Regional Geology Stewardship

Advice Pack

for Geological Collections

Esmée Fairbairn Foundation

City of Stoke on Trent

Geologists' Association 1858 The Curry Fund

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This three year project began in 2009 with the aim of developing and strengthening the stewardship of Natural Science collections in the West Midlands. Much of the work on this project so far was completed by Vicky Tunstall, building on the work she did as part of a two-year traineeship to support stewardship in the region. The project is now being managed by Holly Sievwright, Assistant Collections Officer at The Potteries Museum and Gallery, Stoke-on-Trent.

This advice pack was originally written by Vicky Tunstall, and adapted by Holly Sievwright in February 2012.

Contents List

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1. Introduction

Often it's a box in the corner of the store that catches your eye. You are sure that you've never seen it before and yet there it sits. It either has nothing marked on the outside, or helpfully suggests 'rocks,' or some other such random wording.

Upon opening said box, which incidentally could just as easily be a drawer, cupboard, or a miscellaneous bag, it does appear to contain rocks! It looks like you have found that geology collection you suspected you had but could never find. What's the next stage? What is a geology collection and what should it look like? Where do you go for help?

The following advice pack is designed to be used by organisations and institutions who hold a geological collection, but who do not have a subject specialist on site dedicated to these particular collections. It is hoped that the information contained will be easily accessible for non-geologists. I have assumed no extensive geological knowledge, and have endeavoured to stress and support a view that good curation goes a long way to understanding a geology collection.

There are plenty of excellent publications available, which deal specifically with geological collections, yet I suspect those who perhaps really would like a helping hand do not know about them. Another aim of this advice pack is therefore to bridge this knowledge gap, by recommending good literature, sharing best practice and ensuring that those who need it know where to seek help and advice on managing their geology collections.

Geological collections are often considered to be relatively indestructible. For the most part this is a true, but much generalised assumption. As with any collection, a knowledge and understanding of its foibles is just as important as the curation of the artefacts and specimens. In turn, this extra information can be used to engage, communicate and interpret the collection effectively with staff and visitors alike.

With respect to curation, much will be familiar and applicable to other disciplines, although there are particular points associated only with geology. The format of the pack, with short sections split into topics such as Storage and Conservation, should facilitate the easy retrieval of relevant information.

I hope that this Advice Pack is written so that whoever works with the geology collection will gain confidence and feel as though they can open up more of the collection, while knowing where to seek advice if necessary. Having a basic understanding of geology collections should give you ideas on how to organise the collection within your organisation, and by finding out what you have, and why, you can ultimately determine the best way of using your geology collection.

So in order to get started, firstly return to that box / drawer / cabinet. Persevere with it and get it straightened out. Next time it raises its rocky head, it will be on your terms when you want it to.

Good luck!

Holly Sievwright & Vicky Tunstall

February 2012

2. Identifying what's in your collection

Geology sits as a Natural Science discipline incorporating the study of the materials which make up our planet, the processes that affect these materials, the products that are formed from them, and the history of life forms. Geology collections include any naturally formed specimen that has not been worked by, or associated with, mankind. The exception to this are extracted raw materials from industries, such as coal, tin and clay. The crossovers and links to other disciplines are briefly discussed in section 2.2.

Determining the size of your collection and what it contains will inform how best to organise it, and ultimately how to use it. Working through it systematically, making notes along the way, will make the following points easier to spot.

- Is there any existing order within the collection? This will inform the future organisation and level of classification required. Further organisation of the collection will become clearer where systems of classification are adopted. Section 5.2 provides a suggested outline of classification.
- Are there any conservation problems to address?
- Does anything link the boxes together? – same material, collectors, all minerals etc...
- Do the specimens have any numbers or labels?
- Is there a collection within your collection? i.e., is it made up of material from one or several donors?
- What material does it contain?
- How much is accessioned / registered?

2.1 Is it a Mineral, Rock or Fossil?

These three categories are the largest systematic method for identifying geological material.

2.1.1 Minerals

Figure 1. A variety of minerals.

Minerals make up rocks. They are naturally occurring, inorganic elements or compounds of elements. Their structures at the atomic level produce characteristic chemical compositions, physical properties and crystal forms. Minerals can be grouped according to their chemical classification, for example, oxides, silicates, sulphides, etc.

Examples of minerals include quartz, gold, native copper, feldspars, micas, fluorite, pyrite (Fool's Gold), malachite... (Fig. 1).

2.1.2. Rocks

A rock is made up of a variety of minerals. Occasionally it can be composed of only one type of mineral, e.g. some sandstones. Rocks are split into three primary categories: Sedimentary, Igneous and Metamorphic.

Sedimentary rocks form on dry land or in water, by the consolidation of sediment that has settled out of air or water.

Sandstones, conglomerates (pebbly sandstones), limestones (carbonate rocks), and mudstones are all types of sedimentary rock (Fig. 2). These can be sub-divided still further, but at a basic entry level, this is sufficient.

Figure 2. A selection of sedimentary rocks.

Figure 3. Crystalline igneous rocks

An *igneous rock* originates from molten material deep within the Earth. Igneous rocks are generally characterized by having interlocking crystals. Igneous rocks that cooled within the crust are called *intrusive*. Those formed from magma that has solidified on the surface are *extrusive*. Mineral composition and proportions strictly define the sub-divisions of igneous rocks.

Types of igneous rocks include *intrusive* granites, gabbros, diorites and peridotite, and *extrusive* volcanic rocks such as basalt, andesite and rhyolite (Fig. 3).

Metamorphic rocks form from pre-existing rocks that are subjected to significantly high pressures and temperatures, which change the rock's structure and texture. The classification of metamorphic rocks depends on the degree and type of metamorphism.

Metamorphic rocks include shales, slates, phyllites, schists and gneisses. Metamorphosed limestones are marbles. Igneous rocks, which have undergone changes in their mineralogy due to temperature and pressure, are also classed as metamorphic (Fig. 4).

Figure 4. Classic metamorphic rocks including slate & schist.

2.1.3 Fossils

Fossils are the preserved remains of, or evidence for, extinct or ancient organisms. They are usually formed by the rapid burial and mineralization of the organism, particularly of hard tissues like bones, teeth and shells. This chemical change makes the fossil more resistant to erosion than the surrounding rocks.

Figure 5. Fossil selection spanning over 500 million years.

Fossils usually form in sedimentary rocks such as limestone, mudstone and coal measures, the fossils themselves might then be formed of minerals such as limestone phosphate or pyrite.

The rock record has within it over 700 million years of past life. Fossils are often grouped stratigraphically (keeping the same age fossils together). Within each time period they can then be ordered taxonomically, according to the biological tree of life. Whilst learning and understanding this taxonomic system is beneficial when dealing with a large collection, classification according to simple names is a more productive starting point. You may, for example, be able to distinguish between an ammonite and a trilobite, a fern and a crinoid (Fig. 5).

2.2 Anomalies

When trying to sort a geology collection, please note that there are crossovers when sorting them into rocks, minerals or fossils. Examples would include deciding whether a fossil assemblage belongs to its rock type (e.g. limestone), or to the predominant fossil it contains. Perhaps your collection contains an excellent sample of a mineral embedded in a rock, and should be with minerals rather than the rocks.

Essentially, it comes down to how it will best fit into your collection and what value or purpose the specimen has within its assigned category.

Further sub-divisions of the collection may be possible, once divided into rock, mineral or fossil. Section 5 outlines these and, whilst providing more detail in the classification and recording of geological nomenclature in your documentation system, will relate to the storage plan for your geology collection.

There is always assistance available, and you should choose whatever is the most comfortable and suitable to the collection and policies of your Museum or Heritage organisation. Section 8 details useful contacts that will be able to help.

Other disciplines, for example archaeology, decorative arts, or social history may also be relevant to the geology collection.

2.2.1 Ornamental?

Many rocks, minerals and fossils polish very well. For this reason, they have been used for thousands of years for their aesthetic appearances and properties.

Collections acquired through bequests or donations may include jade or ivory figures, ornamental pieces from semi-precious stones and jewellery. These are classed as decorative arts. Alternatively, if the collections management system allows, they could be accommodated amongst the social history collection, especially if they have come from a significant figure from your local area.

It is worth noting that some susceptible geological specimens may be contained within these artistic works. Further information on these and any display considerations is in section 7.2.1 of this pack.

2.2.2 Geology, Building Stones or Archaeology?

As previously mentioned, geology and archaeology are closely related disciplines. The best way to distinguish archaeological artefacts from geological material lies in the distinction of whether man has interacted with the material. An approximate date for the boundary between archaeology and geology is around 2 million years (Ma) ago.

For example, a piece of chert (flint) will fracture if struck. However, if a human has knapped it, it is archaeology. Problems arise when naturally eroded flint takes a shape similar to that of purposefully worked pieces.

Unfortunately, there will be confusion especially amongst the not-very-clear bits. Unless it has archaeological documentation associated with it, then if it looks like a stone it probably is and should be in the geology collection.

Stone material used in buildings may also be accessioned into the geology collection. Examples would include carved architectural or sculptural features, paving slabs of slates or sandstones, and polished marbles or granites used for floor, surface tops and wall coverings.

3. Understanding Geological Time & Terms

3.1 Geological Time

The geological timescale covers the 4.6 billion years (4600 million or 4600,000,000) of Earth's history. Very little is recorded of the first two-thirds of the Earth's history and most of the rocks collected today were formed between 500 and 65 million years ago. We have evidence of past life in the rock record from up to approximately 700 million years ago.

Major time divisions of geological **eras** mark dramatic changes or events in the history of the Earth. The ages of rocks are assigned to time-based units called **Periods**. The **strata** (segments of rock) these relate to are called **Systems**. Further divisions are made, until eventually individual rock layers (strata), or beds, within larger rock **formations** are named.

The following chart highlights a simple timescale, as this is a useful aid for a 'what's older?' type of exercise. Listed over the page are links to finding supporting resources and more geological charts.

EON	ERA	Period	Key Events (within Period)	Age in millions of years
Phanerozoic	Cenozoic	Quaternary	Evolution of humans	0 to 2
		(Tertiary)	Mammals diversify	2 to 65.5
	Mesozoic	Cretaceous	Extinction of dinosaurs First primate First flowering plants	65.5 to 145.5
		Jurassic	First birds Dinosaurs diversify	145.5 to 199
		Triassic	First mammals First dinosaurs	199 to 251
	Upper Palaeozoic	Permian	Major extinctions Reptiles diversify	251 to 299
		Carboniferous	First reptiles Scale 'trees' Seed ferns	299 to 359
		Devonian	First amphibians Jawed fish diversify	359 to 416
	Lower Palaeozoic	Silurian	First vascular land plants	416 to 443
		Ordovician	Sudden diversification of metazoan families	443 to 488
		Cambrian	First fishes First chordates	488 to 542
Pre Cambrian	Proterozoic	Ediacaran	First skeletal elements First soft-bodied multi-cellular animals First animal traces	542 to 4600
	Archean			

With improved dating techniques and greater study of geological strata around the world, the boundaries between individual beds of rock and the systems they belong to are changing.

This means that the terms now used are increasingly standardised internationally within the geological community. This has resulted in some terms, including *'Tertiary,' 'Old Red Sandstone'* and *'Bunter Pebble Beds',* becoming obsolete.

However, it is extremely useful to retain records of old nomenclature given the age of the collections held in our organisations. Many of the collectors' original labels will use these older stratigraphic terms.

Useful geological charts are available from:

British Geological Survey (BGS)
'Make-a-map' interactive British stratigraphy - *http://www.bgs.ac.uk/downloads/browse.cfm?sec=8&cat=41*
Geological timeline interactive presentation - *http://www.bgs.ac.uk/downloads/browse.cfm?sec=8&cat=42*

International Stratigraphic Chart
http://www.stratigraphy.org/ics%20chart/09_2010/StratChart2010.pdf

Keele University
http://www.keele.ac.uk/media/keeleuniversity/facnatsci/schpgs/esg/esgdocuments/Keele_geol_map_timescale_print.pdf

Books
For reference list, please see section 8.4

3.2 Geological Terms

Having the confidence to tackle terminology allows for greater understanding of any collection and this, in turn, will inform the kind of interpretation you use to display the specimens.

Further research is generally possible if you have knowledge of simple terms. On the other hand, having a vast knowledge ensures translation of information into more simple terms.

The Dorling Kindersley Eyewitness Guides are excellent for basic identifications. They have good quality photographs, giving short, clearly written 'definitions', and are available in all good bookshops. Lists of full titles and similar publications are in section 8.4.

When dealing with a specimen that has good geological data, any geological dictionary is worth having to hand. Pick first the easiest terms from the collector's label. The information supplied may say, for example, the specimen is **'Portland Limestone, oolitic - Tithonian'**. Working in order, through increasingly technical jargon means you can take on as much information as required for your purposes, thus:

Limestone - is a sedimentary rock
Portland - gives an *indication* as to where this type of rock is commonly found (but do not assume this is where it was collected from)
Oolitic - tells you that this is a particular type of limestone
Tithonian - typed into a reputable search engine on the internet, or referred to in a geological dictionary, should inform you that this particular bit of limestone is **Jurassic** in age, approximately 145 million years old.

3.3 Geology of the West Midlands

Each region of the UK has its own specific geology. The land is composed of different rock types and the composition is dependant on the way in which the land was formed. The underlying geology has influenced the land use in a particular area throughout history and this often relates directly to the types of industry, settlement and agriculture that have developed.

As a case study, below we provide more detail about the geology of the West Midlands region. Counties within the West Midlands region include Herefordshire, Shropshire, Staffordshire, Warwickshire and Worcestershire, and major population centres include Birmingham, the Black Country and Stoke-on-Trent.

The underlying geology of the West Midlands has produced a landscape which is rich in economic resources. Our heritage, whether industrial or agricultural, is rooted in these spectacular natural features.

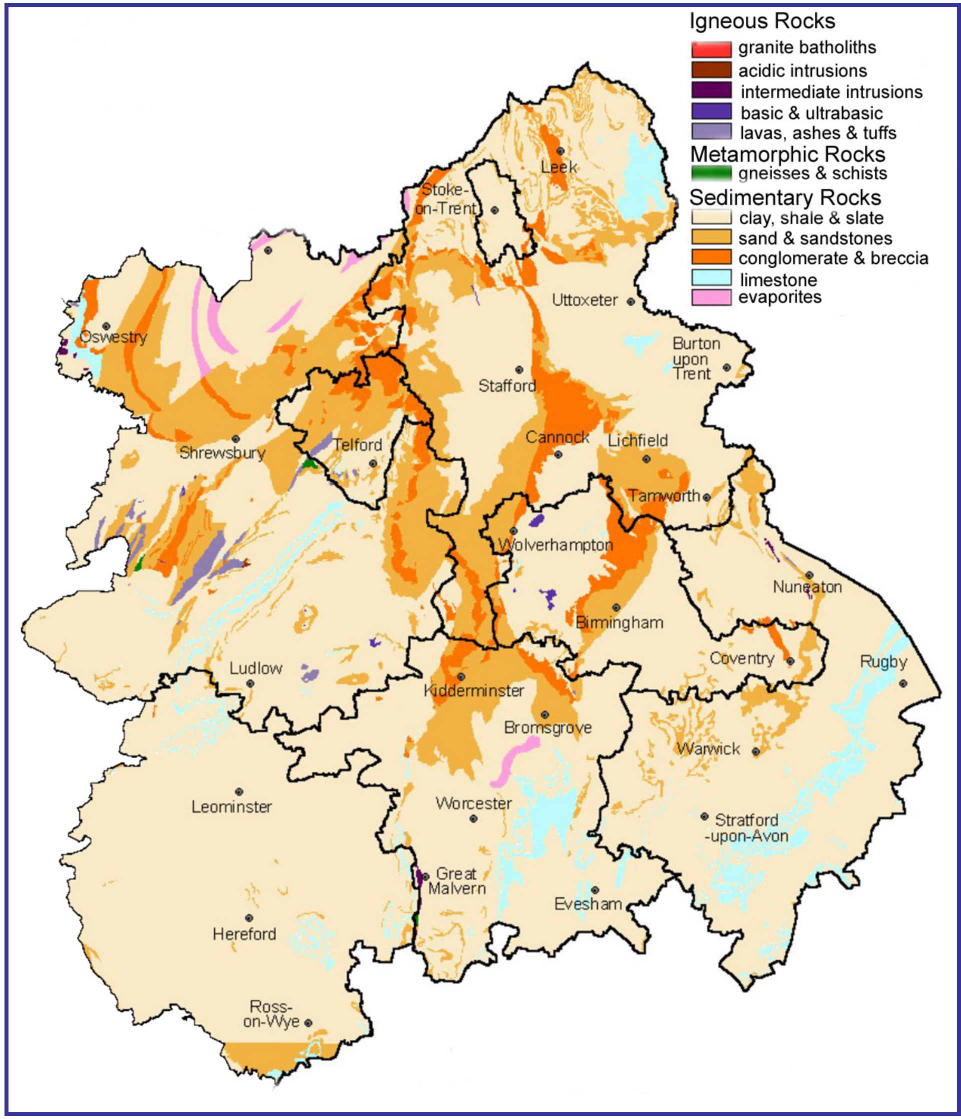
The variety of our natural geological wealth is reflected in the collections held in the region's museums and heritage organisations. Existing, large geology collections can assist the non-geologist who holds a smaller or orphaned collection by providing a useful reference for unidentified material. Contacts for the West Midlands are available in section 8.3.1. For further information about geology collections specialists in your area, please contact the Geological Curators Group, NatSCA or the authors of this advice pack (Holly Sievwright or Vicky Tunstall).

Whilst it is not practical to list each rock, fossil or mineral that occurs in each county, or indeed in each geology collection, a visual representation of the geology of the region created by the West Midlands Geodiversity Partnership is presented in Figure 6. It is especially useful to compare this with the other counties map*, which provides a simplified overview as to the ages of the rocks (Fig. 7).

The table (p13) suggests an overview of specimens typically associated with rock ages, terms commonly used for each age, and a list of broad geographic locations. Please note the locations used in the table are taken directly from the geological sheets (maps) that make up the West Midlands, and should be interpreted with the location listed as being a 'central' starting point of a wider area. Section 3.1 provides ages for each of the geological periods in the timescale.

Geodiversity Action Plans (GAPs) provide more details of the geology for the counties, with more information on these in Section 8.3.5.

* Map digitally adapted from BGS sheet maps of areas in West Midlands



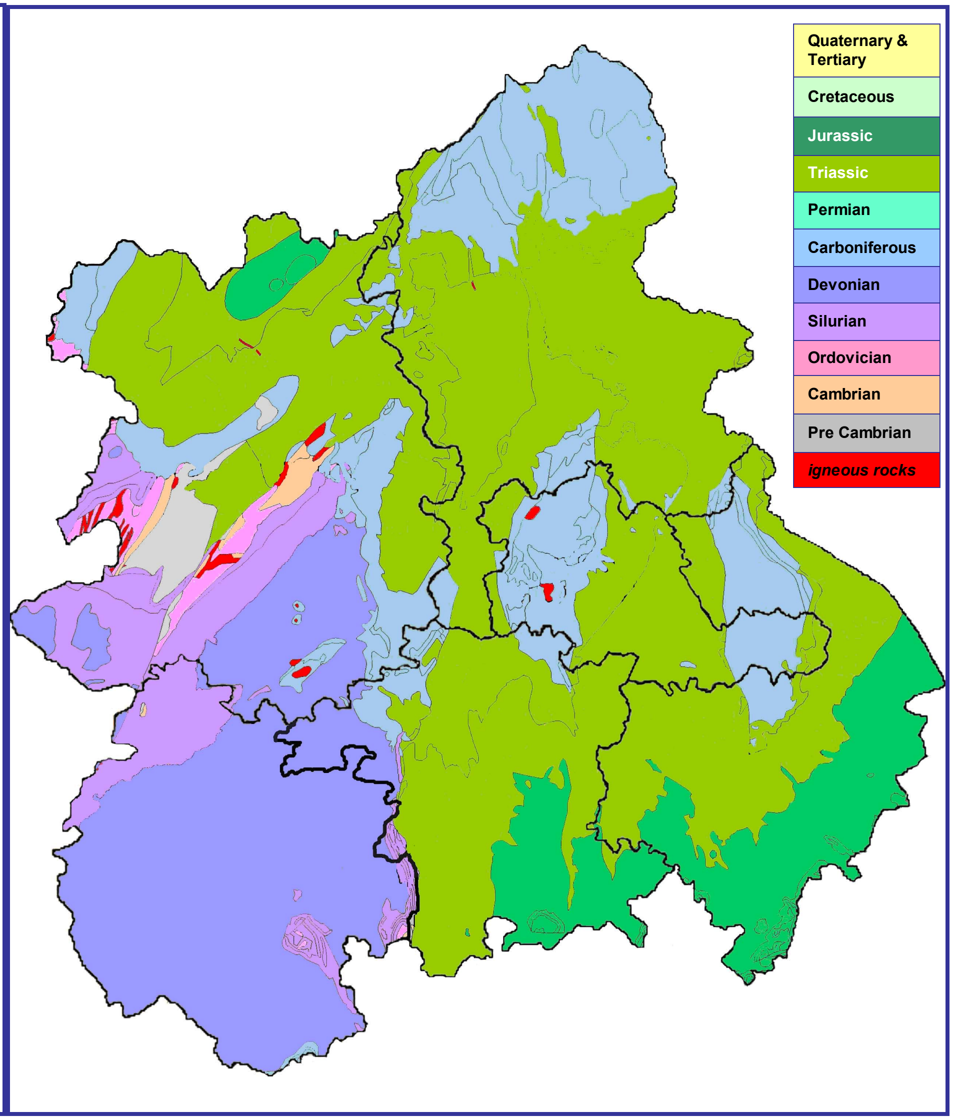


Figure 6. Rock types in the West Midlands (From www.geowestmidlands.org.uk)

Figure 7. Geological ages of rocks in the region

Period	Typical rocks	Typical fossils	Commonly used terms/phrases	Areas found in?
Quaternary & Tertiary	Superficial, drift & alluvial deposits, boulder clays, glacial erratics.	Extinct animals, or those no longer found in Britain, e.g. mammoths, woolly rhino, bears, elk, auroch	Recent, Pleistocene, Kent's Cavern, Red Crag	All of the West Midlands. The majority of bedrock material outcrops in the South East of the country
Cretaceous	Chalk, sandstones	Brachiopods & bivalves (shells), gastropods (snails), ammonites, echinoids (urchins, crinoids & starfish), crustaceans, dinosaurs.	Greensands Maastrichtian, Chalk, Gault.	Specimens are held in collections across WM but few outcrops of this age in region
Jurassic	limestones, mudstones, sandstones	Dinosaurs and marine reptiles (e.g. ichthyosaurs), fish, plants, ammonites,& belemnites, bivalves, echinoids	Purbeck Marble, Lias, Portland, Kimmeridge, clays, jet, oolite, *Dactylioceras*	(Birmingham), Worcester, Stratford, Warwick, (Redditch), (Droitwich)
Triassic	red sandstone, conglomerate (rounded pebbles)	Marine reptiles, dinosaur footprints, turtles (Chirotherium)	Rhaetic, Bunter, Keuper, Sherwood, Mercia	Stoke-on-Trent, Stafford, Oswestry, Burton, (Shrewsbury), Wolverhampton, Lichfield, Dudley, Birmingham, Worcester, Stratford, Warwick, Redditch, Droitwich
Permian	sandstones & conglomerates		Grouped with the above age of rocks as 'Permo-Triassic,	(west of) Wolverhampton, (?Birmingham), Worcester, Stratford, Warwick
Carboniferous	coal, marls (clays), sandstones, limestones. Key terms	Plant fossils (ferns & lycopods); vertebrates; goniatites ('early' ammonites), corals, bivalves, crinoids, brachiopods	Mississippian, Coal Measures, Millstone Grit, Pennsylvanian, Lower Carboni-ferous Limestone, Etruria Marl	Ludlow, Stoke-on-Trent, Church Stretton, Stafford, Oswestry, Burton, (Shrewsbury), Wolverhampton, Lichfield, Dudley, Birmingham, (Worcester), Stratford, Warwick, Redditch, Droitwich
Devonian	red sandstone, conglomerates (pebbles)	Fish, trilobites, gastropods, brachiopods, bivalves	Old Red Sandstone, Ludlow Bone Beds, Downton	Ludlow, Church Stretton, Dudley, (Birmingham), Worcester, Hereford, Droitwich
Silurian	fossiliferous limestones, purple shales & mudstones	Trilobites ('Dudley bug'), brachiopods, graptolites, corals, crinoids, gastropods & bivalves	*Calymene*, Wenlock, Ludlow, Llandovery	Ludlow, Church Stretton, Oswestry, (Shrewsbury), Dudley, Birmingham, Hereford, Droitwich
Ordovician	slates & shales, limestones	Echinoids, graptolites, brachiopods, trilobites	Caradoc, Arenig, Tremadoc	Oswestry, Shrewsbury, (Worcester)
Cambrian	quartzites, sandstones, limestones, shales	Brachiopods, trilobites, sponges, gastropods *Lingula*,	Harlech, Wrekin, Malvern, Hollybush	Shrewsbury, (Worcester), (Warwick), (Redditch)
Pre-Cambrian	volcanic			Church Stretton, Shrewsbury, (Wolverhampton), Worcester, Hereford, (Droitwich)
igneous rocks	dolerite, dyke, lavas, ashes, tuffs			Intrusions into most of the rocks in various forms & of various ages

4. Ways of Using Geology Collections

Geology is a great integrative science. Not only does it embrace both natural and physical sciences, it also complements and inspires the arts and social disciplines. Often it is the non-geologist who really sells it, as these are the best people to provide a hook or seek out an interesting fact in order to engage others.

4.1 Display

Display obviously relies on factors such as the size and content of your collection, the amount of information you have with the specimens and what you wish to do with the collection. Consider the audience you are trying to attract and try to base your displays around a theme, key message or a story.

Questions make good starting points when deciding how to best to create a display. They also inform how familiar you need to be with the collection in order to answer them.

Figure 8. Samples of raw materials and their uses on display at Claymills Victorian Pumping Station.

Here are some examples:

- *Will the collection be assigned a dedicated geology gallery, or be used in a small display?*

Some museums have a geology gallery because of the historical layout of the building, the interests of a past curator, or because there is a strong natural science collection.
If you do have a geology gallery, think about its focus - does it look at the entire geological story, or just the local rock history? Maybe there is a great specimen that deserves a display in its own right.

Tightly focused small displays can be very successful, but should be integrated with the rest of the collections. For example, Claymills Victorian Pumping Station in Burton-on-Trent, Staffordshire use their collection to show the natural origins of the finished metals products used across the site (Fig. 8).

- *Is it a collection of local material?*

Local material will often make the best small display. Understanding local landscapes, for example using natural resources in industrial areas, is a subtle way of using geological samples. The Potteries Museum & Art Gallery incorporates geology into its Natural History gallery, by showing characteristic habitats that arise from the local geology.

- *Is the collector locally significant?*

Material collected by a local figure would open up different methods of interpretation, maybe even creating first person costumed encounters. Perhaps the material was collected from overseas? In this case, the collector and their travels will have stories.

- *Permanent or Temporary?*

This is dependent on how previous questions have been answered. Two examples of temporary displays at The Potteries Museum & Art Gallery have included showing an overview of geology in the West Midlands, and incorporating the story of Darwin as a geologist into a display for the bicentenary of his birth (Fig 9).

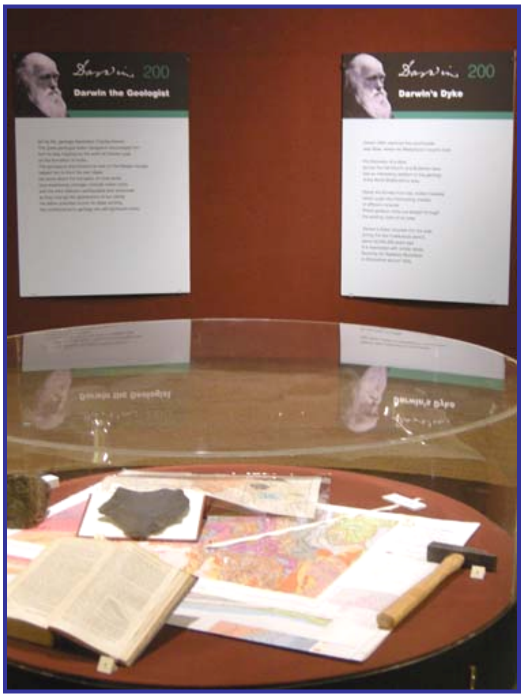


Figure 9: A small temporary display for the Darwin bicentennary at The Potteries Museum & Gallery.

- *Will any of the collection complement a larger exhibition or display?*

Geological specimens can make interesting objects that relate to other disciplines including fine arts, local history and natural history.

An Arts exhibition, for example, may include some decoratively carved works or jewellery – are there uncut stones or rocks in your collection that show how the objects started from raw materials?

Natural forms often inspire artists and sculptors – you could try to commission a work from such specimens or display attractive fossils alongside works of art.

Geology often determines human developments and has an impact on local history. This is especially evident in the West Midlands, where many urbanised areas are linked by their mining and industrial heritage. For example, geological specimens can be used to explain technical processes such as those used in the ceramics industry, presenting the raw clay material and minerals used in glazes alongside fired and finished products.

The majority of Natural Sciences displays appeal to young and old alike, and provide opportunities for the incorporation of key environmental and educational messages concerning issues like climate change and evolution. It is relevant to highlight again that the geology of an area determines its biological flora and fauna, literally underpinning the habitats of local wildlife.

- *Are other formats possible?*

If there is limited space to give over to a geology display or exhibition, try opening up the collection in other ways. Events such as training days and identification session can make use of specimens. Perhaps biologists need to be able to identify rock types when on fieldwork, or those who work with asbestos may never have seen a natural form.

Behind the scenes tours of stores allow the public, specialist groups or colleagues to see something a little different and aspects of collections that are not out on display.

It is important to take advantage of different media and new technologies: the internet can provide an alternative display and a view of stored collections; podcasts or videos in galleries and exhibitions provide a different interpretation style.

4.2 Activities

Both family-friendly and educational activities have the potential to provide better access to your geology collection. Here are some additional ways of using a geology collection:

- Work with local schools and artists to create artwork inspired by fossil collections and local environment.
- Initiate geology-based educational workshops and displays with materials from collection, e.g.

  - Using the fossils, especially the tree bark/seed pod fossils to explain the formation of fossil fuels and where the name comes from, raising awareness of sustainability of resources and alternative energy. This can link with local coal deposits and industry.

  - Past and present uses of different rocks. Flint arrow heads, sand-glass, obsidian-glass, chalk, marble for marbles, flint/chert/Cornish stone/clay in the pottery industry.

  - What is clay/ how can we use it?

  - Look at fossils and discuss or design a modern descendant. Create your own evolutionary chain?
- Devise activities to use the collections at drop in sessions during half term, e.g.

  - Fossil moulding and casting

  - Rocky socks. Hide a 'feelable' shaped fossil in a long walking sock and get people to guess / draw what they are feeling

  - Colouring, cutting and sticking flicker books showing the formation of fossils or the rock cycle.

  - Guess the curio. Bring out an unusual rock or fossil for visitors to ponder what it may be.
- Create word searches and quiz sheets that relate to rocks and minerals, particularly if there is a relevant display to see.
- Produce loan boxes of fossils, minerals or rocks for use with school and community groups outside of the museum.
- Design gallery trails that are inclusive of geology in the building – look for worked natural stone as architectural features or sculptural pieces.
- Encourage local amateur geology groups to hold events at the museum.
- Incorporate geology collections into booked behind the scenes guided tours.

Designing associated activities and uses for the collection is much more appropriate when physical specimens are used. Maybe some of the displays will even lend themselves to becoming activity boxes once the display is over.

5. Documentation, Classification & Organisation

5.1 Documentation

The SPECTRUM standards are the principle guidelines for the documentation of all museum collections[†]. They are the basis for achieving accreditation status. This section therefore assumes processes exist, or are planned, that conform to these standards from the Collections Trust (formerly the Museum Documentation Association, MDA).

The degree of data held with specimens determines the relevance, importance and value of the geology collection to your organisation. It is important to keep previous labels and associated information with the specimen where possible. Do not dispose of old labels, wrapping and mounts which include information about the specimen. Where separation is necessary, a cross-referencing tool needs to be in place between the locations of the specimen and additional documentation, e.g. specimen files, card index, with the same number on all pieces of documentation relating to one specimen.

Should only minimal data exist, for example you may only know the name of the collector, check if additional information is available from other organisations. Support networks can prove very useful, with contact details listed in section 8.3.

Older geological collections that include type or figured specimens, particularly of fossil material, cannot be replaced. Sites from where they were originally collected may be lost either because they have been exhausted, protected, destroyed or built upon. Try not to simply assign these for education / handling use, or dispose of them just because of a lack of, or little data, through misplaced documentation. Again, seeking further advice will determine whether a destructive end is appropriate.

Where little or no data exists, and no further information is available, then opening up your geology collection may actually become easier as you have no curatorial restraints. Ideas for handling geological material are in section 4.2.

When the decision is made to accept an item into the collection, gathering and recording information is vital; it needs to be relevant, organised and accessible.

Unless the documentation system is entirely new it is usually appropriate to use a workable, established system if one exists within your organisation. This will cover everything from how initial entry is recorded to how individual items are numbered and marked.

Any documentation should allow for cross-referencing, tying in the associated computerised and paper records with the same number given to the item. A useful test is to see whether an item can be found from the paperwork, and vice versa. Above all, be consistent.

Is there one continuous document for the entire collection, without discipline divisions? Alternatively, are there separate files for each discipline? Regardless of how the system is managed, it is logical that each discipline still be grouped clearly to make searches easier, i.e. top-level entry should record whether an object is Arts, Archaeology, Natural History etc., whilst still remaining integrated into the collections management system.

[†] Website address for SPECTRUM standards is listed in section 8.3.5

5.2 Classification & Organisation

The degree to which the collection is classified and organised, the associated documentation etc., will depend on type and size of collection held. However, where a sizable collection exists, having it clearly and logically organised will make the specimens much more accessible and usable from day to day.

Fossil specimens are commonly categorized first by geological age (e.g. Carboniferous), then biologically (all the Carboniferous brachiopods together) and geographically if required (e.g., Staffordshire Carboniferous brachiopods).

Rocks are generally split into igneous, sedimentary and metamorphic then arranged stratigraphically (see table opposite).

Minerals are usually grouped using the Dana or Hey chemical classifications as age is often not readily determinable. Other published works including Geology & the Local Museum (Knell and Taylor, 1989) also provide a logical classification system. (See section 8.4 for a full reference list.)

The suggested format overleaf will assist with classification. In addition, it provides a basic lexicon of geological terms, applying to specimens regardless of their geological age.

i. Top level entry	ii. Is it a ….?	iii. What type?	iv. What is it?[‡]	
Geology	Rock	Sedimentary	Conglomerates (pebbles stuck together) Breccias (stuck angular fragments) Pebbles	
			Sandstones Sand	
			Mudstone Shales Muds Siltstone Marls (lime-rich mud) Clays	
			Limestones Chalk Fossiliferous Stalactites	
			Ironstones	
			Coal Peat	
			Structures	Ripple Marks Desiccation cracks Nodules Trace fossils
		Igneous	Extrusive	Basalt
				Andesite
				Rhyolite
				Pumice
				Pyroclastic
			Intrusive	Granite
				Peridotite
				Gabbro
				Diorite
		Metamorphic	Shales Slates Phyllites Schists Gneiss Marbles Quartzites Greenschist Amphibolites	
		(Building stone)	(then categorise as from point iii onwards)	

[‡] List is by no means exhaustive, with categories lending themselves to further divisions

i. Top level entry	ii. Is it a ….?	iii. What type?	iv. What is it?§		
Geology	Fossil	Plant	Can be broken down still further into mosses, horsetail, flowering, seed-bearing, etc. as with botany collections	Examples of Carboniferous plants include *Calamites*, *Lepidodendron*, *Stigmaria*, *Neuropteris*, *Sigillaria etc.* There are plants from other geological periods too!	
		Animal	Arthropods	Crustacea	
				Trilobites	
				Insects	
			Bryozoa		
			Brachiopods		
			Cnidarians (corals mainly)		
			Echinoderms	Sea Urchins	
				Starfish & Brittlestars	
				Crinoids (sea lilies)	
			Graptolites		
			Molluscs	Bivalves	
				Gastropods (snails)	
				Cephalopods	Nautiloids
					Goniatites
					Ammonites
					Belemnites
			Vertebrates	Fish	
				Amphibians	
				Reptiles	
				Birds	
				Mammals	
			Worms & other misc.		
		Trace	Burrows, footprints etc.		
	Mineral	(Oxides, Elements, Sulphides)	Quartz Pyrite Gold Fluorite …..and so on		

§ List is by no means exhaustive; biological classification taken from Knell and Taylor (1998)

5.2.1 Methods of Marking Specimens

Marking is the application of a physical mark on a specimen. Where possible, the method used for marking geological specimens should be reversible and the two methods shown below are preferred. Undiluted acetone will remove both of these marks, but given the nature of most geological specimens, even reversible adhesives will cause some surface discolouration. It is important to note that the second method here is a much more difficult method to remove.

i) Using a paper label (Fig. 10):

- Using archival quality inks on acid free paper, clearly print the number assigned to the specimen.
- Leave to dry.
- Meanwhile select an appropriate place on the underside of the specimen to affix a label, and clean area if required.
- Cut label neatly to size.
- Fix label with the Paraloid B72 adhesive.
- When dry, seal with a top layer of the Paraloid.

Figure 10. A paper label used to mark a specimen.

ii) Paraloid & pen (Fig. 11):

- Select a suitable area to mark, preferably on the underside of specimen.
- Clean area if required.
- Using a soft haired brush, mark a Paraloid area on specimen big enough to write accession/ registration number in.
- Leave to dry.
- If required, apply a layer of artists' white acrylic paint and leave to dry.
- Clearly print number with archival quality inks.
- Leave to dry.
- Apply a top coat of Paraloid to seal number.

Figure 11. The Paraloid & pen method of marking specimens.

What is Paraloid?

Paraloid B72 is a solvent-based adhesive used in the repair of all manner of materials, with the exception of rubber. Unlike older methods of marking objects, Paraloid resists yellowing and cracking for much longer.

It is supplied either ready mixed in a tube form, or in crystals that require dissolving in solvent (acetone). See manufacturer's guidelines for mixing Paraloid and for shelf life. Both forms are readily available from conservation suppliers, such as Conservation by Design or Preservation Equipment Limited (PEL).

H&S note ***Use solvents in a well-ventilated room. Ensure that all tops to solutions are securely fastened and properly stored when not in use***

6. Storage & Handling

As with all collections, geological material requires good storage in order to prevent deterioration. Regulation of temperature (T), relative humidity (rh), light and atmospheric pollution will go a long way to maintaining good geological collections.

Incorrect levels of these parameters cause the majority of problems in geological collections, for example mould growth and pyrite decay. Inappropriate environmental conditions also increase the risks of museum pests, such as silverfish. Extremes in temperature and rh – as might be found in cellars and attics – can lead to the rapid deterioration of the collection. Try to avoid these locations unless regulated.

Environmental conditions will apply when displaying certain geological material. See examples in section 7.2.1

6.1 Conditions

Keep stores dark and insulated. Some glues, labels and minerals will suffer with exposure to intense light levels.

Maintain relative humidity levels between 45% and 55%. Humidifiers and dehumidifiers will assist in maintaining extremes, though rh cannot be ‘set’ as it is dependent on additional external factors, fluctuating inversely with temperature. It is therefore is easier to control the temperature, maintaining it around 20°C (± 2°C). Note that switching off lights and heating will cause fluctuations in temperature, and subsequently in rh.

Keep all geological material off the floor on shelving, where possible. Roller racking is ideal if space is at a premium. Wooden shelving, avoiding oak and birch, and metal shelving may be used, keeping in mind that metal will amplify vibrations. Metal and wooden cabinets with adjustable drawers are often used.

Where shelving is open, specimens need to be contained within sturdy, brown, archival boxes, or the ‘Really Useful’ transparent plastic boxes. This allows for ease of handling and reduces contact with air pollutants. Clearly label the outside of the box with its contents.

Geological specimens obviously vary in weight and size. Ensure that shelves or drawers are readily adjustable to allow for the different ‘heights’ of material. Accommodate the chunkier items in deeper drawers and boxes. Do not over load boxes. Keep storage boxes and drawers to a manageable size with a balanced weight, i.e., not all the weight at the back or to one side.

Overly large and heavy specimens require individually packing or covering. Store off the floor, but not at height. Examples may include large fossil plant stems, large ammonites, and some vertebrate material. Plastazote makes for an excellent cushioning material, perhaps used in conjunction with a wooden pallet base.

6.1.1 Packing within boxes & drawers

All individual specimens should be ‘wrapped’ or packaged (with labels!) within their larger storage boxes / drawers. This helps to prevent breakage and bruising of specimens, and again reduces contact with air pollutants.

Ideally, each specimen requires its own archival card box (PVC lid optional). The specimen sits in the box housed in Plastazote and acid-free tissue (fig 12). Accompany each specimen with an acid-free, archival card label. Complete details with archival ink.

Figure 12. Red Crag vertebrate material in boxes.

The Plastazote in which the specimen sits consists of two layers. One acts as a lining to the box; the second is placed on top with a tissue-lined, bespoke hole cut for the specimen. This method is useful for fragile and friable vertebrate material. Specimens in deeper boxes may require additional layers to hold them in place.

Acid-free tissue paper or see-through, archival zip-lock bags can work too. Acid-free tissue paper is readily available to use as a ‘nesting’ material within the larger card boxes. Do not get lost in the ‘wrapping’ of specimens; it is better to support specimens underneath, around the sides and avoiding their stacking (Fig.13 & 14).

Clearly marked bags and boxes mean that the specimen does not suffer unnecessary handling. Wrapping specimens tightly in too many layers, can lead to bruising and breakage, especially when it rolls out unexpectedly and therefore unsupported from the tissue. Do not use cotton wool as a packing material.

A basal layer of Plastazote is a method sometimes seen where material is in drawers. It becomes more labour intensive and expensive when further material is added to the collection or specimens needed relocating.

Figure 13. Tissue supporting specimens in card trays

Figure 14. A combination of packing methods protecting friable material; photo courtesy of Black Country Living Museum, Dudley.

Priority areas for repacking would include, in no particular order:

- fragile minerals
- friable material
- older collections
- specimens previously packed with cotton wool or in unsuitable cabinets
- specimens that require conservation work
- harmful specimens; whether to the rest of the collection or to staff
- specimens requiring microclimates
- where cleaned / repaired or other conservation work has been completed
- specimens that have been kept previously in unsatisfactory conditions
- whether there are funds available

6.2 Handling

There is no standard method for handling geological specimens. Many of the suggestions apply to other collections, and are included in the daily routine of good curation and common sense.

It is good practice to wear disposable gloves, and to wash hands after handling specimens – particularly if handling potentially hazardous, toxic, or unknown material. The card specimen boxes will eliminate the need to handle specimens directly, until required to do so.

Weight, size, composition, and fragility are just some of the factors that need consideration before handling specimens. Work closely over covered, flat surfaces to decrease the falling distance and impact if a specimen is accidentally dropped. Cover surfaces with tissue or Plastazote, placing specimens carefully on the side that they want to naturally sit on. Wedge with additional Plastazote support if required.

Expect that specimens will be heavy and avoid dragging across surfaces. If it is too heavy to lift, get help.

Expect that specimens are fragile – minerals with long thin crystals, splitting / flaking vertebrate material, sandstones rapidly becoming sand when touched, and previously repaired specimens are a few examples.

7. Conservation & Particular Problems

A key message regarding the conservation of geological specimens is not to attempt anything without first consulting a specialist conservator, or speaking to someone who can provide links and contacts. See Section 8 'Getting Help' for more details.

This section provides some guidelines towards achieving and maintaining a basic level of housekeeping care for a geological collection. Also covered are particular problems that this type of collection is susceptible to, with an outline of what to look for and how to address them. Much of that contained herein forms a précis to the Knell & Taylor (1989) and GCG publications.

Regular checks on collections should already be in place. Take preventative measures where able, especially if problems are spotted early. Good curation and conditions will help to alleviate or prevent some of these changes. Some changes cannot be arrested altogether.

7.1 Conservation

Problems do still occur despite good storage and monitoring of environmental conditions. The decision as to whether a specimen requires conservation is based on:

- size of collection
- value and relevance to organisation
- type of conservation required
- detail of associated documentation
- whether it is for display
- what the conservation problem is
- whether there are funds available for the work

Addressing these points means it is easier to decide how far to take the conservation. Specialist help is always useful, as this will assist in identifying further problems. Not dealing with the original problem will cause a newly conserved specimen to continue to deteriorate. Always record what conservation work has been completed and note the condition of specimen before and after work. Sustained or different periods of work on one object, may highlight particular trends within a collection e.g. too high rh, too low rh, which can subsequently be addressed.

7.1.1 Cleaning

Cleaning geology specimens means the removal of materials introduced to the specimen since entering the museum, such as dirt, dust, varnish, plaster, glues & adhesives. Most of these should not be removed unless absolutely necessary. Field or display preparations are not included in this definition, nor are techniques explained. Seek consultation when dealing with accumulated dust and dirt, as it forms bonds with surfaces. However, careful removal of excess loose dust is possible.

Where collections have previously been neglected, or kept in unfavourable conditions, specimens will most likely require dusting before being correctly packed and organised.
Severely decayed specimens will not survive cleaning. Keep a record of how many have been destroyed and any surviving labels kept if able or appropriate.

Make achievable and realistic targets ensures that the processes of cleaning, packing and organisation are in manageable chunks. Completing these tasks ensures that the collection will be more easily accessible and useable. Conservation courses are available from professional bodies, but the guidelines below will provide a basic starting point.

- In the first instance, only use a dry clean method (i.e. brush) – excessive amounts of water added to a specimen can begin or accelerate internal and surface decay processes. Only a trained conservator should undertake cleaning with solvents.
- Use a soft, natural haired brush to remove dust from the surface. A specialist should remove ingrained dirt. Use a stiffer haired brush if the specimen is robust enough.
- Mineral and rock dust is hazardous if inhaled or ingested – wear appropriate personal protective equipment (PPE) and dust in a well-ventilated area. A controlled suction vacuum cleaner is useful if there is no access to an air extraction system.
- Do not brush delicate or fibrous minerals – of course, if the layer of dust is such that the surface is not seen as fibrous *until* the dust has been removed, then stop dusting after excess dirt removal.
- Do not gouge out supporting material between fossils. This is classed as display preparation rather than housekeeping and requires additional, specialist help.
- If stable, patinas, new mineral growth surfaces, oxidised coatings etc. are best left. These provide a barrier to the 'internal' material and, whilst still a form of decay, often reduce the decay rate through their stability. Active decay does need addressing. Again seeking specialist advice is recommended.
- Decide the purpose of the specimen, for example, for display, research, or photography, to determine whether further cleaning is required.

7.1.2 Repairing & Consolidation

It is strongly recommended not to undertake repairs or consolidation. Seek specialist advice should a specimen be required for display purposes. Techniques favoured in conservation are reversible where possible – one starting point being the Paraloid B72 adhesive mentioned for marking specimens.

7.1.3 Microclimates

Consider creating unique environments ('microclimates') where it is known that specimens will encounter adverse environmental conditions.

Microclimates are a sealed environment – with the specimen placed in either an airtight box or a barrier film bag. They are often used in conjunction with silica gel to keep the rh down. It is useful to have an indicator type of silica gel, which can be changed and reused as required.

Some minerals (e.g. opal, melanterite) and recent fossils require consistently higher rh than 'normal' levels. Preconditioned silica gel is used to prevent these specimens drying out.

Other techniques are available, for example creating anoxic microclimates – these keep rh up but cut out oxygen and are ideal for pyrite shales. For further advice, contact the conservation departments at the National Museums Wales, in Cardiff, or within Birmingham Museums Service. The Geological Curators' Group is an also an invaluable source of information.

7.2 Particular Problems

Change is inevitable for some geological specimens, especially the native elements. Many materials, on exposure to surface conditions, are termed 'metastable'. That is, to remain in a stable form, they will rapidly change to suit their environment and are therefore very susceptible to changing environments. Essentially, good curation in correct environmental conditions is the key to ensuring the future of the specimens in geology collections.

Too high an rh causes a common problem known as pyrite decay. Specimens in orphaned and abandoned geology collections are commonly destroyed in this way. A more detailed explanation of pyrite decay can be found in section 7.2.4.

In the sub-sections below we list a few 'usual' things to look for and to be aware of, in terms of the properties of specimens composed of different types of materials. These lists are by no means exhaustive, but neither should they cause too much alarm where correct procedures are in place. Both Knell & Taylor (1992) and Howie (1989) provide further details. Help is always available from those listed in section 8.

7.2.1 Sensitive Specimens – i.e. to light, high rh, vibration

Alterations can be a slow process resulting in colour changes, splitting, shrinkage, powdering, disintegration, new mineral growth and crusts. These are caused by the specimens being subjected to inappropriate conditions. Light induced changes can also be attributed to the heating effect of light, such as those encountered through unfiltered sunlight. The table below lists a few specimens that are known to be 'sensitive.'

Material	Sensitivity	Recommendations
amber	• darkens with high light levels	• avoid high light levels
arsenopyrite	• damp conditions will cause formation of white arsenolite efflorescence	• keep dry and dust-free
baryte (barite)	• colour change on exposure to light • weight often unexpected • soft and bruises • some may produce colour change in high light levels	• careful handling • control environmental and display conditions • do not subject to severe temperatures
calcite	• effervesces (fizzes) with dilute hydrochloric acid • subject to bruising	• do not test unnecessarily • protect in storage • dry wet calcite slowly in air • do not subject to violent changes in temperature
cerussite	• decomposed by hot water • toxic - contains lead	• avoid • reduce handling
cinnabar	• darken or grey in light • toxic – contains mercury	• avoid • restrict handling
clays & shales	• may contain high proportion of iron-based minerals likely to suffer from pyrite decay. • risk of splitting if kept in severely fluctuating rh and temperature conditions.	• monitor environments
cuprite	• copper based	• keep as for sulphides & metals
fluorite	• all varieties, inc. Blue John, fade with exposure to intense light levels. • frequently associated with pyrite and marcasite • dust will seriously harm specimen, smoke & gases are particularly damaging	• keep in dry, dust-free conditions • do not use cold cathode tubes

gemstones	• turquoise, jade, topaz etc. may fade or experience colour changes, with exposure to intense light & heat levels.	• keep in dark storage • topaz esp. strictly limit display duration, to restrict exposure to light • turquoise, keep to shade in displays out of strong light
gypsum	• and all varieties including alabaster and desert rose, are very soft • solubility, slightly/slowly affected • associated with salts	• handle and store with care • keep in normal parameters
halite	• (salt) will liquefy on exposure to high moisture content in the air, solubility strongly affected	• avoid high rh
malachite	• decomposed by hot water	• use distilled water (at room temperature) to clean
melanterite	• brittle & decomposes in normal and low rh due to formation in cave / mine conditions	• keep rh in the range 57% - 95%
micas	• will take water into structure through capillary action	• do not submerge
opal	• dehydration leads to cracking, turning the specimen white and opaque (Australian opal not affected as formed in semi-arid conditions) • protect from abrasion and physical shock	• keep rh levels at 55-65% using a microclimate, keep out of strong sunlight
sulphides, metal ores & elements	• including galena, cassiterite, pyrite, chalcopyrite, sphalerite, hematite, iron, bornite, cuprite will suffer from decay if kept in high rh conditions. • assume that most will tarnish / oxidize on exposure to light, some even to air especially if moist. • many are toxic if ingested or inhaled. • association with pyrite and marcasite • galena irreversibly tarnishes on open display and in contact with air pollutants • galena is a coarsely crystalline material that can split by its own weight • copper tarnishes • many are associated with each other, so although will have oxides together they may contain some sulphides	• keep in normal rh levels • dust-free conditions are essential • remove from vicinity if close to pyrite decay • reduce handling
quartz	• all varieties, including agate (banded), amethyst (purple), smoky, rose, will fade with exposure to intense light levels	• keep light levels to medium/low
rhodocrosite & rhodonite	• the manganese content may turn black (oxidise) with exposure to intense light levels. • sensitive to shock through vibration	• control light levels
tourmaline	• demonstrates pyroelectricity in response to variable temperature conditions as found in sealed display case, and recognised by dust forming at one end or on faces of crystal	• heat filter on case light
vertebrate material	• prone to splitting in low rh conditions • surfaces may require consolidation; seek advice from a specialist conservator	• consolidation or microclimates
N.B. There are additional minerals that prefer to be in damp conditions. If any specimens are observed to ‘change’ under normal conditions, seek further advice from organisations with larger collections and/or specialist conservators, such as the National Museums Wales, Cardiff and the Lapworth Museum, University of Birmingham.		

7.2.2 Hazardous & Toxic

Assume that most specimens are toxic if ingested or inhaled. Not eating or drinking in the vicinity is common sense. All mineral dust is harmful if inhaled; however, guidelines stating dangerous volumes or time spans do not appear to be in publication. Correct storage is therefore essential.

Asbestos is a naturally occurring mineral. Keep any form in sealed containers, or double bagged, and treat as hazardous. Externally mark packaging as containing hazardous material. Known toxic minerals can be clearly marked with the conventional symbols, and should not be left where others would be able to handle them freely. Treat unidentified minerals with the same care, with immediate action taken in trying to get them identified.

Metal ores are often found in collections because they form attractive specimens. These include galena (lead), chalcopyrite (copper) and sometimes cinnabar (mercury). The latter gives off toxic vapour. All minerals listed in the table below are particularly nasty if swallowed in large quantities.

Moderate to highly toxic minerals	Method = ing (ingestion), inh (inhalation), s (skin)
antimony	Likely ing. & inh.
arsenic	Likely ing. & inh. and highly likely s.
asbestos minerals	Likely ing. & inh.
bornite	Likely ing. & inh.
cerussite (lead)	Likely ing. & inh.
malachite (copper)	Likely inh.
mercury	Likely ing. & inh. and highly likely s.
quartz	Likely inh.
vanadite	Likely inh.

7.2.3 Radioactive Hazards

This is not as alarming as it first sounds for small collections.

Three main radioactive hazards are:

- direct radiation from the specimen
- swallowing or breathing in radioactive dust from specimens which are breaking up
- the accumulation of the radioactive gas, radon, which is slowly emitted by these minerals.

In addition to specimen lists, both Knell & Taylor (1989) and Howie (1992) also provide succinct guidelines on this type of material. Some of the points they suggest are:

- Less toxic / hazardous specimens do not necessarily require additional storage conditions. Reduce handling and keep away from public areas, offices and workrooms.
- Do not breathe in air immediately after opening the storage boxes/cupboards.
- The most hazardous radioactive materials in collections are *pitchblende*, *uraninite* and other *uranium oxides*. These **do** require specialised storage, or removal to another institution that can hold this type of material.
- All radioactive specimens should be clearly marked with the standard radioactivity hazard symbol.
- The radiology officer at a local university or hospital can check levels.
- Half a dozen small specimens, handled rarely and stored correctly, present a negligible risk.

7.2.4 Pyrite Decay

Pyrite and marcasite contribute to the majority of conservation problems in geological collections. Fool's Gold is the common name for pyrite. Pyrite is one of the most common sulphides (FeS_2). It occurs in most types of igneous and metamorphic rocks, as well as in sediments of any geological age. In contrast, marcasite is relatively restricted to sedimentary rocks. The stable form of pyrite grows as identifiable cubes. The forms most susceptible to decay occur as nodules, minute crystals that are finely disseminated in sediments, and the infilling or replacement mineral in fossils.

The oxidation of these minerals, along with the resulting problems it causes, is commonly known as pyrite decay. Oxidation (or corrosion in metals) is the addition of oxygen into the chemical structure. Rust in cars is also a product of oxidation. Many methods have been tested, but none will stop the decay process completely. Creating stable environmental conditions with microclimates will help.

As the pyrite and marcasite oxidize, gases are given off and surface alterations often occur. The acidic oxidation products, for example sulphuric acid, will destroy labels and boxes, and may initiate decay in other specimens within close proximity. Therefore, it is not just sulphide specimens at risk. 'Pyrite decay' can destroy mineral assemblages, innocuous specimens, and even those believed to be pure specimens.

Surface alterations include the growth of white, pale green, grey or yellowish powders 'blooming' on the original specimen. Crystalline growths can also occur as the sulphide alters to a sulphate. This process involves an increase in volume, causing internal stresses and the destruction of specimens (Fig. 15).

Figure 15. Central specimen destroyed by pyrite decay

Totally destroyed specimens should be disposed of, with records kept of when and what (if known) was lost. Sieve through the powder first - there may be remains of other minerals that grew with the pyrite. Keep and file labels if they are still readable – again with a record of what has befallen the specimen. Record too the losses of accessioned specimens. If a specimen has just begun to show signs of decay, brush off the surface powder gently and put the affected specimen into a sealed microclimate. Assess the value of the specimen as to whether it requires treatment.

Decay continues even at low rh because of the nature of the reaction, therefore correct storage conditions are key to the prevention of decay. However, if material has been rescued from unsatisfactory conditions then, as with freshly acquired field material, it needs 'drying.' Use preconditioned silica gel. This will not shock the material too quickly, dry it out too rapidly, or induce any changes from exposure to too much air. Monitor carefully before being repacked. In short, there needs to be a period of acclimatisation.

The amount of time taken to dry will depend on the size of your collection, the type of material affected, and the space you can allocate to it whilst it is drying - perhaps rotate sections based on urgency. Whilst monitoring, note any changes to the specimens (colour change, loose surfaces etc.). It is a judgement call as to how long drying material will take.

7.2.5 Salt Efflorescence, Byne's Disease & Mould

According to Knell & Taylor (1989), salt efflorescence and Byne's Disease appear as white or colourless powdery, or hair-like, crystals on the surface of the specimen.

Salt efflorescence can affect any specimen, but will more likely affect those collected from coastal areas. Fluctuating humidity levels cause salts within a specimen to migrate to the surface. Newly collected material should be flushed with fresh water, unless friable or soluble, after which constant humidity should be maintained. Brush the powdery surface off affected specimens if necessary.

In contrast, Byne's Disease affects calcareous (lime-rich) fossils. Environments with a sustained rh greater than 60% cause volatile organic compounds (VCOs), such as acetic and formic acid vapours, to be released from certain storage or display materials. Birch and oak cabinets, felt, cotton wool, wood composites (MDF) and some glues readily form VCOs resulting in Byne's Disease. Unusual smells (vinegary) may also accompany a white powdery efflorescence.

Off-gassing can be monitored using silver strips within cabinets, cases, storage boxes areas etc. with a 'control' strip kept in an ideal, pollutant-free environment. It is then a matter of monitoring and recording how long the silver takes to turn black (tarnish), to determine whether something is actively off-gassing.

Mould can be confused with salt efflorescence and Byne's Disease. It will more readily affect labels and packaging, but gradually moves over specimens too. Symptoms of mould include brown flecks or spots, or the growth of hair like strands in white, brown, green or black. Environments with sustained humidity levels over 60% encourage mould growth. Treatment is with fungicide, by a specialist and moving the affected or treated specimens to environments with a lowered, stable humidity.

7.2.6 Splitting Specimens

Teeth, tusks, bones, shales (especially containing reptiles or plant fossils), wood and coal are particularly susceptible to splitting. Splitting includes the distortion and cracking of specimens. Fluctuating or low rh is the main cause, but sometimes vibration can affect specimens. A specialist conservator can consolidate these specimens, if friable. Prevention of splitting is through maintaining a constant rh of 50%.

8. Getting Help

8.1 Volunteer Programmes

Volunteers are an invaluable source of help – whether in volunteer-run organisations or within a museum with fixed staffing structure. They benefit from sharing and learning skills, working with different collections and assisting with accreditation procedures.

Suggested projects for volunteers include:

- Organisation, sorting and storage – particularly if collection is in unfavourable condition
- Marking and labelling specimens
- Documentation – especially at a basic entry level on collections management system
- Research – whether into a significant collector or specimen (those with specialised knowledge or interest can cross-reference any updated terminology where applicable).

8.1.1 Volunteer Initiatives

Different organisations run volunteer programmes throughout the country, offering structured training schemes, work experience, career development, life skills etc. The contacts below approach volunteering and the recruitment process from different view points.

Kim Thompson-Lawrence is based in North Shropshire as an Outreach Volunteering Officer. She will be able to provide information on finding and placing volunteers, as well as finding the relevant person to contact throughout the rest of Shropshire. Visit www.do-it.org.uk

Graham Worton, at Dudley Museum and Art Gallery has a team of up to 20 regular volunteers that assist with documentation, specimen curation and research. Many of the volunteers are students from nearby universities who have at least some geological knowledge. As well as regular weekly volunteers, groups of students come to Dudley to do volunteer work for periods of 1-4 weeks at a time, allowing them to gain experience in collections management and handling specimens and allowing the museum to work through and document large quantities of material to a high standard.

Most of the region's museums have at least some regular volunteers, giving one day or a half day of their time each week to help with curatorial activities. There are many more volunteer schemes available and it is worth speaking with your area's Museum Development Officer (MDO) to see what they are aware of in your area.

8.2 Funding Sources

When applying for additional funding it is imperative that the form / questionnaire is filled out as comprehensively and as clearly as possible. Your project being relevant and matching the funding criteria and bear in mind that some funding streams are only available to accredited organisations. Your MDO and other museums in your area will be able to provide additional lists and ideas. A few finding sources are listed below:

- Esmée Fairbairn Foundation
- Natural England
- English Heritage
- Big Lottery Fund and Heritage Lottery Fund
- Arts Council (previously Renaissance) / MLA
- DCMS / Wolfson Funding
- Designation Development Fund (MLA)

Small grants may be available from:

- Friends groups
- Local interest groups
- Businesses
- Universities

8.3 Contacts list

8.3.1 Geology Specialists in the West Midlands

The following contacts are qualified geologists and are all responsible for geology collections across the West Midlands region. *(Information correct as of February 2012, though job titles may vary.)*

Name: Graham Worton **Title:** Keeper of Geology **Organisation:** Dudley Metropolitan Borough Council **Address:** Dudley Museum & Art Gallery St. James's Road, Dudley, West Midlands, DY1 1HU **Specialist Field:** Geological Collection Care **t:** 01384 815575 **e:** dudley.museum@dudley.gov.uk	**Name:** Daniel Lockett **Title:** Natural Sciences Collections Manager **Organisation:** Shropshire County Council Museums Service **Address:** Ludlow Library & Museum Resource Centre, 7-9 Parkway, Ludlow, Shropshire, SY8 2PG **Specialist Field:** Natural Science Collection Care **t:** 01584 813665 **e:** llmrc@shropshire-cc.gov.uk
Name: Don Steward **Title:** Collections Officer (Natural History) **Organisation:** Stoke-on-Trent Museums **Address:** The Potteries Museum & Art Gallery Bethesda Street, Cultural Quarter, Hanley, Stoke-on-Trent, ST1 3DW **Specialist Field:** Natural Science Collection Care **t:** 01781 232323 (ext. 4312) **e:** naturalhistory@stoke.gov.uk	**Name:** Jonathan Clatworthy **Title:** Curator **Organisation:** University of Birmingham Museum **Address:** Lapworth Museum of Geology University of Birmingham, Edgbaston, Birmingham, B15 2TT **Specialist Field:** Geological Collection Care **t:** 0121 414 7294 or 6751 **e:** lapworth@contacts.bham.ac.uk
Name: Kate Andrew **Title:** Principle Heritage Officer **Organisation:** Herefordshire Heritage Services **Address:** Museum Resource & Learning Centre 58 Friar Street, Hereford, HR4 0AJ **Specialist Field:** Natural Science Collection Care and Geological Conservation **t:** 01432 383383 **e:** herefordmuseums@herefordshire.gov.uk	**Name:** Jon Radley **Title:** Keeper of Natural Sciences **Organisation:** Warwickshire Museums Service **Address:** Market Hall Museum Market Place, Warwick, CV34 4SA **Specialist Field:** Geological Collection Care and Field Services **t:** 01926 418182 **e:** museum@warwickshire.gov.uk

For geology specialists outside the West Midlands, please check information on the Geological Curators Group (GCG) website (see section 8.3.2).
You can also contact Holly Sievwright, Vicky Tunstall or Cindy Howells, who may be able to help find a geology specialist in your local area:

Name: Holly Sievwright **Title:** Assistant Collections Officer (Regional Geology) **Organisation:** Stoke-on-Trent Museums **Address:** The Potteries Museum & Art Gallery, Bethesda Street, City Centre, Stoke-on-Trent, ST1 3DW. **Specialist Field:** Natural Science Collection Care **t:** 01781 232323 (ext. 2439) **e:** holly.sievwright@stoke.gov.uk	**Name:** Vicky Tunstall **Title:** Curatorial and Teaching Support Technician **Organisation:** University of Leicester **Address:** Department of Geology, Bennett Building, University of Leicester, Leicester LE1 7RH **Specialist Field:** Geological Collection Care **t:** 0116 252 3369 **e:** vijt@le.ac.uk	**Name:** Cindy Howells **Title:** GCG Membership Secretary, Collections Manager (Palaeontology) **Organisation:** National Museum of Wales **Specialist Field:** Geology collections Care; information on regional geology specialists **t:** 029 2057 3354 **e:** Cindy.Howells@ museumwales.ac.uk

8.3.2 Subject Specialist Networks

Those who are listed in 8.3.1 form part of the Subject Specialist Network for Natural Science Collections. They attend the bi-annual meetings of the West Midlands Natural Sciences Curators Group – a larger body of people with responsibility for Natural History collections in the region.

This group also feeds into two specialist networks at national level:

- Natural Sciences Collections Association (NatSCA) is the UK's organisation for representing Natural Science Collections and associated museum staff. They hold regular meetings, seminars and trainings for members, in addition to producing publications and having a very active discussion email forum. More details at http://natsca.info/

- The purpose of Geological Curators' Group (GCG) is to improve the state and status of geological collections and curation. They too hold meetings, trainings, conferences, and produce publications. GCG, founded in 1974, has an international membership and is affiliated to the Geological Society of London. More details at www.geocurator.org/

8.3.3 Geology groups

Geodiversity Partnerships bring together geology groups, museum specialists and academic researchers in particular regions to share knowledge, influence planning decisions and policies and develop projects and regional geodiversity initiatives. These include:

The West Midlands Geodiversity Partnership - *http://www.geowestmidlands.org.uk/*

The East of England Geodiversity Partnership - *http://www.geo-east.org.uk/index.html*

London Geodiversity Partnership - *http://www.londongeopartnership.org.uk/*

Northwest Geodiversity Partnership - *http://www.nwgeo.org.uk/*

Yorkshire and Humber Geodiversity Forum - *http://www.yhgeodiversity.org.uk/*

Scottish Geodiversity Forum - *http://scottishgeodiversityforum.org/*

Many counties across the UK have active geology groups. Details can usually be found through the internet, through the geodiversity partnerships, or through The Geology Trusts, an umbrella organisation that supports the work of some of the major county geology groups. In the West Midlands local groups include:

- North Staffordshire Group of the Geologists Association (NSGGA)
- Staffordshire RIGS group
- Shropshire Geological Society
- Black Country Geological Society
- Warwickshire Geological Conservation Group
- Herefordshire & Worcestershire Earth Heritage Trust
- The Abberley and Malvern Hills Geopark

8.3.4 Additional Contacts

Museum Development Officers

Museum Development Officers (MDOs) provide advice, local information and support to museums in each county or area. Contact details for MDOs in each region that provides a museum development service are listed on the MLA website, following the links to find contacts in your region.

See http://www.mla.gov.uk/what/programmes/renaissance/regions.

8.3.5 Conservation Contacts

Name: Jane Thompson Webb **Title:** Acting Head of Collections Services **Organisation:** Birmingham Museums Service **Address:** Birmingham Museum & Art Gallery Chamberlain Square, Birmingham, B3 3DH **Specialist Field:** Collection Care **t:** 0121 303 4589 **e:** jane.thompson-webb@birmingham.gov.uk	**Name:** Dr Caroline Buttler **Title:** Geological Conservator **Organisation:** National Museum Wales **Address:** The Department of Geology National Museum Cardiff, Cathays Park, Cardiff, Wales, CF10 3NP **Specialist Field:** Geological conservation **t:** 029 2057 3213 **e:** through contact form on website www.museumwales.ac.uk/en/geology/contact/
Nigel Larkin Natural Science Conservation **t:** 07973 869613 **e:** enquiries@natural-history-conservation.com www.natural-history-conservation.com	**Simon Moore** Natural Science Conservation www.natural-history-conservation.com
Conservator Register www.conservationregister.com/index.asp	

The Walsall Box Company Ltd Bank Street, Walsall, WS1 2ER **t:** 01922 628 118 **f:** 01922 723 395 **e:** mail@thewalsallbox.co.uk www.thewalsallbox.co.uk/index.php	**Conservation by Design** Timecare Works, 5 Singer Way, Woburn Road Industrial Estate, Kempston, Bedford, MK42 7AW **t:** 01234 846300 **f:** 01234 852334 **e:** info@cxdltd.com www.conservation-by-design.co.uk/
Preservation Equipment Limited Vinces Road, Diss, Norfolk, IP22 4HQ **t:** 01379 647400 **f:** 01379 650582 e: info@preservationequipment.com www.preservationequipment.com/	**Ramplas Ltd** (Plastazote suppliers) 84 Birmingham Road, Dudley, West Midlands, DY1 4RJ **t:** 01384 453160 **f:** 0121 535 7108 **e:** info@ramplas.com www.ramplas.com/home.asp
Watkins & Doncaster Mail order: PO Box 5, Cranbrook, Kent, TN18 5EZ Showroom: Conghurst Lane, Hawkhurst, Kent, TN18 5ED **t:** 0845 833 3133 **e:** sales@wadon.co.uk http://www.watdon.co.uk/the-naturalists/	

8.3.6 Web addresses

The Geodiversity Action Plans (GAP), written by specialist geological groups, are plans for the conservation of the natural landscape. The UKGAP sets out a framework for geodiversity action across the UK. For more information see: http://www.ukgap.org.uk/

Many of the counties across England, Scotland and Wales have or are in the process of developing their own Local Geodiversity Action Plan (LGAP) and links to these can be found at: http://www.ukgap.org.uk/getting-involved/lgaps.aspx

Museums in the West Midlands with specialist geologists on staff from section 8.3.1

Dudley Museum & Art Gallery
www.dudley.gov.uk/leisure-and-culture/museums--galleries/dudley-museum--art-gallery

Herefordshire Museum & Learning Resource Centre
www.herefordshire.gov.uk/leisure/museums_galleries/2872.asp

Lapworth Museum of Geology *www.lapworth.bham.ac.uk/*

Ludlow Library & Museum Resource Centre
http://www.shropshirehistory.org.uk/html/search/verb/GetRecord/homepage:20060929155704

The Potteries Museum & Art Gallery *www.stokemuseums.org.uk*

Warwick Market Hall Museum
www.warwickshire.gov.uk/web/corporate/pages.nsf/Links/EECBBCA09D75241A8025745F004F6973

Other useful websites

Collections Link *www.collectionslink.org.uk*

Collections Trust *www.collectionstrust.org.uk/*

Culture 24 *www.culture24.org.uk/home*

Environmental control solutions for museums and archives *keepsafe.ca*

National Parks Service – Conserve O gram
http://www.nps.gov/museum/publications/conserveogram/cons_toc.html

Society for the Preservation of Natural History Collections *www.spnhc.org*

SPECTRUM *http://www.collectionslink.org.uk/programmes/spectrum*

8.4 Useful Specialist Publications

Please note that where the ISBN (international standard book numbers) is given, this is not necessarily the latest edition. Good bookshops will be able to provide further assistance when ordering the newest copies where available.

Various publications available	Dictionary of Geology. HarperCollins and Penguin both do quite comprehensive ones that are easily accessible
British Museum, Natural History (1975)	British Palaeozoic fossils, Unwin Brothers Ltd., London
British Museum, Natural History (1975)	British Mesozoic fossils, Unwin Brothers Ltd., London
British Museum, Natural History (1975)	British Caenozoic fossils, Unwin Brothers Ltd., London
Brunton, CHC, Besterman, TP & Cooper, JA (eds.) (1985)	Guidelines for the Curation of Geological Materials, Misc. Paper No.17, Geological Society, London
Buttler, C	How Geological Collections Deteriorate and Methods to Preserve them within the Museum Environment, p85-95, *Paper for Environmental Hazards and Conservation Issues, Summer School - Professional Development Program Postgraduate Museum Studies, National & Kapodistrian University of Athens*
Child, RE (ed.) (1994)	Conservation of Geological Collections, Conservation Monograph, Archetype Publications for the National Museum Wales. ISBN 1873132603
Child, RE	'Environmental Factors in the Deterioration of Geological Materials', p77-84, *see Buttler article reference*
Collins, C (ed.) (1995)	The Care and Conservation of Palaeontological Material, Butterworth-Heinemann, Oxford. ISBN 075061742x
Howie, F (1992)	The Care and Conservation of Geological Material; Minerals, Rocks, Meteorites and Lunar finds, Butterworth-Heinemann, Oxford. ISBN 0750603712
Knell, SJ & Taylor, MA (1989)	Geology & the Local Museum; Making the most of your geological collection, HMSO, London. ISBN 0112904599
Pellant, C (2007)	Eyewitness Guides: Rock & Mineral, Dorling Kindersley Limited, London. ISBN 1405321555
Pellant, C (2000)	Eyewitness Handbooks: Rocks and Minerals, Dorling Kindersley Limited, London. ISBN 0751327417
Pellant, C (1995)	Rocks, Minerals & Fossils of the World, Pan Books Ltd, London. ISBN 0330299530 (possibly out of print)
Taylor, PD (2004)	DK Eyewitness Books: Fossil, Dorling Kindersley Limited, London. ISBN 0756606824

9. Evaluation Form

It would be very much appreciated if you could take the time to fill in this evaluation form with regard to the West Midlands Rocks: Regional Geology Stewardship Project.

Museum Name		Contact at Museum
Address		Date

Was a visit to your geology collection useful? …………………………………………………

How many visits did your receive? ……………………………………………………………

Are there plans for future visits? ……………………………………………………………

Has the geology collection received previous attention? If so, by whom? ……………………
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Was a Benchmark Assessment carried out? ……………………………………………………

If not, would you like one? …………………………………………………………………

How has a visit, and/or assessment, helped with your geology collection?
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What plans do you have for your geology collection?
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Is the Advice Pack useful? …………………………………………………………………

Which sections are the most useful and why? …………………………………………………
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Is there anything missing from it? ……………………………………………………………
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Are there any suggestions for improvement?

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Do you feel there is a need for such a specialist project? Please explain your answer.

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Please feel free to make any further comments regarding the project

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Thank you for taking the time to complete these questions. Forms can be posted back to Holly Sievwright, Assistant Collections Officer (Regional Geology) at the following address:

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The Potteries Museum & Art Gallery
Bethesda Street, Cultural Quarter, Hanley
Stoke-on-Trent, Staffordshire, ST1 3DW
t 01782 232539
e holly.sievwright@stoke.gov.uk
e naturalhistory@stoke.gov.uk

www.stokemuseums.org.uk