and thin sections used during ‘Sedimentary and Metamorphic
Petrology’ practical at Leeds, as sets for interpretation...................................................127
Figure 4f: Combination of objects and information used during Manchester Museum’s Dinosaur
Detectives session as sets for interpretation.................................................................128
Figure 4g: Health Rocks at the Manchester Museum, displaying poetry alongside minerals and
rocks that were used as objects for inspiration.............................................................130
Figure 4h: Diagrams illustrating the four research functions of earth science objects,
highlighting the relationship between objects, techniques, practices and outputs...........133
Figure 4i: Diagrams illustrating the chronological arrangement and routes around galleries..142
Figure 4j: ‘Stan’ the life-size replica T-rex skeleton, in the Fossils Gallery at the Manchester
Museum. ............................................................................................................................143
Figure 4k: Display of fossils in the mahogany wing of the Sedgwick Museum, showing variation
at a glance. ..........................................................................................................................144
Figure 4l: Arrangement of fossils attached to wooden tablets, at the Sedgwick.................145
Figure 4m: ‘A Crucial Difference’ at UCL showing aesthetic arrangement of microfossil slides.
...........................................................................................................................................146
Figure 4n: Mineral display in the Sedgwick’s Whewell Gallery minerals aesthetically in order to
illustrate colour variation...............................................................................................147
Figure 4o: Display in the Sedgwick’s Whewell Gallery in which minerals are displayed
according to their chemical groups.................................................................................147
Figure 4p: Annotated specimen in the Sedgwick’s mahogany wing..................................149
Figure 4q: The use of diagrams in order to enhance specimens in the Sedgwick’s mahogany
wing....................................................................................................................................149
Figure 4r: The use of diagrams and the arrangement of objects in the Sedgwick’s mahogany
wing....................................................................................................................................149
Figure 4s: The combination of objects, diagrams and text in the Sedgwick’s mahogany wing.
...........................................................................................................................................150
Figure 4t: A display in the Sedgwick’s oak wing combining an object, text, a model and an
image in order to support the visitor’s interpretation of a fossil ecosystem assemblage. .150
Figure 4u: The use of photography in the Sedgwick Museum’s oak wing, showing the
combination of object and labelled photograph to highlight particular features of a
specimen (perhaps the modern equivalent of strategies shown in 4p and 4q). ...............151
Figure 4v: A display in the Fossils Gallery at the Manchester Museum combining various specimens, models, diagrams, maps, images, and text.................................................................152

Figure 4w: ‘Alfred Harker’s Workspace’ in the Sedgwick’s Darwin the Geologist exhibition, showing the combination of objects and props.................................................................153

Figure 4x: Table showing Falk and Storksdieck’s (2005: 122-3) factors that affect learning in the museum. ..............................................................................................................................156

Figure 5a: Diagrams illustrating the common trajectories along which objects circulate within the case study institutions........................................................................................................161

Figure 5b: Basalt specimen from the Beagle Collection. ..............................................................162

Figure 5c: Diagram illustrating the movement of material as part of the research process. (interview with G. Droop 10/11/10). ..................................................................................167

Figure 6a: Far from being inert, this photograph shows what can happen when we turn our backs. Here an object containing the mineral pyrite has been stored in damp conditions. As a result, the object has started to burn a whole in the bottom of the drawer (photograph taken at Southport Museum). ........................................................................196
Abstract

As an academic discipline, the earth sciences generate, use, and retain vast quantities of objects. This ‘material archive’ exists, first and foremost, as a functional scientific resource; the objects that it contains were never intended to express culture. Since the earth sciences rely heavily on claims that its objects of study remain the same as they were in nature, it follows that the specimens contained in university earth science collections are treated as objective scientific evidence. In this sense, the material that is collected, used and retained by earth scientists may appear to be devoid of culture – passive, inert and neutral.

This thesis sets out to challenge these assumptions by treating university earth science objects and collections as material culture. In material culture studies, geological materials appear in a variety of different forms and contexts, however, such work has tended to focus on either their occurrence in the landscape, or their use as raw materials from which objects are made. Thus, while the earth sciences provide an abundant source of ‘material’ for material culture studies, rarely (if at all) do they seem to provide the culture. Furthermore, while the treatment of ‘natural’ objects as cultural artefacts has become increasingly popular in museology, much of this work has concentrated on the processes and practices that are enacted on these things in museums. Museology has therefore tended to consider these things in what effectively corresponds to their retirement, meaning that with few exceptions, little attention has been paid to their active use as functional scientific objects.

This research explores the implications of treating university earth science objects and collections as material culture through the empirical investigation of contemporary object-related practices in UK earth science departments and university museums. As such this thesis addresses questions surrounding the relevance of existing theories and methods, in both material culture studies and museology, for exploring natural scientific objects and collections. These questions are approached through four thematic chapters concerned with the coming into being of earth science objects, their transformation into collection items, their functions, and their mobility.
Declaration

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Acknowledgements and Dedication

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A note on the Author

This research has grown from both my academic background and over ten years of experience of working in the museum sector.

I graduated from the University of Manchester in 1999 with a degree in Geography / Geology. In 1999, I undertook the University of Leicester’s Museum Studies masters course (distance learning), and in 2007, I returned to the University of Manchester in order to embark upon a (part time) PhD. By undertaking both my masters and PhD on a part time basis, I have been able to develop my professional career in the museum sector, alongside my academic career.

I started my museum career at Lancashire County Museum Service as Assistant Curator of Geology (2000-2003), and then Lifelong Learning and Outreach Officer (2003-2005). In 2003 I was awarded a Winston Churchill Traveling Fellowship, which allowed me to spend 6 weeks in a variety of North American Museums. I have subsequently worked in a variety of different roles in the museum sector, both curatorial (as Curatorial Assistant at the University of Manchester’s School of Earth, Atmospheric and Environmental Sciences) and educational (as Lead Educator for Primary Science at the Manchester Museum, and where I continue to work as a freelance educator). I have also been involved in a number of projects on a freelance basis, for example at Leeds City Museum (2005-2008) where I developed the geological elements of the new galleries, and more recently at Southport Botanical Gardens Museum where I am currently working as a freelance curator. Between 2010-11 I was involved in the ‘New Light on Old Bones’ project (funded by Renaissance North West), both in the re-interpretation of Rossendale Museum’s natural history gallery, and through my involvement in the main research project concerned with the development of innovative and practical approaches to using the natural science collections at Blackburn and Rossendale Museums.
This research sets out to explore the implications of treating university earth science objects and collections as material culture through the empirical investigation of contemporary object-related practices in UK earth science departments and university museums. This thesis, then, is about natural objects. It is not, however, about all natural objects, but is concerned with one particular group thereof - earth science objects - that are located in one particular type of institution – the university. In focusing on university collections in particular, it has become increasingly apparent that the terminology used to describe and define academic disciplines is often inconsistent with that which museums use to classify the subject matter of collections. While this can, in part, be attributed to the complex and interconnected histories of the natural science disciplines, the distinct ways in which museums and universities define and distinguish between different groups of natural objects (and knowledge) also highlight their growing independence as different types of institution. Before I continue, it is vital to clarify some of the terminology that I use throughout this thesis so as to avoid any confusion surrounding the scope of this research.

I use ‘natural science’ as an umbrella term for those scientific disciplines and collections concerned with nature, both biological and physical. Within the natural sciences, and specifically with reference to the academic context, I use the term ‘earth sciences’ to describe both objects - rocks, minerals, and fossils (and collections thereof) – and disciplines - petrology, mineralogy and palaeontology, amongst others. Indeed, within the academic context, the earth sciences must be understood as entirely separate from the biological sciences and their corresponding zoological and botanical objects and collections, which I refer to as ‘natural history’. However, while my use of the term ‘earth sciences’ is made with reference to a distinct contemporary academic discipline that emerged during the latter part of the twentieth century, in much of the literature originating from the museum sector, the term geology remains in relatively common use. Therefore, I use the term ‘geology’ when referring to museums, objects and collections that are not specifically academic, or to the subject prior to the emergence of the earth sciences.

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1 During the 1990s, Cato attempted to quantify the extent to which these terminological ambiguities had permeated the museum sector, concluding that “there was not a consensus among the museums on the meaning of natural history relative to natural science” (1994: 259).
2 See, for example; Guntau (1996), Jardine (1996), Rudwick (1996b), and Nyhart (1996). It is worth noting that literature concerning the historical development of what we now know as ‘the earth sciences’, necessarily makes use of a variety of different terms (such as natural history and geology) to describe the discipline at various points of its evolution (see; Laudan 1987: 229 for example).
3 According to the Federation for Natural Science Collections Research (FENSCORE), natural science collections combine the areas of botany, zoology and geology (see website: Pettitt 1999).
4 The division between the earth and biological sciences in academia corresponds to the that between geology and natural history that divides natural science collections within UK museums, as is apparent from the existence of the Geological Curators Group, which is concerned with geology collections, and the Natural Science Collections Association, with the remit of natural history collections.
This research is about the rocks, minerals and fossils that are found in both academic departments and campus museums, and therefore aims to contribute to our understandings of museums and collections, in particular the growing field of research concerned with ‘museum nature’. However, this thesis is not just about museums and neither, for that matter, is it just about collections: it is also about objects, whether or not they form part of a formal collection. In focusing on university earth science objects and collections, this research is also about science and the scientific processes and practices in which earth science objects are involved. Therefore, this research is also about objectivity, authenticity and natural knowledge; it is - as the title suggests – about material culture (see: Figure 1a). As well as considering the opportunities that emerge from extending material culture theory to university earth science objects and collections, I am also interested in its limitations. It follows that thesis is not only about what we can learn about these things by treating them as material culture, but is also concerned with what this exercise reveals about material culture theory itself. This research, to borrow from Alberti, is about “relationships between people and people, between objects and

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5 Alberti uses the term ‘museum nature’ with reference to “the practices of collecting, preservation, and displaying certain things – animals, plants, fossils and rocks – and the conceptual and exhibitionary frameworks in which they are set” (2008: 74). For a detailed account of the origins and growth of interest in museum nature within the history of science, science studies and museology, see Alberti (2008: 73-77 in particular).
objects, and between objects and people” (2005: 561). In exploring these relationships, this research is of interest to those who work with objects and collections – from curators to scientists - as well as those who theorize them. Before I continue, it is useful to introduce how this research came about.

I first encountered material culture studies a number of years ago whilst undertaking the University of Leicester’s museum studies course. While much of the course covered generic practical matters, I found the more theoretical aspects of the course rather challenging because they were almost entirely concerned with art, archaeology, social history and ethnographic objects and collections. Indeed, this bias was acknowledged within the literature, as is apparent from Susan Pearce’s observation about one of the core readings for the material culture module:

it must be admitted that the great majority of the texts here [in this edited volume] are written in terms of artefactual rather than natural materials and acknowledgement of natural science specimens is only, as it were, by the way (1994: 1).

Thus, while the course materials for such modules occasionally made reference to natural science objects and collections (for example, see Pearce’s (1992: 30) semiotic analysis of a magpie), there was an assumption that all museum objects and collections could be treated and theorized in the same way. In fact, Pearce explicitly states this assumption in the introduction to another core text for the material culture module:

It is clear that the acquisition of a natural history specimen involves selection according to contemporary principles, detachment from the natural context, and organization into some kind of relationship (many are possible) with other, or different material. This process turns a ‘natural object’ into a humanly-defined piece, and means that natural history objects and collections, although like all other collections they have their own proper modes and histories of studies, can also be treated as material culture and discussed in these terms (1992: 5-6).

This, however, seemed problematic. If natural science objects could be treated as material culture, why was it that they had not received more attention as such? Why were they rarely included as examples in the course material and literature? And why did it feel so difficult to simply accept that – to quote Pearce again - “natural history specimens are… as much social constructs as spears and typewriters and as susceptible to social analysis” (1992: 6)?

A year into the course, I started my first job in the museum sector in the role of ‘assistant curator of geology’ within a large local authority museum service. Over the five years that I worked there, I gradually came to understand Pearce’s point because in many ways, the objects with which I was working could just as easily have been spears or typewriters; in spite of their ‘geological’ origins, they were primarily used and valued as local and social history items. However, when I started working with a collection of minerals in an academic department, I found that the uses and treatment of the objects were so starkly different from those that I had

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6 I undertook the course via distance learning between 1999-2002 having decided upon a career as a geological curator.
experienced previously, that the idea that even these two types of collections could be
understood and theorized in the same way seemed problematic, let alone that these ‘scientific
objects’ could be understood on the same terms as artefacts such as spears and typewriters,
simply on account of their existence within a collection. And it was with that matter in mind that I
returned to academia.

On returning to academia, it soon became apparent that in the five years that had
passed since I completed my masters course, material culture studies had undergone a
substantial change, and interest in natural objects and collections – ‘museum nature’ - both
within museology and the history of science had started to flourish. However, and in spite of
this, contemporary collections of earth science objects in general, and those within academia in
particular, remained largely untheorized. This lack of attention became all too apparent when I
attended the ‘Nature Behind Glass’ conference, which promised to attend to ‘historical and
theoretical perspectives on natural science collections’.

Likewise, since my first encounters with the discipline, museology had “expanded and
pluralized” (Macdonald 2006c: 5) into a “rich, hybrid terrain” (Carbonell 2004a: 2). Nonetheless,
and in spite of growing interest in ‘museum nature’, the “vast bulk” (Conn 2010: 5) of theoretical
work continued to focus on cultural collections. According to Conn, this should come as no
surprise since; “[art and anthropology] lend themselves most readily to the kinds of analysis
scholars want to impose on them” (2010: 5). Furthermore, and in response to calls for a ‘New
Museology’ (Vergo 1989: 3), the volume of literature concerned with “museum theories,
practices, policies and history” (Dubuc 2011: 501) had grown considerably. However, this shift
in emphasis had tended to polarize the division between the practical work of museums (the
day-to-day work of directors, registrars, curators, conservators, educators, amongst others) on
one hand, and the theoretical world of academia (the more abstract worlds of cultural theorists,
sociologists, historians and philosophers, amongst others) on the other (c.f. Conn 2010: 4; Starn
2005: 70). Thus it would appear that, in spite of the development of museology into “one of the
most genuinely multi- and increasingly inter-disciplinary areas of the academy today”
(Macdonald 2006c: 1), it still remained unrepresentative of the field as a whole.

By applying the theories and methods of material culture studies to university earth
science objects and collections this research is, in some ways, a natural extension of a number
of existing areas of research. Indeed, in material culture studies, there is a significant body of

7 ‘Nature Behind Glass’ took place at the University of Manchester from 6th – 8th September 2007 (see website: Centre
for Museology 2007). A selection of papers (Alberti 2008; Chaplin 2008; Ellis 2008; Patchett and Foster 2008;
Poliquin 2008; Rader and Cain 2008) were published in a special issue of Museum and Society.
8 This is apparent from the content of (and the need for) edited volumes, of which Carbonell’s Anthology of Contexts
(2004b) and Macdonald’s Companion to Museum Studies (2006b) are just two examples.
9 While the ‘old museology’ was critcised for its focus on museum methods, the ‘New Museology’ was to focus on
theorizing the purpose of museums (Vergo 1989: 3).
literature that considers geological materials, and as I suggest in the next section, my research builds on the methods and concepts that run through such work. In section 1.2 I consider the traditional exclusion of natural objects from material culture studies before moving on, in section 1.3, to consider the scope and methods of contemporary material culture studies. In section 1.4 I introduce the geological tradition and subsequently critique a number of assumptions that have emerged from the existing literature surrounding earth science (geological) objects and collections. Section 1.5 highlights the contribution that I am able to make on account of focusing on university earth science objects and collections, and in section 1.6 I set out the aims and objectives of this research, the structure of this thesis, and describe the methodology that I have adopted.

1.1. Set in stone? 10

It is difficult to think of earth science objects without succumbing to their associated connotations of hardness. Indeed, links between geological materials and notions of durability, strength and immutability, have become part of our everyday language; the massy and tenacious qualities of rocks, minerals and fossils are implicit in words such as concrete, cement, gritty, adamant, crystallization, and petrify, for example. Likewise, these things force us to exert ourselves (particularly when we must leave no stone unturned), they constrain us (when we write or carve in stone), and they also obstruct (such as when we are stone-walled). They are hard (rock hard), cold (stone cold) and firmly rooted (stone still); they are foundational (bedrock) and sturdy (cornerstone), and they represent the genuine article (touchstone).

Because the hardness and durability of these materials permeates our everyday language, it has become natural to assume that they are both physically and ontologically stable, and it is precisely these qualities that make them suitable metaphors for all that is solid. Daston, for example, considers the ‘folklore’ that associates modern facts with rocks, explaining that:

Rocks are… the very essence of the trivial, and therein lies their charm as the prototype of facts. No one cares about them one way or another, and indifference chimes in with the fabled neutrality of facts. Rocks are also easily distinguishable from one another, another desideratum for the ideal fact, which must somehow be chiselled out of the continuum of experience. The texture of facts is granular and discrete like pebbles on a beach, not smooth and flowing like water. Otherwise, facts wouldn’t be listable…rocks are given, not made. They epitomize discovery, as opposed to invention, a world that is found rather than fabricated (2005: 681).

Likewise, Hacking has observed that; “When thinkers… want to say that something is real, they resort to rocks” and as he goes on to explain, rocks are “what some distinguished thinkers seem to regard as the most unquestionable reality” (1999: 192). These metaphorical associations are not restricted to the modern Western world, as is apparent from the work of anthropologists who have linked the use of stone in certain cultures – particularly in Australia (Taçon 1991) and

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10 The terms ‘stone’ and ‘rock’ are taken to refer to all geological materials (rocks, minerals, and fossils).
Madagascar (Bloch 1995) - to its power to symbolize wisdom and immortality (Boivin 2004a: 7-9). Archaeologists too have increasingly recognized the relevance of this work on the symbolic qualities of stone, to their own interpretations of the past (ibid: 6), with stone monuments providing a popular focus (on Stonehenge see, amongst others Bender (1998), Parker-Pearson (2004), and Parker Pearson et al (2006), and see Foster and Jones (2008) and Jones (2010; 2011) on the Hilton of Cadboll cross-slab).

However, and as anyone who has held a piece of pumice will know, not all rocks are heavy; indeed, neither are they all rigid, as becomes all too apparent when trying to carry a sheet of flexible sandstone. Furthermore, the durability of these things is also questionable, as we discover when we pick up a pyrite-ridden fossil, only to see it crumble to dust in front of their eyes. Neither is the hardness of these things without exception, particularly when it comes to the almost fluffy fibrous asbestos minerals such as Chrysotile (see: Figure 1b). While such cases may be treated as exceptions to the rule, my point is that when all geological materials are assumed to be heavy, rigid, durable and hard, we overlook the nuances that make these things interesting, as light and airy, flexible, evanescent, and fluffy. Likewise, the assumption that such weighty, obdurate, resilient and robust qualities can simply be extended to earth science objects on an ontological level is equally problematic.

In spite of their cumbersome and unyielding qualities, these things are of interest to a variety of disciplines. Indeed, that geological materials provide a fruitful area for investigation as material culture is apparent from their consideration by authors writing on themes ranging from globalisation, folklore, and urban networks of materiality, to commodity chains, literature, heritage monuments and mythology (see respectively; Braun 2000; Duffin 2007; Edensor 2009; Ferry 2002; Heringman 2004; Jones 2011; Mcnamara 2007). Studied as material culture, there is a common belief that:

Figure 1b: Chrysotile specimen (2603) from the Harwood Mineral Collection (SEAES), showing fluffy asbestiform texture.
…stones always have meanings and relationships extending beyond themselves. They are not replete unto themselves. They are always more than themselves; in a process of becoming rather than a static state of being (Tilley 2004: 222).

However, those who are interested in the meanings and significance of these things and the ways in which they are encountered and experienced, have tended to focus on their occurrence either within the landscape (amongst others see: Massey 2006; Tilley 2004; Tilley et al. 2000), or as raw materials from which objects are made (see, for example; Boivin and Owoc 2004; Brumm et al. 2006; Kinsey 2009; Robb 2009). In this sense, it would appear that while the earth sciences provide an abundant source of ‘material’ for material culture studies, rarely (if at all) do they seem to provide the culture (but see; Knell 2000 for example). In focusing on university earth science objects and collections, this research is concerned with a particular group of geological materials – namely those of a natural scientific kind – that have largely been overlooked in material culture studies. As such, this research contributes to material culture studies by offering an entirely different perspective for understanding the uses, meanings, and values of geological materials.

1.2. A natural exclusion?

In material culture studies, the emphasis on geological materials as raw materials or landscape components reflects a tradition in which it has been precisely the ‘naturalness’ of natural objects that led to their exclusion from the discipline. After all, a prerequisite for the ‘material’ of ‘material culture’ studies was that the objects were ‘made or modified by man’, as Prown explained in his Introduction to Material Culture Theory and Method:

The word material in material culture refers to a broad, but not unrestricted, range of objects. It embraces the class of objects known as artefacts – made by man or modified by man. It excludes natural objects. Thus the study of material culture… would exclude trees, rocks, fossils, skeletons… (1982: 2).

Therefore, in order to justify the treatment of university earth science objects and collections as material culture, the most fundamental objection – that of their ‘naturalness’ – requires further consideration. Here, it is useful to briefly turn to archaeology, where the distinction between natural objects and those made by humans is fundamental.

For archaeologists, as Hurcombe explains, “it is essential to recognise whether an object has been modified by humans, or is simply a fortuitously shaped piece of natural material” (2007: 4). In order to determine whether an object is ‘archaeological’, it is therefore necessary to distinguish between ‘cultural’ materials (altered and moved by humans) and ‘natural’ materials (altered and moved by natural processes).11 If we apply this principle to the earth sciences, it is clear that a similar distinction can be made between earth science

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11 For example, terms such as ‘manuport’ (unaltered natural objects that have been moved by people) (Hurcombe 2007: 5; see also: Oakley 1981) and ‘geofact’ (natural objects that resemble artifacts) (Haynes 1973: 305; see also: Peacock 1991). See also Ingold’s consideration of ‘artefacts’ versus ‘naturefacts’ (1986: 52-55), and Yarrow (2003) and Goodwin (2010) on the ways in which archaeologists distinguish between natural and cultural artefacts in the field.
specimens (that have been selected, modified and moved (collected) by humans) and material that remains in situ (geological materials and features ‘in nature’ that are moved and altered by natural processes). Thus it would appear that the traditional exclusion of earth (and other natural) science objects from material culture studies has overlooked the element of ‘modification’ that takes place when an earth scientist removes a piece of rock from an outcrop, or selects a sample to analyse.

Field collecting is a human activity and therefore, collected specimens and samples are unavoidably steeped in the conventions, beliefs and intentions of the individual collector and the context in which they are collecting. Acknowledgement of this, however, leads to questions surrounding the extent to which ‘natural’ objects, on account of being collected / found, can be understood on the same terms as collected / found ‘cultural’ artefacts (such as those of interest to archaeologists),\(^\text{12}\) or whether their ‘naturalness’ - the fact that these objects are ‘natural’ and become ‘cultural’ through the collecting process - sets them apart from other types of material culture.\(^\text{13}\) That this matter has not yet been fully resolved is apparent from the lack of consensus in the literature. In museology, for example, while Susan Pearce suggests that, on account of the processes of selection, detachment and organisation, all museum objects (whether natural or not) should be treated in the same way (1995a: 18), for Alberti: “there is something particular about natural specimens in museums that distinguishes them from other, more obviously crafted things” (2008: 79).\(^\text{14}\) While this matter is clearly of interest to those who work with and manage collections of natural objects, by raising and addressing these questions, this research is also of interest to archaeologists, anthropologists and natural historians, all of whom must ‘collect’ their objects of study from ‘the field’ (c.f. Kohler 2007 who refers to these disciplines as ‘the collecting sciences’).

1.3. Matters of meaning: material culture

While I do not intend to write (another) history of material culture studies, suffice is to say that particularly since the 1920s, material culture studies have undergone various ‘shifts’ and ‘turns’ (see: Tilley \textit{et al} (2006) for a brief historical overview, and Hicks (2010) for a more critical account). Broadly speaking, contemporary material culture studies “involve the analysis of a domain of things, or objects, which are endlessly diverse” and as Tilley \textit{et al.} continue, may include “anything from a packet of fast food to a house to an entire landscape, and either in the past or in the present” (2006: 3). From this statement it becomes clear that the distinction between ‘nature’ and ‘culture’ is no longer central to defining the material of interest to material culture studies. However, with objects of study as diverse as fast food packets and landscapes, what is contemporary material studies actually about?

Contemporary material culture studies may take as their principal concern, and starting point for analysis, particular properties of objects or things: things as material matter, as found or made, as static or mobile, rare or ubiquitous, local or exotic, new or old,

\(^\text{12}\) See: Lucas (2010: 244) on the distinction between found and given objects in archaeology.
\(^\text{13}\) In asking such questions, it becomes clear that ‘naturalness’ is not a natural category, but is itself culturally made.
\(^\text{14}\) Precisely what it is that sets them apart is, however, left open by Alberti.
ordinary or special, small or monumental, traditional or modern, simple or complex. Alternatively, material culture studies may take the human subject or the social as their starting point: the manner in which people think through themselves, and their lives and identities through the medium of different kinds of things (Tilley et al. 2006: 4).

So if material culture constitutes things (c.f. Tilley et al. 2006: 4) / objects (c.f. Woodward 2007: 14) / stuff (c.f. Miller 2010: 1), then material culture studies are about relationships between these things / objects / stuff and people. But how does one ‘do’ material culture studies? Unfortunately, this seemingly simple question requires a rather more complex response, largely on account of the interdisciplinary nature of material culture studies.

Before I explore the matter of interdisciplinarity in more detail, it is important to acknowledge that how one does material culture studies is also related to how one understands the relationship between people and objects. Indeed, and largely growing from a feeling that traditional dualistic conceptions inadequately account for the complexity of the world, the precise nature of this relationship has itself become the focus of considerable debate. Responses to this challenge have been many and varied, ranging from those who attempt to blur the boundaries that have traditionally been drawn between subjects and objects, humans and non-humans, and mind and matter, to those who have proposed a more radical course of action that involves doing away with such categories and divisions altogether. While this matter remains unresolved, it is nonetheless important to acknowledge that precisely what it means to ‘do’ material culture studies depends upon the way in which this relationship is configured.

1.3.1. On being interdisciplinary

As a field of research transcending established disciplines material culture studies are always changing and developing, redefining both themselves and their objects of study, cross-fertilizing various other ‘disciplined’ ideas and influences: impure, contingent, dynamic (Tilley et al. 2006: 1).

According to this quote, material culture studies can be understood as a means of exploring people-thing relationships in an interdisciplinary and flexible way. There is, however, a fine line between being interdisciplinary and becoming undisciplined, and while Miller and Tilley for example, have advocated a lack of discipline as a way of opening up new areas that have otherwise been overlooked (1996: 13), others are perhaps more cautious (see: Hicks (2010: 94-8) for example). But must one side with either disciplinary knowledge and respect, or the innovation and flexibility that is offered by interdisciplinarity? Can one not be both disciplined and interdisciplinarily? This research is based on the assumption that such a balance is entirely

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15 For a lively example, see Ingold’s (2007b) ‘Materials against Materiality’, and the responses that it received (Knappett 2007; Miller 2007; Nilsson 2007; Tilley 2007).
16 This undertaking is variously described as overthrowing the “modern Constitution” (Latour 1993), dissolving “onto-theological binaries” (Bennett 2010: x), and rebalancing the Western hylomorphic model of creation (Ingold 2009).
17 This is apparent from the variety of terms that are used to describe the relationship between people and objects, ranging from ‘networks’ (Callon 1981; Callon and Latour 1981; Latour 2005), ‘assemblages’ (Deleuze and Guattari 1987; Deleuze and Parnet 1987; DeLanda 2006) and ‘meshworks’ (Ingold 2006; 2009) to ‘rhizomes’ (Deleuze and Guattari 1987; Ingold 2008a; Latour 1999c) and “entanglements” (Hodder 2011; 2012; Thomas 1991).
possible – necessary, even (as I consider below). That is not, however, to suggest that such an approach should not be undertaken with caution, since interdisciplinarity “is always as risky as it is rewarding” (Knappett 2011: 214). As Olsen explains with reference to what he calls ‘theoretical bricolage’:

…open-minded and risky theorizing is not a plea for the ignorance of strong intellectual traditions and the hard work that has made them successful. Avoiding swearing allegiance to this or that theoretical regime is not to say that we should be unconcerned with their content and their integrity or that any use or representation of them is acceptable. Thus, defending eclecticism does not mean defending more versions of "anything goes" (2010: 14).

In extending material culture studies to university earth science objects and collections, this research is, by its very nature, interdisciplinary and experimental, and as such, relies upon a flexible and open approach rather than one that is constrained by disciplinary divisions. Before I even venture into material culture studies, by focusing on both collections and objects as they are encountered in museums and departments, this research has no single disciplinary allegiance since it straddles museology and science studies (both of which are interdisciplinary). This thesis therefore builds on- and experiments with- various concepts and methods from disciplines such as museology and science studies, as well as anthropology, archaeology, geography, the history of science, and other social sciences, and while I have acknowledged and attempted to minimise the risks of interdisciplinarity, I believe that they are outweighed by the potential rewards.18

This research is not without its challenges. As mentioned above, I draw heavily on existing work from museology and science studies in which both the materials and cultures of the sciences are explored. However, the point at which these two disciplines overlap with material culture studies does not constitute a distinct (or even coherent) body of work, but rather situates this research amongst a variety of different (often conflicting) theories and methods. To illustrate this, I will focus on the matter of ‘agency’ and in the following two sections I briefly present two contrasting disciplinary responses to the matter of agency,19 before briefly highlighting some of the most recent themes to emerge from material culture studies.

1.3.2. Agency in museology

While museology encompasses a diverse range of different perspectives and methods, I focus here on a particular understanding of agency that has its origins in the work of Kopytoff (1986) and Appadurai (1986), and which has largely grown from Gosden and Marshall’s *The Cultural Biography of Objects* (1999) in which they apply these concepts to the museum.

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18 As well as carrying out an extensive and detailed review of the literature continuously throughout the duration of this research, the risks associated with interdisciplinarity have also been minimised through ongoing consultation with and feedback from both my supervisors and panel whose expertise and backgrounds cover disciplines including museology, social anthropology, archaeology, history of science, science communication and the earth sciences, and the application of such disciplinary knowledge both theoretically and practically.

19 To clarify, these two examples are not necessarily representative of the disciplines as a whole, but have rather been selected in order to illustrate the diversity of opinions.
The central idea [of the object biography] is that, as people and objects gather time, movement and change, they are constantly transformed, and these transformations of person and object are tied up with each other (ibid: 169).

In this view, objects are integral to human action, rather than just providing a "stage setting" (ibid.). Objects are not, however, attributed agency. For example, Gosden and Knowles "want to include things as a central element in [their]…social analysis" but feel that "any use of the active voice when describing objects must be suspect" (2001: 22). Similarly, in considering what the ‘biographical approach’ can add to our understandings of ‘objects in the museum’, Alberti makes the following statement:

I do not attribute too much power to the things themselves. To do so would be to diminish the agency of the humans in the story – things did not act in their own right but, rather, material culture was acted upon… Objects prompted, changed, and acted as a medium for relationships but were nonetheless inanimate (2005: 561).

While such work goes as far as ‘acknowledging’ the roles of non-humans, the central position of humans can be seen to align these authors with Gell’s work in which (art) objects are treated as “secondary agents” (1998: 17). For Gell, ‘primary agents’ are “entities endowed with the capacity to initiate actions/events through will or intention” and in this sense, can be understood as broadly referring to humans. ‘Secondary agents’, on the other hand, are “entities not endowed with will or intention by themselves but… [instead] they borrow their agency from some external source, which they mediate and transfer…” (ibid: 36). While agency, in the ‘Gellian’ sense, is a human capacity that may be ‘borrowed’ by objects or distributed to objects by humans, it nonetheless remains external to them. In science studies, agency is understood in rather different terms.

1.3.3. Agency in science studies

Until relatively recently, philosophical, historical and social accounts of science had largely focused on science as a field of knowledge whereby “theory (rather than empirical, factual knowledge) was always at the centre of attention” (Pickering 2010: 192). However, since the 1970s, a growing interest in ‘science as practice and culture’ (to borrow from the title of Pickering’s (1992) edited volume), has generated a vast and diverse body of work that falls under headings such as ‘the sociology of scientific knowledge’ (SSK), ‘the social construction of technology’ (SCOT), and ‘science, technology, and society’ (STS).20 For the purposes of my own research, the body of work falling under the broad heading of ‘material semiotics’,21 has been particularly influential, and therefore, provides a useful focus for considering the matter of agency within science studies.

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20 Law (2010: 173-8) clarifies these distinctions.
Material semiotics is largely defined by two key principles; ‘relational materiality’ and ‘performativity’ (c.f. Law 1999: 4 in Bennett 2002: 36). The basic premise of material semiotics is that it treats “everything in the social and natural worlds as a continuously generated effect of the webs of relations within which they are located” and, as Law goes on to explain, it does this by describing “the enactment of... relations that produce and reshuffle all kinds of actors including objects, subjects, human beings, machines, animals,” “nature,” ideas, organizations, inequalities, scale and sizes, and geographical arrangements” (2009: 141). In this sense, and considering the variety of different ‘actors’ that may be involved, it is clear that as far as agency is concerned, material semiotics, as a method, does not privilege the human – neither, for that matter, does it simply shift ‘the ability to do things’ from humans to non-humans (Latour 2005: 72) - but rather, leaves the matter “entirely open” (Callon and Latour 1992: 361).

From this common starting point, there are various different conceptions of agency within material semiotics. Thus, while Pickering describes agency as “emergent in the brute sense of being unknowable in advance of specific performances” (2010: 195), for Barad - who prefers to talk about agential intra-actions (2003: 803) - “agency is not an attribute but the ongoing reconfigurings of the world” (ibid: 818). In spite of these variations, there is a common understanding that agency is more of an emergent effect than an attribute. While agency, in the Gellian sense, is synonymous with intentionality and therefore originates in humans, in material semiotics, agency is more about the capacity to act, to quote Latour, it is “not [simply] a property of humans but of an association of actants” (1999b: 182).

While this section has only touched the tip of the iceberg as far as the variety of different methods and approaches to contemporary material culture studies (and agency) are concerned, at the very least, I hope to have highlighted both the challenges and rewards that arise from interdisciplinary research. I will now, however, move away from material culture studies to focus on some of the more traditional ways in which earth science objects and collections have been presented in the literature, before identifying some of the more problematic assumptions on which they are based.

1.4. The geological tradition

The British legacy to geological science is not purely an abstract inheritance, it is a material one too and because geology is a science of observation, the mass of rock, fossils, and minerals is not a by-product of developing concepts but part of the very stuff of them (Doughty 1981 in Fothergill 2005: 56).

For earth scientists, the durability of their objects of study – their particular materiality – is fundamental to the science. Indeed, it is precisely because their temporality far exceeds that of humans, that these objects are so vital; functioning as witnesses to- and evidence of- events and processes that we can never experience for ourselves. In this sense, their power lies in their ability to make the past present. Due to their origins in outside nature (as opposed to the nature that is constructed within institutions ranging from universities to museums), these things
are deemed to be truthful - reliable evidence - with the authority to speak, as material witnesses, of the facts of nature (c.f. Dahlbom 2009). In this sense, the job of the earth scientist is to make ‘silent stones speak’.

Attempting to understand university earth science objects and collections as material culture has not been a simple task. In fact, there have been many obstacles in my way, not least the conception of earth science objects as presented by earth scientists themselves: Since the earth sciences rely heavily on claims that its objects of study remain the same as they were in nature, it follows that the specimens contained in university earth science collections are treated as objective scientific evidence – quite literally as “hard facts” (Knell 2007b: 10). However, a consequence of this particular relationship with objects, is that the earth sciences generate, use, and (often) retain vast quantities of specimens, and it is to this matter that I now turn in the next three sections.

1.4.1. Really real (really?)

A common assumption that runs through the literature about earth science collections is that the specimens contained within them are authentic: not representations, equivalents, analogies or examples, but the real thing. For example, with reference to display collections – but equally as applicable to research and education – Jakubowski states that;

…collections of minerals, rocks and fossils are ‘the real thing’ for visitors, in other words, they are ‘natural’ nature objects, different from other natural history museum specimens of the recent living world which are only dead objects torn from their natural environment (1997: 85).

Similarly, Doughty distinguishes geological specimens “from most others in Natural History. Unlike biological specimens they are not merely a convenient but poor substitute for the living organism, but the ideal expression of its nature” (1992: 514). Interestingly, both Doughty and Jakubowski make two similar claims: firstly, they both focus on the fact that geological material was never ‘alive’ to distinguish it from (less ‘real’ / ‘natural’) natural history specimens, and secondly, this leads them to refer to geological material as more ‘natural’ or ‘ideal’. These comments are, however, problematic for (at least) two reasons.

Firstly, and as Frodeman has observed with reference to the earth sciences; “historical entities do not spring into being fully formed, nor do they remain unchanged to the time of their destruction” (1995: 965). Indeed, while rocks and minerals were never ‘alive’ (arguably, fossils were) they were in situ and this implicitly incorporates them in ‘the rock cycle’ whereby change is guaranteed, albeit (often) over vast timescales; they are never static or complete. In this respect, the act of collecting is as destructive for earth science objects as it is fatal for natural history specimens.

Secondly, to suggest that earth science specimens are ‘natural nature objects’ or ‘ideal expressions’ implies that the act of collecting has no effect on the collected objects. The
standard logic behind this type of claim tends to focus on the physical composition of objects, which may be largely unaffected by the process of collecting. Furthermore, the impact of removing material from its in situ occurrence – the loss of context – tends to be glossed over as something that can be overcome by making good field notes. On one hand, these features do set earth science specimens apart from natural history objects, for which ‘being collected’ tends to equate with death, and which may subsequently undergo varying degrees of modification as they are cleaned, preserved, stuffed, dried, mounted etc. However, on the other hand, the suggestion that collected earth science objects are ‘ideal expressions’ of nature, seems to oversimplify the collecting process.

By considering the field collecting in more detail, it becomes apparent that we are dealing with an altogether more complex process. Rudwick, for example, has suggested that the difference between in situ and ex situ is fundamental – at least for geologists in the past - who: “were deeply dependent on what they had seen of these immobile features [strata in situ] with their own eyes, since the mobile proxies for that direct experience were by comparison so inadequate” (1996a: 144). Rudwick’s notion of ‘mobile proxies’ implies that specimens replaced the fixed stratigraphic features that were studied in situ, and considering that he is referring to geologists in the eighteenth and nineteenth centuries, this makes sense. However, while the removal of a sample from its surroundings may constitute the production of a ‘mobile proxy’ for the person who collected it, it is questionable that this concept applies to the specimen once it has entered a museum or collection; surely, for those studying the specimen ex situ, it becomes a valid ‘feature’ in its own right since it no longer substitutes an experience (ibid: 145). Instead, the specimen itself becomes an authentic source of experience. Indeed, Latour’s ‘immutable mobiles’ (1987: 226-227) provide a similar framework, but with the addition of the concept of ‘centres of calculation’, thus acknowledging the importance of a place in which immutable mobiles can be accumulated, compared and classified (Braun 2000: 18).

While Rudwick and Latour both provide satisfactory frameworks that acknowledge the quality of being not exactly the ‘real thing’ so much as an ‘exact representation’ of it, the fact that both authors include images, maps and diagrams in the same group as specimens seems problematic. On one hand, specimens, like maps and diagrams, may visually represent something else. However, what sets specimens apart is the combination of physical and chemical properties that extend the connection between a collected specimen and ‘the real thing’ beyond a purely visual association. It is therefore apparent that geological objects are neither genuinely natural, nor authentically constructed; they are essentially hybrids that have been displaced and transformed. What happens, however, when these hybrids are themselves refined and become the source of material? How does the creation of new specimens from existing ones affect the ‘cultural value’ of specimens? In becoming new objects in their own right, do new ‘sub-specimens’ retain the qualities associated with the originals or do they become a ‘blank canvas’? The insights gained from treating university earth science objects and collections as material culture will begin to address such questions.
1.4.2. Objections to objective objects

The earth sciences are ‘deep-time sciences’ and this means that objects are retained for future use and for reference (see: Henderson 2005: 22; Jackson and Faithful 2003: 45; Jeram 1997: 63; Knell 1997: 13; Kollmann 2005: 113; Kriegsman 2004: 207; Simpson 2003b: 19; Suarez and Tsutsui 2004: 72). Indeed, in peer reviewed journals, there is a formal system requiring that described specimens are deposited in a museum and receive a museum accession number before articles can be published (RIN 2008: 23). This, along with the tendency for certain types of research to generate large collections of material (Arnold-Forster 1993: 45), has meant that in many cases, earth science departments (and their museums) house vast collections of research objects. The continued retention of such objects can therefore be seen to rely upon objects performing the function of what Latour refers to as guarantors for knowledge, in a similar way to footnotes in an article that can be used to trace information to its original source (1999b: 34). As guarantors, objects remain passive, inert and neutral: stable and reliable, and trustworthy.

However, this is not quite as straightforward as it may seem. As Kollmann explains: “scientific assumptions and conclusions have to be reproducible and… material witnesses have to be stored for this purpose” (2005: 13). So far, so good. However, he continues to explain that: “In the earth sciences, collections are necessary for testing earlier hypotheses which may be falsified and replaced by new ones” (ibid.). Understood in these terms, earth science objects appear to perform a rather miraculous feat because they are retained, on one hand, as evidence – guarantors – and on the other hand, as ‘potential’ and ripe for reinterpretation and new meanings. The idea of keeping objects for the purpose of their potential reinterpretation (Clercq 2001: 89; Clercq and Lourenço 2003: 5; 2004; Hutterer 2005: 19; Lourenço 2005: 4; Mack 2001: 34) is in fact (also) central to the presumption against disposal. As Kreigsman explains, the “futurological dilemma has led to a cautionary (or ‘no regret’) principle… stipulating that objects should not be removed permanently where their future use cannot be excluded” (2004: 207). In practice, therefore, earth science objects become problematic because, as Robertson and Meadows observe; “they are the sources of knowledge production, the storehouses of that knowledge, and the means of its dissemination” (2000: 224).

If, however, university earth science collections are understood as material culture, it follows that their assumed existence as passive, inert, and neutral must be called into question. In fact, the extension of material culture studies to university earth science objects and collections – their treatment as more than simply ‘scientific’ specimens – may usefully contribute to the ongoing debates surrounding the sustainability of collecting. As Merriman explains, such debates are leading to the realization that:

…the museums profession has to give far greater attention to the purpose of holding collections in museums than it has before, rather than hiding behind notions of objectivity and permanence as a means of avoiding tackling pressing issues of collections management (2008: 14).

22 Warhurst (1992: 98) considers whether university museums are the most appropriate place to store research material.
1.4.3. Keeping for the future?

Once collected and accessioned, most geological specimens comprise a permanent, (relatively) stable scientific record. This quality is particularly pertinent considering the rate at which new technologies are developing, and the improved precision and sensitivity that they provide. With this in mind, it follows that the intrinsic scientific value of any earth science object is indefinite since it will always be subject to revival, reconsideration and reappraisal arising from the development of new techniques and methods, thus: “Theoretically, the information that can be gained from specimens is unlimited. In reality, it is limited by the fact that it is stored ex-situ, and by the insufficiency of documentation” (Kollmann 2005: 114).

However, if earth science collections are truly believed to be the source of ‘unlimited’ potential, why is it so often the case, that museum collections remain unused? As Keene writes; “It seems entirely justifiable to question why, if these collections are important, are they stored at considerable cost, undisplayed, and unvisited?” (2005: 2). On the other hand, why is it that in academic departments - where earth science objects are (more) actively used - they are not afforded the same degree of security as those in museums? Indeed, and particularly in academic departments, an additional complication arises when preservation is compromised by the ‘consumption’ of specimens in research activities – where the specimen’s ‘information value’ is deemed to be more important than the value of the specimen itself.

Such matters can be usefully explored through existing work in material culture studies, which has recently called attention towards the transience of objects. As DeSilvey explains:

In conventional terms, in order for the object to function as a bearer of cultural memory it must be held in perpetuity in a state of protected stasis. Acts of counting, sorting, stacking, storing and inventory convert things from the category of ‘stuff’ to the status of museum object (2006: 324).

Such attempts to fix, freeze and stabilize objects, as mentioned above, do not necessarily sit well with their use. However, treatment of university earth science objects as material culture provides an opportunity to understand what Rudi Colloredo Mansfield has described as a particular type of materiality that is concerned with “the using up of matter… [rather than] one dependent on permanence” (2003: 252).

There are clearly tensions surrounding the notion of use and permanence that require further consideration, not least the apparent challenge of combining active (and destructive) use (as in academic departments) with preservation and permanence (as in university museums). At this level, however, it is not the physical existence of specimens that is under scrutiny, rather, the assumption that collections should be kept indefinitely for posterity; as Keene notes; “the purpose of collections then, is challenged” (2005: 2). The fact that much of the material stored in university earth science collections remains largely unused, tends to be inaccessible, and is often insufficiently documented, suggests that for many collections, their latent value has failed
to materialize. As a result of the continued growth of collections, shifting expectations, and changes to the ways in which museums are governed, funded and used, the fundamental dilemma facing museums is “whether... the notions of permanence, posterity, set-aside and presumption against disposal of the modernist museum, still pertain?” (Merriman 2008: 13). By exploring the uses, treatment, and values of departmental earth science objects and collections alongside those in university museums, this research may contribute to such debates.

1.5. Taken for granite?

“We took her for granite” a student wrote about his mother. This brilliant mistake renders the intended meaning more poignantly than the correct spelling would. The hard / rock / granite quality resonates what it means to be underestimated, not valued, taken for granted. Furthermore, “taking someone for granite” implies that she is supposedly capable of enduring anything without feeling or orientation herself, that is, hard as granite (Klaver 2001: 183).

This research largely grew from a feeling that university earth science objects and collections had been taken for granite. Indeed, and as this quote captures so well, by their very nature, these things are quite susceptible to being overlooked. Whether it is because of the popular tropes of hardness and durability surrounding their materiality, or their lack of charisma and appeal, it is clear that university earth science objects and collections have failed to attract the level of attention that has been paid to other collections, both within and beyond the natural sciences. This research aims to correct this imbalance, and in so doing can be seen to benefit from focusing on university earth science objects and collections in the following ways.

Firstly, while there is an increasing volume of work focusing on the cultures of natural history objects, those authors who acknowledge the cultural nature of earth science specimens (Alberti 2005; Carneiro 2005; Knell 2000; 2007a; Pickert 2007; Rudwick 1985), tend to focus on historical collections. By contrast, while the university museum sector has considered contemporary natural history and earth science collections (see for example: Clercq 2003; Halliwell and Simpson 2010; Simpson 2003a ; 2003b; Tomiya et al. 2010), this work has largely focused on practical matters such as their current and future protection and use. The application of material culture studies to the university museum context – the treatment of academic earth science collections as cultural entities – is therefore an area that remains largely unexplored. In this sense, by focusing on university earth science objects and collections, I am able to carry out research into a distinct ‘group’ of natural objects that has otherwise been overlooked. This research therefore provides a source for comparison with existing literature concerned with the uses, meanings and values of both historical geology collections and contemporary natural history collections.

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23 In a survey of stored collections in England and Wales (not specific to university collections), geology collections emerged as the least used of all types of stored objects (Keene 2008: 51).

Secondly, while the museological treatment of ‘natural’ objects as cultural artefacts has become increasingly popular in recent years, it has necessarily tended to focus on the passive roles of objects; in particular, as they are stored, taxidermied and exhibited (see, amongst many others; Aloï 2008; Dahlbom 2009; Ferry 2010; Patchett 2006; 2008; Patchett and Foster 2008; Poliquin 2008; Rader and Cain 2008; Wonders 1993). This focus on what Alberti refers to as ‘nature behind glass’ (2008: 74) has meant that, with few exceptions (but see Ellis (2008) on the use of natural history specimens for DNA bar-coding), little attention has been paid to their active use as functional scientific objects. Unlike the life and biological sciences where the collection and use of natural objects has largely declined in academia, in the earth sciences, objects remain central to much of the teaching and research that takes place in university departments. In this sense, while natural history objects and collections are largely historical artefacts on account of the decline in both academic collecting and their active scientific use (although, again, see; Ellis 2008), by focusing on the earth sciences, I am able to explore the uses, meanings and values of contemporary, functional and active scientific objects.

Finally, the existence of university earth science objects in both museums and departments provides an opportunity to study and compare the uses, meanings, and values of these things in two very different contexts. While earth science objects and collections in museums can be understood as ‘intentionally cultural’ on account of the institutional context in which they exist, in departments, their primarily functional existence makes them ‘unintentional expressions of culture’. In this sense, a focus on university earth science objects and collections provides an opportunity to compare two distinct ‘types’ of natural objects in a way that is neither artificial nor forced on account of their existence (in some cases) within the same institution. This research will therefore contribute to ongoing debates surrounding the extent to which objects and collections existing outside of the museum can be understood museologically.25

From this brief consideration of the ways in which university earth science objects and collections have been taken for granite, the significance of this research becomes clear. Indeed, by exploring these things using the theories and methods of material culture studies, this research moves into uncharted territory, both in terms of its content (university earth science objects and collections) and methods (from material culture studies). As such, its potential relevance is wide, both theoretically - for disciplines such as material culture studies, museology, science studies, the history of science and archaeology (amongst others) – and practically - for those who work with and use these objects, ranging from curators and conservators to research scientists and technicians.

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25 For example, while Pearce has suggested that the study of collecting (‘collecting studies’) constitutes ”a new field of enquiry” (1998: 10), according to Sharon Macdonald, “collecting is fundamentally museological, whether the museum is directly involved or not” (2006a: 95). Merriman, however, suggests that the ‘gulf’ between university museums and department collections is so fundamental that the latter may be more usefully understood on the same terms as archives (2002: 79).
1.6. Research outline

This research does not question whether earth science objects and collections are suitable candidates for material culture analysis, but instead asks what the application of material culture theories and methods to university earth science objects and collections, reveals about their uses, meanings and values. On one level, then, this research is about what happens when material culture theories and methods are extended to university earth science objects and collections; in this sense, it is about object-related practices. It is also, however, about the broader implications of treating university earth science objects and collections as material culture: what does this approach tell us about natural objects, the cultures of the earth sciences, and the cultures of collections? In order to address these two threads, it has been necessary to limit the scope of this study both spatially – to the UK – and temporally – to the present / recent past – and the overall aims of this research can therefore be summarised in the following statement:

This research aims to explore the implications of applying material culture theories and methods to university earth science objects and collections through the empirical investigation of contemporary object-related practices in UK earth science departments and university museums.

To clarify: although this research is about the implications of a particular approach, much of this thesis is concerned with the approach itself. As a result, the central task of this research is concerned with investigating relationships and interactions between individuals (researchers, lecturers, students, technicians, curators, conservators, and educators, amongst others) and objects (earth science specimens and collections) in a particular setting (UK university museums and academic departments), using the theories and methods of material culture studies. At this point, it is useful to introduce the central objective of this research and to provide further details about the core themes and broad questions that I originally set out to address:

Objective: To learn about the uses, meanings and values of university earth science objects and collections from those who work with and use them.

Theme 1: Selection
- How and why are objects selected for field collection / entry into a collection?
- How are natural objects transformed into scientific specimens / collection items?
- What strategies are used to maintain notions of objectivity?

Theme 2: Modification
- What are the processes and practices that are enacted on objects?
- How do they modify objects and at what point does the modification of an object transform it into something else?
- How does this affect the credibility and authenticity of an object?

Theme 3: Functions
- Who are the communities of users?
- How does the use of an object affect is meaning, treatment and value?
- What techniques are used to ensure that objects retain their authenticity?
- Which are acknowledged and which are deleted?

Theme 4: Movement
- Where are objects and why are they there?
- How and why do objects move?
- How does the location of an object affect its treatment and credibility?
In order to address the central objective of this research, it was first necessary to determine the nature and range of UK university earth science collections. Methodologically, then, this research involved two stages: the initial ‘groundwork’ which took the form of a survey of existing secondary data, followed by the empirical research phase where I gathered qualitative primary data. In the following sections, I will describe the ‘groundwork phase’ in more detail before providing the reader with an explanation of the approach that I adopted and the sources that I used in order to carry out and supplement the empirical research.

1.6.1. Preliminary groundwork

In order to establish a sound understanding of the contexts in which university earth science objects and collections exist, the foundations from which they have grown, and their current distribution, the initial task of this research was to conduct a thorough review of the literature. In particular, I focused on three broad themes (both generally and with specific reference to the UK), namely: university museums and collections; geology / earth science museums and collections; and geology / earth sciences as an academic discipline. From this it became apparent that the contemporary state of UK university earth science collections was largely unknown, and that it was up to me to carry out further research in order to establish a clear and accurate picture of their nature and range.

The task of identifying and locating UK university earth science collections involved bringing together previously fragmented information from a variety of sources. Using regional surveys of UK higher education museums, galleries and collections and other reports, I was able draw up a provisional list of 42 UK institutions with earth science collections - both in museums and departments. While the information gathered from the surveys and reports provided a useful starting point, further research was required in order to ensure that these existing records were up to date. I was also keen to identify any additional collections that had not been included in the original surveys either due to their (small) size or as a result of the timing of the surveys (i.e. institutions that received ‘university status’ after the surveys had been carried out). Based on the assumption that earth science collections exist in institutions that carry out teaching and/or research in the earth sciences, I was able to discover a further 16 institutions that had not been mentioned in the original surveys and which therefore potentially housed university earth science collections.

In order to update the existing list of institutions from the surveys, and to confirm whether there were earth science collections at any of the additional 16 institutions, I initially searched for evidence (ranging from direct references to departmental / museum collections to indirect evidence such as references in course unit descriptions and staff responsibilities) using

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26 For the provisional list of institutions, see appendix 1a, and for the sources that were used to identify them, see appendix 1d (section 1a).
27 For the list of institutions that were identified, see appendix 1b, and for the sources that were used to identify them, see appendix 1d (section 2).
online databases and university websites. In the absence of such information, I attempted to contact members of staff (such as technicians / laboratory managers) via email with a brief request for confirmation of the existence of teaching and/or research collections. As a result of this process, I was able to identify a total of 44 UK institutions with university earth science collections (see: Appendix 1a and 1b institutions in bold type). The list of 44 institutions was subsequently supplemented with details about collections (size and basic descriptions) and the institutions themselves (their origins, quality of teaching and research) (see: Appendix 1c).

1.6.2. Selecting an appropriate approach and case studies

The information that I gathered through the groundwork phase revealed the diversity of UK university earth science collections, however this variety was not simply a matter of differences between institutions, but was also apparent within institutions. Since no single institution could be seen to provide a ‘typical’ example, it became clear that only by studying a selection of different institutions, would it be possible to acknowledge and account for this diversity in my research. In spite of the uniqueness of each collection, I was able to identify three broad ‘types’ of collections, based on their context and purpose, namely: university museum collections, large departmental (research and teaching) collections, and small departmental (teaching) collections. Using these three ‘types’, I was able to group the institutions into categories based on collection ‘types’ and combinations thereof (see: Figure 1c).

In order to attempt to acknowledge the diversity of UK university earth science collections, while ensuring that the scope of this study remained achievable, a multiple-case study approach was felt to provide the most appropriate method for carrying out this research. While this method allows for detailed consideration of multiple cases, it is important to clarify that the selection of case studies was made in order to ensure that I acknowledged the diversity of UK university earth science collections, and with this in mind, I selected one institution from each category (institutions highlighted in grey in Figure 1c). It is perhaps useful at this point to summarise what each case study was felt to add to this research:

The University of Cambridge: The Sedgwick Museum of Earth Sciences and the Department of Earth Sciences.

The decision to select the University of Cambridge was based on both the long history of the institution and its significant position in the history of geology and the contemporary study of earth sciences. The existence of the vast and historically important (designated) collections in the Sedgwick Museum of Earth Sciences (hereafter abbreviated to the Sedgwick) as well as a small teaching collection within the department – both of which exist within the same building – made this institution an important case study.

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28 See appendix 1d (sections 1b) for information sources.
29 See appendix 1d (sections 3-5) for information sources.
Figure 1c: Table showing the categories used to group UK university earth science collections.

<table>
<thead>
<tr>
<th>Category</th>
<th>Collection:</th>
<th>Type of provision:</th>
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<td>University</td>
<td>Museum</td>
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<td>Category 1: University Museums</td>
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<td>Category 2: Departmental (teaching &amp; research) Collections</td>
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<td>of Southampton</td>
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<td>Category 3: University Museums alongside Department Collections</td>
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<td>of St Andrews</td>
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<td>Category 4: Departmental (teaching only) Collections</td>
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<td>John Moores</td>
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<td>Lancaster</td>
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<td>of Wales, Aberystwyth</td>
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<td>Category 5: Interesting anomalies</td>
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<td>College, London</td>
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<tr>
<td></td>
<td>Non-Discipline use</td>
<td>University of York</td>
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</table>

Note: Case study institutions are highlighted grey.
The University of Leeds: School of Earth and Environment
The decision to select the University of Leeds as a case study was based upon the existence of a significant collection of material within an institution that is highly regarded in both its research and teaching activities. While the institution does not have a museum, the existence of a ‘school curator’ was taken to reflect a degree of commitment to the care and use of objects within the school.

The University of Manchester: The Manchester Museum and the School of Earth, Atmospheric and Environmental Sciences
The decision to include Manchester as a case study was based on the Manchester Museum’s hybrid status as a civic/university museum (with designated collections and accredited status), which, unlike the Sedgwick or UCL’s rock room, is not restricted to collections of earth science objects. Furthermore, the existence of the museum alongside (over the road from) a large and active collection within the School of Earth, Atmospheric, and Environmental Sciences (hereafter abbreviated to SEAES) made this institution an important case study.

Liverpool John Moores University: School of Natural Sciences and Psychology
Liverpool John Moores University (hereafter abbreviated to LJMU) was selected because it provides an example of a departmental collection that is solely used for teaching purposes (i.e. there is no earth science research in the school). Again, the fact that a member of staff (senior technician) is responsible for the curation of the collections, suggested that the use and retention of objects for teaching purposes was valued by the school, in spite of the relatively small size of the department.

University College London: ‘Museums and Collections’ and the Department of Earth Sciences.
University College London (hereafter abbreviated to UCL) provided an opportunity to explore a distinct hybrid, since the collections exist as part of ‘Museums and Collections’ which is a central “non-academic support service” that provides support for the management, care and conservation of both museum and departmental collections (including the earth sciences) across the university (Were 2010: 295). However, the earth science collections exist physically within the department, and include an accredited ‘museum’ – the Rock Room – but which is only open to the public for one day per week. Again, UCL provided an example of a particularly strong research department.

Although the decision to select particular case studies was primarily concerned with ensuring that I explored a range of different ‘types’ of collections (and combinations thereof) within different ‘types’ of institutions, logistical matters (such as a preference for institutions located in the North West of England in order to facilitate access) were also taken in to consideration. At this point it is useful to briefly clarify what I mean when I refer to case study research, and to justify my decision to adopt this approach.

Case study research is defined by Yin as: “an empirical inquiry that investigates a contemporary phenomenon in depth and within its real life context” (2009: 18). 30 As a result of

30 While I address the matter of ethics below with reference to particular research methods and sources, it is important to acknowledge, as Yin observes, that; “the study of ‘a contemporary phenomenon in its real-life context’ obligates you to important ethical practices” (2009: 73).
Figure 1d: Six characteristics of case study research (based on: Denscombe 2007: 37).

<table>
<thead>
<tr>
<th>Depth of study</th>
<th>rather than</th>
<th>Breadth of study</th>
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<tr>
<td>The particular</td>
<td>rather than</td>
<td>The general</td>
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<td>Relationships and processes</td>
<td>rather than</td>
<td>Outcomes and end-products</td>
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<td>Holistic view</td>
<td>rather than</td>
<td>Isolated factors</td>
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<td>Natural settings</td>
<td>rather than</td>
<td>Artificial situations</td>
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<tr>
<td>Multiple sources</td>
<td>rather than</td>
<td>One research method</td>
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this focus, case study research has a number of characteristics, and these are summarised in figure 1d. From both the definition and characteristics of case study research, it is clear that this is an appropriate approach for a research project that aims to: explore (holistic view) contemporary object-related practices in the earth sciences (a contemporary phenomenon / a particular set of relationships and processes) by applying the theories and methods of material culture studies to UK university earth science objects and collections (a real-life context / a particular natural setting), and to consider the theoretical and practical implications of this approach. Furthermore, and considering the central objective of this research – namely to learn about the uses, meanings and values of university earth science objects and collections from those who work with and use them – both the depth of study and the use of multiple sources that characterise case study research make it an ideal approach for this research.

While the case study approach is clearly suitable for addressing the aims and objectives of this research, it is important to acknowledge that it is not without its critics. Perhaps the most fundamental criticism against this method relates to the emphasis that is placed on studying a limited number of cases in depth and that the approach therefore provides “little basis for scientific generalization” (Yin 2009: 15). As Denscombe has observed, “the point at which the case study approach is most vulnerable to criticism is in relation to the credibility of generalizations made from its findings” (2007: 45). While there is an extent to which case study research may lack the statistical credibility of quantitative methods, the generalizations that can be made are, nonetheless, based on in-depth and detailed evidence. In this sense, the generalizations that can (and for this research, will) be made are of a particular qualified type.

1.6.3. Empirical research: sources and methods

Having explained how I came to adopt a multiple case study method, and the criteria that I used to select case studies, I will now address the sources and methods that were used in order to gather the primary empirical data. I identified two key methods – interviews and observations – that would allow me to generate empirical data about the uses, meanings and values of university earth science objects and collections (see: Figure 1e). The following two sub-sections

31 While I address the matter of ethics below with reference to particular research methods and sources, it is important to acknowledge, as Yin observes, that: “the study of ’a contemporary phenomenon in its real-life context’ obligates you to important ethical practices” (2009: 73).
therefore introduce the key features of interviews and observational research, and explain how
they were used and any difficulties that were encountered in doing so.

**Interviews**

Interviews provide an opportunity to gather in-depth information and insights directly from
informants, and as Denscombe observes, one of the benefits of this method relate to its
flexibility – allowing the informant to communicate their own priorities and opinions to which the
interviewer may respond as appropriate (2007: 102). There are various different approaches to
conducting interviews and these are generally distinguished according to the level of structure
that is imposed by the researcher (see: Figure 1f). In order address the broad themes and
questions identified above (see: Figure 1e), while remaining open to new lines of enquiry, the
semi-structured approach was felt to be the most suitable type of interview for this research.

Semi-structured interviews provide the opportunity to gather in-depth information,
insights and opinions about particular themes and topics, directly from the interviewee (and thus
increasing the validity of the data), without the need to acquire complex or expensive equipment
(Denscombe 2007: 202). Indeed, the suitability of semi-structured interviews for gathering
detailed qualitative data about the uses, meanings and values of university earth science
objects and collections is apparent from the following description:

[Semi-structured interviews] …are most typically associated with the collection of
qualitative social data when the researcher is interested in people’s experiences,
behaviour and understandings and how and why they experience and understand the
social world in this way (Matthews and Ross 2010: 221).
While the advantages of this method are clear, it is also important to mention some of the issues that arise from using semi-structured interviews relating to resources, reliability and ethics.

The resource implications of semi-structured interviews relate to both the interviews themselves and their subsequent analysis. Since semi-structured interviews tend to involve direct contact between the interviewer and the interviewee, there are likely to be costs associated with time and travel. Furthermore, in order to make use of interview data, it is first necessary to generate a transcript and this is a particularly time-consuming task, as is the process of analysing the type of non-standard responses that arise from semi-structured interviews (Denscombe 2007: 203). While the resource implications for this method were not felt to be prohibitive (in fact, and as becomes apparent below, the resource implications for this method were considerably less than those for observational research), it is also important to mention some of the difficulties surrounding the reliability of data gathered using semi-structured interviews.

Perhaps the main challenge of this approach relates to the accuracy of information that is gathered and the honesty of the interviewee which Denscombe describes with reference to the notion of the ‘interviewer effect’: “The data from interviews are based on what people say rather than what they do. The two may not tally… In particular, interviewee statements can be affected by the identity of the researcher” (2007: 203). Likewise, the quality of interview data may be compromised by the use of audio recording equipment, either as a result of interviewees feeling daunted or uncomfortable or in a similar way to the ‘interviewer effect’. Issues surrounding the reliability of data were addressed through both the careful selection of informants (reliable, experienced and qualified), and by triangulating both the methods that I used (confirming the accuracy of data using data gathered using alternative sources and methods) and data that I collected (using data collected from different informants to corroborate

<table>
<thead>
<tr>
<th>Interview type</th>
<th>Interviewer role</th>
<th>Interviewee role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standardised Survey</td>
<td>Active</td>
<td>Passive</td>
<td>Interviews follow standard structure</td>
</tr>
<tr>
<td>Surveys Interviews</td>
<td></td>
<td></td>
<td>Closed questions set in advance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Questions asked in standard order and way</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Interviewee selects answers from a set of responses</td>
</tr>
<tr>
<td>Structured Interviews</td>
<td>Active</td>
<td>Passive</td>
<td>Interviews follow standard structure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Open-ended and closed questions prepared in advance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Responses do not influence the structure of the interview</td>
</tr>
<tr>
<td>Semi-Structured</td>
<td>Active</td>
<td>Active</td>
<td>Interviews address common themes</td>
</tr>
<tr>
<td>Interviews</td>
<td></td>
<td></td>
<td>Open-ended questions and themes prepared in advance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Flexible order and approach to questions and themes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unrestricted responses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Responses may lead to unplanned questions</td>
</tr>
<tr>
<td>Unstructured Interviews</td>
<td>Passive</td>
<td>Active</td>
<td>Interviews focus on broad themes for discussion</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Broad questions and themes prepared in advance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unrestricted responses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Structure guided by responses</td>
</tr>
</tbody>
</table>
and compliment themes and issues). Furthermore, I feel that my previous experience of working in museums and my background in the earth sciences also proved beneficial, not only by providing me with credibility as a trustworthy researcher but also by allowing me to empathise with interviewees. As a result, interviewees responded to my questions with great honesty and were keen to discuss their experiences in great depth (indeed, many of the interviewees openly commented on how nice it was for someone to be interested in their work, and this ‘therapeutic’ (Denscombe 2007: 203) aspect of interviewing generated in-depth and insightful data).

Finally, it is vital to address the matter of research ethics in relation to the collection, analysis and use of information from semi-structured interviews. In the first instance, this involves ensuring that participants understand the context and purpose of the research project, and gaining written consent for the use of the interview data. As Denscombe observes:

People should never be forced or coerced into helping with research. Their participation must always be voluntary, and they must have sufficient information about the research to arrive at a reasoned judgement about whether or not they want to participate. These are the premises of ‘informed consent’ (2007: 145).

In order to gain access to potential interviewees, I initially contacted (via email) curatorial staff at the case study institutions in order to introduce myself and the research project, and to ask if they would be interested in participating in the project. On receiving a response, I then sent another email in order to make arrangements to carry out the interview, and to provide further details about the research project (see: Appendix 2a) and the broad themes that I was interested in discussing. I also informed them of my intentions to make a recording of the interview, and that following the interview, they would be able to decide whether or not to give me written consent to use the interview data in my research. As well as making notes, the majority of interviews were recorded using a digital recording device32 and at the end of each interview, I asked participants to complete a consent form (see: Appendix 2b).

While I had originally intended to anonymize the interview data, as the project progressed, it became apparent that this strategy was rather impractical,33 and, indeed, unnecessary since all of the participants gave me permission to attribute their words to them. In order to protect the interests of participants, I exercised discretion with certain details and information that was discussed during interviews, and when selecting quotations for use in the thesis, I was careful to avoid any misunderstanding or misrepresentation of the interviewees.

The interviews themselves involved a variety of different informants (see: Figure 1e), however at all of the case studies, I initially made contact with and interviewed a member of

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32 Three interviews were not recorded due to the interview conditions (i.e. in a cafeteria) or its nature (i.e taking place while being shown around the department).

33 This research necessarily contains detailed information about the unique characters of the case studies and therefore, any attempt to conceal the identities of the case study institutions would be very difficult and relatively futile. Knowledge of the identities of the case study institutions, however, poses a direct threat to the anonymity of the participants because with this information, any interested reader with internet access could easily discover their names, simply by searching a university website for key words such as ‘curator’ or ‘lecturer in palaeontology’. As such it would be almost impossible to guarantee the anonymity of participants.
curatorial staff who, following a discussion of the themes that I was intending to pursue, subsequently recommended other members of staff to approach in order to discuss particular themes. Interview questions and themes were identified in advance (see: Appendix 3a-f), and these were revisited following each interview in order to make any adjustments as appropriate. It is perhaps worth mentioning that my background in both geology and museums proved particularly beneficial, both in terms of gaining access and trust as a researcher, and in providing the insight on which the interview questions were based. The length of interviews varied considerably from around 30 minutes to two and a half hours, although the average duration was around one hour in most cases. Directly after each interview I spent some time reading through the hand-written notes, and added any additional thoughts or observations that had not been included. Each interview was then transcribed (see: Appendix 4a) and studied in detail in order to identify key themes and issues, and as mentioned above, these themes and issues were used to inform the direction of subsequent interviews.

A final point that I would like to make concerns the use of interview data; as the reader will soon discover, I regularly refer to evidence that was generated during interviews, and in many cases, I include quotations taken from the interviews themselves. Indeed, Denscombe explains that:

Extracts from transcripts can be used to good effect in social research. For one thing, they can be interesting in their own right, giving the reader a flavour of the data and letting the reader ‘hear’ the points as stated by the informants. For another, they can be used as a piece of evidence supporting the argument that is being constructed in the report by the researcher (2007: 199).

The decision to use interview data in this way also reflects my intentions to learn about the uses, meanings and values of university earth science objects and collections from those who work with and use them. Indeed, it seems to me that the most appropriate way of talking about people’s thoughts, opinions and experiences of interacting with objects is to use their own words. This approach, however, must be undertaken with caution because, as Denscombe notes: “The significance of extracts from transcripts is always limited by the fact that they are, to some extent, presented out of context” (2007: 199). Following Denscombe, in order to ensure that the intended meaning of an extract is communicated, I have used verbatim quotes and included some background on the individuals being quoted (see: Appendix 6) and, where necessary, the context in which the quotations were made (2007: 200). In order to link the background information to the relevant individual, I direct the reader to the appropriate appendix reference on the first occasion that I refer to an extract from their interview in the text.

Observational Research

As a research method, observation involves “the systematic description of events, behaviours, and artifacts in the social setting chosen for study” (Marshall and Rossman 1989: 79). While observation is variously described as “the most natural of all ways of making data” (Richards and Morse 2007: 115), “the most basic way to collect data” (Matthews and Ross 2010: 255), and “the bedrock source of human knowledge” (Adler and Adler 1994: 377), as Richards and
Morse observe: “observing unobtrusively is extremely difficult” (2007: 115). Indeed, the issues surrounding ‘unobtrusive observation’ are central to this method, and this difficulty is known as the ‘observer effect’. As Matthews and Ross observe: “there can be no doubt that, if people know that their behaviour is being observed, then it will change” (2010: 259), and therefore, any participation on the part of the researcher may be seen to interfere with the ‘natural setting’. On the other hand, the decision to conceal the role of the researcher in order to observe unobtrusively requires careful consideration due to the ethical issues that may arise from covert research. In response to these problems, observational research may take a variety of forms. Gold (1958), for example, identified four different roles that a researcher may adopt when undertaking fieldwork, ranging from covert to overt observation and varying in the degree of participation on the part of the researcher (see: Figure 1g).

**Figure 1g**: Table summarising four different approaches to observation (based on: Gold 1958; Matthews and Ross 2010: 257-8).

<table>
<thead>
<tr>
<th>Researcher Stance</th>
<th>Researcher’s role as observer</th>
<th>Researcher’s role as participant</th>
<th>Advantages</th>
<th>Disadvantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete participant</td>
<td>Covert</td>
<td>Full</td>
<td>Observation as a group member</td>
<td>Ethical issues with covert research</td>
</tr>
<tr>
<td>Participant-as-observer</td>
<td>Overt</td>
<td>Full</td>
<td>Observation as part of the group</td>
<td>Opportunity to seek clarification</td>
</tr>
<tr>
<td>Observer-as-participant</td>
<td>Overt</td>
<td>Minimal</td>
<td>Observation of group with the potential to participate</td>
<td>Opportunity to seek clarification</td>
</tr>
<tr>
<td>Complete observer</td>
<td>Covert</td>
<td>None</td>
<td>Fully naturalistic setting</td>
<td>Ethical issues with covert research</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Elimination of ‘observer effect’</td>
<td>Lack of opportunity to seek clarification</td>
</tr>
</tbody>
</table>

Observational research methods, as Richards and Morse observe, provide the researcher with an opportunity to “learn what is taken for granted in a situation and to discover what is going on” (2007: 116). Considering my intention to understand the uses, meanings and values of university earth science collections, I originally identified participant-observation as an ideal method for generating detailed and in-depth qualitative data across all four themes. In practice, however, observational research is both time- and resource-consuming. As a result of these factors along with a number of logistical issues, it was not possible to make use of this method to the extent that I had originally intended (see: Appendix 5b) and therefore, I was unable to generate data about field collecting, curatorial work, the research process, the exhibition development process or the movement of objects using this method.

While it was necessary to reassess the extent to which observational research was used in this project, I was still able to adopt this method in order to gather data about the functions of earth science objects. In particular, this method was used in order to gather observational data about the uses of objects in undergraduate practical sessions, museum
sessions and in museum exhibitions. Indeed, the set duration and regularity of undergraduate practicals and museum sessions, along with the ease of accessing museum exhibitions made them ideal settings on which to focus.

In order to gather observational data about the uses of objects in teaching, learning and exhibitions, for a number of reasons, it was most appropriate to adopt the ‘complete observer’ role, namely to make observations without participating in what was being observed and without revealing my presence to those being observed (see: Figure 1g). Before I explain some of the practical reasons for adopting this role in each setting and the ways in which I used this method, it is important to acknowledge the advantages, disadvantages and ethical implications of undertaking this type of observational research. While the ‘complete observer’ offers an opportunity to make observations without interfering with that which is being observed, the detached position of the researcher means that there is no opportunity to clarify observations, and as a result, this type of observation is susceptible to misunderstandings and inaccurate interpretations (Matthews and Ross 2010: 258) . In terms of observing undergraduate practicals and museum sessions, my background in the earth sciences (and my experience of being an undergraduate student using objects in practical sessions) and my experience of working as a museum educator reduced the likelihood of misunderstanding the ways in which students and pupils were interacting with objects.

In the role of the ‘complete observer’, the researcher is necessarily carrying out covert research and this notion has negative connotations of dishonesty and intrusion of privacy (Adler and Adler 1994: 387-9). While my intentions to observe individuals interacting with objects in an unobtrusive way required a covert approach, I was able to ensure that this was done in an ethical way by seeking permission to carry out observational research from the appropriate course leaders, teachers and museum staff. As well as revealing my role to those in charge, the nature of this research itself enabled me to carry out covert observational research in an ethical way. Indeed, the purpose of carrying out observational research was purely concerned with the ways in which individuals interacted with objects; I was not interested in the individuals themselves, their personal beliefs, emotions or any other sensitive areas. Furthermore, the identity of the individuals that I observed were not known and therefore their anonymity was preserved. In order to provide more detail about the ways in which I used observational research, it is useful to describe the three different situations in more detail.

In order to gain access to undergraduate practical sessions, I originally approached my curatorial contacts and explained my intentions to observe the use of teaching material. The curators were able to recommend appropriate course units and provide contact details for the relevant course leaders, and also agreed to inform the course leaders of my research and pre-warn them that I would be contacting them. I then emailed the course leaders in order to introduce myself and my research (see: Appendix 2a), and to enquire about attending one of their practical sessions for the purpose of observing the use of objects. On all occasions, I received a positive response and was sent a list containing timetabling information for practical
sessions that they felt would be relevant to my research. Prior to observing the practical sessions, I introduced myself to the course leader and was given copies of the worksheets and resources that would be used during the session. Due to the size of the classes and the layout of the rooms, I was able to adopt the ‘complete observer’ stance, by positioning myself within earshot of a group while remaining inconspicuous (as well as the large class sizes, I benefited from observing first year practical sessions early on in the academic year and therefore, did not draw attention to my presence as an outsider). Observations were made according to a number of broad themes and questions (see: Appendix 3g) and as well as making detailed notes throughout the session (see: Appendix 4b), I also took photographs of the specimens and other materials at the end of the practical session. While I gained permission to observe the sessions from the course leaders, no further permission was sought from individuals since the students that I observed remained anonymous.

The process of arranging access to museum sessions was much more straightforward as I was able to take advantage of both my contacts at the Manchester Museum (where I currently work as a museum educator), and the opportunity to observe sessions as part of the process of being trained to lead them. The museum sessions that I observed therefore all took place at the Manchester Museum. As with the case above, my observations were guided by a broad plan (see: Appendix 3g) and were made as a ‘complete observer’. Again, I sought permission from both the museum educator and also the school teachers who accompanied the classes, and since all observations were anonymous, no further permission was sought.

Permission to carry out observational research in exhibitions was obtained from relevant members of museum staff and again, since the visitors that I observed remained anonymous, no further permission was sought from those who I observed. In order to observe both the exhibitions themselves and the ways in which visitors engaged with them, I adopted the ‘complete observer’ stance, and was able to achieve this by positioning myself in an inconspicuous location, and carrying out observations at relatively busy times, so as to blend in. Observations were structured using a broad plan (see: Appendix 3h and 3i) and were supplemented with photographs of the displays and objects of interest.

1.6.4. Supplementary sources

In order to generate primary empirical data, as I have explained above, this research has made use of two different research methods: semi-structured interviews and observational research. These methods were not, however, used in isolation, and as Figure 1h illustrates, a variety of different sources were used to supplement the empirical evidence. Indeed, as well as providing a means of gathering detailed contextual information about each of the case study institutions prior to and following fieldwork, these sources were also used to triangulate the empirical data that I gathered. It is therefore important to both acknowledge these supplementary sources and to provide a brief explanation of the ways in which they were used.

34 As a result of my work, I have a full CRB check and have attended a number of child protection training courses.
Figure 1h: Table illustrating the variety of sources that were used for this research.

<table>
<thead>
<tr>
<th>Themes</th>
<th>Primary sources</th>
<th>Activities / Events</th>
<th>Institutional Documents and Records</th>
<th>Physical Objects</th>
<th>Other Documents (published &amp; unpublished)</th>
<th>Personal Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case study background</td>
<td>People: Curators</td>
<td>Activities: Annual reports</td>
<td>Strategic plans</td>
<td>Promotional material</td>
<td>Institutional histories</td>
<td>Surveys and reports</td>
</tr>
<tr>
<td>Selection</td>
<td>Scientific objects: Collectors</td>
<td>Field notebooks</td>
<td>Fieldwork diaries</td>
<td>Fieldwork guides</td>
<td>Collected objects</td>
<td>Textbooks and guidelines on fieldwork / collecting</td>
</tr>
<tr>
<td></td>
<td>Collection items: Curators</td>
<td>Collecting policy</td>
<td>Policies &amp; Procedures</td>
<td>Accessions register</td>
<td>Collection items</td>
<td>Collections management guidelines and standards</td>
</tr>
<tr>
<td>Modification</td>
<td>Collectors, Curators &amp; Conservators</td>
<td>Users (see below)</td>
<td>Policies &amp; Procedures</td>
<td>Forms: sampling / destructive testing</td>
<td>Modified objects</td>
<td>Collections management guidelines and standards</td>
</tr>
<tr>
<td>Research</td>
<td>Researchers, Curators &amp; Conservators</td>
<td>Data &amp; Notebooks</td>
<td>Laboratory handbooks / procedural manuals</td>
<td>Research specimens</td>
<td>By-products of research</td>
<td>Textbooks and guidelines on research techniques</td>
</tr>
<tr>
<td>HE Teaching</td>
<td>Teaching staff</td>
<td>Practical sessions</td>
<td>Worksheets</td>
<td>Course handbooks</td>
<td>Exam papers</td>
<td>Teaching sets</td>
</tr>
<tr>
<td>Museum Learning</td>
<td>Museum educators</td>
<td>School sessions</td>
<td>Worksheets</td>
<td>Session plans</td>
<td>Evaluation reports</td>
<td>Handling collections</td>
</tr>
<tr>
<td>Display</td>
<td>Exhibition team, Curators &amp; Conservators</td>
<td>Museum visits</td>
<td>Guidebooks &amp; Leaflets</td>
<td>Promotional material</td>
<td>Annual reports</td>
<td>Displayed objects</td>
</tr>
<tr>
<td>Movement</td>
<td>Curators &amp; Conservators, Researchers, Teaching staff/educators, Exhibition team</td>
<td>Collections management forms and documents</td>
<td>Policies &amp; Procedures</td>
<td>Annual reports</td>
<td>Catalogues</td>
<td>Collections management guidelines and standards</td>
</tr>
</tbody>
</table>
I use the term ‘institutional documents and records’ with reference to unpublished material that is specifically related to an institution and activities taking place therein. These sources include both historical and contemporary material, and range from items held in institutional archives (as was the case with much of the material that I examined at the University of Leeds), and personal material (such as contemporary field notebooks). These sources provided vital background and contextual information about the case study institutions and were also used to supplement and validate interview data. In order to gather relevant information from institutional archives, it was necessary to sift through vast amounts of unrelated evidence, and the time consuming nature of this task (and the tendency to become side-tracked with irrelevant yet interesting material – such as a student newspaper for the geology department at the University of Leeds which included satirical songs about former lecturers and technicians) led me to focus on using more easily searchable and accessible sources, such as the internet.

In spite of the focus of this research, it is perhaps surprising that physical objects were only used as a supplementary source, and this reflects the fact that opportunities to access physical objects were limited by the amount of time available during site visits. Indeed, on a number of occasions, interviewees made use of objects to support their accounts, particularly on the theme of field collecting. Objects also featured heavily in the observational research that I carried out, and when examining displays and exhibitions in particular, I was able to carry out detailed analysis of their arrangement, presentation and enhancements using a variety of visual and textual techniques. As well as making written notes and observations, I also took photographs of objects in order to create a visual record of items of interest, a selection of which appear in this thesis in order to provide the reader with additional context.

As well as institutional documents and records, I also made use of other published and unpublished literature and documents. These sources ranged from discipline-specific textbooks and manuals, such as those concerned with field collecting and research techniques, to formal standards and guidelines addressing elements of collections management, and were used in many cases to supplement and verify interview data. Documentary sources were also valuable for generating contextual details about the case study institutions.

Finally, much of this research drew on my own personal experience both in terms of my background in the earth sciences, and my employment in various roles in the museum sector. In many ways, this source was most influential in the early stages of this research, as it provided me with the basic foundations on which to develop the themes and questions that were subsequently addressed. Furthermore, and as I have mentioned above, I was also able to make use of my knowledge and experience as a means of triangulating interview and observational data, and an understanding of the terminology and conventions of the earth sciences was often vital for probing interviewees and understanding their responses.
1.6.5. Knitting it all together: a brief account of the research process

In order to bring together the various strands that have been introduced above, it is useful to provide a brief summary of the research process. Prior to any fieldwork, I carried out detailed research into the case study institutions and their collections in order to establish a sound understanding of the broad contexts of collections. This background research was perhaps most intensive at the beginning of a case study, however, it did continue throughout (and in many cases, beyond) the period of focused fieldwork. On account of limitations on my time and resources, it was not possible to spend an extended period of time in the field and therefore, I made repeated visits to each institution over a length of time (for a list of fieldwork activities at each site, see: Appendix 5). In fact, this strategy proved particularly beneficial as, in most cases, it provided me with sufficient time between visits to carry out preliminary analysis of the evidence that I had gathered, and to use this in order to inform the sources and thematic focus of the subsequent visit. This iterative strategy was also used at the case study level by spending time synthesizing the information that had been gathered about each case study before moving on to the next one. By writing a case study report for each institution, I was able to bring together all of the evidence and data that I gathered, and to use this to inform the focus and source-selection for the next case study. In particular, this allowed me to ensure that I built on any strong themes and addressed any gaps. In this sense, the approach that I took was continually unfolding and evolving through the life of the project (see: Figure 1i).
Given the nature of this research, it is important to make clear to the reader that, while I have made every effort to ensure the accuracy of the content of this thesis, and have provided the reader with some insight into my background and position, the interpretations that I offer and the conclusions that I draw are unavoidably a reflection of my intentions, interests, background, and experience.

1.6.6. Thesis structure

The final task of this introductory chapter is to provide the reader with a sense of what follows. One element of the structure of this thesis that requires further explanation is my decision to gradually introduce theoretical and conceptual matters as they arise. Therefore, rather than bombarding the reader with such information in the introductory chapter, it has been woven into the relevant thematic chapters. Furthermore, and as I have explained above, throughout this research, I continually refined and revised the themes that I addressed and the questions that I asked. As a result, the original four themes that I set out to explore – selection, modification, functions and movement – evolved into a slightly different structure. While the selection of objects remained important, it became apparent that the selection of objects for field collection, and the selection of objects for entry into a collection were so distinct that they required individual attention. Furthermore, the notion of ‘modification’ seemed to cut across the other three themes, and it became clear that it was impractical to attempt to consider this theme in isolation. Therefore, while the themes of ‘functions’ and ‘movement’ have chapters dedicated to them, the theme of selection has generated two discrete chapters – one focusing on field collecting and the other focusing on collection items – and the modification theme has been dispersed across all four. This last section also provides an opportunity to explain my reasons arranging this thesis thematically, but before I do so, it is useful to introduce the chapters.

Firstly, since earth science objects originate in nature, it has been necessary to understand how these things come into being. In considering the coming into being of earth science objects, my intentions have been to shed some light on the act of field collecting with a particular focus on the ways in which objects are selected, the processes and practices that are enacted on them, and the strategies that are used to maintain notions of objectivity. Chapter two – The coming into being of earth science objects – is therefore concerned with the transformation of pieces of nature into pieces of science. This chapter considers the ways in which the naturalness of objects – the very quality that is of interest to earth scientists – is affected through the collecting process, and the strategies that are adopted in order to overcome this.

Secondly, the purpose and nature of ‘the collection’ has required careful consideration. By focusing on the coming into being of collection items, I have attempted to unpack the collection with a particular emphasis on the ways in which objects are transformed on becoming collection items, and how this varies according to different types of collections. In chapter three – The coming into being of collection items - I shift attention towards the processes and
practices involved in transforming scientific objects into collection items. In this chapter, I introduce the ‘assemblage perspective’ and suggest that in order to capture the complexity of ‘the collection’, it is more usefully treated as a process, rather than a fixed entity. By considering the variety of approaches to- and purposes of- ‘the collection’, this chapter explores its power as a means of regulating earth science objects.

Thirdly, it has been vital to explore the different functions that earth science objects perform. In particular, I consider how objects are used and by whom, the ways in which different functions may affect the meanings of objects, and the different ways in which objects are treated. In the fourth chapter – The functions of objects - I focus on three broad functions of university earth science collections, namely; teaching and learning, research, and display. In this chapter, I suggest that the Peircean semeiotic provides a useful tool for exploring the meanings and interpretations of earth science objects. For each function, I consider in detail the particular means by which objects are encountered, regulated and modified, revealing the complex ways in which the meanings, treatment, values and authority of objects both affect and reflect their use.

Finally, and cutting across the previous three themes, the matter of mobility emerged as particularly significant. In considering the mobility of earth science objects, I have explored how objects move, the routes along which they travel, and the extent to which their mobility affects their treatment, credibility and value. In the fifth chapter – The mobility of objects - I consider the various trajectories along which objects may flow into, out of and within institutions, departments, and collections. In focusing on why and how objects are mobilized and the strategies that are used to regulate their movement, this chapter explores the ways in which the mutability of earth science objects is harnessed and exploited, and how this impacts on their values.

Before I close this chapter, it is important to note that the decision to present this research thematically reflects my intentions to emphasise the objects rather than the institutions, and while the processes and practices that are enacted on objects showed considerable variation across the five case study institutions, it became apparent that this variation was around a number of central themes. Therefore, rather than simply telling five separate (although nonetheless interesting) stories, by following a thematic arrangement, I have been able to remain focused on the objects themselves, and at the same time illustrate the complexity that surrounds them, using evidence, examples and detailed accounts from the case studies. Indeed, and as the reader will discover in the next chapter, this complexity is apparent from the moment that these things are collected.
Chapter 2: The coming into being of earth science objects

This chapter is about the activity that is commonly known as ‘field collecting’ and explores the processes and practices that are enacted on objects as they are removed from their in situ field occurrence and brought into an academic institution.\(^{35}\) While the reasons for collecting material from the field are many and varied, in focusing on the university context, this chapter is necessarily limited to the field collection of material for research and teaching purposes.\(^{36}\)

It has been observed on a number of occasions that ‘the field’ has largely been neglected as a site of scientific practice (amongst others, see; Dewsbury and Naylor 2002; Driver 2000; Kohler 2007; Kuklick and Kohler 1996). Likewise, collecting as a mode of scientific practice has suffered a similar fate (but see: Latour (1999) on pedology), and while a number of authors have attempted to address this imbalance, most of this work has focused on historic cases (see, for example; Knell 2000; McCook 1996; Rudwick 1985). Nonetheless, through these historical studies of geology, we discover that attempts to develop a systematic approach to field collecting were made in the formative years of the discipline.\(^{37}\) We also learn that the importance of fieldwork for both the collection of samples and the observation (first-hand) of features in situ, had become established by the end of the eighteenth century (Rudwick 1996b: 273).\(^{38}\) While such work provides useful insight into the historical origins of field collecting methods, it does not tell us much about the processes and practices of contemporary fieldwork. Indeed, attention to contemporary field collecting in the earth sciences is largely limited to the standard disciplinary guidelines,\(^ {39}\) and while this type of work tells us about some of the principles of fieldwork, it sheds little light on the practices.

As a result of this lack of attention, contemporary field collecting in the earth sciences has largely avoided the degree of analysis and scrutiny given to more popular sites (such as the laboratory) and practices (such as experimentation) of science.\(^ {40}\) It therefore follows that a number of fundamental questions remain unanswered, such as: How and why are objects selected? How are natural objects transformed into scientific specimens? What strategies are used to maintain notions of objectivity? This chapter therefore offers a response to these

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\(^{35}\) Because this research is concerned with ‘natural objects’, this chapter does not address objects that are created rather than collected, such as artificial minerals or plaster replicas of fossils.

\(^{36}\) I consider the alternative routes along which material may travel from the field to an institution, such as field collecting by museum curators and the general public, in chapter five (see section 5.3.2. in particular).

\(^{37}\) John Woodward’s guidelines (1696) provide an early example. However, as Knell observes, these instructions were primarily concerned with the collection of geological objects as a form of natural curiosity (2000: 60).

\(^{38}\) Knell refers to instructions made by John Farey (a surveyor who worked alongside William Smith) in 1815 that emphasised the need to number and record details about the stratigraphical and geographical contexts of specimens as soon as possible after collecting them (2000: 18).

\(^{39}\) As well as general fieldwork and field mapping guides (see respectively: Compton 1972; Garrard 2005), more specific instructions are provided palaeontologists (Golding 1999), and with reference to metamorphic, sedimentary and igneous geology (see respectively: Fry 1984; Thorpe and Brown 1993; see respectively: Tucker 2003).

\(^{40}\) During the 1980s and 1990s, much attention was paid to the laboratory (Hacking 1992; amongst many others, see; Knorr-Cetina 2003; Latour 1983; 1987; Latour and Woolgar 1986; Law 1986; Lynch 1991).
questions through detailed consideration of the processes and practices involved in the coming into being of earth science objects.

2.1. Introduction

The notion of coming into being is borrowed from Daston and used to emphasise “the distinctively generative, processual sense of the reality of scientific objects” (2000: 13). In talking of the coming into being of earth science objects, I attempt to capture the ways in which scientific attention affects natural objects; appearing to turn pieces of unruly nature into more cooperative pieces of science. Indeed, the selection, removal and transportation of these objects from nature outside into a scientific institution alters them significantly; the coming into being of a scientific object is a transformative process that affects both its physical and conceptual nature. To talk of transformation and change is, however, at odds with the logic behind collecting material in the first place; the earth sciences rely heavily on the assumption that collected objects remain ‘the same’ as they were in nature (Bernasconi et al. 2007: 3; and on natural sciences more generally, see; Dahlbom 2009: 67). As scientific objects, earth science specimens appear to function as objective, impartial evidence and are treated accordingly. However, in selecting particular pieces of outside nature to bring inside, the collector unavoidably affects the object, just as the object affects the collector.

The coming into being of an earth science object is a unique event, emerging from a distinct combination of interrelated factors; in this sense, no two objects are collected in the same way. In order to explore the collecting process, it has been useful to distinguish between the immediate, often-uncontrollable experience of collecting, and the broader context within which this takes place. On one level, then, the decision to collect material is situated within a broad set of circumstances that I refer to as the ‘collecting context’. The collecting context is concerned with the larger disciplinary, personal and institutional circumstances within which the decision to collect material from the field actually takes place. Within this relatively reasonable and rational framework, the actual process of collecting material has emerged as an altogether more complex event relating to the particular individual(s) involved in the collecting process, the distinct nature of the material being collected, and the specific locality (environment and conditions) from which it is being collected. I use the term ‘pragmatics’ to describe how the selection and removal of material from the field emerges from these unique interactions between collector, material and locality. Thus, while the collecting context relates to why material is collected – setting the stage and shaping the intentions for the act of collecting, the pragmatics of collecting are concerned with what is collected – the immediate experience of field collecting that leads to the selection and removal of particular pieces of material and not others.

In order to understand the coming into being of earth science objects, it is therefore necessary to acknowledge both the collecting context and the pragmatics of collecting. After a brief explanation of the collecting context, I use specific examples from the case study...
institutions to illustrate the ways in which the decision to collect material from the field may relate to particular disciplinary, personal and institutional factors. Within this broader set of circumstances, I then introduce the pragmatics of collecting and outline the variety of ways in which field collecting – the selection, removal and inscription of particular pieces of material – relates to the immediate conditions experienced in the field. Finally, I draw these two strands together, using two accounts of the collecting process in order to illustrate the ways in which the context and pragmatics of collecting combine to shape the coming into being of earth science objects.

2.2. The collecting context

The coming into being of earth science objects cannot be separated from the wider circumstances within which the decision to collect material is made. Through detailed examination of both personal and formal accounts of the collecting process, it has become apparent that, in spite of the singularity of every collecting event, the collecting context is largely shaped by disciplinary, personal and institutional factors. It is, however, important to note that, while the divisions and categories that I describe below are, to some extent artificial, they provide a useful framework within which to consider this complex subject. Indeed, throughout this section, it becomes evident that these three factors blend and merge into one another and the boundaries that define them are rarely clear-cut. Therefore, while this section attempts to unpick the collecting context into three broad strands, in section 2.4, where I focus on two accounts of field collecting, it becomes apparent that, in practice, the institutional, disciplinary and personal factors that shape the collecting context are often closely related - and in some cases, inseparable.

2.2.1. Disciplinary factors

In considering the decision to collect within its disciplinary context, I acknowledge the circumstances that have shaped the nature and development of the earth sciences both as a discipline and as an academic subject. In order to contextualize the impact of disciplinary factors, it is useful to begin by briefly addressing some recent historical developments in both the discipline in general and its academic context in the UK. I then refocus attention towards contemporary practice, addressing the more immediate ways in which the decision to collect emerges from within the disciplinary context, in particular through the relationship between research and technology.

A key factor in the growth and development of the earth sciences both in general terms and as an academic subject, occurred during the middle of the twentieth century as a result of ‘The Plate-Tectonic Revolution’ (Muir-Wood 1985: 189) or ‘The Revolution in Earth Sciences’ (Wilson 1967). This ‘revolution’ involved a fundamental change to the methods and scope of geology, from an observational science concerned with understanding the earth’s surface using

41 A detailed discussion of the nature of this ‘revolution’ is beyond the scope of this chapter, however, see: Branagan (2005), Hallam (1973), Marvin (2005), Hodder (1997) and Ruse (1978; 1989), amongst others.
maps and collections of samples, to one concerned with its processes on a global scale (Muir-Wood 1985: 190). As a result of the theory of plate tectonics, the science of geology was transformed into the new ‘earth sciences’ (Hodder 1997) and in the academic world, the result of this ‘revolution’ was a “marked shift in research and education from the field to the laboratory, from macro to micro, from description to experiment” (Clercq 2003: 27). These developments directly affected academic institutions, as is apparent from the changes that were made to university departments, both in terms of their scope and names. For example, at the University of Leeds; “the Department of Geology developed into a finely equipped Department of Earth Sciences with world-wide interests and reputation” (Shackleton 1966a: 5) and this change in title reflected the focus of the new department on; “the whole planet rather than just the crust, and a shift of emphasis from the observational methods of classical geology to a balance between experiment, theory and observation” (ibid: 5).

Emerging from these wider disciplinary developments were significant changes to both the research and teaching activities carried out in university departments (Clercq 2003: 27). As Boylan observes, “the 200 year tradition of comparative stratigraphy dated by fossil correlations” was replaced by new methods of physical and chemical dating (1999: 51). Indeed, the emergence of new fields such as geochemistry and geophysics fundamentally changed the collecting context because, while objects remained important, they no longer occupied a central position; things became secondary to data. More specifically, academic research was directly and immediately affected by the emergence of the new earth sciences through the generation of new questions, focusing on new places, new types of material, and new techniques and methods (Muir-Wood 1985). These changes significantly impacted on the collecting context, as became apparent when I asked Steve Laurie (Collections Assistant (Mineralogy and Petrology) at the Sedgwick) about the factors that influenced the development of the collections at the Sedgwick:

Plate tectonics certainly had some effect… you had research ships going out [collecting] more and more often… and it definitely becomes much more systematic; actually going out on different cruises and [sampling] different areas of the sea floor. And then it moves on land again; you’ve got the ophiolites in Cyprus and Oman…[and] you suddenly realize that these are bits of ocean floor, and you can study them in more detail than little scraps [collected from the sea floor] (interview 18/08/09).

While the ‘dissemination of geology into the earth sciences’ (c.f. Selley 2005: 433) was global in reach and affected the discipline as a whole, an additional large-scale factor that has shaped the collecting context relates specifically to the earth sciences as an academic discipline in the UK. In the late 1980s, as Rickard explains; “the Thatcher government decided to look into creating larger departments on the basis that critical mass would improve both research and teaching” (2004: 3), and in response, a review of university earth science departments was

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42 See: Appendix 6l.

43 The outcome was a document titled ‘Strengthening University Earth Sciences’, also known as the Oxburgh Report (Oxburgh 1987) in which it was proposed that university earth science departments should be restructured within a three tiered system (Taylor 1987: 146).
commissioned by the University Grants Committee (UGC). As part of the review process, departments were graded according to their teaching and research provision, and this grade was used to determine the amount of funding and resources that they received (Taylor 1987: 146). While this led to the provision (by the UGC) of special funding and support for the larger departments, the reorganisation of university earth science provision ultimately led to the demise and loss of many departments. The review also impacted on collections, both in terms of ‘recommendations’ for the size of collections and levels of curatorial support (in relation to departmental grades), and through the establishment of five “earth science collections centres” that were to receive funding and support in order to act as repositories for surplus and orphaned collections (see Liston (2011) for a recent assessment of the review).

In terms of the collecting context, by assigning particular research areas and disciplinary strengths to particular departments - through the allocation of funding, staff, and equipment - the UGC review had an impact on both the amount and types of material that were collected for both research and teaching purposes. For example, research areas such as palaeontology and sedimentology (allocated to Cambridge and Manchester) generate and rely upon objects considerably more than those concerned with neotectonics and structural geology (allocated to UCL and Leeds) (O'hara et al. 1989: 63). Furthermore, this had a knock-on effect on the distribution of researchers across UK university departments, both in the long term and immediately as a result of department closures. For example, in 1989, as a result of the closure of the University of Nottingham's Department of Geology, Professor Baker (Head of Department) was transferred to the University of Leeds (Wilson 2008), where he subsequently collected a significant amount material for both teaching and research purposes (interview with R. Finch 06/05/08). In this sense, the UGC review, while primarily a disciplinary factor, can also be seen to have shaped the collecting context indirectly through personal factors.

Within the context of the larger disciplinary developments taking place in the earth sciences and the academic reform that effectively transformed UK earth science provision, the more immediate disciplinary factors that continually shape the contemporary collecting context relate to research. In the earth sciences, research is central to the growth of the discipline; it is through research that new knowledge, theoretical developments and discoveries are made, and these, in turn, generate new questions and problems to address. Such developments may affect the collecting context in a number of ways, for example, at SEAES the curator described how researchers investigating radioactive waste disposal are making use of existing material, rather than collecting new samples (interview with A. Edwards 07/12/10). Thus, while objects may remain central to such research, the ways in which they are used (in this case, the samples...
perform as ‘materials’ rather than ‘geological specimens’) may make it unnecessary to collect new samples from the field.

While various factors may drive the development of research in certain directions, I will focus briefly on just one, namely the availability and precision of technologies and techniques. Indeed, Oreskes suggests that in the earth sciences, “often theory has followed advances in instrumentation and data-processing rather than the other way around” (2003: 773). Likewise, the significance of technologies and techniques is apparent from Hodder’s proposition that that the emergence of the new earth sciences “may be better considered as a change brought about by new “facts” that were themselves the result of technological improvement and innovation” (1997: 561). It is therefore useful to consider the ways in which the decision to collect emerges from the relationship between technology and research, and in order to do this, I will focus on two examples that were brought to my attention whilst interviewing academic research staff at the University of Manchester. So as to reflect the variety of ways in which technology may relate to different research areas, I have selected two very different research areas, namely, metamorphic petrology, and palaeontology.

The increasing precision of isotopic dating techniques has significantly affected a variety of different research areas. In order to both illustrate my point and provide some background to one of the examples that I explore in section 2.4, it is useful to focus on metamorphic petrology. Metamorphic petrology is concerned with understanding the processes that take place deep within the earth, and the ways in which they change rocks. It therefore follows that an understanding of the timescales involved in these processes is vital (interview with G. Droop 10/11/10). With increased instrumental precision, isotopic dating techniques have become more and more accurate, reliable and detailed, and as Dr Droop (Senior Lecturer in Geology at the University of Manchester) explained, in metamorphic petrology, one consequence has been the discovery that orogenic belts take considerably less time to form than had previously been assumed (ibid.). This, however, has meant that the established explanation no longer fits with the evidence available, and has therefore generated new research questions surrounding the mechanisms involved in the construction of orogenic belts. As Dr Droop explained: “new things come to light and it raises new questions, and sometimes, old established favourites have to be thrown away” (ibid.). Thus, through the increasing precision of dating techniques, new research questions arise which may (or may not) require the collection of new material from the field, and in this sense, the relationship between technology and the decision to collect is clear.

A further example can be found in the field of palaeontology where the application of new techniques is impacting on the ways in which vertebrate palaeontologists, in particular,
collect material. Whilst discussing the broader impacts of his research, Dr Manning⁴⁹ (Reader in Palaeobiology at the University of Manchester) explained; “the new techniques we’re developing will change the ways that all palaeontologists should collect fossils in the future” (interview 07/02/11). Here, however, it is not simply the emergence of new technologies that is of interest, but also the application of existing techniques from different fields – for example geochemistry – that are driving the discipline forward. Indeed, as Dr Manning explained:

…usually with palaeontology, or with any science, you’re contributing to a field. Here we’re building a new field. It’s a major difference – you’re looking at paradigm shifts in true Kuhnian fashion – from one major paradigm of how we presume how fossils are preserved, to one which is quantifiable, as opposed to qualitative (interview 07/02/11).

In order to apply geochemical techniques to palaeontological material, however, it has been necessary to move away from the traditional approach to field collecting:

…no longer are we jumping in a hole in the ground, ripping all the sediments away and pulling the bones out one by one. Now we’re trying to take out carcasses, because in amongst the bones there’s still remnants of the meat. And we can only find that if we collect the sediment which is encasing it (interview with P. Manning 07/02/11).

In this case, because the techniques require not only the fossils but also their surrounding matrix, it is less likely that existing material can be used for this type of research. In fact, it is precisely this surrounding material that has traditionally been painstakingly removed from fossils (for example, see: Clack 2002: 9). Furthermore, the need for ‘pristine’ uncontaminated material means that “samples, which have been handled and curated using traditional methods, are no longer suitable” (Edwards et al. 2011). Therefore, as well as affecting the ways in which material is collected, this research is also creating a need to go out and collect new ‘pristine’ material from the field (interview with P. Manning 07/02/11).

While these two examples illustrate the ways in which the development of new techniques and technologies may directly shape the collecting context for research material, the relationship between disciplinary developments and the collecting context for teaching material is perhaps less direct. In spite of the fact that course content - and therefore teaching collections - must necessarily reflect the discipline, and the fact that most research staff are also involved in departmental teaching activities, the effects of disciplinary developments on the collecting context for teaching material are less immediate than they are for research. This delayed response reflects the tendency for undergraduate course content – particularly lower-level courses – to focus on ‘finished science’ as opposed to the ‘unfinished science’ with which academic research is concerned. Thus, the impact of disciplinary developments on the collection of teaching specimens is less stark and much slower to take effect than it is for research collecting.

Although disciplinary developments tend to have little impact on the content for lower level courses due to their focus on classic or basic concepts that remain more or less stable

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⁴⁹ See: Appendix 6m.
(interviews with G. Droop 10/11/10; R. Finch 06/05/08; M. Holness 28/10/09; E. Passmore 13/04/10), higher level courses are more likely to be affected because they are often concerned with ‘unfinished science’ and more specialist concepts. At UCL, for example, there has been an increase in the number of higher-level courses concerned with less tangible topics such as trace elements and isotopes, amongst others, that do not require hand-specimens (interview with E. Passmore 13/04/10). However, while there may be no need to collect teaching sets to support such course units, objects may remain important, as the curator at SEAES explained; “whilst you haven’t got the physical object there, quite often they’re manipulating data, and the data comes from the object which may be sat downstairs” (interview with A. Edwards 26/10/10).

As these examples illustrate, disciplinary factors, ranging from the large-scale ‘revolution’ in the earth sciences and the national review of university provision, to the ongoing developments in research that continue to drive the discipline, necessarily influence the collecting context. From the fundamental matter of whether or not new material is in fact needed, to the particular localities and types of material that are collected, it is clear that the coming into being of earth science objects is inseparable from the disciplinary context within which it emerges. However, the examples above also confirm that within the collecting context, disciplinary factors intermingle, merge and blend into institutional and personal factors. For example, the fact that each of the case study institutions has particular research specialisms and strengths and offers particular course units for its undergraduate students, suggests that the response to disciplinary developments is settled at the institutional level. Furthermore, the relationship between disciplines and individuals is complicated by the fact that, as well as contributing to developments within the earth sciences, individuals may also be directly affected by them, as we saw with the UGC review. This relationship between individuals and the disciplines and institutions within which they work, becomes increasingly apparent below as I consider in detail the extent to which personal factors influence the coming into being of earth science objects.

2.2.2. Personal factors

The context within which collecting takes place cannot be considered without acknowledging the role of individuals, and again, it is useful to explain this in terms of two different levels of influence. Thus, and as mentioned above, on one level, individuals may influence the collecting context indirectly through their involvement in institutional or disciplinary matters. However, on a more direct level, individuals may also influence the collecting context through their direct involvement in the collecting process. In order to illustrate these two levels of influence, it is useful to make use of examples.

The regime within which the collection and subsequent use of earth science objects takes place, cannot be understood without acknowledging the numerous individuals who manage and work within academic departments, of whom the most powerful is likely to be the head of department. The head of department may influence the collecting context in a number
of different ways, and according to departmental curators who have witnessed a number of regime changes, disciplinary background, in particular, appears to play a significant role. For example, whilst reflecting on her experience of working with the collections at UCL since the late 1970’s, Dr Kirk (Curator of Collections at UCL) explained that individuals with a background in palaeontology, petrology or mineralogy have tended to be the more sympathetic and supportive of collections and collecting, due to the continued use of specimens for both research and teaching in these disciplines (interview 21/07/10). On the other hand, and as Mandy Edwards (Curator and Learning Resource Manager at SEAES) observed, the importance of collecting and collections may be less immediately apparent to an atmospheric scientist, for example, who may not have personally experienced the value of collecting and collections in practice (interview 07/12/10). In this sense, the disciplinary background of the head of department may fundamentally impact on the collecting context by either encouraging or discouraging the collection of material.

The extent to which personal factors may indirectly affect the coming into being of scientific objects has been particularly apparent at the University of Leeds where the influence of W.Q. Kennedy, both during his tenure and beyond, was brought to my attention by Bob Finch (School Curator and Deputy Technical Services Manager at the University of Leeds), and which provides an interesting example on which to focus. As Chair of Geology from 1945 to 1967 (Sutton 1980: 275), Kennedy’s advocacy for the importance of collections in both research and teaching was influential across the department, and ultimately leaded to the creation and growth of large collections.

As well as having learned and practiced geology at a time when the hand specimen constituted the basic unit of investigation for both research and teaching (interview with R. Finch 06/05/08), Kennedy’s enthusiasm for collecting and collections may also relate to his work at London’s Geological Museum. Kennedy was seconded to the Geological Museum for a brief period during 1932-3 in order to develop exhibits for the new museum which was to open at South Kensington (Sutton 1980: 284). His particular task was to develop exhibits concerned with metamorphism and volcanism for non-specialist members of the public, and according to Sutton, it was while organising the specimens for relocation to the new site, that Kennedy made “perhaps the most spectacular discovery of [his] career” (ibid). In laying out the metamorphic rock collection, Kennedy was able to identify relationships that had previously gone unnoticed, namely that movement along the Great Glen Fault had predominantly been horizontal, rather than vertical (ibid: 284-285). Thus, the opportunity to observe the distribution of various Scottish metamorphic rocks in this manner led Kennedy to “develop… his idea of the 100-km displacement along the Great Glen Fault in Scotland” (Thackray 1985). Such a positive

50 See: Appendix 6k.
51 See: Appendix 6f.
52 See: Appendix 6g.
53 As I explore in the discussion section, this ability to rearrange and reshuffle the objects - observing them with a unifying gaze – is precisely what Latour describes in Pandora’s Hope (1999b: 38).
experience of working with collections is likely to have contributed to Kennedy’s attitude towards collections and as a result, his attitude towards collecting.

As Chair of Geology, Kennedy became the driving force behind the growth and expansion of both the department and its collections: “To improve the practical teaching he compiled extensive explanatory notes and upgraded the teaching collection with additional material arranged in a schematic manner which emphasized the essentials” (Sutton 1980: 291). In order to generate the material that he believed was essential to the success of the department, Kennedy actively encouraged the collection of specimens; “He had a philosophy of: collect the stuff, bring it back, and we’ll deal with it later” (interview with R. Finch 17/11/08). As well as influencing the attitude towards collecting, Kennedy’s disciplinary interests were also fundamental in shaping both the research and teaching activities of the department: “One can be sure that Kennedy arrived in Leeds with a clear picture of what he intended to do. He shifted emphasis in research to studies of petrogenesis and tectonics” (Sutton 1980: 290).

This influence is particularly apparent in the establishment of the Research Institute for African Geology (RIAG) which was driven by Kennedy’s personal interest in African geology – an interest that had been sparked by Professor J.W. Gregory (Chair of Geology at Glasgow University) when Kennedy was an undergraduate student in the 1920s (Sutton 1980: 277). The establishment of the RIAG, so the story goes, came from a ‘chance meeting’:

Kennedy, on a plane in Africa, was talking to Ernest Oppenheimer, of Anglo American Corporation. In conversation, Oppenheimer said that conventional techniques of mineral exploration and conventional geological ideas needed supplementation. He would like to endow a group to do research and to develop new ideas on mineral deposits in Africa, and "who should he give the money to". Kennedy said "Leeds", and Oppenheimer did so (P.G. Harris quoted in: Sutton 1980: 295).

As well as creating the RIAG, Kennedy "inspired and guided most of its work: he …also held together those working in the Institute by bonds of personal friendship and admiration" (Shackleton 1966b: 1).

In shaping the department and in particular, by establishing the RIAG, Kennedy also affected both the types of material being collected and their uses, and this continued for a period of over 20 years. To some extent, all of the material collected during this period can be attributed to his influence (interview with R. Finch 17/11/08). Indeed, even after Kennedy left the department, his influence endured through the legacy of both the collections he amassed and his attitude towards collecting. While the period of ‘obsessive and frantic' collecting was most marked under Kennedy’s leadership (interview with R. Finch 06/05/08), it was not until the mid 1980s that the phase of active collecting for teaching finally came to an end, over a decade after he left. This legacy suggests that to some degree, Kennedy’s attitude to collecting had become ingrained in the department, demonstrating the extent to which personal factors are capable of influencing collecting.
In addition to the indirect influence of individuals, it is also important to acknowledge the direct ways in which people may influence the collecting process. In terms of the collecting context, perhaps the most direct influence over the material being collected relates to the individual collector. In order to illustrate this, I focus on Dr Marian Holness54 (Reader in Petrology at the University of Cambridge), whose research into the textural development of high-temperature rocks has most recently involved collecting samples from an igneous intrusion in East Greenland. In discussing the collecting process with Dr Holness, it became increasingly apparent that her particular approach to collecting and the value that she places on objects – in particular, those that have been well documented – reflects her personal experience of using existing collections of material.

Dr Holness attributes her appreciation for objects and collecting to an incident that occurred relatively early on in her career when she experienced, first-hand, the value of accessible and well-documented samples as a source of inspiration:

…when I started doing my PhD, I was given a rather nebulous idea of what problem to work on, and so I went to see Graham Chinner [former curator of the Sedgwick]… and I said ‘I’ve got this problem. What sort of rocks should I look at?’ and he said ‘I know just the one’. And he sort of took me into the teaching lab and opened the drawer and said ‘Right. These are the rocks you should look at’. And so ever since then, whenever I’ve had an idea about a possible problem to work on, I go to the Harker Collection and I think… where in the world am I going to find these things. And I just look there. I just browse through the thin sections (interview 28/10/09).

Indeed, her current research in East Greenland grew from existing collections in much the same way:

Because there was an ancient drill core out in the rock store, and it had been worked on by several people - PhD students. There are one hundred and something thin sections through this drill core, and that was the first place I went when I was sort of scoping out this project; the very first place. And I found something, you know, within a couple of weeks of looking… And that’s the way I work; I go to our collection and look, I find something, and then I think what are the samples I need to chase this up. And then I have to go and collect the samples myself (ibid.).

As well as positive experiences of using existing collections, Dr Holness’ attitude towards collecting, and in particular her approach to the documentation and accurate field recording of material, has been influenced by some less constructive encounters. For example, due to the age of much of the material in the Sedgwick’s Harker Collection, the accuracy of the locality data and the ambiguity of the field notes that are archived alongside the objects, have made many specimens relatively useless for modern research. Her awareness of the difficulties associated with relying on other people’s data have strongly influenced the way that she collects; in order to ensure that her material remains as useful as possible in the future, Dr Holness is particularly thorough when recording associated information in the field (interview 28/10/09).

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54 See: Appendix 6j.
In considering the impact of personal factors on the coming into being of earth science objects, it is clear that individuals have the capacity to shape the collecting context in a variety of different ways. On one level, personal experiences and attitudes towards objects may directly affect the approach that is taken in the field. Likewise, it is also clear that individuals - in particular those who are powerful within an institution – may also indirectly shape the collecting context through both their attitude towards collecting and their interests in particular disciplines. Indeed, in the case of Kennedy, the influence of the individual appears to have become embedded in the department, to an extent that it continued to shape the collecting context - even in his absence. The influence of personal factors, whether direct or indirect, does not, operate in isolation; individuals cannot be separated from the particular contexts and conventions of the disciplines within which they work and likewise, disciplines themselves are, to some extent, driven by the work and passions of individuals. Perhaps even more fundamental, however, is the relationship between people and institutions. In considering the influences that affect the coming into being of earth science objects, it has become increasingly apparent that the institution dominates the collecting context by effectively acting as a filter through which the other factors are refined.

2.2.3. Institutional factors

The collecting context is fundamentally related to the particular institution within and for which field collecting takes place. In order to illustrate the impact of the institution on the collecting context, I focus on two particular institutional factors that directly affect the collecting context, namely policies and resources. However, it has also become apparent that institutions also affect the collecting context in a broader, more general sense and therefore, having considered the ways in which policies and resources may shape the collecting context, I take a step back in order to acknowledge the ways in which the broader institutional context influences the coming into being of earth science objects.

While it has become clear that both disciplinary and personal factors may significantly influence the collecting context, to some extent, they are themselves shaped by institutional factors. Indeed, policies provide an effective means of embedding the larger ethos and direction of an institution. For example, the school curator at Leeds explained how institutional policies determine the relative proportions of research and teaching provision within departments:55

> [there is a] dichotomy between teaching and research and the two can’t really exist in the same plane. But these things switch focus over a period of time. At the moment it’s research intensive so staff are forced to put in research grants and forced to earn their money in that way, and that is the focus at the moment. That will change… a while ago it was all about teaching and everyone was forced to do teaching, but now it’s all about research. It will switch (interview with R. Finch 06/05/08).

55 With the exception of LJMU (where there is no earth science research) this shift in emphasis between research and teaching is common at all of the case study institutions (interviews with: A. Edwards 26/10/10; W. Kirk 21/07/10).
Such decisions significantly affect the collecting context by determining the intended use of objects within the department and therefore influencing the amount and type of material that is collected.

At UCL, for example, Dr Kirk explained how the current teaching focus has led to a steady increase in student numbers and as a result of this, it has been necessary to collect additional duplicate samples in order to bolster the teaching sets used for certain course units (interview 21/07/10). However, superimposed onto the university-wide teaching focus, the collecting context at UCL has also been influenced by department-level policies. For example, in 2008 the department carried out a review of its undergraduate teaching provision (see: UCL 2008a) which led to a reduction in the number of practical sessions offered for particular course units, and therefore, impacted on the collecting context by reducing the demand for certain types of teaching material (interview with W. Kirk 21/07/10). In this case, however, the policy itself reflected the need for the department to balance the costs of undergraduate teaching with the income it generates (UCL 2008a). Indeed, as this example illustrates, the distinction between policies and resources is not always clear because policies are not only a means of controlling resources, but may themselves also be shaped by the availability of resources in the first place.

At the most basic level, financial resources directly impact on the collecting context by dictating whether or not field collecting actually takes place. However, the availability of resources may also affect the particular locality from which material is collected, the length of time available in the field, and the amount of material that is collected, because travel, time and transport all cost money. In terms of research material, the influence of resource availability on the coming into being of scientific objects is particularly well illustrated by the RIAG at the University of Leeds, which was established using a substantial grant (£100,000) from the Anglo American Corporation of South Africa (Kennedy 1956b: 1). A particularly significant factor for the RIAG was that the grant had no conditions attached to it and as a result, it was solely on the basis of geological factors that the Institute selected its particular research focus. Therefore, because there were no restrictions on the grant, Kennedy was able to direct the Institute’s activities towards those areas in which he was personally interested, namely on problems concerning the geochemical provinces of Africa and the structure of the Precambrian rocks in Central and Southern Africa (Kennedy 1956a: 5). This decision fundamentally shaped the nature of the Institute’s research projects, and therefore, influenced the material that was generated as a result. While Kennedy played an important role in shaping the RIAG, it was the lack of restrictions that were placed on the grant that allowed him to exert such influence.

As well as directly impacting on field collecting on the grand scale, it is also worth briefly mentioning the indirect impacts of resource availability on the collecting context. For example, as result of the particular nature of the grant from Anglo American, the RIAG was free to purchase any equipment that it felt was necessary to conduct fieldwork in Africa, and this allowed the Institute to acquire numerous Land Rovers specifically for use in African fieldwork.
Considering the fact that “successful geological field work in Africa depends primarily on transport” (Kennedy 1956b: 2), the presence of these Land Rovers was vital in order for fieldwork (and therefore the collection of material) to take place. As such, the availability of resources influenced the collecting context by providing both the opportunity to collect and transport material, and the means of accessing particular localities from which it was collected.

In addition to the impacts of institutional policies and resources, the coming into being of scientific objects is also related to the larger institutional context within which collecting takes place. In order to explore the impacts of the institution itself on the collecting context, I focus on LJMU. Perhaps the most significant feature of LJMU is that, unlike the other case study institutions, earth science provision is limited to undergraduate-level activities. The lack of earth science research has directly impacted on the collecting context in two ways. Firstly, in order to support the content of undergraduate course units, material tends to be collected from classic British localities. Furthermore, in order to function as teaching specimens, it is necessary to collect ‘representative’ or ‘ideal’ examples, as opposed to the collection of material for sampling or analysis that would occur in research. In this sense, the focus on undergraduate activities directly shapes the collecting context by limiting the functions of collected objects. The lack of research in the school can also be seen to have affected the collecting context at LJMU indirectly. For example, because the school does not receive funding for research in the earth sciences, Hazel Clark56 (Senior Technician at LJMU), explained how there is neither the means nor the need to acquire high-tech sophisticated analytical equipment, and as a result, teaching is relatively low-tech with an emphasis on object-based learning (interview 23/03/09). Indeed, the importance placed on the role of objects in teaching appears to have granted collecting a special status, not just a necessity but also something to be encouraged (interview with J. Crossley 24/06/09).

As well as affecting both the demand and attitudes towards field collecting, a further impact of the school’s teaching focus relates to the availability of space. The absence of research-level collecting and, therefore, the lack of responsibility for retaining (potentially bulky) collections of research material, combined with the availability of storage space due to “strategic investment over the past few years” (Kerwin 2003: 40), has effectively sanctioned the continued growth of the collections (interview with H. Clark 23/03/09). Indeed, the relatively small size of the collection means that it is fairly well contained and discreet; it is not a ‘problem’ to be dealt with because its existence and growth appear not to impact on the daily running of the school. Thus, at LJMU, the school’s teaching focus, the emphasis placed on object-based learning, the attitude towards collecting, the continued availability of space for storing material, and the unimposing nature of the collections (amongst other things) contribute to the unique institutional context within which resources are allocated, policies are implemented, and through which disciplinary and personal matters are filtered.

56 See: Appendix 6c.
As the case of LJMU illustrates, the institution plays a fundamental role in influencing the context in which collecting takes place. While this role cannot be overstated, it is worth noting that, because of the complex ways in which various components of the collecting context interact, and the geographical and intellectual distance that separates the act of collecting from the constraints of the institution, it is difficult to identify particular examples of the relationship without making generalizations. Nonetheless, having considered examples from a variety of different university departments, it is evident that the collecting context is shaped by institutional, disciplinary and personal factors and the larger institutional context from which they arise. However, the collecting context is only half of the story; in order to understand the coming into being of earth science objects, it is also vital to acknowledge the pragmatics of collecting.

2.3. The pragmatics of collecting

The creation of an earth science object is the result of a conscious decision to remove a particular piece of material from the field. While the collecting context provides the intentions and rationale for collecting material, the decision to collect an object must also be understood in relation to the immediate conditions experienced in the field (over which the collector may have little or no control) – the pragmatics of collecting. While the act of collecting may appear to be relatively straightforward – knowing what you want, finding it and then collecting it - detailed discussions with collectors have revealed that the coming into being of scientific objects is perhaps more complex than originally expected.\(^{57}\) Indeed, due to the interplay of various factors, every act of collecting must be considered unique. It has, however, become apparent that in spite of this complexity, the collecting process can be broken down into a number of smaller steps, namely selection, removal and inscription, and these provide a useful framework within which to consider the pragmatics of collecting. After introducing the pragmatics of collecting in relation to these three steps, section 2.4 focuses on two accounts of the collecting process in order to illustrate the variety of ways in which the coming into being of scientific objects is shaped by both the immediate conditions experienced in the field and the broader collecting context.

2.3.1. Selection

Selection lies at the heart of the collecting process, and as Daston and Galison explain; “No science can do without such standardized working objects, for unrefined natural objects are too quirkily particular to cooperate in generalizations and comparisons” (2007: 19 & 22). In the earth sciences, the coming into being of scientific objects is the result of a conscious decision to select and remove a particular piece of material from its in situ occurrence, and as such, involves some degree of intention on the part of the collector. While selection takes place within the larger collecting context, it is also significantly influenced by the immediate experience of the collector, the particular material being collected, and the specific locality from which material is being collected. Central to the selection process, whether collecting rocks, minerals or fossils, is

\(^{57}\) As is apparent from the initial accounts of the collecting process given by collectors (for example; Interview with R. Finch 06/05/08), as I have explored in considerable detail elsewhere (Chalk 2011).
the matter of legality; ensuring that any regional, national, or international laws that may restrict or regulate the field collection of material, are closely followed. For example, and as Dr Manning explained with regard to the field collection of palaeontological material:

If, for instance, it is covered by CITES convention [Convention on the International Trade in Endangered Species of Wild Fauna and Flora] or by regional government or even local parish laws [this] can restrict access to material. And there is absolutely no point in collecting that material unless you abide to those laws, because you are unable to publish it... If I collect something and I can't publish on it, what was the point? The outlay of the money and time is just pointless (interview 07/02/11).

The transformation of pieces of nature into scientific objects therefore begins with selection, and the selection process is subject to a multitude of different factors relating to the individual collector, the material being collected, and the place where collecting takes place. For example, Dr Droop explained that when collecting rocks, a standard requirement is that material is ‘fresh’ because this aids identification and shows the true nature of the rock more clearly (as opposed to a weathered surface which may have been altered and may also be more friable) (interview 10/11/10). Furthermore, and particularly for research specimens, material should ideally be collected in situ where it is possible to identify the exact position, locality and associations of the specimen (ibid.).

As well as general conventions of collecting, other factors such as an individual’s prior knowledge and experience may affect the decision to sample particular pieces of material, as was apparent from Dr Holness’ account of collecting material in Greenland on her return trip to the research site:

...the first time we went out there and we just did a rough sample traverse every ten metres, and you get the data back and you think [gasp] if only I had more samples from this particular region, I could address some new questions there... that’s why I always try to go back to the same place twice. So the second time we went, we were doing a lot of re-sampling in between previous samples to make sure we had full coverage of the different variations (interview 28/10/09).

However, while the collector may set off with such intentions in mind, the conditions experienced at the time and place of collecting may also considerably impact on the selection process. Thus, uncontrollable factors such as the environment, in particular the terrain, light levels, visibility or weather conditions, may significantly impact on the selection process; as Dr Holness continued:

When the sun comes out it can be lovely but we were plagued with sea fog that would come in every afternoon. So you’d see them come in; they’d look lovely - small fluffy clouds – and then they’d stream in, and then they’d overwhelm you. It gets freezing cold and just horrible (interview 28/10/09).

The particular occurrence, distribution, associations, or appearance of the material being collected may also influence the selection of samples. Indeed, the ways in which collectors encounter relevant material may significantly shape the selection process, and this
was particularly apparent from Emma Passmore’s\(^{58}\) (Curator of Collections at UCL) account of
the collection of Suevite\(^{59}\) samples (see: Figure 2a) from the Reis Crater in Germany (interview
21/06/10). Because in this particular case, the collecting site was a former quarry, the
appropriate samples had to be selected from loose material rather than being located within a
larger outcrop. Therefore, the selection process required the collector to distinguish potentially
useful samples from the abundant mass of deteriorating and crumbly material that covered the
floor of the collecting site. However, because the material was being collected for teaching
purposes, in selecting samples, it was also necessary to collect hand-specimen sized pieces.
Thus, as a result of both the occurrence and purpose of the material, the collector explained
that; “I did end up leaving stuff behind that was quite altered because it just won’t be any good
in the collections in five years time, it would have fallen apart” (interview with E. Passmore
21/06/10). Finally, in this case, the selection process was also strongly influenced by the way in
which the material was to be transported back to the department, as Emma Passmore
explained:

> I brought them home in my hand luggage, in my hold luggage. But its one of those
things where you want to bring back specimens that are big enough to be useful for

teaching but you’re usually limited by Easy Jet’s baggage allowance …in this situation,
you know, you have to sort of be careful, and I didn’t want to bring back 15 kilos of rock
and lug them all the way across London. So it was literally a couple of hand specimens
(interview 21/06/10).

In selecting samples, the collector must constantly negotiate between what is required
and what is available, making judgements and compromises to ensure that they collect material
that is suitable for its particular purpose, whilst remaining realistic about its accessibility,
removal and transportation. Selection, however, is largely a conceptual stage in the collection

\(^{58}\) See: Appendix 6n.

\(^{59}\) Suevite is a type of rock that is associated with impact craters.
process, and while it may involve physically moving around a site, the collector’s interaction with their surroundings is largely visual. Thus, while these examples have illustrated the extent to which selection is affected by the various experiences and intentions of the collector and the conditions in the field, selection alone does not transform pieces of nature into pieces of science; having identified suitable material, the next step is to physically remove it.

2.3.2. Removal

Having identified a suitable sample, the collector must go about removing it, and this process of removal is also shaped by the interplay of a variety of factors. For example, the level of skill, strength, experience and dexterity of the collector may affect the material that is collected; so too may the material’s hardness, distribution, friability and structure. While loose material may be relatively easy to collect, as was the case for the suevite samples; “we were literally picking bits of rock up off the floor” (interview with E. Passmore 21/06/10), removing material from in situ – physically hammering material from an outcrop may be less straightforward. For example, as Dr Droop explained, the easiest way to remove samples from an exposed surface is to focus on the corners as these can most easily be knocked off with a hammer; it is almost impossible to remove samples on flat or concave surfaces using just a hammer (interview 10/11/10).

The physical act of hammering material from an outcrop requires a certain degree of strength and skill, and even for experienced collectors, this remains a challenge. With reference to her experience of collecting samples in Greenland, Dr Holness explained how:

…the rocks are really really hard and it takes maybe five or six hammer swings with a four pound hammer. And sometimes what you break off is not good enough, so you have to do it again. And I spent one day collecting 38 samples and I could barely move by the end of the day… Physically your whole back and body seizes up (interview 28/10/09).

Furthermore, the removal of material may also be shaped by the particular conditions at the collecting site, and in addition to the environmental factors mentioned above, accessibility is also significant here. Indeed, as Dr Holness explained, the collector may have to make a compromise between collecting the ideal sample and personal safety:

You just have to make a judgment as to how desperate you are and whether you can move sideways and maybe get something from the same layer but in a different place (interview 28/10/09).

In this sense, the selection and removal of material may take the form of a cycle rather than a linear sequence: if the collector is unable to access or remove the selected material, it may be necessary to revisit the selection criteria and start again.

No matter whether material is physically extracted from an outcrop or simply picked up off the floor, the process of removal changes the object both physically and conceptually. As Henning observes; “The very act of collecting is a transformative act, a surgical operation of excision which violates that which it leaves behind” (2006: 59). Physically, the appearance of an
object may change as a fresh surface is revealed, or as all three dimensions of the object are exposed; removal may also involve reshaping or resizing an object, changing its mass and dimensions. Conceptually, removal transforms pieces of something – whether that 'something' is a landscape, outcrop, exposure, deposit, debris, scree or talus – into objects with particular purposes. If the object is discarded at this point, its involvement with the collector would mean that it returns to nature as an artefact – albeit a fleeting one, because of the intention involved in its selection and removal. However, selection and removal alone do not change natural material into scientific objects; in order to achieve this status, a further step is required.

2.3.3. Inscription

In order to turn pieces of nature into pieces of science, the material that has been selected and removed must be inscribed, and once again, this process affects the object both physically and conceptually. Physically, rocks in particular are often marked directly with various numbers, symbols, letters or words in order to record reference numbers or to orientate the specimen. However, and as Dr Manning explained, this practice is perhaps less appropriate for palaeontological material:

> …with fossils if you can avoid writing on them you do. If you do have to write on them, you do it in a place where you think, well, I’m not going to lose any data from that. If you collect it, keep it on its matrix so you can write on its matrix if need be, and also with matrix, you can also sub-sample below the surface to get actual quantitative data on the sediments (interview 07/02/11).

The precise details and style of inscriptions are strongly influenced by institutional, personal and disciplinary factors such as particular conventions, expectations, requirements or preferences (as I consider in more detail in the next section). However, while some details may be written directly onto the object, the vast majority of the detailed information that is recorded by the collector is written in a field notebook. For example, when asked about the purpose of field notes, the school curator at Leeds explained that:

> …it’s all matched up to this synchronization with the field note book – the thing is that the field note book should have the information in there referring to your collection point – that’s vital (interview with R. Finch 17/11/08).

The type of information that is recorded about an object varies considerably depending on why it is being collected and its intended use. However, it is relatively standard practice to record observations about the object’s occurrence such as its position, location, associations and horizon: “you try to write down as much as possible that you know about it” (interview with E. Passmore 21/06/10). The record in the field notebook is linked to the object through a shared reference number; conceptually, the object is changed through its attachment to such data, observations and records. As Latour notes; “samples will remain attached to their original

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60 The extent to which such 'worked stones' remain natural resembles the 'eolith controversy' which was played out in archaeology during the Victorian period (see, for example: Bont 2003; Ellen 2008; O'Connor 2003), as mentioned in section 1.2.

context solely by the fragile link of the numbers in black felt-tip pen on the little transparent bags” (1999b: 46). Indeed, the reference and its continued association with the object is essential for scientific objects, and this is apparent from the lengths to which collectors (in this case Dr Holness) will go in order to ensure that the two remain attached:

I have an indelible marker pen and I write the sample number on the rock. And then it goes into a plastic bag and it’s written on there as well... and we’re always worried when we’re shipping them that they’re going to be rattled around and the numbers might be abraded off, so we get a piece of paper and write the number on that and put that in the bag, and then tape it up with duct tape (interview with M. Holness 28/10/09).

Through inscription, the selected and extracted object becomes a tangible vessel for the associated information that its number represents, and therefore, it also becomes a substitute for the original natural object in situ. By combining object, inscription and associated information, the collector is able to bring a piece of the field back to the department, and in this sense, the processes and practices involved in the collecting process create a stabilizing network which tames the potentially unruly object (c.f. Edensor 2005: 313). At this point, having been selected, removed and inscribed, the object has become something else; no longer part of outside nature, the object has become a scientific specimen.

2.4. The collecting process

In order to illustrate the ways in which the coming into being of scientific objects emerges from both the pragmatics of collecting and the larger collecting context within which the decision to collect material is made, it is useful to focus on concrete examples. At this point, it is useful to move away from the brief snap-shots that I have thus far used to illustrate the impacts of various factors in isolation, and instead consider first-hand accounts of the coming into being of earth science objects. In order to reflect the range of objects that I have identified as ‘scientific’, it is necessary to consider the collecting process for both research and teaching material. Therefore, the first example is concerned with the collection of research material for the University of Manchester, whereas the second example focuses on teaching material for the University of Leeds. After examining these two detailed accounts of field collecting, I close this section by reflecting on the extent to which the intended purpose of material affects the collecting process.

2.4.1. The coming into being of research objects

The ways in which both the collecting context and the pragmatics of collecting relate to the material that is collected for research purposes will be illustrated by focusing on an account provided by Dr Giles Droop (The University of Manchester) concerning the collection of eleven samples of material from a locality on the top of a mountain called Cima Di Gagnone in the Swiss Alps. The material was collected during fieldwork in the Central and Western Alps which took place over a period of three and a half weeks during September 2010 and which resulted in the collection of approximately 280 specimens from 112 individual localities (interview with G. Droop 10/11/10). The fieldwork took place as part of a research project concerned with
understanding how seawater elements get down into the earth’s mantle (see: Figure 2b), and the material will be analysed using a mass spectrometer to measure the noble gases and halogen isotopes contained within the samples (ibid.). In its research context, the material will be used as evidence of either the presence or absence of pristine seawater (or the total isotope signature thereof) in minerals (or inclusions therein) in deeply subducted ocean floor.

Because the research project aims to discover whether or not a particular phenomenon exists, the material that was collected had to meet a number of criteria in order to maximise the chances of finding a seawater signature. Firstly, because the research is concerned with a particular process (i.e. subduction), it was necessary to collect samples of subducted oceanic crust, as this is the most likely type of material to contain seawater signatures, if they do in fact exist (interview with G. Droop 10/11/10). Secondly, in order to ensure that the material would be appropriate for isotopic analysis, it was also necessary to collect relatively young material (ibid.). Finally, in order to enhance the authority of the research, it was necessary to collect material from well-known and well-studied localities - if material was collected from poorly known localities where the process of formation was uncertain, the research findings would lack

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**Figure 2b:** A sample of garnet peridotite (a piece of the earth’s mantle) collected by Dr Droop from Alpe Arami (Central Alps), during fieldwork (specimen TCL3).

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62 The research project - titled ‘Noble gas, halogen and water recycling into the terrestrial mantle’ - began in July 2010 and is taking place at the University of Manchester’s SEAES within the Isotope Geochemistry and Cosmochemistry Research Group involving Deborah Chavrit (postdoc researcher) Professor C. Ballentine, Dr R. Burgess, Dr G. Droop and Dr. A. Pawley (see website: SEAES 2010).
credibility. Furthermore, by collecting from well-characterised localities, the team benefited from much of the groundwork having already been completed by other researchers (ibid.).

The decision to collect material from the Central and Western Alps was made because the locality met all three criteria; providing an opportunity to collect samples of oceanic crust that had been subducted relatively recently and which occurred in well-characterised terrain:

…there’s a huge literature on the Alps, because it’s one of the best places for finding that sort of thing. And they’re also very young which is good from an isotopic point of view. So young well-characterised terrain is absolutely ideal for this project. If there’s no signature in the material we collected, there’s no signature! (interview with G. Droop 10/11/10)

The decision to collect material from the Central and Western Alps was, however, also related to Dr Droop’s long-term interest in the area, as he explained: “I’ve always been interested in the Alps. I did my PhD in the late 70s in the Austrian Alps” (interview 10/11/10). In selecting this locality, the project therefore also benefited from Dr Droop’s extensive knowledge of the terrain and his awareness of the depth and extent of existing research. Thus, having selected the broad area from which to collect material, the team had to select particular field sites to visit during the fieldtrip.

…we drew up a wish list of localities… In many cases, there’s enough information about a particular locality to start with. So it wasn’t a mapping trip – we were relying on other people’s maps and other people’s information… There’s a huge amount of very very high resolution detail there, so basically, making use of all that useful stuff so we could hone in on the selected sites and pick out different parts of it (interview with G. Droop 10/11/10).

One of the sites happened to be on the top of a mountain called Cima Di Gagnone and it is on this particular locality that I now focus.

In order to collect material from Cima Di Gagnone, it was necessary to overcome a number of access issues, both physical and political. Firstly, there was the matter of physical access; at 2380 metres above sea level “there was no way we were going to climb [it]” (interview with G. Droop 10/11/10), and therefore, the team had to write the cost of chartering a helicopter for a day (£1,000) into the research grant. Furthermore, it was also necessary to get permission to collect material from the site and as Dr Droop explained:

I don’t think there’s anything that prevents you from sawing the rock – you aren’t allowed to use gunpowder! That was in the large print! Yes, so we had to get permission – anything in the Swiss part in particular - they are very strict (interview 10/11/10).

For this research project, the costs of accessing the site were justified by the importance of the locality. Indeed, the particular processes involved in the formation of the rocks on Cima Di Gagnone made them ideal candidates for yielding a seawater signature (interview with G. Droop 10/11/10).
While the need to collect material that was likely to contain evidence of seawater provided the main criteria for selecting specimens, a number of other factors concerned with both the nature of the research project and the intended use of the samples, were taken into consideration when deciding which samples to collect. In addition to the standard preference for fresh material collected in situ, the size of samples was also felt to be important. In order to ensure that there was sufficient material to act as a reference for future checking after cutting thin sections and carrying out a number of different destructive tests, it was decided to collect samples roughly the size of a brick (interview 10/11/10). Furthermore, it was also preferable to collect coarse-grained material because of the particular nature of the research project: “If it’s the inclusions in the minerals that are important as hosts to this seawater, then obviously… [it’s] the larger crystals that are going to be important” (ibid.). Finally, in order to cover all bases and to ensure that a sufficient amount of relevant material informed the research findings, even if the origins of some of the samples were subsequently called into question, it was necessary to collect plenty of material: “that’s the thing, all these different types of opinion that one has to watch out [for]. So, the issue was… that we had [samples] from enough places” (ibid.).

Therefore, in selecting samples, as well as a preference for coarse-grained unweathered material of a particular size, the team also had to ensure that they collected a sufficient number of samples, ideally from in situ. With this in mind, a total of 11 samples were collected from ‘Locality 2’ on Cima Di Gagnone. The material was given a reference ‘DC’ (the initials of the post-doc student) plus a locality number (in this case, 21) and a letter (identifying individual items from each locality – in this case letters A-H were used and E consisted of four pieces which were marked i-iv), both of which followed in sequential order. The reference was marked directly onto the rock using permanent pen and then the sample was put into a plastic bag which was also marked with the reference (see: Figure 2c) (interview with G. Droop)
Due to the nature of the research project, the purpose of the associated information was to add context to the samples, effectively recording; “what makes it different from the others, so... almost why you sampled it. And we’d usually photograph the place” (ibid.). Therefore, the information that was recorded in the field notebook included: the exact locality details (GPS grid-reference), whether it was collected from in situ or ex situ, measurements of the associated structures, any foliation or attitude information, and if it was close to a contact then details of the nature of the contact and it’s attitude (ibid.). The labelled and documented samples were subsequently posted back to the department.

While these details illustrate the reasons for collecting and selecting material, they do not fully account for the decision to collect particular samples rather than others. In order to understand this, it is also necessary to acknowledge the ways in which the immediate conditions experienced in the field influenced the selection and collection of material. In this case, the collectors arrived at the site knowing exactly what they wanted to collect, however, what they did not know was exactly where to find it. Because the material of interest was located within a larger body of rock measuring approximately 100 metres in diameter, this took some time:

And well, we found it because it was a different colour and it’s got garnets in it. But it did take quite a bit of finding. So we were scrabbling around on a fairly steep slope – ok we were on the top of the mountain and luckily, that side of the mountain was fairly flat, but even so, we were scrabbling around in the scree – it was fairly hard going (interview with G. Droop 10/11/10).

Having located the material, it became apparent that the site had already been heavily sampled by people using rock saws: “you could see where they’d cut into the rock and cut stuff out. They must have taken the heavy machinery up there in a helicopter to get it up there” (interview with G. Droop 10/11/10). As a result of the previous sampling, it was much more difficult to remove material, and this influenced the collection process by reducing the amount of potentially useful material from which to select samples.

The availability of tools was also an important factor that affected the particular pieces of material that were removed: “I have a long-handled 4lb sledge hammer which is my main weapon!” (interview with G. Droop 10/11/10). Having removed material, a smaller hammer with a chiselled edge was used to “trim off the weathered surface and get it down to a practical size” (ibid.). However, tools alone do not remove samples from an outcrop; when it comes to collecting, a hammer without a geologist is as effective as a geologist without a hammer. Thus, as well as the availability of particular tools, the particular pieces of rock that were removed from the outcrop were also related to the skill and strength of the collector. As Dr Droop explained:

I’ve had years of practice. I can tell whether things are going to yield... And a lot of these places, you’d have to pound away quite a lot to get some decent samples. And of course a place like that, maybe only a couple of percent of the rock is the stuff you wanted (interview 10/11/10).

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63 See Klemun (2011) on the relationship between geologists and their tools.
While the original selection criteria included a preference for material in situ, in practice, this was not always possible. Indeed, only four in situ samples were collected from the Cima Di Gagnone site, reflecting the difficulties experienced in removing appropriate material. While it is considered good practice to collect material in situ (as mentioned above in section 2.3.1), the availability of a considerable amount of material ex situ and the circumstances of its occurrence affected the decision to collect some ex situ samples:

...we also made use of loose material – you can guarantee it there. You know, you have huge great meter-long angular blocks of peridotite [a coarse grained igneous rock] in a peridotite locality, there’s no doubt that it’s from there. So we were poking around to see what we could find (interview with G. Droop 10/11/10).

As a result of the occurrence of the ex situ material, in particular the degree of certainty with which it could be located, a further seven samples were taken from the loose blocks. Finally, the decision to select and collect particular samples was also influenced by the conditions experienced on top of the mountain. On the day, the weather conditions were particularly favourable; “it was just beautiful blue sky, fantastic – hot” (interview with G. Droop 10/11/10). In terms of the collecting process, such weather conditions were advantageous for both finding the appropriate material and more generally, for working at the particular site. However, “you could feel the thin air. You could definitely notice the slightly thin altitude at that height” (ibid.). In this sense, the effect of the altitude may have also affected the collection of material, in particular by making the task of removing material from in situ even more difficult.

By examining a detailed account of the collection of research material, it is clear that the particular objects that were collected can be understood as a combination of intentions - established through the collecting context, and experiences - related to pragmatic factors. In this case, the collecting context combined: institutional factors such as the availability of resources and support for the research, as well as the department’s strength in isotope geochemistry; disciplinary factors which relate to the research project and the broader technological developments that have made such research possible; and personal factors which include Dr Droop’s particular interest in the Alps, his knowledge of the existing research in the area, as well as his skill and experience in using a hammer. The decision to collect particular pieces of material was, however, more directly a result of the distribution and occurrence of the particular material of interest, the fact that the site had previously been heavily worked over, the hardness of the rock, the availability of tools, the weather, and the altitude, amongst other things. In this sense, it was both the intentions of the collector and the experiences of collecting that generated the eleven particular samples that were removed from the mountain.

2.4.2. The coming into being of teaching objects

As mentioned above, scientific objects are taken to include both research and teaching material, and it is therefore necessary to consider an additional account of the collecting process – one concerned with the coming into being of teaching material. For this example, I focus on an account provided by Bob Finch (School Curator at the University of Leeds), concerned with the
collection of three pieces of sillimanite schist (a type of metamorphic rock) during a field trip to Ireland. Due to an increase in class size, it had become apparent that the teaching sets used for ‘Sedimentary and Metamorphic Petrology’ practicals were no longer sufficient to cater for the number of students studying the course. In particular, there was a need to acquire additional samples of sillimanite schist. In its teaching context, the function of the sillimanite schist - through the combination of a hand specimen and thin section - is to display a distinct fabric and mineralogy. By observing these features, students can determine relationships between the sillimanite schist and the other rocks contained in the teaching set, with a view to establishing the chronologies of the metamorphic processes that have taken place (interview with R. Finch 06/05/08).64

The sillimanite schist in the teaching sets had in fact been taken from an old research collection (see: Figure 2d), and because there was no further material available in the research archive, it was agreed that the new material would need to be collected from the field when a suitable opportunity arose (interview with R. Finch 06/05/08).65 Indeed, the opportunity arose during the school’s annual second year Easter field course in Connemara, where similar rocks are known to exist. Because the function of the sillimanite schist relies on the presence of particular fabric and mineralogy, and since these features are not location-specific, the collection of new material was not limited to the site from which the original material came (ibid). Therefore, the main influences that directed the selection process were the need to collect material that both contained sillimanite and displayed the particular fabric. As a result, three separate pieces of sillimanite schist were collected from three different locations at the collecting site.

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64 I consider this use of objects in section 4.2.4. (see: Figure 4e).
65 The movement of objects along this trajectory is considered in more detail in section 5.2.2.
The decision to collect three samples (see: Figure 2e) was made in order to satisfy the need for sufficient material to replace or 'garnish' the existing teaching sets, and also in order to take into account the possibility that some of the material may not, in fact, be similar enough to the original material to be of use. Having collected the samples, the collector recorded appropriate information for the particular use for which the material was being collected, so, for example, the strike and dip were not marked on the specimen because the function did not require the material to be oriented. While observation of the specimens in the field suggested that the material was appropriate for its intended purpose, it was understood that a more detailed investigation of the material (in thin section) would be needed in order to confirm this. Therefore, with this in mind, the three specimens were assigned individual reference numbers consisting of the initials of the locality and a consecutive number, which were written directly onto the specimen with permanent ink. Additional information, including the date of collection, locality, rock type and intended use, were also recorded in a field-collecting notebook (interview with R. Finch 06/05/08).

While the selection and collection of the material was influenced by its intended purpose, the particular objects that were collected were also affected by the conditions experienced at the time. The decision to collect material from particular outcrops was influenced by the relative abundance of sillimanite schist in the area, the location of the outcrops next to a road, and the occurrence of material at accessible height, all of which increased the chances of identifying and selecting material appropriate for its purpose (interview with R. Finch 06/05/08). Furthermore, the presence of the appropriate ‘collecting paraphernalia’ - including large hammers, chisels, safety glasses, newspaper, sacks and permanent markers which were taken on the field trip specifically for the purpose of collecting these samples - permitted the effective and safe removal of sufficient material, and its subsequent labelling, wrapping and removal from the site (ibid.). However, the selection and collection of material was also affected by other uncontrollable factors:
It was raining and we were in a peat bog, so basically, it was quite hard – physically hard work – trying to break some of the stuff off, but it was just a matter of persisting (interview with R. Finch 06/05/08).

Therefore, the selection process and the particular material that was collected resulted from a negotiation between the planned, rational intentions of the collector and the pragmatics of the field experience. In this case, the collecting context combined institutional factors such as the increase in class size, and the collecting policy; disciplinary factors, including the content of the course unit, the use of teaching sets, and the convention of recording associated information in a field notebook; and personal factors for example, the choice of collecting site, the particular system with which material was numbered, the fitness and strength of the collector, and his determination and skill at hammering. While such factors shaped the material that was collected, so too did pragmatic factors, such as the conditions experienced at the time - the rainy weather, the presence of a peat bog (relating to the landscape, climate, vegetation cover and relief), visibility, the spatial distribution of outcrops, and the hardness of the rock.

Understood in these terms, it is apparent that the coming into being of earth science teaching objects has much in common with that of research objects. However, there are some subtle differences that require further consideration.

2.4.3 Collecting for a purpose

In comparing these two accounts of the collecting process, it becomes increasingly apparent that the processes and practices enacted on an object during its collection are perhaps most strongly influenced by the purpose of the material being collected. Indeed, when asked about the selection process, the school curator at Leeds explained: "Well, what you do is you limit your options…You pick your sample because of what you want to do with it" (interview with R. Finch 17/11/08). For example, and as Emma Passmore explained with reference to the Reis Crater material, collecting for teaching purposes involves finding a sample that shows specific features clearly and that is sufficiently large and homogeneous so as to provide a certain number of hand-specimen sized duplicates:

...in terms of teaching and hand specimens, one of the things that is quite useful – unless you do want to chop up a big block – is getting one or a series of things that are actually hand specimens sized – so you can actually hold them in your hand (interview with E. Passmore 21/06/10).

On the other hand, collecting research material is far more complex as the size and dimensions of an object must reflect the particular techniques and processing to which the specimen will be subjected. For example, if a thin section is to be made, small rectangular chips (the same size as the thin section) will be cut from the sample, and it will be from these derived pieces that the sections will be made, rather than the original object (interview with G. Droop 10/11/10). If a number of techniques are to be used, again, the size of the sample must reflect this. For example, elaborating on the selection process, the school curator at Leeds explained:
You can quite easily make a thin section and then put it on the probe and you might want to crush some and put it in the XRD [x-ray diffractometer]. You might want to do some geochronology on it. You might have an idea about what you want to do with it in the first place, but you don’t want to come back and find that you haven’t got enough. At the same time you don’t want to be carrying massive amounts, and you don’t need to take huge slabs of rock because you can use the cuttings of one process to do the other (interview with R. Finch 17/11/08).

Perhaps most important, however, is the information that is recorded during collection; as a general rule “Its useless if it’s not documented” (interview with M. Holness 28/10/09). For example, failure to orientate a specimen during field collection will render it almost worthless for applications such as the analysis of fluid flow, palaeocurrents, deformation processes and history, mineral nucleation, strain, and numerous other critical concepts (Prior et al. 1987). Therefore, in order to increase the potential uses of an object, as a general rule, the more information that is recorded, the better.

In comparing the field collection of research and teaching material, it has become apparent that an interesting relationship exists between the collecting process and the use of material. In one sense, the intended use of an object – whether for teaching or research purposes – directly impacts on the collecting process, such as the need to record particular contextual information and the amount of material that is collected. Likewise, the processes and practices involved in collecting material – such as the particular contextual information that is recorded and the size of the object, for example – fundamentally affect its ability to function in certain ways and its mobility, and these relationships are followed up in chapters four and five.

In addition to providing valuable insight into the processes and practices involved in field collecting, the detailed accounts on which I focused above, also serve as a useful reminder of the extent to which every collecting event is fundamentally unique. The coming into being of scientific objects – whether for research or teaching purposes – is the result of a complex combination of factors. However, by considering these factors both in isolation and as they interrelate and coalesce, it has been possible to begin to untangle the intricate and unique web of relations that constitutes the collecting process. Building on this, the final part of this chapter returns to my original questions surrounding the coming into being of earth science objects.

2.5. Discussion

In collecting material from the field, earth scientists create new scientific objects. Whether material is hammered from an outcrop, drilled from the ground or simply picked up, the object that enters an academic institution is not the same as it was in nature. This begs the question of why? If the objects are changed, then why bother collecting them? As far as the coming into being of earth science objects is concerned, this is perhaps the most fundamental question of all, and in attempting provide an answer, I am also able to respond to my earlier questions

66 However, as I consider in section 4.3.3, this may not affect the use of specimens as ‘materials’. 
surrounding the selection of material, the processes and practices involved in transforming pieces of nature into scientific objects, and the strategies that are used to maintain notions of objectivity.

In the earth sciences, the distinct (but not unique) role of fieldwork reflects the geographical specificity of many geological phenomena (Rudwick 1996a: 144), and as a result; “...[the] primary data source remains the rocks, in the field, and their spatial distribution” (Eppler 1997: 1). So how and why are objects selected? The act of collecting is best understood as a negotiation between the collector - their expectations, requirements, strength, skill and judgement - and the object being collected - the surroundings, available tools, the weather, and numerous other factors. As I have illustrated above, the selection and collection of material combines intention and improvisation. Intention originates from the collecting context; the institutional, disciplinary and personal circumstances within which the decision to collect is made. Improvisation, on the other hand, results from the pragmatics of collecting; the often unexpected, uncontrollable and unavoidable conditions and experiences in the field that directly affect the decision to select and collect a particular piece of material rather than any other.67 While the combination of collecting context and the pragmatics of collecting can help to explain how material is selected, it does not explain why.

While the “ultimate ground truth” (Dott 1998: 17) may reside in nature outside, there are a number of practical reasons for selecting a series of ‘tangible representatives’ (Griesemer 1990: 20) and bringing them inside. Fundamentally, by collecting material and bringing it inside - away from the complexities of reality – objects can be studied at leisure and subjected to levels of scrutiny and analysis that would be impossible in nature outside. Gieryn describes this as:

the epistemic risks of fieldwork in science – a lack of precision and control, peculiarities of a site that make generalizations impossible, emotional attachments to ‘my site’ that introduce subjective biases, endless distractions and contaminations – have led some scholars to conclude that the field must in effect become a laboratory before it can serve as an authoritative space for knowledge-making (2006: 6).

The neutral and controlled academic settings into which they enter, empower objects to act as ‘guarantors’ (Latour 1999b: 38) for the knowledge that becomes bound to them. In this sense, the benefits of extracting pieces of nature and bringing them inside are relatively logical; the availability of machines and equipment, the relatively comfortable working conditions, the proximity to resources and support, and perhaps most important of all, the credibility that is gained through association with the institution (Gieryn 2002). Nonetheless, in order to reap these benefits of action at a distance (Latour 1987: 219) the collector must “enhance the mobility, stability and combinability of the collected items” (ibid: 225) so as to ensure that what is brought back actually counts as a ‘scientific object’. Indeed, as we saw above, the collecting process itself - through the practices of selection, removal and inscription – is designed to create mobile, stable and combinable objects.

67 For Deleuze and Guttari; “to improvise is to join with the World, or to meld with it” (1987: 311).
For both earth scientists and their objects of study, the cost of achieving ‘scientific’ status is high; by removing material from nature outside, these objects lose their context – precisely what made them valuable in the first place. In order to compensate for the losses that occur in bringing pieces of outside nature inside, earth scientists substitute the natural context that is lost, with their own detailed observations and measurements thereof. The field notebook is used to record such contextual information, and this becomes linked to the object through a shared reference which is inscribed on both the surface of the object and on the paper of a notebook (see: Jenkins 1994: 253; Latour 1999b: 46). The successful transition of an object into the world of academia is reliant on the recording of this associated information, and its secure attachment to the object. This information represents all that has gone before in nature outside; without it, the specimen is just a piece of stuff.

Following the selection and removal of an appropriate specimen, it is only through the judicious recording and secure attachment of contextual information to an object, that pieces of nature are transformed into scientific objects. As Dr Droop explained, while well-documented material “is not so different now from when it was attached to the rock because the context is still known”, once the link between an object and its contextual information has been broken, “it has changed because they’re really just rocks” (interview with G. Droop 10/11/10). However, with this in mind, it is questionable whether such objects can truly be considered as what Latour refers to as “immutable and combinable mobiles” (1987: 227) since the mobility of these objects relies on physically extracting them from their original context, and in doing so, the object becomes transformed.

Finally, it has become apparent that field collecting, is like any other form of collecting, is both personal and partial (Pearce 1992: 5). However, as unwanted by-products of the collecting process, these idiosyncratic meanings and associations are rarely mentioned or acknowledged (see: Bowker 2005: 7). That is not to say that they do not exist, but rather, that they remain, for the most part, lingering below the surface, hidden from view. Indeed, in the earth sciences, the individual is inseparable from the selection, collection and interpretation of material because they are both “the data-collecting instrument and the interpreter of that data” (Parcell and Parcell 2009: 308). In this sense, field collecting is about “the synergy of practitioner, tool and material” (Ingold 2011: 56), and it is from this type of “deep mutuality” (Edwards et al. 2006a: 5) that earth science objects come into being.

The personal and experiential dimensions of field collecting are rarely documented and this reflects both the situated nature of fieldwork and the disciplinary conventions of the earth sciences. As a result of the immediate, uncontrollable and often-unpredictable conditions experienced in outside nature, field collecting must combine the rigor of standard protocols with the flexibility of instinct and intuition. The tacit and embodied nature of field practice itself makes it difficult to document, and the lack of reference to such activities in published work also reflects the “impersonal, formal and formulaic” (Fortey 2000: xvi) conventions of reporting in the earth sciences. As Clifford observes, the process of writing up fieldwork involves “the translation of
ongoing experience and entangled relationships into something distanced and representable” (1997: 57) and in this sense, the personal experience of field collecting is effectively lost in translation (Lorimer 2003: 292). The sterilization of objects, however, is essential as it renders them functional in the academic world, and it is through such disciplinary conventions (Parcell and Parcell 2009) that notions of objectivity are maintained.

The processes and practices of field collecting can be understood as a way of ‘doing’ or enacting earth science objects. However, and as Law notes, enactments “don’t just present something that has already been made, but also have powerful productive consequences” (2004a: 56). In this sense, the conventions of selection, removal and inscription that have become associated with field collecting add credibility and authority to the collected object, transforming pieces of nature into scientific objects. These processes and practices are ways of enacting earth science objects as natural, in spite of the fact that it is precisely this naturalness – valued so highly by earth scientists - that is lost when these things are collected. This paradox of unnatural nature – the fact that in order to create scientific objects, natural objects lose their naturalness – is a symptom of all earth (and natural) science objects that, as the following three chapters will reveal, has implications for their management, use and mobility.

In addressing the coming into being of earth science objects, this chapter has focused on the collecting process through which new objects are created. I am not, however, simply concerned with the creation of scientific objects. Indeed, I am also interested in the means by which scientific collections are formed, and this necessarily involves addressing the ways in which scientific objects become scientific collection items. This leads to a number of questions: How are earth science objects transformed into collection items? How does this vary for different types of collection? What are the purposes of collections? Therefore, in the next chapter, I shift attention towards the processes and practices involved in creating collection items; the physical and conceptual changes that objects undergo, and how this affects earth science objects.
Chapter 3: The coming into being of collection items

Having considered in detail the coming into being of earth science objects, I have thus far focused on the processes that transform nature into science. This chapter is concerned with another similarly fundamental event in the lives of many of these things, as they are changed from ‘objects’ into ‘collection items’. Once again, I use the notion of ‘coming into being’ as a way of acknowledging the transformative nature of this process, as it is similarly concerned with attempts to control and manage pieces of nature. In considering the ways in which entry into a collection transforms earth science objects into collection items, it has become increasingly apparent that the processes and practices involved in this transformation are variable both within and between institutions. In order to acknowledge such complexities, while at the same time, avoiding becoming overwhelmed by the details, it is useful to adopt a similar approach to that which I used in the previous chapter. Therefore, this chapter will address both the broader contexts in which collections themselves emerge, as well as the practical act of creating collection items.

While much has been written about collecting and collections, the actual transformation of objects, through a particular set of practices, into collection items (particularly within institutions) has received little critical attention since: “[i]t is not controversial in its theoretical treatment, its applicability, or even in the willingness of museum workers to accept it” (Maroevic 1998: 16). It follows that the practices that have developed in response to modern institutional collecting, namely the need to manage and order vast amounts of material and data - to “know what you have and where to find it” (Matassa 2011: 3) - are rarely questioned. Rather, they are presented as uncontested facts in the form of ‘guidelines’ and ‘standards’ for carrying out a practical task (see, for example: Harrison and McKenna 2009; Hillhouse 2008; Matassa 2011).

Within museology, a handful of authors have considered the practices of creating collection items, and such work has focused on the role of the museum register (Swinney 2012), the documentation process (Cameron and Mengler 2009), and on museum practices in general (Alberti 2009), for example. Furthermore, the studies contained in a recent edited volume titled Unpacking the Collection (Byrne et al. 2011b), have addressed themes such as materiality and agency by exploring “the networks and social relations that both form and are formed by collections” (Byrne et al. 2011a: 20-21). However, and in spite of their innovative approach, these papers all focus on existing or historical collections and therefore fail to consider the contemporary practices of creating collection items. Indeed, and much like the earlier wave of material culture studies of museum objects and collections - of which ‘Entangled Objects’ (Thomas 1991), ‘Collecting Colonialism’ (Gosden and Knowles 2001), ‘Knowing Things’ (Gosden and Larson 2008) and edited volumes such as ‘Hunting the Gatherers’ (O’Hanlon and

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68 As well as such general guidance, each discipline has its own set of guidelines and standards (for the earth sciences, see: Howie 1992; Paine 1993; Stanley 2004).
Welsch 2000) and ‘Sensible Objects’ (Edwards et al. 2006b) are notable examples - the studies contained in this book are specifically concerned with ethnographic objects and collections. While such work provides a useful starting point, the extent to which it applies directly to non-museum (department) collections, or indeed, to all museum collections is questionable, and requires further consideration.

In order to explore the ways in which collection items come into being, it is first necessary to acknowledge that the notion of ‘the collection’ is neither fixed, nor definitive. Thus, while this chapter aims to explore both the contextual and pragmatic elements of creating collection items, this requires a basic understanding of the different types of collections into which earth science objects may enter. Therefore, I start this chapter by introducing some of the distinctions that are used to divide up groups of objects at the case study institutions. In section 3.2 I situate collections within their broader contexts, and explore how they continually emerge over time. Building on this contextual framework, in section 3.3 I introduce the pragmatics of creating collection items and consider the processes and practices that are enacted on objects as they are acquired, processed and stored. Finally, I close this chapter by drawing all of these strands together in order to respond to the questions that I set out at the end of the previous chapter concerning how objects are changed by entry into a collection, the extent to which this varies for different types of collection, and the purposes of collections.

3.1. Introduction

Throughout this research, it has become increasingly apparent that the term ‘collection’ is used to describe an almost bewildering array of different object groupings. In order to avoid confusion, this introductory section aims to sketch out the different ‘types’ of collection that have been encountered at the case study institutions (see: Figure 3a). Since each different type of collection has its own status, purpose, values, admission criteria, and enrolment procedures, such nuances must be taken into account and acknowledged in order to fully understand the ways in which entry into a collection affects objects in different ways. While every collection is unique, a number of generalizations may be made about the types of earth science collection into which objects may enter; indeed, such generalizations have been necessary due to the complex and varied ways in which each institution distinguishes between different collection types.

University earth science collections can, most broadly, be divided according to their position within an institution, namely, whether they are located within a museum or a

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69 The forthcoming edited volume titled Reassembling the Collection (Harrison et al. forthcoming 2013) contains a similarly innovative collection of papers, however these too focus on existing and historical ethnographic / anthropological objects and collections, and therefore fail to address the contemporary processes and practices of creating collection items.

70 An overview of the terminology for university museum collections is provided by Lourenço (2005: Appendix 7).

71 This has been particularly challenging for departmental collections where the mobility of objects blurs the boundaries between different types (see chapter five).
Figure 3a: Table showing collection ‘types’ at the case study institutions.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Collection</th>
<th>Accessioned</th>
<th>Unaccessioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Leeds</td>
<td>Department</td>
<td>Teaching reference collection</td>
<td>Teaching collection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Archived research collection</td>
<td>Exam collection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Display collection</td>
<td>Personal research material</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Surplus research material</td>
</tr>
<tr>
<td>Liverpool John Moores</td>
<td>Department</td>
<td>Reference collection</td>
<td>Ex-research material</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teaching collection</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Display collection</td>
<td></td>
</tr>
<tr>
<td>University of Cambridge</td>
<td>Museum</td>
<td>Sedgwick Museum collection</td>
<td>Learning collection</td>
</tr>
<tr>
<td></td>
<td>Department</td>
<td>Teaching collection</td>
<td>Ex research material</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Personal research material</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University College London</td>
<td>Museums &amp; Collections</td>
<td>Reference collection</td>
<td>Handling collection</td>
</tr>
<tr>
<td></td>
<td>Department</td>
<td>Teaching collection</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Exam collection</td>
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<td></td>
<td></td>
<td>Display collections</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Manchester</td>
<td>Museum</td>
<td>Manchester Museum collection</td>
<td>Teaching collection</td>
</tr>
<tr>
<td></td>
<td>Department</td>
<td>Reference Collection</td>
<td>Exam collection</td>
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<td></td>
<td></td>
<td>Personal research material</td>
<td>Personal research material</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Surplus research material</td>
</tr>
</tbody>
</table>

This distinction is particularly significant due to the implications that it has on the treatment and legal status of a collection. Therefore, perhaps the most fundamental attribute that distinguishes department collections from those in museums is what De Clercq describes as their *incidental nature*, namely that they are “kept by bodies that do not regard caring for a collection as a primary concern” (2001: 85). Because the care and management of collections is not the primary purpose of an academic department (Crowther 1987), it follows that departmental collections are treated, used, and valued differently to those in museums. For example, collections are treated as a by-product of- and resource for- departmental activities, and therefore, the value of objects lies in their use rather than their preservation. This, however, is not the case for university museums.

The relationship between university museums and their collections is distinct from that described above for departments, as museums do regard caring for collections as their primary concern, as is apparent from the standard definition of a museum which states that they; “collect, safeguard and make accessible artefacts and specimens which they hold in trust for society” (MLA 2004: 6). As a result of the importance of collections to the purpose of museums, it follows that, unlike departmental collections, museum collections are regulated by various codes of practice and are expected to meet certain standards, such as those set out by the

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72 Although even this distinction is not necessarily as straightforward as it may appear. For example, at UCL ‘The Rock Room’ is an accredited museum, however, it is simply a room in the department of earth sciences which is open to the public for one day per week (interview with E. Passmore 13/04/10).
Museums, Libraries and Archives Council’s (MLA) accreditation scheme. Indeed, all of the case study museums are ‘accredited’, meaning that they have met or exceeded “basic requirements on how they care for and document their collections, how they are governed and managed, and…the information and services they offer to their users” (MLA 2004: 1). As a result, the earth science collections at the case study museums, compared to those in the departments, are better protected, more permanent, and are managed within a relatively standardized system of formal procedures.

A further distinction can be made between those collections that contain ‘accessioned’ objects, and those that remain ‘unaccessioned’. Accessioning is defined as “the formal acceptance of acquisitions into… [a] permanent collection” involving; transfer of title, entry of a permanent record into an accessions register, and the allocation of a unique accession number to the object(s) (Harrison and McKenna 2009: 18). While the distinction between accessioned and unaccessioned collections has been encountered both in museums and departments, the meaning of the term is variable. For example, at the Manchester Museum, accessioned objects are those items for which legal responsibility has been formally accepted, whereas for the departmental collections at both Cambridge and LJMU, the term is used with reference to objects that have been formally numbered (interviews with G. Caruana 12/08/09; H. Clark 23/03/09). In spite of this, there is a common implication for the permanence and level of responsibility afforded to accessioned collections and collection items. Thus, in the context of a department, accessioned objects are more secure and better protected than unaccessioned items, which may be discarded quite freely. Therefore, while the notion of ‘accessioning’, strictly speaking, involves the formal ‘transfer of title’ and is therefore restricted to museum collections, in order to reflect the situation in the departmental context, I will use the term in its broadest sense to reflect an acceptance of responsibility for an object.

While it is useful to distinguish between departmental and museum collections, and accessioned and unaccessioned objects, these divisions do not account for the variety of different types of university earth science collections that have been encountered at the case study institutions. Indeed, if collections are understood as; “an organized accumulation of objects …with like characteristics or a common base of association” (Simmons 2006: 168), it follows that different types of collection often reflect particular uses, whether implicitly or explicitly (see: Figure 3b). In this sense, ‘the collection’ is a group of objects with a common function, and as a result, may have certain requirements in terms of organisation, management, arrangement, acquisition, indexing, storage, preservation, access and security, to name but a few (Wissenschaftsrat 2011: 50). Material may be further divided according to disciplinary fields (i.e. mineralogy, palaeontology and petrology that may themselves be further divided into

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73 The ‘Accreditation’ scheme was established in 2004 as a replacement for ‘Registration’ (see website: Lowry 2008).
74 The Manchester Museum was awarded accreditation in 2005, the Sedgwick in 2006 and UCL’s Geology Collections in 2009 (see website: MLA 2010).
75 Transfer of title is described as the process by which an institution “becomes the owner of objects by signing a formal contract with the previous owner” (Harrison and McKenna 2009: 4).
76 The policy on acquisitions and disposals states that: “Legal title for the accessioned collections held by the Museum resides with the Board of Governors of the University of Manchester, the governing body of The Manchester Museum.” (The Manchester Museum 2005: 7).
Figure 3b: Table explaining collection ‘types’ identified at the case study institutions.

<table>
<thead>
<tr>
<th>Collection Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Museum Collection</td>
<td>‘Permanent’ group of accessioned objects owned by the museum for which it has accepted legal responsibility.</td>
</tr>
<tr>
<td>Learning Collection</td>
<td>Museum collection of unaccessioned objects that lack information or provenance but that are of sufficient quality to be used for learning activities.</td>
</tr>
<tr>
<td>Handling Collection</td>
<td>Synonym for Learning Collection: see above</td>
</tr>
</tbody>
</table>
| Reference Collection             | **Type A: UCL and LJMU**
  Objects that are retained as examples or representatives. Usually one-offs and tend to be relatively accessible.

**Type B: SEAES**
Objects that originate from completed departmental research. Selected for retention in order to provide a reference for future checking / a resource for subsequent research / a record of the research / a source of material for other uses. This material has a known value and may develop additional values over time. 
 Somewhere between Type A and Archived Research Collection |
| Teaching Reference Collection    | Similar to Type A Reference Collections but retained specifically for the purpose of teaching                                                                                                               |
| Archived Research Collection     | Similar to Type B Reference Collections but lacking the element of selection and known value.                                                                                                            |
| Display Collection               | Objects with an aesthetic value. Either on display or are kept securely for future use.                                                                                                                  |
| Teaching Collection              | Sets of duplicate objects. Likely to undergo periods of heavy use. Understood that they may be damaged, lost, broken and will gradually deteriorate.                                                       |
| Exam Collection                  | Similar to Teaching Collection but used for exams and therefore kept out of general circulation and stored in a secure location.                                                                       |
| Personal / Working Material      | Material that is actively being used for research purposes.                                                                                                                                              |
| Ex-Research Material             | Objects that were generated through research activities but not selected for incorporation into a collection. Not retained by choice; treated as a burden and eventually discarded (note at LJMU this includes Crossley’s personal material). |
| Surplus Research Material        | Similar to Ex-Research Material but that are retained through choice (temporary) because they may be of use in the future.                                                                           |

subgroups), the particular form of material (i.e. hand specimens, thin sections, and drill cores), or the status of objects (i.e. type or figured specimens). As I consider in the next section, such divisions may reflect various factors ranging from staffing structure and institutional traditions, to storage space and resource limitations.
Before I continue, it is useful to clarify the scope of this chapter and in particular, to both identify those groups of objects that will not be considered, and justify why they have been excluded. In considering the coming into being of collection items, this chapter must discriminate between collections and other groups of objects, and as a result ‘personal material’, ‘ex-research material’ and ‘surplus research material’ will not be considered as they fall into the latter category (see: Figure 3b). While these groups of material are more than simply random accumulations of unrelated objects, on account of the more “organic process” (c.f. Cook 1993: 33) by which they form, and in the absence of an intention to “build a coherent whole” (Desvallées and Mairesse 2010: 26), they do not constitute collections. While the series of distinctions that I have identified (see: Figure 3b for a summary of the key features of different types of collection identified in Figure 3a) provide a useful means of approaching a complex situation, this section is intended only as an introduction. In order to understand why and how such distinctions come about, it is necessary to consider the contexts of collections.

3.2. The contexts of collections

While collections may appear to be the result of careful, rational, purposeful, systematic planning, in practice, and as I will reveal below, this is rarely the case. My initial attempts to try to understand collections by treating them as the effects of their particular contexts only revealed the inadequacy of such explanations to account for the complexity of the situation. While there is no denying that collections are affected by their contexts, and as I will show below, can be understood in relation to the institutions in which they exist, the disciplines that they serve, and the individuals who curate and use them, this is only half of the story. Indeed, the problem with this view is that it assumes that collections are passive, treating them as “faithful intermediaries” (Latour 2005: 40) that simply ‘reflect’ their contexts like a mirror. The alternative is therefore to do away with these assumptions and instead approach collections as active components of their contexts with capacities to cause their own effects and to act back. Collections conceived in this way, become ‘mediators’ that, as Latour explains, “transform, translate, distort, and modify the meaning or the elements they are supposed to carry” (2005: 39).

In the following three sections I explore how collections are both affected by and affective within their contexts, and consider the ways in which collections relate to contextual features; specifically those of a disciplinary, institutional and personal nature. However, while this approach may usefully introduce the extent to which the collection is thoroughly enmeshed within its context, such snapshots do not capture the vitality of collections: the ways in they continually emerge and evolve over time like ‘living organisms’ (c.f. Maroevic 1998: 221). In order to explore ‘the collection’ in this way – in order to treat the collection as a process – it is useful to concentrate on a single example and, due to their long and well-documented histories, the collections at the Sedgwick provide an ideal focus. Therefore, in section 3.2.4 I attempt to capture the continual development and evolution of the collections at the University of
3.2.1. Collections and disciplines

By their very nature, university earth science collections are shaped by the disciplinary context of the earth sciences. As I have already described (see section 2.2.1), new fields of knowledge may generate new types of objects, or may use objects in different ways, and as such may impact on collections as well as collecting. In this section, I consider the relationship between collections and disciplines by focusing on an example that was brought to my attention by the curator at SEAES, with regard to the creation of a new petroleum engineering teaching collection.

In order to understand how collections relate to their disciplines, it is useful to consider the example from SEAES in more detail. By acknowledging the broader circumstances surrounding this example, and by attending to the temporal dimension, we can describe the situation in the following way: in spite of the growth of petroleum engineering over the second half of the twentieth century, only recently has this impacted on the collections at SEAES, because petroleum engineering has been taught using the department's standard 'geology teaching collection'. Understood in this way, it is apparent that it may take time for disciplinary developments to filter down to the level of the collection, and this was confirmed by the curator who explained that: “now that the course has sort of bedded in enough, it's time that we actually accepted that it's here and staying. And they can have their own things” (interview with A. Edwards 07/12/10). So, the lag time between the disciplinary development and the creation of a new teaching collection was related to a decision to make use of resources.

It takes work and effort, money and objects, willingness and cooperation to create new collections, and attempts to mobilise such resources require both time and timing and will only be made once a need has been identified. At SEAES, the need for a new collection did not arise for a number of years as it had been possible to 'make do' and 'get by' using existing resources. However, it has recently become apparent that 'making do' with existing resources has been detrimental to the geology teaching collections, and therefore, the need for a new tailor made teaching collection for petroleum engineering has been identified: “that’s only really come to a head this term. Because of the pressure of one set of rocks having to do two jobs at the same time” (interview with A. Edwards 07/12/10). While I have so far focused on the relationship between collections and disciplines in terms of the decision to mobilise resources, these factors alone do not account for the particular unfolding of events at SEAES.

At SEAES, the emergence of petroleum engineering changed the disciplinary context through the establishment of new undergraduate courses, which required the use of objects. In the first instance, the impact of this disciplinary development was deflected towards- and

77 While the assemblage perspective provides a useful tool for exploring particular case studies in detail and over time, it is less appropriate for the brief snapshots that I consider in the first three sections, and I therefore do not introduce this approach until section 3.2.4.
subsequently absorbed by the existing teaching collection. Therefore, as a result of this disciplinary development, what was formerly the ‘geology teaching collection’ was transformed into ‘the geology and petroleum engineering teaching collection’. In one sense then, the ‘geology and petroleum engineering teaching collection’ emerged from the new disciplinary context at SEAES. While the collection appears to have initially acted as an intermediary, if we extend our field of view, it becomes clear that over time, we are in fact dealing with a mediator.

Because ‘the geology and petroleum engineering teaching collection’ has its own limits - both in terms of the amount of use it can withstand and the ways in which it can be made to function – in fulfilling its current purpose (i.e. in doing two jobs), the collection has started to show signs of overuse. The deterioration of the collection has prompted the decision not only to create a new teaching collection, but also to create a teaching collection that is different to the existing one. In this sense, the need for a new petroleum engineering collection was not simply a disciplinary matter, but was also related the deterioration of the ‘geology and petroleum engineering teaching collection’.

While university earth science collections are linked to developments occurring within the discipline, as this case illustrates, the relationship between collections and disciplines is not necessarily straightforward: in spite of their scope, collections are not simply reflections of disciplines. As well as revealing the ways in which collections may themselves be actively involved in shaping the contexts from which they emerge, this example has also considered the matter of resources, in particular their role in shaping the response to disciplinary developments. However, the fact that the effects of disciplinary developments on collections may vary considerably across different institutions, suggests that it is at the level of the institution that such matters are settled.

3.2.2. Collections and institutions

Collections are inextricably linked to the institutions in which they exist and the policies and decisions, ethos and mission of an institution may shape the development of collections. However, the extent to which collections may nonetheless develop independently from such constraints must also be acknowledged, and in order to do this, I will focus on the case of LJMU. At LJMU, earth science provision is limited to undergraduate teaching (see section 2.2.3.) and at present, the school offers six modules that are broadly earth scientific in scope (LJMU 2011). However, the collection contains considerably more material than that which is currently used for teaching, and as the senior technician described: “we have thousands of items - not all catalogued. We are not really a research department. Most of the specimens are associated with teaching and current/past field areas” (Clark 2009 pers. comm.). Thus at LJMU, the volume and diversity of material in the collection is inconsistent with contemporary provision in the earth sciences. In order to appreciate how the current situation has come about, it is necessary to understand more about the origins and development of the collection.
At LJMU the collections can be traced back to the provision of geology as part of an education programme at CF Mott College in Prescott, which was established in 1969 when the college employed Joe Crossley78 (Principle Lecturer (retired) and former Head of Geology at LJMU) to teach education and geology. While a small amount of local material already existed at the college when he arrived, Crossley explained how he found it inadequate for the requirements of the course, so went about building up the collections (interview with J. Crossley 24/06/09). As well as adding his own personal material to the collection, Crossley also acquired material during visits to check on students carrying out project work, and during field trips with the Liverpool Geological Society (ibid.). However, alongside the growth of the collections, the provision of geology underwent a number of significant changes as it moved through a variety of different institutions before eventually forming part of the School of Natural Sciences and Psychology within LJMU (ibid.). While earth science provision reached a peak around 2001 when LJMU started to offer an honours course in geology, the gradual decline in student numbers subsequently led to the termination of the course (with the last intake of students in 2008) and a reduction in provision (interview with H. Clark 23/03/09).

In the case of LJMU, the current collection can be understood as an enduring relic of a time when the earth sciences were more popular and more prominent within the institution; when there were more courses, more staff and more students (interview with J. Crossley 24/06/09). While the last decade has seen a gradual reduction in the number of earth science courses offered, the number of specialist staff, and the number students studying the discipline, this decline has not affected the size or status the department’s collection (interview with H. Clark 23/03/09). On one hand, the continued existence and growth of the collection at LJMU suggests that the institution has sufficient resources available to support it. However, on the other hand, I believe that there is something else at stake.

While the previous section identified the growth of new collections as a matter of timing and resources, once established, it appears that the continued existence and growth of collections requires much less co-ordination, and considerably less effort. In this sense, collections appear to take on a life of their own, gathering momentum as they grow and becoming ingrained within institutions. At LJMU the continued growth and care of the collection appears to have become a habit whereby the time and effort involved has become part of a routine. Alongside this momentum, however, and as a result of their growth, collections also seem to generate considerable inertia. The situation at LJMU can therefore also be understood as an effect of the collection itself, which, through its physical presence and materiality, starts to act back and cause its own effects. While this inertia may be understood on purely physical terms - as the materiality of the collection becoming an obstacle or providing resistance - I believe that it also extends beyond the collection itself. Thus, in talking of inertia and habit, it is also important to acknowledge the other aspects that may become drawn into the momentum of a collection, such as the individuals who get caught up in their growth.

78 See: Appendix 6d.
3.2.3. Collections and people

While many individuals may become associated with collections, in order to explore the relationship between collections and people, I will focus on the curator, as it is their job to manage and care for the collection, while at the same time ensuring that objects are appropriately used. Unlike users who encounter ‘the collection’ through individual objects, or non-users/stakeholders for whom ‘the collection’ is an entity in itself, the curator is directly involved with the collection on both of these levels. As a result, curators form distinct and often enduring relationships with collections, and as I will illustrate with an example from UCL, this relationship is more about negotiation than it is about direct control.

When Dr Kirk started working as the curator of the earth science collections at UCL, the mineral collection was catalogued and arranged numerically – by accession number (interview with W. Kirk 21/07/10). However, this system made the process of retrieving and returning mineral specimens quite time-consuming as it was necessary to consult the catalogue in order to both identify and locate particular items. Therefore, shortly after she arrived, Dr Kirk explained that:

I actually recatalogued the minerals …with a system I thought was better …I’d come from a map library and they were catalogued according to country and then region, and they reflected the places they showed. So I recatalogued [the minerals] …according to whether they were native elements - gold, silicates, tectosilicates, quartz, amethyst, and they had these codes put on them so its great! Now if I see something, I then don’t have to go and look it up to put it away (interview 21/07/10).

The curator’s decision to recatalogue the collection was therefore a response to the existing system of arranging and cataloguing the minerals. Rather than simply learn to live with it, the curator decided to implement a new system that would make her job easier. The curator’s decision to number the minerals in a particular way was, therefore, a personal one. However, this personal decision was related to her previous positive experience of working in a map library in which the objects (maps) were catalogued in a meaningful way, and her knowledge of an existing system of classifying minerals. In this sense, it is also important to acknowledge that this decision was itself shaped by an institutional experience and furthermore, was implemented using a disciplinary system.

The curator recatalogued the minerals by inscribing them with meaningful references that relate to the objects themselves, rather than their order of acquisition, and as a result, she has changed the ways in which individuals interact with the specimens by making them easier to locate within the storage system. Indeed, this was apparent from Emma Passmore’s comment about the arrangement of the mineral collections at UCL;

…if you see something and it’s got a number on it, then you can actually work out which class of mineral it is, which is actually massively really helpful, but probably really bad in terms of museum practice (interview 13/04/10).
By inscribing the minerals in this way, the curator has linked each object to a ‘proper position’ both mineralogically (within the system of classification based on their chemical composition), and spatially (within the system of drawers in which the minerals are stored, and which is itself arranged according to the same mineralogical system). In this sense, the curator has enhanced the minerals by expanding their repertoire: as well as encountering the tangible qualities of an object through its materiality and appearance, the addition of a coded reference number adds a further analytical dimension to the minerals, since the code not only identifies the mineral and its relative position within the larger system of chemical classification, but also pinpoints exactly where the object belongs.

As a result of adopting this system, the curator has modified the objects both physically, through their inscription with a reference, and conceptually, through the analytical dimension that this reference represents. As part of the process that transforms objects into collection items, this system of numbering objects can therefore be understood a means of creating particular types of collection items. However, in order for these collection items to function effectively, someone who is able to decode it must encounter the number. In this sense, while both of the curators agree that this system facilitates the use of the mineral collection, this is because they understand the particular system of mineralogical classification. For anybody who does not have this knowledge, the system is meaningless. Furthermore, while this system makes it easier for the curators to use the mineral collection, the use to which the curators refer is just one possible use amongst many others. By focusing on the mineralogical qualities of the objects, their histories, origins and associations, for example, withdraw into the background, and therefore, this system also must be equally understood as limiting the repertoire of the minerals and constraining their meanings.

As this example suggests, in spite of their existence within larger institutions, university earth science collections may also be shaped by personal decisions. On one hand, this should come as no surprise since it is at the level of the individual that institutional policies, procedures, resources and systems, as well as disciplinary developments, are interpreted and applied. Nonetheless, this relationship between individuals and institutional collections of scientific objects contradicts the notion of the academic collection as an objective, impartial scientific resource. Furthermore, and as I have hinted above, this particular case was not simply a matter of personal choice, but also related to disciplinary and institutional factors. Indeed, all three examples have illustrated the ways in which collections emerge from their complex and tangled relationships between individuals, institutions and disciplines, and in this sense, the collection can be understood as a process.

3.2.4. The collection as a process

In order to capture the ways in which collections are not only active components of their contexts, but also continually emerge and unfold within them, it is useful to adopt an
‘assemblage perspective’. However, and as mentioned above, this approach is most appropriately applied to individual case studies and therefore, after briefly introducing the assemblage perspective, this section will focus on its application to the collections at the University of Cambridge. An assemblage perspective can be broadly understood as a way of exploring both the relations and processes, through which “living, throbbing confederations… are able to function despite the persistent presence of energies that confound them from within” (Bennett 2010: 23-4).

The relational element of assemblages allows for an understanding of “wholes whose properties emerge from the interactions between its parts” (DeLanda 2006: 5). In particular, the effects of assemblages are understood as emergent properties; “their ability to make something happen is distinct from the sum of the total force of each materiality considered alone” (Bennett 2010: 24), and in this sense, while the assemblage may generate its own effects, it does so without melting together its components. A further relational feature of the assemblage is its capacity, as a whole, to constrain or enable its component parts: effectively a capacity to act back on itself (DeLanda 2006: 35).

The processual element of assemblages concerns the emergence and maintenance of some degree of stability in spite of the goalposts for what it means to be stable, continually moving. In DeLanda’s interpretation, assemblages constitute a powerful tool with which to explore collections by providing a means of analysing the roles played by component parts (expressive or material) and acknowledging the processes through which assemblages come into being and maintain their identity over time (territorialization and deterritorialization) (2006: 18-19). Furthermore, assemblages also capture the collection as emergent and changing over time as their “ontological status… is that of a unique, singular, historically contingent, individual” (ibid: 40).

At the University of Cambridge, there are currently two distinct ‘groups’ of collections, one in the Sedgwick and one in the Department of Earth Sciences (see: Figure 3a). Within the Museum, the collections are divided into discrete disciplinary groups, namely, palaeontology, sedimentary rocks, petrology (igneous and metamorphic), mineralogy, building stones, and the learning collections. While the learning collections constitute a functionally distinct group of (unaccessioned) objects, the other divisions are relics of former traditions and developments that relate to various disciplinary and departmental changes that have occurred since the collections were originally established in 1728. Like the original Woodwardian Museum from which the Sedgwick originated, the contemporary collections are broadly ‘geological’ in scope; including rocks, minerals and fossils, but while the founding collection existed as a single entity, the modern situation is far more fragmented (see: Figure 3c).

79 While the ‘assemblage perspective’ is largely attributed to Deleuze and Guattari (in particular: 1987), it has become variously used and incorporated to an extent that, as Macdonald observes, “…[it] has itself to be assembled from various sources” (2009: 132). For a summary of the various ways in which the assemblage has been used, see Anderson and McFarlane (2011) and Dewsbury (2011). For my purposes, the work of Latour (2005), DeLanda (2006) and Bennett (2010) have proved particularly significant.
Figure 3c: Diagram illustrating the key events in the development of the collections at the University of Cambridge.
The emergence of new departments has had a significant effect on the ways in which the collections are divided, and in many cases, this corresponds with the retirement of members of staff. This can be understood as the ways in which habit and tradition may generate considerable inertia within departments, with the effect of stabilizing such departmental assemblages by maintaining the internal homogeneity of component parts and effectively ensuring a degree of cohesion. However, the retirement of staff – particularly long serving members of staff or those occupying positions of influence – can be understood as disruptive and destabilizing to departmental assemblages through the loss of cohesion that arises from the disturbance of routines. Indeed, the arrival of a new member of staff causes further disruptions by diluting the internal homogeneity of an assemblage, bringing in new skills, and further disturbing routines. In this sense, retirement provides a window of opportunity to enforce changes, in particular, to rearrange disciplinary boundaries and thus re-establish new assemblages with new identities.

An example of this occurred in 1931 following the simultaneous retirement of Alfred Harker from the Chair of Petrology in the Department of Geology, and Arthur Hutchinson from the Chair of Mineralogy in the Department of Mineralogy (see: Figure 3c). While Harker had occupied the position of Professor of Petrology since 1918, his involvement with the university and its collections dates back to 1884 when he took up a position as a university demonstrator and began working on the petrology collections at the museum. Therefore, Harker's retirement and the disruption and disturbance that this would have caused within the Department of Geology, and similarly, the effects of the retirement of Hutchinson within the Department of Mineralogy, appears to have provided a window of opportunity to redraw the weakened boundaries between disciplines and departments, and to form new assemblages in the form of two new departments. Corresponding to the reconfiguration of the departments was a similar rearrangement of the collections. Thus, in 1931 the hard rock petrology material from the Sedgwick Memorial Museum and the mineral collections from the Department of Mineralogy were brought together within the newly formed Department of Petrology and Mineralogy, and the remainder of the museum's collections continued their association with the Department of Geology.

In 1933 the Department of Mineralogy and Petrology relocated to a newly built extension of the Sedgwick Memorial Museum. However, in spite of this proximity, the department of petrology and mineralogy remained “entirely separate from Geology, the connecting doors were locked and access was not permitted between the South Wing (geology) and the adjoining extension” (Whyte et al. 2004: 25). By keeping this door locked, the museum can be seen to have ensured that its boundaries remained distinct and stable; opening the door and letting the petrologists in would destabilize the Museum's identity as a discrete entity by increasing the heterogeneity of the assemblage as well as by literally losing territory. Furthermore, by keeping the door shut, the distinction between 'Museum Staff' and 'Petrologists'

80 In fact, the split was not quite as simple as this: of the metamorphic rocks, the slates remained in the museum, as did the tuffs from the igneous collections as these were seen as 'sediments' and therefore the remit of the museum (interview with S. Laurie 11/08/09).
became much more stark, and this ‘us and them’ attitude, according to DeLanda, may sharpen the identity of the assemblage, and thus increase its stability (2006: 58).

The amalgamation of the Departments of Geology, Mineralogy and Petrology, and Geodesy and Geophysics in 1980 led to the creation of the present Department of Earth Sciences (Bayliss-Smith et al. 1998: 13). However, the collections remained separate until 1998 when the Faculty Board decided that:

…while the several collections are distinct and need specialists to oversee their curation, there is no reason to retain the present organizational structure…[T]he existing museums should be amalgamated to form a single unit which would be named the Sedgwick Museum of Earth Sciences (ibid.).

This delay between the amalgamation of the departments and the merger of the collections suggests that the divisions that had originally been established through the departmental arrangements, were particularly well defined and ingrained. Indeed, the considerable inertia that collections may generate, along with the individuals who work with them, can in this sense be understood as themselves forming assemblages. Thus, the disciplinary divisions that had shaped the collections prior to the merger appear to have remained in place for the collections following the merger, and the persistence of these discrete disciplinary collections for a period of 18 years following the merger, demonstrates the strength of such assemblages. This would suggest that people, disciplines, buildings and equipment are significantly easier to rearrange than collections.

While the Sedgwick supposedly operates as a distinct entity, remnants of former divisions are still apparent today, such as the specialities of ‘collections assistants’ that correspond to the departmental divisions prior to 1931 (namely ‘palaeontology’ and ‘mineralogy and petrology’). A further relic of the historical development of the departments and collections at Cambridge is the sedimentary rock collection, and the tensions that surround its management. The sedimentary rocks originally belonged to the Department of Geology and remained with the Sedgwick Memorial Museum collections alongside the palaeontology material following the 1931 split. However, following the merger in 1998, it appears that responsibility for the sedimentary rocks was not formally clarified, and as a result, the position of the collection remains ambiguous. While the historical development of the various departments at Cambridge have continued to shape the contemporary collecting context, so too have individuals. Indeed, this is all too apparent from the following two statements that were made by the collections assistants with regard to the sedimentary rock collection. When asked about who was responsible for its curation, the collections assistant (mineralogy and petrology) explained that:

…it really is in limbo; there’s nobody really responsible for it. I'm certainly not going to take it on - I’ve got half a million things to look after as it is - I don’t need more (interview with S. Laurie 11/08/09).

Indeed, this division reflects Harker’s interests in igneous and metamorphic (hard-rock) petrology and the emphasis of the Harker Collection on such material.
Likewise, in response to the same question, Matt Riley\textsuperscript{82} (Collections Assistant (Palaeontology) at the Sedgwick) responded:

I believe that [the collections assistant for petrology / mineralogy] doesn’t “do” the sedimentology collections... But I’ve not had much involvement with that but supposedly it’s on my side - just because it’s not on his! (interview 19/08/09).

The problematic nature of this collection and the tensions that continue to surround its status can therefore be understood as a particularly volatile mixture of individuals, objects, and traditions occurring within a particular institution. As such, it is clear that the divisions that are made between different collections are rarely straightforward or planned. Indeed, this can in part be attributed to the collections themselves and the difficulties of managing and changing such vast and weighty entities that appear to form their own particularly stable and well-defined assemblages.

Before considering the pragmatics of creating collection items, it is useful to summarise the relationship between collections and their contexts. It has become clear that university earth science collections cannot be understood in isolation from the broader contexts in which they have developed and currently exist. In this sense, collections are shaped, to varying degrees, by institutional, personal and disciplinary features. However, from an assemblage perspective, institutions, disciplines and individuals do not so much influence collections, rather, collections, as assemblages, emerge from the interactions of such features, and are therefore inseparable from them. As DeLanda explains:

The identity of any assemblage at any level of scale is always the product of a process and it is always precarious, since other processes can destabilize it. For this reason... assemblages, large or small, ...[are always] unique singular individuals (2006: 28).

While I initially focused on applying the assemblage perspective to the broader collecting context, and in this sense, made use of the University of Cambridge as a means of illustrating how collections may be understood as component parts of larger departmental assemblages, it has also emerged that collections themselves may be understood as assemblages. Thus, as the persistence of discrete disciplinary collections within the Sedgwick has illustrated, such assemblages may generate considerable inertia through their composition as dense networks in which the component parts are strongly linked to each other. Furthermore, in forming such cohesive and stable wholes with ingrained and well-defined boundaries, such collections may be difficult to disassemble. Indeed, I build on this notion of the collection as assemblage in the next section, where it provides a useful framework within which to explore the processes and practices that are enacted on objects as they are transformed into collection items.

3.3. The pragmatics of creating collection items

While the contexts of collections provide useful ways of situating collections and acknowledging the broader circumstances surrounding their existence, in order to understand how, within this

\textsuperscript{82} See: Appendix 6o.
broader context, collection items come into being, it is also necessary to explore the various processes and practices that are enacted on objects as they are acquired, processed and stored. In considering the coming into being of collection items in both museums and academic departments, this section will necessarily identify and acknowledge the distinct practices that create particular types of collection items. In so doing, I address both the underlying theory behind the different stages of creating collection items, and also the divergence in practices that enable different types of collection items to come into being.

The assemblage perspective provides an interesting way of understanding the pragmatics of creating collection items. On one hand the growth of collections can be seen to make them inherently unstable because the addition of new objects increases the internal heterogeneity of the assemblage. Therefore, practices of acquisition, processing and storing can be understood ways of increasing the internal homogeneity of the assemblage in order to counteract the destabilizing effects of growth. Viewed in these terms, however, it also becomes apparent that such stability is the result of work and effort, and is therefore always precarious, particularly considering the fact that what counts as stability is itself continually changing. As such, in order to understand the coming into being of collection items, it is necessary to understand the practices that define collection items; to attend to how they are done in practices (c.f. Law and Mol 2008).

3.3.1. Acquisition

Acquisition is concerned with obtaining material (Simmons 2006: 37), and for museum objects in particular, the treatment of objects on crossing the institutional threshold constitutes an important step in their transformation into collection items. Every item that is brought into a museum is subjected to ‘object entry’ procedures and as a result, receives a record and a number. As well as providing a means of keeping track of objects that enter the museum, the object entry process provides an opportunity to capture general contextual and biographical information about an object (and donor), via the object entry form. By specifying and documenting details such as the history, locality, circumstances of find and national grid reference, as well as information about the donor and depositor (The Manchester Museum 2002b: 11), the object entry procedure effectively generates a two dimensional version of the original, thus ensuring that, even if the object leaves the institution, a trace of it will remain. As a result of completing the ‘object entry’ process, objects become known – i.e. their existence is recorded – and from this point onwards (as long as they remain in the museum) they also become locatable; this practice can therefore be understood as a means of regulating objects from the moment that they enter a museum.

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83 I consider the means by which objects enter institutions in chapter five.
84 Object entry procedures are “the management and logging of every item which is left in the care of the museum” (Harrison and McKenna 2009: 12). Object entry is therefore not limited to the acquisition process as it is also a means of managing loans, and objects being brought in for identification, for example.
In direct contrast to the situation in museums, in academic departments where material crosses the institutional threshold for a variety of reasons that may not be concerned with collections, the notion of object entry is inappropriate. As the school curator at Leeds captured during a discussion about the different types of material that enter the school:

Because of the way we operate – and I think that this is the crux here – we have no control over who brings material in, so basically, everybody who is doing research brings their own material in and we can’t control that (interview with R. Finch 06/05/08).

In this sense, it is neither possible nor desirable for the curator to become involved with material until it has served its purpose (interview with A. Edwards 26/10/10), and as a result, acquisitions in departments are not subjected to object entry procedures.

Whether in a museum or an academic department, in order to become a collection item, an object must be selected. There are many different strategies and methods that are used to determine whether or not material is suitable for entry into a collection, and these reflect the purpose of the particular institution and collection, which may or may not be formalised in a policy or procedure. For example, at one end of the scale, LJMU has no formal policies to determine what is added to the collections, and in this case, the small size of the collection and the relatively low volume of material that is added, mean that there is little need to formalise the process (interview with H. Clark 23/03/09). Indeed, the lack of formal policies for regulating the material entering departmental collections can also be understood in terms of their relatively closed nature, namely new material tends to originate from within the department and is therefore, more likely to be of relevance, use or value to the collections. Formal acquisitions policies and systems are, by contrast, essential for museums, not only in terms of their practical value as a means of regulating the flow of objects into an institution, but also as a requirement of the accreditation scheme (MLA 2004: 31).

At the Manchester Museum, for example, all new acquisitions must either be useful in existing or potential displays and programmes for learners, generate or link to academic research, or develop new or existing audiences through their display (The Manchester Museum 2005: 9-10). While such formal acquisitions policies may appear to provide straightforward criteria against which potential acquisitions will be judged, in order for such judgements to be made, it is necessary to involve people. As Knell has observed, while policies may act as “the gatekeeper documents of the collection”, it is the individuals who interpret such policies who ultimately “hold the keys to that gate” (2004: 12). In order to ensure that the process remains ‘objective’ and is not subject to personal whim or bias, it is common for the selection process to involve a variety of individuals. For example, at the Manchester Museum, any material that fulfils at least one of the requirements mentioned above is then subjected to further scrutiny; firstly through consultation with internal and external stakeholders, secondly through an impact assessment, thirdly by an acquisitions panel, and finally by the Director who must approve all new acquisitions (The Manchester Museum 2005: 20).
While objects entering museums and departmental collections must be deemed suitable and relevant, the selection process – its formality and the degree of impartiality involved - varies between museums and departments. While accreditation requires that the selection process in museums is relatively formal and transparent, this is not the case for departments. At SEAES, for example, “the department collects according to current teaching and research programmes” (Handley and Besterman 1998: Appendix 6: 7). Here, the decision to accept or reject material is ultimately made by the curator in accordance with the collecting policy (if one exists) and is strongly informed by their personal knowledge of both the collections (what there is and how it is used), and the research and teaching activities (current and future) carried out in the department.

For those institutions with more than one ‘type’ of collection, the selection process is further complicated by the need to determine which ‘type’ of collection item the object should become. At UCL, for example, there are three different accessioned collections, namely the reference collection, the display collection and the teaching collection, each with its own entry criteria, values and uses (see: Figures 3a and 3b). While the divisions between collection types may seem relatively clear cut, the selection of objects for entry into particular collections is unavoidably one that combines both practical and personal considerations. Thus, while the decision to add material to a particular type of collection is, on one hand, a matter of suitability (i.e. for particular use, storage and treatment) and relevance (i.e. demand), on the other hand, having considered such practicalities, the decision remains largely in hands of the individual. Indeed, this is particularly apparent from Dr Kirk’s explanation of the accessioning process:

…so we have to decide if something’s a reference specimen with 4 parts or whether it’s a teaching object with multiples… If it’s something that’s going to be used in a class, then I’ll probably put it in an ‘x’ number [teaching collection], or if there are 20 specimens, I might put 19 with an ‘x’ number and one with a ‘p’ number [reference collection] (interview 21/07/10).

The acquisition of objects is an important aspect of the coming into being of collection items. In museums, the object entry process regulates the initial flow of objects into a museum – ‘capturing’ objects as they cross the institutional threshold – by formalizing, authenticating and specifying them. While object entry procedures are limited to museums, all collections items must, in some way - whether formally or informally, implicitly or explicitly, by an individual or involving various panels – be selected. Through selection, objects acquire status and are allocated a value; for institutions with numerous ‘types’ of collection, this value may reflect an object’s physical properties, associated information, previous use, or potential function, for example. Within museums, being selected as a suitable candidate for becoming a collection item implies that an object is worthy of being preserved and retained in the long term, and that the benefits of doing so justify the time, effort and resources that this will involve.

The decision to turn an object into a collection item or indeed, into a particular type of collection item is therefore a life-changing event for an object as this decision will impact on the ways in which it is treated and valued. In this sense, being selected is akin to being
compartmentalized. Viewed from an assemblage perspective, selection is a vital sorting process that increases the internal homogeneity of a collection and thus enhances its stability. While the selection process in departments in fact relies upon the personal bias and knowledge of the curator, and their ability to discriminate between relevant and irrelevant objects, in museums, significant effort is made in order to appear transparent and unbiased. However, and as Scharer has observed, such efforts are ultimately in vain: “A collection policy, however defined, is always based on socially defined criteria… No matter how neutrally formulated… the selection process remains culturally specific” (2009: 89). Acquisition constitutes a conceptual transformation as objects become associated with particular collections through practices of selection. Because they tend to remain isolated from other members of the collection that they will eventually join, and because they have not yet been initiated into their collections, these things have not yet achieved their full status as collection items. In order to understand how collection candidates are transformed into collection items, it is necessary to consider how objects are processed.

3.3.2. Processing

As a result of ‘acquisition’, suitable objects with varying degrees of associated information and background context are identified for entry into a particular collection, and as mentioned above, thus far, the relationship between objects and their collections remains largely conceptual. In order to become collection items, objects are subjected to practices that align them with their contemporaries so that they conform to the conventions of the collection to which they have been assigned. While the ways in which objects are processed varies within and between institutions and collections, in general, processing involves recording and inscribing objects and this is achieved through practices of accessioning, registering and recording, ordering and classifying, numbering and documenting.

In museums, accessioning involves the ‘transfer of title’ for an object, which effectively hands over responsibility and ownership of an object to an institution. This document is a vital means of securing the stability of a collection as an assemblage as it adds authority to the acquisition. Understood in this way, the presence of a signature on the dotted line legitimises the transaction, and therefore also the object and collection. Following the transfer of title, the accessioning process can begin, and this involves the creation of a permanent record of the object and assigning it a unique number. The accessions register is, according to Harrison and McKenna; “the most important document in the museum’s documentation system” (2009: 18). Traditionally, the inventorying of new accessions has involved hand-written entries and, while this practice continues in some institutions such as at the Manchester Museum and UCL (interviews with D. Gelsthorpe 24/11/10; E. Passmore 13/04/10), others have developed alternative systems. At the Sedgwick, for example, rather than copying information from an object entry form into the accessions register, object entry forms for accessioned objects are physically appended to the Museum’s accessions register (interview with S. Laurie 11/08/09).
It has been suggested that accessioning is a value-free act of list making, for example, Findlen suggests that; “Inventories record the contents of a museum. They quantify its reality, listing the objects without attaching analytical meaning to them” (1994: 36). This, however, implies that the information that is entered about an object is unambiguous. Furthermore; “Putting a name on any specimen implies a confidence on the part of the identifier who is safe in their systematic know-how” (Donovan and Riley 2011: 359). In this sense, to suggest that accession entries are neutral overlooks the judgements and values that come into play when deciding, for example, what the identity of an object is, or what constitutes a simple description. As Swinney observes:

The representation of each specimen in documentary form is itself the product of processes of selection and manipulation and is but one of a multiplicity of sets of data that could have been selected to describe and delineate that object. The register constructs the museum in a particular way (2012: 34).

Furthermore, and as Swinney hints, the act of accessioning also involves making decisions about the amount of detail that is recorded for an object. The way in which an entry is written may reveal how an object is valued. For example, at the Manchester Museum during the bulk accessioning of the palaeontology backlog material, David Gelsthorpe (Curator of Earth Sciences) explained how:

…we just wrote a line in the accession register saying ‘previously unaccessioned bivalves’, or whatever... So LL1500.2 is plants I think. And so next to that I wrote previously unaccessioned plants… that’s the entire previously unaccessioned plants - about 3,000 specimens (interview 24/11/10).

While accessioning the backlog appears to have become part of a necessary yet mundane act of list-making, when the same curator described the process of accessioning a purchased collection of six pieces of amber, he explained that:

I actually wrote those down [in the accessions register] because there were only six specimens, and it's quite nice from traditions' point of view to have that there. It's a bit irrational I think (interview with D. Gelsthorpe 24/11/10).

This suggests that for the curator, the items that were accessioned in bulk were different from those that were newly acquired and for which the entry of a record into the accessions register almost constituted a ceremonial act (see: Figure 3d). In this sense, while the creation of a permanent record in the accessions register can be seen as confirmation of the special status of an object as a museum piece, the way in which the entry is made may also reflect the value placed on an object.

While a similar process of recording and numbering may be carried out for departmental collections, due to the absence of a formal ‘transfer of title’, this is not accessioning in the true sense. In spite of this, the notion of accessioning appears to correspond to what effectively

85 See Pearce (1992: 127-129) on accessioning, and in particular, the naming of objects.
86 See: Appendix 6i.
constitutes a ‘transfer of trust’, as is apparent from the curator’s description of the situation at SEAES, for example:

It’s the thing that once it becomes accessioned – almost – I view it as almost, then it’s my decision how the material gets used. So if I say its ok, then it’s ok. And that’s what people agree to when it becomes accessioned, when they ask me to take over looking after it (interview with A. Edwards 07/12/10).

In departments, ‘accessioning’ is also used to distinguish between permanent (accessioned) collections and more transient material such as teaching collections. At SEAES, for example, ‘accessioned’ objects are recorded as hand-written entries in an ‘accessions register’ for the practical reason of ‘keeping track’ of them (interview with A. Edwards 07/12/10). Similarly, at LJMU and Leeds, where available, information is recorded on sheets and cards respectively, which are retained for the same purpose (interviews with H. Clark 23/03/09; R. Finch 06/05/08). Nonetheless, it is clear that the decision to ‘accession’ material constitutes a value-judgement concerned with the functionality of an object, thus, at Leeds, for example, unaccessioned teaching material would not be “ascribed status” (interview with R. Finch 06/05/08). In this sense, the distinction is a practical one, as the act of recording information about objects is only carried out for those items that are likely to be retained for long enough to justify the time spent ‘accessioning’ them.

As well as creating a permanent record for an object through entry into the accessions register (or equivalent for department collections), the practice of accessioning or registering objects associates them with a unique number. With the exception of the mineral collection at UCL (as discussed in 3.2.3.), the case study museums adopt one of the ‘standard’ systems of numbering objects, either using a running number or combining the year of accession with a
running number (Harrison and McKenna 2009: 20). However, in addition to a number, it is also common to make use of various prefixes to distinguish between different parts of a larger collection or between different types of collections. Indeed, all of the case study museums use unique systems of prefixes in order to distinguish between different ‘types’ of collections, or different disciplinary divisions.

At the Sedgwick, for example, the palaeontology collections were originally numbered according to a complex system of prefixes in order to distinguish between very specific taxonomic and stratigraphic divisions. While the original prefixes provided a direct link between objects and their stratigraphic position, and therefore specific physical (storage) location within the museum, since new material has been stored in the Brighton Building, acquisitions have been assigned the prefix ‘X’, unless they have been published, in which case the prefix ‘CAMSM’ is used (interview with M. Riley 19/08/09). At the Manchester Museum, there have been various different systems of devising prefixes, however, the original system of prefixes remains in use whereby distinctions are made between petrology, mineralogy and palaeontology. Interestingly, such systems simultaneously segregate (by distinguishing between distinct parts of a collection) and integrate (by creating a common identity that is shared by the distinct parts of a collection).

While departmental collections adopt similar strategies of prefixing to number their ‘accessioned’ collections, it is the teaching collections that present the biggest challenge in terms of management. Teaching collections, by their very nature, are actively used, dynamic, and therefore, difficult to control; objects may go missing, get broken, and material may be added or removed as required (interview with E. Passmore 13/04/10). While it is still necessary to number teaching collections both in order to keep track of material and to provide a reference for the students and staff who use the objects, a different approach is required. Unlike ‘accessioning’ that assigns unique numbers to individual objects, for teaching collections, the situation is almost reversed whereby single numbers are assigned multiple objects. For example, at SEAES, the curator explained that;

R24 is like Penrith Sandstone. Now R24 stays the same, the number, but the actual individual bits of sandstone change, but they’re all R24. So if we need more, we bring it in, and they all become R24. It’s because it’s just being that thing. R24 has a description; it’s felspathic iron coated sandstone with rounded grains… Anything that fits that becomes R24… [and the thin sections of R24], they’re R24 too (interview with A. Edwards 07/12/10).

87 The original prefixes denoted periods of time (i.e. A: Palaeozoic) or, within these, distinct groups of material (i.e. and F: Foreign Mesozoic / M: Carboniferous plants) (interview with M. Riley 19/08/09).
88 Prefixes have been used for prominent collectors (i.e. P: William Boyd Dawkins / W: George Wilde). During the 1990s in an attempt to catalogue the palaeontology backlog, a system of prefixes was used to distinguish between taxonomic groups (i.e. GRA: Graptolites / BRA: Brachiopods). The prefixes were originally allocated by running through the alphabet, assigning letters to each collection area, whereby L=Palaeontology, M=Petrology, and N=Mineralogy, although at some point, the palaeontology numbers were felt to be “too large”, so an ‘LL’ prefix was adopted. In the past, objects have been labelled using a colour-coding system (i.e. L=red, LL=light red) whereby numbers (without prefixes) were painted directly onto objects (interview with D. Gelethorpe 24/11/10).
89 At LJMU, objects have an ‘ES’ (earth sciences) prefix, followed by R (rocks), M (minerals) and F (fossils) (interview with H. Clark 23/03/09). At SEAES, M=minerals and SF=fossils (special fossils) and rocks have no prefix (interview with A. Edwards 26/10/10).
Thus, for teaching collections, the system of numbering objects provides a means of acknowledging their value, namely in their ability to represent something, as opposed to being something unique or individual (see: Figures 3e and 3f). In this sense, it is that which the objects represent that is valued and given a number, rather than the discrete lumps of stuff that perform the task of representing it.

For museum objects and ‘accessioned’ departmental collection items, the number links an object to all of its information, and represents its membership to a particular community of objects (collection). Therefore, securely attaching a number to an object is necessary in order to ensure that objects remain linked to both their context (such as information files and catalogue entries) and to the collection to which they belong. For teaching collections, however, the number represents a substance for which objects are mere examples, and the number links objects to others of the same type.
The development of professional standards has led to the establishment of accepted practices of marking and labelling which are secure, reversible, and discreet but visible, convenient and safe (Harrison and Hillhouse 2011b: 1). Again, the choice of method varies across the case study institutions, and reveals different responses to the dilemma of time consuming reversible methods, favouring both the scientific and aesthetic values of objects, versus quick and easy permanent methods which favour the scientific value of an object plus its information, over its aesthetic value. At UCL, Emma Passmore explained that the teaching and reference objects are labelled by creating a smooth visible surface using a blob of white gouache paint, onto which the accession number is written using permanent black ink (interview 21/06/10). However, for any fossils, display specimens or particularly attractive objects, a different approach is taken:

We tend to put on a removable label [with paraloid]… And the idea is that you can actually remove it again with acetone… If it turns out that your fossil is incredibly important, you haven’t just destroyed it (interview with E. Passmore 21/06/10).

In this sense, the time-consuming process of marking objects using a reversible method is reserved for objects that are attractive or visually important. No such distinction is made at the Manchester Museum where all new accessions are marked using reversible methods, suggesting that the value placed on ‘objects and their associated information’ is equal to that placed on them visually. However, when the curator was faced with marking the aforementioned amber specimens (see: Figure 3g), even reversible methods were felt to be inappropriate: “they are really small, so you don’t want to stick a whacking great number over them” (interview with D. Gelsthorpe 24/11/10). In this case, the problem was overcome by marking the accession numbers on the containers rather than the objects themselves, and attaching photographs of each object to their catalogue record so that they can also be visually identified.

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During the bulk accessioning of the palaeontology collections, printed numbers were placed with specimens and only if they are used, will the numbers be physically attached to the objects (interview with D. Gelsthorpe 24/11/10).
At the Sedgwick, a distinct shift in practice took place in the 1930s when Albert Brighton took over the management of the collections. Previously, it was common to attach duplicate palaeontology specimens (of the same taxon, and from the same horizon and locality) to labelled wooden tablets (Price 1987: 95). In this system, it was the tablets that were assigned a number (and therefore, status), rather than the objects attached to them (Price 1987: 96), reflecting the primary purpose of the collection as *museum pieces*. By contrast:

Brighton saw the need for each individual specimen to have a unique number and even for distinguishing between its associated parts. He also realized the importance of determining the history of use of each specimen (ibid.).

This change in practice, from numbering tablets to numbering objects, reflects a shift towards their functional value as research objects. Brighton devised a numbering system to distinguish between specimens (non-loanable descriptive units) and objects (material units). This system is still in use because it provides an effective means of recording detailed information (for both objects and specimens), and allows the museum to keep track of objects and their derivatives (which are often stored and used separately) whilst retaining a link between them (see: Figure 3h).

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91 This system has implications for displaying objects, as I consider in section 4.4.2. (see: Figure 4l), as well as for their use in research (see: section 4.3.1).
92 For palaeontological material, an ‘object’ may contain numerous fossil ‘specimens’ and for that single ‘object’, each individual ‘specimen’ would be identified, numbered and labelled. In petrology, a piece of rock (‘specimen’) may have originally existed as a hand-specimen (in which case the hand specimen would be both the ‘object’ and ‘specimen’), but if the rock (‘specimen’) was subsequently processed to make a thin section and polished block, the derivatives and the hand specimen would all become ‘objects’ (interview with M. Riley 19/08/09).
The final element of processing is cataloguing; “the assembly of all primary information about items in a collection” (Harrison and Hillhouse 2011a). While all of the case study museums use computerised catalogues, each uses a different system. Catalogues are not, however, neutral tools (Alberti 2009: 132; see also: Shavit and Griesemer 2011). Rather, systems of cataloguing, particularly databases, have the capacity to either constrain or enable the documentation process, for example, by affecting the amounts or types of data that are recorded. Documentary practices, as Swinney observes “do not merely record collections, they construct them: …[they] are part of a technology through which collections are made and delineated” (2012: 35). At UCL, for example, work is currently underway to unite all of the university’s collections on a central catalogue using the Adlib system (interview with W. Kirk 21/07/10). However, the new system will not allow duplicate numbers and this limitation has implications for the teaching collections, and those who are required to catalogue them, as Emma Passmore explained:

So our IT guy blindly said ‘oh, well, give them all different accession numbers then’ but what you’ve got is 15 hand specimens with one number and then another 15 ad nauseum for about 400 sets, and there’s no way on god’s green earth I’m going to sit there painting new numbers onto all of them… what will probably happen when we go onto this new database, is instead of having you know [accession number] x170 with 15, or whatever, we’ll have x170a, x170b… basically, just duplicate it (interview 13/04/10).

Cataloguing is an important stage in the coming into being of collection items, because the record that is generated - its accuracy, validity and authority - may affect an object’s future use and value. As Findlen observes: catalogues are “more than an unadorned list…. [they are] a self conscious presentation of a collection;… repositories of multiple intersecting stories that textualized and contextualized each object” (1994: 36). While department catalogues, like those in museums facilitate the identification and retrieval of objects, they are perhaps less capable of (and less concerned with) the retention of details of the life stories and personal associations of objects. Indeed, the use of systems such as Excel (at Leeds and SEAES) or Access (at LJMU) limits the complexity of the records that may be entered for collection items and the links that may be made between them. Nonetheless, whether in a department or a museum, any attempt to identify, classify or otherwise pin-down an object must be understood as significant as it necessarily has implications for the object’s existence as a collection item. This is because the catalogue is, in most cases, the means by which objects are accessed; in this sense the catalogue must be understood as a powerful mediator that stands between people and objects.

Viewed from an assemblage perspective, processing further stabilizes the identity of a collection. The accessioning process and transfer of title can be seen to add authority and legitimacy to collection items in museums, and as such, strengthen the identity of a collection.

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93 UCL and the Sedgwick have changed their cataloguing systems at least three times (interviews with: W. Kirk 21/07/10; S. Laurie 11/08/09). Both the manual and computerised systems at the Sedgwick have received considerable attention (Etchells-Butler 1982; Price 1981; 1984; 1985; 1987; Price and Rickards 1984; Roberts 1986; Torrens 1979).
Furthermore, the simultaneous segregation and integration that is achieved by numbering and labelling objects further sharpens the boundaries between distinct groups of objects. Documentation systems provide a further means of increasing the internal homogeneity of the collection as an assemblage, by restricting the amount and type of information that may be recorded about an object, and thus ensuring that all records conform to the same system. Processing is therefore another way of sharpening the boundaries of a collection and reinforcing its identity as a distinct entity.

While processing can broadly be understood as a practical means of organizing, classifying and controlling objects (Matassa 2011: 8), facilitating their use, preservation and general management, it is by no means neutral. The implications of processing are significant, considering that the practices enacted on objects effectively specify the identities of collection items. Processing varies according to collection types and the purposes of objects. Thus, while teaching collections may simply be numbered and counted, this is not the case for museum collections or any collection containing material intended for scientific use. As scientific collection items, processing is all about building and maintaining links between objects and their associated information, forming “chains of connections vitally linking the specimen to information, to nature, and back again” (Ellis 2008: 173). In this sense, by establishing what a collection item is, processing has significant implications on what it may become, how it may be used, treated and valued. Through practices such as recording, identifying, numbering, labelling, classifying, describing, and cataloguing, processing can be understood as a means of taming and stabilizing objects within the context of a collection (cf: Bennett 2002: 36; Jenkins 1994: 254). This, however, is not simply a human endeavour; to achieve order within a collection, it is necessary to delegate certain tasks to forms, registers, databases and inscriptions.

While practices of acquisition and processing develop increasingly tight bonds between objects and collections, in most cases, the two remain physically detached. For most objects, it is not until they are arranged and stored that they meet their contemporaries, and it is the final storage element of the coming into being of collection items that will now be considered.

3.3.3. Storing

The arrangement and storage of objects is a powerful means of controlling collection items. In practice, however, it is often a negotiation between the logical ideal position of an object within an existing system of arrangement, and the practicalities of working with space restrictions. Perhaps more so than at any other stage, it is during the storage process that the physicality of objects becomes most apparent; the fact that they occupy space, and for earth science collections in particular, the fact that they are heavy and difficult to move, may make them difficult to manage.
The difficulties of arranging objects are perhaps most problematic for museum collections due to both the volume and permanence of material that they store. As a result, it is common to find a variety of different systems of arranging objects within one institution. At the Sedgwick, for example, the original palaeontology collection was stored in stratigraphic order, both within the Museum’s display cases and below them in drawers (interview with M. Riley 19/08/09). While this system was initially used to arrange material in the offsite stores, the practicalities of maintaining a stratigraphic arrangement (namely leaving sufficient amounts of empty space for future acquisitions), proved impossible to maintain (ibid.). One of the offsite palaeontology stores has now been filled, and the material has subsequently been arranged in stratigraphic order (see: Figure 3i). In the active store, however, new material is simply added where sufficient drawer space exists (see: Figure 3j) (ibid.). The Sedgwick’s petrology collections are arranged according to accession number, and therefore, new material is much easier to store. However, this system is reliant on the catalogue in order to locate and identify similar types of object, and in this sense, is perhaps less suitable for arranging objects that are regularly used for research purposes (interview with S. Laurie 11/08/09).

The arrangement of objects by anything other than their accession number is inherently problematic, as it will inevitably involve either predicting the growth of each part of the collection, or constantly having to shift material along to make room for new acquisitions. Due to the practicalities involved in the latter option, the arrangement of material and the amount of space available for expansion is unavoidably bound up in the interests and values, intentions and expectations of the person who decides how much space to leave for expansion in particular areas of the collection. As one curator explained; “I’ve heard it described on several occasions...
as the stores, particularly palaeontology, being set out like a collecting policy” (interview with D. Gelsthorpe 24/11/10). Likewise, the decision to keep a collection ‘intact’ may also be seen to reflect the value that is placed on it. For example, the isolation of discrete collections of material, such as the Eagar collection of non-marine bivalves in Manchester Museum which is stored separately in “a dedicated Eagar Room” (Nudds 2010: 10), the ‘Johnston-Lavis collection’ of volcanic rocks and minerals at UCL (see: Figure 3k), and the Woodwardian cabinets at the Sedgwick, suggests that the value of such material lies in the whole collection as a distinct entity, rather than on the individual objects within it (interviews with D. Gelthorpe 24/11/10; W. Kirk 21/07/10; M. Riley 19/08/09).

The difficulties of arranging and storing objects are common to both museums and departments, and while there is an extent to which the availability of storage space is largely beyond the control of those who care for and manage collections, the decision to store particular elements of a collection in particular locations can be seen to reflect the values that are placed on them. For example, the Sedgwick has two offsite stores; while the fossils and minerals are stored in the environmentally controlled conditions of the Brighton Building, the petrology collections are stored at High Cross, which the collections assistant (mineralogy and petrology) described as follows:
It's an old factory that's been converted and its very damp, and it's literally falling to bits. It's been maintained on the understanding that it won't be used for more than ten years, but it's been like that for more than 20 years (interview with S. Laurie 11/08/09).

While storage space is a problem for most collections (interview with S. Finney 18/08/09), at UCL the issue is polarised by the cost of land in London, and as a result, the earth science collections at UCL are stored in a variety of locations both on and off campus, each with its own particular environmental conditions and access restrictions.

At UCL, the majority of the department’s teaching activities take place in the South Wing, and it is in this building that much of the core collection is stored (interview with E. Passmore 13/04/10). However, all of the palaeontology material (both teaching and reference collections) is stored in the Lewis Building which is located across the quadrangle from the main South Wing (interview with W. Kirk 21/07/10). The location of palaeontological material is perhaps revealing of departmental and staff interests:

…since the palaeontology has been over there, it’s a lot less used, just because people don’t see it and it’s hard to trolley it over in large volumes. And you do find that out of sight is out of mind – especially for some of the academics. I think that quite a lot of them don’t realise quite how much stuff we have so they don’t ask for it for teaching, which is a bit of a problem (interview with E. Passmore 13/04/10).

The location of the palaeontology collections is rather interesting as it reveals the complex relationship between access and use. While it is unclear whether the decision to store the palaeontology collections in the Lewis Building was the cause or the effect of its low use, either way, it is apparent that this material is less valued than other parts of the department’s collections.

In academic departments, due to the functional nature of the collections, it is common for material to be stored near to where it is most likely to be used. For example, at UCL, with the exception of the palaeontology material, much of the teaching collection is stored in the second floor teaching labs in the South Wing (interview with E. Passmore 13/04/10). This material is actively used in practical sessions, and is stored in unlocked drawers under the lab benches, and in cupboards around the room where it is easily accessible for staff and students (see: Figure 3l). The material is arranged in sets which group together specimens according to the particular course units and practical sessions in which they are used (interview with E. Passmore 21/06/10). The functional value of this material is apparent from both its location in the main building, and its storage in accessible and well-used spaces (ibid.). While this material is regularly handled, picked up, carried around and shaken about as the drawers in which it is stored are opened and closed, this treatment does not reflect a lack of value, but is rather a side-effect of its use. For teaching material, it is not the physical integrity of the intact, untouched, pristine object that is of importance; rather it is as an object-in-use that the value arises.
The use-value of departmental collections often determines where they are stored. At SEAES, LJMU, Leeds and UCL, for example, the teaching collections are stored in the appropriate teaching laboratories (interviews with H. Clark 23/03/09; A. Edwards 07/12/10; R. Finch 06/05/08; E. Passmore 13/04/10). By contrast, material that is rarely used is likely to be stored in less prominent locations, such as the archived research collection at Leeds which is stored away from the department in the basement of the former ‘Mining School’ (interview with R. Finch 06/05/08). Furthermore, and as a result of the lack of restrictions that are placed on access to departmental buildings, the location of collections may also relate to the security requirements for particular types of objects. For example, at SEAES, the financially valuable mineral collection is stored in the curator’s office, and at Leeds, the exam collection is stored in a locked cupboard adjacent to the teaching laboratories (interviews with A. Edwards 07/12/10; R. Finch 06/05/08). In this sense, while the location of museum collections is often constrained by historical arrangements, for the more actively used department collections, the decision to store objects in a particular place is often related to the functions and security requirements of material.

In considering the ways in which objects are affected by the storage process, it is apparent that this is another means of stabilizing the meanings and values of objects. By literally putting objects in their place, they become physically and spatially associated with other objects. In this sense, the spatial arrangement of objects can significantly enhance the stability of a collection as an assemblage, as the density of objects together literally adds weight to the identity of a collection. Over time, this weight, along with the accretion effect of collections may generate considerable inertia, as we saw at both LJMU and Cambridge (see: sections 3.2.2 and 3.2.4).
3.4. Discussion

This chapter has explored the coming into being of earth science collection items as a process of transformation. Objects are not simply modified but, rather, become something different. As ‘collection items’, through practices of acquisition, processing and storing, these things are enacted differently than they were before. Furthermore, the collection itself is continually changing, both as it grows and with regard to its broader contextual circumstances, and in this sense, is perhaps better understood as an active process of continual emergence, rather than a stable entity. Building on the observations made throughout this chapter, I will now respond to the three questions that I set out to answer, concerning the transformation of earth science objects into collection items, the extent to which this varies for different types of collections, and the purposes of collections.

The transformation that objects undergo as they enter collections is broadly conceived as follows: “Their function has been removed and they have been ‘decontextualised’, which means that from now on they will no longer serve their original purpose” (Desvallées and Mairesse 2010: 63). While artefacts may no longer serve their original purpose on account of becoming collection items – the example given by Desvallées and Mairesse is the way that a chair may no longer be sat on once it has become part of a museum collection (2010: 63) - the same does not seem to hold true for natural science objects. For earth (and other natural-) science objects whose ‘original purpose’ is scientific, practices of recording, documenting, preserving and arranging tend to enhance their functionality, rather than removing it. Entry into a collection, therefore, does not seem to affect natural science objects in quite the same way as it does for artefacts.

In order to understand what makes the transformation of natural science objects into collection items distinct, it is useful to return to Desvallées and Mairesse’s conception of the creation of collection items in which they also refer to the loss of context. While the loss of context for artefacts constitutes a loss of function, this is quite different for earth science objects because on arriving in a collection, they have already lost their context. Indeed, and as I explored in the previous chapter, this hurdle has already been overcome through the substitution of the object’s original context in situ, with detailed records and observations thereof. In this sense, any earth science object that enters a collection has already undergone the traumatic process of being extracted from its context (an act of ‘violation’, c.f. Brunton et al. 1985: A4), and must be assumed to have survived the transition from outside nature, inside, with its contextual information intact. Therefore, in exploring the coming into being of collection items, it is clear that earth science objects (and natural objects in general) undergo a different type of transformation, on account of their origins in nature and their prior existence as decontextualized objects before they enter a collection.

While earth science objects may arrive in collections having already lost their original context, that is not to suggest that their transformation into collection items does not involve
further recontextualization. Indeed, it is precisely because the collection constitutes a distinct context that objects are transformed on entry. As I have suggested, both the collection itself and the broader context in which it exists – whether a museum or department – can be usefully viewed as assemblages. Starting with the collection itself, the processes and practices that are enacted on objects as they are transformed into collection items contribute to the stability of the collection as an assemblage. In the first instance, the selection process regulates the flow of objects into a collection by sorting collection candidates so that only ‘appropriate’ objects gain entry, thus reducing the ‘dilution effect’ of acquisition. In order to maintain the identity of the collection as an assemblage, those objects that are deemed suitable are subsequently subjected to a variety of different practices that ensure that they conform to the conventions of the collection. Objects are named, classified, recorded, documented, catalogued, numbered, labelled, and arranged in order to ensure that they are aligned with their contemporaries. By increasing the internal homogeneity of the collection, such practices have the effect of sharpening its boundaries and reinforcing its identity as an assemblage. In this sense, recontextualization is about conforming to the conventions of a collection. The collection, however, may also be understood as a component of other larger assemblages. On this level, the collection is continually unfolding as it interacts with other contextual components (as I explored in section 3.2), and as I have suggested, an implication of understanding the collection as an ongoing process is that what it means to be ‘stable’ is itself unstable. What the assemblage perspective reveals, therefore, is that collections are not just groups of objects; they are also inseparable - active and reactive - components of their contexts, as well as forming contexts in their own right.

The collection is, however, not simply defined by the objects within it, but is also about people. At SEAES, for example, the curator can be seen to have established herself as an integral component of the functioning collection and, having been in post for 25 years, this partly reflects her unique insight into its content and use. As well as controlling the collection through knowledge about it, the curator also physically regulates access to the objects: “the collections belong to everybody that uses them… [but] you do need a curator because otherwise you get anarchy! But it's easier to manage if people don’t have access” (interview with A. Edwards 07/12/10). Thus, the curator has also crafted a very particular role within the institution that centres around the active use of the collection but which – vitally – is always through her. In this case, the growth of the curator alongside the collection, and the central position that she occupies in terms of both knowledge about its contents and access to it, can be described in terms of the curator behaving as a mediator through which all requests, enquiries, and donations are channelled. Here, we see how “the us and the it slip-slide into each other” (Bennett 2010: 4), and as a result, one can only assume that the collection, in its current form, would no longer exist in the absence of the curator.

That is not, however, to suggest that the collection is purely a human endeavour. In order to manage and mediate the collection, institutions and their curators rely heavily on non-humans to carry out some of their duties. By delegating certain tasks to objects such as forms,
ledgers, numbers, labels, databases, shelves and drawers, amongst other things, it becomes possible to achieve some form of order. However, and as Latour has observed: “objects, by the very nature of their connections with humans quickly shift from being mediators to intermediaries” (Latour 2005: 79). Thus, such objects may be so effective that their work becomes invisible. Indeed, over time, the forms and ledgers, numbers and labels, databases, shelves and drawers may become so ingrained in the working collection that they start to shape the collection itself or become part of it. And this is precisely what happens when databases limit the data that can be entered about an object, as we saw at UCL with the teaching collections, or when the storage system interferes with the ideal arrangement of objects, as the curators at the Sedgwick have experienced.

I have suggested above that collections are a means of managing objects, and as I will show in the following chapter, the uses of earth science objects rely on their polysemic nature. The collection can therefore be seen as a way of managing objects while they are not in use, and the processes and practices that are enacted on objects constitute what Kohler has described as; “the arts of preserving and curating that make collections of fragile objects permanent” (2007: 432). In order to manage objects - in order to regulate and stabilize these things, collections capture objects:

Objects are situated within a web of techniques …which banish epistemological and aesthetic ambiguity and disguise the innumerable ways of using objects, thereby limiting the interpretative and practical possibilities for those who encounter things (Edensor 2005: 312).

In talking of collections as a means of capturing objects while they are not in use, it becomes clear that different types of collection operate over different timescales, and it is this difference in timescale that distinguishes museum collections from departmental collections.

Departmental collections are fundamentally concerned with making objects available for use. Therefore, collection items in departments, even those that have been ‘accessioned’, are held over relatively limited timescales because their purpose lies in their use. Departmental collections are not concerned with protecting such items in the long term, and therefore the survival of objects may be understood as an unintended consequence of their transformation into collection items. At SEAES, for example, the curator explained that: “the older it gets, then it acquires the cultural thing. And they’d go to the museum because… we don’t really want to use them for teaching or research” (interview with A. Edwards 26/10/10). The processes and practices that are enacted on departmental objects are therefore intended to enhance the use-potential of objects by facilitating access. By contrast, museum collections, on account of their preservational role, operate over long timescales: many collection items in museums may never be used, but may nonetheless remain in museum collections. Collection items in museums are afforded security and protection – held in perpetuity – and in this sense, the processes and practices that are enacted upon them are directed towards their regulation primarily for the purpose of their long-term preservation, and secondarily for their use.
In spite of the different ways in which objects are treated as they are transformed into collection items, it is useful to return to the similarities. As mentioned above, the common theme is control, and while the particular strategies that are employed may vary, the reasons for regulating objects and the benefits of doing so are common across all collections. In order to stabilize the meanings of objects, they must be closely regulated, however, detailed scrutiny of the processes and practices enacted on objects as they are acquired, processed and stored reveals a contradictory state of affairs whereby the collection stabilizes objects by transforming them. This paradox of stability through change, the fact that in order to manage objects, collections transform the very things that they are supposed to be preserving, is further complicated by the amount of effort and work that this involves. This chapter has illustrated how the apparently stable objects that exist as collection items, are in fact the result of various techniques and practices that are enacted on them as a means of coping with their mutability. Indeed, neither the stability nor the immutability of these things is inherent (Law 2009: 148), but rather are only achieved, by no mean feat, through the effort and work involved in both acknowledging and responding to their instability. Indeed, this mutability is a feature that remains vital to earth science objects in use, as I will now explore in detail as I shift attention towards the functions of earth science objects.
Chapter 4: The functions of university earth science objects and collections

Specimens are collected for specific purposes, and the ways in which they are collected, the intentions and expectations of the collector at the time of collecting, and the information that is bound to them when they are collected, shape the specimen’s future career; its use, authority and credibility. In collecting specimens, the earth scientist transforms pieces of unruly nature into bespoke scientific objects – tailor-made to meet a particular need, and to serve a particular purpose. Ex situ, without their original context, the existence of these objects is precarious. Caught quickly, these objects can be stabilised by binding to them a new scientific context, comprising associated information and data. However, this stability is temporary, and is only achieved through their continual crafting. These objects retain their transience, and as I reveal in this chapter, it is fundamental to their broad functionality; if these things were static and fixed, they could not function in such a range of different contexts.

There is a considerable volume of work in which the uses of museum objects are explored, and while this necessarily informs what follows, it is also important to acknowledge its limitations for the purposes of this research. Firstly, the emphasis that is placed on the use of objects in exhibitions (amongst others see: Basu and Macdonald 2007; Hooper-Greenhill 1995; Macdonald 1998), and learning activities (such as; Chaterjee 2008; Falk et al. 2007; Hein 1998; Hooper-Greenhill 1994; 1999; Paris 2002), fails to account for the range of functions that I have encountered at the case study institutions. The scope of this chapter necessarily extends beyond the walls of the museum to include academic departments, and this is an area that remains largely overlooked, even in the literature from the university museum sector.94 Secondly, much of the existing work that analyses the meanings of museum objects is based upon Saussurian semiology and the related work of Barthes, Lévi-Strauss, and Baudrillard amongst others (in particular, see; Pearce 1992; 1995b), which tends to focus on the symbolic meanings of objects. While earth science objects may function as symbolic representations, their repertoire extends beyond this, and therefore, such approaches are inadequate for considering earth science objects.

As a consequence of the emphasis that is placed on both the more public uses of museum objects, and the symbolic meanings of objects, a number of important questions concerning the functions of university earth science objects and collections remain unexplored in the existing literature, such as: How do objects function and for whom? How does this affect the meanings of objects? What are the processes and practices that are enacted on objects? Indeed, because this research moves beyond the boundaries of the museum to explore earth

94 In spite of the recent interest in ‘putting university collections to work in teaching and learning’ (c.f. MacDonald et al. 2010), the university museum sector has tended to focus on particular initiatives and case studies (such as: Ladkin et al. 2010; Tomiya et al. 2010), rather than addressing the broader theoretical implications of using objects (but see: Duhs 2010; Meadow 2010; Weber 2010).
science objects and collections at the institutional level, this chapter provides an opportunity to address some of these important questions.

4.1. Introduction

Throughout this research, I have encountered a wide variety of uses for earth science objects, both conventional and innovative. Objects may be encountered in person or virtually, on- or off-site, fleetingly or repeatedly, and as scientific, historical, artistic, or cultural objects. Those who encounter objects range from scientists, curators, technicians, students, pupils, and teachers, to amateur enthusiasts, museum visitors and ‘the general public’, or various mixtures thereof. ‘Users’ may be of any age and may encounter objects alone or in groups, with families, friends, colleagues, or peers. Encounters may be formal or informal, and may be mediated, to varying degrees, by people, words, images and a whole host of other contextual features. Objects may be viewed, observed, handled, tested, sampled, probed, analysed, destroyed or preserved: the uses of earth science objects are many and varied. While I hope to capture some of this variety, it is important to emphasise that this chapter is concerned with the functions of objects, and therefore, I will not simply be describing the various uses of these things.

In distinguishing between use and function, my intentions are twofold. Firstly, focusing on functions allows a broader view that both acknowledges the various uses of objects, and provides a means of exploring them without becoming encumbered by the specifics. Secondly, while use implies a passive object to which things are done, function, as something that is performed, better captures the object as an active participant in any encounter in which it is involved. In focusing on university earth science objects and collections, I am interested in the ways in which these things function in both museums and departments, and therefore, it is useful to consider the functions of objects within a contextual framework. This chapter will therefore distinguish between three broad functional contexts, namely, teaching and learning, research, and display. While this framework provides a useful structure in which to consider the functions of university earth science collections, it is important to acknowledge that the boundaries between different contexts are both permeable and flexible (as I explore in detail in chapter five). Drawing on evidence gathered during both interviews with practitioners and observations of objects in use, the following three sections explore some of the ways in which objects function within each context, focusing in particular on the effects of objects as they are encountered, treated, presented and regulated in different ways. Building on these observations, I close this chapter by returning to the questions set out above concerning the functions, users, and meanings of objects.

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95 This chapter is limited to the formal functions of objects, and while ‘unofficial’ uses of objects have been encountered (such as an ammonite fossil serving as a bookend, a coal ball (a spherical nodule found in coal beds) functioning as a doorstop, and the corners of a map being held down by rock specimens), these appear to be one-offs and therefore will not be considered in this chapter.
4.2. Teaching and Learning

The visual and interpretive nature of the earth sciences require students to develop what Frodeman describes as ‘the practiced geologic eye’, which he explains; “has learned how to penetrate the object – probing, testing, sizing it up – seeing the surface as a surface of depth rather than simply a surface” (2004: 159).96 In this sense, disciplinary objects may function as tools for developing ‘trained judgement’ (Kitts 1977: 35) and ‘intuitive awareness’ (Frodeman 2003: 155). In higher education, objects also play an important role in socializing students into the earth science community as they learn which questions to ask and how to go about answering them (Livingstone 2003: 18). This disciplinary familiarity is described by Bowker and Star as naturalization; “learning the ropes and rules of practice in any given community entails a series of encounters with the objects involved in the practice: tools, furniture, texts and symbols, among others” (1999: 299).

The use of objects in context of teaching and learning reflects an underlying belief that; “learning by handling specimens or seeing ‘the real thing’ is considerably better than just seeing an illustration of it” (Clercq and Lourenço 2003: 4).97 In the context of teaching and learning, however, encounters with objects are both regulated and mediated: objects do not function as pieces of the ‘real world’ because the real world is too complex. Instead, objects are used; “to simplify an explanation, to provide an analogy, to illustrate or demonstrate a particular point, or to simulate reality” (Lourenço 2005: 46). In this sense, objects function as signs, in that they “represent, stand for, or refer to something” (Johansen and Larsen 2002: 26). In order to understand how objects function as signs, it is useful to refer to C.S. Peirce’s theory of signs (known as semeiotic / semiotic as opposed to Saussurian semiology).98

Peirce’s work is particularly useful as it acknowledges that objects may ‘determine’ (1998: 478) their signs in different ways. There are three fundamental sign:object relationships, and in addition to symbolic signs (in which the relationship between an object and its sign is based on conventions), Peirce also identified iconic signs (where the relationship is one of visual or physical similarity) and indexical signs (where objects and signs are either connected physically or causally related). With specific reference to earth science objects, it is apparent that most disciplinary objects function as either indexical signs (such as the texture of an igneous rock that is directly caused by its cooling history) or iconic signs (such as a fossil that resembles the creature that it preserves).

In order to illustrate some of the functions that objects perform in the context of teaching and learning, and making use of observations and interviews from the case study institutions, 96 The visual nature of geology is considered in detail by both Oldroyd (1996: 6) and Rudwick (1976).
97 In spite of this, only relatively recently has the value of handling objects been addressed in any particular depth (see: Candlin 2010; Chaterjee 2008; Pye 2007).
98 As well as the application of Peirce’s work to the earth sciences by authors such as Baker (1999; 2009), Parcell (2009), and Von Engelhardt and Zimmerman (1988), it has also been used in material culture studies by Keane (2003; 2005), Bauer (2002), Preucel (2006), Knappett (2002; 2011), Watts (2008), Lele (2006), and Dant (2008), amongst others, and applied specifically to the museum by Latham (2012), Dorsett (2010) and Taborsky (1990).
I will focus on five ‘scenarios’ which I refer to as ‘show and tell’ (in which material is encountered at a distance), ‘surfaces to examine’ (where engagement is visual and tactile but restricted to superficial features), ‘samples to test’ (where visual and tactile engagement probes beneath the surface), ‘sets to interpret’ (where visual and engagement occur within the framework of problem based learning), and ‘objects to inspire’ (in which visual and tactile engagement are geared towards non-disciplinary interpretations). These scenarios are not intended to represent the entire spectrum of uses that have been encountered (for a summary, see: Figure 4a), but rather provide a way of comparing the most common functions of objects, and while the first three scenarios consider different levels of interaction, the final two focus on the effects of using objects in different circumstances.

### 4.2.1. Show and Tell

The ‘show and tell’ scenario refers to mediated encounters at a distance where engagement with an object is restricted to a purely visual level, as is the case in lectures, talks and demonstrations. In this scenario the person doing the ‘showing and telling’ is in control of the

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99 For further detailed consideration of the functions of university earth science objects and collections in higher education, see: Chalk (Forthcoming 2013)
encounter and in this sense, the balance of power and authority is one-sided. Objects that are used to ‘show and tell’ perform as props or illustrations to support the presentation of information, and as a result of the purely visual level of engagement, contextual information about an object (such as provenance, history and associations), is limited to that which the mediator deems relevant.

In spite of the decline in the use of objects in lectures (Lourenço 2005: 141), this practice continues at both Cambridge and UCL (interviews with G. Caruana 12/08/09; W. Kirk 21/07/10). At UCL, for example, due to the small class size in many lectures, objects provide an effective alternative to images, as a means of illustrating a point. Thus, while the old adage may recognise that a picture is worth a thousand words, in this context, an object is perhaps worth considerably more, as Dr Kirk explained when asked about her reasons for using objects in lectures:

…I think it [the use of objects] makes the lecture more interesting: rather than listening to my dull voice droning on about metamorphic rocks… I try to find things to illustrate what I’m saying (interview with W. Kirk 21/07/10).

Although these objects are viewed at a distance, this function may facilitate the learning process by providing a tangible link between theoretical and abstract content and real work experiences (Hodgson 2005: 171; see also: Reid and Naylor 2005). The way in which an object is encountered, however, is closely controlled by the timing of its presentation within the lecture, the explanation provided by the lecturer, and most importantly, the content of the lecture itself. In this sense, the students’ involvement in the interpretation of an object is minimal because of the distance and the context in which it is encountered: objects function as visual aids.

This strategy is also used as a means of providing supervised visual access to objects. For example, the Manchester Museum’s A-Level ‘Trilobites’ session closes with a ‘show and tell’ activity in which the curator shows students a number of “wow-factor fossils” including what he described as an “incredibly delicate” Moroccan trilobite with antlers (interview with D. Gelsthorpe 24/11/10) (see: Figure 4b). Because the specimen has been broken in the past, the curator is “reluctant to pass it around” (ibid.) and in this case, the ‘show and tell’ strategy provides access to a delicate, rare and impressive object without sacrificing its preservation. The curator also uses this strategy during tours around the earth science stores, and as he explained:

I show people a holotype\(^{101}\) of a cockroach fossil and which obviously – it’s the only one in the entire world. So I still really want to show people it, I don’t pass it around, I show people (interview with D. Gelsthorpe 24/11/10).

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\(^{100}\)This decline has been attributed to the development of increasingly sophisticated ‘technologies of display’ (Alberti 2000: 74-76 & 159-161) - from the magic lantern (Shaub 1938: 25) to the digital projector (Nicholson 2002; Sutherland and Badger 2004). For the historical use of objects in lectures, see: O’Connor (2007: 75), Oldroyd (2002: 67), Rudwick (1975: 255).

\(^{101}\)A holotype is a specimen “which provides a fixed point of reference against which the application of species names can be unequivocally decided” (Brunton et al. 1985: B31).
While this regulated visual access provides opportunities for individuals to encounter objects that would otherwise remain inaccessible on account of their frailty, scientific importance, or value, the use of ‘show and tell’ strategies during store tours may, in some ways be rather counterintuitive. If the purpose of ‘behind the scenes’ tours is to ‘open up’ and demystify the museum by providing an opportunities for visitors to engage with collections (Caesar 2007; Matassa 2010), the way in which the curator mediates such encounters may reinforce the notion of privileged access, curatorial authority and scientific elitism. Indeed, this is precisely why museum educators go to great lengths to avoid the ‘show and tell’ strategy, and instead, encourage individuals to interact with objects directly (interview with A. Shelford 19/08/09), as is the case with the following two scenarios.

4.2.2. Surfaces to examine

As ‘surfaces to examine’, objects are encountered directly by individuals and engagement is both visual and tactile. This scenario is popular in both higher education (during practical sessions, particularly for low-level courses) and museums (mostly during formal school sessions), as it provides a means of training individuals to recognize particular attributes and characteristic traits in objects. This, however, requires specimens that clearly display the features of interest. As ‘surfaces to examine’, objects are “purified to single meanings” (c.f. Edensor 2005: 312) through practices of modification (temporary or permanent), ranging from information management (concealing or deleting unnecessary or misleading information), to techniques such as reshaping, resizing, highlighting, annotating or enhancing objects. Furthermore, the ways in which individuals encounter objects may also be regulated, both through the careful arrangement and presentation of material, and more directly using written or verbal instructions, guidance notes, diagrams, or ‘knowledgeable individuals’.

In the disciplinary context, the role of the object is to represent a feature, and the role of the individual is to observe the feature; the aim is for the individual to observe the correct
feature and to make a link between the object and its feature. The feature is decided in advance and the object is modified and presented accordingly. Here, the individual encounters an object within a context that has been manipulated in order to facilitate and encourage a particular interpretation. In spite of the superficial level of engagement (i.e. probing no further than the surface), this scenario can be seen to “...[strip] away the contingencies of an object’s creation” (Bowker and Star 1999: 299). Indeed, this is particularly important for the use of objects in undergraduate practical sessions, where they perform the task of introducing students to the conventions of the earth sciences. Interestingly, both ‘virtual objects’ and replicas (fossil casts) may, in many respects, replace the originals because the level of engagement in this scenario is strongly visual. While virtual and replica objects are ideal ‘surfaces to examine’ because they can be easily manipulated, annotated or enhanced without impacting on the integrity of the ‘real object’, they are less capable of naturalizing students because they are not the ‘real (physical) thing’.

The ways in which objects function as ‘surfaces to examine’ in the context of higher education is illustrated by an example from LJMU where I observed a first year practical session for a course titled ‘understanding the earth’ (observation at LJMU 06/10/09). Students were asked to examine a selection of ‘standard’ sedimentary rock samples (see: Figure 4c), and this involved picking up the specimens, rotating them around to gain alternative views, and feeling the specimens to help judge grain size. Having observed the specimens, students used

Figure 4c: A set of sedimentary rocks used during ‘Understanding the Earth’ practical at LJMU as surfaces to examine.
additional tools such as transparent ‘grain-size charts’, in order to formulate detailed
descriptions,\textsuperscript{102} and then using their observations, students identified each specimen using a
flowchart. In this case, by working through the processes of observation, description and
identification, students were becoming familiar with the distinguishing characters for each of the
rocks (06/10/09).

In undergraduate practicals, objects tend to be selected because they are
‘representative’ and unambiguous – ‘classic material’ – in order to introduce ‘the basics’ and
avoid confusion. By contrast, in the context of a museum, emphasis is often placed on using
‘evocative objects’ (c.f. Turkle 2007) - visually impressive specimens - in order to stimulate
curiosity and enthusiasm.\textsuperscript{103} At the Manchester Museum, for example, the curator selected
“complete” and “spectacular” trilobite specimens for the A-Level ‘Trilobites’ session, in order to
“inspire and enthuse [students] and show variation as well” (interview with D. Gelsthorpe
24/11/10). In this session, the specimens function as evidence of distinct trilobite lifestyles and
the combination of objects alongside a worksheet, supporting information, and museum
facilitators, within the broader context of the task in general, all ensure that the students
encounter the objects in a particular way. However, in this case, the objects are also used to
illustrate the ways in which one specimen may be interpreted in a number of different ways, and
while there are ‘correct interpretations’ for most of the specimens, a number of more ambiguous
elements are included in order to make this point.

A similarly flexible approach to interpretation is also apparent at Cambridge where
students may be introduced to alternative uses and meanings of material during supervisions.
For example, and as Dr Anderson\textsuperscript{104} (Isaac Newton Trust Research Fellow at the University of
Cambridge) explained with reference to the uses of objects during supervisions at Cambridge:

I use things from the actual practicals that they’ve seen before and maybe demonstrate
a different aspect of knowledge that can come out of that, that they wouldn’t have been
told about in the practical (interview 12/08/09).

While objects in practicals are manipulated to serve a very specific purpose, in supervisions,
they may be encountered more freely – as they are – and with all of the complexity and
uncertainty that this implies. Supervisions, therefore, appear to provide an opportunity to
reattach some of the meanings that are deleted or concealed for the purpose of a practical;
introducing students to a more realistic experience of encountering earth science objects.
Interestingly, the outcomes and impacts of such encounters are starkly different from those
within a traditional practical, in spite of the fact that in both cases, the same individuals
encountered the same objects. This emphasises the ways in which the meanings of objects are
strongly mediated by various additional elements (in this case, the individual supervisor).

\textsuperscript{102} The ‘grain-size chart’ allows students to quantify grain size and also provides them with the corresponding
terminology to describe their observations. This is a similar tool and process to the use of the Munsell Colour Chart
by pedologists (Latour 1999b: 58-61), and archaeologists (Goodwin 2010: 105-8).

\textsuperscript{103} While I focus on A-level sessions, this is also a common way of using objects for both primary and secondary school
sessions.

\textsuperscript{104} See: Appendix 6a.
In this scenario, both the objects and the circumstances in which they are encountered are carefully orchestrated and managed, although less so than the ‘show and tell’ scenario on account of the direct contact (visual and tactile) between the individual and the object. The superficial level of interaction between individuals and ‘surfaces to examine’ means that (in theory), this function should not significantly impact on the physical integrity of an object (although in practice, objects may deteriorate as a result of increased handling), and this is perhaps why museum objects commonly function in this way. By contrast, however, and as I will now consider in detail, when the level of engagement penetrates beneath the surface, museum objects are unlikely to be used.

4.2.3. Samples to test

As ‘samples to test’, interaction extends beyond the surface of an object. In this scenario individuals carry out various tests and investigations in order to discover the properties of objects for themselves. In higher education, the use of objects as ‘samples to test’, like the previous scenario, is a common strategy for practicals in low-level courses, as it provides students with the opportunity to actively discover information for themselves. This scenario was used, for example, during a first year practical at the University of Leeds in which students were required to carry out a number of physical property tests on minerals (05/10/09). Having carried out a test, students used various resources such as identification charts, tables, diagrams and lists in order to translate the results into meaningful information.

The use of objects as ‘samples to test’ also introduces students to the basic ‘tools of the trade’ and provides opportunities to develop some of the basic skills required to use them. At Leeds, for example, students used ‘streak plates’ for the streak test, coins and nails for the hardness test, and a hammer and safety glasses for the cleavage test. The hardness test, for example, requires a certain amount of dexterity in order to scratch a small mineral specimen with a coin or nail; a skill that students learn through a process of trial and error, with additional guidance from the student demonstrators. Again, such close contact with objects also contributes to the process of naturalizing students. During the Leeds practical, students appeared be comfortable and confident with the objects - almost blasé, suggesting that the objects had lost their ‘anthropological strangeness’ (Bowker and Star 1999: 299).

The nature of testing means that the physical integrity of these objects is ultimately sacrificed, and because they function as consumables, duplicate samples are often purchased in bulk specifically for the purpose (interview with R. Finch 06/05/08). However, the notion of ‘duplicates’ extends beyond the visual features of an object; as ‘samples to test’ it is also the physical and chemical properties of objects that must be consistent and typical (see: Figure 4d). Therefore, unlike the previous scenario, the ‘real thing’ is essential here, because it is the intrinsic properties that are of interest, replicas or virtual objects cannot be used in place of specimens.
While this scenario gives students more control over their learning experience, the situation remains rather contrived; students are not discovering unknowns (as is the case in research), rather, they are discovering specific, predetermined, and unambiguous information for themselves. During the mineral testing practical at Leeds, a worksheet was used to ensure that students only tested specimens that provided useful results or particular outcomes. In this sense, ‘samples to test’ and ‘surfaces to examine’ are both based on the same underlying principles, and the difference lies in the level of physical engagement with the object.

Although the use of objects in this way is uncommon in museums (and clearly does not involve accessioned specimens), it is not, however, unheard of. For example, at the Manchester Museum, the primary science ‘rocks revealed’ session made use of purchased (unaccessioned) rock samples for testing in a similar way to that described above. In this case, groups of pupils worked on a set of rocks which, with the exception of one specimen, all belonged to the same broad ‘type’ reflecting similar processes of formation (i.e. igneous, sedimentary or metamorphic). After grouping and sorting the objects based on their observations, pupils also carried out hardness and permeability tests, and used this evidence to decide which rock was the odd one out. Again, the situation was highly contrived and objects were selected in order to illustrate both patterns and anomalies. Indeed, while this session made use of objects as samples for testing, it can also be understood in terms of the broader outcomes in which the test results and observations formed the basis of interpretations, and in this sense, the objects together functioned as sets for interpretation.

4.2.4. Sets for interpretation

The use of objects as ‘sets for interpretation’ is a typical method of approaching problem based learning, and in higher education, this scenario is often used in practical sessions for higher-
level courses (interviews with G. Caruana 12/08/09; R. Finch 06/05/08). Here, objects function collectively as ‘surfaces to examine’, and are combined with resources such as maps, diagrams and data. ‘Sets for interpretation’ are often concerned with fabricated scenarios (interview with R. Finch 06/05/08) that are constructed through the careful selection and arrangement of particular objects, in order to make a particular point or develop particular skills. For example, at the University of Leeds, second year students use a ‘set’ containing hand specimens, thin sections and a map in order to determine both the relationships between a suite of rocks, and the processes leading to their formation (see: Figure 4e). In this case, the various resources are combined in order to provide students with different scales of information, as the school curator explained:

…the teaching is geared toward looking at the hand specimen, working with the hand specimen and the thin section in conjunction with some maps and the regional history, to get the students to appreciate the processes (interview with R. Finch 06/05/08).

Because interpretation necessarily begins with observation, the objects that are used in this scenario function in the same way as ‘surfaces to examine’ in that interaction is strongly visual and it is only particular features or characters of objects that are of interest. However, as ‘sets to interpret’, students are required to construct an interpretive framework using their own observations and knowledge. Therefore, in addition to tactile and visual engagement, students must engage mentally with the objects and resources. Indeed, because the use of objects as ‘sets to interpret’ is an extension of the observation scenario, it is possible to use virtual objects for this purpose. Again, the increased level of control that is afforded by virtual objects; the ability to manipulate and modify them in order to shape the ways in which they are interpreted, makes them particularly useful.
This scenario is also used in museums, for example, at the Manchester Museum, objects function as sets for interpretation in a number of different sessions, ranging from the A-Level 'Quaternary Climate Change' session to the primary science 'Dinosaur Detectives' session. During the dinosaur detectives session, pupils observe a simulated 'crime scene' consisting of a large floor mat showing footprints and bones, and from this, conclude that a T-rex was killed by a carnivorous 3-toed land animal. Having looked at the crime scene, pupils investigate five ‘suspects’ with a view to identifying the guilty creature. Pupils are provided with specimens that relate to each of the suspects and are asked to use the objects in order to help them to decide whether or not a creature fits the profile of the guilty suspect (see: Figure 4f).

Here, the nature of a task itself is used to focus attention on particular features and qualities of objects, directing the ways in which pupils encounter and investigate objects. In this context, pupils focus on particular features rather than the objects themselves, for example, rather than observing an entire ichthyosaur skull, the scenario is constructed to direct them towards the sharp teeth as evidence that the creature was a carnivore, and similarly, a mammoth tooth becomes evidence of a plant-eater. Furthermore, these objects do not act alone, but are rather presented alongside images and data that, together, provide the pupils with evidence to decide whether or not a creature is guilty. Therefore, when they encounter the ichthyosaur skull, while it may well have sharp teeth, the fact that the image of a skeleton depicts a creature with a tail and paddles but no legs, leads them to the conclusion that it could not be the guilty creature.
because it did not live on land and could not have made the footprints that they saw at the crime scene.

Like the use of objects as sets for interpretation in higher education, in museum sessions, the objects are similarly modified and regulated to ensure that a particular meaning is conveyed or function is performed. Indeed, the use of sets for interpretation in both higher education and museums provide a valuable way of contextualizing objects, and while the scenarios in which objects are used are, to some extent, simplified versions of reality, they make disciplinary encounters with objects more meaningful.

4.2.5. Objects for inspiration

While the scenarios that I have thus far considered are largely geared towards the use of earth science objects within their disciplinary context, this final scenario focuses on the creative use of earth science objects. The use of ‘objects for inspiration’ is perhaps most commonly encountered in museums, as, to some extent, it is easier to achieve when those who encounter objects have little or no prior disciplinary knowledge. In this scenario, objects are presented on their own, preferably without supporting information or resources, with the aim of distancing them from their disciplinary context. By presenting objects as ‘unknowns’ these things are open to interpretation, and individuals are encouraged to interact and engage with objects on a personal level. As unknowns, while the interpretations of objects are, in theory, only limited by the imaginations of those who encounter them, in practice, it is often difficult to unlearn habits such as wanting to know what something is.

At the Sedgwick Museum, Annette Shelford105 (Education Officer) makes use of this scenario in an activity called ‘Poetry Rocks’ in which objects function as a source of inspiration for creating a piece of group poetry (see: Shelford 2007). In this context, the object remains anonymous; it is not named and its identity remains entirely irrelevant. The object is passed around a group, and each pupil is asked to provide a new word about the object, that describes what it means, looks like, feels like, suggests, or says to them (interview with A. Shelford 19/08/09). By shifting the focus away from the name or identity of the object, and instead, towards personal interpretations based on observations, thoughts and feelings, the activity allows pupils to become familiar with an object in a creative way, and in an environment in which there are no right or wrong answers. By using the words generated through this activity in order to construct a poem, this type of encounter benefits both the pupils and the teacher:

…[by] helping and encouraging teachers to firstly engage with geology themselves, and through them encouraging children to sustain early interests in geology which often come from dinosaurs or crystals… cross-curricular activities such as this one can give teachers the confidence to use rocks and fossils in different parts of the curriculum (Shelford 2007: 313)

105 See: Appendix 6p.
Indeed, a similar approach was used at the Manchester Museum, for an adult learning project called Health Rocks.

‘Health Rocks’ took place over a period of twelve weeks in 2009, and involved a group of twelve adults - six adults with severe mental illness, and six museum volunteers – working together along with a project team combining museum staff, artists and members of an arts and mental health agency called ‘Start’ (interview with G. Thiara 04/01/11). The purpose of the project was to provide participants with opportunities to take part in creative activities centred around handling and experiencing objects from the museum’s collections – using the collections “as a starting point for well-being and creativity” (Froggett et al. 2011: 37) – and ultimately led to the creation of a display in the Manchester Museum (see: Figure 4g). The project involved weekly afternoon sessions at the museum, and each session explored different objects using different art techniques. The ways in which participants encountered objects also varied, and the programme included opportunities to engage with material on display in the galleries, during store tours led by the curators where objects were passed around the group, as well as during handling sessions that combined question and answer sessions with the curators (ibid.).

Interestingly, the project leader observed that the group (particularly the museum volunteers) often struggled to move away from treating the objects as scientific museum specimens: “there was this thing where some people wanted factual information and responded to factual information” (interview with G. Thiara 04/01/11). While the aims of the project were concerned with generating emotional responses to objects, the decision to focus on the earth science collections meant that many of the participants were uneasy about their lack of
familiarity with the objects that they encountered. Therefore, it was often necessary to contextualize objects using information about their formation, origins, or histories. The challenges of working with earth science objects were also felt by the artists:

...their usual approach to working with art galleries is that participants are encouraged to consider the intent of the artist and their story, in order to develop a personal connection. As they did not have this route with the naturally occurring objects at the museum, Start saw working with the Museum collection as a challenge as it required a reconsideration and modification of approach (Froggett et al. 2011: 42).

In the Health Rocks project, the objects were required to function in different ways to those for which they had been collected. While the artists and curators were vital in mediating between the objects and the participants, in particular by encouraging participants to move away from viewing the objects as scientific museum specimens, the fact that the project was felt to be successful, illustrates that objects have the potential to be used in innovative ways. As the evaluation report states: “people made connections with objects in ways which could not have been anticipated, as in the imaginative ‘animation’ of inanimate minerals” (ibid: 65).

This section has introduced some of the functions that objects may perform in the context of teaching and learning, illustrating the ways in which they may generate a wide variety of effects, ranging from knowledge and understanding, to experiences and inspiration. The five scenarios have drawn attention to the ways in which different functions may generate different outcomes as a result of the different types of encounters. The first four scenarios are concerned with the standard ‘disciplinary’ interpretations of objects, and therefore, they function as iconic or indexical signs. Particularly in the context of higher education, objects function as tools for communicating pre-decided ‘facts’ to students, and in spite of various levels of contact with objects, the ways in which individuals interact with them is largely non-discursive (c.f. Taborsky 1990: 58-60). By contrast the non-disciplinary ‘creative’ use of objects – as ‘inspiration’ – requires objects to function as symbolic signs. Interestingly, in the case of ‘Health Rocks’, the participants’ interest in contextual and factual information about the objects suggests that the objects were initially encountered as disciplinary objects (as iconic signs: they just looked like rocks / minerals / fossils), and it was through the mediation provided by the project team, that the participants were able to interpret these things symbolically. It follows that the effects and outcomes of objects are not only affected by the objects themselves, but are also shaped by the circumstances in which they are encountered: the individuals who encounter them, and the various strategies and techniques that are used to regulate both the objects and the individuals. Having considered the teaching and learning context, I will now move on to explore the functions of university earth science objects in the context of research.

4.3. Research

In order to explore the ways in which earth science objects and collections function in the context of research, I will focus (again) on the ways in which they are encountered. Such an approach has been developed by Pickstone in his Ways of Knowing, where he distinguishes
between knowledge arising from: the description and classification of objects (natural history),
the deconstruction of objects into elements (analysis), and the rearrangement of such elements
(experimentalism) (2000: 8). A different approach is adopted by von Engelhardt and
Zimmerman (1988) who focus specifically on research in the earth sciences, and whose
categorical concepts of ‘things’, ‘configurations’ and ‘substances’ provide a useful framework for
understanding the relationship between research techniques and objects. In this scheme,
‘things’ are “material objects which in some way can be isolated from their surroundings and
which preserve their identity” (von Engelhardt and Zimmerman 1988: 83). Importantly, von
Engelhardt and Zimmerman note that; “a thing is not a permanently fixed ontological unit. What
is defined as a thing in the context of a discipline depends upon the research goals, and may
change with these research goals” (ibid: 85). ‘Things’ are three-dimensional objects that occupy
space, display properties, have temporal duration, and consist of ‘substances’ (ibid: 83-4).
‘Configurations’ are the structures and formations (such as stratification, texture and bedding),
that are produced by various forces and processes, and which are imposed upon ‘substances’
(such as chemical elements, minerals or rocks) (ibid: 85-6). Earth science research may be
concerned with ‘things’, ‘configurations’, or ‘substances’.

While these two approaches provide valuable insight into the different ways in which
objects may feature in scientific research, they fail to capture the range of functions that I have
encountered during my research. My interest in objects and collections in both academic
departments and museums requires a broader understanding of research that extends beyond
purely scientific investigations, to acknowledge the use of earth science objects in cultural,
historical and various other ‘non-scientific’ forms of research. With this in mind, I will focus on
four research functions of objects that I refer to as ‘observed objects’, ‘amplified objects’,
‘objects as materials’ and ‘objects as associations’ (see: Figure 4h). While the first three
functions correspond to the existing categories and distinctions mentioned above, the use of
‘objects as associations’ bears no relation to the existing schemes as it is concerned with the
ways in which objects may function as a tangible link to particular individuals, events,
institutions, practices, or beliefs, with which they have been involved. Finally, it is important to
acknowledge that objects are not restricted to performing just one function. For example,
‘observation’ may lead to ‘amplification’ and if the original object is retained, it may subsequently
be ‘re-observed’ or ‘re-amplified’, or may be used as a ‘material’ or as evidence of its
‘associations’ (I consider the mobility of objects in the next chapter). In this sense, in the context
of research, earth science objects are ‘epistemic things’ in that their “possibility is beyond our
present knowledge” (Rheinberger 1992: 307).

### 4.3.1. Observed objects

‘Observed objects’ are whole complete specimens that are looked at, described, measured,
identified, named, compared and contrasted (see: Figure 4h.i) they are ‘things’ that function as a
source of information about either themselves, their ‘configurations’ or their ‘substances’. As
signs, observed objects function in much the same way as they do in the learning context in that
they are interpreted as either icons (particularly with fossils) or indexes (as with trace fossils, or
See the document for the full context. The text refers to descriptive sciences such as palaeontology, where observation remains vital despite the development of new quantitative techniques. It highlights the importance of understanding the physical features and qualities of objects that are directly linked to their formation. For example, Dr Manning explained that the taxonomy and phylogeny of an organism are critical for their work. Observed objects may be collected during exploratory research and geological mapping, although their use as ‘observed objects’ may be followed by analysis if material is of interest. While objects may be collected specifically for the purpose of being ‘observed’, it is also common for existing material to perform this function.

By its very nature, observation does not affect the physical integrity of an object, and therefore, it is the most common research function performed by museum objects. At both the Manchester and Sedgwick museums, this type of research is most often concerned with palaeontological material, and requests for access to type and figured material are relatively common. (Interviews with S. Finney 18/08/09; D. Gelsthorne 24/11/10). In addition to descriptive...
work where it is the morphological features of the specimens that are of interest and where the researcher’s gaze penetrates no deeper than the surface, comparative work may require closer encounters with objects in order for a researcher to make measurements, for example (interview with D. Gelsthorpe 24/11/10).

While the act of observation itself has no physical impact on material, it may be necessary to interfere with objects in order to make them ‘observable’. For example, Sarah Finney106 (Conservator at the Sedgwick) described how she received a request for access to approximately 200 fossil crab specimens, for the purpose of studying particular anatomical features. This research was purely observational and descriptive in nature, and was therefore in no way intrusive to the specimen. However, as a result of a past curatorial practice (as mentioned in section 3.3.2.) in which one or more specimens were attached to small wooden tablets, it was necessary for the conservator to carefully remove each of the requested objects from their tablet and clean off the adhesive, because the particular features of interest to the researcher were located on the dorsal side of the specimens (interview with S. Finney 18/08/09). Interestingly, the tablets were retained after the objects had been removed, because they have themselves become part of the history of the objects or, to quote Pearce, they are “the fossils of the history of meanings” (1999b: 20). Practices of curation and conservation may occasionally prevent an object from performing this function, such as when irreversible techniques are used.107 At the Manchester Museum for example, the curator described how:

When the Ichthyosaurs were first collected, they prepared them in a way that removed some of the Acanthoteuthis claws, which were claws on things like belemnites [that were often found preserved as stomach contents]. And we had a research project a couple of years ago… looking at these claws and how they relate to the stomach acid of the ichthyosaur. But in a lot of the original specimens, the claws were removed as the specimens were prepared (interview with D. Gelsthorpe 24/11/10)

The meanings that observed objects generate depend upon both the contextual information that was recorded during their collection, and the context in which objects are encountered. For example, objects may acquire new or different meanings as a result of changing theories or even, being viewed with fresh eyes,108 and this is precisely why collections are retained for restudy. While this function has little physical impact on objects, if ‘observation’ reveals that an object is (or is not) particularly important, relevant, or interesting, then it may be treated, valued or used differently as a result. However, observation often forms part of a larger research process, providing a means of identifying material that requires further attention and scrutiny. In such cases, ‘observed objects’ may subsequently function as ‘amplified objects’ (interview with G. Droop 10/11/10).

106 See: Appendix 6h.
107 This type of problem is less likely to arise when existing material belongs to a departmental collection, because curatorial practices are less invasive (more basic) and carried out with the future use of objects in mind (interview with Edwards 26/10/10).
108 This has been the case when ‘new discoveries’ are made using existing objects, such as with the conodont animal (see, for example: Knell 2004: 27-8).
4.3.2. Amplified objects

Amplification, like observation, is concerned with original objects. While observation is limited to the surface of an object, as seen through the human eye, amplification moves beyond this to use either ‘things’ themselves or (more often) samples thereof, as a source of evidence about their ‘configurations’ or ‘substances’ (see: Figure 4h.ii). Amplification may be visual, analytical or a combination of the two: while visual amplification is about enhancing what is seen – zooming in visually, analytical amplification is about enhancing what is known – focusing on components. However, both types of amplification require equipment and machines. Visual amplification involves what Haraway describes as “techniques for enhancing the eye” (1988: 581), such as an optical microscope, scanning electron microscope (SEM), or x-ray micro-tomography (XRT). Analytical amplification uses techniques such as x-ray diffraction (XRD), x-ray fluorescence (XRF), mass spectrometry (MS), electron microprobe analysis (EMPA), for example, in order to carry out detailed investigation / diagnosis / examination of objects via their components.

While amplification enhances objects visually or analytically, it tends to achieve this by focusing on samples rather than the entire original objects (although there are exceptions, as I explain below). Amplification is therefore often concerned with ‘derivatives’ – samples removed from the original object and often transformed into new objects such as thin sections, SEM stubs, powder samples, polished blocks - rather than the original objects (interview with R. Finch 17/11/08). However, while amplification may impact on the physical integrity of the original (by removing a sample), this is simply a side effect of this research function and is not carried out for the purpose of changing the original object’s composition or creating new things from scratch.

The amplification of palaeontological material is perhaps less straightforward because of the importance that is placed on the physical integrity of the original complete object. However, and as Dr Manning explained, the use of different scanning techniques is providing an increasingly viable means of amplifying palaeontological research objects intact:

All of the techniques we are developing are non-destructive, which should be music to the ears of any museum, because sadly, over the last ten years, a lot of the techniques and technologies - methods applied - have been destructive. And it’s not necessary now… depending on the fossil …in many cases it is not necessary to destructively sample the fossil (interview 07/02/11).

While palaeontological objects have perhaps proved more challenging to amplify on account of the discipline’s qualitative tradition (although, see 2.2.1) and the value placed on the original complete specimen, such concerns have generally not affected the use of more destructive techniques of amplification (where a sample is removed from the original) in other areas of the earth sciences (interview with A. Edwards 26/10/10).

At the University of Cambridge, for example, Dr Holness is currently carrying out research into the cooling history of rocks from an igneous intrusion in East Greenland. It is not,
however, the original specimens that she works with. Rather, the specimens are cut into blocks from which thin sections are made, and these are viewed under a microscope using a universal stage in order to measure the angles between grain boundaries at three-way junctions (interview with M. Holness 28/10/09). For each specimen, 30 angles are measured and recorded in a notebook, and subsequently transferred onto an Excel spreadsheet. This data is used to calculate the median values and standard deviations, which are then plotted up and examined in order to identify any patterns (ibid.). It is therefore from the data, not the objects, that she is able to decipher the cooling history of the rock.

Amplification shifts attention towards the derived object as a source of data and depictions, and it is these data and depictions that are of interest to researchers. As the school curator at Leeds observed:

Research now doesn’t generate material; it generates data, which is different. People used to look at material to make observations and now they get their data from specimens and look at the data. It’s almost like a step out of the process that uses the specimens (interview with R. Finch 06/05/08).

Material from departmental collections is often used for this type of research, particularly when it is not possible for researchers to collect their own material for financial, access or safety reasons. For example, the curator at SEAES explained how a PhD student is carrying out research into island and ocean arc basalts and that:

…we had a member of staff and a PhD from the early 1960s and they went out to a lot of Pacific islands. And obviously that’s very expensive…so she’s going through those collections at the moment… [she] will want to use that stuff and she’s going to want to take thin sections …and that’s what it’s for (interview with A. Edwards 26/10/10).

While many departmental collections are specifically geared towards such uses, the preservational role of the museum makes the amplification of museum objects more challenging. As the Research Information Network (RIN) has acknowledged, in the earth sciences, “handling is not enough, and researchers may wish to sample materials for analysis… This might include destructive sampling, which will of course present challenges for museums” (RIN 2008: 13).

Due to the potential tensions between preservation and amplification, requests for the use of museum objects are given careful consideration and judged upon the relative benefits of the information that will be gained, compared to the damage to the physical integrity of the object (interview with S. Finney 18/08/09). At the Sedgwick, for example, a number of specimens from the museum’s ‘Beagle Collection’ were recently analysed in order to determine whether or not they had been mislabelled by Darwin (see: Herbert et al. 2009). This required the creation of thin sections that necessarily involved removing pieces of the original sample. In spite of the historical value of these objects, it was decided that the research was important enough to warrant damaging the physical integrity of the specimens, because the additional scientific value that would be added as a result of the analysis, outweighed the potential impact on their historical value (interview with S. Finney 18/08/09). As with observation, the processes
and practices of curation and preservation may obstruct the amplification of museum objects, making them unsuitable for this type of research. For example, at the Sedgwick, a request to use samples of sub-fossil material for the purpose of radiocarbon dating was declined because the material had been coated in varnish. Since the coating was likely to affect the results, it was decided that the benefits of using the material were not sufficient to justify the removal of samples from the specimens (ibid.).

On one hand, on account of the emphasis that is placed on samples and data, and on various visual and analytical techniques, amplification can be seen as a step away from the original object itself. However, whether amplification generates data, produces images or graphs, or simply enhances the eye, the processes and practices that are enacted on objects are carried out in order to understand the original object. Understood as signs, data and depictions function either as indexical signs (in the case of analytical amplification where the depictions are causally related to the original object) or iconic signs (in the case of visual amplification where the image resembles the original object), and importantly, they relate directly to the original object. While both amplification and observation are concerned with the original object – as a ‘thing’, its ‘configurations’ or ‘substances’ - this is not the case when objects function as materials.

4.3.3. Objects as materials

The use of objects as materials shifts attention away from the ‘things’ themselves, and treats them as a source of ‘substances’ (see: Figure 4h.iii). Because this function either transforms or destroys the objects involved, this use is limited to departmental collections and objects that have been purchased specifically for the purpose. There are two ways in which objects may be used as materials. Firstly, objects may be used to calibrate machines. However, because this function requires pure samples, it is often easier to purchase material specifically for this purpose, rather than using existing material. For example in Leeds, if material is requested in order to calibrate the XRD, then: “it’s quite easy for them to go and buy something of lesser value, but if we’ve got a lot of specimens then they may use it” (interview with R. Finch 06/05/08). Similarly, at SEAES, the curator explained that there is often a tension when it comes to using minerals because of their value as display pieces:

We had a request the other day from someone who wanted a mineral from the Harwood collection, and they just wanted it because of the elements that were in it. So they didn’t care where it was from – the locality wasn’t important. So it was easier to say to them; go to a mineral dealer and get some (interview with A. Edwards 26/10/10).

While the use of material for purposes of calibrating machinery is not always seen as sufficient justification for destroying objects from departmental collections, their use for experimental research is often viewed more favourably. This second type of use either transforms or destroys the original object. For example, at SEAES, as the curator explained:
The thing we’ve got at the moment is a big research grant looking at radioactive waste disposal… and they’re looking at pore spaces in rocks, so …they’re interested in the rocks almost for the properties they have… Because it’s been funded by the UK, they’re actually interested in a rock from the UK (interview with A. Edwards 07/12/10).

The curator has provided the research group with various specimens of granite and shale from the ‘accessioned’ collection, and these will ultimately be destroyed as a result of their use. However, in this case, the decision to allow the destructive use of collection items is likely to reflect both the fact that the material of interest was location specific, and (perhaps more significantly), the fact that “we just don’t get as fussy about the rocks” (interview with A. Edwards 07/12/10).

When objects function as materials, their value lies in their capacity to yield particular results or to provide a particular ‘substrate’. The original object becomes a disposable tool for the researcher, who is not concerned with retaining either its integrity or its original context. Indeed, this is apparent when objects are used as ‘materials’ outside of the earth sciences. For example, at UCL, a member of research staff from the life sciences requested a piece of obsidian and as Dr Kirk explained: “…he wanted to cut an animal whisker in half …and apparently it had been done using obsidian because it has such a sharp edge” (interview 21/07/10). While this particular request was declined due to the lack of appropriate samples in the collection, it highlights the potential use of earth science specimens for research outside of the discipline, in which objects simply function as tools. The meanings of objects as materials do not arise from their interpretation as ‘disciplinary objects’, but are instead related to the techniques and processes that have been enacted upon them. For example, experimental research may transform an object (see ‘experiments’ and ‘transformations’ in Figure 4biii), and the new (transformed) object may be subsequently amplified. However, in such cases, interpretation is concerned with the object as an indexical sign of the processes that transformed the original object, rather than the original object itself. This lack of concern with the original ‘disciplinary’ object is apparent from the fact that objects may often function as materials in the absence of any associated information. By contrast, and as I shall now consider, this is not the case when objects function as associations.

4.3.4. Objects as associations

Earth science objects and collections are increasingly recognised as a valid source of historical evidence (see: Figure 4h.iv). In the past, curators often carried out historical research into prominent donors in order to enhance their knowledge of the collections in their care. However, more recently, the tendency to publish this type of research (such as: Kirk 1995; 2004a; 2004b; 2004c; 2004d; Kirk et al. 2000 at UCL) suggests that it also provides a means of promoting the collections and their use as associations. Indeed, at all of the case study museums, there is a growing interest in the use of ‘objects as associations’ from external researchers (interviews with S. Finney 18/08/09; D. Gelsthorne 24/11/10; S. Laurie 11/08/09).
Research involving ‘objects as associations’ is concerned with what Walley refers to as their ‘social history value’ (1997). However, such research is often more concerned with the associated information about objects and collections, than the objects and collections themselves:

Social history value comes from data which are either directly associated with the specimen, such as the locality, date, etc. or with wider associations with the people, places and times connected with them, or else associated with a collection, for example, its cabinets, or its sale or other transfer (1997: 49).

Due to the importance of detailed associated information, this type of research is more common in museums than it is in departments. At the Manchester Museum, for example, the ‘William Boyd Dawkins archive’ is regularly consulted by researchers who are interested in finding out, using diaries and field note books, whether Dawkins was in a particular place at a particular time (interview with D. Gelsthorpe 24/11/10). Here, researchers may have no interest in the objects themselves but are instead, purely interested in the associated information.

By contrast, at the University of Cambridge, research into the Beagle Collection has made use of the combination of both specimens and records. Dr Anderson (Isaac Newton Trust Research Fellow) has used both objects and their information, such as field notebooks, letters, diaries, specimen labels, and published descriptions, to learn more about Darwin’s geological collecting during the Beagle Voyage. In particular, he has been able to discover details of Darwin’s routes around South America by making a link between the size of Darwin’s specimens and his distance from the Beagle; reflecting the logistics of travelling on horseback across the Andes and his careful planning (interview with L. Anderson 12/08/09). Anderson has also traced the objects that Darwin did not collect himself, to identify the network of contacts that Darwin used to acquire specimens (see: Anderson 2009). Dr Francis Neary and Suzy Antoniw have also carried out work on the Beagle Collection as part of the University of Cambridge’s ‘Darwin the Geologist’ project. Their work has focused on constructing a biography of the Beagle collection using both specimens and associated records. This has shed light on Darwin’s theorizing during the voyage, revealing, for example, that it was not until he reached Cape Verde, that he felt confident enough in his abilities as a geologist, to start formulating his own theories about his field observations and specimens (interview with S. Antoniw and F. Neary 28/10/09). This work has formed the basis of the ‘Darwin the Geologist’ exhibition at the Sedgwick (for a review of the exhibition, see: Blyzinsky 2009), which I consider in the next section.

The use of objects in the research context varies depending upon the nature of the research being carried out, and as I have suggested, this is not limited to their scientific use. While observation and amplification are concerned with the interpretation of objects either directly or indirectly, this is not the case when they function as materials and associations. However, and in spite of the different ways in which objects are encountered, treated and

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109 While there is no evidence of objects performing this function at either Leeds or LJMU, at SEAES research into the Harwood Mineral Collection has been carried out (see website: SEAES 2006).
interpreted in each of the four functions, they all rely (to varying degrees) on the existence of earth science objects. That objects can be used for such different purposes suggests that they are capable of many different meanings and interpretations, and while this makes them valuable as research objects, it is perhaps more of a challenge when it comes to displaying these things.

4.4. Display

In the earth sciences, the development of academic departments alongside museums - described by Lourenço (2005: 65) as “a symbiosis between teaching, study and display” - in many cases, led to the creation of teaching museums (Boylan 1999: 47). From the 1960s onwards, universities have moved away from their traditional ‘Ivory Tower’ image, and are increasingly focused on serving the wider public; broadening access beyond the campus (Lourenço 2005: 89-90). The functions of university museums and collections are therefore no longer restricted to academic users; “University museums in varying ways have increasingly sought to serve wider audiences: through exhibition and permanent displays, and through education and public services” (Arnold-Forster and Mirchandani 2001: 49).

The Sedgwick is a typical example of this path of development, and while the museum’s collections continue to serve the academic community, the museum itself has become increasingly public-oriented (Whyte et al. 2004: 29). While the growth of UCL’s collection and ‘museum’ have also taken place within the context of an academic department, the museum remains largely inaccessible to the public on account of the limited opening times (the rock room is only open for one day per week), the size of the ‘museum’ (i.e. the ‘Rock Room’ is a single room), and its location (hidden deep inside the South Wing). By contrast, however, on account of its hybrid status as “both a university and public museum” (Eagar 1986: 182), the Manchester Museum has always existed at the interface between ‘town and gown’ (see: Alberti 2009: 164-9), and in the earth sciences, this division was polarised following the establishment of a separate academic department with its own collections during the 1950s. While the vast majority of university earth science objects are displayed in museums, it is important to acknowledge the existence of small departmental displays (Arnold-Forster 1993: 48). Indeed, at Leeds, SEAES, LJMU and UCL, material is displayed throughout the departments, in wall-mounted cases along corridors, in teaching laboratories and in foyers.

While there are numerous ways in which exhibitions may be analysed (for a comprehensive overview, see; Moser 2010), in order to reflect the various functions of objects within this context, I will focus on the techniques and practices that are used to mediate encounters with objects, in particular through their arrangement within an exhibition, their juxtaposition alongside other objects within displays, and their presentation alongside text, images, and props. By exploring displays in this way, I am able to focus on the objects themselves and to compare the ways in which these techniques are used in different

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110 An interesting approach can be found in Ferry’s investigation of the mineral exhibitions at the Smithsonian between 1876 and 1997 where she identifies four exhibition ‘types’ according to different ‘views of nature’, namely: as a resource, as order, as spectacle and as fine art (Ferry 2010).
circumstances in order to present objects in particular ways.

4.4.1. The arrangement of displays

In the earth sciences, objects are commonly arranged systematically in order to illustrate variation over time, and this approach is used at both the Sedgwick and Manchester museums. Indeed, the stratigraphic arrangement of rocks and fossils has a long history, and as Pearce explains:

…it is doubtful whether the taxonomic affinities of animal and plant species, or the stratigraphic connection of geological beds and the fossils within them, could be made intelligible, could really be said to exist at all as a meaningful concept, without the organized space and serried showcases that demonstrate the related specimens and make knowledge actual (1999a: 13).

While the arrangement of objects in stratigraphic order provides a means of presenting the development of life in a chronological order, literally allowing the visitor to “journey through the evolution of life” or “travel through time”, the continued use of this strategy is also likely to reflect a more pragmatic factor: because of their age, the cases that were originally constructed in order to present material in this way have themselves effectively become musealised, forming part of the structure of the institution and therefore, the displays must fit around the display cases.

Both the Sedgwick and Manchester museums follow a similar pattern of layout in which objects are displayed in cases forming ‘bays’ off a central aisle, however, the extent to which visitors understand this chronological arrangement is unclear. For example, at the Manchester Museum in order to view material in chronological order, the visitor must walk in a loop around the gallery (see: Figure 4i.i). While there are banners suspended from pillars at the end of each bay which identify the geological period with which displays are concerned, this relies on firstly, the visitors actually looking at the banners, and secondly, a degree of familiarity with the concept of ‘the geological column’ and its terminology.

While the arrangement of displays at the Sedgwick is perhaps more straightforward as a result of the linear path that visitors must follow, the location of the entrance (i.e. in the Cretaceous Period) means that in order to benefit from the stratigraphic arrangement, visitors must start at one end of the museum (see: Figure 4i.iii). At the Sedgwick, a chronological arrangement has also been used for the ‘Darwin the Geologist’ exhibition, however, rather than presenting material systematically, this exhibition takes a biographical approach. In this case, the material is arranged in order to illustrate various periods of, firstly, the life of Charles Darwin, and subsequently, the objects that he collected. However, chronological order is complicated by the fixed nature of the display cases, and in order to experience the material in the correct order, the visitor must walk in a number of loops around the exhibit (see: Figure 4i.ii).

111 Quotes are taken from the Manchester Museum’s website (see website: The Manchester Museum 2012) and the Sedgwick’s gallery plan (see website: Sedgwick Museum of Earth Sciences 2009).
Figure 4i: Diagrams illustrating the chronological arrangement and routes around galleries.
Perhaps the most effective chronological display is that in UCL’s Rock Room. Indeed, as a result of the comparatively small scale of the display, namely that it runs along a single wall, the chronological order is both obvious and easy to follow. Interestingly, UCL is the only case study in which both fossils and rocks are displayed alongside each other in chronological order. While the Sedgwick’s geology displays occur in the same gallery as the fossils (see: Figure 4i.iii), they do not form part of the chronological display, and are arranged according to three broad themes, namely building stones, the restless earth and planet earth. At the Manchester Museum, the geological displays are located alongside the minerals in a separate gallery from the fossils, and here, the rocks are grouped according to their formation processes.

As these examples have illustrated, the historical tradition of systematic and chronological displays remains the most common means of arranging cases within an exhibition. Indeed, in one sense this type of arrangement provides an opportunity for visitors to walk through time, and as such, may reinforce the evolutionary narrative on which such galleries are based. As Bennett explained: “the museum, in its ordering of series, aimed to embody its message in spatial arrangements that the visitor was to enact as much as to see” (1998: 358). However, as well as this type of arrangement relying, to some extent, on the visitor’s ability to understand the relatively subtle clues as to the order in which to view the displays, it also requires them to notice them in the first place. At the Manchester Museum, for example, on entering the fossils gallery the visitor is naturally drawn, not to the banners that illustrate the geological timescale, but, instead, to the life-sized replica T-rex skeleton that is located directly in front of them (see: Figure 4j). Likewise, at the Sedgwick, the presence an Iguanodon skeleton directly to the right of the entrance immediately captures the visitor’s attention. In this sense, the presence of these...
large, eye-catching, iconic objects within galleries may have the effect of distracting visitors’ attention, and drawing them away from the chronological narrative, and this loss of narrative constitutes a loss of context for the objects.

4.4.2. The arrangement of objects

While the arrangement of display cases within exhibition spaces may be used to contextualize objects according to ‘grand narratives’, on a smaller scale, the arrangements of objects within cases may serve a similar purpose. At the Manchester Museum, the objects that are displayed in the fossils gallery are assembled in groups to illustrate the typical variety of life forms – both plants and animals – that have inhabited the planet throughout its history. Here objects function as examples in order to illustrate ecological assemblages. While the oak wing at the Sedgwick adopts a similar strategy, in the mahogany wing, a different approach is taken whereby objects are arranged in order to demonstrate morphological variation within different species (and less commonly, also geographical variation), and in many cases, this is achieved by displaying a large number of specimens alongside each other (see: Figure 4k). Indeed, as a result of the volume of material and the lack of either interpretation or explanation (other than labels that identify the name, age, locality and collector), this approach is possibly quite overwhelming for the modern visitor with little geological knowledge.

While the visual impact of this type of arrangement appeals to some visitors (interview with S. Finney 18/08/09), these displays were not developed with the general public in mind, but rather, were created as instructive displays for academic use. Understood on these terms, the displays arrange objects in this way in an attempt to provide an overview of the history of life on earth by facilitating and encouraging visual comparisons. It is, however, also worth noting that the spatial arrangement not only reflects the morphological variation within and between
species, but is also related to the more practical problem of displaying specimens that are attached to wooden tablets, effectively turning the task of arranging material into something akin to making a jigsaw puzzle (see: Figure 4l). Here, the objects are left to speak for themselves, and they do this collectively by providing a general overview. Such displays can be viewed from a distance as their visual nature encourages and facilitates comparisons to be made. This is described by Henning as “a kind of comparative looking that notes surface resemblance, moves from left to right and commits things to mind based on their arrangement in a visual sequence” (2006: 111-112).

At UCL, a similar strategy was used in a temporary exhibition called ‘A Crucial Difference’ which ran from April until June 2010 and combined material from the Grant Museum and the earth science collections. The exhibition aimed to tackle the notion of ‘duplicates’ by presenting large volumes of apparently identical objects, and the two cases containing geological material focused on microfossils and lava specimens. The purpose of displaying objects in this way was intended to encourage people to look closer at the seemingly duplicated items in order to appreciate the uniqueness of each object as an individual (interview with E. Passmore 21/06/10). While a small amount of scientific context was provided at the side of each case, the displays presented the material with no supplementary text alongside the objects, and this made the displays particularly visual (see: Figure 4m). In this exhibition, the objects were functioning in an interesting way, as they were displayed as ‘scientific specimens’, but were presented almost as if they were works of art.112

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112 At the Manchester Museum, a similar strategy is used to display minerals in the Living Worlds gallery.
The arrangement of objects in order to emphasise their aesthetic qualities is also a common strategy for presenting minerals, for example, in the ‘Whewell Gallery’ at the Sedgwick, one of the displays arranges objects in order to illustrate the variety of colours (see: Figure 4n). These objects are presented in order to emphasise their beauty; the relative lack of text that accompanies them suggests that they are able to speak for themselves. By contrast, however, the other displays in the gallery are more instructive in that the objects are grouped according to their chemical composition (see: Figure 4o). These displays contain relatively few objects but a considerable amount of text, and resemble textbooks.

An alternative approach to the arrangement of minerals can be found at UCL in the Rock Room where they appear in four display cases that run along the length of one of the walls. One display is concerned with mineral identification, while the other three focus on mineral classification. The ‘mineral identification’ case contains minerals that are grouped according to four themes, namely crystal habit, colour and lustre, structure and bonding, and variety within a single species. The specimens are arranged on three shelves, and the particular choice of material that is presented on each shelf appears to have been influenced by two key factors: firstly, the need for material to be visible and attractive from a distance (as is required for the top shelf), and the need to display heavy material low down. This second factor is more concerned with practical matters than it is aesthetic ones, as not only does this ensure that the
shelves won’t be overloaded and potentially collapse, but it also means that the curator does not have to try to lift heavy material too high up. While displaying heavy material on the lowest shelves is the most practical solution, it does mean that large, often spectacular objects (that are ideal for displaying higher up), take up space that would ideally be better suited to smaller specimens that need to be viewed close-up.
The arrangement of objects in the ‘Darwin the Geologist’ exhibition at the Sedgwick is perhaps more heavily reliant on the careful juxtaposition of objects as a result of its attempt to present objects in a variety of different contexts, demonstrating the polysemic nature of a scientific collection. While the objects that are used in the exhibition have all been included as a result of their association with Darwin, they are used to communicate a diverse range of different messages. Indeed, the careful arrangement of the four specimens contained in the case titled ‘Collecting the Things that Matter’ is an interesting example of the use of objects in order to illustrate a point. Here, objects are used to set out the scientific rationale behind Darwin’s collecting on one hand by illustrating the standard size of the specimens Darwin collected, the need for careful selection in order to ensure that the most information-rich material was collected (i.e. in relation to the limitations of collecting on a voyage), and the tendency for ‘representative samples’ to be fairly unimpressive. However, on the other hand, by presenting rare and attractive material alongside these objects, the display is intended to illustrate Darwin’s occasional susceptibility to the lure of attractive, valuable and rare objects, in spite of the need to collect only those specimens showing scientific merit. While this arrangement of objects supports the message about the scientific rationale behind Darwin’s collecting, it is clear that without the text and the other contextual features that accompany the objects, this message would be lost. Indeed, and as I will now consider in more detail, displays do not just rely on objects and their arrangement in cases and galleries, but also the various texts, images and models that are displayed alongside them.

4.4.3. The mediation of objects

Whether objects are displayed in museums or departments, it has become increasingly apparent that they are never presented on their own. Indeed, the use of various techniques, resources and strategies to enhance objects is evident even in the earliest displays. Take, for example, the displays in the Sedgwick’s mahogany wing, which were created over a century ago. While object labels provide the only interpretation for many of displays, there are also a number of alternative strategies that have been adopted to aid the viewer. For example, a number of specimens are annotated (with letters, numbers, symbols or text) in order to identify particular features (see: Figure 4p). Other specimens are displayed alongside diagrams, which are used to enhance the specimens by showing the observer what they should be seeing (see: Figure 4q). Displays in which specimens are arranged in order to show the classification of species also make use of diagrams (see: Figure 4r), however these may also require additional textual support (see: Figure 4s). This type of strategy resonates with Bennett’s description of displays:

Arranged by experts – by “eyes that know how to see” – rationally ordered collections were to instruct untutored eyes in what was to be seen within the realm of the visible by placing a filter of words between sight and its objects; a rationalizing nomenclature in the form of a system of labels that, since their purpose was simply to nominate the visible that they made transparent, attached themselves to objects like cling-wrap (1998: 351).
Figure 4p: Annotated specimen in the Sedgwick’s mahogany wing.

Figure 4q: The use of diagrams in order to enhance specimens in the Sedgwick’s mahogany wing.

Figure 4r: The use of diagrams and the arrangement of objects in the Sedgwick’s mahogany wing.
Here, the objects function as scientific specimens but, rather than giving a general overview at a distance, these displays are concerned with detail and require close inspection, observation and reading in order to function effectively. While these displays made use of such techniques and strategies in order to enhance the ability of these objects to perform a didactic function, even those displays that are comparatively less instructive, rely heavily on such strategies. For example, the objects that are displayed at the Sedgwick's oak wing combine text (although using more accessible language), graphics, specimens, models, and paraphernalia in order to show reconstructions of both individual organisms and ecosystem assemblages (see: Figure 4t). The reduced number of objects used in the more modern displays is perhaps an attempt to communicate more simple, straightforward messages to the visitors. Many of the specimens, do, however, continue to function in the same way as those featured in the original
displays; namely as evidence of past life on earth. The readings of these objects are, however, more contrived and while the original displays effectively present the evidence for visitors to judge for themselves, the modern approach does the work for them by telling visitors what the objects mean.

While the oak wing has retained the original stratigraphic arrangement, and uses the original cabinets and cases, it has a very different feel to it; the noticeable reduction in the number of objects, their presentation, the clarity of titles in the cases, the use of lighting and consistent interpretative strategies, along with the presence of large decorative kites (representing the themes of some of the cases) make this part of the museum more accessible. There are, however, some similarities between the original displays and the more modern ones, for example, strategies used to enhance and annotate specimens, while taking advantage of photography and graphics, remain necessary in many cases (see: Figure 4u). It seems that even 100 years of technology and progress have not solved some of the problems associated with displaying geological specimens.

The ways in which objects are displayed in the fossils gallery at the Manchester Museum is, again, quite different, as it appears to operate on two different levels (see: Figure 4v). The use of large colourful images depicting ancient environments, the use of models, displayed alongside specimens in order to illustrate what some creatures would have actually looked like when they were alive, and the absence of labels alongside objects suggests that on one level, the objects may be encountered on a purely visual level. However, the inclusion of diagrams and maps, explanatory text and detailed information about objects also suggests that on a different level, in order to understand these things, the visitor must do a bit of reading. Interestingly, however, while the displays, in one sense, are about the remains (often partial) of organisms that have long-since died, the graphics and models that are displayed alongside the specimens are all geared towards complete, reconstructed organisms depicted ‘in life’. While it is unclear exactly what visitors gain from their encounters with the objects in this gallery, the fact
that they spend time in front of displays suggests that they are engaging with the objects, on some level.

Perhaps the most heavily mediated objects are those on display in the Sedgwick’s ‘Darwin the geologist’ exhibition, and this is likely to reflect the challenges involved in attempting to display objects outside of their disciplinary context. The exhibition combines specimens (field samples, thin sections, casts, replicas and models) with paraphernalia (tools, scientific equipment, collecting bags and boxes), things (Darwin toys and a bust of Darwin) visual objects (photos, paintings, maps, sketches and diagrams), textual objects (documents, specimen labels, specimen descriptions, notebooks, journal articles, books, text books and instructions) and interactives (a puzzle, computer game, an interactive globe and a computer database), in order to present the biography of the Beagle Collection. While this, to some extent, involves the biography of Darwin himself, the exhibition also extends beyond this to illustrate the various ways in which the objects have been used following their arrival at the museum. Specimens are displayed both in cabinets and drawers, as well as on open display.

The ways in which objects are combined with various props, text and images is particularly important for this exhibition, as the messages that are being communicated are not the usual ones that one expects to encounter in a university museum. Thus, the drawer titled ‘seeing through Darwin’s eyes’ relies heavily on textual objects in order to illustrate the multiple interpretations that are possible from a single specimen. Here, the drawer contains a single specimen alongside four small texts containing different interpretations and descriptions that Darwin made for the single specimen. The use of props is also significant in this exhibition,
ranging from the reconstructed ships’ cabin to the display titled ‘Alfred Harker’s Work Space’ where specimens are exhibited alongside thin sections that Harker subsequently made from them, a microscope, a volume of the ‘Catalogue of the Beagle Collection’, and an article written by Harker about Darwin’s Beagle rocks (see: Figure 4w). In this context, it is Harker rather than Darwin that is of interest, and the specimens are used to illustrate the ongoing work on Darwin’s collection following his death.

There is a heavy use of text throughout the exhibition, and a layering approach is adopted whereby the font size is used to distinguish between different depths of information. For example, large simple ‘titles’ are used to identify the themes of each display, whereas smaller fonts are used for the dense blocks of text that variously describe, interpret, hypothesize, identify, instruct, inform and question. In this exhibition, the reliance on text and the heavy use of various forms of images and props suggests that it is perhaps not very easy to tell the story of a collection with objects alone. Indeed, throughout this section, it has become increasingly apparent that the meanings of objects are closely regulated through a variety of means, ranging from the presence or absence of interpretation and the overall ‘feel’ of the space, to the arrangement of objects and displays. The ways in which objects function, and their close regulation reflects the ways in which institutions employ: “distinctive procedures (of abstraction, purification, transcription, and mediation) through which they work on and with gatherings of heterogeneous objects that they assemble” (Bennett 2005: 4).
4.5. Discussion

In considering the various ways in which objects may function in the contexts of teaching and learning, research, and display, it has become increasingly apparent that these things may be used and interpreted in many different ways. But how does this affect their scientific status? If the meanings of objects can be regulated, does this also mean that they can mean anything at all? In attempting to tackle such matters, I will also address the questions that I set out at the beginning of this chapter concerning the functions, meanings and uses of objects.

The ways in which earth science objects function correspond to Prown’s distinction between evidence and illustrations (1982: 1). Thus, objects perform as illustrations in the contexts of teaching and learning and display, whereas they become evidence when encountered in the research context. As illustrations, objects are used to communicate particular messages and meanings. Here, the object appears to function as a medium or channel through which pre-existing knowledge is transferred from the knowledgeable communicator (i.e. lecturer, curator, or educator) to a passive recipient (i.e. student, museum visitor, or school child). This, however, is an illusion that is achieved by manipulating the ways in which objects are encountered: an object here must be understood as a sign, which, in Peirce’s semeiotic is:

anything which is so determined by something else, called its Object, and so determines an effect upon a person, which effect I call its interpretant, that the later is thereby mediately determined by the former (1998: 478).

For Peirce, interpretation (and, importantly, not necessarily linguistic, but any interpretation) involves a triadic relationship between the representamen (or sign), an object (not necessarily material) and an interpretant. As a sign, meaning is not simply transmitted from the object to the interpretant, rather, “there is a three-part process of semiosis that is operative, with the artefact or ‘sign’ at the centre” (Bauer 2002: 44). By following Peirce’s system, it is possible to move away from the notion of objects transmitting facts to those who come into contact with them, and instead to understand interpretation as processual (Keane 2003: 413), relational (Preucel 2006: 55), and meditative (Bauer 2002: 41). Fundamental to Peirce’s theory of signs is the acknowledgement that in order for an ‘object’ to have meaning, it must first be recognised as a sign (Peirce 1991: 255). Indeed, by acknowledging that interpretation involves both the physical context of the object and the mental context of the interpretant, the idea of using objects to make a point suddenly seems rather more challenging.

Understood in these terms, when objects appear to communicate information to those who encounter them - as if by magic – this is because they are doing their jobs well: “carrying out their effects while becoming silent is what they [objects] are so good at” (Latour 2005: 80). It therefore follows that, in order to explore the involvement of objects in more detail, we need, as Latour has suggested, to focus on those situations in which the actions and performances of objects become more visible (ibid: 79). One such situation may arise when objects are encountered at a distance - when they seem puzzling – as is often the case when learning how
to use them. While it is possible to shape the meaning of an object by embedding within it particular intentions and by providing particular tools to guide the way in which it is ‘read’ (see: Dant, 2008), objects remain unruly, and this becomes all too apparent when things go wrong.

During a practical session at the University of Leeds (observation at the University of Leeds 05/10/09), a student was having problems deciding how to describe the habit of a piece of haematite (see: Figure 4d). After referring to the worksheet, checking notes from previous sessions and asking the person sitting next to him, the student called over a demonstrator. The demonstrator observed the specimen and then responded with the following:

…this is not a good sample; I think its fibrous –no – botroydal, no – this could actually be both; its not a good specimen. It could be either fibrous or botroydal. Maybe try looking at a different piece. Its supposed to be botroydal.

Here, the student’s encounter with the object was interrupted as a result of the ambiguous nature of the specimen. The student’s reaction was to try to use a variety of tools to help him ‘read’ the object. However, when the demonstrator confirmed that the object was not a good example and suggested trying a different piece, the student’s engagement with the object ended. A similar example was also observed during a first-year practical session at LJMU (observation at LJMU 06/10/09), where a student was attempting to identify a piece of breccia (see: Figure 4c).

Having carefully observed the hand-specimen, the student attempted to determine the rock’s identity using a flowchart. Starting at the top of the chart, the student used his finger to trace a route through a series of questions – ‘Is the rock mainly made of calcite? No… Are the grains visible with the naked eye? Yes… Does it contain pebbles? Yes’ – leading him to identify the rock as a conglomerate. The student had, however, already identified another rock as a conglomerate, so asked the student sitting next to him for help. The other student explained that it was a breccia and using the flowchart, demonstrated how he had reached this conclusion; ‘Does it contain pebbles? No… Does it contain angular pieces of rock? Yes… It’s a breccia’. After a brief discussion about the difference between pebbles and angular pieces of rock, the student still seemed unsatisfied with the identification, explaining; ‘…but I thought that breccia would be much darker than that’.

As these example show, encounters with objects are not simply about linear flows of information from objects to subjects, and in this sense, the inadequacy of the transmission model (Shannon and Weaver 1949) as a way of understanding such encounters becomes all too clear. On one hand, while the ways in which objects are presented, manipulated, arranged, modified and variously mediated may considerably limit what an object may ‘mean’ to an individual when they encounter it, this does not explain why individuals may interpret the same object in different ways. Indeed, this is precisely where the ‘mental context’ of the individual comes into play, and as Dant explains: “the determination of the object as a sign is tied up with its interpretation, which is, at least in part, determined from what the interpreter already knows” (2008: 17). In the above case, it is therefore likely that a previous encounter with a dark-
coloured breccia had led the student to associate the rock with its colour. Thus, by acknowledging that these objects function as signs, it becomes apparent that the ways in which objects are interpreted depend upon both the individuals and the objects.

If, however, we consider the ways in which objects are encountered in the context of museum displays, it becomes clear that there is an added complication. According to the ‘Interactive Experience Model’ – developed by Falk and Storksdieck (2005) with specific reference to learning experiences in science museums – a museum visitor’s learning experience depends upon various personal, sociocultural and physical factors (see: Figure 4x). What this framework reveals, therefore, is that the techniques that are used to regulate the meanings of objects (labelling, interpretation, design, layout and arrangement) constitute just one aspect of a visitor’s experience – indeed, the majority of the factors that shape the experience of a museum visitor are beyond the control of the museum. If we apply this model to the use of objects in practical sessions, for example, it becomes clear that such situations are much more manageable than those involving museum displays. Indeed, as well as regulating the objects (through their selection, arrangement and presentation), there is also an extent to which the presence of demonstrators and the grouping of students can be seen to influence the sociocultural context. Furthermore (and in contrast to museum visitors), in practical sessions, the personal context is less problematic considering the fact that students, by their very nature, necessarily share common motivations (i.e. attending university), prior knowledge (i.e. meeting entry criteria) and expectations with their peers.

What we learn from this, therefore, is that the meanings of objects do not simply depend upon the individuals, the objects, or the particular circumstances in which they are encountered, but are more about what happens when all of these elements come together. In this sense, it may be more appropriate to talk about encounters with objects in more active terms, and to view encounters with objects as processes from which effects may emerge. To be clear, this is not to say that the meanings of objects are simply arbitrary or made up; indeed such concerns are particularly significant when it comes to objects that function as evidence, as encountered in the research context. There is something about objects - whether it is called a diagram (c.f. DeLanda 2006; Deleuze 1988), hinterland (c.f. Law 2004a) or an affordance (c.f. Gibson 1979) - that constrains their possibilities.

Figure 4x: Table showing Falk and Storksdieck’s (2005: 122-3) factors that affect learning in the museum.

<table>
<thead>
<tr>
<th>Context</th>
<th>Factors affecting museum learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal</td>
<td>Motivation and expectations, Prior knowledge and experience, Prior interests and beliefs, Choice and control</td>
</tr>
<tr>
<td>Sociocultural</td>
<td>Within-group mediation, Facilitated mediation by others</td>
</tr>
<tr>
<td>Physical</td>
<td>Advance organizers, Orientation to the physical space, Architecture and large-scale environment, Design of exhibits and content of labels, Subsequent reinforcing events and experiences outside of the museum</td>
</tr>
</tbody>
</table>
The ways in which research objects function as evidence can also be understood in the same way as illustrations. Thus, their meanings emerge from research practices, and are therefore affected by the objects themselves, as well as the particular researcher that is carrying out the research, the questions that are being asked, and the techniques that are being used to answer them (amongst many other factors). However, that is not to suggest that their meanings are simply made up. Indeed, as evidence, research objects can be understood as what Knorr Cetina describes as ‘knowledge objects’ in that they “are always in the process of becoming materially defined, [and] they continually acquire new properties and change the ones they have” (2008: 89). Thus, in the context of research, the ways in which they are encountered and the practices that are enacted on them mean that these objects can never be fully known. But if the meanings of objects do not reside in the objects themselves, but, rather, emerge through our encounters with them, then what makes scientific knowledge so special? Understood on these terms, scientific knowledge is perhaps more usefully understood as – and to borrow from Pickstone – a particular ‘way of knowing’ that emerges from a particular way of doing. In this sense, the distinction between the ways in which objects function as illustrations and evidence is a matter of different ways of knowing arising from different ways of doing.

This brings me back to my original question surrounding the uses, meanings and treatments of objects in university earth science collections. If we consider the relationship between the uses and meanings of objects, once we acknowledge the negotiated and situated nature of ‘meanings’, it becomes apparent that they are closely related to ‘use’. For example, a specimen can be used in a practical session, analysed for research, used by primary school children, or put on display in a museum. Depending on which function an object performs, the object’s meaning would vary, reflecting not only the particular systems of regulation that may be enacted on it, but also the particular people who may encounter it.

The treatment of objects is perhaps more complex as, on one level, it can be understood as related to use, but in another sense, may also affect the meaning of an object. The relationship between use and treatment is about the particular contexts and situations in which uses occur; in a research laboratory, an object may be treated as a sample to analyse, but this would not be the case if the same object was placed in a museum display, and similarly, the way that an object is treated by a school child will not be the same as the way that a student would treat it. In this sense, the treatment of objects is similarly related to the particular contexts and people that are linked to certain uses. However, on a different level, the treatment of an object will affect its meaning. For example, treated as consumables, the minerals that were used as ‘samples to test’ during a practical session provided students with particular meanings such as information about hardness. If, however, the same objects were used to as ‘surfaces to examine’, they would not have had the same meanings, as their treatment would only generate visual information. It is therefore apparent that while the meanings and treatment of objects vary with use, the ways in which objects are treated are also significant.
If we accept that the meanings of objects do not simply reside in the objects themselves, or purely in the minds of individuals, then they are perhaps better understood as effects; as what happens when particular objects are encountered by particular people in particular circumstances. The polysemic nature of university earth science objects has emerged as vital for their use: if these things only had single meanings, they would not be able to function in such a variety of different contexts. Indeed, there would be absolutely no need to study or keep these things. However, it is precisely because these objects are polysemic that they require such effort and regulation; whether as illustrations or as evidence, these things are far too complex to be meaningfully encountered as themselves. Again, I close a chapter with a paradox: the polysemic nature of objects is vital for these things to be of use, but their usefulness relies on their singularity.
Chapter 5: The Mobility of Earth Science Objects and Collections

Having explored the coming into being of earth science objects and collection items, and having considered the various ways in which they may function, this final thematic chapter focuses on the mobility of objects. Here I attend to some of the matters that have arisen in the preceding chapters by addressing fundamental questions surrounding the mobility of earth science objects and collection items: how they move, the trajectories along which they travel, and the ways in which this mobility affects their credibility, values and meanings. In order to address these questions, this chapter traces some of the paths and channels along with objects travel, revealing that in spite of their weighty and concrete qualities, earth science objects are surprisingly mobile.

5.1. Introduction

In order to explore the mobility of earth science objects consistently across all of the case studies, it is necessary to focus on the movement of material at the institutional level, however this requires a number of distinctions to be made between different types of trajectories. The initial distinction that I draw is that between the internal and external movement of earth science objects, whereby the internal circulation of material is concerned with the movement of objects within an institution and external movement can be further divided according to whether material moves in or out of an institution. However, and in addition to considering mobility in terms of the directions in which material travels, it is also important to acknowledge how objects move. As Appadurai has observed with regard to the ways in which objects may move into or out of the sphere of commodities; “such movements can be slow or fast, reversible or terminal, normative or deviant” (1986: 13). Therefore, and following this observation, as well as considering the trajectories along which earth science objects move, I will also explore the speed at which these things flow, whether their movement is temporary or permanent, and the extent to which they travel along formal or informal routes.

In section 5.2 I trace the various trajectories along which objects may circulate both formally and informally, temporarily and permanently, within institutions. I then move on, in section 5.3, to explore the external movement of objects, firstly by focusing on the temporary routes along which material may circulate, before moving on to consider the permanent inward and outward movement of objects. I then shift attention away from the physical objects themselves, in order to briefly consider, in section 5.4, the circulation of proxies such as digital objects, casts, and derivatives of specimens. Finally, I close this chapter by returning to my initial questions surrounding the mobility of earth science objects: how they move, the trajectories along which they travel, and the ways in which this mobility affects their credibility, treatment and meanings.
5.2. Internal circulation of objects

While it is increasingly accepted that entry into a collection does not necessarily equate to the end of an object’s career (in particular see: Alberti 2009; Gosden and Knowles 2001; Gosden and Marshall 1999), the work on which this observation is based has primarily focused on museum collections. By approaching the mobility of objects at the institutional level, and therefore, considering both museum and department collections as well as less formal groups of material, it becomes clear that on crossing the institutional threshold, for many objects their careers have only just begun. By acknowledging this broad range of material and by expanding my scope to the institutional level, the complex nature of the internal circulation of objects becomes clear (see: Figure 5a).

It has, however, also become apparent that the trajectories along which objects move are, to some extent, limited by what broadly corresponds to the original purpose of material on entry, and all that this implies (as addressed in previous chapters). It therefore follows that it is useful to approach internal circulation by distinguishing between the different ‘types’ of collection (see: Figures 3a and 3b) that are held within an institution. Therefore, I will start by considering the internal circulation of museum material, firstly within museums themselves, before exploring how museum objects may travel to other departments or schools within an institution. I will then move on to consider the movement of objects within departments, focusing in particular on the various trajectories along which research material travels around both collections (teaching, reference or display) and less formal groups of material (such as personal and surplus or ex-research material) both within departments and beyond into other parts of an institution.

5.2.1. Museum Collections

The transformation of objects into museum collection items has traditionally been viewed as a violent process, and as Harris explains with reference to the works of Adorno (1967), Heidegger (1971) and Merleau-Ponty (1993), amongst others; “separating an object from its use and context… results in such traumatic change of meaning to the object that only the metaphor of death is adequate to describe this process” (2008: 214). In spite of such morbid connotations, entry into a museum does not necessarily render objects immobile, and as Alberti has observed, being ‘in storage’ may in fact turn out to be a surprisingly active phase of an object’s life (2009: 6). Collections may be moved for a variety of different reasons, from the pragmatic to the political. At the Sedgwick, for example, the radioactive minerals were transferred from the Brighton Building to lead-lined storage at High Cross stores for health and safety reasons (interview with S. Finney 18/08/09). Perhaps more political, however, have been the ways in which the collections at the University of Cambridge have been repeatedly “carved up” (interview with L. Anderson 12/08/09) as a result of the reorganisation of various departments (see: Section 3.2.4. and Figure 3c), and in order to illustrate the effects of this, I will briefly focus on the Beagle Collection.

113 I address UCL’s collections in the following section as they are more appropriately considered alongside departmental collections.
Figure 5a: Diagrams illustrating the common trajectories along which objects circulate within the case study institutions.

*Note: LJMU is not included in this diagram due to the absence of internal circulation, as I consider in section 5.2.2.
The ‘Beagle Collection’, comprising material gathered by Charles Darwin during the voyage of HMS Beagle in the 1830s, was transferred to the Sedgwick museum on the death of Darwin’s wife in 1897. On its arrival, the collection remained largely untouched for almost a decade before Alfred Harker started work on it, initially by relabelling all of the rocks with ‘Beagle Collection’ labels (see: Figure 5b) and assigning them new numbers (interview with S. Antoniw and F Neary 28/10/09). While the rocks remained attached to their special status as ‘Darwin material’ – through both their distinct labelling and their storage in a separate chest of drawers - the fossils were incorporated into the Sedgwick collection and subsequently became disassociated with their origins (ibid.). Indeed, only recently has the Museum discovered the significance of Darwin’s fossils, as Dr Anderson explained:

There’s a collection of about 100 fossil shells – recent fossil shells from South America - which I came across in the collection downstairs [in the museum]. They don’t have the little green ‘Beagle Collection’ label because they’re not rocks and Harker was interested in rocks. So basically all these disappeared into the general collection. So it was a case of reverse engineering: These are from South America. They were collected in the 1830s. I wonder… and sure enough! Some of them have got Darwin’s handwriting on. So you can kind of prove it (interview 12/08/09).

The detachment of the fossils from the Beagle Collection, and their subsequent absorption into the Sedgwick’s fossil collections, effectively transformed them from ‘Darwin’s fossils’ to just ‘fossils’. However, the rediscovery of their origins instantly transformed them: as ‘Darwin fossils’ they suddenly acquired new meanings and values –scientific, historical and financial. Indeed, this example of the Darwin fossils illustrates the ways in which mobility may directly impact on the values that are assigned to objects and collections as a result of the loss (or acquisition) of associations and context. Furthermore, while the example of the Beagle Collection may, today, be seen as an accidental ‘loss’ and subsequent lucky rediscovery of valuable specimens, such hindsight tends to overlook the importance of the members of staff who work with collections, as a valuable source of institutional memory.
By far the most common reason for the circulation of museum material is concerned with its use, and this type of trajectory may remain within the boundaries of museums or may extend beyond the museum into other departments or schools within an institution. While the Manchester Museum is located within a single building and therefore, the circulation of material for use in research, teaching and learning, or display, even when conservation is involved, does not require objects to leave the museum building, the Sedgwick operates across three sites in Cambridge. The Sedgwick on Downing Street is the main museum site, combining both the display and storage of (mostly palaeontological) material. The Brighton Building, located off Madingley Road in West Cambridge, houses the main stores for palaeontology, mineralogy and the petrological thin section collections as well as the museum's archive, conservation laboratories and study room. The store at High Cross, also located in West Cambridge, contains the rock collections as well as uncatalogued and oversized material of a general nature. Therefore, while the use of material for research at the Manchester Museum may simply involve transporting objects from the basement where they are stored, via the lift, to the museum's resource centre, the circulation of material at the Sedgwick is more complex. Research requests for petrological material, for example, involve transporting material from High Cross to the Brighton Building where the study room is located (interview with S. Laurie 11/08/09).

The internal circulation of objects for research purposes takes place over relatively short timescales and therefore, this trajectory is one in which material is moved from storage to where it will be used, and subsequently returned to storage relatively quickly. Similarly, the use of museum material for learning may also have a relatively fast turnaround, for example, the palaeontological material that is used for A-Level Study Day sessions at the Manchester Museum is removed from storage, used, and returned on the same day. However, by contrast, the circulation of objects for use in exhibitions may take much longer as a result of the exhibition development process and requirements for conservation and holding once objects have been removed from storage. For example, the Sedgwick’s ‘Darwin the Geologist’ exhibition involved the movement of large amounts of material, initially to free-up space for the new exhibition by dismantling the existing Holocene displays (Antoniw and Neary 28/10/09; Finney 18/08/09). As the conservator explained:

To do the Darwin displays, we’ve had to pack and move 800 objects from the museum in the last two years and that’s been done really carefully, making sure everything is cushioned as much as possible. It’s hard with delicate stuff like skulls… speed bumps are the last thing we need. The physical nature of the building being so far from the museum – it’s quite frustrating really (interview with S. Finney 18/08/09).

Only after the previous material had been removed, could the new material be transported, again, from the Brighton Building to the Sedgwick. The duration of such trajectories involving the display of museum objects also depends upon the nature of the particular exhibit. For example, Darwin the Geologist is ‘permanent’ and will therefore last for at least ten years, if not longer (Antoniw and Neary 28/10/09). It is worth noting, however, that being on display does not prevent an object from becoming involved in other use-trajectories, for example at the Manchester Museum, Pleistocene cave material (and, perhaps more problematically – as I
consider below) marine reptile specimens, are regularly removed from display for research purposes (interview with D. Gelsthorpe 24/11/10).

As the previous chapter has illustrated, the circulation of objects between different spheres of use may, for the objects themselves, be relatively straightforward. However, the practicalities of physically accessing material may be more problematic, as is the case for one of the fossil marine reptiles - fondly known as ‘Percy the Plesiosaur’ – that is on display at the Manchester Museum. The mounted specimen has been on display in the museum for many years, contained in a large glass-covered case in the fossils gallery. However, as well as being a popular exhibit amongst visitors, this specimen is also an important scientific object (holotype) and as the curator explained, the museum receives two to three requests per year from researchers asking for access to it (interview with D. Gelsthorpe 24/11/10). In the past, due to the particular construction of the case in which it had been mounted – namely, one that; “needs specialist lifting equipment to take the glass off” - such requests were problematic (ibid.). As a result of this, along with the curator’s concern for the specimen’s stability, the skull and neck of the specimen were removed from display, thus allowing access for researchers as well as ensuring that the material would not become damaged due to the lack of humidity control in the case (ibid.). However, in addition to the specimen’s research value, this object has other, perhaps conflicting values, that the museum has had to resolve.

The specimen was discovered by Dr Fred Broadhurst in the 1960s whilst on a department fieldtrip to Robin Hood’s Bay in Yorkshire (see: Broadhurst and Duffy 1970), and following its display in the department, it was subsequently loaned to the museum where it has been on display ever since (interview with A. Edwards 26/10/10). In addition to its palaeontological value, the specimen has gradually acquired the status of an icon (akin to animal mascots and charismatic animals, see: Alberti 2011), reflecting the heroic tale of its discovery by Dr Broadhurst and a team of six research students who worked:

…for two days in appalling weather conditions with driving sleet and hail... The route up the cliff lay first over a boulder field on the shore itself and then across rough ground with a narrow, steep and winding path. Specimens had to be man-handled as far as the path and were then loaded, in turn, on to a section of ladder (found washed up by the sea) which served as a sledge. Every member of the expedition was required to form a part of a human ‘husky dog’ team (Broadhurst and Duffy 1970: 30).

The removal of part of the specimen from display therefore became a matter of concern, particularly for Dr Broadhurst’s family, who subsequently started a campaign to raise funds for the redisplay of the entire specimen. As a result of this fundraising, in January 2012 Percy was rehoused in a new display case which not only allows the specimen to be viewed by visitors and accessed by researchers, but also will ensure the long term preservation of the specimen. As this example demonstrates, while the circulation of material between different spheres of use may, in theory be possible, such trajectories may become complicated as objects acquire alternative or additional values, not to mention the practicalities of physically accessing material.

114 See website: Percy the Plesiosaur Appeal (2012)
In addition to factors ranging from the institutional furniture to the iconic status of objects, more practical matters such as the physical task of moving material, and the collections management procedures that must be followed when doing so may also affect the internal circulation of material and these two factors are particularly apparent at the University of Cambridge. While the Sedgwick and the Department of Earth Sciences are closely linked, and indeed, occupy the same building, they currently operate as distinct entities, and as already mentioned, the Sedgwick stores collections both on and off site. These factors, combined with the complex histories of the collections and the systems and procedures (or lack thereof) that were used in the past have impacted on the circulation of material between the museum’s collections and the department.

Perhaps the most common trajectory along which objects from the Sedgwick move, relates to the use of museum specimens for department teaching activities. The department uses museum specimens for both practical sessions and (less often) for lectures, and because the courses for which material is used have changed very little, the department uses the same museum specimens every year. While the demand for petrology material is relatively low, the more heavily-used palaeontology collections are a different matter: “there’s hundreds of specimens moving around between the stores and the practicals” (interview with S. Laurie 11/08/09). Indeed, the well-rehearsed annual cycles of circulation between the museum and department appear to have become part of a ritual, as the collections assistant (palaeontology) described:

We have this huge heavy slab that I take up to the lab for students to look at, so I think, why don’t you bring the students down here, down one flight of steps, instead of me carrying this huge chunk of rock up the stairs (interview with M. Riley 19/08/09).

While material moved quite freely between the museum and department in the past (interview with S. Laurie 18/08/09), following the appointment of a new collections manager in 2004, the regulation of material has been “tightened up” and “professionalized” so that now, when the department requests material for teaching, it is treated in the same way as an external loan request (interview with S. Finney 18/08/09). The process of loaning museum specimens to the department now inevitably involves “lots and lots of bits of paper” (interview with S. Laurie 11/08/09): numerous forms, signatures, and ‘terms and conditions’, as the following description demonstrates.

When the department requires museum specimens, Glynis Caruana115 (Class Technician in the Department of Earth Sciences at Cambridge) contacts the relevant collections assistant and gives them a list of items (interview 12/08/09). The collections assistant then locates the objects using the catalogue, and writes out object movement tickets (in triplicate) for each item. As objects are removed from either storage or display, one ticket is put in their place, while one remains with each object and the third copy is kept on file. When all of the required objects have been gathered, they are listed (along with any conditions of use) on a loan

115 See: Appendix 6b.
agreement form, which is signed by the technician on receipt of the objects. When the department has finished using the objects, the collections assistant collects the objects, the return of which is receipted both individually, as well as using an object exit form that, when signed, records the completion of the loan (interview with M. Riley 19/08/09).

By reinforcing the boundaries that have been drawn between the museum and the department, this form of regulation can be seen to strengthen the identity of the museum as a distinct enclave within the university (c.f. Appadurai 1986: 25-6). While the implementation of the new procedures and systems has become quite a contentious issue (interview with G. Caruana 12/08/09), this type of conflict may actually benefit the museum: since the unregulated circulation of objects blurs the boundaries between the museum and department, it weakens their identities as distinct assemblages. However, because “conflict sharpens the identity of a community” (DeLanda 2006: 58), the tensions surrounding the regulation of objects may have the unintended consequence of counteracting this by reinforcing the distinctions between the museum and department.

The use of Sedgwick material for research, however, is less controversial. Indeed museum specimens are regularly used for departmental research activities, and both the department and museum see this use as a strength of the collections, in spite of the regulations that are imposed on its use by the museum:

Material on loan must be kept in closed drawers and not left lying around in research students’ rooms; type and figured material must be LOCKED away when not in use (Department of Earth Sciences 2007: 20).

In spite of the close regulation and monitoring of material by the museum, the circulation of research objects appears to run very smoothly. While this may relate to the fact that considerably less material circulates along this trajectory, it may also reflect the value that museum staff place on research as opposed to teaching. Finally, it is worth noting that, as far as the case study institutions are concerned, the active circulation of research material between a museum and department is particular to the University of Cambridge; at the Manchester Museum, no such relationship exists, and as I describe in the next section, this reflects the existence of distinct departmental collections within SEAES.

5.2.2. Departmental Collections

While the internal movement of museum objects tends to follow a circular path whereby trajectories often start and end in the museum’s stores, with the exception of LJMU, departmental material is much more dynamic. For example, with reference to the movement of material at SEAES, Dr Manning explained that; “it’s like a conveyor belt” (interview 07/02/11). At LJMU, as a result of the focus on providing objects for teaching purposes, there is little movement of material (see section 2.2.3.): as this section will reveal, the presence of research material is a significant driving force behind much of the circulation of material within departments. Thus, in addition to the temporary use-trajectories mentioned above, the routes
Figure 5c: Diagram illustrating the movement of material as part of the research process. (interview with G. Droop 10/11/10).

along which departmental material travels may also be permanent. Indeed, this reflects the variety of different ‘types’ of collection and other loose groupings of material that are found in departments (see chapter three) and their primarily functional existence (see chapter four), as opposed to the tendency for museums to contain their objects within a single collection and their commitment to the long term preservation of material. The main source of material that moves within departments originates from research (see: Figure 5a), and in addition to its ongoing use for research purposes, such active working objects may also be used for teaching. Indeed, this trajectory of use is a natural extension of research material since research staff are often involved in teaching courses related to their research projects (interviews with R. Finch 06/05/08; M. Holness 28/10/09). Such temporary trajectories may be relatively short-lived and reversible, as individuals tend to retain their personal working material for the life of their research projects, if not beyond (interview with M. Holness 28/10/09).

As I suggested in the previous chapter, research may take the form of a series of selective and analytical processes through which material is gradually thinned out until only the most relevant samples remain (see: Figure 5c) (interview with G. Droop 10/11/10). However, while the final research collection of representative samples may be transferred into museum or departmental collection, the research process also generates varying quantities of surplus material, and such objects may also travel around departments and into museums. In order to address the internal movement of research material, I will initially focus on the University of
Leeds as it provides a relatively straightforward illustration of trajectories along which objects may move within a department. I will then illustrate the movement of research material between a department and museum, focusing on Cambridge, before considering the case of UCL where the relationship between the Department of Earth Sciences and ‘Museums and Collections’ has led to an altogether different situation.

As the school curator explained, material at the University of Leeds may move into a collection – usually teaching or occasionally display or reference – either directly or indirectly via the ‘archived research collection’ (see: Figure 5a) (interview with R. Finch 06/05/08). As I mentioned in chapter three, the ways in which objects are processed and managed at Leeds is informed by the need to track objects through these various uses, and when asked about the use of different objects for different purposes, the school curator explained:

There is a hierarchy of use, in terms of what it can be used for – and it's all information based. So you can go to our [archived] research collection and pull out something that we don’t have enough information on, and it can be useless for absolutely every purpose… If we’ve got material that is unlabelled, suddenly it’s hardcore. There is no further use unless it has got something obvious like a beautiful display specimen like a nice crystal or something, or if it shows fabric or something that can be used in teaching. It can’t always move from research to teaching… but stuff rarely moves from teaching back to research, unless it’s something that has come from research in the first place (interview with R. Finch 06/05/08).

This notion of a ‘hierarchy of use’ is particularly insightful as it illustrates the importance of both the amount of information that becomes attached to specimens, and the information requirements for different functions. Thus, the research function has the highest information requirements and it follows that active research material has the most information associated with it. However, while the process of transferring research material to the research archive should, in theory, have no impact on the amount of information that is associated with an object, in practice, this may not always be the case. For example, information is often lost when details are omitted or overlooked during the documentation process, or when researchers fail to complete a record card for their research material (interview with R. Finch 06/05/08).

Furthermore, once an object has been archived, its associated information may be further reduced, for example labels may fade or become detached from objects, specimens may be misplaced or data may be lost (ibid). As a result, archived collections contain objects ranging from those with full and thorough records to those with no data or associated information at all. Therefore, while it is theoretically possible for archived material to move back into the research realm, in practice, it may be hampered by the loss of information occurring during the transition from research to archive.

Compared to research specimens, the level of information required for objects to function as teaching or display material is relatively low. In terms of the hierarchy of use, the large amount of information that becomes attached to research material means that theoretically, it can be transferred to display or teaching collections either directly or via an
intermediary archival stage. Indeed, this was the case for the original samples of sillimanite schist that were used to make up teaching sets for the Sedimentary and Metamorphic Petrology course, mentioned in chapter two (interview with R. Finch 06/05/08). In practice, however, additional factors may also come into play, and for a variety of reasons, the transition may not be possible. For example, specimens may be irrelevant, inappropriately sized, hazardous, or too fragile to function effectively as teaching objects (interview with R. Finch 06/05/08). With regard to the information requirements for particular uses of material, and as I explored in chapter four, the movement of research specimens or archived research material into teaching or display collections involves a significant reduction or modification of associated information.

Due to the ways in which the mobility of objects and their associated information are managed at the University of Leeds, teaching material may return to the realm of research. For example a specimen of Pipe Rock (quartzite) from one of the teaching sets has been recently used for a research project (interview with R. Finch 06/05/08). Significantly, however, this specimen originated from a previous research project, so it effectively followed a circular trajectory from research to archive, archive to teaching, and teaching back to research, and as a result, the information requirements for the research function could be satisfied (ibid.). While the vast majority of material originates from departmental research activities, occasionally, if there is no relevant material available, teaching specimens may be collected or purchased. However, because the information associated with such objects is likely to be limited to that which is required for their particular use context, they are unlikely to be able to satisfy the information needs of other functions (ibid.). Therefore, the circulation of this type of material, even within the teaching collections, is unlikely; take, for example, the sillimanite schist samples that I considered in chapter two. These cannot be used for courses such as structural geology, global geophysics or deformation processes because no structural information was recorded at the time of collection (ibid.). In this sense, as a result of the hierarchy of use, the circulation of material tends to stop at the level of the teaching collection.

While there are some similarities between the internal movement of research material at the University of Leeds and the University of Cambridge, the presence of the Sedgwick at the latter provides an additional opportunity for circulation. In particular, the routes along which research material circulates on completion of a project are quite distinct, and in order to illustrate this it is useful to distinguish between the final research collection and surplus research material. The Sedgwick acts as a repository for the final research collections of both PhD students and staff. The transfer of material by PhD students is relatively formal: prior to the binding of a thesis PhD students request accession numbers from the collections manager and must allocate these to their own specimens, which they must then list in the appendices of their thesis (interview with S. Laurie 11/08/09). The museum receives around four or five PhD collections per year, each of which may contain up to 200 individual items ranging from hand specimens to derivatives such as thin sections and SEM stubs, and once they have been formally transferred, the museum keeps them for perpetuity (interviews with S. Laurie 11/08/09; 116 I consider the acquisition of objects in section 5.3.2.)
M. Riley 19/08/09). Similarly, most of the researchers within the department formally transfer their completed research collections or published material to the museum (ibid.). For Dr Holness, for example, this formal handover of material is integral to the research process “that whole move for me is tied up with finishing that particular project and moving on to something else” (interview 28/10/09). Indeed, the movement of material from the department to the museum is crucial to the ongoing research value of the Sedgwick’s collections.

While the formal movement of final research collections to the museum can be seen as both regulated and mutually beneficial, there is also an informal (deviant) flow of surplus research material that takes place in the background. Surplus research material is often initially offered to the class technician explained how she incorporates any useful specimens into the department’s own teaching collection, and that any remaining items are usually left in the department “for people to pick through” (interview with G. Caruana 12/08/09). The material may subsequently travel along one of two possible routes: perhaps the least common trajectory runs from the department to a skip, however, even this may not necessarily be as terminal as it may sound, as becomes apparent in the following account from the collections assistant (palaeontology):

There was somebody who basically collected a bunch of specimens, and he left the department and nobody in the department wanted them so they just went in the skip. So we were just poking around the skip and - actually, well… that's quite nice! Let’s take this to the education handling collection (interview with M. Riley 19/08/09).

The second trajectory involves what the class technician referred to as ‘disposal to the stores’ (interview with G. Caruana 12/08/09). This notion of ‘disposal’, however, is rather revealing because it is perhaps less about physically throwing material away than it is about moving material elsewhere, out of sight and out of the way of the department. For the department, the museum stores are therefore seen as somewhere to put surplus research material, much of which lacks associated information or any form of documentation. However, from the point of view of the museum, the transfer of such material from the department to the museum’s stores (both on and offsite) effectively shifts the burden of disposal from the department to the museum. This flow of material, again, highlights the lack of clarity in the distinction between the museum and the department, and as a result, for the collections assistants in particular, this trajectory is problematic:

We’ve got drawers and drawers – at the museum – of things that came from the department. And whether that's ten years ago and these people wouldn’t want to use it again. As if it was just – oh we don’t use these things any more, just send them to the Brighton Building – and we’re going well, actually, it’s the department's not ours. Are we storage for the department? Is it the same collection (interview with M. Riley 19/08/09)?

Ownership between the museum and the department is a big issue, yes. Usually it goes unnoticed. So, I don’t see why I should spend my time moving other people’s material. I haven’t got enough time to look after the collections I’m responsible for so why should I spend my time moving all the junk from the department (interview with S. Laurie 11/08/09).
A similar issue also arises at UCL; however, the circumstances leading to it are quite different due to the relationship between ‘Museums and Collections’ and the department. While UCL’s university’s museums fit quite easily into this structure due to their independence, the situation is rather more complicated for research and teaching collections that both fall within the remit of Museums and Collections and remain linked with their home department. For the earth science collections, the department not only houses much of the collection, provides the majority of its users, and supplies much of the material that is added to it, but also employs one of the part-time curators who manages it. As Were has observed; "the teaching and research collections are embedded in a web of interdepartmental politics, with each collection having its own history, traditions, and knowledge set" (2010: 293).

In spite of the hybrid nature of the collections at UCL much of the movement of research material at UCL follows a similar path to that described above both at Leeds and Cambridge, albeit crossing different boundaries and entering different types of collections (see: Figure 5a). However, in addition to the regulated functional circulation of research material either into accessioned collections (teaching, reference or – less often – display) or alternatively into the unaccessioned handling collection, there is also an informal flow of research material that, like Cambridge, is perhaps less well regulated (interviews with W. Kirk 21/07/10; E. Passmore 13/04/10; 21/06/10). This particular trajectory is related to the fact that, unlike the other institutions, UCL does not have a formal system of dealing with completed research collections such as those generated by PhD students and academic staff working on departmental research projects. As Dr Kirk confirmed: “we don’t actually accession anything – I don’t think – in terms of research material” (interview 21/07/10). Thus, while material offered (or abandoned) by members of staff or research students within the department may be accessioned into the teaching, reference or display collections, the main purpose of doing so is to support teaching and learning.

The management of departmental research collections is therefore felt to be outside of the remit of both of the earth science curators, as the following two quotes illustrate. When asked about the responsibility for research material, Dr Kirk responded with the following:

Now that [the responsibility for departmental research material] always was a problem, because I didn’t especially want to look after everyone else’s old toot…So the general idea was that students were supposed to give you a list – select material from their PhD and give you a list and then we would look after that – well not so much look after it so much as store it (interview 21/07/10).

Likewise, in response to a question about the division between Museums and Collections and the department, Emma Passmore explained:

…the we tend to try to keep quite separate - the earth science [departmental] research material and ‘Museums and Collections’ collections - and make sure that earth science research material doesn’t actually become my headache, because I’m not actually employed by earth sciences so it’s not actually my job to look after that. Historically it’s always been assumed that the curator will deal with the stuff, but it’s not actually my job (interview 21/06/10).
As a result, research collections generated by the department tend to be transferred to an offsite store, Gospel Oak, however, and as the following description from Emma Passmore illustrates (which is worth quoting at length), this trajectory is rather revealing of the value (or lack thereof) that is placed on such material:

We have an offsite store, which is really horrible that we don’t keep any collections in, but some of the earth science research material is there, and that’s called the Gospel Oak store. And that’s a couple of miles north of here, so it’s not on campus - which isn’t very helpful, and it floods a lot, and it’s kind of grotty, and [it’s] on the edge of a slightly sketchy council estate. And it’s generally a horrible place... And people tend to deposit things there and not think about them for about 15 years and then occasionally we will get an email from them saying can you dig out my PhD samples from 1982 and they’ve left them in an unlabelled box and it’s gone mouldy... Traditionally there’s been an interlacing between what the curator does and doesn’t do for earth sciences, and that’s been one of the things we’ve done in the past but now we’re trying very much to say this is not Museums [and Collections] problem, this is earth science’s problem... it’s a huge problem, one that we haven’t in any way adequately resolved. At the moment people tend to end up with boxes of stuff and say please can we stick it at Gospel Oak, and someone will either hire a transit van or get one of the porters to do it. But it happens in a very ad hoc fashion; it’s not something we do in any way rigorously, and it just ends up being boxes and boxes of old stuff... But again, it’s not our problem. It will become our problem eventually (interview 21/06/10).

As this explanation suggests, the material stored at Gospel Oak is of little value – scientific or otherwise - to either the department or Museums and Collections, and as a result, it appears to be acceptable to store it in such poor conditions. The distinction that is made above between the ‘collections’ (the objects that are either accessioned or used for teaching) and ‘research material’ (unaccessioned research collections) is particularly revealing as it implies that the ‘research material’ has no status whatsoever – it is neither historically, financially, scientifically, aesthetically or functionally valuable. As such, it is knowingly sent off to rot away in a damp car park that has been deemed unfit for the storage of ‘collections’. Indeed, this illustrates some of the tensions that have developed as a result of the particular system by which UCL manages its collections and the different values that are associated with particular types of material. However, it also demonstrates that the collections at UCL are unique amongst the case studies in that they do not in any way attempt to fulfil an ‘archival role’ by retaining research material. Indeed, this distinct set of values is even more apparent when the treatment of departmental research collections is compared with that of surplus teaching material.

Due to the high cost of land in London, the collections at UCL are particularly prone to relocation both on and off campus. While the research material is sent off to Gospel Oak, in 2008, excess teaching material – sets of objects that are of sufficient quality to warrant retention but not actively in use – was transferred to an offsite store called Belnor House (UCL 2008b: 7;
Asked about the process of relocating the material, Emma Passmore described how:

...we boxed them up into lots of ten and sent them out there. So the idea is that we have a database and you can say I want box number whatever, and they will porter it back for us, which should be good (interview 13/04/10).

The treatment and careful management of the surplus teaching material demonstrates the primary function of the collections at UCL is concerned with teaching and learning, rather than research. However, and in spite of the best efforts of the curatorial staff to encourage the use of these objects through the development of a database, Emma Passmore explained that:

...we sent it all out there about 18 months ago, and we've not had anyone wanting to bring anything back, which makes you question in the long run if its worth it (interview 13/04/10).

Thus in this case, it is apparent that the relocation of material offsite has effectively removed these objects from circulation. Indeed, this example illustrates the difficulties associated with managing functional objects at a physical distance, and it would appear that once out of sight, such objects quickly become out of mind (as with the palaeontology material considered in section 3.3.3.).

In considering the internal movement of earth science objects, and as I have suggested in chapter four, in order to function, these things require a degree of mobility, both physically and conceptually. However, alongside this, there is also a need to manage, record and control this mobility, and the importance of the systems and strategies that have been devised to regulate the circulation of material becomes particularly apparent when they are not followed. While the internal movement of objects may be limited by logistical factors such as being able to access and physically move an object, on the other hand, the information associated with a specimen may also be vital. Thus, internal circulation relies on the ontological flexibility of objects, which directly relates to the quantity and quality of associated information: the more information there is, the more opportunities there are for an object to circulate. And as the next section will suggest, this also has implications for the ways in which objects flow both into and out of institutions.

5.3. External movement

Having considered the ways in which material circulates internally, it is useful to take a step back and address the external trajectories along which earth science objects may travel, namely the inward and outward flows of material. This matter has recently received attention through work carried out as part of the ‘Relational Museum’ project at the Pitt Rivers Museum (see: Gosden and Larson 2008). The project set out to investigate “a range of collecting networks and relationships that have shaped the institution over the years and [to provide] …a window on

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117 Belnor House is located near Wickford in Essex. The site is used by the library for 'store material' which it makes accessible using couriers who transport material to and from the site on a daily basis (Percival 2007).
contrasting geographical, disciplinary, social and historical contexts” (Larson et al. 2007). By carrying out network analysis on records contained in the museum’s collections management database, it was possible to map out (visually using network diagrams) the relationships between various individuals (collectors and curators) and objects within the museum and beyond. While I have not attempted to quantify the external movement of material (indeed, to carry out this level of analysis on just one of the case study institutions would constitute a research project in its own right), it is nonetheless important to acknowledge the value of such work.

I start this section with a brief consideration of the temporary trajectories along which earth science specimens may enter or leave an institution, ranging from loans and identifications to the brief circulation of material out of an institution as part of the research process. I then move on to address the permanent movement of objects into institutions before considering the trajectories along which objects may permanently leave institutions. However, before exploring the external movement of material in more detail, it is useful to briefly clarify some of the terminology that I use to describe different trajectories, in particular, terms such as field collecting, transfer, donation, disposal and deaccessioning.

All earth science objects must, by their very nature, have been collected at some point in their lives. However, when I refer to field collecting or fieldwork as a source of material I intend to emphasise the direct movement of material from nature outside into an institution as opposed to the other means of acquisition that involve some intermediary stage. I use the term donation to refer to the movement of material from an individual to an institution by gift or bequest, ranging from single or multiple objects to entire collections; the key point here is that such items originate from an individual. The majority of donations, traditionally associated with museums, involve private collections or objects originating from members of the public. However, in order to accurately reflect the movement of material into both museums and departments, it is necessary to recognize what I refer to as ‘academic donations’; a term I use to describe material that is acquired by members of staff through their academic contacts, and that has therefore been collected or acquired and donated by an external academic within their field.

Donations, whether standard or academic, are concerned with material being passed from an individual to an institution. By contrast, I use the term transfer with reference to the movement of material from one institution to another, ranging from entire complete collections to parts thereof. Although such objects may originate from an individual, they cannot be understood as donations on account of the fact that they were generated through institutional activities. As far as the outward movement of material is concerned, it is also useful to clarify the distinction that I make between disposal and deaccessioning. I use the term disposal to describe the act of physically throwing objects away, whether material is discarded into a bin, a skip or driven down to a local recycling centre. The term deaccessioning, however, refers to the formal procedure through which museums must work in order to dispose of (or transfer) material.
from their accessioned collections. In this sense, deaccessioning may lead to the disposal or transfer of material out of an institution.

5.3.1. Temporary external circulation

In considering the various trajectories along which material may temporarily enter or leave institutions, it has become increasingly apparent that the length of time inferred by the term ‘temporary’ varies considerably in different contexts. For museums in particular, material may enter the institution temporarily for purposes of identification, and in most cases, this involves a member of the public bringing an object into a museum to show a curator, and then leaving with it (interviews with D. Gelsthorpe 24/11/10; S. Laurie 11/08/09; M. Riley 19/08/09). However, it is worth noting that at both the Sedgwick and the Manchester Museum, material that is left in the museum for identification, may remain there for significant periods of time (interview with M. Riley 19/08/09). For example, at the Manchester Museum, the curator described how:

…we had a fossil turtle that came in to the museum years and years ago and eventually it turned out that it was an enquiry and this person contacted us to ask if they could have their turtle back… it had been about ten years or something. And it wasn’t a problem because we gave it them back, but it had been given a number (interview with D. Gelsthorpe 24/11/10).

While this matter was resolved quite easily by deaccessioning the object and returning it to its owner (interview with D. Gelsthorpe 24/11/10), it does illustrate the particularly variable interpretation of the meaning of the term ‘temporary’. At the Sedgwick, deciding what to do with such unclaimed material is an ongoing problem that has not yet been resolved: when asked to elaborate on the amount of unclaimed material, the collections assistant (palaeontology) explained that:

there’s drawers and drawers of things that are five or six years old and you’re thinking, well, these people don’t want it back… but it’s a case of writing letters to them and saying you brought this specimen in six years ago. We don’t want it. Do you want it back or shall we just get rid? …we’ve got drawers full of ‘disposals’ but we’ve – just got to sit down …and go through the procedure of how we actually do it. Is disposal ‘woops’ it fell in the bin, or do you have to go through the proper procedures (interview with M. Riley 19/08/09)?

Perhaps more easily controlled is the external circulation of material through loans, and this may involve material being brought into an institution, or being sent out. Loans into institutions are relatively uncommon, mainly because both museums and departments tend to have any material that they need or want already, and for departments in particular, if they don’t already own the material it is relatively easy to acquire it permanently by some other means (as I explain in the next section). However, if material does enter an institution temporarily, it is most commonly borrowed for use in an exhibition, for example at UCL, a specimen of cubic zirconia was borrowed from a jeweller for use in the ‘Dust to Diamonds’ exhibition (interview with E. Passmore 21/06/10).
By contrast, and particularly for museums, it is much more common that material circulates out of an institution as it is loaned elsewhere, and this may be for either display or research purposes. The Manchester Museum, for example, loaned around 20 fossil plant specimens to Chester Museum for use in a temporary exhibition about the evolution of plants (interview with D. Gelsthorpe 24/11/10). At the Sedgwick in particular, material may leave the institution temporarily for research use, and while researchers may occasionally come to Cambridge and pick material up in person, it is more common for the museum to post material out (interview with S. Finney 18/08/09). Such temporary circulation of material out of an institution may last for months to years, depending on the conditions attached to the loan. By contrast, the temporary movement of research material for processing has a much faster turnaround. For example, at the University of Cambridge, Dr Holness explained how she sent her Greenland samples out for thin sectioning:

Well I always ring up [my contact] at the BGS [British Geological Survey] to say how many [samples] there are coming and to get an estimate with him. And so I think I get a little bit of a personal service because I know him quite well now… So I think that what we did last time, there were 250 samples and he told me to send them in batches of 40 to 50 and he’d send them back to me as he did each batch. And that worked really well because he could do the batch in a month and then they’d be back and it would take me at least a month to process them and then the next lot would come (interview 28/10/09).

In considering the temporary movement of material into and out of institutions, it is interesting to consider how mobility may affect the meanings and physical integrity of an object. For example, material that is brought into an institution for identification may be transformed by being given a name, and for the owner this may well impact on the value of the object. Circulation of material through loans may also lead to a change in the meaning of an object, for example, if material is loaned for use in a display, it may well be interpreted in a new context or positioned alongside particular objects, which may effect its meaning (as considered in section 4.4). Material that has been loaned for research purposes may be transformed on returning to an institution if the research has generated new or additional information and meanings about an object. The circulation of objects for the purpose of processing, however, has an altogether different type of impact on material; while its meaning remains intact as it travels along this trajectory, it is physically altered. Therefore, while one object may be sent out for processing, what returns may well be part of the original object, a thin section slide, and any off-cuts that were generated through the process of creating the thin section (interview with M. Holness 28/10/09). However, and as mentioned above, the temporary circulation of material in and out of institutions is only the tip of the iceberg; by far the most common forms of external movement are permanent.

5.3.2. Permanent inward movement of material

The means by which earth science objects enter an institution varies according to whether material is entering a museum or a department, and whether it is doing so in order to be used for a particular purpose or to become incorporated into a collection. The most common route
along which material enters departments is directly from ‘nature outside’ through fieldwork, and
while I have considered this in detail in chapter two, it is useful to briefly mention some of the
key features of this type of material in terms of its circulation. While field collecting for
departmental research activities, may generate a significant amount of material, it is unlikely to
arrive in a steady flow. Indeed, field collecting is only likely to occur for particular types of
research. At SEAES, for example, a substantial amount of material has recently entered the
department as a result of an intense period of collecting in the Alps and Greenland for two
particular research projects (interview with A. Edwards 26/10/10). Furthermore, and within this
ongoing flux, the flow of material into a department will also vary throughout the life of a
research project, and this depends upon the nature of the research being carried out. Thus,
while some types of research may involve a single phase of field collecting at the beginning of a
project, such as that carried out by Dr Droop in the Alps (see section 2.4.1) (interview 10/11/10),
others may generate material through successive phases of fieldwork, such as Dr Holness’
Greenland research project where a two year gap has separated the two phases of field
collecting (interview 28/10/09).

In addition to research specimens, a similar type of material may also be generated
through departmental fieldtrips and undergraduate fieldwork. While on one hand, this material is
—in theory - no different from that which is collected by researchers, on the other hand it is
apparent that – in practice - both the quality and value placed on such objects is significantly
different. With reference to the situation at Cambridge, Dr Holness described how:

They [the students] tend to bring back really cruddy things because they haven’t been
shown how to sample, or what to look for. And they tend to bring back stuff that they
couldn’t identify in the field because it was so altered and messed up (interview
28/10/09).

At both Cambridge and UCL, for example, the movement of material along this trajectory is
concentrated in the summer term when most of the departmental field trips take place (interview
with M. Holness 28/10/09; interview with E. Passmore 13/04/10). However, due to the poor
quality of material, it tends to be of little use to either the students or the department, and as I
will explain in more detail in the next section, such objects tend not to remain in the department
for long periods of time.

Material may also be collected specifically for use in teaching or exams, and at Leeds,
for example (as we saw in chapter two), if material required for teaching does not already exist
in the collections, the next port of call would be to look into collecting it directly from the field, as
the school curator explained; “if we want to teach something, then really what we should do is
go and get it” (interview with R. Finch 17/11/08). A similarly directed approach to field collecting
is also apparent at Cambridge where material has been collected to bolster the department’s
exam collection (interview with S. Laurie 18/08/09). However, in addition to such needs-driven
collecting, it is also apparent that material may flow from the field to a department for less clear
reasons, and such opportunistic field collecting generates a significant amount of material at
both LJMU and UCL. Describing the material stored in the Rock Room at UCL, Emma Passmore explained how:

Quite often if it’s a fieldtrip that runs regularly, the academics taking the trip may want a suite of rocks to teach from. This is quite a typical way that hand specimens start getting accrued, and how suddenly you end up with – instead of 1 teaching set, you end up with 15 teaching sets – because people have done it for years and years and years. So we have a lot of things from the Cambrian stratigraphy in Assynt because there’s been a fieldtrip around there for a lot of years now (interview 21/06/10).

Finally, while the flow of material directly from the field to museum collections was common in the past, there is no contemporary evidence of objects entering the case study museums in this way. Historically, museums relied heavily on the field collection of material by members of staff to enhance their collections. For example, at the Sedgwick, a significant amount of material was collected by Stuart Agrell who occupied the position of Curator and Lecturer in the Department of Mineralogy and Petrology from 1949 until 1980 (Chinner 1998: 666; Pillinger et al. 1996), and who, according to the collections assistant (mineralogy and petrology) “used to go on long tours through the USA collecting loads and loads of rocks and the like” (interview with S. Laurie 11/08/09). At the Manchester Museum too, curators such as Michael Eagar contributed substantial amounts of material to the collections through field collecting, and this practice continued at Manchester until relatively recently. For example, analysis of the number of minerals accessioned between 1993-2002 – totalling approximately 5,200 - revealed that 35% of this material originated from members of staff collecting objects directly from the field (Green 2003: 64-5). While all material, by its very nature, must have originated from some form of field collection, the movement of material into an institution may also involve various intermediary stages, namely dealers, other institutions or individuals.

The flow of material into departments via commercial dealers is common to all of the case study institutions, and while departments may purchase material for teaching or research purposes, they tend to spend relatively small amounts of money, compared to museums that tend to spend a lot more money but less often. Departments often purchase teaching material as a last resort when large numbers of duplicate specimens cannot be sourced internally using existing collections, or externally through either field collecting or via personal contacts (interviews with G. Caruana 12/08/09; H. Clark 23/03/09; A. Edwards 07/12/10; R. Finch 17/11/08; W. Kirk 21/07/10). Material may also be purchased for research purposes, particularly when ‘generic’ objects are required (as mentioned in section 4.3.3.), such as for calibrating machines, for example (interviews with A. Edwards 07/12/10; R. Finch 17/11/08). The use of purchased material within departments suggests that such objects are essentially valued as consumables, specifically acquired in the knowledge that they will either deteriorate or be destroyed as a result of their use. Indeed, unless they survive the research process, purchased items are unlikely to be accessioned into more permanent collections (interview with A. Edwards 07/12/10).
While it was common in the past for museum curators to have an annual purchasing budget, such luxuries are no longer available and therefore the amount of material arriving via this route is significantly lower than it has been historically (interviews with D. Gelsthorpe 24/11/10; S. Laurie 11/08/09). For example the collections assistant (mineralogy and petrology) described how, at the Sedgwick; “In 1981 the purchasing budget for the mineral collection was cut – was done away with completely. Before that there were about 50 years of fairly steady growth” (interview with S. Laurie 11/08/09). In spite of this, museums continue to purchase material, however, such acquisitions are perhaps less opportunistic than they were in the past, reflecting the procedures that are in place to regulate the flow of material into museums. Furthermore, the flow of purchased material into collections is much less regular and fluctuates considerably over time in response to the availability of funding. At the Manchester Museum, for example, the afore-mentioned amber specimens (see: Section 3.3.2) were purchased by the curator using a central pot of money from bequests (interview with D. Gelsthorpe 24/11/10). Museums may also purchase objects using grant funding (interview with M. Riley 19/08/09), and at the Manchester Museum, for example, the funding received for the redevelopment of the Prehistoric Life Gallery (which opened in 2000) included a considerable purchasing budget (interview with D. Gelsthorpe 24/11/10):

The Keepers of Geology and Mineralogy visited the Tucson Gem and Mineral Show in February 2000 to purchase further specimens for the new gallery displays, including a dragonfly and a floating crinoid from the Jurassic Solnhofen Limestone, banded ironstone from Australia, a 2.5 billion-year-old stromatolite from Morocco and a fine, iridescent ammonite from Alberta, Canada (The Manchester Museum 2002a: 7).

The treatment and value of purchased material that enters institutions varies considerably depending on whether it enters a museum or department. While departments tend to purchase objects as consumables, in museums, as a result of the strict selection criteria used to regulate the growth of collections, any material that is purchased must be in some way ‘special’. In museums, considering the need for accountability, particularly when material is purchased using grant funding, purchased objects are usually either put on display or regularly used rather than being kept in storage, and therefore, tend to be particularly visual items. The distinct attitudes towards purchasing material are particularly apparent at UCL due to the hybrid nature of the collections, as is apparent from Dr Kirk’s account of a recent purchase:

…we managed to create quite a furore because we had a curators weekend away in the Peak District, and we decided to buy a lovely specimen of Labradorite and two or three other things – and we thought that it would make a really lovely display collection – it’d look really good in the Rock Room. And we bought it and my colleague got quite a lot of flack from the other curators because she hadn’t put it through the heritage committee to see if you could acquire it (interview 21/07/10).

In this case, there appears to have been a clash between a departmental mentality of buying something for a reason, and the museological system involving formal acquisitions procedures. For museums, the decision to purchase material is not simply a matter of an individual making a judgement; rather, it must follow particular procedures where it is subject to scrutiny by other
members of staff (as outlined in section 3.3.1.). Thus, while the decision to purchase material for a department would not normally be a problem, at UCL, it is.

The hybrid nature of the collections at UCL, and the difficulties faced by staff wanting to purchase material opportunistically has led the curators to bring purchased material in through a slightly diverted route. For example, and with reference to the challenges of working within this system, Emma Passmore explained that:

> Anything to do with acquisitions – if we’re going to use money from our ‘Museums and Collections’ budget, we need to go through an acquisitions panel and put in a request. So if, for example, we know that we need some pieces of amphibole for teaching, then we’d officially have to go through that channel. But then - I know that if I’m in a mineral shop and I see something and I know we don’t have one - and it’s about a fiver - then I’ll quite often just buy it and donate it (interview 13/04/10).

The acquisition of objects through donation, however, is not the norm when it comes to the inward flow of material into university departments and museums.

Due to their origins in academia, the volume of donated material is relatively small compared to that entering local museums, for example, where it is more likely that material donated by members of the public falls within the remit of a museum’s collecting policy. For museums (as explained in section 3.1.1), the purpose of acquisitions policies and panels is to ensure that only relevant material enters an institution, and due to the volume of material that exists in collections already, the decision to accept donated material is not taken lightly. At the Manchester Museum, for example, the curator was keen to emphasise that; “our focus has got to be on what we’ve already got” (interview with D. Gelsthorpe 24/11/10). At the Sedgwick, because the primary function of the collection is that of a research repository, it is rare that public donations are accepted, as the collections assistant (mineralogy and petrology) explained:

> …these days, we are very strict about that. We don’t take anybody’s holiday seashells. It has to be of interest. We [have to] know where it’s from, how it’s been obtained; its got to be of high scientific interest, has [to have] been published or have something known about it (interview with S. Laurie 11/08/09).

However, in spite of the strict selection criteria, material may still be acquired by museums in this way.

The Manchester Museum, for example, has an important collection of Pleistocene cave material and researchers specialising in this area regularly contact the curator and often visit the museum in order to access specimens (interview with D. Gelsthorpe 24/11/10). Due to the highly specialised nature of this research, it naturally follows that the individuals who are

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116 It is, however worth noting that the museum was less strict in the past; “when the museum was formed, McKenny Hughes was getting funding and taking over the space – he basically took whatever people were offering… we came across a cannonball that had been frost shattered and a Derby Winner – the 1904 Derby Winner’s skull” (interview with S. Antoniw and F. Neary 28/10/09).

117 Much of this material originates from the collection of Boyd Dawkins who was involved in the excavations of Creswell Crags (interview with D. Gelsthorpe 24/11/10).
interested in these objects form a relatively small close-knit group who, as the curator observed: “talk to each other a lot” (ibid.). However, many of these researchers collect their own material, and therefore own large private collections of important specimens (ibid.). Thus, by building up relationships with individuals, albeit a time consuming and gradual process, the museum has been able to secure the bequest of a very large, sought-after private collection of Pleistocene cave material (ibid.). Indeed, this donation will quite possibly add further momentum to the growth of this area of the collection, illustrating what Alberti refers to as “the gravity of donation” (2009: 92).

While departments are less constrained by procedures and policies that regulate the intake of donated material, it is perhaps even less common for donated objects to be accepted. At Leeds, for example, when asked about public donations, the school curator explained that:

We do get people trying to give us material. I’ve been quite strict really on taking material in – we don’t need to keep it, we don’t necessarily want it – we’ve got so much stuff already ourselves and we’re not a museum! And I understand why people want to give their collections to us but you’ve just got to be cruel – you know, its very rare that you find anything of value to the school because it won’t fit into our collections (interview with R. Finch 06/05/08).

However, while material is unlikely to enter a department as a result of public donations, the movement of material into departments through academic donations is a different matter, and teaching material in particular, is regularly sourced in this way. As the school curator explained:

…more often than not stuff [teaching material] that comes into the department is through contacts from different countries. And they’ll send us what stuff they have… [so staff use] their contacts in their field to get the material they want (interview with R. Finch 17/11/08).

For example, a number of andesite specimens were recently acquired by a member of staff at the University of Leeds through a contact in South America (interview with R. Finch 06/05/08).

The movement of material through transfers is common to both museums and departments, and indeed, this trajectory tends to involve considerable volumes of material, although occasionally such material may be ‘cherry-picked’ and may therefore arrive in much smaller quantities. While LJMU, Leeds and UCL have all acquired material through transfers from other university departments, this trajectory is perhaps most significant at the Sedgwick. As a ‘Regional Collections Centre’, the Sedgwick is responsible for taking collections from eight other university departments that do not have the facilities to look after material themselves (The Sedgwick Museum 2010: 4). For example, as a result of this status, the conservator explained that the museum has recently acquired a collection of volcanic material from the

120 An example of ‘cherry-picking’ (c.f. interview with R. Finch 06/05/08) is the recent transfer of material from Wigan and Leigh College to the Manchester Museum where the curator took only a fraction of the material that was on offer, selecting only the items for which there was a clear use (interview with D. Gelsthorpe 24/11/10).

121 For example material LJMU has received material from Aberystwyth, Leeds has acquired material from Hull, and material has been transferred from both Luton and Queen Mary’s College to UCL (interviews with: H. Clark 23/03/09; R. Finch 06/05/08; W. Kirk 21/07/10).

122 This status relates to the UGC review, see section 2.2.1.
University of Sheffield (interview with S. Finney 18/08/09). In addition, material may also be transferred to the Sedgwick in response to requests made by members of academic staff in the department, for example, two large collections have recently been acquired from academics at Durham and Edinburgh universities in this way (interview with S. Laurie 11/08/09). However, a problem that becomes all too apparent when large volumes of material are concerned, relates to the task of physically moving objects, as the collections assistant (mineralogy and petrology) described in relation to his experience of collecting these two collections:

The big problem for me was that they underestimated the weight, so I arrived in [Edinburgh with] a 3-ton van, and there was about 12 ½ tons. So I was coming down the A1 very carefully - steep hills - nearly burnt the clutch out! So when I went to Durham, I took a 7-ton truck. Just in case, and I needed it! (interview with S. Laurie 11/08/09).

While transfers tend to originate from other university departments, they may also include material from higher education institutions - such as Wigan and Leigh College from which both SEAES and the Manchester Museum recently acquired material (interviews with A. Edwards 07/12/10; D. Gelsthorpe 24/11/10) - or larger national research centres such as the British Geological Survey, from which UCL acquired material (interview with W. Kirk 21/07/10). However, while transfers are likely to involve large numbers of specimens, the movement of material along this trajectory tends to occur sporadically over time. Indeed, it has become apparent that none of the trajectories along which material may enter an institution generate a steady or regular flow of objects; rather the inward movement of material fluctuates considerably over time. But considering the volume of material that flows into institutions, it is perhaps surprising how little actually flows out.

5.3.3. Permanent outward movement of material

While there are a number of different means through which material may leave an institution, as far as the case studies are concerned, the amount of material that actually moves out of an institution is less than the amount that is brought in. Indeed, at LJMU, once material has entered the institution, it appears that it never leaves; when asked about how material leaves the department, the senior technician responded:

There is no disposal of material. Any broken specimens or damaged specimens get fixed because the type of material that gets damaged is the stuff that is used a lot, so repairing damaged material is the most cost effective way of dealing with it (interview with H. Clark 23/03/09).

While this lack disposal is directly related to the particular circumstances at LJMU, and therefore, unique among the case study departments, the similar lack of outward movement from museum collections is the result of an altogether different set of factors.

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123 As explained above (section 2.2.3 and 3.2.2), the lack of research in the department means that there are no large volumes of material to be dealt with (interview with H. Clark 23/03/09).
For museums, due to their preservational role, the curator at the Manchester Museum suggested that deaccessioning is perhaps "a lot more acceptable in theory than it ever was in practice" (interview with D. Gelsthorpe 24/11/10). As Macdonald has observed: “A museum, for most objects, is a final resting place – a moment frozen in time for future contemplation – not a stop-over on a journey elsewhere” (2002: 92). Therefore, and in spite of the existence of carefully planned policies and procedures for deaccessioning material, it remains a rare occurrence. At the Sedgwick, for example, the collections assistant (palaeontology) explained:

There is no deaccessioning from the collections. There are policies but nothing has ever been deaccessioned. The fact that the collection is at capacity and more interesting material keeps coming in, means that deaccessioning is having to be considered as a serious option for managing the collections (interview with M. Riley 19/08/09).

By contrast, material has been formally deaccessioned from the Manchester Museum, however, while it is useful to consider the process in more detail, it is worth noting that for the earth science collections, this is a one-off (interview with D. Gelsthorne 24/11/10). The material that was deaccessioned comprised a number of large plaster casts of figured fossilized trees that were discovered near Bolton in the 1890s (ibid.). The decision to deaccession these objects reflects a number of factors; as well as their size (about 3 metres across) and the fact that they were casts rather than original objects, the degradation of the plaster was such that, not only was it becoming a health hazard, but also, in order for the material to be retained, it would have required significant conservation work in order to stabilize the plaster (ibid.). Thus, having identified these objects as potential candidates for disposal, the curator described the process as follows:

Then the next process was doing as much research as possible into them; finding out where they were from, why they came to the museum, what significance they were, if anybody had ever used them - things like that. All things that tend not to be recorded, which is difficult… So once I’d done that …I came up against a problem that we don’t actually have a form for disposals! So what I had to do was to use the acquisitions form and change the word acquisition to disposal! The forms obviously weren’t geared up for disposals to start with. I did that and then it went to the collections development panel, after I’d made a recommendation to dispose of them and why. And then the panel… they okayed it, then we went ahead [and advertised it in the Museums Journal and] …we had quite a few enquiries. And what happened in the end, I think 5 or 6 went to Bolton Museum because they had a link to Bolton… I mean my personal opinion is that they shouldn’t have gone anywhere because they weren’t worthy of being in a museum. But the rest of them, they went in a skip (interview with D. Gelsthorpe 24/11/10).

While such procedures exist with regard to the removal of accessioned collections, for unaccessioned material, objects may be more easily transferred, taken with members of staff or simply disposed of. In departments, for example, where objects may circulate more freely on account of their incidental nature, the movement of material out of the institution, whether ‘accessioned’ or not, is relatively straightforward. Indeed, it is precisely because departments are concerned with the use of material – as the school curator at Leeds puts it: “it’s not a collection for collection’s sake” (interview with R. Finch 06/05/08) – that the movement of objects out of the department having served their purpose, is so vital.
For ‘unaccessioned’ research material, it is common for researchers to take specimens with them if they move on to a different institution (interviews with G. Caruana 12/08/09; A. Edwards 07/12/10; R. Finch 06/05/08; W. Kirk 21/07/10), or alternatively, as described above, it may circulate within an institution. Indeed, at SEAES, surplus research and teaching material may be retained, with a view to giving it away to visitors or schools (interview with A. Edwards 07/12/10), and at Leeds, “we have a network of schools and local groups and we do offer material to these people” (interview with R. Finch 06/05/08). Similarly, ‘accessioned’ material may be transferred if space is required for new material entering through current research projects,\(^\text{124}\) and at SEAES, for example, the curator explained how:

> …what we tend to do is send stuff to BGS or the NHM [the Natural History Museum] because they accept material more readily… And generally, because it’s going to be research material, all fully recorded, they’d generally be happy to take it (interview with A. Edwards 26/10/10).

Again the situation at UCL and the difficulties that staff have encountered in attempting to move material out of the institution, highlights the distinct attitudes held by museums and departments with regard to this form of movement. Indeed, this is particularly problematic since at UCL, the teaching collections – perhaps the most dynamic type of material - are accessioned and as Dr Kirk explained: “it’s not worth advertising a piece of granite in the Museums Journal, for heaven’s sake!” (interview 21/07/10). Like Cambridge, the department at UCL also generates a lot of material through research and undergraduate fieldwork, for example, and this is often ‘abandoned’ and left for curatorial staff to deal with. As Emma Passmore observed:

> Quite often we’ll try to get people to take it with them, but for that sort of situation where it’s not accessioned collection material - if it’s just stuff from their office - we’re all curators and have been working with geologists for a long time, and if we don’t see it as being of any use to the collections - if it can’t be used by a school or given to someone - then yeah sometimes stuff does just get chucked in a skip. But it’s actually really hard to do that now, but we have in the past dumped some stuff in a skip that was on site, but we have had raised eyebrows from contractors as you fill their skip up with rocks (interview 21/06/10).

Indeed, as well as disposing of material in skips, at Cambridge disposal of such unaccessioned material may also involve driving it down to the local recycling centre, however, this is a very gradual process: “…[it] is very slow – partly the time, and partly because they get suspicious if we take too much, so I have to take it in fairly small loads (interview with S. Laurie 11/08/09).

Thus, having considered the movement of earth science material out of institutions, it is apparent that, for many objects in museum collections, while they may continue to circulate internally, they are unlikely to ever permanently leave the institution. By contrast, for departmental material, and whether or not they are ‘accessioned’ it is likely that at some point, objects will leave the institution. However, while some trajectories may take objects to other institutions where they may continue to circulate, for others, if they are disposed of, this may

\(^{124}\) This is part of the notion of the ‘Transfer of Trust’ mentioned above (section 3.3.2.) whereby members of staff pass material over to departmental curators knowing that the curator will do what is best for the material.
mean the end of the road – albeit as far as their circulation over human timescales is concerned - as they are returned to the ground from which they came, to gradually become incorporated back into nature.

5.4. The circulation of proxies

While I have thus far focused on the mobility of original physical objects, it is important to acknowledge that earth science objects may also circulate as ‘proxies’. Such proxies may take the form of derivatives, for example, at SEAES when researchers visit the department in order to carry out research on material, they may take any thin sections or other derivatives that they have had made, with them when they leave (interview with A. Edwards 26/10/10). Proxies may also constitute more pieces of the same thing, as is apparent for the teaching material at UCL:

So we have basically got lumps of rock. So, you know, sometimes if you need another hand specimen and you’ve got a lump of rock, then you go outside and smash it with a hammer and you have two lumps of rock (interview with E. Passmore 13/04/10).

Perhaps slightly further removed from the original is the circulation of casts, and such proxies may be made because an original is either too valuable or inappropriate for a particular use. At the Sedgwick, the conservator may make casts of objects if she feels that it is not appropriate or possible to loan the original object, for example, the conservator recently made a cast of a fossil lightning strike that was discovered on Arran by an undergraduate student in the 1950’s. The Isle of Arran Museum Trust had originally hoped to borrow the original object in order to display it in the museum, however, rather than loaning the original object, the conservator felt that it was more appropriate to give them a cast which could be kept permanently (interview with S. Finney 18/08/09). Finally, specimens may be transformed into digital objects, which may circulate globally online, or which may have access restrictions. For example, at UCL, Dr Kirk has devised an online course for undergraduate students using thin section images and photographs of hand specimens, in order to provide a means by which students can access the teaching material that they encounter during practicals, on their own terms and in their own time, away from the physical collection (interviews with W. Kirk 21/07/10; E. Passmore 13/04/10).

Proxies can therefore be understood as providing a means of enhancing the mobility of objects by allowing them (or versions of them) to be in more than one place at any one time. However, there are different ways in which achieving this may impact on an object, and as a result, proxies may be limited to particular types of material. For example, by breaking a specimen into two pieces, apart from its size, the original composition of the object remains largely unchanged by the process. However, while this may be a practical means of turning one rock into two rocks, for fossils, where the emphasis is on the external features of the object, rather than on its physical composition, this is inappropriate. Similarly, in creating derivatives, while the composition of the original can circulate freely and independently as a thin section, again, in order to do this, it is necessary to remove part of the original, and such processes are therefore most commonly applied to rocks. However, when it comes to casts, while the physical
composition of a replica is created from scratch and therefore bears no relation to that of the
original, it generates an exact duplicate of the physical form of an original. Therefore, while this
method is unlikely to be of any use for rocks or minerals, it is an ideal means of circulating fossil
material. Moving further still from the original are digital objects; while these may be able to
duplicate an original object visually, they have no capacity to capture any of its physicality or
composition. Thus, while proxies may significantly enhance the mobility of objects, potentially
preserving something of the original beyond the life of the original, they are in various different
ways a compromise, because no matter how they are made, they lose something that remains
with the original, as Dr Kirk explained: “They’re only ever an addition, or a reminder of what
you’ve seen; you’ll never ever replace it [the original]” (interview 21/07/10).

5.5. Discussion

Having explored some of the trajectories along which earth science objects may move, I will
now return to the original questions that I set out to answer through this chapter, namely, how
do objects move; what are the trajectories along which objects travel; and how does their
mobility affect their credibility, treatment and meanings?

In considering how objects move, it may appear that the answer is relatively
straightforward; by people. While there is no denying the involvement of people, the simple
response in which all of the power is attributed to humans, does not satisfactorily account for
much of what I have described above. Indeed, in order to understand the driving force behind
the mobility of objects, it is necessary to acknowledge the involvement of the objects
themselves, as Latour observes: “action is distributed among agents, very few of whom look like
humans” (2005: 50). This is particularly well illustrated by the curator’s account of the amber
specimens that were purchased by the Manchester Museum:

We did a little bit of publicity around that [the purchase of amber specimens] and since
then we’ve had quite a lot of relations with one of the lecturers down at MMU
[Manchester Metropolitan University]… but she’s really interested in amber and she has
subsequently purchased I think about 5 quite rare specimens and donated them to the
museum (interview with D. Gelsthorpe 24/11/10).

Here it is clear that while the curator did the buying and the publicity, and the donor did the
giving, neither of these two events could have taken place without objects as it was the objects
that were being publicised, that attracted the donor’s attention, and that formed the common
ground between the curator and the donor, on which the relationship was built. Indeed, and as
this case demonstrates, people without objects would be just as ineffective as objects without
people. Thus the donation of amber specimens following the original purchase of material was
 driven by a particular configuration of people and objects and publicity and timing; remove any
of these factors and there would have been no mobility.

In order to understand how objects move, it is therefore vital to acknowledge the
objects, the people, and the ways in which they interact. However, such “webs of relations”, as
Law observes “have no status, no shape, no reality, outside their continued production” (2004b: 2). Thus as well as people and things, in order to understand the mobility of objects it is also necessary to acknowledge the effort and work that are involved, not only in mobilising things in the first place, but also in sustaining a flow of objects along any particular trajectory. Thus, and as the case of the Pleistocene cave material at the Manchester Museum demonstrates, while people may appear to be the links that form the relationship, in practice such relationships would neither exist nor be sustainable, and indeed, would not gather momentum, without the objects. But equally, with the cave material, it is the unique combination of people and objects, along with a significant amount of effort and work, that has generated and subsequently maintained this relationship – remove any one of these elements and the whole thing will collapse.\(^\text{125}\)

This is not restricted to museums, and at SEAES, for example, a similar need to remain vigilant and maintain relationships is vital to the functioning of the department's collections, as the curator described:

> It can’t be so open and transparent that anybody can use it. Somewhere along the line you have to have a [control] …what you as a curator have got though, you have an overview of the collection. So you have to find a way that people can think to include you in their discussions when they are trying to work out what material they want. And if I didn’t have any knowledge that they don’t have, then they’d have no need to talk to me\(^\text{126}\).

Indeed, what the curator describes here is exactly what has been variously referred to as a form of choreography or dance (see, respectively: Cussins 1996; Pickering 1995: 21); an active and ongoing intermingling of humans and non-humans. However, and as I have illustrated throughout this chapter, the second that your back is turned and any of the components become neglected, the whole thing breaks down – you can end up with “anarchy” (interview with A. Edwards 07/12/10), and this is precisely why, in certain situations, objects become unruly and appear to take on lives of their own, as I will now illustrate.

On a number of occasions, the curators at the case study institutions talked about objects as if they had personalities or intent. Thus, while some objects may “loiter” (interview with A. Edwards 07/12/10), “just turn up” (interview with S. Laurie 11/08/09), or actually “go walking” (interview with E. Passmore 21/06/10) others, particularly en masse, are more destructive, such as the “huge amounts of rock” that were disposed of into the department’s bins at the University of Cambridge, and which “pulled a huge lorry off the ground and lifted it up at the back” (interview with S. Laurie 11/08/09).\(^\text{126}\) Here it is apparent that for those who work with them, these objects do have capacities; “not only to impede or block the will and designs of humans but also to act as quasi agents or forces with trajectories, propensities, or tendencies of their own” (Bennett 2010: viii). Therefore, while objects do not just turn up on their own accord

\(^{125}\) Indeed, Knell has described a similar phenomena with reference to the relationships between networks of donors and philosophical societies in the nineteenth century, and explained how such breakdowns in relationships could “establish a cancer in such a closely interlinked and often politicised network” (2000: 117).

\(^{126}\) The museum was subsequently charged with the costs of repairing the lorry (interview with S. Laurie 11/08/09).
or actually go walking without the help of humans, on account of their materiality - their durable, massy physicality - earth science objects do loiter and are entirely capable of breaking dustbin trucks.

However, if objects have such unruly tendencies, and if the realities of regulation require the attention and involvement of people, then what do these practices entail and how is it that curators get anything else done? Indeed, to be constantly vigilant and directly involved with the movement of all of the objects within an institution would be impossible and attempting to do so would quickly become overwhelming. Therefore, when I talk of practices, it is clear that some of this responsibility must be somehow delegated – practiced at a distance - and this is where all of the forms, the lists, the procedures and the vast amounts of paper come into their own. Thus, to avoid chaos, regulation is delegated to paperwork that provides a means of controlling the circulation of these objects, but at a distance, and while it takes time and effort to design, implement and manage these forms of control, when used properly, they are perhaps more effective at managing the mobility of objects than people. Therefore, to speak of enacting the regulated movement of objects is to speak of objects, people, paper and a whole lot more. As Law describes, discipline: “is about bodies. It is about architectures. It is about time. It is about texts. It is about sight. It is about furniture. And finally, it is about the soul” (2003: 3).

That is not, however, to suggest that things never go wrong – they do – but they do so much less often than they would if there was no paperwork at all, and this is particularly apparent at Cambridge. At times, earth science objects have the capacity to frustrate in ways that we tend to associate with other humans, as we saw at Cambridge due to the ‘disposal’ of unwanted material from the department to the museum’s stores. However, while the objects themselves may appear to have become the source of irritation for the museum staff, I believe that the situation is perhaps more complex. That is not, however, to suggest that the physical presence of these objects does not become an obstacle, or that their weight and durability does not present a problem when it comes to trying to dispose of them. Rather, I believe that in addition to this, for the museum staff - who are increasingly reliant on the procedures and systems that are actively enforced by the collections manager to regulate material entering and moving around the museum - it is perhaps the lack of control over the mobility of such material that is at the root of their frustration, rather than the objects themselves. The systems and standards of collections management that curators have become accustomed to and reliant upon - all of the entry and exit forms, loan agreements, accessioning, documenting, object movement tickets, and databases – are perhaps so ingrained that the circulation of material outside of them, becomes unthinkable. Indeed, such deviant informal circulation weakens the collection as an assemblage, by blurring its boundaries, and therefore, this may also be the cause of frustration for the museum staff.

In response to my first question then, the mobility of objects is enacted in precarious but powerful webs of relations between various humans and non-humans. As I have shown, objects may trickle, flow or flood into an institution, they may travel directly from nature outside or may
pass through many hands before arriving at an institution, and they may move along formal, established paths or circulate deviantly behind the backs of curatorial staff. However, the ways in which objects move are directly related to the distinct trajectories along which they travel – my second question - and in addressing the matter of where objects travel, I am also able to respond to my third question concerning the impacts of mobility on the meanings, credibility and values of objects.

As this chapter has illustrated, objects may circulate both internally and externally, and the trajectories along which they travel have implications for their meanings, values and credibility, both within and beyond an institution. While all objects originate in nature, the ways in which they were collected and the intentions of the collector significantly affect the movement of material once it enters an institution. Therefore, for research material for example, the fewer hands it passes through, the better; here it is the associated information – the quantity, quality and reliability of the records that are made when objects are collected – that is valued and indeed, necessary in order for them to function. It follows that research material tends to travel directly from the field to a department, and on account of this, as I described in chapter two, these objects are transformed from pieces of nature into scientific objects, and are treated and valued as such. Having travelled along this trajectory, and as long as their information remains associated with them, these things have the most potential to continue circulating, as is apparent from the notion of a hierarchy of use. Therefore, other researchers may use them, they may be used for teaching or be put on display, they may become museum objects, they may move on to different institutions, although they may also be discarded. Thus the important factor here is information and with the loss of associated information, such objects quickly become useless. While they may circulate in other forms such as teaching objects, the loss of scientific value is terminal, and unless they are particularly attractive, such objects are likely to either be used as consumables or simply discarded. However, and in spite of their origins (as I have shown in chapter four), the treatments and meanings of this things as they circulate is directly related to their use.

An interesting feature of scientific objects is that either the individual with whom objects are associated or the passing of time may alter their meanings and status. Thus, if an individual becomes particularly successful in their field, the objects that they collected and used may acquire additional importance on account of their association with that individual, as with the Beagle Collection, for example. A further, yet closely related factor is time, and while research material may become irrelevant after a period of time, if it survives for long enough, then such objects may become valuable as historical artefacts. Indeed, the combination of these two factors is particularly apparent in the Eagar Collection at the Manchester Museum whereby the association of the objects with their collector – Michael Eagar – has significantly affected their value.

Michael Eagar joined the Manchester Museum in 1945 as Assistant Keeper of Geology and subsequently occupied a variety of roles before retiring as Deputy director in 1987 (Bishop
Throughout his 42 years at the Manchester Museum, Eagar carried out research on Carboniferous non-marine bivalves, through which he amassed approximately 20,000 specimens (Nudds 2003: 341). As Bishop described;

…no bivalve will escape his scrutiny or hammer… once a humble and ephemeral subject unworthy of palaeontologists’ attention, [bivalves] are avidly levered out of their ancient resting places for a predestined home in the Manchester Museum (1986: 560).

The collection, however, is not used, and as the curator explained, has remained largely untouched for the last 30 years (interview with D. Gelsthorpe 24/11/10). In spite of this, within the Museum, the collection is afforded special treatment. The collection – known as the Eagar Collection – remains a discrete entity within the museum’s larger collections, and is stored in “…a dedicated Eagar Room” (Nudds 2010: 10). The duration of Eagar’s association with the Museum and the size and importance of the collection that he created meant that: “Eagar’s name became synonymous with non-marine bivalves and with The Manchester Museum” (Nudds 2003: 341). While Alberti explains this as the way in which “the dedication (or obsession) of the collector is embedded in the meanings of the objects, and they remain connected with those who found them” (2009: 107), I believe that this is also partly due to the fact that Eagar is still remembered by individuals associated with the museum. The collection has become more than just scientific, more than just historical, and more than just the ‘Eagar Collection’ as a material link to the individual, it has also become cultural.127

This complex status makes it a challenging collection to deal with because it is fundamentally a research collection but in order for this value to be realised, it must be researched, however, this use is not necessarily facilitated by the historical and cultural values that the collection has acquired. In an attempt to maximise its potential, the curator looked into transferring the Eagar Collection to an institution where it would be actively used for research; where it could stand a chance of fulfilling its latent potential (interview with D. Gelsthorpe 24/11/10). However, as a result of the hostility and negativity that the curator encountered in making such enquiries, the idea of transferring the Eagar collection was not pursued any further (ibid.). In this sense, and as the negative reaction suggests, the Eagar Collection must also be understood in terms of not just Michael Eagar, but also the other individuals who remember him, and who remain closely associated with the institution. Therefore, as well as Eagar becoming embedded within the collection on account of his direct involvement with it, in order for such an association to persist, it is also vital to acknowledge the importance of other individuals who, through their continued memory of Michael Eagar through the collection, keep the material link alive.

At this point, it is useful to refer to Weiner’s work on the symbolic density of objects in which she observes that “objects that are especially dense circulate exceedingly slowly in comparison with less dense ones” (1994: 394). In this sense, we may understand the Eagar collection’s lack of mobility in terms of its density – the weight of its historical, cultural and

127 The same is true for ‘Percy the Plesiosaur’ at the Manchester Museum, as mentioned in section 5.2.1.
scientific values and meanings. By contrast, teaching specimens are low-density objects – they are treated as replaceable consumables – and are therefore considerably more mobile (disposable, even). Symbolic density, however, is not simply a matter of how replaceable something is, or whether it has been associated with someone famous, but may also gather over time.

In spite of their primarily functional purpose, departmental collections are not immune to acquiring additional values. For example, the archived collections at the University of Leeds are retained initially as guarantors or vouchers for research, although they more commonly provide a source of material for teaching. Over time, the research archive has acquired a collective value as it has come to represent the research history of the school, and as such, strengthens the department’s status as a research institution: “it’s almost like the evidence of our publication history” (interview with R. Finch 06/05/08). Here, while individual items may be moved from the research archive and circulate along various use-trajectories, the collective value of the archived research collection as a whole makes it particularly dense, as the school curator explained:

…if I turned round and said I was binning it [the archived research collection], people would say oh god no, you can’t chuck the collection away …there’s an expectation that we keep the collection, it’s very much seen as part of the school (interview with R. Finch 06/05/08).

This situation is contrary to Pomian’s observation that the removal of museum objects from the cycle of economic exchange - “their knowledge generating circulation” (te-Heesen 2007: 37) – renders them static (1988: 16 in; te-Heesen 2007: 37). In the case of the archived collections at the University of Leeds, it would seem that it is, in fact, the removal of material from circulation that increases their value.

As I have already suggested in the previous chapters, the objects contained in university earth science collections require management in order for them to remain useful, and this is apparent from the various strategies of containment and regulation that are enacted on these things as they come into being and become collection items (see chapters two and three). In this sense, and as this chapter has confirmed, these objects are naturally quite unruly, flighty and mobile; indeed, in certain circumstances, this characteristic becomes problematic, as we have seen when material is allowed to move freely, from departments to stores. However, to describe such heavy and durable objects as flighty and mobile seems strange; the materiality of these objects – their composition and physical form – is far from light and airy. As I have suggested throughout this chapter, this quality of heaviness may lead to all kinds of problems for those who are required to physically move these things about. So on one hand, they are slippery and transient, and on the other hand, they are cumbersome and unwieldy. It is with this paradox – the paradox of ‘mobile stones’ that I end the chapter because it is to this, along with all of the other contradictions that have emerged throughout this research, that I must now turn as I conclude this thesis.
Chapter 6: Conclusions

This thesis has set out to explore what happens when university earth science objects and collections are treated and understood as material culture. Having considered in detail the coming into being of earth science objects and collection items, explored the ways in which objects function, and examined their mobility, there are a number of matters to which I must turn my attention in this final chapter. Firstly, there are a number of loose ends that need to be tied up, namely, the four paradoxes that I have uncovered throughout this thesis. My first task, then, is to revisit these paradoxes, both in order to attempt to make sense of them, and consider their implications for this research. Having done this, my second task is to offer some concluding thoughts about the implications of treating university earth science objects and collections as material culture with reference to the themes that I set out to explore in the introduction. Before I continue, however, it is perhaps useful to pause for a moment in order to briefly revisit how this research came about.

6.1. Introduction

This research largely grew from a feeling that university earth science objects and collections had been taken for granite. Throughout this research I have attempted to move beyond their conception as objective scientific evidence, as devoid of culture, and as passive, inert, and neutral, and instead to try to find out what lies behind these assumptions. In order to understand how they are used, the meanings that become attached to them, and the ways in which they are valued, I have approached these things not simply as scientific or museological objects and collections, but also as cultural things in their own right in that they are brought into being, used, treated, manipulated, and retained by people within institutions. In this sense, I have treated these objects as ‘cultural’ in that they are part of the cultures of the earth sciences - as both an academic and museological discipline.

In talking of material culture, my intention has been to understand people-thing relationships, and fundamental to my interpretation of this relationship has been a belief that it goes beyond understanding objects merely as passive surfaces that reflect and represent feelings, values, meanings and thoughts of people. Indeed, in focusing on earth science objects, the importance and implications of the physical materiality of these things has also been central to my understanding of people-thing relationships. While I initially felt rather ill equipped to be tackling the matter of material culture, with hindsight, I believe that a background in the earth sciences has in fact provided a useful foundation for this research, allowing me to develop a distinct approach to material culture studies.

This research has developed and incorporated what I will call a geological mindset, which can be understood as follows. Firstly, and as Frodeman has observed: “the geologist
exemplifies... the *bricoleur*, the thinker whose intellectual toolbox contains a variety of tools that he or she selects as appropriate to the job at hand” (2000: x). In this sense, *the geological mindset* is interdisciplinary and open, rather than being limited by disciplinary boundaries. Secondly, as a science that is concerned with trying to untangle inherently complex systems, *the geological mindset* is naturally geared towards a relational understanding of objects. Finally, on account of the vast timescales involved in understanding the earth, a *geological mindset* accepts that objects, no matter how durable and inert they may seem, are always *actively* changing; in a continual process of becoming.

These three features can be seen to align the geological mindset with particular areas and themes within material culture studies. Indeed, *the geological mindset* corresponds to what Boivin describes as an ‘integrated approach’ to material culture, in that it brings together both the “methods and models for studying matter” that have emerged from the natural sciences, and the “research techniques and theories for dealing with people, including their behaviours, social formations, cosmological beliefs, and experience” that have been developed by the social sciences and humanities (Boivin 2008: 229).

While I believe that this research has largely benefited from my background in the earth sciences, it is important to acknowledge that the *geological mindset* is not without its faults – no pun intended – particularly with regard to ‘directionality’. While the earth sciences are often concerned with “reasoning back from the existence of clues towards a hypothesis to explain their presence and relationships” (c.f. Frodeman 1995 in; Parcell and Parcell 2009: 379), this research has, at times, attempted to move in precisely the opposite direction. Thus, rather than starting with a piece of evidence and trying to *explain* it by looking backwards, I have attempted to start at the beginning and *trace* the events and effects as they unfold; working forwards in time.\(^{128}\)

By examining in detail both the objects and the relationships in which they are embroiled, however, rather than leading toward a simple, straightforward conclusion, this thesis has in fact, on occasion, achieved the opposite. Indeed, in spite of my best efforts to discover simple underlying patterns, to reveal straightforward causes and effects, and to uncover clear-cut categories, what I have ended up with is a set of detailed observations that, in many cases, contradict each other, as is exemplified by the ‘four paradoxes’ to which I shall now turn my attention.

### 6.2. Paradoxical thinking

While the contradictions and complexities that have continually emerged throughout this thesis were initially rather unsettling, as this research has progressed, they have started to make more

\(^{128}\) This is by no means intended as a criticism; earth scientists do not necessarily have the luxury of starting at the beginning and working forward, so to speak, since the events and effects of interest to them are likely to have already happened (often millions of years ago). Rather, this observation has been made in order to acknowledge some of the challenges that have arisen from my background in the earth sciences.
Before I continue, however, it is perhaps useful to briefly revisit the four paradoxes that have emerged from this research.

1. In chapter two, it became apparent that the practices of selection, removal, and inscription that are enacted on objects during field collection, transform pieces of nature into scientific specimens. Thus, while earth scientists rely on the assumption that collected objects remain the same as they were in nature, detailed consideration of the coming into being of earth science objects revealed otherwise. Indeed, in collecting pieces of nature and bringing them inside, not only do these things lose their context, but they also lose the naturalness that earth scientists value. Thus, in considering the coming into being of earth science objects, chapter two revealed the paradox of unnatural nature.

2. In chapter three I turned my attention towards the coming into being of collection items. I suggested that, while collections provide a means of managing and stabilizing objects when they are not in use, in order to capture and contain earth science objects within collections, they must become ‘collection items’. Thus it became apparent that the practices of selection, processing, and storage do not preserve objects intact but rather transform them into something else. In considering the coming into being of collection items, I therefore discovered another contradiction: the paradox of stability through change.

3. Chapter four focused on the functions of university earth science objects and collections, where it became clear that meanings do not reside within objects, individuals, or the circumstances of an encounter but instead, emerge from the coming together of all of these elements. I benefited from adopting Peirce’s theory of signs in order to understand how, on many occasions, objects appeared to be able to communicate, as if by magic, yet on other occasions may simply confuse. While the polysemic nature of objects is vital for their use, their usefulness relies on their singularity.

4. Finally, in chapter five, where I considered the mobility of earth science objects, it became apparent that, in spite of their weighty and solid physical qualities, these things are surprisingly mobile. Indeed, this led to a fourth contradiction; the paradox of mobile stones.

Considered together, these four paradoxes share a number of common themes surrounding – to put it crudely – struggling with stuff. In this sense, the four paradoxes are not a problem to be resolved, and I therefore have no intentions of trying to ‘figure them out’ since to do so would have the effect of explaining them away. Indeed, and as Law and Mol have observed: “That which is complex cannot be pinned down. To pin it down is to lose it” (2002: 21). Instead, I want to leave them intact and focus my attention on what we can learn from them. By embracing the paradoxes - by accepting that they are not simply mistakes, confusions or misunderstandings – we are prompted to think about objects in a different way. This different way of thinking is aligned with a body of work arising from ‘the turn to enactment’ (c.f. Law 2004b: 6) within material semiotics.129

129 The turn to enactment has generated a distinct body of work within material semiotics (as introduced briefly in section 1.3.2.). In particular, such work has focused the how different practices enact different realities, and is
6.2.1. On enacting earth science objects

If we turn to enactment, the first implication is that we may rephrase the four paradoxes as follows:

1) **The paradox of unnatural nature**: Practices of selection, removal and inscription are ways of enacting objects as natural, and thus qualify them to function as ‘scientific objects’.

2) **The paradox of stability through change**: Practices of selection, processing and storage are ways of enacting collection items as stable and manageable.

   However, it is important to acknowledge that what counts as ‘stable and manageable’ is itself neither stable nor manageable. Rather what it means to be stable and manageable is continually emerging from the (constantly changing) circumstances within which collections exist. The various different types of collection that were encountered can therefore be understood as different ways of enacting objects as stable and manageable under distinct circumstances, and therefore:

   (a) Accessioned collection items are enacted as stable and manageable in practices of identification, recording, numbering, classifying, documenting, labelling and storing. However, these practices also enact accessioned objects as unique, important, valuable and authentic.

   (b) Teaching collection items are enacted as stable and manageable in practices of identification, numbering and storing, and the effects of these practices are that teaching collection items are enacted as common, typical and representative.

   In this sense, the practices of field collecting and making collections are perhaps more appropriately understood as ways of doing that enact earth science objects so that they are useful; in ways that enable these objects to exist and function outside of their natural origins – as ‘inside nature’.

3) **The paradox of singular polysemic objects**: While these things are polysemic, they are enacted and encountered as singular.

   (a) Scientific objects are enacted as ‘natural’, ‘objective’ evidence through research practices (i.e. distinct ‘ways of doing’).

   (b) Museum displays enact objects as singular and authentic through practices of arrangement, presentation and mediation.

   (c) Didactic objects are enacted as singular and authoritative through practices of presentation, arrangement, manipulation and contextualisation.

4) **The paradox of mobile stones**: When objects appear to ‘behave’ that is because they are being enacted in collections management practices: any sense of objects being mobile and flighty is the effect of other practices that enact objects differently.

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Concerned with the question of how these realities fit together (see: Law 2004b: 5-9). Work has focused on a diverse range of ‘objects’ ranging from medical conditions and practices (Law and Singleton 2005; Mol 1999; 2002a;2002b), and foot and mouth disease (Law and Mol 2008), to salmon farming (Law and Lien 2010; 2011) and social science research (Law and Urry 2004).
Figure 6a: Far from being inert, this photograph shows what can happen when we turn our backs. Here an object containing the mineral pyrite has been stored in damp conditions. As a result, the object has started to burn a whole in the bottom of the drawer (photograph taken at Southport Museum).

(a) Practices of collections management enact accessioned objects as dense, rigid, and manageable; this means that when they move, they do so slowly, carefully, and formally.

(b) In the absence of collections management systems, a variety of different practices (research, teaching, curatorial) may enact unaccessioned objects in any number of different ways.

The four paradoxes can, therefore, be understood to arise from the ways in which people struggle to collect, manage, use, and keep track of earth science objects. Indeed, and as this research has revealed on numerous occasions, earth science objects are therefore just as unruly, mutable, unstable, flexible, mobile, transient and slippery as they are manageable, immutable, inert, rigid, immobile, fixed and solid (see: Figure 6a). Thus, the apparent contradiction arises because, in order to enact objects in particular ways - whether as natural, stable, singular or controlled - it is necessary to acknowledge that such attributes are not inherent qualities that reside within objects themselves, but are, rather, effects of practices. So if objects are enacted in practices – if they emerge from the particular set of relations in which they are enacted – then it follows that different practices – different sets of relations – may enact different versions of an object. As Mol has observed; “the radical consequence of this is that reality itself is multiple” (1999: 74).130

130 To be clear, and as Mol is quick to point out; “this is not a matter of pluralism” (1999: 83), rather, what we are looking at is the quality of being more than one but less than many, since the different versions co-exist, and remain connected by somehow ‘hanging together’ (c.f. Mol 2002a: 55). Indeed, the ways in which they relate to each other are themselves variable; different versions may correspond, contradict, overlap, fuse together or include other versions (c.f. Law 2010: 184-5).
This consequence may sound radical, but it is precisely what happens when an object is ‘reinterpreted’ or ‘re-identified’. So instead of talking about objects as if they contain fixed attributes to be teased out and discovered - as we do when we suggest that a single object may be interpreted in numerous alternative ways – by talking about multiplicities, it becomes possible to acknowledge the emergent and complex ways in which we encounter and engage with objects. Indeed, this consequence is in keeping with the assemblage perspective that captures the continual unfolding of the broader circumstances within which objects and collections emerge. In this sense, it follows that as an object is encountered in different times, places and contexts, and with different intentions, through different eyes, and for different purposes, each encounter can be understood as enacting that object anew. These objects are not new in that they have no history or baggage (i.e. they are not plural), but rather in saying that they are enacted anew I mean that they are brought into being as distinct and different versions of that object.

In one sense, to talk of university earth science objects as multiple, unruly, unnatural and transient is rather challenging; these are hardly the qualities that come to mind when we think about these things or confront them in person. This, however, is to be expected when we focus our attention on apparently mundane and trivial things; things that we tend not to notice; things that we take for granted; things that we assume are beyond our control; or things that we just learn to live with. As we have seen, these objects have the capacity to frustrate, challenge and obstruct, to fascinate, intrigue and inspire, but also – and perhaps most often on account of their tendency to shrink into the background – they may simply go unnoticed.131

The four paradoxes therefore demonstrate the value of taking things seriously, particularly as a means of bringing to light some of the struggles and tensions that would otherwise be omitted or glossed over, and prompt us to think differently about the objects themselves, their effects, and our involvements with them. A ‘turn to enactment’ moves away from thinking about ‘reality as destiny’ (c.f. Law 2004a: 44) and is, instead, concerned with reality as open and relational; as shaped within practices; and as active, emergent, and multiple. As I see it, this way of thinking has important and practical implications for those who work with and use university earth science objects and collections.

6.2.2. On being mindful

…if realities are enacted, then reality is not in principle fixed or singular, and truth is no longer the only ground for accepting or rejecting a representation. The implication is that there are various possible reasons, including the political, for enacting one kind of reality rather than another, and that these grounds can in some measure be debated. This is ontological politics (Law 2004a: 162).

131 Indeed, when objects behave, their roles and effects generally go unnoticed, and this is particularly apparent in science since objects are often enacted in “practices that strive to efface themselves and bury their own traces” (Pickering 2010: 199).
As Law suggests in the quote above, once we start talking about multiplicity we are suddenly confronted with options, and it follows that if there are options then there may also be choices: this is what ontological politics is about. So, the first point that I want to make is that this way of thinking about objects urges us to be mindful and aware of our own involvement with objects; both our intentional (conscious decisions and choices) and unintentional (personal preferences and beliefs of which we may be less conscious) effects. In talking of being mindful and aware, my point is that we need to accept that our involvement with objects is neither impartial nor innocent. When we make choices about how to enact objects, we should be asking ourselves why we are making these choices, what difference we are making, and whether there are other options.

This is particularly relevant when it comes to the use-trajectories along which different types of objects may travel, and therefore, this type of mindfulness may help curators to decide whether or not an object should / could be used for particular purposes. Take, for example, an object that, through various research practices, is enacted as objective. Being enacted as objective will not prevent the object from also being used for teaching purposes, or being incorporated into a departmental collection. Furthermore, a research object may also be ideally suited for entry into a museum collection since the practices that enact objects as objective (such as documentation and analysis) correspond with museum practices that enact objects as authentic and valuable. If, however, we try moving the other way and think about using a museum object for research, it may be more challenging since practices (such as preservation) that enact museum objects as authentic and valuable are assumed to be incompatible with research practices such as destructive sampling. Rather than making assumptions, however, being mindful may lead a curator to ask whether the object would become any less authentic if a sample was removed from it, or whether its involvement in research would in fact enhance the object’s value and authenticity: Does value always lie in the preservation of the pristine object?

To be clear, this is not to suggest that we are ever in full control of objects or their effects, as we have seen throughout this thesis, and as the assemblage perspective revealed. This is particularly apparent when it comes to the physical properties of objects, which may significantly limit and constrain both the practices that are enacted on them, and their effects.132 Most obviously, the different ways in which objects may be used depend, to a certain extent, on the physical properties of the objects themselves. So, for example, an impure calcite specimen could not be used to calibrate a mass spectrometer since its impurity would prevent it from being capable of the function. On a more subtle level, however, the physical properties of objects may influence the practices that are enacted on them. For example, an asbestiform mineral requires different practices of storage (i.e. in a sealed container) to a radioactive specimen (i.e. in a lead-lined room) or a collection of cut diamonds (i.e. in a secure locked

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132 Once we acknowledge the constraining or enabling effects of the physical properties of objects, we may better understand ‘symbolic’ associations (see: Section 1.1), as more than just arbitrary signs. Indeed, once we move away from treating objects and materials as passive surfaces, as Boivin has observed, “meanings emerge out of specific encounters between embodied minds and the physical properties of the material world” (2004b: 64-5).
cabinet), but these properties do not prevent the objects from being stored, they simply require different practices of storing, and this relates to the second point that I want to make.

Since we are never fully in control of either the objects or the practices within which they are enacted, we should also be mindful and aware that the effects and consequences of objects may be unpredictable and unexpected. Therefore, once we start to talk about multiple versions of objects, we must also acknowledge the alternatives: “every time a practice selects it is at the same time backhandedly acknowledging those others” (Law and Lien 2010: 9). In this sense, enacting objects as natural / authentic / objective / stable / singular / controlled ‘backhandedly acknowledges’ their unnaturalness / inauthenticity / subjectivity / instability / multiplicity / unruliness. In acknowledging these ‘others’, we may become more aware that there are different ways of enacting objects, and this is particularly important when it comes to using objects as ‘illustrations’ such as when objects are displayed in museums. Indeed, such an understanding may usefully alert us to the variety of different ways that visitors may enact objects, and the extent to which they may or may not correspond with our intentions.

Take, for example, a replica dinosaur skeleton such as the T-rex at the Manchester Museum. This object is displayed in a museum, alongside a text panel that explains that the object is a cast. In spite of this, visitors often enact the object as authentic and natural because they do not read the text panel: since they are unable to touch the object in order to confirm what it is made of, they assume that it must be real because it is in a museum. Here, we can see how unintended consequences may have nothing to do with an object itself, or even the practices of display, but instead, arise from the context in which the object is encountered – a museum - and the assumptions that visitors may hold about such institutions. And this is where Peirce’s theory of signs comes into play, as it provides a way of understanding the different relationships between objects and their signs, and the importance of the ‘personal context’ when it comes to interpretation. The status of ‘the museum’ as a ‘truth-spot’ – as a place of credible, authentic, trusted knowledge – may therefore have an effect on the ways in which visitors enact objects. In this sense, we may need to ask questions such as whether it matters that visitors regularly believe that the replica object is in fact real, natural and authentic, or whether replica objects should even be displayed in museums, and if so, whether there are ways of doing it either better or differently.

Our lack of full control over objects is perhaps most apparent when objects are used to intentionally deceive others such as when fake objects are enacted as natural and authentic, usually for financial reasons. Even this type of practice, however, is not necessarily a simple matter. For example, in 1999 a Chinese feathered dinosaur fossil was acquired by a museum in North America, and it was only after an announcement of its discovery had been published, that the object was identified as a fake. However, in this case, the object had been ‘faked’ by constructing a specimen from two different fossils - the front end belonging to a bird, and the back end belonging to a dinosaur – and while the composite object was a fake, the two parts in

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133 Nicholas Thomas has made a similar point with particular reference to role of the curator (2011).
isolation were genuine and authentic; indeed, they were subsequently identified as two new species (see, for example: Martill 2005; Padian 2000).

In this sense, while we should be mindful of our involvement with objects since it is never entirely innocent, at the same time, we should also be mindful of unintended consequences because we are never fully in control. Indeed, this complex and entangled relationship with objects is precisely why people do struggle with stuff, and why tensions may arise when they attempt to enact objects in certain ways. In prompting us to think differently about university earth science objects and collections, the four paradoxes that have emerged from this research suggest that it is useful to treat these things as material culture. Indeed, the perspective that has been developed in doing so has practical implications for those who work with and manage earth science objects and collections. However, while I have thus far largely focused on the practical implications, I shall now move on to illustrate some of the theoretical consequences that arise from treating university earth science objects and collections as material culture.

6.3. On getting the material culture treatment

This research set out to explore the implications of extending the theories and methods of material culture studies to university earth science objects and collections. While the matter of exploring university earth science objects and collections using the theories and methods of material culture studies has been dealt with in the four thematic chapters, in this final section, I turn my attention towards the implications. As I have mentioned in the previous section, there are practical implications of this approach, particularly surrounding the matter of ‘mindfulness’, and this is of interest, not simply to those who work with earth science objects and collections, but those who work with all objects and collections more broadly.

On one hand, there is a certain extent to which the implications of this research are in the hands of those who read this thesis. On the other hand, it is up to me to provide the reader with a sense of what I feel that this thesis has to offer, and this final section, I shall attempt to do this with reference to some of the themes and question that I set out in the introduction. I will start by suggesting that while university earth science objects constitute material culture, they are perhaps better understood as a distinct type. I will then move on to highlight some of the ways in which this research contributes to our understanding of the cultures of the earth sciences, before considering what this research has revealed about collections. Finally, this thesis will close with some broad concluding thoughts.

6.3.1. Earth science objects as material culture

Within the geological tradition (see: Section 1.4), the naturalness and authenticity of university earth science objects has largely been taken for granted on account of their origins in nature. In one sense, if ‘naturalness’ is about not being artificial, and if ‘authenticity’ is about not being fake, then I agree earth science objects are indeed natural and authentic: they are “natural
nature objects", “the real thing” (Jakubowski 1997: 85), and “ideal expressions” (Doughty 1992: 514). However, it seems to me that this way of understanding objects is not particularly helpful since it not only limits objects to either one binary opposite (natural / real / ideal) or the other (artificial / fake / inferior), but it also assumes that the distinctions are themselves fixed and clear cut. In this sense, such a simplistic understanding is problematic since it fails to acknowledge the complexity that has been revealed throughout this research, leaving us with the impression that we are simply dealing with inert, passive and neutral lumps of stuff.

By treating these things as material culture, it has become clear that such assumptions fail to take into account what being collected (and also subsequently used and managed), actually does to an object. If, as I have suggested, we talk about objects as being continually enacted in webs of relations, then asking whether they are natural / real / ideal seems to miss the point. By moving away from the assumption that such properties reside within objects, we have more usefully turned our attention towards the practices that enact them in particular ways. As I have shown in chapter two, for example, careful attention to personal accounts of the collecting process and the information that is recorded at the time of collecting, suggest that field collecting is not simply a matter of impartial and detached sampling. Rather, the particular object that is collected is tangled up in a complex web of relations that concern not only what I referred to the pragmatics of collecting, but also the collecting context. As I have suggested, this approach reveals that collecting is an act of negotiation between the collector – their expectations, requirements, strength and judgement – and the object being collected – the surroundings, available tools, the weather and numerous other factors. But if we move away from the assumption that earth science objects are simply natural, real, and ideal on account of their origins in nature, where does this leave us? Are we any better off talking about these things as cultural artefacts?

On one hand, earth science objects are cultural artefacts on account of the human involvement in their coming into being and their subsequent existence. In this sense, they can be understood on the same terms as any artefact made from a raw natural material, since the processes of selection and collection by an individual necessarily transform pieces of nature into cultural artefacts. So just as an earth scientist may select and remove a piece of rock from an outcrop as a source of raw material from which to make thin sections or multiple hand-specimens, a different individual may similarly select and remove a piece of rock from an outcrop as a source of raw material from which to make an arrowhead. Understood on these terms, there is little difference between thin sections and arrowheads because both objects are similarly selected and transformed by individuals for particular purposes. It therefore follows that these objects constitute material culture and can therefore be studied as such.

On the other hand, however, and while I am not denying that the collecting process significantly affects the meanings, uses and values of objects, it seems to me that to classify university earth science objects alongside flint arrowheads, or malachite beads and pendants made from fossilized sharks teeth for that matter, risks oversimplifying the situation. These
objects are different from other man-made artefacts, and it seems to me that what sets them apart is their purpose: these things are collected precisely because of their origins in nature. Indeed, what earth scientists are trying to capture when they collect samples is exactly this naturalness. So while an object may be collected because of its hardness, shape, colour, composition or any one of the multitude of properties, it is not because these properties make it useful as a raw material from which to create something else like an arrowhead, beads or a pendant, rather it is the properties themselves - as evidence or illustrations of geological processes, evolution or ancient environments, for example – that are being collected. Or to use Peirce’s terms, it is because they are indexical signs. In this way, the rocks, minerals and fossils in a university earth science collection cannot be understood in the same way as a flint arrowhead, a malachite bead, or a sharks-tooth pendant in an archaeology collection, and neither would they be treated in the same way.

This research has suggested that university earth science objects constitute a distinct ‘type’ of material culture on account of their naturalness. The naturalness to which I refer is not, however, simply about originating in nature, but is perhaps more to do with the practices that enact these things as a certain kind of natural object. This seems to relate to their status as scientific objects, and the value that is placed on naturalness as a means of constructing objectivity; if objectivity is about withstanding interrogation (c.f. Shanks and Hodder 1995: 19), then it makes sense to collect objects in a way that, in Latour’s words, is traceable (1999b: 69) back to nature. This research has revealed some of the ways in which earth scientists attempt to capture and retain nature through the collecting process, and has suggested that the act of collecting is perhaps more negotiation than it is mastery. In this sense, what I have discovered about the coming into being of earth science objects can be seen to align field collecting with the archaeological process of excavation (on which Lucas 2012 provides a detailed contemporary analysis), and it follows that this common ground opens up the opportunity for more dialogue between the two disciplines. Indeed, one may ask if there is scope for earth scientists to adopt a similar degree of reflexivity about field collecting as is apparent in archaeology with regard to excavation? Would such a reflexive approach have implications for the validity or authority of their work?

There is significant scope for further research. Further research may therefore explore the extent to which all natural objects fall into the same category, or whether there are other different ‘types’. Indeed, do all earth science objects (both within and outside of academia) fall within the same category? I also believe that there is much more to be said about field collecting, and the ways in which earth scientists are simultaneously detached from- and engaged with- their objects of study (c.f. Candea 2010). This way of thinking about earth science objects as material culture is, however, largely concerned with their coming into being, and therefore, is just one way of understanding these things. As I will now move on to consider, we may further expand our understanding of these things by considering their treatment after they have been collected, both within academic departments and museums.
6.3.2. The cultures of the earth sciences

By treating university earth science objects and collections as material culture, I have been able to discover more about the cultures of the earth sciences, and the position that objects occupy therein. By observing and interviewing some of the people who work with and use these things, it has become apparent that in various different ways, objects are a vital element of the disciplinary culture. Indeed, this research has revealed the variety of object-related practices that lie at the heart of the discipline. Furthermore, while objects are used for both teaching and learning, research and display, there are also implications; not only must these things be collected, but they must also be managed and stored: it is not just a matter of use – it is also a matter of finding and keeping (c.f. Kohler 2007). In this sense, while technologies and techniques have changed, the underlying relationship between the discipline and its objects has remained consistent since its early development (as Knell (2000) has explored in detail).

While this research has suggested that, in spite of various disciplinary developments, objects remain a central feature of the earth sciences, the extent to which this constitutes being ‘a collecting science’ is, however, less clear. For example, Kohler has suggested that collecting sciences are those disciplines that “…still depend on collecting objects in the field and on large permanent collections” (ibid: 431). Based on this distinction, Kohler identifies palaeontology as a collecting science, but goes on to explain that:

Geology and mineralogy are other field sciences in which collecting and classifying natural objects were once central practices, before being largely replaced by observing and measuring — that is, by gathering data rather than things. The exception is stratigraphic geology, which still requires collections of fossils (as well as geophysical and geochemical data) gathered in the field, and is likely to remain a collecting science (ibid.).

This, however, means that with the exception of palaeontology and stratigraphic geology, the earth sciences constitute an ‘ambiguous type’ of science:

…whose data return from the field embodied in objects… But unlike bird skins, fossils, or potsherds, such [items] …have no intrinsic value as objects: they are simply unprocessed data, and in yielding up those data they are used up (ibid: 432).

This distinction is particularly interesting because it implies that such objects ‘have no intrinsic value’ and are ‘simply unprocessed data’ that gets ‘used up’. Indeed, this relationship with objects is perhaps more relevant to the treatment of objects in academic departments where objects are largely retained for functional reasons. However, even this is problematic because, as we have seen, objects do acquire values other than those relating to their scientific use – whether this is intentional or not. Furthermore, while departments do not tend to hold objects in collections on a permanent basis with a view to their preservation, this is a function of museums. Indeed, this need to retain objects – the matter of keeping - remains central to the earth sciences, and in this sense, Kohler seems to miss the point when he suggests that only palaeontology and stratigraphic geology count as collecting sciences. Nonetheless, he goes on to make an important point that requires further attention.
According to Kohler; “dependence on found objects engenders a distinctive moral economy of data” (ibid: 449). As I see it, this is a vital feature of the earth sciences:

Collections are an intellectual commons on which all producers depend, and the owners or keepers of collections are understood to be responsible for keeping them in good order and accessible to users. These moral precepts doubtless reflect the fact that important collections tend to end up in public museums. But I think they also derive from the reality that found objects, unlike manufactured data, are a unique and irreplaceable resource, the loss of which deprives all practitioners of the means of best practice (ibid: 449).

In referring to collections as a ‘moral economy of data’ and an ‘intellectual commons’, Kohler captures precisely what lies at the heart of the relationship between the earth sciences and objects / collections / museums. Again, I think that it is precisely this relationship that further distinguishes university earth science objects as a distinct type of material culture.

The treatment of university earth science objects and collections as material culture encourages us to attend to the processes and practices involved in collecting, using and managing scientific objects. This insight can enhance our existing knowledge of the content, development, history and uses of collections, and may help us to make informed decisions about the uses, treatment and status of objects in the future. We have also, however, discovered much about the cultures of the earth sciences, and the importance of this insight cannot be overstated considering their central role in our understanding of and responses to the changing planet on which we live.

There is much scope for further research into earth science objects and the complex and changing relationships in which they are embroiled, both in terms of individuals, institutions, and the discipline as a whole. This research has only considered UK case studies and therefore, there is also significant scope for exploring how the cultures of the earth sciences are ‘done’ in different parts of the world, and how objects are treated within them. Indeed, the lack of attention that has been paid to contemporary ‘collecting sciences’ has become all too apparent, and I feel that this research has demonstrated that the ‘university collection’ may provide a useful focus for such work. There is also significant scope for exploring the new techniques and methods that are being developed in fields such as palaeontology, where they are likely to impact on the relationship between individuals and objects. Finally, the matter of how the ‘ambiguous sciences’ such as atmospheric sciences, oceanography and glaciology, manage their objects may also be an interesting area to explore, as the relationships between individuals and objects – the notion of ‘the collection’ - is likely to be different from those sciences with more durable objects of study. This usefully leads on to the final section where I shall turn my attention towards ‘the collection’.

6.3.3. The cultures of collections

In focusing on university earth science objects and collections, this research has considered ‘the collection’ in both museums and academic departments. By exploring these two distinct
contexts alongside each other, it has become apparent that they share a number of common features, largely on account of departmental curators adopting collections management strategies that were originally developed in museums. Detailed consideration of the practices of making collection items – through selection, processing and storage – and the broader context in which collections exist led me, in chapter three, to suggest that we may more usefully understand the collection as a process, rather than as a fixed entity. Indeed, the assemblage perspective has provided a useful way of understanding collections as both affected and affective within larger assemblages, and also drew attention to the ways in which the practices of creating collection items can be understood to enhance the cohesion and stability of collections.

In spite of their similarities, however, the differences between museum and departmental collections are considerable, and this is largely related to their purposes. As I have shown, in departments, there is an understanding that the collections are there to be used and therefore, objects have a finite lifespan; this was apparent when we saw ‘important’ or ‘valuable’ objects being transferred to museums, rather than being retained by departments. By contrast, and in spite of the increasingly open-minded attitudes of many museum curators, museum collections are largely retained for preservation purposes. They are rarely used and when they are, there are various procedures, forms and policies that must be followed. In this respect, the collections that exist in museums and departments are noticeably different, and this is most apparent when both types of collection exist within the same institution, perhaps in the same building, like at the Sedgwick, or maybe over the road, as is the case in Manchester. In such cases, there are more than likely vast numbers of duplicate objects that are physically ‘the same’ but that, on account of their location, are treated and valued in different ways. This research has therefore illustrated the extent to which the collection itself may affect objects, and by expanding the scope of this research beyond the museum, it has become clear that there are many different ‘types’ of collection, each of which enacts objects in distinct ways.

In exploring ‘the collection’ in both museums and departments, this research has, however, faced a number of challenges. For example, while the museological literature is useful for considering museum collections and displays, when it comes to the uses and treatment of objects in departments, I have found little of any relevance. By contrast, the literature from science studies has been particularly valuable for considering the treatment and uses of objects in departments, but has little to say about collections. In this sense, the existing literature tends to widen the gap that exists between these two types of collection.\(^\text{134}\) I do not, however, think that the differences are irreconcilable. Indeed, I hope that this research provides an initial bridge between the two worlds that seem so distant yet, in many cases, are separated only by a door or a road.

\(^{134}\) A handful of authors have started to bridge this gap (see, for example Gisler (2010), Meyer (2011), Maurstad (2012), Patchett (2008), Ellis (2008), and Wyše (2009), amongst others), however such work is the exception rather than the rule.
While I do not believe that it would be particularly useful for collections to form the basis of a new discipline (as suggested by Pearce), I do believe that for collections to remain the remit of museology (as suggested by Macdonald), there is much work that needs to be done. To start with, museology is a challenging discipline in itself, since it is not just about institutions, but is also inseparably about the distinct disciplinary cultures that exist around individual collections. When it comes to collections, museological research will tend to be discipline-specific and this is unavoidable. However, what is avoidable is the lack of attention that is paid to certain types of collection. Firstly, and as Conn observes:

>a more thorough examination of the history and practice of science museums will yield a different set of questions about the nature of museums, about the relationship between knowledge and display, and about museums and the public than has been asked thus far (2010: 5).

Thus, in order to ensure that museological research is representative of the sector as a whole, and considering that natural science objects account for approximately two thirds of the material in UK museum collections,\textsuperscript{135} it is vital that more theoretical attention is paid towards natural objects and collections. Secondly, if museology is to remain relevant, as Macdonald wrote six years ago, it needs to expand “beyond the museum as a physical site” (2006a: 95). To this I would add - with specific reference to the natural sciences – there is also an urgent need to focus on contemporary collections and collecting, and to expand our horizons beyond the more popular areas of natural history.

In one sense, this research is timely, since only in recent years have material culture studies developed ways of thinking about objects that are not simply concerned with their ability to represent and symbolize other things. While this way of thinking about objects is not entirely redundant, when it comes to scientific objects, it is perhaps less appropriate. Interestingly, natural history collections seem to lend themselves to such ways of approaching material culture, and this is likely to relate to the emphasis that is placed on the uses of museum natural history objects – their display and presentation as opposed to their active use as scientific evidence. While material culture studies have started to move beyond the ‘representational impulse’, this way of thinking about objects remains prominent in museology. Indeed, this may be explained in terms of the historical relationship between museums and material culture:

…the representational impulse in material culture studies has resulted from efforts to fix the meaning or social use of objects in particular moments in time. This is an old complaint about ethnographic and archaeological museums, but is also one that can be extended to mainstream material culture studies (Hicks 2010: 81-2).

In order to overcome this tendency to treat objects as static, it has proved beneficial to adopt methods and techniques such as the assemblage perspective (which has allowed us to

\textsuperscript{135} Based on figures from the DOMUS report of collection sizes (1999), there are 99.95 million items in Natural science (natural history + geology) collections compared to 52.15 million items in the remaining collection types (Archaeology, Social history, Fine art, Transport, Science / industry, Decorative / applied arts, Numismatics, Costume / textiles, Ethnography, Agriculture, Military, Personalia, Maritime, Medicine, Music, Oral history, Arms + armour). (DOMUS report, cited in: Keene 2008: 81)
capture the continual unfolding of events) and material semiotics (which similarly captures the relational and emergent nature of objects). While such approaches may be found in contemporary material culture studies, they may challenge traditional museological ways of thinking about objects. Indeed, it has become apparent throughout this research that much of the insight that may be gained from other disciplines – in this case, from science studies – may not necessarily sit well with the ways in which museology has tended to understand its objects. For example, in order to capture the ways in which the functions of objects may relate to their material qualities, I have found it useful to adopt a Peircian approach, which goes against the conventional Saussurian semiology that is used in museology. Furthermore, and as I mentioned in the introduction, within museology, there has been a general aversion towards the attribution of anything other than ‘secondary agency’ to objects. Rather than starting this research from such a position, I have attempted to leave the matter open, and as a result, I have suggested that such a limited view of objects is not only inaccurate but also unhelpful.

This research has approached university earth science objects and collections with an ‘open mind’ – privileging neither people nor objects – in order to explore what they are, why they are, and how they are. I have suggested that these things are neither passive nor neutral but are rather actively and continually emerging from - and in relation to - their circumstances (which are themselves continually unfolding). In taking this approach, I feel that I have been able to acknowledge the more active involvement of objects in their uses, meanings, and values, and have furthermore been able to reveal some of the ways in which objects may challenge us.

This research has demonstrated that the application of the theories and methods of material culture studies to university earth science objects and collections is not only feasible, but is also worthwhile: I have discovered some of the nuances of object-related practices in the earth sciences and revealed an otherwise hidden world that is both significant and genuinely interesting; not just for myself, but for those who work with, use and manage these objects and collections, as well as for those who theorize them. By focusing in detail on personal accounts and direct observations, I also hope to contribute a piece of research that is firmly grounded in the practical day-to-day worlds of both university museums and academic department. By focusing on object-related practices in the earth sciences, the materiality of the materials has necessarily been fore-grounded. Indeed, the approaches that I have adopted, such as the Peircian semiotic and assemblage theory, demonstrate that it is possible to theorize the meanings of objects in a way that acknowledges the objects themselves, rather than simply their context. By attending to both the material and the cultural, I have revealed that an understanding of object-related practices in earth science museums and departments requires that both of these factors taken into account. In this respect, this research contributes to the growing body of work that seeks to bring the ‘material’ back into material culture studies.

136 Both in general, such as Conneller’s ‘Archaeology of Materials’ (2012), and with specific reference to museology such as the recent edited volume ‘Museum Objects: Experiencing the properties of material things’ (Dudley 2012).
# Appendix 1. Tables listing UK university earth science collections.

## Appendix 1a. Institutions identified using existing surveys

<table>
<thead>
<tr>
<th>University</th>
<th>Collection</th>
<th>1: Source</th>
<th>2: Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bath Spa University</td>
<td>30k</td>
<td>28</td>
<td>N/A</td>
</tr>
<tr>
<td>Brunel University</td>
<td>30k</td>
<td>28</td>
<td>N/A</td>
</tr>
<tr>
<td>Bournemouth University</td>
<td>32k</td>
<td>28</td>
<td>N/A</td>
</tr>
<tr>
<td>Coventry University</td>
<td>60k</td>
<td>22</td>
<td>N/A</td>
</tr>
<tr>
<td>Imperial College, London</td>
<td>100k</td>
<td>27</td>
<td>Department of Earth Science and Engineering</td>
</tr>
<tr>
<td>Nottingham Trent University</td>
<td>50k</td>
<td>45</td>
<td>School of Architecture, Design and the Built Environment</td>
</tr>
<tr>
<td>Oxford Brookes University</td>
<td>100k</td>
<td>54</td>
<td>Closure 2003</td>
</tr>
<tr>
<td>Queen's University, Belfast</td>
<td>60k</td>
<td>22</td>
<td>Closure 2001</td>
</tr>
<tr>
<td>Royal Holloway, University of London</td>
<td>15k</td>
<td>29</td>
<td>Department of Earth Sciences</td>
</tr>
<tr>
<td>Staffordshire University</td>
<td>20k</td>
<td>36</td>
<td>Closure 2001</td>
</tr>
<tr>
<td>The Open University</td>
<td>40k</td>
<td>53</td>
<td>Department of Earth Sciences</td>
</tr>
<tr>
<td>University College London</td>
<td>40k</td>
<td>49</td>
<td>Department of Earth Sciences</td>
</tr>
<tr>
<td>University of Aberdeen</td>
<td>50k</td>
<td>44</td>
<td>Department of Geology and Petroleum Geology</td>
</tr>
<tr>
<td>University of Birmingham</td>
<td>150k</td>
<td>50</td>
<td>School of Geography, Earth &amp; Environmental Sciences</td>
</tr>
<tr>
<td>University of Bristol</td>
<td>100k</td>
<td>41</td>
<td>Department of Earth Sciences</td>
</tr>
<tr>
<td>University of Cambridge</td>
<td>35k</td>
<td>41</td>
<td>Department of Earth Sciences</td>
</tr>
<tr>
<td>University of Derby</td>
<td>20k</td>
<td>38</td>
<td>Department of Geographical, Earth &amp; Environmental Sciences</td>
</tr>
<tr>
<td>University of Dundee</td>
<td>118k</td>
<td>6</td>
<td>Closure 2008</td>
</tr>
<tr>
<td>University of Durham</td>
<td>25k</td>
<td>69</td>
<td>Department of Geological Sciences</td>
</tr>
<tr>
<td>University of Edinburgh</td>
<td>119k</td>
<td>42</td>
<td>School of Geosciences</td>
</tr>
<tr>
<td>University of Exeter</td>
<td>5k</td>
<td>35</td>
<td>Camborne School of Mines</td>
</tr>
<tr>
<td>University of Glasgow</td>
<td>90k</td>
<td>41</td>
<td>Division of Earth Sciences</td>
</tr>
<tr>
<td>University of Gloucester</td>
<td>80k</td>
<td>55</td>
<td>Department of Natural and Social Sciences</td>
</tr>
<tr>
<td>University of Hull</td>
<td>60k</td>
<td>65</td>
<td>School of Geology and Earth Resources</td>
</tr>
<tr>
<td>University of Leeds</td>
<td>109k</td>
<td>38</td>
<td>Department of Earth Sciences and Geoscience</td>
</tr>
<tr>
<td>University of Lancaster</td>
<td>200k</td>
<td>64</td>
<td>Department of Earth and Ocean Sciences</td>
</tr>
<tr>
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<td>75</td>
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</tr>
<tr>
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<td>140k</td>
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<td>School of Earth, Atmospheric and Environmental Sciences</td>
</tr>
<tr>
<td>University of Newcastle upon Tyne</td>
<td>150k</td>
<td>65</td>
<td>School of Civil Engineering and Geosciences</td>
</tr>
<tr>
<td>University of Northampton</td>
<td>110k</td>
<td>40</td>
<td>Division of Environmental Science</td>
</tr>
<tr>
<td>University of Nottingham</td>
<td>100k</td>
<td>41</td>
<td>Department of Environmental Science</td>
</tr>
<tr>
<td>University of Oxford</td>
<td>110k</td>
<td>55</td>
<td>Department of Earth Sciences</td>
</tr>
<tr>
<td>University of Portsmouth</td>
<td>87</td>
<td>67</td>
<td>School of Earth and Environmental Sciences</td>
</tr>
<tr>
<td>University of Reading</td>
<td>100k</td>
<td>69</td>
<td>School of Human and Environmental Sciences</td>
</tr>
<tr>
<td>University of St Andrews</td>
<td>110k</td>
<td>42</td>
<td>School of Geology and Geosciences</td>
</tr>
<tr>
<td>University of Sheffield</td>
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<td>62</td>
<td>Department of Environmental and Geospatial Sciences</td>
</tr>
<tr>
<td>University of Southampton</td>
<td>50k</td>
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<td>School of Ocean &amp; Earth Sciences</td>
</tr>
<tr>
<td>University of Strathclyde</td>
<td>111</td>
<td>64</td>
<td>School of Civil and Environmental Engineering</td>
</tr>
<tr>
<td>University of Westminster</td>
<td>36k</td>
<td>36</td>
<td>School of Applied Sciences: Environment and Geography</td>
</tr>
<tr>
<td>University of Worcester</td>
<td>36k</td>
<td>37</td>
<td>Applied Sciences, Geography and Anthropology</td>
</tr>
<tr>
<td>University of York</td>
<td>100k</td>
<td>101</td>
<td>Department of Environment</td>
</tr>
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</table>
Appendix 1b. Additional institutions identified through course searches

<table>
<thead>
<tr>
<th>University</th>
<th>Collection</th>
<th>1: Source</th>
<th>2: Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiff University</td>
<td>✓</td>
<td>✓</td>
<td>Department of Earth Sciences **</td>
</tr>
<tr>
<td>Edge Hill University</td>
<td>✓</td>
<td>✓</td>
<td>Department of Geography &amp; Geology</td>
</tr>
<tr>
<td>Heriot Watt University</td>
<td>✓</td>
<td></td>
<td>Institute of Petroleum Engineering *</td>
</tr>
<tr>
<td>Kingston University</td>
<td>✓</td>
<td>✓</td>
<td>School of Geological Sciences **</td>
</tr>
<tr>
<td>Lancaster University</td>
<td>✓</td>
<td>✓</td>
<td>Department of Environmental Science</td>
</tr>
<tr>
<td>Liverpool John Moores University</td>
<td>✓</td>
<td>✓</td>
<td>Department of Biological &amp; Earth Sciences</td>
</tr>
<tr>
<td>Swansea University</td>
<td>✓</td>
<td>3,000</td>
<td>School of Geography</td>
</tr>
<tr>
<td>University of Brighton</td>
<td>✓</td>
<td>1,000</td>
<td>School of the Environment*</td>
</tr>
<tr>
<td>University of East Anglia</td>
<td>✓</td>
<td>✓</td>
<td>School of Environmental Sciences*</td>
</tr>
<tr>
<td>University of Glamorgan</td>
<td>✓</td>
<td>✓</td>
<td>Division of Earth Space &amp; Environment</td>
</tr>
<tr>
<td>University of Greenwich</td>
<td></td>
<td></td>
<td>Natural Resources Institute</td>
</tr>
<tr>
<td>University of Plymouth</td>
<td>✓</td>
<td>✓</td>
<td>School of Geography, Earth and Environmental Sciences **</td>
</tr>
<tr>
<td>University of Ulster</td>
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<td></td>
<td>School of Environmental Sciences</td>
</tr>
<tr>
<td>University of Wales, Aberystwyth</td>
<td>✓</td>
<td>1,000</td>
<td>Institute of Geography and Earth Sciences</td>
</tr>
<tr>
<td>University of Wales, Bangor</td>
<td>✓</td>
<td>2,000</td>
<td>School of Ocean Sciences</td>
</tr>
<tr>
<td>University of the West of Scotland</td>
<td>✓</td>
<td>3,700</td>
<td>School of Engineering and Science</td>
</tr>
<tr>
<td>Institution Type</td>
<td>Institution</td>
<td>University</td>
<td>Collection Type</td>
</tr>
<tr>
<td>------------------</td>
<td>-------------</td>
<td>------------</td>
<td>----------------</td>
</tr>
<tr>
<td>M</td>
<td>Bath Spa University</td>
<td>School of Art and Design</td>
<td>Stratigraphic series, palaeontology, semi-precious stones and minerals</td>
</tr>
<tr>
<td>C</td>
<td>Birkbeck College, University of London</td>
<td>A department collection of around 30,000 specimens covering fossils, rocks, minerals and micropalaeontology (some now at UCL)</td>
<td>School of Earth Sciences</td>
</tr>
<tr>
<td>N</td>
<td>Bournemouth University</td>
<td>Conservation Collection: Large collection of rock samples and thin sections of many common rocks and minerals</td>
<td>N/A, Non-disciplinary department</td>
</tr>
<tr>
<td>C</td>
<td>Cardiff University</td>
<td>Teaching around 2,000 geology and research (around 10,000); active palaeontology research department, small display. Possibly no longer in use?</td>
<td>Department of Earth Sciences</td>
</tr>
<tr>
<td>N</td>
<td>Coventry University</td>
<td>Teaching collection</td>
<td>Department of Geography &amp; Geology</td>
</tr>
<tr>
<td>M</td>
<td>Edge Hill University</td>
<td>Teaching collection</td>
<td>Department of Geography &amp; Geology</td>
</tr>
<tr>
<td>P</td>
<td>Heriot Watt University</td>
<td>Teaching collection</td>
<td>Institute of Petroleum Engineering</td>
</tr>
<tr>
<td>C</td>
<td>Imperial College, London</td>
<td>The Murchison Museum of Palaeontology and Stratigraphy</td>
<td>Department of Earth Science and Engineering</td>
</tr>
<tr>
<td>N</td>
<td>Kingston University</td>
<td>Teaching collection Petrology, mineralogy specimens and thin sections</td>
<td>Geol / Geophysics &amp; Geo</td>
</tr>
<tr>
<td>P</td>
<td>Lancaster University</td>
<td>Evidence of teaching material but lack of details.</td>
<td>Department of Environmental Science</td>
</tr>
<tr>
<td>N</td>
<td>Liverpool John Moores University</td>
<td>Collection of rocks, minerals and fossils covering teaching, reference and reserve collections, some display</td>
<td>Department of Biological &amp; Earth Sciences</td>
</tr>
<tr>
<td>N</td>
<td>Nottingham Trent University</td>
<td>PALaeontology, mineralogy, petrology, thin sections, borehole core samples, maps and geographical preparations (much of which is research material) used for teaching and is displayed in labs transferred due to departmental closure</td>
<td>School of Architecture, Design and the Built Environment</td>
</tr>
<tr>
<td>N</td>
<td>Oxford Brooks University</td>
<td>PALaeontology, mineralogy, petrology, thin sections, borehole core samples, maps and geographical preparations (much of which is research material) used for teaching and is displayed in labs transferred due to departmental closure</td>
<td>School of Architecture, Design and the Built Environment</td>
</tr>
</tbody>
</table>
| University                  | Collection | Department / School Name | Course subjects (2008)
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Queens University, Belfast</td>
<td>C</td>
<td>Department of Earth Science **</td>
<td>Geol / Geolos / Enviro Geol / Environ Geol / Geosci / Planetary Geol / Phys Geol &amp; Geol / Petroleum Geol</td>
</tr>
<tr>
<td>Royal Holloway, University of London</td>
<td>C</td>
<td>Department of Earth Science **</td>
<td>Geol / Geolos / Enviro Geol / Environ Geol / Geosci / Planetary Geol / Phys Geol &amp; Geol / Petroleum Geol</td>
</tr>
<tr>
<td>Staffordshire University</td>
<td>N</td>
<td>Department of Geography</td>
<td>Environ Studie / Geosci / Nat Sci</td>
</tr>
<tr>
<td>Swansea University</td>
<td>C</td>
<td>Department of Geography</td>
<td>Environ Studie / Geosci / Nat Sci</td>
</tr>
<tr>
<td>The Open University</td>
<td></td>
<td>Department of Earth Science **</td>
<td>Geol / Geolos / Enviro Geol / Environ Geol / Geosci / Planetary Geol /Phys Geol &amp; Geol / Petroleum Geol</td>
</tr>
<tr>
<td>University College London</td>
<td>16c</td>
<td>Department of Earth Science **</td>
<td>Geol / Geolos / Enviro Geol / Environ Geol / Geosci / Planetary Geol /Phys Geol &amp; Geol / Petroleum Geol</td>
</tr>
<tr>
<td>University of Aberdeen</td>
<td>A</td>
<td>Department of Geology &amp; Petroleum Geology **</td>
<td>Geol &amp; Geolos / Geol and Petroleum Geol / Geolos</td>
</tr>
<tr>
<td>University of Birmingham</td>
<td>R</td>
<td>School of Geography, Earth and Environmental Sciences **</td>
<td>Geol / Resource &amp; Applied Geol / Environ Geol / Geol &amp; Biol / Geol &amp; Geog</td>
</tr>
<tr>
<td>University of Brighton</td>
<td>N</td>
<td>School of the Environment*</td>
<td>Geol / Geolos / Geol</td>
</tr>
<tr>
<td>University of Bristol</td>
<td>R</td>
<td>School of Geography, Earth and Environmental Sciences **</td>
<td>Geol / Resource &amp; Applied Geol / Environ Geol / Geol &amp; Biol / Geol &amp; Geog</td>
</tr>
</tbody>
</table>

Collection Description:
- Large geology collection amassed over 150 years. Much material transferred to Ulster Museum on closure of department but fossils (c. 30%) retained. Transferred to the School of Biology and Biochemistry and held in basement. The premises where the specimens should be available if geology is reinstated.
- Combined collections of Beddows, Kings and Chelsea College, covering rocks, minerals and fossils.
- A collection covering a wide range of geological material primarily built by staff for teaching purposes, much of which was transferred in 1984. Department closure c. 2007. Collections to Liverpool and The Potteries.
- Wellcome Museum: Small collection of rocks, minerals and fossils.
- Department of Geography.
- ICL Museums and Collections, Rock Room. An extensive collection of rocks, minerals and fossils collected from all over the world since the last 150 years. Accredited.
- Extensive collections of minerals, rocks and fossils, a selection of which is on display in corridors; act as a repository for research material in palaeontological, mineralogical and palaeontological nature. Accredited.
- Extensive collection of fossils, minerals and rocks dating back to 1810; national and international importance with a high proportion of type and figured and cited specimens. Includes teaching material as well as a number of important individual collections associated with eminent geologists and is available for students, schools and colleges, research workers, enthusiasts and anyone with an interest in, or desire to learn about, geology. Accredited.
- An extensive collection of mineral and rock specimens, fossils and geological maps from around the world.
- Collections of rocks, minerals and fossils specifically for use in practical classes. Those are stored in drawers in the teaching laboratories.
<table>
<thead>
<tr>
<th>University</th>
<th>Institution type</th>
<th>Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Cambridge</td>
<td>A</td>
<td>✓</td>
</tr>
</tbody>
</table>

**Collection Description:**
- Sedgwick Museum of Earth Sciences: The museum is open to the public and is used by local schools and students. The collection is regarded as one of the outstanding geological collections in the world and contains rocks, fossils, minerals, sediments, building materials, and decorative stones. These are essential to teaching and research in the department. It has been built up by donations, loans, bequests, and fieldwork and several thousand specimens are added per year. The collection is constantly used as a research source; the research output based on the museum collections is considerable linked, particularly, to the work of departmental research groups but also to the work of visiting researchers. Accredited
- A small collection of rocks, minerals, fossils, and thin sections retained by the department for teaching

**2: Department**
- Department of Earth Sciences
  - Course subjects: Geol, Geophys, Geosciences

**3: Teaching**
- Department accredited by the Geological Society

**4: Research**
- RAE 2008: 1.5 mil

**5: UGC Review**
- Large Mainstream

| University of Derby | M | ✓ |

**Collection Description:**
- Extensive collections of rocks, minerals, and fossils from all over the world

**2: Department**
- Department of Geographical, Earth, and Environmental Sciences
  - Course subjects: Geol, Geophys, Geosciences

**3: Teaching**
- Department accredited by the Geological Society

**4: Research**
- RAE 2008: 20k

**5: UGC Review**
- Large Mainstream

| University of Dundee | C | x |

**Collection Description:**
- Most material transferred to Glasgow University. The department's work is now based on material collected in Scotland.

**2: Department**
- Department of Geographical Sciences

**3: Teaching**
- Department accredited by the Geological Society

**4: Research**
- RAE 2008: 14k

**5: UGC Review**
- Small Mainstream

| University of Durham | 1c | ✓ |

**Collection Description:**
- Teaching, research and reference collection of rocks, minerals and fossils, with supporting map collection

**2: Department**
- Department of Geographical Sciences

**3: Teaching**
- Department accredited by the Geological Society

**4: Research**
- RAE 2008: 25k

**5: UGC Review**
- Large Mainstream

| University of East Anglia | P | ✓ |

**Collection Description:**
- Small unattached teaching collection and informal research collection

**2: Department**
- School of Environmental Sciences

**3: Teaching**
- Department accredited by the Geological Society

**4: Research**
- RAE 2008: 15k

**5: UGC Review**
- Large Mainstream

| University of Edinburgh | A | ✓ |

**Collection Description:**
- Cockburn Museum of Geology and Geophysics: Rocks, fossils, and minerals, maps, and slides for use in undergraduate teaching and research work. Displays of geology and geophysics, limited identification and loans service. All aspects of the collections are open to the public by arrangement. Accredited

**2: Department**
- School of Geosciences

**3: Teaching**
- Department accredited by the Geological Society

**4: Research**
- RAE 2008: 120k

**5: UGC Review**
- Large Mainstream

| University of Exeter | C | ✓ |

**Collection Description:**
- Camborne School of Mines Geological Museum: The museum houses a highly significant and comprehensive systematic mineral collection, together with suites of minerals and host rocks from important mining areas all over the world. (closed except for occasional visits)

**2: Department**
- Camborne School of Mines

**3: Teaching**
- Department accredited by the Geological Society

**4: Research**
- RAE 2008: 8k

**5: UGC Review**
- Large Mainstream

| University of Glamorgan | N | ✓ |

**Collection Description:**
- Evidence of teaching material but lack of details.

**2: Department**
- Division of Earth, Space & Environment

**3: Teaching**
- Department accredited by the Geological Society

**4: Research**
- RAE 2008: Division of Earth Sciences

**5: UGC Review**
- Small Mainstream

| University of Glasgow | A | ✓ |

**Collection Description:**
- Hunterian Museum: Rocks, Minerals and Geomorphology. The rock collections include much material resulting from the research activities of Glasgow University geologists over the past two centuries. The fossil collections are among the largest in the UK. Accredited

**2: Department**
- Department of Geoscience

**3: Teaching**
- Department accredited by the Geological Society

**4: Research**
- RAE 2008: 80k

**5: UGC Review**
- Large Mainstream
<table>
<thead>
<tr>
<th>University</th>
<th>Location</th>
<th>Collection Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Hull</td>
<td>C</td>
<td>P: Collecting and studying rocks and fossils including minerals, fossils, and other geological materials.</td>
</tr>
<tr>
<td>University of Leeds</td>
<td>R</td>
<td>C: Collection of rocks, minerals, and fossils, covering a wide range of geological period and type.</td>
</tr>
<tr>
<td>University of Manchester</td>
<td>M</td>
<td>R: Collection of rocks, minerals, and fossils, covering the entire geological period and type.</td>
</tr>
<tr>
<td>University of Newcastle upon Tyne</td>
<td>C</td>
<td>M: Collection of rocks, minerals, and fossils, covering a wide range of geological period and type.</td>
</tr>
<tr>
<td>University of Northampton</td>
<td>M</td>
<td>Selection of rocks, minerals, and fossils, covering the entire geological period and type.</td>
</tr>
<tr>
<td>University</td>
<td>Institution collection</td>
<td>Department / School Name</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>------------------------</td>
<td>------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cambridge</td>
<td>A</td>
<td>Department of Earth Sciences</td>
</tr>
<tr>
<td>Oxford</td>
<td>A</td>
<td>Department of Human and Environmental Sciences *</td>
</tr>
<tr>
<td>University of Reading</td>
<td>C</td>
<td>School of Geography, Earth and Environmental Sciences **</td>
</tr>
<tr>
<td>Plymouth</td>
<td>N</td>
<td>School of Earth and Environmental Sciences **</td>
</tr>
<tr>
<td>University of Portsmouth</td>
<td>N</td>
<td>School of Geology and Geosciences **</td>
</tr>
<tr>
<td>University of St Andrews</td>
<td>A</td>
<td>Department of Environmental and Geoscience</td>
</tr>
<tr>
<td>University of Sheffield</td>
<td>R</td>
<td>Department of Environmental and Geoscience</td>
</tr>
<tr>
<td>University</td>
<td>Collection</td>
<td>Department</td>
</tr>
<tr>
<td>------------</td>
<td>------------</td>
<td>------------</td>
</tr>
<tr>
<td>University of Strathclyde</td>
<td>P ✗</td>
<td>Department of Civil and Environmental Engineering</td>
</tr>
<tr>
<td>University of Ulster</td>
<td>P</td>
<td>School of Environmental Sciences</td>
</tr>
<tr>
<td>University of Wales, Aberystwyth</td>
<td>C ✔</td>
<td>Institute of Geography and Earth Sciences</td>
</tr>
<tr>
<td>University of Wales, Bangor</td>
<td>C ✗</td>
<td>School of Ocean Sciences</td>
</tr>
<tr>
<td>University of the West of Scotland</td>
<td>M</td>
<td>No evidence of collections</td>
</tr>
<tr>
<td>University of Wolverhampton</td>
<td>N ✗</td>
<td>School of Applied Sciences</td>
</tr>
<tr>
<td>University of Worcester</td>
<td>M ✗</td>
<td>Applied Sciences, Geography and Archaeology</td>
</tr>
<tr>
<td>University of York</td>
<td>P ✗</td>
<td>Department of Environment</td>
</tr>
</tbody>
</table>

- University types: A = Ancient University, C = Civic University, M = Modern University (former college), P = Plato Classical University, N = New University (former polytechnic), 16c = 16th Century University

- Institution types: A = Ancient University, C = Civic University, M = Modern University (former college), P = Plato Classical University, N = New University (former polytechnic), 16c = 16th Century University

- Collection Description: A substantial collection held by the school of ocean and earth science containing teaching, reference and research material, stored in teaching labs and various stores in the oceanography centre. Includes PETROS collection of mid ocean ridge gneiss rocks and BOSCORF sediment core collection.


- RAE 2008 rank (59): 9 (2.83)

- HEFCE eco-friendly?: Small interdisciplinary

- Regional Earth Science Collections Centre: Oxford

- Natural History Society collection: Rocks, minerals and fossils
Appendix 1d: References and Sources for Appendix 1

1a. Published sources
Standing Commission on Museums and Galleries (1968) Universities and Museums: Report on the Universities in Relation to Their Own and Other Museums. London: HMSO.

1b. Online sources
Cornucopia: www.cornucopia.org.uk/
FENSCORE: fenscore.man.ac.uk/cgi-bin/fensearch
UMAC worldwide database: http://publicus.culture.hu-berlin.de/collections/

2. Department sources
Committee of Heads of University Geoscience Departments: www.chugd.ac.uk/institutions.php
Geological Society Accreditation: www.geolsoc.org.uk/en/Education%20and%20Careers/Universities/University%20Departments
UCAS: www.ucas.ac.uk/

3. Teaching sources
UCAS: www.ucas.ac.uk/
Geology Rocks 2008/9 geology and related subjects undergraduate courses: www.geologyrocks.co.uk/articles/2008_9_uk_university_geology_and_related_subjects_degree_courses
Geology Rocks 2008/9 geology / geoscience postgraduate taught courses: www.geologyrocks.co.uk/articles/2008_9_uk_university_geology_and_related_subjects_degree_courses
2012 Rank: www.thecompleteuniversityguide.co.uk/league-tables/rankings?subject=Geology&y=2012
4. Research sources
RAE 2008: www.rae.ac.uk/results/outstore/RAEOutcomeFull.pdf
HEFCE QA Geology 1994/5: www.qaa.ac.uk/reviews/reports/subjectlevel/qo14_95_textonly.htm

5. UGC review resources

Note: *The implications of departmental grades with regard to collections were as follows:*

Type M
Departments should have at least a reference collection in the care of a full time curator.

ESCCs: These institutions with type collections of national importance require 1 curator for every 200k specimens and one conservator.

Non-ESCCs: Any type collections should be relocated to ESCCs or National / Local Museums.

Type I
Type and reference collections to be relocated to ESCCs or National / Local museums. Departments may retain collections (up to 20k specimens) in the care of 1 part time curator.

Type J
Collections should be restricted to materials used in teaching, no more than 10k specimens and requiring only periodic staff supervision. Any research material should be relocated.

Type P
All collections except those relevant to specialities allocated to department should be relocated.

Closures
All collections should be relocated.
Appendix 2. Project outline and consent form

Appendix 2a. Project outline to accompany consent form

How are natural objects attributed value?
Exploring the uses, meanings and values of university earth science collections

Hannah-Lee Chalk, hannah-lee.chalk@manchester.ac.uk
Center for Museology, School of Arts Histories and Cultures, The University of Manchester

Summary of research project
This research aims to question the assumption that University Earth Science Collections (UECs) are natural and objective in order to provide a new perspective based on their uses, meanings and values when treated as material culture.

University earth science collections include those belonging to both campus museums and academic departments.

University collections provide the ideal focus for this project because academic research in the earth sciences relies heavily on the notion of scientific objectivity and claims that its objects of study are natural.

Methodology
Because UECs remain largely untheorised and unresearched by museologists, it will be necessary to develop new tools and adapt existing methods. While conventional methods will be used to generate historical and quantitative information from archives and collection records, this project is primarily concerned with qualitative analyses of the uses and polysemic meanings of UECs.

Detailed primary data will be gathered using interviews and by observing objects and collections in use (i.e. by students, academics, public). The fieldwork will reflect the range of UECs by including both department collections and university museum collections.

Analysis and interpretation of data will be strongly informed by contemporary theory. In particular, I will incorporate museological methods with approaches to material culture studies.

Project Outline
Site visits

A selection of institutions will be visited in order to gather qualitative data related to four key themes, addressing the following broad questions:

**Theme 1: Selection**
- How and why are objects selected for field collection / entry into a collection?
- How are natural objects transformed into scientific specimens / collection items?
- What strategies are used to maintain notions of objectivity?

**Theme 2: Modification**
- What are the processes and practices that are enacted on objects?
- How do they modify objects and at what point does the modification of an object transform it into something else?
- How does this affect the credibility and authenticity of an object?

**Theme 3: Functions**
- Who are the communities of users?
- How does the use of an object affect is meaning, treatment and value?
- What techniques are used to ensure that objects retain their authenticity?
- Which are acknowledged and which are deleted?

**Theme 4: Movement**
- Where are objects and why are they there?
- How and why do objects move?
- How does the location of an object affect its treatment and credibility?

**Equipment**
- Recordings are made digitally using a digital voice recorder.
- All interviews will be backed up to CD-R.

**Legal and ethical issues; ownership and storage**

Interviews are held under conditions of informed consent. Interview partners may assert the right to be named or anonymous; otherwise informants will be attributed as appropriate whenever their words are used. Interview partners will be given the option to review their contribution before depositing the recording.

The sound recordings will not be broadcast or electronically published for commercial purposes without your explicit written consent. Any person seeking to use the interviews in broadcasts or publications by law must undertake not to subject the recordings to adaptation or editing to create a false impression.
Appendix 2b. Interview consent form

How are natural objects attributed value?

Exploring the uses, meanings and values of university earth science collections

Hannah-Lee Chalk, hannah-lee.chalk@manchester.ac.uk

Center for Museology, School of Arts Histories and Cultures, The University of Manchester

Consent Form

The purpose of this agreement is to ensure that your contribution to the project is used
and shared in accordance with your wishes. It should be read in conjunction with the
written outline of the project. Interview partners are in no way obliged to take part in the
project, and may withdraw at any time. All material will be kept for the duration of this
research project for use in this research project. The sound recordings may not be
broadcast or electronically published for commercial purposes without your explicit
written consent. Transferring copyright will allow your contribution to become a valuable
resource not just for this project but for future researchers.

[please delete as appropriate]

1. May your contribution be used for this research project? yes/no

2. May your words be attributed to you? yes/no

3. May your contribution be used immediately? yes/no

   Please give details of any time restrictions before your contribution is used:

4. Will you give your Copyright of the recording to the University of Manchester? yes/no

SIGNED: DATE:

PRINT NAME:

ADDRESS:

INTERVIEWER SIGNATURE: DATE:
Appendix 3. Plans showing broad themes and questions to be addressed during interviews / observations at case study institutions.

Appendix 3a. Interview theme: Collecting

Supplementary material
- Photographs of collected objects
- Copies of field notebooks

Broad themes
- Field collecting process and stages
- Context from which the need to collect arose

Questions
- Why was material collected?
  - As evidence, for reference, as a source of data / samples?
  - Purposeful / planed / opportunistic
- How, where and when was the material collected?
  - Was it all done at the same time (one-off opportunity), or did it take place over a length of time?
- What sort of planning was involved prior to field collecting?
  - Background research, logistics, legislation, permission, transport?
- How were the particular pieces selected?
  - Any scientific / financial / practical / legal considerations?
  - How was the appropriate material identified - any challenges / limitations / compromises?
- How was it removed?
  - Hammer / drill / picked up?
- What records were made in the field notebook?
- How was the material labelled / marked / packaged?
- How was the material transported back to the department?
- On returning to the department, what was done to the material?
  - Was the material relabelled / numbered / cleaned / repaired?
  - Was all of the material appropriate for the purposes for which it was collected?
- What records were made for the material?
  - Photographs, descriptions, locality, classification – and how were these linked to the objects?
- Was any of the material processed?
  - What techniques were used and for what purposes?
- How did the processing change the original material?
  - Did it involve reshaping / resizing / cutting / polishing / crushing / remounting / dissolving / sieving?
  - Was a sample of the original material retained or was it all processed – why / why not?
  - Did any new objects result from the processing – thin sections, polished blocks, powder samples, SEM stubs – and were they allocated new / the same number / reference?
  - What measures were taken to ensure that the material retained its authenticity / validity through the processing stage?
- What techniques were used to analyse the material and why were they selected?
  - What types of information did they generate and in what format? What happened to the material following analysis – was it discarded / retained? Why – evidence / reference / archive?
- How useful is the original material / new objects that have been created?
- Who owns the material?
Appendix 3b. Interview theme: Curation

Supplementary material
- Policy documents
- Photographs

Broad themes
- Brief institutional history
- History of earth sciences in institution
- Key people – roles and relevance
- Strengths in teaching and research
- Types of collection held by institution
- Origin of collections – key people / periods

Questions
- What is your background?
  - Previous work – curator / technician / researcher
  - Professional training in museum
  - Personal attitude towards collections
- What is the background to your role?
  - Previous curators, their influence and impact
  - Historical background – changing status, responsibility
  - Future of the role
- What is the range and scope of the collection?
  - How much material?
  - Disciplinary, geographical, historical coverage
  - Strengths and weaknesses?
- What types of material are contained in the collection?
  - Hand specimens, thin sections, powder samples and any other products of research, artificial objects such as man-made minerals and items created through experiments, data, casts or replicas
  - Reasons for keeping different types, relative status and value
- How is material organised?
  - Division by themes / age / location / function
  - Storage location and reasons, access restrictions
- How is material acquired?
  - Methods and reasons
  - Quantities of material per year
  - Active or passive?
- How is material disposed of?
  - Methods and reasons
  - Quantities of material per year
  - Active or passive?
- What function does the collection perform?
  - Who uses it, how, why, and when?
  - Historical changes?
• What factors have influenced the collection?
  - Key people, events, policies that have shaped it.
  - Any historical changes?

• How is the collection justified?
  - Reasons for retaining / expanding collection.
  - Purpose and value

• What are the attitudes towards the collection (personal, departmental, institutional)?
  - In relation to involvement / use of collection
  - Iconic / best loved objects

• What associated information is retained alongside objects?
  - Basic requirements for collection data and reasons for retaining it
  - Methods of data retention – accession register, database, catalogue
  - Who uses it; how / why / when?
  - Reasons for keeping records
  - Attitudes of other staff

• Who owns material?
  - Does this change / static? Any implications of this
  - Is this formal / informal and at what point does it belong to department / museum?
  - Staff personal collections – movement with staff?

• How are objects treated?
  - Reasons for some objects being more or less used / valued or used / valued in different ways
  - Objects with status
  - Destructive use of objects

• What are the (personal, departmental, institutional) aspirations for the collection?

• What policies / procedures are in place?
  - Types of policies / procedures
  - Who instigated them, why and when?
  - Attitudes towards them by others
Appendix 3c. Interview theme: Conservation

Supplementary material
- Photographs of stores / conservation studios

Broad themes
- Background to position within institution
- Uses of objects and any tensions with preservation

Questions
- What is your role?
  - Day to day tasks
- What is your background?
  - Previous jobs, training, qualifications
- What are the challenges that you face in your role?
- Tensions between use and preservation?
  - What do you think are the most appropriate ways of using the collection?
  - Is it used in this way? How often?
  - What makes it appropriate for this type of use?
- What sort of issues do you have to take into account when assessing requests for using objects?
  - Is there a checklist? Does it vary for particular types of material?
  - Who is involved in decision making?
  - Examples of requests for use that have been fulfilled / declined and why?
- What is the most demanding / challenging / controversial / time consuming use of the collection?
  - Research / teaching / display?
  - Has this always been the case or has it changed over time?
- What is the most valuable part of the collection?
  - Petrology / mineralogy / palaeontology / thin sections etc.
  - Has this always been the case?
- How is the collection treated?
  - By academics / museum staff / public / external visitors?
  - Is it appreciated / valued and how does this impact on its treatment?
  - Are there tensions between different stakeholders / expectations
Appendix 3d. Interview theme: Research

Supplementary material
- Photographs of research material: objects, derivatives
- Working notes / data
- Research publications

Broad themes
- Background to research project: funding / origins / individuals involved
- Research process: stages / phases and outputs

Questions
- How do you use objects in your research?
  - Source of data / scientific or historical evidence / examples / representatives / materials?
- Where do the objects that you use come from?
  - Collected in person / purchased / sourced through contact / taken from an existing collection or source?
- Are there any issues with using objects that have been sourced in this way?
  - Reliability / quality / quantity / validity / value
- How do you select which objects to use?
- What processes are objects subjected to and why?
  - Physical processes: sampling / processing / destruction / analysis
  - Conceptual processes: identification / naming / describing / observing
- What outputs are generated through your use of objects?
  - Data / descriptions / images / charts
- Are there any other ways that the objects could be used?
  - Teaching / research / display
- What is your relationship with the objects that you use?
  - Detached scientist? Any emotional attachment / aesthetic appreciation?
- What is your relationship with earth science objects in general?
  - Any interest in museum or departmental collections?
  - Any personal material retained in office / at home?
  - How / when / why does material get transferred to museum / departmental collection?
- Who owns the objects?
- Have you had any ‘eureka moments’ when working with objects?
- Do you / does your discipline always use objects in the same way or has this changed over time?
  - What changes and why?
Appendix 3e. Interview theme: Teaching and learning

Supplementary material
- Photographs of educational objects
- Copies of course syllabus / handbook / session materials / resource packs
- Any policies (access / handling / learning)

Broad themes
- Background to teaching / learning role within institution
- Types of provision that use objects and any changes over time

Questions
- What is the purpose of the objects in this context?
- Do they function independently as objects in their own right or are the objects supported with additional resources such as maps / thin sections / text / diagrams?
- What are the key features / properties that make the objects appropriate for this learning context?
- What are the students supposed to do with the objects in order to achieve the learning outcome?
- What level of guidance / support / instruction is provided to ensure / facilitate this?
- Where did the objects come from - were they collected specifically for the purpose / purchased / taken from an existing collection?
  - If the objects were collected specifically for teaching, this will be followed up with questions about the selection, removal and inscription processes
  - If the objects were purchased, this will lead to questions about the supplier and the criteria used for deciding whether the objects would be appropriate
  - If the objects were taken from an existing collection, this will lead to questions surrounding the previous history of the objects, their original function, their appropriateness for their new function
- How were the particular objects selected?
- Where are the objects stored?
- How accessible are the objects?
- How often are the objects used and by how many students?
- Are the objects replaceable? If so, how?
- What level of information is associated with the objects?
- How much of this is available to the students using the objects?
- Are the objects labelled – if so how, why and by whom?
- How valuable are the objects / how are the objects valuable?
Appendix 3f. Interview theme: Displays and exhibitions

Supplementary material
- Photographs of display / exhibition
- Promotional materials: booklets / leaflets / online information

Broad themes
- Background to display / exhibition
- Account of the process of developing the display / exhibition
  - Timescale and duration
  - Funding source / inspiration / origins
  - People involved: curators / conservators / registrars / academics
  - Was there consultation or formative / summative evaluation?
  - Stages – preparation of space / object selection / conservation / production etc.
  - Constraints / limitations – what, why and how did they effect final outcome?
  - Hindsight – anything that would be done differently / better / not done at all?

Questions
- Where did the displayed objects come from?
  - Were they part of the collection or were purchased / collected specifically for the purpose?
- What is the purpose of displaying the objects?
  - Is the display aimed at particular audiences?
  - Is it suitable for all audiences?
- Do the visitors that encounter this display know what the purpose is?
- What makes an object suitable / unsuitable for display?
  - Who decides?
  - Examples of excluded items and reasons for exclusion
- What information is associated with objects?
  - How much of this is presented alongside the object?
  - What information is left out?
  - Why is it left out and who decided?
  - What format is used to present information?
- What other (non-text) resources are displayed alongside specimens?
  - Models / images / diagrams / reconstructions / audio visual / digital?
  - Why are they used: what do they add?
Appendix 3g. Observation of teaching / learning

Supplementary material
• Photographs of objects
• Copies of worksheets / resources

Broad themes
• Background to particular teaching/learning context of session

Specific themes
• Instructions:
  - Are students / pupils given instructions for handling objects?
  - By whom and what form?
• Uses:
  - How are pupils / students using objects?
  - Are they handling, observing, or investigating them?
  - Is interaction task oriented or relatively free?
• Interaction with objects:
  - Do the pupils / students seem comfortable with the objects?
  - What clues suggest this?
  - How are they treating the objects?
• Effectiveness of objects for task
  - Are they using them as they are intended to be used?
  - Cross reference observations with worksheet task
  - Are the objects functioning effectively in the learning context?
  - Are there any issues with use?
  - Do pupils / students get the answers correct?
• Alternative meanings
  - Do pupils / students engage with the objects in any ways other than those that they are intended?
  - How?
  - Is this encouraged?
• Learning process
  - What is the process that takes pupils / students from object to learning outcome?
• Supplementary resources
  - What support is provided alongside objects and how does this compliment objects?
  - Worksheets, teaching assistants / postgraduates / teachers
Appendix 3h. Inspection of display / exhibition

Supplementary material
- Photographs of exhibition / display
- Promotional materials: booklets / leaflets / online information

Broad themes
- Background to exhibition / display

Specific themes
- Context
  - Where is the display?
  - How long has it been there?
  - Why was it created?
  - What is the display about?
  - Who are the people behind the display / exhibit?
  - Are they mentioned / acknowledged / or is it anonymous? – Why?
- Purpose
  - What is the purpose of the display?
  - Is this obvious?
  - Who is the display aimed at?
  - What is the message?
  - Which interpretations / meanings are promoted / encouraged?
  - How is this achieved?
  - What alternative messages / meanings / interpretations are there?
  - How and why are they discouraged / ignored / concealed?
- Objects
  - What different types of objects are displayed?
  - Are there any different strategies for displaying different types of object?
  - What functions do the objects perform?
  - How does the inclusion of an object in a display / exhibit affect its value and status?
- Display elements
  - How are the objects displayed?
  - Open display / cases?
  - Are there different methods of displaying objects and why are they used?
- Spatial elements
  - How are objects grouped / positioned?
  - What relationships do the objects have to each other?
  - How are they arranged?
  - Aesthetically (size, shape, colour), chronologically, thematically, geographically?
- Supporting elements
  - What level of information is provided?
  - Labels, explanations, headlines, textbook style?
  - Are there any other resources available to support the objects?
  - Text, diagrams, models, photographs, audio, video?
Appendix 3i. Observation of visitors at display / exhibition

Supplementary material
- Photographs of exhibition / display
- Promotional materials: booklets / leaflets / online information

Broad themes
- Background to exhibition / display

Specific themes
- Movement: watching
  - How do people approach the display?
  - Where did they come from?
  - Do people make a b-line for the display or is it part of a methodical ordered approach?
  - Where do people start and how do they move around the display?
  - Where do they go after?
- Reactions to objects: listening
  - How do people interpret / see / read the objects?
  - Is this the way that they are intended / supposed to be interpreted / seen / read?
  - If not, how does it differ from the intended interpretation?
- Depth of engagement: watching for gestures and movement, and listening
  - Do people use the labels / additional resources?
  - How effective are the labels / additional resources?
  - Do different people respond to the display in different ways?
  - What catches people’s attention and what is ignored?
  - How long do people spend looking at the display / reading information / discussing it?
- Interest / knowledge: listening
  - What are visitors talking about at the display?
  - Is this related to the display and if so how?
  - What are visitors talking about as they move away from the display?
Appendix 4. Samples of raw data from an interview transcript and field notes from observational research.

Appendix 4a. Sample extract from an interview transcript

**Interview: Gurdeep Thera – Manchester Museum 04/01/11**

**Interview date:** 04/01/11  
**Interview location:** Manchester Museum  
**Intervener:** Hannah-Lee Chalk  
**Disc details:** MANMUS_040111  
**Length of interview:** 01:18:54  
**Interview abstract:** Discussion about Health Rocks  
**Additional references:** MANMUS_040111N

So health rocks, could you let me know some of the background to the project – how it came about.

It all started with the money being available through Renaissance, to launch a project called Who Cares, which was wanting to examine how museums and galleries can impact on people’s health and well-being – that was kind of the broad remit of what that research project was kind of looking for.

So there were 6 of the hub venues that were involved; the Whitworth, ourselves, Tullie House, Preston, um... and Bolton Museum, and we decided that in order to give the work some weight, we’d have some research attached, and that’s being done by its like a social unit that’s based in UCLAN, the University of Central Lancashire. So that will be available, and they’re going to write up some research, so they’ve been researching each venue’s programme, and they’ll write up their findings in a report that will be available in March.

So when we... the real interest is in looking at - in being involved, and also because of our... I suppose because of our past work that’s been looking at sort of health and well being broadly, the work that we’ve been doing with refugee women, asylum seekers... and the discovery centre, and I suppose that’s the first example of the work that we did. And then there’s been elements of the ‘In-Touch’ volunteer programme. So our scope has probably been more around the well-being agenda, because that’s the most general.

And the health rocks – we decided, as we were thinking about what aspect we wanted to – what aspect of well being we wanted to look at, we decided on mental health, because my background is mental health, and there were 2 routes that we took. One was to go down a kind of self-referring route, so people could opt in to our programme, and then the other was to work with a referred service, so that’s when we got in contact with START who work with people who have severe mental illness. And they run an arts and multicultural project. So we approached them and said, we have this money, we have the resources in the museum, and we’re interested in exploring what impact it makes, um, would you be interested in some partnership work with us, and that’s how it started, and they came to us. They kind of wanted to know what the scope of the output would be – they were interested in showcasing the work that was going to be produced. Um, so after some discussions we decided on a case in the minerals gallery. And both Davids were involved with that and... But they, the whole of the collection was up for grabs, kind of thing, but they decided on, on rocks and minerals. They decided on rocks and minerals because they wanted to stay clear of Egypt and death – they didn’t want to go near there.

I guess most collections are about death – some aspect of death there.

There’s all kinds of – I think there’s lots of scope around, even if we were to look at death, it would have been a different kind of thing, but there was still scope to explore, because its such a huge subject. We have difficulty...
Appendix 4b. Sample extract from field notes made during observational research

**Observation: Introduction to Palaeontology 1, University of Manchester. 08/10/10**

**Observation Date:** 08/10/10  
**Observation location:** School of Earth Atmospheric and Environmental Sciences, University of Manchester  
**Observer:** Hannah-Lee Chalk  
**Additional references:** Worksheet SEAES_081010S1

Practical led by Dr John Nudds (JN) - Senior Lecturer in Palaeontology, with support from a post-doc student specializing in arthropods (JJ). Observation of 2 female 1st year Geography/Geology students (A and B)

A [measuring trilobite and discussing if it is round or oval] Tapering posteriorly?  
B Oval?  
A It does kind of taper  
B Oval I’d say  
A Oval and tapering?  
B Do you have to do a full description?  
A I’m just going through all these  
B What does C mean?  
A Uh, oh yeah – find the diagram in the booklet  
B Are you putting micro or hetero? [holding cast] How do you know?  
A The surface – this isn’t it! [it’s a cast]  
B Is it smooth?  
A There are these bits though  
B Wouldn’t it depend on what bit?  
A Guess – you could specify where, maybe smooth on head and tuberculate elsewhere  
B Ok, is cephalon elsewhere?  
A [picks up fossil with 2 fingers] Cephalon is the head [holding specimen at a distance]  
B Is the cephalon semicircular? I don’t know what quadragonial means [finds diagram in booklet] – Oh yes!  
A [Lots of looking at specimen but specimen stays in box]  
B Is it triangular?  
A I put triangular  
B [Student more happy with handling specimen – picks it up frustrated] Is it triangular?  
A Just put what you want. What is genal angle? [searches through booklet] Oh yeah, it’s these [points to genal angle on trilobite with bird]. Short, long, straight or curved?  
B I’d say curved  
A I’ll put relatively long. They go all the way down there [looking at booklet more than objects and flicking back and forward to work out the meanings of terms]  
B What does distinctive or indistinctive mean?  
A Distinct  
B I know what distinct means but what does it mean in this context?  
A It’s visible  
B What does parallel sided mean?  
A It is expanded anteriorly  
B What’s the head shield? Is it flat or convex?  
A What?  
B The head I guess  
A It’s got to be  
B What does swollen mean? I’m going to put convex with distinct glabella grooves  
A Are they distinct? [Student points to them and feels them with finger, then starts counting them]  
B What the hell is a facial suture?  
JN Remember that species names have lower case  
B There isn’t a facial suture is there? [Looks at specimen and asks A who looks at specimen and points out eye]  
A If you compare it to the pictures you can see which part it is [puts specimen on image to make it easier to compare]
### Appendix 5. Summary of fieldwork

#### Appendix 5a. Summary of fieldwork carried out at each case study institution

<table>
<thead>
<tr>
<th>Case study</th>
<th>Date</th>
<th>Nature of work</th>
<th>Purpose</th>
<th>Details of activities</th>
<th>Transcript</th>
<th>Notes</th>
<th>Photos</th>
<th>Additional material</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAMU</td>
<td>23/04/2008</td>
<td>Site visit - Department Displays</td>
<td>Tour around the displays in the department</td>
<td>Interviews with HC about the uses and developments of the departmental collections.</td>
<td>LAMU,</td>
<td></td>
<td></td>
<td>Handsouts</td>
</tr>
<tr>
<td></td>
<td>06/05/2008</td>
<td>Interview - Bob Finch (Technical Services Manager &amp; School Caterer)</td>
<td>Interviews with RF about the collections and field collecting, and tour of teaching facilities</td>
<td>LAMU, 000000AB</td>
<td>LAMU,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>08/05/2008</td>
<td>Archives</td>
<td>Visit to University Archives: examination of annual reports and other institutional records</td>
<td>LAMU, 000000AB</td>
<td>LAMU,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15/09/2008</td>
<td>Archives</td>
<td>Visit to University Archives: examination laboratory notebooks, field notebooks and fossil diaries</td>
<td>LAMU, 000000AB</td>
<td>LAMU,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17/09/2008</td>
<td>Interview - Bob Finch (Technical Services Manager &amp; School Caterer)</td>
<td>Interviews with RF - general follow-up, followed by visit to the archive</td>
<td>LAMU, 000000AB</td>
<td>LAMU,</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>05/10/2008</td>
<td>Observation - Undergraduate Practicals</td>
<td>Observation of Geology Materials, practical 2</td>
<td>LAMU, 000000AB</td>
<td>LAMU,</td>
<td></td>
<td></td>
<td>Handsouts</td>
</tr>
<tr>
<td></td>
<td>27/10/2009</td>
<td>Observation - Undergraduate Practicals</td>
<td>Observation of Geology Materials, practical 5</td>
<td>LAMU, 000000AB</td>
<td>LAMU,</td>
<td></td>
<td></td>
<td>Handsouts</td>
</tr>
<tr>
<td>Cambridge</td>
<td>1/08/2009</td>
<td>Interview - Steve Luerse (Defensive Assistant, Mammology &amp; Palaeontology)</td>
<td>Interviews with SL about collections, then historical development and his work</td>
<td>SDS, 000000AB</td>
<td>SDS,</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>12/08/2009</td>
<td>Museum Exhibition</td>
<td>Observation of displays and exhibits</td>
<td>SDS, 000000AB</td>
<td>SDS,</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>18/08/2009</td>
<td>Interview - Sarah Pennie (Conservation)</td>
<td>Interviews with SP about conservator’s role and the Regal collections, and a tour of the Regal Building</td>
<td>SDS, 000000AB</td>
<td>SDS,</td>
<td></td>
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<tr>
<td></td>
<td>19/08/2009</td>
<td>Interview - Steve Luerse (Defensive Assistant, Mammology &amp; Palaeontology)</td>
<td>Interviews with SL about the exam collections</td>
<td>SDS, 000000AB</td>
<td>SDS,</td>
<td></td>
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<tr>
<td></td>
<td>19/08/2009</td>
<td>Interview - Annette Sheldon (Education Officer)</td>
<td>Interviews with AS about educational work with the collections</td>
<td>SDS, 000000AB</td>
<td>SDS,</td>
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<tr>
<td></td>
<td>19/08/2009</td>
<td>Interview - Matt Riley (Defensive Assistant, Palaeontology)</td>
<td>Interviews with MR about the palaeontology collections and tour around some of the on site storage areas</td>
<td>SDS, 000000AB</td>
<td>SDS,</td>
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<tr>
<td></td>
<td>28/10/2009</td>
<td>Museum Exhibition</td>
<td>Observation of displays and exhibits at the Sedgwick</td>
<td>SDS, 000000AB</td>
<td>SDS,</td>
<td></td>
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<tr>
<td></td>
<td>30/09/2010</td>
<td>Interview - Marian Holmes (Keeper in Palaeontology)</td>
<td>Interview with MH about research, field collecting and use of the collections</td>
<td>SDS, 000000AB</td>
<td>SDS,</td>
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<tr>
<td></td>
<td>04/10/2010</td>
<td>Interview - Susan Anthony (Exhibition Assistant) &amp; Frances Nobby (Project Manager)</td>
<td>Interviews with SA and FN about the development and use of objects in the Darwin the Geologist exhibition</td>
<td>SDS, 000000AB</td>
<td>SDS,</td>
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<td></td>
<td>13/04/2010</td>
<td>Interview - Emma Pasterine (Curator of Collections)</td>
<td>Interviews with EP about the collections and their main features</td>
<td>UCL, 000000AB</td>
<td>UCL,</td>
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<tr>
<td></td>
<td>24/05/2010</td>
<td>Site visit - Department Displays and Exhibition</td>
<td>Observation of conder displays and ‘A Crucial Difference’ exhibitions</td>
<td>UCL, 000000AB</td>
<td>UCL,</td>
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<tr>
<td></td>
<td>21/06/2011</td>
<td>Interview - Emma Pasterine (Curator of Collections)</td>
<td>Follow-up interview with EP and discussion about collection processing, and tour of storage and teaching labs</td>
<td>UCL, 000000AB</td>
<td>UCL,</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>21/07/2011</td>
<td>Interview - Wendy Kirk (Curator of Collections / Lecturer (Comparative Zoology))</td>
<td>Interviews with WN about the departments collections and tour of a tour of storage and teaching labs</td>
<td>UCL, 000000AB</td>
<td>UCL,</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>UCL</td>
<td>27/01/2011</td>
<td>Observation - Museum Session</td>
<td>Visit to ‘From Dust to Diamonds’ exhibition</td>
<td>UCL, 000000AB</td>
<td>UCL,</td>
<td></td>
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<tr>
<td></td>
<td>16/02/2010</td>
<td>Observation - Museum Session</td>
<td>Observation of primary science ‘Dinosaur Detectives’ session</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
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<tr>
<td></td>
<td>04/08/2010</td>
<td>Observation - Museum Session</td>
<td>Observation of primary science ‘Dinosaur Detectives’ session</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>09/10/2010</td>
<td>Observation - Undergraduate Practical</td>
<td>Observation of Introduction to Palaeontology practical 1</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
<td></td>
<td>Resource sheets</td>
</tr>
<tr>
<td></td>
<td>26/10/2010</td>
<td>Interview - Merry Edwards (Curator &amp; Learning Resource Manager)</td>
<td>Interviews with AE about departmental collections</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
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<tr>
<td></td>
<td>16/11/2010</td>
<td>Interview - Glen Droop (Lecturer in Geology)</td>
<td>Interviews with GD about field collecting and research use of collections, training</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
<td></td>
<td>Field research copies</td>
</tr>
<tr>
<td></td>
<td>24/11/2011</td>
<td>Interview - Derek Sheltope (Curator of Earth Sciences)</td>
<td>Interviews with DG about the Manchester Museum collections</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manchester</td>
<td>01/12/2010</td>
<td>Site visit - Museum Exhibition</td>
<td>Observation of exhibits and displays, Rocks and minerals</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>07/12/2010</td>
<td>Interview - Merry Edwards (Curator &amp; Learning Resource Manager)</td>
<td>Follow up interview with AE</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>29/12/2010</td>
<td>Site visit - Museum Exhibition</td>
<td>Observation of exhibits and displays, Palaeontology</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>04/01/2011</td>
<td>Interview - Alex James (R ead E ducator, Seniority &amp; Part 14 Reference)</td>
<td>Interviews with AJ to discuss the use of objects in secondary learning sessions</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>04/10/2011</td>
<td>Interview - Gundraye Thames (Curator of Community Engagement)</td>
<td>Interview with GT to discuss the use of collections for adult learning</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>07/02/2011</td>
<td>Interview - Phil Manning (Reader in Palaeontology)</td>
<td>Interviews with PM to discuss the use of collections for research, and the impacts of research on field collecting</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>26/07/2011</td>
<td>Site visit - Museum Stores</td>
<td>Tour of the stores and examination of accession registers</td>
<td>MAN, 000000AB</td>
<td>MAN,</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 5b. Summary of observational research sources that were not used

<table>
<thead>
<tr>
<th>Theme</th>
<th>Source</th>
<th>Difficulties</th>
<th>Alternative source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection</td>
<td>Observation of the field collecting process</td>
<td>I had originally intended to use participant observation as a means of gathering insight and empirical evidence about the process of field collecting. The costs of undertaking this research, both in terms of time and resources were, however, prohibitive and this method was therefore not used.</td>
<td>Rather than making direct observations of field collecting, it was necessary to rely on accounts of field collecting from collectors.</td>
</tr>
<tr>
<td></td>
<td>Observation of curatorial work</td>
<td>Primarily for logistical reasons (although also as a result of financial and time constraints), the observation of curatorial work in action was felt to be impractical. In academic departments, the individuals who work with collections do so alongside numerous other roles, and therefore, their curatorial work was rarely timetabled, and rarely took place in isolation from their other duties. While the former factor was not a problem for museum curators, the varied nature of their roles and the relative lack of material being accessioned made the observation of the acquisitions process impractical.</td>
<td>Rather than making direct observations, I relied on accounts of the acquisitions process from curators.</td>
</tr>
<tr>
<td>Functions</td>
<td>Observation of the research process</td>
<td>As a result of the duration of research projects and the challenges of arranging access, it was not possible to arrange to carry out direct observations of the research use of earth science objects.</td>
<td>Instead of making direct observations of the research process, I relied on accounts of the use of objects for research purposes from the researchers themselves.</td>
</tr>
<tr>
<td></td>
<td>Observation of the exhibition development process</td>
<td>The development of new exhibitions containing earth science material is a relatively rare occurrence in museums. Both timing (I unfortunately embarked on fieldwork at the University of Cambridge towards the end of the development process) and resources meant that I was unable to observe the development of the Darwin the Geologist exhibition at the Sedgwick.</td>
<td>I was, however, able to gather first hand accounts of the process from individuals involved in the project shortly after the opening of the exhibition.</td>
</tr>
<tr>
<td>Movement</td>
<td>Observation of object movement</td>
<td>The logistics of adopting a ‘follow the object’ approach prevented me from making any observations of the movement of objects (such as through loans, identifications and dispositions). The nature of object movement (as I subsequently discovered) is both irregular and often takes place at relatively short notice, and due to my financial and time constraints, it was apparent that it was not worth pursuing this source.</td>
<td>Rather than making direct observations, I was able to gather information about the movement of objects from curators.</td>
</tr>
</tbody>
</table>
Appendix 6. Background information about interviewees

Appendix 6a. Dr Lyall Anderson

Institution: University of Cambridge, Department of Earth Sciences
Position: Isaac Newton Trust Research Fellow

Lyall Anderson started working at Cambridge in 2007 when he undertook a two and a half year long research fellowship titled: “Charles Darwin’s Geology – modern relevance in historical context”. His work involved carrying out historical research focused around the Beagle Collection, and he also contributed to the development of the ‘Darwin the Geologist’ exhibition. As well as carrying out this collections based research, he has also been involved in departmental activities including teaching and supervisions.

Background: Dr Anderson has a background in palaeontology, through both his PhD research at Manchester (1996) and subsequent postdoctoral research at Aberdeen. He also has experience of museums through his curatorial work at NMGS, initially in 2001 as Curator of Invertebrate palaeontology and in 2004 as principal curator, where he became interested in researching the history of collections and collecting.

Developments: Dr Anderson is now Honorary Visiting Research Fellow at the University of Leicester’s School of Museum Studies.

See also: www2.le.ac.uk/departments/museumstudies/people/dr-lyall-i.-anderson/Dr_Lyall_I_Anderson

Appendix 6b. Glynis Caruana

Institution: University of Cambridge, Department of Earth Sciences
Position: Classroom Technician

Glynis manages the use of objects for teaching purposes within the department. She is responsible for both the small departmental collections as well as arranging for the use of material from the Sedgwick’s collections. She is also responsible for co-ordinating fieldtrips within the department (paperwork, health and safety and equipment). Glynis has been in post for about 20 years. As well as her formal role, she also helps out with museum public programme events occasionally.

Appendix 6c. Hazel Clark

Institution: Liverpool John Moores University, School of Natural Sciences and Psychology
Position: Senior Technician

Hazel has been in post for 25 years. Her role includes managing the collections and their use within the department. Her curatorial work is only part of her role as technician, and she also undertakes various other duties within the school, including the development of virtual resources to support teaching and learning. Although another technician supports her role, the collections fall specifically under her remit.

Background: Hazel has a background in geology (degree and masters) and has worked in the museum sector (Stoke and Buxton) prior to her current position at LJMU.

See also: www.ljmu.ac.uk/NSP/100233.htm
Appendix 6d. Joe Crossley

Institution: Liverpool John Moores University, School of Natural Sciences and Psychology

Position: Principle Lecturer (retired) and former Head of Geology

Joe Crossley was central to the development of geology at Liverpool John Moores, arriving in 1969 (when it was called CS Motte College) where he provided teacher training in geology. He subsequently occupied various positions including Head of Geology and Senior Lecturer and his roles within the department meant that he was involved in both collecting and using material. He admits that he is a collector by nature and used to collect stamps before he collected rocks. As well as donating personal research material to the collections, Joe continues to add to the collections through field collecting during LGS field trips. Since he retired, Joe remains associated with the school through contact with Hazel Clark, and he also provide lectures, workshops and fieldtrips to local geology groups through his active involvement with the Liverpool Geological Society (for which he is secretary).

Background: Joe Crossley studied geology at Liverpool University and subsequently spent a year carrying out research on Palaeozoic trace fossils from Wales, SE Ireland and Shropshire with TP Crimes. Prior to his involvement at LJMU, he spent ten years teaching at St Mary’s College in Middlesbrough.

Appendix 6e. Dr Giles Droop

Institution: The University of Manchester, SEAES

Position: Senior Lecturer in Geology

Dr Droop specialises in metamorphic petrology and his role includes teaching metamorphic geology courses as well as a number of first year earth materials courses. He is also involved in research, both supervising research students and carrying out his own research, on metamorphic rocks (their temperature and pressure history) in particular. Dr Droop has always been interested in both nature and collecting; he admits to being a bit of a collector; he has his own collection of rocks and minerals in his office, that he sometimes uses for teaching.

Background: Dr Droop attributes his interest in the Alps to his PhD research at Oxford (completed in 1979). Following postdoctoral research at Cambridge and work at Oxford as a Demonstrator in Petrology, he started working (in 1983) at the University of Manchester, initially as a ‘New Blood Lecturer’ and then from 1993, as Senior Lecturer in Geology.

See also: www.seaes.manchester.ac.uk/people/staff/profile/?ea=giles.droop&pg=6

Appendix 6f. Mandy Edwards

Institution: The University of Manchester, SEAES

Position: Curator and Learning Resource Manager

Mandy has worked in the department for over 25 years, and while her title and responsibilities have changed over this time, her involvement in the care, management and maintenance of the collections has remained central. While Mandy is involved in the departmental collections in general, she is less directly responsible for the teaching collections (for which the day to day management falls under the remit of a technical support role). Her involvement with the research and reference collections is heavily reliant on her in-depth knowledge of the department’s teaching and research activities.

Background: Mandy has formal training and a professional qualification in museum studies, and in the past, has been closely involved in the work of the Geological Curator’s Group.
Appendix 6g. Bob Finch

**Institution:** The University of Leeds, School of Earth and Environment

**Position:** Deputy Technical Services Manager; School Curator

Bob Finch has been in post for over 10 years and his involvement with the collections is only part of his role as Deputy Technical Services Manager. His curatorial work involves organising and managing both the teaching, reference and archived collections. While the school had previously employed a dedicated curator, when the position was disbanded in 1986 and until Bob's involvement, the collections were managed on an ad hoc basis.

**Background:** Bob Finch has a background in geology and originally started working at Leeds in a more technical role, which subsequently grew to include the curation of the school’s collections. Whilst working at Leeds, he undertook a qualification in museum studies in order to gain a different perspective of his role, and for this purpose, developed an interest in the history and development of the collections.

Appendix 6h. Sarah Finney

**Institution:** The University of Cambridge, Sedgwick Museum of Earth Sciences

**Position:** Conservator

Dr Finney started working as conservator in 2002 and her role at the Sedgwick is broadly concerned with the ongoing care and use of collections. In practice this may involve carrying out condition checks, environmental monitoring and providing advice on the care of collections in relation to storage, exhibitions and research requests, as well as physically working on objects – preparation, cleaning, casting and repairs. She also works closely with the Collections Manager in the development and implementation of policies and procedures. The conservator position at the Sedgwick was established as a result of its position as an Earth Science Collections centre and she is the second person to occupy this role.

**Background:** Sarah Finney originally trained as an archaeologist and then in 1989 started working as a fossil preparator at the University Museum of Zoology at Cambridge, where she also carried out palaeontological research.

See also: [www.pbs.org/wgbh/nova/link/fossils.html](http://www.pbs.org/wgbh/nova/link/fossils.html)

Appendix 6i. David Gelsthorpe

**Institution:** The University of Manchester, The Manchester Museum

**Position:** Curator of earth sciences

David started working at the Manchester Museum as Curator of Palaeontology in 2006 and spent much of his first two years in post tackling the palaeontology collection-backlog through bulk accessioning. As a result of restructuring in 2010, David has subsequently taken on responsibility for both the petrology and mineralogy collections (which had been fully documented and catalogued) in his new position as curator of earth science collections. David’s role involves the curation, use and development of the collections and he has recently been involved in major gallery re-displays.

**Background:** David has a background in palaeontology (PhD in microfossils), and has experience of working in museums. Prior to Manchester, he volunteered and then worked at Sheffield Museum before moving on to Scarborough and Whitby Museums and then the Yorkshire Museum.

See also: [palaeomanchester.wordpress.com/about/](http://palaeomanchester.wordpress.com/about/)
Appendix 6j. Dr Marian Holness

**Institution:** University of Cambridge, Department of Earth Sciences

**Position:** Reader in Petrology

Dr Holness originally studied at Cambridge and returned in the late 1990’s originally as an Assistant Lecturer and then as Lecturer, Senior Lecturer and since 2005 as Reader in Petrology. Her role involves both teaching and research. She teaches courses on igneous and metamorphic rocks and minerals as well as carrying out research into igneous intrusions, in particular the textural development in high-temperature rocks. She has a distinct give-and-take relationship with the collections at the Sedgwick, and uses them both as a source of inspiration and material, and as a safe and accessible repository for research material, which she transfers to the museum on the completion of a research project. As a result of this, she values both the collections and the work carried out by the collections assistant (mineralogy and petrology).

**Background:** Dr Holness originally undertook her undergraduate degree and PhD at Cambridge. In 1990 she started postdoctoral research at Edinburgh where she subsequently became a Royal Society University Research Fellow before returning to Cambridge.

**See also:** www.esc.cam.ac.uk/people/academic-staff/marian-holness

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Appendix 6k. Dr Wendy Kirk

**Institution:** University College, London, Department of Earth Sciences

**Position:** Curator of Collections, Lecturer in Metamorphic Petrology and Undergraduate Tutor

Wendy has been working for the department for over 35 years. While her original role was to look after the collections and to get them out for practical sessions and exams, this role gradually evolved as she started to get involved in demonstrating, running fieldtrips, and lecturing. Her current role combines teaching, curating and a pastoral role as undergraduate tutor and her time is divided between these three roles. Her curatorial work with the collections is varied (and supported by Emma Passmore), and includes cataloguing and accessioning material, and other collections-related tasks. She has also carried out research into the historical development of the collections and the individuals involved in its growth.

**Background:** Dr Kirk has a background in geology, and a PhD in metamorphic petrology, and prior to UCL, she worked in a map library.

**See also:** www.ucl.ac.uk/es/people/staff/academic/kirk

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Appendix 6l. Steve Laurie

**Institution:** The University of Cambridge, Sedgwick Museum of Earth Sciences

**Position:** Collections Assistant, Mineralogy and Petrology

Steve is responsible for the day-to-day running of the Harker Collection (petrology), the mineral collection and the exam series. He has been in post since 1990 and over that time his role has remained largely unchanged. His day-to-day work is largely concerned with curatorial matters, research enquiries, and responding to loan requests for material both internally (from the department) and further a field. He has considerable knowledge about the petrology and mineralogy collections and their historical development.

**Background:** Steve’s interest in curating originated during his undergraduate degree where he was interested in the work that the technicians did. He subsequently completed training as a technician and worked for Queen Mary’s College, London until its closure.

**Developments:** Steve Laurie has since left the Sedgwick.
Appendix 6m. Dr Phil Manning

**Institution:** The University of Manchester, School of Earth, Atmospheric and Environmental Science / The Manchester Museum

**Position:** Reader in Palaeobiology

Dr Manning’s current role at the University of Manchester is split between SEAES where he is involved in both teaching and research, and the Manchester Museum where he is a Research Fellow. Alongside his involvement in cutting-edge international research projects, Phil also carries out public engagement work and has appeared on numerous natural history television and radio programmes (both in the UK and USA). Dr Manning is genuinely passionate and enthusiastic about his work and this is apparent from his work on engagement and communication.

**Background:** Dr Manning originally studied at Leicester and went on to develop an interest in palaeontology through his masters (Manchester) and PhD research (Sheffield) Prior to his research career, he spent a number of years working in the museum sector, and has experience or working in a range of curatorial, educational and technical roles.

**See also:**
- [www.seaes.manchester.ac.uk/people/staff/profile/?ea=phil.manning&pg=1](http://www.seaes.manchester.ac.uk/people/staff/profile/?ea=phil.manning&pg=1)
- [www.seaes.manchester.ac.uk/people/staffspotlights/philmanning/](http://www.seaes.manchester.ac.uk/people/staffspotlights/philmanning/)

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Appendix 6n. Emma Passmore

**Institution:** University College, London, UCL Museums and Collections

**Position:** Curator of Collections

In spite of her involvement with the collections and other activities in the Department of Earth Sciences, the role of ‘curator of collections’ is based within and managed through UCL Museums and Collections. Emma’s part-time curatorial role complements the work of the department-based curator (Dr Kirk), and involves the ongoing management and maintenance of the earth science collections. She has also been actively involved in the development and implementation of strategies to improve access to and awareness of the collections, for example, through displays and exhibitions. As well as her curatorial role, Emma has been involved in departmental activities such as supporting undergraduate practical sessions and field trips.

**Background:** Emma originally studied at UCL as an undergraduate student and it was during this time that she first became involved with the collections, photographing the thin section collection as a summer project. She went on to obtain a PhD in igneous petrology from Edinburgh before returning to UCL in 2008.

**Developments:** Emma Passmore now works at the British Museum.

**See also:**
- [www.ucl.ac.uk/es/study/careers/events/alumni_forum_2011](http://www.ucl.ac.uk/es/study/careers/events/alumni_forum_2011)
- [www.britishmuseum.org/about_us/departments/staff/conservation_and_science/emma_passmore.aspx](http://www.britishmuseum.org/about_us/departments/staff/conservation_and_science/emma_passmore.aspx)
Appendix 6o. Matt Riley

**Institution:** The University of Cambridge, Sedgwick Museum of Earth Sciences  
**Position:** Collections Assistant, Palaeontology

Matt started working as Collections Assistant, Palaeontology in 2007, a role concerned with the day-to-day running of the palaeontology collections at the Sedgwick. As well as general curatorial duties, much of his time is spent responding to enquiries and loan requests (a significant proportion of which are made by the department for teaching purposes). Matt is very enthusiastic about his work and particularly enjoys the opportunity to work directly with the collections on account of their historical importance. He is also keen to contribute to the development of policies and procedures with the collections manager.

**Background:** After studying at Portsmouth and obtaining a Masters in Palaeobiology at Bristol, Matt pursued a career in museums, firstly by volunteering at the Manchester Museum for 2 years, before undertaking a trainee curator post at Royal Holloway Museum.

Appendix 6p. Annette Shelford

**Institution:** The University of Cambridge, Sedgwick Museum of Earth Sciences  
**Position:** Education officer

Although Annette started working at the museum in 1996, it was not until 2006 that she was officially appointed as an ‘Educator’. Annette is responsible for the development and delivery of all of the formal and informal learning for the Sedgwick, covering both museum-based and outreach activities. While a development of learning opportunities are limited by a number of factors (ranging from funding to the layout of the museum), Annette is very positive and enthusiastic about her work and is a strong advocate for the use of objects to inspire and engage both children and adults.

**Background:** Annette has a PhD in geology from Cambridge and was originally involved in cataloguing the collections at the Sedgwick. She then took on the position of museum assistant which involved running the shop, doing front of house work, cataloguing and gradually developed and increased the educational aspects of her role.

**Developments:** Annette’s role is now supported by a part time educator post.
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http://www.chugd.ac.uk/institutions.php

http://fenscore.man.ac.uk/

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http://www.museum.manchester.ac.uk/yourvisit/galleries/fossil

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SEAES (2010) *Deborah Chavrit* (access date: 04/01/2011).
http://www.seaes.manchester.ac.uk/aboutus/staff/staffprofile.php?id=259
Interviews

Anderson 12/08/09: Interview with Lyall Anderson (Newton Trust Research Fellow) about the use of the Sedgwick Museum’s collections in his research into Darwin research, and discussion about the uses of objects during supervisions.

Antoniw and Neary 28/10/09: Interview with Dr Francis Neary (Project Manager, Darwin the Geologist) and Susie Antoniw (Exhibition Assistant, Darwin the Geologist) about the use of objects in the Darwin the Geologist exhibition at the Sedgwick Museum of Earth Sciences.

Caruana 12/08/09: Interview with Glynis Caruna (Class Laboratory Technician) about the use of collections in departmental teaching activities at the University of Cambridge.

Clark 23/03/09: Interview with Hazel Clark (Senior Technician) about the earth science collections at Liverpool John Moores University.

Crossley 23/03/09: Telephone interview with Dr Joe Crossley (formerly Head of Geology) about the origins of the earth science collections at Liverpool John Moores University.

Crossley 24/06/09: Interview with Dr Joe Crossley (formerly Head of Geology) about the growth of the earth science collections at Liverpool John Moores University.

Droop 10/11/10: Interview with Dr Giles Droop (Senior Lecturer) about the collection and uses of earth science objects for research and teaching at the School of Earth, Atmospheric, and Environmental Sciences, The University of Manchester.

Edwards 26/10/10: Interview with Amanda Edwards (Curator) about the use and management of the collections in the School of Earth, Atmospheric, and Environmental Sciences, The University of Manchester.

Edwards 07/12/10: Follow-up interview with Amanda Edwards.

Finch 06/05/08: Interview with Bob Finch (School Curator) about the University of Leeds’ earth science collections, and their historical development, and discussion about the process of collecting teaching material.

Finch 17/11/08: Follow-up interview with Bob Finch.

Finney 18/08/09: Interview with Sarah Finney (Conservator) about the uses and preservation of the collections at the Sedgwick Museum.

Gelsthorpe 24/11/10: Interview with David Gelsthorpe (Curator of Earth Sciences) about the history and use of the collections at the Manchester Museum.
Holness 28/10/09: Interview with Dr Marian Holness (Reader in Petrology) about the use of objects in academic research and teaching at the University of Cambridge Department of Earth Sciences.

Jeanes 20/12/10: Interview with Alexa Jeanes (Lead Educator for Secondary and Post-16 science) about the use of earth science objects during A-level sessions at the Manchester Museum.

Kirk 21/07/10: Interview with Dr Wendy Kirk (curator) about the history and use of the earth science collections at UCL.

Laurie 11/08/09: Interview with Steve Laurie (Collections Assistant, Mineralogy and Petrology) about the mineralogy and petrology collections at the Sedgwick Museum of Earth Sciences.

Laurie 18/08/09: Interview with Steve Laurie (Collections Assistant, Mineralogy and Petrology) about the Department of Earth Sciences’ examination collections at the University of Cambridge.

Manning 07/02/11: Interview with Dr Manning (Senior Lecturer in Palaeontology and Research Fellow) about the uses of palaeontological material in his research and the functions of the collections in the School of Earth, Atmospheric, and Environmental Sciences, The University of Manchester.

Passmore 13/04/10: Interview with Emma Passmore (Curator) about the management and use of the earth science collections at UCL.

Passmore 21/06/10: Follow-up interview with Emma Passmore and discussion about fieldwork and collecting at UCL.

Riley 19/08/09: Interview with Matt Riley (Collections Assistant, Palaeontology) about the palaeontology collections at the Sedgwick Museum of Earth Sciences.

Shelford 19/08/09: Interview with Annette Shelford (Education Officer) about the educational use of objects at the Sedgwick Museum of Earth Sciences.

Thiara 04/01/11: Interview with Gurdeep Thiara (Curator of Community Engagement) about the use of earth science objects in the Health Rocks project at the Manchester Museum.

**Observations**

Observation. (05/10/09) Observation of Geological Materials (Practical 2) at the University of Leeds: first year practical session for the course Geological Materials titled: 'Minerals - examination and identification using physical properties'

Observation. (06/10/09) Observation of Understanding the Earth (Practical 3) at Liverpool John Moores University: first year practical session for the course Understanding the Earth titled: 'Sedimentary Rocks'

Observation (26/10/09) Observation of Geological Materials (Practical 5) at the University of Leeds: first year practical session for the course Geological Materials titled: 'Igneous Rocks / Volcanic Rocks'.

Observation (08/10/10) Observation of Introduction to Palaeontology (Practical 1) at the University of Manchester: first year practical session for the course Introduction to Palaeontology.