Unit 42: Geology of Natural Resources

Unit code: M/502/5608

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

The aim of this unit is to allow learners to explore the range of geological natural resources which modern society depends on. Learners will do this by studying the nature of rock, mineral and hydrocarbon resources, their formation, resource exploration and extraction as well as the environmental impact of resource exploitation.

Unit introduction

Geological resources such as oil, metal ores and minerals form an essential part of a developed economy. People depend on resources from beneath the Earth's surface for their energy supply, manufactured goods and built environment. Very little of modern life is possible without ready access to a wide range of natural resources. Geological resources have been formed by igneous, sedimentary and metamorphic processes over millions of years throughout geological time. Many of these resources are finite, and are being used by humans at an increasing pace. Geologists play a key role in ensuring resource supply. They are involved in:

- studying the formation of natural resources
- carrying out prospection and exploration beneath the Earth's surface to locate resources
- extracting and processing resources
- working to minimise damage to the natural environment which might result from exploitation of natural resources.

This unit introduces learners to the range of geological resources and explores the processes which formed them. It shows them the techniques used by geologists to explore for new resources and how the resources are extracted and processed. The unit examines the environmental issues that resource exploitation raises, and how damage can be minimised. Learners will undertake practical examination of geological materials and engage in site and field visits.

This unit enables learners to consider what it is like to work as a geologist or geological science technician. It is suitable for all learners who are interested in a career in geology or Earth science.

Learning outcomes

On completion of this unit a learner should:

1 Know how geological resources are formed by geological processes

2 Be able to investigate the geology and geological features of an area

3 Know the methods used to explore for and extract geological resources

4 Be able to investigate the environmental impacts and management of resource exploitation.

Unit content

1 Know how geological resources are formed by geological processes

Geological features: texture, structures and mineralogy of rock specimens, and physical properties of mineral samples

Igneous, sedimentary and metamorphic processes: magmas and crystallisation of igneous rocks; weathering, erosion, transport and deposition processes; lithification of sedimentary rocks; metamorphism by heat and/or pressure

The formation of geological resources: oil and gas, accumulation in traps; formation of coal of different grades; hydrothermal and magmatic ores and minerals; placer, evaporation and residual ore formation; bulk materials such as sand and gravel

2 Be able to investigate the geology and geological features of an area

Mapping: age and type of rocks on British Geological Survey (BGS) maps using key and geological column; fold and fault types; location of geological resources and areas of extraction; construction of cross sections from simple geological maps (not BGS) to show rock type and structure; GIS

Fieldwork: preparation and planning; equipment lists, health and safety and outdoor risk assessment; accurate recording by field sketches, graphic logs, simple mapping and written interpretation, photography

3 Know the methods used to explore for and extract geological resources

Prospection and exploration: drilling and borehole logging; geophysical surveying using magnetic, gravity and seismic methods, eg satellite mapping of planets/earth; geochemical prospection techniques, remote sensing methods

Extraction: opencast mining and quarrying, deep mining, oil and gas drilling and recent development, eg directional drilling and enhanced recovery methods, hydraulicking and brine pumping

4 Be able to investigate the environmental impacts and management of resource exploitation

Investigating environmental aspects: preparation and planning for site visit; use of secondary research sources; health and safety and outdoor risk assessment considerations; data collection methods such as photographs, interviews, sketches, mapping and environmental monitoring

Producing a report: evidence collected linked to environmental impacts and management methods used to minimise environmental impacts

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The assessment criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 identify the physical features of igneous, sedimentary and metamorphic rocks	**M1** describe the physical features of geological samples	**D1** discuss how geological processes produce certain features in geological samples
P2 describe the geological processes responsible for the formation of geological resources	**M2** explain the geological processes responsible for the formation of geological resources	
P3 identify geology and geological structures using geological maps	**M3** produce a record of geological field data	**D2** analyse geological field data
P4 carry out fieldwork to enable the recording of geology and geological structures in the field [TW1,3,5]		
P5 describe prospection, exploration and extraction techniques used to exploit geological resources [SM3]	**M4** explain the choice of prospection, exploration and extraction techniques used to exploit different geological resources	**D3** compare and contrast different prospection, exploration and extraction techniques used to exploit geological resources
P6 plan a site visit to assess the environmental aspects of a geological resource extraction or processing site. [EP1,2,3,4]	**M5** assess the environmental impact of an extraction or processing site, suggesting improvements to be made to the environmental management of the site.	**D4** evaluate the investigation into the environmental management of the extraction or processing site, suggesting improvements for future investigations.

PLTS: This summary references where applicable, in the square brackets, the elements of the personal, learning and thinking skills applicable in the pass criteria. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key			
	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

The purpose of this unit is to develop learners' understanding of geology and geological materials. It is recommended that this unit be based as much as possible on practical activities in the classroom, lab and out in the field and onsite visits. Delivery strategies should reflect the investigative nature of practical geology and encourage observation and careful recording.

The unit requires learners to undertake practical work to investigate the nature of geological materials (rocks and minerals), some of economic importance, and to explain how these materials are formed by geological processes. This is particularly important foundation work as it underpins other aspects of the unit. Learners should have many opportunities to handle and investigate hand specimens of a wide range of geological materials to build confidence and familiarity.

Learners need to go on field visits. Whilst at least one field visit forms part of the assessment, this does not preclude the use of other visits where possible. Learners need to be made aware of the risks of doing fieldwork and ideally should be involved in preparing risk assessments and activities, taking account of guidance such as the Geological Fieldwork Code. Careful preparation for field visits is essential and pre-visit work using BGS maps and even Geographic Information Systems (GIS) systems such as Google Earth would give learners a clear idea of where they are going, and why.

The unit offers opportunities for group work both in the centre and in the field. Learners can undertake some activities as a whole group, perhaps with individual research or investigation focuses within a whole group context. Research is highlighted as an important aspect of the unit in several of the learning outcomes (for instance 3 and 4) and learners should be encouraged to use a range of sources, including books and journals, as well as the internet.

Visits to the centre by industry representatives and professionals, as well as visits and placements would be very useful to put concepts and ideas in a vocational context.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan demonstrates one way in planning the delivery and assessment of this unit.

Topic and suggested assignments/activities and/assessment
Introduction to the unit and structure of the programme and assignments.
Introduction to geology – basic concepts and key ideas, eg plate tectonics and the rock cycle.
Learning outcome 1 – Know how geological resources are formed by geological processes Theory introduction to rock types and processes. Practical work observing, recording and explaining rock textures, structures and mineralogies. Researching processes of rock formation. Theory input on natural resource formation processes. **Assignment 1 – Investigating Geological Samples (P1, P2, M1, M2, D1)** Research on natural resource formation processes. Laboratory work and written assignment.
Learning outcome 2 – Be able to investigate the geology and geological features of an area Theory input on geological structures. Fieldwork to practice identification, observation and data collection techniques. Theory input on geological map work and cross sections. Practice cross sections. **Assignment 2 – Fieldwork Investigation (P3, P4, M3, D2)** Planning and preparation for assessment. Fieldwork and map work for assessment. Writing up assignment.
Learning outcome 3 – Know the methods used to explore for and extract geological resources Theory input on prospection. Researching prospection techniques. Theory input on extraction. Researching extraction methods. Choice of assignment focus. **Assignment 3 – Geological Resources (P5, M4, D3)** Assignment research. Assignment write-up.

Topic and suggested assignments/activities and/assessment
Learning outcome 4 – Be able to investigate the environmental impacts and management of resource exploitation
Theory input on environmental considerations of resource extraction and environmental management.
Researching environmental management of resource extraction.
Assignment 4 – Extraction/processing Site Investigation (P6, M5, D4)
Planning and preparation for site visit and data collection.
Site visit and data collection.
Analysis of data.
Report write-up.
Review of unit and programme of assignments.

Assessment

Learning outcome 1 could be evidenced through a written report. Learners could record their observations and tests on rock/mineral samples in the laboratory using suitable notebooks. Records could include drawings, observations and the results of simple tests. These records could be handed in along with a summative written report. This could include annotated photographs of the samples if desired.

Learning outcome 2 could be evidenced through the production of a fieldwork portfolio. This could include information on planning, including risk assessments, and annotated site maps. Field notes could be recorded in a suitable field notebook which would form part of the evidence portfolio. This could include sketches, graphic logs and simple geological mapping – including how BGS maps were used. A brief report on overall findings could be written, which could incorporate photographs. Learners are likely to visit a fieldwork location as a group.

Learning outcome 3 could be evidenced in the form of a presentation, recorded for internal and external verification purposes. The presentation evidence could form part of a portfolio containing research notes from books and journals, printouts from internet sites and a research log. Early drafts of presentations should be retained as evidence of critical reflection on the part of the learner.

Learning outcome 4 would most likely be carried out as a group, perhaps visiting a local quarry or industrial processing site. Learners could identify and use secondary data sources such as the local press prior to their site visit, in which case annotated copies would need to be retained as part of the evidence portfolio. Planning materials such as interview schedules, risk assessments and methodologies for collecting environmental impact data could also be included. A written report could be produced to assess the environmental impact of the visited site.

Pass grade learners will require significant assistance from a tutor to achieve all of the outcomes in this unit. Pass grade learners will be able to follow an assignment brief which guides them through the investigations. They are unlikely to be able to deviate from this guidance, for instance by developing their own ideas. They will be able to follow an investigative process and record information with some accuracy. They will use some correct terminology and be able to identify problems and errors. Much of the pass grade learners' work, whilst reasonably accurate, will be descriptive in nature.

For P1, learners should record their observations of geological specimens, some of which should be geological resources (such as ores, economically important minerals or hydrocarbons).

Following observation, recording and identification for P1, learners should be able to make some statements on the geological formation processes responsible for the specimens to achieve P2.

For P3, learners should identify structures from geological maps such as faults, dipping strata, horizontal and folds.

Pass grade learners are likely to need assistance in making the link between geology as shown on a map and what they observe in the field for P4. In the field learners should identify and record geological strata and structures for P4.

For P5, learners must choose a geological resource to investigate in more depth. They may need assistance in choosing a suitable area to investigate. They should use some range of research resources to produce a written report.

For P6, learners need to plan a site investigation by identifying areas to investigate and methods they could use. These are likely to be straightforward methods that allow for a limited range of information to be collected.

Merit grade learners will work with more independence. They will be able to investigate and research with less initial, structured guidance and will be able to plan practical work and field visits in more depth. They will identify some problems without prompting and be able to offer some solutions independently. Merit grade learners' work will be accurate and detailed from a description standpoint, and will offer some discussion, explanation and reasoning.

For M1, learners need to describe the properties of the specimens they investigate with accuracy. They should offer some reasons for some of the properties they observe and record, which will lead into an explanation of some of the geological processes responsible for the properties of their specimens for M2.

For M3, learners need to make practical use of geological maps and identify structures and features more independently. They should be able to use maps as part of the preparation for the fieldwork criterion M3.

For M4, learners' fieldwork record should be accurate and well organised.

For M5, learners should work more independently to produce an analysis of their site investigation. The completed report must analyse the environmental impacts of the site rather than just identifying them.

Distinction grade learners will work with significant autonomy and will not require detailed guidance from the tutor. They are likely to view the tutor as one resource among many. They will access and use a wide range of resources and be able to synthesise these. Their planning and written work will be accurate and detailed. Their practical work will recognise the difficulties of recording information and look for alternative methods. There will be a tendency towards summative work and conclusions, plus an ability to see several sides to a discussion, problem or debate. Distinction learners' work will be descriptively accurate and detailed, as well as offering in-depth explanations and, where appropriate, evaluation or assessment.

For criteria D1 the learners will provide detailed discussion of the geological processes that are linked to the observed properties of their specimens.

For criteria D2 learners will be able to use geological maps with independence and identify structures and link these to their field observations for D4.

For criteria D3 learners fieldwork record will show evidence of interpretation, perhaps by careful annotation of field sketches and logs.

For D4, the evaluation of the site investigation plan will show evidence of independent enquiry skills and the written report an assessment of the environmental aspects of the site which weighs up the management of the location.

Programme of suggested assignments

The table below shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the assessment and grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, M1, D1 P2, M2	Investigating Geological Samples (individual laboratory investigation into properties of rocks and minerals, some of which should be of economic importance)	Samples provided by a geotechnical exploration company for laboratory analysis and identification, leading to a report on formation processes of samples.	Portfolio evidence consisting of: • laboratory notes and diagrams • report.
P3, M3, D2 P4,	Fieldwork Investigation (group field visit to a suitable location to investigate and record geology and structure)	Brief from a survey company wishing to identify background information on geology of an area, prior to more detailed economic investigation.	Portfolio evidence consisting of: • planning evidence • maps • fieldwork notes • written report.
P5, M4, D3	Geological Resources (individual research investigation into the exploration, extraction and processing of an economically important geological resource)	Brief from a Government department considering a planning application to extract/process geological resources and needing detailed information on what this might involve.	Portfolio evidence consisting of: • research materials • research log • presentation (recorded).
P6, M5, D4	Extraction/processing Site Investigation (group visit to assess the impacts of geological extraction or processing)	Brief from an environmental pressure group wishing to identify the impacts of extraction/processing on local people and the environment.	Portfolio evidence consisting of: • planning evidence • research materials • site visit record • written report.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Applied Science sector suite. This unit has particular links with the units shown below in the BTEC Applied Science suite of qualifications:

Level 2	Level 3
Energy and Our Universe	Fundamentals of Science
Physical Applications of our World	Scientific Investigation
Monitoring the Environment	Principles of Plant and Soil Science

Essential resources

For this unit learners should have access to a range of geological material, in the form of samples of rocks and minerals. Some simple geological hand specimen testing equipment should be provided. Learners should have access to a chemistry or science laboratory for some of the time. Learners will need to be able to access research material in the form of books, journals and websites.

Employer engagement and vocational contexts

Visits to companies and from employees would prove very valuable in the delivery of this unit. The use of vocational contexts is essential in the delivery and assessment of this unit. Centres should aim to develop links with local mining and quarrying companies, and processing firms.

Links with geoprospection and geotechnical companies would also be valuable to learners.

The British Geological Survey website www.bgs.ac.uk provides information on careers in geology and related fields as well as a database of companies involved in the industry around the UK (www.bgs.ac.uk/services/services_for_you/business/home.html)

The Geological Society also provides a wide range of information geology within the UK (www.geolsoc.org.uk/index.html) and on regional geology groups and organisations.

Descriptions of jobs in earth sciences can be found at (www.earthsciencejobs.co.uk).

Indicative reading for learners

Textbooks

Edwards D et al – *Geoscience: Understanding Geological Processes* (Hodder & Stroughton, 1999) ISBN 9780340688434

Pipkin B and Trent D – *Geology and the Environment* (Brooks Cole, 2004) ISBN 978053449015

Skinner B and Porter S – *The Dynamic Earth: An Introduction to Physical Geology* (Wiley & Sons, 2003) ISBN 9780471152286

Todgill P – *The Geology of Britain* (The Crowood Press, 2002) ISBN 9781840374049

Woodcock N – *Geology and Environment in Britain and Ireland* (Taylor & Francis, 1994) ISBN 9781857280548

Journals

Earthwise – the magazine of the BGS

Geology Today – published by Wiley for the Geologists Association

Websites

geology.com	Resources website
www.bgs.ac.uk	British Geological Survey
www.es.ucl.ac.uk/undergrad/fieldwork/image/code/fwcode.htm	Geological Fieldwork Code for site and field visits
www.geologists.org.uk	Geologists' Association
www.geologyrocks.co.uk	Resources website
www.geolsoc.org.uk	Geological Society of London
www.usgs.gov	United States Geological Survey

Delivery of personal, learning and thinking skills

The table below identifies the opportunities for personal, learning and thinking skills (PLTS) that have been included within the pass assessment criteria of this unit.

Skill	When learners are ...
Team workers	[TW1,3,5] collaborating with others to plan a field visit and taking account of group concerns such as risk assessment
Self-managers	[SM3] organising time and resources and planning action to produce a research report on a geological resource
Effective participators	[EP1-4] engaging research and data collection into the environmental impact of extraction or processing of geological resources.

Although PLTS are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	[IE1,2] planning and carrying out research into fieldwork locations or the site they plan to visit, plus doing their own research into the exploration, extraction and processing of a geological resource
Reflective Learners	[RL2] setting goals and targets within the planning of their work [RL4] inviting feedback when presenting the results of their research to the whole group
Team workers	[TW5] working in a group to plan their site visit and taking responsibility for their own role
Self-managers	[SM4] anticipating, taking and managing risks as part of a geological investigation.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	researching exploration, extraction and processing of resources
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	planning for either of the field visits or planning a presentation
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	producing tables, graphs and maps as part of the report write-up stage following field visits; incorporating photographs
Bring together information to suit content and purpose	bringing information together for fieldwork assignments reports
Present information in ways that are fit for purpose and audience	producing fieldwork assignment reports or report of chosen geological resource
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	discussing fieldwork and lab work risk assessments presenting the result of research into chosen geological resource
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	researching back ground information for field visits researching chosen geological resource from a wide range of sources
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	writing field visit reports.