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MUSEUM OF NATURAL HISTORY, OXFORD, ENGLAND

http://www.oum.ox.ac.uk/

MINERALS, LANDSCAPES AND HERITAGE

A MUSEUM FIELD TRAIL FOR KS4 STUDENTS

Designed by Emma Hughes , Oxford Brookes University,

April 2008 Printed on 100% recycled paper

ADDITIONAL SPACE FOR NOTES IS PROVIDED ON PAGE 21

INFORMATION FOR STUDENTS AND TEACHERS

Getting to Oxford—park and ride solutions:

http://www.oxfordbus.co.uk/main.

The Natural History Museum and this field trail are both wheelchair accessible. This booklet aims to be dyslexia-friendly through simple terms and minimal colour use.

FULL DETAILS OF MUSEUM OPENING HOURS AND GENERAL INFORMATION INCLUDING RISK ASSESSMENTS ARE GIVEN AT THE WEBSITE ADDRESS ON THE FRONT OF THIS BOOKLET.

APPROXIMATE TIME REQUIRED FOR FIELD TRAIL: 3 HOURS

THE TRAIL IS SPLIT INTO THREE PARTS. EACH CAN BE MANAGED SEPERATELY IF DESIRED. PART 1 IS 90 MINUTES, PART 2 IS 20 MINUTES AND PART 3 IS 40 MINUTES (APPROX)

Students can be directed to begin the trail at any part— ie. Split into three groups to avoid overcrowding at cases

EQUIPMENT REQUIRED TO COMPLETE THIS TRAIL:

- Pen, pencil and coloured pencils
- Clipboard is useful but not mandatory
- A map of the museum, available at the entrance for free. One between four people should suffice. Return when trail completed.

TERMS OF REFERENCE:

The main part of the trail centres around 11 individual exhibits that are identical in size and shape—these are referred to as ‘cases’ throughout this guide. A picture of the case as a thumbnail is posted at the top of the relevant page.

Throughout this booklet the term ‘heritage’ is used. There has been no formal definition given at any point, as the term is open to debate/discussion and students are encouraged to arrive at their own conclusions.

USEFUL LINKS TO ADDITIONAL MATERIAL:

A list of useful links is available at the end of the booklet. Some of these are websites and some are journal articles. There is a short discussion regarding credibility and the importance of peer reviewed material that will be most relevant to future studies.

ADDITIONAL SPACE FOR NOTES IS PROVIDED ON PAGE 21

INTRODUCTION TO THE MUSEUM AND TRAIL, AND LEARNING OUTCOMES

Introduction

Oxford Natural History museum was built by the Victorians through public and private subscription, and is an outstanding example of architectural achievement and classic English heritage for its time. The museum layout is 'open plan' which enables large groups of students to be easily managed in a contained environment. The primary aim of this field trail is to support and reinforce the information presented within the museum about minerals, and to further link this with specific landscapes and earth processes. It is hoped that after completing this booklet, students will be inspired and encouraged to research the topics further using credible sources and to follow up on important issues such as sustainability and the importance of heritage and landscape preservation.

LEARNING OUTCOMES

- Be able to identify different types of minerals, know where they are formed and how, and what types of landscapes they are commonly found in. Appreciate the time periods involved in formation.
- Know the major landscape influences on mineral composition ie. Colour, lustre, texture etc. Appreciate the rich diversity of minerals present in the UK, formed as a result of its rich geodiversity. Appreciate their heritage value, and the importance of preserving landscapes where possible.
- Know what tests are used to recognise minerals and physically use a selection of these tests to identify and evaluate mineral examples. (Parts 1 and 2) Relate these minerals to UK landscape sources.
- Understand the importance of minerals in industry and the consequences of mineral extraction for landscapes and topographical features. Examine and suggest possible short and long term solutions to combat sustainability and heritage issues. Begin to appreciate the conflict of issues involved.
- Understand what minerals are formed through heat, water and compression over time. Understand what complimentary landscape features occur simultaneously on local and global scales. Appreciate their beauty.
- Appreciate the changing nature of our earth from a holistic perspective, and appreciate the dynamic ongoing processes that influence mineral and landscape interaction.
- Physically view a selection of minerals from outer space and relate them to accounts of their local impact on earth. Appreciate the use of proxy evidence to show these, and the importance of scientific evidence in addition to eyewitness accounts.
- Examine and admire the 30 different stone pillars within the building and appreciate that these are all sourced from Great Britain and are part of our heritage.

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WHAT ARE MINERALS, AND WHAT MAKES THEM SO SPECIAL? CASE 1

COMPLETE THE SENTENCES BELOW USING THE WORDS AT THE BOTTOM OF THE PAGE. EACH WORD CAN ONLY BE USED ONCE.

What is so special about minerals?

The **e**______________ is a remarkable chemical laboratory. Over 4000 different

m__________ are found within it. Some are natural and in-**o**__________________, and

others are **e**__________________ or **c**_______________________.

Minerals are everywhere, including right in the earths **c**________________,. Some are

exposed in **m**_____________________, **q**___________________ and road

c_______________. Great Britain has an abundance of minerals that form an important part

of its **H**__________________.

Minerals are an invaluable **r**__________________ resource for geologists, mineralogists,

c___________________________ chemists and **p**___________________. They were

studied in the past by **m**_______________________ students for their healing properties.

Minerals have many uses in our everyday lives. They include **g**________________,

t_____________, washing powder, **c**___________________ and **ae**___________________.

AEROPLANES	ORGANIC	CRUST	HERITAGE
HEALING PROPERTIES	ELEMENTS		CUTTINGS
PHYSICISTS	EARTH		MEDICAL
QUARRIES	CRYSTALLOGRAPHERS		COMPOUNDS
MINES	RESEARCH		COMPUTERS
GEMSTONES	MINERALS		TOOTHPASTE

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FINDING OUT ABOUT MINERALS CASE 2

This case explains how to test minerals in order to find out what they are. There are a total of ten tests, some of which must be done in a laboratory using specialist equipment. Study the tests carefully as you will be using some of these methods later.

Consider what landscape properties contribute to mineral formation:

1. **Colour and lustre**—the chemicals present in the landscape now and previously
2. **Hardness**—how much compression was involved over time
3. **Crystal shapes / angles**—what was involved in the process e.g. water
4. **Specific gravity**—the position of the mineral on earth when it was formed
5. **Radioactivity**—the proximity of the landscape to certain other minerals
6. **Chemical testing**—the chemical processes involved in mineral creation
7. **Magnetism**—the amount of metal ore present in the rock now and in the past
8. **Flouresecence**— the chemicals present in the landscape that reflect UV light
9. **Cleavage and fracture**—the time period over which the rock was formed and the bonds made in the process
10. **Streak** (colour when powdered) - chemicals present in the landscape

Moh's Hardness Scale 1-10 (1812)

Complete the rocks that make up the remainder of the scale from 1-9 below:

1. DIAMOND

2.

3.

4.

5.

6.

7.

8.

9.

10. GYPSUM

Remember—each stone will only scratch the stone below it.

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INDUSTRIAL MINERALS CASE 3

Minerals are widely used in industry on small and large scales. All sorts of items that we use every day are made from one or more minerals as raw materials which undergo different processes on order to become a marketable product.

MINERAL(S) > PROCESS(ES) + (OTHER INGREDIENTS) = PRODUCT

BASED ON THE SEQUENCE ABOVE, COMPLETE THE PROCESSES BELOW:

C________________ + D________________ > CRUSH and ROAST + OTHER INGREDIENTS

(minerals) (Processes)

= (LIME) CEMENT AND FERTILIZER

G__________________ > POWDER + MIX WITH WATER + GENTLY HEAT

(Mineral) (Processes)

= PLASTER OF PARIS (CERAMICS, PLASTERCASTS)

(PRODUCT)

K ___________________ > MOISTEN, SHAPE AND HEAT = PORCELAIN

(Also known as 'China clay')

(Mineral) (Processes) (PRODUCT)

Consider for a moment the enormous quantities required of these minerals worldwide in order to meet the human demand for the products studied above alone. After all, most households in the world use porcelain in some form every day in order to eat—most crockery is porcelain based. Cement is used in just about every building erected today and a large proportion of man made structures designed since the industrial revolution approximately 50 years ago.

What do you think will be the eventual outcome of this industry demand?

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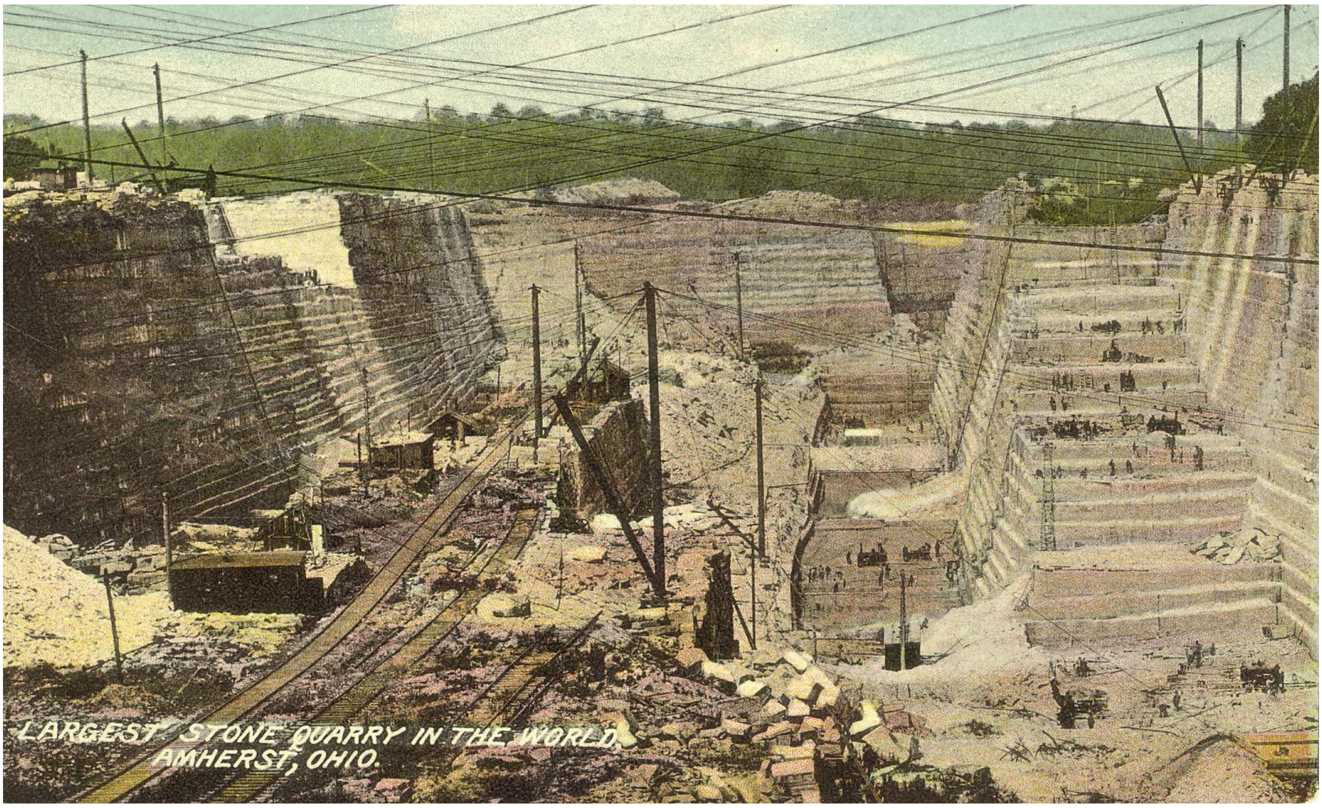
INDUSTRIAL MINERALS CASE 3
LANDSCAPE IMPACT

The following pictures are the result of mineral mining on the landscape. Replacing minerals takes hundreds of thousands of years, and the places they are removed from are never the same again. Look at the pictures below and consider answers to the questions on the next page.



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INDUSTRIAL MINERALS CASE 3

LANDSCAPE IMPACT

The first picture is from Bethesda in North Wales, and shows a slate mining quarry. If you look closely in the upper left hand side of the photo you can make out some site buildings. This gives you an idea as to the enormous size of the area and the amount of slate removed over time.

The second picture is the largest sandstone mine in the world at Cleveland, Ohio in the USA. Look closely at the surrounding countryside, which is wooded, and consider the depth and breadth of the quarry.

1. **What are the major changes that appear to have occurred to the landscapes since quarrying began? Could they be viewed positively or negatively?**

2. **What impact do you think these changes might have had on the plants and animals that live there? Do you consider these impacts to be temporary or permanent? Positive or negative?**

3. **Do you think that the impact of this quarry was just local, or might it have caused changes in other places? Would these changes have been welcomed? How do you think these sites affect the heritage of a Country?**

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METALLIC ORES CASE 4

Match the chemical sign for each metallic ore to the picture of the mine shown below:

Hg

Iwami-Ginzan Silver Mine, Oda, Shimane JAPAN

Fort Knox Gold mine, Fort Knox, USA

Au

Peak District Lead Mine, Peak District, ENGLAND

Sn

Zinc Mine, Elura, New South Wales, USA

Pb

Trevellas Coombe Tin mine, Cornwall, ENGLAND

Au

McDermitt mercury mine, Dugout, USA

Ag

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BRITISH MINERALS—A HERITAGE REVEALED - CASE 5

This case shows the incredible amount of minerals that are present in Great Britain, and shows how each mineral is unique due to the unique properties of the landscape it was formed in. Great Britain has an extremely diverse range of landscapes which in turn support a wide range of minerals formed in many different ways.

Take some time to study the various colours, shapes and textures of the specimens, and note that each is named after the person who found it—WAVELLITE, for example, was named after Dr William Wavell, who discovered it at High Down quarry in Devon. Use the skills you have obtained from Case 2 to record information below.

Many of Britains mineral sites are found within landscapes that are not always viewed as 'valuable' to English Heritage by Local Governments. Governments are under pressure to provide housing and services, and make land profitable. Preservation of specific landscapes and features, many of which are small and would not be suitable as tourist attractions is in direct conflict with economic demand. They can also be expensive to protect and maintain.

Reflecting on the information above, do you agree that landscapes and their mineral features should be recognised as an important part of Englands heritage? Why? What measures would you take to support your decision? Write your answers below.

NOTES:

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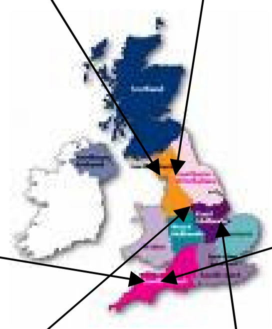
BRITISH MINERALS—A HERITAGE PRESERVED - CASE 6

Listed in the boxes below are six minerals from this case. Their names and locations are plotted on a map for you. Use the blank spaces in each box to draw and colour the mineral, and describe each one using as many mineral assessment techniques as you can. Look back in your booklet for possible techniques.

Purple fluorite with brown siderite, Alston Moor, Cumbria

Hematite, kidney variety, West Cumbria

Cuprite, chalcotrite variety, Gunnislake, Cornwall



Lollingite, Castle-Au-Dinas mine, Cornwall

Siderite on fluorite, St Peters mine, Northumberland

Quartz, Grove Rake mine, Durham

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ROCKS FROM SPACE—CASE 7

The following description is an eye witness account that has been recorded as a meterorite shower occurred:

At around 10:30 am on February 12, 1947, eyewitnesses in the Sikhote-Aun mountains,Primorve, Russia, observed a fireball brighter than the sun that came out of the north and descended at an angle of about 41 degrees. The bright flash and the deafening sound of the fall were observed for three hundred kilometres around the point of impact near the village of Paseka (approximately 440 km northeast of Vladivostok). A smoke train, estimated at 32 km long, remained in the sky for several hours.

As the meteorite entered the atmosphere, traveling at a speed of about 14 km/s, it began to break apart, and the fragments fell together. At an altitude of about 5.6 km, the largest mass apparently broke up in a violent explosion.Specimens of the Sikhote-Alin Meteorite are basically of two types; pieces showing fusion crust and signs of ablation, and those showing evidence of violent fragmentation. The first probably broke off of the main object early in the descent. These pieces are characterized by regmaglypts (cavities resembling thumb prints) in the surface of each specimen. The second type are fragments which were either torn apart in the atmosphere during the descent or blasted apart upon impact. Most were probably the result of the explosion at 5.6 km altitude.

The strewn field for this meteorite covered an elliptical area of about 1.3 km². Some of the fragments made craters, the largest of which was about 26 m across and 6 m deep. Fragments of the meteorite were also driven into the surrounding trees.

Proxy evidence (indirect evidence that has been presented to show that an event occurred when actual evidence is no longer available) has shown that France did indeed have a large meteorite shower on its landscape long ago….

Rochechouart is an impact crater in France.

The crater diameter is still under debate but expected to be about 21 km and the current age estimate is given as 214 ± 8 million years placing it in the Upper Triassic period. Since then the crater has been deeply eroded, and no trace of its original surface morphology is visible anymore.

Its centre is tentatively located at the hamlet La Judie 4 km west of Rochechouart, in the Haute-Vienne District; its surface extent includes the villages of Rochechouart, Chaillac Bagnac, Pressignac, Saint Quentin, Cherronnac, Chassenon and Chabanais.

The remnants of this ’astrobleme’ have been a big subject of debates among geologists since their discovery in the early 19th Centuery. The explanation was only given in 1969 by the French geologist, François Kraut who definitely proved the impact origin of the breccais.

The Rochechouart impact crater was the first crater proven by the determination of the impact effects on the rocks, without any circular topographic feature visible.

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EARTHS BUILDING BLOCKS—CASE 8

COMPLETE THE SENTENCES BELOW USING THE WORDS AT THE BOTTOM OF THE PAGE. EACH WORD CAN ONLY BE USED ONCE

The products of weathering and erosion are known as **s**______________________.

G______________ is a metamorphic rock with layers of different minerals in it.

Solid rock broken down into fragments by natural forces is termed **P**_____________

W___________________.

Two types of sediment are associated with volcanic rocks. Anything that came directly

from the volcano is **P**_________________. Examples include **V**_____________ **A**____

And **V**_______________ **B**_________________.

Weathering and erosion cause **C**__________________ sediments.

When basaltic rocks are buried to great depths in the earths crust they are

M_____________________ and dramatic changes take place. New **M**______________

Grow. Because basaltic rock is **B**___________, its products are known as

M____________________________.

METABASITES	CLASTIC	GNEISS
VOLCANIC ASH	BASIC	PYROCLASTIC
SEDIMENTS	MINERALS	PHYSICAL WEATHERING
VOLCANIC BOMBS	METAMORPHOSED	

ADDITIONAL SPACE FOR NOTES IS PROVIDED ON PAGE 21

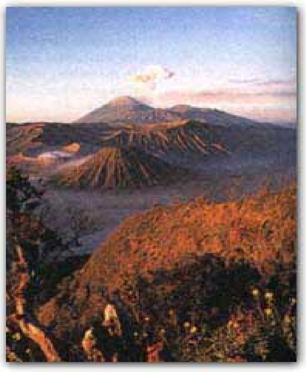
MINERALS FROM FIRE—CASE 9

Heat from the earths processes is a rich source of minerals. These minerals form new landscapes across the world. Some take hundreds of thousands of years, and some take just a few days. Some are quietly forming on the sea bed, such as SEA FLOOR SPREAD, whilst others are spectacularly exploding in front of our eyes such as VOLCANOES . Below are some examples.

Creeping molten lava off the side of an old volcano, Mt Fukubonsai in Hawaii. Molten Lava is rich in minerals and is an IGNEOUS rock.

Most of the volcanoes in Hawaii are gently emitting lava and there have been no major explosions for many years. This makes it an ideal study site for anyone interested in Volcanology (the study of volcanoes.)

Calderas are huge bowl-shaped craters usually formed by volcanic activity. Some of the earliest geologists thought the **calderas** are formed when *violent* volcanic eruptions blew the tops off the volcano. However, few **calderas** are formed this way. **Calderas** are formed because eruptions of huge volumes of pyroclastic materials had left the roof of the magma chamber unsupported, causing it to fracture and fall downwards into the chambers. Magma is also being drained from the chamber through fissures at depth. Collapse of the cone occurs, as it becomes a jumble of enormous blocks, some of which sink through the magma. This process is termed **cauldron subsidence**. This process may take a long time to complete and often happens in an extinct volcano. An example is the **caldera** of Tengger in Java, Indonesia.



Lava plateaus are formed by the large outpourings of fluid lava from long narrow openings in the crust. During each eruption, the lava flows out from these openings, solidifies and builds up layer upon layer each time.

Geysers are **natural fountains** that throw up **jets** of hot water and steam at regular intervals through a vent in the surface. In some areas, rainwater seeps through cracks in the rocks and drains into a crevice or a large cave-like chamber so deep that it reaches hot rocks. The heat of these rocks comes from the molten rocks below. Eventually, the intense heat **boils the water**, which then turns into steam. This *increases the pressure* inside the crevice as bubbles of steam build up. Finally, the pressure is strong enough to shoot the water and steam upwards and out through a vent, high into the air. When the jet has died down, the crevice fills with new water and the process repeats. Some **geysers** gradually lose their power and stop erupting as the **volcanic heat** dies down. A **geyser** that experienced this is Iceland's **Great Geyser**, which gave its name to all other **geysers**.

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MINERALS FROM WATER—CASE 10

Minerals that form in water usually take a very long time to do so and require very specific conditions in which to grow. Some are found in underground CAVES where the temperature and humidity is constant. The features they form are called SPELEOTHEMS and are often spectacular and a huge tourist attraction. Below are some examples which you may be familiar with.

Daveli's CaveSouth-western slopes of Mount Pendeli, Northern Athens, Greece

Daveli's Cave is located in an **ancient marble quarry**, where much of the marble for the Parthenon on the Acropolis of Athens was excavated. It's exact location is not widely known (except to some climbers who scale the surrounding cliff) & it is infrequently visited as the rough track leading to the cave is unmarked. The inside of the cave is a beautiful blue-green colour where local minerals have stained the stalactites and stalagmites.

Buchan Caves, Victoria, Australia

These ancient caves have spectacular limestone and mineral formations created by underground rivers cutting through limestone rock that was formed almost 400 million years ago. Professionally guided tours of Royal Cave and Fairy Cave are conducted every day of the year except for Christmas. Both caves are lit and have walkways. Royal Cave features calcite-rimmed pools and in Fairy Cave you will see elaborate stalactites and stalagmites. Tours to 'wild' unlit caves can also be arranged for small groups. The caves are a constant 17 degrees Celcius making the tour a comfortable temperature all year round.

Spar crystals in Flatlands, Lechuguilla Cave, New Mexico.

Look carefully at the angles and cleavage that have occurred.

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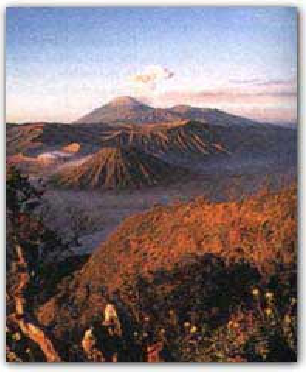

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MOVING EARTH—CASE 11

This case reviews the earths processes that have been explained in previous cases. Make notes below to help you consolidate your knowledge. It may also help you to draw diagrams to show the processes involved.

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THE TOUCH AND FEEL EXHIBITS IN THE CENTRE AISLE—PART 2

Here you have an excellent opportunity to put your knowledge into practise and touch and record some mineral examples for yourself. If you are starting the trail at this point, please begin at CASE 2 which will allow you to see how minerals are examined. Then proceed immediately to the centre aisle.

Imagine the environment and landscape from which these samples were extracted, and appreciate how very old they are. Many have been chosen for their beauty and unique composition: read the information given with each one and record it in the spaces provided.

GNEISS—GREENLAND

AGE:

FORMATION AND MINERAL FEATURES:

NANTON METEORITE

AGE:

FORMATION AND MINERAL FEATURES:

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THE TOUCH AND FEEL EXHIBITS IN THE CENTRE AISLE—PART 2

STROMATOLITE

AGE:

FORMATION AND MINERAL FEATURES:

QUARTZ:

AGE:

FORMATION AND MINERAL FEATURES:

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THE TOUCH AND FEEL EXHIBITS IN THE CENTRE AISLE—PART 2

PYRITE

AGE:

FORMATION AND MINERAL FEATURES:

LEWISIAN GNEISS

AGE:

FORMATION AND MINERAL FEATURES:

THE TOUCH AND FEEL EXHIBITS IN THE CENTRE AISLE—PART 2

ORBICULAR GRANITE

AGE:

FORMATION AND MINERAL FEATURES:

ADDITIONAL NOTES

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NOTES

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PART 3—STONE COLOMN MAPPING

When the museum was designed, the Victorians decided that it should have 30 pillars of various different rocks from all over the United Kingdom.

A map of each pillar is attached. Using this map, navigate your way to the base of each pillar and record its stone details on the following page.

Be careful to double check your starting point, or the entire list will need to be altered!

ADDITIONAL SPACE FOR NOTES IS PROVIDED ON PAGE 21

PART 3—STONE COLOMN MAPPING

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PART 3—STONE COLOMN MAPPING

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NOTES

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REFERENCES AND FURTHER READING

Mines and quarries:

www.uvm.edu/.../Vermont%20Mining/Home.html

www.anglesey.info/bethesda_photograph_archive.htm

www.amherst.lib.oh.us/Postcard%20page.htm

http://www.jnto.go.jp/tourism/img/org/64-1.jpg

infotrek.er.usgs.gov/mercury/yukon_photos.html

www.peakdistrict-nationalpark.info/time/indus...

www.jupiterimages.com/itemDetail.aspx?itemID=...

www.cornwall-aonb.gov.uk/stagnesHistoric.html

www.scs.unr.edu/~sjbarnes/mines.html

Meteorites

http://en.wikipedia.org/wiki/Burkina_Faso

http://www.meteorites.com.au/favourite/december2003.html

http://www.nhm.ac.uk/jdsml/research-curation/projects/metcat/

http://tin.er.usgs.gov/meteor/index.php

VOLCANOES

www.fukubonsai.com/bi3.html

http://library.thinkquest.org/17457/volcanoes/features.calderas.php

http://library.thinkquest.org/17457/volcanoes/features.plateaus.php

http://library.thinkquest.org/17457/volcanoes/features.geysers.php

Caves

www.rjhorne.com/Main_HTML/davelis-cave.htm

http://images.google.co.uk/imgres?imgurl=http://www.visitvictoria.com/content/2007/may/buchan-caves

www.metafilter.com/60941/Americas-Deepest-Cave

General

Learning more from the Natural History museum website, 2008 (details on the front page):

In particular articles on Oxford Geology, Meteorites, minerals formed by water and minerals formed by fire.

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REFERENCES AND FURTHER READING

Mines and quarries:

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www.anglesey.info/bethesda_photograph_archive.htm

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VOLCANOES

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http://library.thinkquest.org/17457/volcanoes/features.plateaus.php

http://library.thinkquest.org/17457/volcanoes/features.geysers.php

Caves

www.rjhorne.com/Main_HTML/davelis-cave.htm

http://images.google.co.uk/imgres?imgurl=http://www.visitvictoria.com/content/2007/may/buchan-caves

www.metafilter.com/60941/Americas-Deepest-Cave

General

Learning more from the Natural History museum website, 2008 (details on the front page):

In particular articles on Oxford Geology, Meteorites, minerals formed by water and minerals formed by fire.