

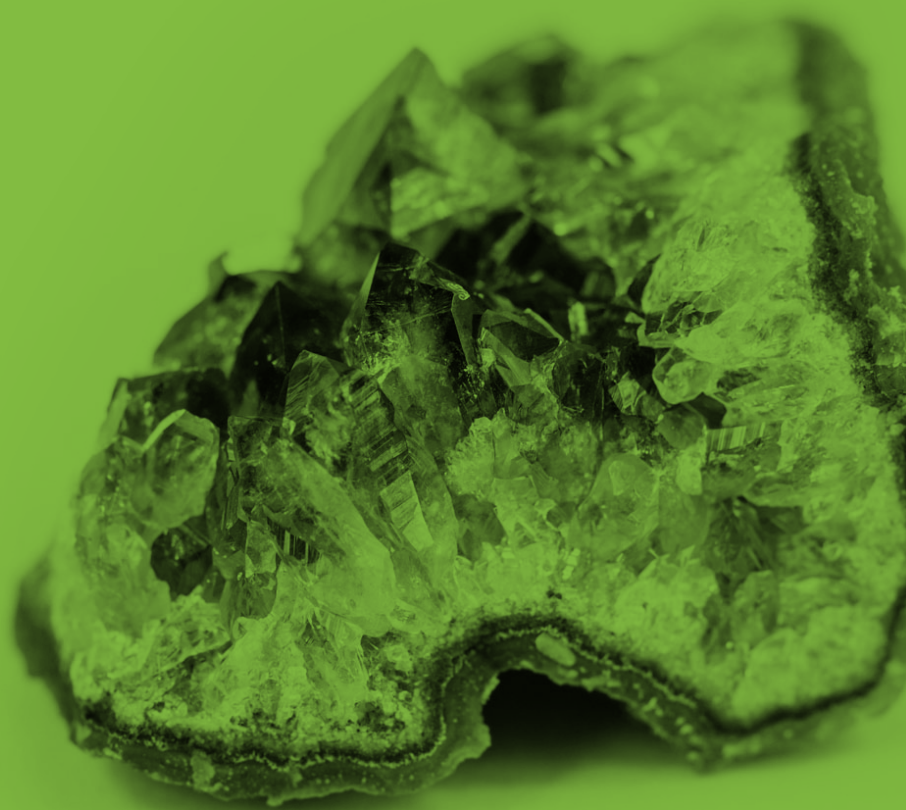
GCSE (9-1)

WJEC Eduqas GCSE (9-1) in
GEOLOGY

ACCREDITED BY OFQUAL
DESIGNATED BY QUALIFICATIONS WALES

**GUIDANCE FOR
TEACHING**

Teaching from 2017
For award from 2019



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Introduction

The **WJEC Eduqas GCSE Geology** qualification, accredited by Ofqual for first teaching from September 2017, is available to:

- All schools and colleges in England
- Schools and colleges in independent regions such as Northern Ireland, Isle of Man and the Channel Islands

The GCSE will be awarded for the first time in Summer 2019, using grades 9-1.

The qualification provides a broad, coherent, satisfying and worthwhile course of study. It encourages learners to develop confidence in, and a positive attitude towards, geology and to recognise its importance in their own lives and to society.

The specification is intended to promote a variety of styles of teaching and learning so that the course is enjoyable for all participants.

Practical work is an intrinsic part of geology. It is imperative that practical skills are developed throughout this course and that an investigatory approach is promoted.

Additional ways that WJEC Eduqas can offer support:

- Specimen assessment materials
- Face-to-face CPD events
- Question paper database
- Examiners' reports on each question paper
- Free access to past question papers and mark schemes via the secure website
- Direct access to the subject officer
- Free online resources
- Exam Results Analysis
- Online Examination Review

If you have any queries please do not hesitate to contact:

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Aims of the Guidance for Teaching

The principal aim of the Guidance for Teaching is to support teachers in the delivery of the new **WJEC Eduqas GCSE Geology** specification and to offer guidance on the requirements of the qualification and the assessment process.

The guidance is **not intended as a comprehensive reference** but as a support for professional teachers to develop stimulating and exciting courses tailored to the needs and skills of their own learners in particular institutions.

The guidance offers assistance to teachers with regard to the depth of coverage required as well as links to useful digital resources (both our own, freely available, digital materials and some from external resources) to provide ideas for engaging lessons.

Possible Delivery Model

	GCSE Geology
Year 10 Term 1	1.1 Minerals 1.2 Igneous Rocks and Processes 1.3 Sedimentary Rocks and their Fossil content (sections a-f)
Year 10 Term 2	1.4 Metamorphic Rocks and Processes 2.1 The Rock Cycle 1.5 Deformational Structures 1.3 Sedimentary Rocks and their Fossil content (section g) 2.3 Geochronological Principles
Year 10 Term 3	2.2 Plate Tectonics Revision Internal Examinations
Year 11 Term 1	2.4 Global Climate and Sea Level Change 2.5 The Origin and Development of Life on Earth 3.1 Planetary Geology
Year 11 Term 2	4.1 Earth Hazards and their Mitigation 4.2 Earth Resources and Engineering
Year 11 Term 3	Revision GCSE examinations

Practical work should be taught as an integral part of the theory.

Assessment Objectives

	Objective
AO1	Demonstrate knowledge and understanding of geological ideas, skills and techniques. 1a: Demonstrate knowledge of geological ideas 1b: Demonstrate knowledge of geological skills and techniques 1c: Demonstrate understanding of geological ideas 1d: Demonstrate understanding of geological skills and techniques
AO2	Apply knowledge and understanding of geological ideas, skills and techniques. 1a: Apply knowledge and understanding of geological ideas 1b: Apply knowledge and understanding of geological skills and techniques
AO3	Analyse, interpret and evaluate geological ideas, information and evidence to make judgements and draw conclusions. 1a: Analyse geological ideas, information and evidence 1b: Interpret geological ideas, information and evidence 1c: Evaluate geological ideas, information and evidence 1d: Make judgements 1e: Draw conclusions

The following questions in the sample assessment materials exemplify the WJEC interpretation of each of the assessment objectives:

AO1 1a: Demonstrate knowledge of geological ideas

e.g. Component 1 Q4 b (ii) asks for factual recall of methods to reduce the loss of life in the event of a tsunami. This is clearly the demonstration of geological ideas and is assigned to AO1 element 1a.

AO1 1b: Demonstrate knowledge of geological skills and techniques

e.g. Component 2 Q4 a (i) requires learners to demonstrate knowledge of the identification a geological structures in the field. This is a practical skill contained within paragraph 9 of the DfE GCSE Subject Content for Geology document and hence is assigned to AO1 element 1b.

AO1 1c: Demonstrate understanding of geological ideas

e.g. Component 1 Q2 a (iii) requires learners to demonstrate understanding of the formation of magnetic stripes in the rocks of the oceanic crust and is assigned to AO1 element 1c.

AO1 1d: Demonstrate understanding of geological skills and techniques

e.g. Component 2 Q1 d (i) requires learners to demonstrate an understanding of identification of a rock texture from a photomicrograph. This is a practical skill contained within paragraph 8 of the DfE GCSE Subject Content for Geology document and hence is assigned to AO1 element 1d.

AO2 1a: Apply knowledge and understanding of geological ideas

e.g. Component 2 Q3 a (iii) asks why a mineral, with stated physical properties, commonly forms the highest proportion of grains in a beach sand. To answer this question, learners are required to apply their knowledge of the mineral to explain the statement hence it is assigned to AO2 element 1a.

AO2 1b: Apply knowledge and understanding of geological skills and techniques

e.g. Component 1 Q2 c (ii) requires learners to perform a 2 stage calculation. This is clearly the application of a mathematical skill. Consequently it is assigned to element AO2 1b.

AO3 1a: Analyse geological ideas, information and evidence

e.g. Component 2 Q6 c requires learners to analyse evidence, appraise it coherently and draw a conclusion. They are required to analyse evidence, finding connections between a range of information including fossil footprints, sand grain shape and sedimentary structures. Consequently this aspect is assigned to AO3 1a. In addition learners are required to weigh up/evaluate potentially conflicting evidence such as the likelihood of the ripple marks forming in shallow marine conditions, alongside the likelihood of the sand grains forming in aeolian conditions, before reaching a conclusion. It covers therefore three AO3 elements, AO3 1a (analyse), AO3 1c (evaluate) and AO3 1e (draw a conclusion).

AO3 1b: Interpret geological ideas, information and evidence

e.g. Component 2 Q3 b (ii) requires learners to explain the evidence that can be interpreted from a photograph, for changes in sea level in the recent geological past. This involves ascribing meaning to features in a photograph and consequently it is assigned to AO3 element 1b.

AO3 1c: Evaluate geological ideas, information and evidence

e.g. Component 2 Q6 c requires learners to analyse evidence, appraise it coherently and draw a conclusion. They are required to weigh up/evaluate potentially conflicting evidence such as the likelihood of the ripple marks forming in shallow marine conditions, alongside the likelihood of the sand grains forming in aeolian conditions. Consequently this aspect is assigned to AO3 element 1c. In addition learners are required to analyse a range of evidence including footprints, sand grain shape and sedimentary structures before reaching a conclusion. It covers therefore three AO3 elements, AO3 1a (analyse), AO3 1c (evaluate) and AO3 1e (draw a conclusion).

AO3 1d: Make judgements

e.g. Component 2 Q2 b requires learners to analyse the information in a diagram of a limestone in order to provide two reasons to support a judgement regarding the environment of deposition. Two of the three marks available are for the reasons which are AO3 element 1a, and one mark is for making a judgement or decision regarding the environment of deposition (AO3 element 1d).

AO3 1e: Draw conclusions

e.g. Component 2 Q6 c requires learners to analyse evidence, appraise it coherently and draw a conclusion. It covers therefore three AO3 elements, AO3 1a (analyse), AO3 1c (evaluate) and AO3 1e (draw a conclusion).

1.1 Minerals

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. Minerals are formed by:</p> <ul style="list-style-type: none"> • crystallisation from a melt [quartz, feldspar, mica, olivine and augite] • metamorphic recrystallisation [calcite, garnet] • crystallisation from solution in evaporating water [halite] • crystallisation as cement from flowing pore waters [quartz, calcite] • crystallisation from hydrothermal fluids [in veins and faults: gangue minerals – quartz, calcite; ore minerals – haematite, galena]. 	<p>Use appropriate tests of:</p> <ul style="list-style-type: none"> • physical properties of minerals [observation of colour, hardness, streak, cleavage, lustre] • [reaction with 0.5 mol dm⁻³ hydrochloric acid] <p>to identify and distinguish between the minerals on the data sheet.</p> <p>Interpret data from the data sheet.</p>	<p>Equipment to be used includes a streak plate, hand lens, 0.5 mol dm⁻³ hydrochloric acid, fingernail, copper coin, steel pin and a mineral data sheet.</p> <p>See Practical Guidance Sheet 1.</p> <p>See Practical Guidance Sheet 2.</p> <p>Candidates are not required to memorise information on the data sheet, which will be provided in the assessments.</p>
<p>b. Modern laboratory techniques can be used to image mineral samples on a small scale and determine their chemistry e.g. the scanning electron microscope and electron microprobe. N.B. Access to these techniques is not required.</p>		<p>Candidates should be made aware of the laboratory techniques and equipment used to image and identify minerals at a microscopic level.</p> <p>Knowledge of the workings of the instruments and the methods of sample preparation is not required.</p>

1.2 Igneous Rocks and Processes

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. Igneous rocks have diagnostic properties; colour and texture [crystal size, equicrystalline, porphyritic and orientation].</p>	<p>Identify the named igneous rocks in hand specimens/rock exposures, diagrams and photomicrographs from observation of their colour, crystal size [coarse >3 mm, fine <1mm], random crystal orientation of phenocrysts/groundmass and mineralogy.</p>	<p>See Practical Guidance Sheet 4.</p> <p>See Practical Guidance Sheet 5.</p>
<p>b. Igneous rocks [peridotite, basalt, andesite, granite] can be classified by:</p> <ul style="list-style-type: none"> • texture • mineralogy. 		<p>Candidates should be able to distinguish between peridotite, basalt, andesite and granite in hand specimens, photomicrographs and photographs on the basis of crystal size and mineralogy.</p>
<p>c. Crystal size in igneous rocks is related to the cooling rate of magma.</p>		<p>Candidates should be able to interpret the cooling history of igneous rocks from measurements of crystal size including porphyritic in hand specimens, photomicrographs or diagrams. Interpretation to include two stage cooling in addition to slow, moderate or rapid cooling rates.</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>d. Magma viscosity affects the type of volcanic activity and the shape of volcanoes – the differences between relatively passive [fissure] and violent eruptions [central vent].</p>	<p>Recognise and interpret the differing shapes of volcanoes from diagrams/photographs.</p> <p>Investigate factors affecting the length of lava flows using the ‘Jelly lava flow’ simulation experiment or equivalent. Factors investigated to include viscosity (related to temperature) and slope angle.</p>	<p>Candidates should be able to distinguish between shield volcanoes and composite cones based on their size, shape and composition. Kilauea/Mauna Loa v Mount Pinatubo/Mount St. Helens.</p> <p>Practical activity using a rigid smooth surface at a range of angles with materials of different viscosities being timed to flow down it. Materials could include jelly.</p> <p>Materials could be tested from the fridge, at room temperature and after heating to a predetermined temperature.</p> <p>See Practical Guidance Sheet 3.</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>e. Igneous bodies can be distinguished by:</p> <ul style="list-style-type: none"> • structure [columnar jointing, pillow lava] • form [lava flows, sills, dykes and plutons] • field relationships. 	<p>Identify the characteristics of igneous bodies [crystal size, structures, field relationships] as seen in hand specimen/rock exposures, diagrams and photographs. Analyse simplified geological maps and cross-sections to interpret their contrasting modes of formation.</p>	<p>Candidates should have the opportunity to make annotated sketches of these features from photographs or field outcrops.</p> <p>Candidates should be able to distinguish between baked and chilled margins, metamorphic aureoles and discordant and concordant relationships with the country rocks.</p> <p>Candidates should be able to distinguish between lava flows and sills on the basis of field evidence; baked margins, vesicles, xenoliths, crystal size, weathered upper surfaces.</p>

1.3 Sedimentary Rocks and their Fossil Content

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. Rock is disaggregated by weathering and erosion into particles of various sizes and dissolved materials that are transported and deposited to form new sediments.</p>	<p>Distinguish between the processes of weathering and erosion and evaluate their significance in the sedimentary characteristics and the geological history of sedimentary rock.</p>	<p>Candidates should be able to describe and explain the following weathering processes; freeze-thaw (mechanical), carbonation (chemical) and the action of plant roots (biological).</p> <p>Weathering takes place in situ, erosion involves transport/removal of weathered products from site of production.</p> <p>Candidates should be able to describe and explain the following erosional processes with respect to rivers, the sea, ice and wind: Abrasion, attrition, hydraulic action, solution.</p>
<p>b. The grain size, shape and sorting of the resultant sediment is influenced by the energy of the transporting medium and the depositional environment [scree, rivers, shallow/deep seas, wind- formed dunes].</p>	<p>Interpret:</p> <ul style="list-style-type: none"> • the distance of transport from the shape and sorting of sediment • the energy level of the environment of deposition from sediment grain size. 	<p>Candidates should be able to describe the grain size characteristics of sediments from photomicrographs, hand specimens and photographs.</p> <p>See Practical Guidance Sheet 4.</p> <p>See Practical Guidance Sheet 5.</p>

Knowledge and understanding	Geological techniques and skills	Comments
		<p>Candidates should be able to identify sediments that are well sorted, moderately sorted and poorly sorted sediments from photomicrographs, hand specimens or photographs on a six-point scale from very angular, angular, sub-angular, sub-rounded, rounded and well-rounded.</p> <p>Candidates should be able to interpret size, shape and sorting characteristics of sediments as a function of the length of time in transport, the distance the sediment has been transported and the type of transporting medium (i.e. wind, ice or water).</p>
<p>c. Porosity and permeability of sedimentary rock depends upon the characteristics of the original sediment and the degree of compaction and cementation.</p>	<p>Distinguish permeable from impermeable rocks by observing the effects of dropping water on specimens and/or by immersing them in water.</p>	<p>Candidates should be able to identify the factors that control porosity and permeability; grain size, grain shape, sorting, cement, laminations, bedding, joints, faults and cleavage planes.</p> <p>See Practical Guidance Sheet 6.</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>d. Sedimentary rocks [breccia, conglomerate, sandstone, shale, evaporites, limestone] have diagnostic properties [colour, texture, reaction with acid] mineralogies and other diagnostic features.</p>	<p>Identify the named sedimentary rocks in hand specimens, rock exposures and diagrams/photographs from observation of their colour, texture [use of sediment comparators to determine grain size, shape and sphericity], [coarse >2 mm, fine <1/16 mm], reaction with 0.5 mol dm⁻³ hydrochloric acid, mineralogy and other diagnostic features.</p> <p>Construct and apply a classification system/key to identify the named sedimentary rocks.</p>	<p>Candidates should be able to distinguish between clasts, matrix and cement.</p> <p>See Practical Guidance Sheet 4.</p> <p>See Practical Guidance Sheet 5.</p> <p>See Practical Guidance Sheet 7.</p>
<p>e. Sedimentary rock type is dependent upon the environment of deposition:</p> <ul style="list-style-type: none"> • Shallow marine: [limestone, sandstone, conglomerate] • Deep marine: [turbidites, black shale] • Terrestrial: <ol style="list-style-type: none"> 1. deposited in rivers and deltas [shale, sandstone, conglomerate, coal] 2. deposited by wind and water in deserts [breccia, desert sandstone] 3. deposited by precipitation from saline water during evaporation [evaporites – halite and gypsum] deposited by ice [glacial till/tillite]. 	<p>Use the characteristics of sedimentary rocks, including their distinctive sedimentary textures, structures, mineralogy and their fossil content, as seen in hand specimens, rock exposures, diagrams and photographs to interpret their environments of deposition.</p> <p>Analyse sedimentary rock formations on simple geological maps, cross-sections and graphic logs to interpret geological structure and the history of sedimentation.</p> <p>Construct a simple graphic log from bed thickness and grain size data.</p>	<p>See Practical Guidance Sheet 8.</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>f. Distinctive sedimentary structures [lamination/bedding, cross bedding, graded bedding, ripple marks, desiccation cracks] are characteristic of their environments of deposition.</p>		
<p>f. Fossils are indicators of past environments:</p> <ul style="list-style-type: none"> • reef-building corals [marine, shallow, warm] • trilobite [marine], ammonite [marine] • plants [terrestrial, indicating past climate] • trace fossils [tracks indicating terrestrial, burrows indicating shallow water]. 	<p>Identify the following fossil groups on the basis of their morphology [trilobite, ammonite, coral, plants, trace fossils – burrows, footprints], as seen in hand specimens, diagrams/photographs.</p>	<p>The following morphological features should be recognized in these fossil groups:</p> <p>Corals; septa.</p> <p>Trilobites; cephalon, thorax, pygidium, eye.</p> <p>Ammonites; suture line.</p> <p>Plants; leaf, stem, root.</p> <p>Trace Fossils; footprints, burrows.</p>

1.4 Metamorphic Rocks and Processes

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. Metamorphic rocks are the result of increased temperature and/or pressure on pre-existing rocks causing recrystallisation to form new minerals and textures.</p>	<p>Identify the named metamorphic rocks in hand specimens from observation of their crystal size [coarse, fine], crystal orientation [aligned, random] and reaction with 0.5 mol dm⁻³ hydrochloric acid.</p>	<p>See Practical Guidance Sheet 4.</p>
<p>b. Metamorphic rocks [slate, schist, marble, metaquartzite] have diagnostic textures [crystal size and orientation]:</p> <ul style="list-style-type: none"> • non-foliated texture • foliated texture [slaty cleavage and schistosity]. 	<p>Identify the characteristic features of a metamorphic aureole on diagrams and simplified geological maps and cross-sections.</p>	<p>Candidates should know the cause of contact and regional metamorphism.</p> <p>Candidates should be aware that some of the stated rocks can be the product of both contact and regional metamorphism.</p>
<p>c. Metamorphic rocks [schist, marble and metaquartzite] have diagnostic mineralogy.</p>	<p>Use the characteristics of metamorphic rocks [texture, mineralogy, acid reaction] as seen in hand specimens/rock exposures, diagrams and photographs, simplified geological maps and cross-sections to interpret their contrasting modes of formation [contact and regional metamorphism].</p>	<p>See Practical Guidance Sheet 4.</p> <p>See Practical Guidance Sheet 5.</p>

1.5 Deformational Structures

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. The rock record provides evidence of tectonic activity.</p>	<p>Describe safety precautions to be taken when visiting field exposures.</p> <p>Measure strike and dip.</p> <p>Analyse strike and dip measurements to describe and interpret rock structures in 3D.</p>	<p>Candidates should be aware of the importance of a range of safety precautions when visiting field locations (including coastal locations).</p> <p>See Practical Guidance Sheet 9.</p> <p>Candidates should be able to interpret dip and strike data to interpret rock structures in 2D (maps and cross sections) and 3D (block diagrams).</p>
<p>b. Folding is caused by tectonic stress [compressional].</p>	<p>Interpret characteristic features of folding in field exposures, diagrams, photographs, simplified geological maps and cross- sections:</p> <ul style="list-style-type: none"> • horizontal beds • dipping beds • folded beds [antiform, synform, axial plane trace, limb]. 	<p>Candidates will not be required to distinguish between the terms antiform/anticline synform/syncline.</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>c. Faulting is caused by tectonic stress [compressional, tensional, shear].</p>	<p>Interpret features of rock deformation by faulting in field exposures, diagrams, photographs, simplified geological maps and cross sections:</p> <ul style="list-style-type: none"> • normal fault • reverse/thrust fault • strike-slip fault • fault displacement. 	<p>Candidates should be able to measure the amount of fault displacement using an appropriate scale from a map or cross section.</p>
<p>d. Unconformities are gaps in the rock record. Angular unconformities are formed by a sequence of events including deformation, uplift, erosion and later deposition.</p>	<p>Identify unconformities in the field, in diagrams, photographs, geological maps and cross-sections. Use unconformities in interpreting the geological history of exposures.</p>	

2.1 The Rock Cycle

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. Sedimentary, metamorphic and igneous processes and rocks are linked by the rock cycle [energy transfer] over geological time.</p>	<p>Interpret rock cycle diagrams.</p>	<p>Candidates should be aware that the sedimentary processes of the rock cycle are controlled by the hydrological cycle. Igneous and metamorphic processes are controlled by plate tectonics.</p> <p>Candidates should be aware of the importance of gravity in order for the rock cycle to operate.</p>
<p>b. Rock cycle processes take place at different rates, from seconds to millions of years [catastrophism v gradualism – e.g. meteorite impact v river erosion].</p>	<p>Distinguish between processes reflected in the rock record that occurred at different rates.</p>	<p>Candidates should be able to order geological events in terms of their duration from a given list for example meteorite impact, earthquake, landslide, volcanic eruption, formation of an ocean, formation of a mountain range.</p>

2.2 Plate Tectonics

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. The Earth has a concentric structure based on its:</p> <ul style="list-style-type: none"> • chemical properties [crust, mantle and core] • mechanical behaviour [lithosphere, asthenosphere]. 		<p>Candidates should be able to appreciate the relative thicknesses of the different layers of the Earth.</p> <p>Teachers are referred to the following practical demonstrations:</p> <p>1. Using a toilet roll to demonstrate the variation in thickness of the Earth's layers (crust, mantle, lithosphere and core). http://www.earthlearningidea.com/PDF/196_Journey_centre_E.pdf</p>
<p>b. The mechanical behaviour of the outer Earth involves the lithosphere [cold, rigid outer shell composed of crust and uppermost mantle]. It is underlain by the asthenosphere [weaker layer composed of upper mantle].</p>		<p>2. Bending two chocolate bars, one of which has previously been frozen, to demonstrate the effect of temperature on brittle and plastic deformation of the same material.</p>
<p>c. The lithosphere is divided into a number of rigid 'tectonic plates' which move relative to one another by mechanisms not yet completely understood.</p>		<p>Candidates should be aware of the possible causes of plate movement (slab pull and ridge push).</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>d. With new evidence, plate tectonic theory developed from continental drift.</p> <ul style="list-style-type: none"> • Continental drift was proposed by Wegener (1915) • Evidence for sea floor spreading was discovered by Hess (1960) Vine and Matthews (1963) J. Tuzo Wilson (1965). 	<p>Analyse the evidence for plate tectonics [jigsaw pattern fit, fossil distributions, heat flow, magnetic stripes, age of the ocean floor, Global Positioning System (GPS) data].</p>	
<p>e. There is a range of evidence supporting the theory of plate tectonics and the direction and rate of plate movements.</p>	<p>Use maps to interpret the global distributions of present day earthquakes, volcanic activity and mountain belts in the context of processes at or near to plate boundaries.</p>	

Knowledge and understanding	Geological techniques and skills	Comments
<p>f. The relative movements between plates produce a range of magmatic types, structures and topography identified at different types of plate boundary.</p> <ul style="list-style-type: none"> • Divergent plate boundaries [basalt extrusion, sea floor spreading, the origin of basaltic magma by partial melting of the upper mantle, ocean ridges, high heat flow, rift valleys, abyssal plain] e.g. Mid-Atlantic Ridge. • Conservative plate boundaries [earthquake activity, transform faults] e.g. San Andreas fault zone. • Convergent plate boundaries: <ol style="list-style-type: none"> 1. oceanic-oceanic [island arc/trench systems] e.g. Java-Sumatra/Caribbean. 2. oceanic-continental [active continental margins; subduction zones, Benioff zone, partial melting producing andesitic and granitic magmas] e.g. the Andes. 3. continental-continental [mountain building, folding, thrust faulting, partial melting of the crust producing granites, associated regional metamorphism] e.g. the Himalaya. 	<p>Interpret the relative movement of plates from their plate boundary context shown in maps and diagrams.</p> <p>Interpret the type of plate boundaries from data [magmatic, seismic and topographic] provided in text, diagrams/photographs and maps.</p>	<p>Candidates should be able to explain why different types of volcanoes and earthquake activity occur at different plate boundaries.</p> <p>Candidates should be able to calculate average spreading rates or subduction rates from given data.</p> <p>Candidates should be able to interpret plate movement directions from given data.</p>

<p>Knowledge and understanding</p>	<p>Geological techniques and skills</p>	<p>Comments</p>
<p>g. Plate theory is being continually re-evaluated in the light of new evidence e.g. seismic tomography and ocean drilling – RRS James Cook, Joides Resolution 360 (2016).</p>		<p>Candidates should be aware of the latest advances in plate tectonic theory by using internet based resources.</p> <ul style="list-style-type: none"> • seismic tomography is providing evidence of asymmetric spreading at the Mid Atlantic Ridge • deep ocean drilling is leading to a re-valuation of the base of the ocean crust. <p>https://teacheratseablog.wordpress.com/tag/science/</p> <p>http://www.nature.com/news/quest-to-drill-into-earth-s-mantle-restarts-1.18921</p> <p>https://www.cardiff.ac.uk/earth-ocean-sciences/about-us/supporting-education</p>

2.3 Geochronological Principles

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. Geological events are dated and interpreted using stratigraphic principles:</p> <ul style="list-style-type: none"> • uniformitarianism – the present is the key to the past • the concepts of original horizontality, lateral continuity and superposition of strata • the relative dating of rocks on the basis of included fragments, cross cutting relationships. 	<p>Investigate the link between ancient and modern processes by applying the principle of uniformitarianism.</p> <p>Apply the principles of relative dating to interpret the evidence in rock exposures in the field, in diagrams/photographs and simplified maps and cross- sections for the sequence of geological events that formed/deformed them.</p>	
<p>b. Rocks can be dated and correlated using the evolutionary change of zone fossils over time.</p>		<p>Candidates should be aware that graptolites are used to zone the Lower Palaeozoic and cephalopods can be used to zone the Upper Palaeozoic and Mesozoic.</p>
<p>c. The following zone fossil groups have morphological changes with time that are used in dating/correlation:</p> <ul style="list-style-type: none"> • cephalopods [goniatites, ceratites, ammonites – suture line] • graptolites [stipes, thecae]. 	<p>Use the named fossils, as seen in specimens and diagrams/photographs to interpret the geological history of a rock sequence.</p>	

Knowledge and understanding	Geological techniques and skills	Comments
<p>d. The decay of radioactive materials provides a method of absolute dating for some rocks and minerals.</p>	<p>Carry out a simple analysis of the age of a radioactive mineral based on the half-life concept [parent - daughter ratio, unstable parent, stable daughter].</p>	
<p>e. The development of the concept of <i>Deep Time</i> [Ussher (The Bible), Hutton, Kelvin, Joly and Holmes] has extended the age of the Earth back to around 4.6 billion years.</p>		<p>Candidates should be aware of the different methods that have been used to attempt to find the age of the Earth during historical times.</p>

2.4 Global Climate and Sea Level Change

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. There is evidence for global climate change through geological time [icehouse to greenhouse conditions]. Deposition of glacial deposits in regions close to the equator [Carboniferous tillites], deposition of limestone in areas outside the Tropics [Cretaceous limestones/chalk].</p>		<p>Candidates should be able to distinguish between icehouse and hothouse conditions and be able to interpret graphs showing carbon dioxide concentrations in the atmosphere and average global temperatures.</p>
<p>b. There is evidence for change in the climate of the British area caused by a change in its latitude.</p>	<p>Interpret the evidence from hand specimens of rocks and fossils, maps, diagrams/photographs for the changes in latitude of the British area from the Lower Palaeozoic to the Cenozoic. Interpret data from the data sheet.</p>	<p>Candidates should be directed to the following areas of study:</p> <p>Devonian red sandstones in the UK 370 Ma (UK 30°S).</p> <p>Carboniferous limestone and coal in the UK 320 Ma (UK on the equator).</p> <p>Permian red sandstones and evaporates in the UK 280 Ma (UK 30°N).</p> <p>Quaternary boulder clay in the UK 2 Ma (UK 50°N).</p>
<p>c. There is evidence for changes in sea level [drowned forests].</p>		<p>Candidates should be aware that sea level changes are relative and can be caused by changes in sea or land level or a combination of both.</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>d. The major sources of carbon dioxide in the atmosphere are volcanic emissions and the burning of fossil fuels.</p>	<p>Evaluate the relative roles of volcanic emissions and fossil fuels in current rates of climate change.</p>	
<p>e. There is evidence for changes in atmospheric carbon dioxide levels over geological time [ice cores and sedimentary rock].</p>		<p>Candidates should be aware of Antarctic ice core evidence for past atmospheric carbon dioxide levels.</p> <p>Candidates should be aware that the dating of past carbon dioxide levels comes from radiometric dating of “sedimentary” particles such as volcanic ash within ice cores.</p>
<p>f. There is both positive [reduction of icecap albedo accelerating warming] and negative [carbon dioxide dissolved in sea water, absorption by organisms to form limestone] feedback on the carbon dioxide content of the atmosphere [subduction, volcanic emissions, chemical weathering and marine storage].</p>		

Knowledge and understanding	Geological techniques and skills	Comments
g. Global warming/cooling affects continental ice sheet dimensions and global sea level.	Investigate the evidence from the internet, maps and aerial images for past and current fluctuations in continental ice and the effect on global sea levels.	
h. Carbon sequestration/capture is a geological strategy for reducing atmospheric carbon dioxide.		Candidates should be aware of the potential of depleted oil and gas reservoirs as being suitable sites for carbon sequestration.

2.5 The Origin and Development of Life on Earth

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. Life probably originated from the oceans or hydrothermal pools 3500 Ma [black smokers].</p>		
<p>b. The development of diversity in the evolution of life [through single cells, multicellular organisms, animals with hard parts, fish, amphibians, reptiles, mammals, birds and humans] is identified from the fossil record.</p>	<p>Use simple evolutionary tree diagrams [cladograms] to demonstrate evolutionary trends. Interpret data from the data sheet.</p>	
<p>c. The development of life on Earth was punctuated by major extinction events [Cretaceous/Palaeogene (K/Pg) mass extinction].</p>		<p>Candidates should be aware of the two possible causes of the K/Pg mass extinction (meteorite impact in Mexico and flood basalts in India).</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>d. Major fossil finds show:</p> <ul style="list-style-type: none"> • rare and exceptional preservation [Burgess shale fauna] • the links in macro fossil evolution through the morphology of modern reptiles and birds [<i>Archaeopteryx</i>] • that complex fossil skeletons have to be interpreted from incomplete and disarticulated remains [dinosaurs] • features of early hominids ["Lucy"]. 	<p>Evaluate the significance of the incomplete nature of the fossil record.</p>	<p>Candidates should be aware that the fossil record is biased and over represented by marine organisms that had shells.</p> <p>Candidates should be aware that many reconstructions of extinct organisms, particularly dinosaurs, are often based on just a few bones.</p> <p>Candidates should be aware that hominid fossils are exceptionally rare and only a few quality specimens of early hominids exist e.g. Lucy. Important features include bipedal gait and enlarged brain case of skull.</p>

3.1 Planetary Geology

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. There are similarities and differences between the Earth and its planetary neighbours [rocks, landscapes, atmosphere, temperature, pressure and gravity].</p>	<p>Use the principle of uniformitarianism to interpret the geological processes operating on planetary bodies within the Solar System.</p>	<p>Candidates should be aware that the different physical/chemical conditions that prevail on other planetary bodies will affect the processes (igneous and sedimentary – erosion, transport deposition) operating there compared to those on the Earth e.g. rate of change in the landscape of the cooler Moon, with no running water, no plate tectonics, under a lower force of gravity and lacking an appreciable atmosphere.</p> <p>Candidates are not required to have specific knowledge of individual planetary bodies and systems but to analyse data presented in terms of the processes operating on Earth (as outlined in igneous and sedimentary rocks/processes in 1.2 and 1.3) and the resulting rocks and landscape features (See c below).</p> <p>Candidates should be aware that the Earth may currently be the only tectonically active planet in the Solar System with a convecting mantle resulting in plate tectonics. Other planets e.g. Mars being smaller than Earth cooled quicker but indicate surface evidence of past tectonic activity.</p>

Knowledge and understanding	Geological techniques and skills	Comments
		<p>Useful additional resources</p> <p>https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Exploring.the.Moon.html</p> <p>http://mars.nasa.gov/</p> <p>Introducing the Planets and their Moons – Peter Cattermole (Dunedin Academic Press 2014)</p> <p>The following URL is a link to the images from this book which Dunedin Academic Press have kindly made freely available for educational use.</p> <p>https://www.dropbox.com/sh/sp405vbjuu09cu8/AACD01p3B_ZinPfiWfdRaUSYa?dl=0</p>
<p>b. Meteorites provide evidence for the composition of the Earth.</p>		<p>Candidates should be aware of the significance of stony and iron meteorites in interpreting the composition of the Earth’s mantle (stony) and core (iron).</p> <p>Candidates should be aware of differences between the internal structure of the Earth and other rocky and gaseous planetary bodies within the Solar System; e.g. Moon, Mars, and Jupiter.</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>c. The relationship between landforms and geological processes on Earth provides an analogue for interpreting landforms on planetary bodies within the Solar System.</p>	<p>Use evidence from space imagery and other planetary exploration data [maps, diagrams/photographs] to interpret the landforms and processes operating on planetary bodies within the Solar System e.g. Moon and Mars.</p>	<p>Candidates should be aware of the landscapes and processes on Earth associated with:</p> <p>igneous rocks (as outlined in 1.2) sedimentary rocks (as outlined in 1.3)</p> <p>Candidates should be aware of the following landscape features for comparison with the Earth:</p> <p>topographic highs and lows – mountains and plains</p> <p>volcanic shape – fissure/ central vent volcano, calderas e.g. Moon and Mars</p> <p>lava flows – flood basalts e.g. lunar maria</p> <p>canyon/channel/stream and lake network e.g. Valles Marineris on Mars</p> <p>fault features – fault scarps</p> <p>landslide features</p> <p>meteorite craters</p> <p>dunes e.g. Mars</p> <p>glacial features e.g. Mars</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>d. Planetary landforms provide evidence for unseen Earth processes e.g. Moon impact craters.</p>		<p>Candidates should be able to explain why some planetary bodies (e.g. Moon and Mars) have large numbers of well-preserved impact craters whilst the Earth has very few.</p> <p>Candidates should be able to interpret the size and shape of impact craters in relation to the size of the bolide and the angle of impact. (See http://www.earthlearningidea.com/PDF/68_Moon_craters.pdf</p> <p>http://www.open.edu/openlearn/science-maths-technology/science/physics-and-astronomy/meteoric)</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>e. Impacts from meteorites/comets may have had a significant effect on the evolution of the Earth and its biosphere.</p>		<p>Candidates should be aware of the collision theory that suggests the Moon formed out of the debris left over from a collision between Earth and a Mars sized planetesimal approximately 4.5 Ga.</p> <p>Candidates should understand the influence of the Moon on tides and the increase in length of an 'Earth Day' over geological time.</p> <p>Candidates should be aware that the origin of life on Earth may be linked to the early bombardment of the Earth by comets and meteorites around 3.85 Ga.</p> <p>Candidates should be able to explain the likely effect of large meteorites/comets on climate, the biosphere and evolution:</p> <ul style="list-style-type: none"> – short term – wildfires, tsunamis, global cooling and disruption of the biosphere – long term – global warming, extinctions

4.1 Earth Hazards and their Mitigation

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. Geological events can be hazardous:</p> <ul style="list-style-type: none"> • earthquakes [shaking triggering landslides] • volcanic eruptions [lava, ash, pyroclastic and mud flows] • landslides [and related subsidence] • tsunamis. 	<p>Investigate and interpret geological data relating to the distribution, measurement and possible causes of earthquakes, volcanic eruptions, landslides and associated tsunamis.</p>	<p>Candidates should be aware of the link between the distribution of earthquakes and volcanoes and their proximity to plate margins.</p> <p>Candidates should be aware of how earthquakes are recorded and measured. Mercalli Intensity Scale and Richter Magnitude Scale.</p> <p>Candidates should be able to link the type of volcanic hazard to the type of magma associated with the volcano; basaltic and andesitic.</p> <p>Candidates should be aware that tsunamis are secondary hazards and can be triggered by earthquakes, volcanoes or landslides.</p>
<p>b. The level of risk of a hazard is associated with life and property and relates to:</p> <ul style="list-style-type: none"> • population density • technology [buildings] • development [economic situation, education, communication]. 	<p>Use examples to contrast the risk of naturally occurring hazards in areas of contrasting development – LEDC and MEDC.</p>	<p>Candidates should be familiar with a selection of case studies in both LEDC and MEDC but they will not be required to recall specific case study detail in assessments.</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>c. The level of accuracy of hazard prediction is limited.</p>		<p>Candidates should realise that volcanic eruptions are more reliable in terms of prediction than earthquakes but the actual timing of any event is very difficult to determine.</p>
<p>d. The methods of reducing risk include:</p> <ul style="list-style-type: none"> • building design and regulation • prediction <ol style="list-style-type: none"> 1. hazard interval patterns [seismic gaps] 2. ground deformation [tiltmeters] 3. groundwater changes 4. gas emissions <ul style="list-style-type: none"> • warning schemes and evacuation. 		<p>Candidates should be familiar with a selection of case studies in both LEDC and MEDC but they will not be required to recall specific case study detail in assessments.</p>

4.2 Earth Resources and Engineering

Knowledge and understanding	Geological techniques and skills	Comments
<p>a. There is a distinction between Earth's:</p> <ul style="list-style-type: none"> • resources – naturally occurring useful substances • reserves of a resource – the calculated amount that is economic to extract. 		
<p>b. Mineral resources are important in construction, industrial manufacturing and energy generation.</p>	<p>Investigate the uses of the following minerals</p> <ul style="list-style-type: none"> • [Limestone for aggregate in construction • Haematite in the steel industry • Uranium in energy generation]. 	<p>Candidates should be aware of how the physical and chemical properties of these three geological materials influence their use.</p>
<p>c. Geologists prospecting for new reserves use a variety of techniques:</p> <ul style="list-style-type: none"> • geological mapping • borehole correlation [using microfossils] • geophysical [seismic, magnetic and ground penetrating radar] • geochemical [soil and river sediment analysis]. 	<p>Interpret prospecting data [geological mapping, geophysical, geochemical] to identify possible valuable mineral resources.</p>	<p>Candidates should be able to decide which prospecting technique(s) is/are the most appropriate for locating different types of geological materials (e.g. oil and gas, metalliferous minerals).</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>d. There are characteristic structures and rock properties associated with the migration and accumulation of oil and gas in potential on-shore and off-shore gas/oilfield resources:</p> <ul style="list-style-type: none"> • source rock • contrasting porosity and permeability of reservoir and cap rocks • the main types of trap for oil and gas [anticline, fault, unconformity, salt dome]. 	<p>Interpret data from maps, cross-sections and seismic surveys to identify possible gas/oilfields.</p>	

Knowledge and understanding	Geological techniques and skills	Comments
<p>e. There are technological difficulties and environmental issues involved in exploring for and extracting oil and natural gas [including fracking].</p>		<p>Candidates should have studied a range of case studies such as Blackpool/USA (fracking) and Gulf of Mexico (oil leak) but they will not be required to recall specific case study detail in assessments.</p>
<p>f. Factors affecting the extraction of underground water from aquifers include:</p> <ul style="list-style-type: none"> • height of the water table • porosity/permeability of the aquifer • the presence of natural springs • the distribution of wells. 	<p>Analyse different rock types for their suitability as an aquifer.</p>	<p>Candidates should have studied a range of case studies such as Nottingham (desert sandstone) and London (chalk) but they will not be required to recall specific case study detail in assessments.</p>
<p>g. The impact of domestic and hazardous waste disposal on vulnerable aquifers depends upon:</p> <ul style="list-style-type: none"> • geological factors [permeability] • engineering factors [geomembranes] • monitoring of potentially polluted water • restoration of contaminated ground. 	<p>Use data from descriptions, diagrams/photographs, maps and cross-sections to:</p> <ul style="list-style-type: none"> • investigate the suitability of a potential landfill site for the disposal of domestic waste. • investigate the suitability of a potential site for the long term storage of hazardous waste. 	<p>Candidates should have studied a range of case studies such as Sellafield and the Arthurstown landfill site, but they will not be required to recall specific case study detail in assessments.</p>

Knowledge and understanding	Geological techniques and skills	Comments
<p>h. Geological factors affect the siting of engineering projects e.g. reservoirs, dams, tunnels and cuttings [permeability, stability of bedrock, dip of strata, the presence of faults and joints].</p>	<p>Use data from descriptions, diagrams/photographs, maps and cross-sections to investigate the geological factors affecting the siting of major engineering projects.</p>	<p>Candidates should have studied a range of case studies such as the Channel Tunnel, Vaiont Dam, Three Gorges Dam, A55 Conway N. Wales, but they will not be required to recall specific case study detail in assessments.</p> <p>The British Geological Survey (BGS) website has a set of 3D geological models, at http://mapapps.bgs.ac.uk/geologyofbritain/home.html?mode=groundhog</p> <p>These models can provide virtual cross-sections and virtual boreholes which candidates could use to answer geological questions related to siting of engineering activities.</p> <p>See Practical Guidance Sheet 13.</p>

Useful additional resources may be found at

British Geological Survey <https://www.bgs.ac.uk/>

Earth Learning Ideas <http://www.earthlearningidea.com/>

Earth Science Teachers Association <http://www.esta-uk.net/>

United States Geological Survey <https://www.usgs.gov/>

GCSE Geology Practical Guidance Sheets

Appendix B of the specification lists Practical skills and techniques required by WJEC Eduqas GCSE Geology. These should be developed through regular hands-on practical activities undertaken in the classroom and in the field.

In addition, some practical activities are specified in the Geological techniques and skills column in the Subject Content of the specification.

The following Practical Guidance sheets have been matched to the order they appear in the Geological techniques and skills column in the Subject Content of the specification, with the insertion of those skills and techniques listed in Appendix B in relevant places.

Where no additional information/guidance can be usefully provided e.g. Appendix B “Recording Observations”, practical guidance sheets have not been produced.

GCSE Geology Practical Guidance Sheet 1

Title: Identification of minerals using appropriate tests (colour, hardness streak, cleavage, lustre and reaction with cold 0.5 mol dm^{-3} hydrochloric acid)

Specification reference: 1.1a

Aim: To use physical and chemical testing to identify minerals.

Apparatus:



Mineral testing equipment:
Streak plate/unglazed tile to test the colour of powdered minerals.

Dilute hydrochloric acid (“bench strength” 0.5 mol dm^{-3}) in a dropper bottle to test if a mineral is a carbonate.

Copper coin (pre 1992 coins are 97% copper, post 1992 they are copper plated steel), hardness ~ 3.5 on Mohs scale.

Steel pin/needle (dissecting pin from Biology department or steel nail), hardness ~ 5.5 on Mohs scale.

Learners to also use own fingernail, hardness ~ 2.5 on Mohs scale.

Method:

Carry out the appropriate tests and record results.

Complete a table (similar to below) to logically record the results of observations.

Description and identification of mineral specimen X		
Colour		
Cleavage		
Hardness	mineral is scratched by	mineral is softer than
	mineral is not scratched by	mineral is harder than
	hardness of mineral is between and on Mohs hardness scale	
Streak		
Lustre		
Reaction with cold dilute HCl		
Conclusion: identification of mineral X		

Analysis:

1. Identify the mineral by appraising the results of the tests.
2. Compare the mineral identification reached with published results eg. Eduqas Mineral Data Sheet or other sources.

For example a completed table:

Description and identification of mineral specimen X		
Colour	grey	
Cleavage	mineral cleaves along 3 planes parallel to the edges of its cubic crystals	
Hardness	mineral is scratched by copper coin	mineral is softer than copper coin
	mineral is not scratched by fingernail	mineral is harder than fingernail
	hardness of mineral is between ~2.5 and ~3.5 on Mohs hardness scale	
Streak	light grey	
Lustre	metallic	
Reaction with cold dilute HCl	teacher advised me not to carry out this test	
Conclusion: identification of mineral X: GALENA		

Teacher/Technician notes

Appropriate tests listed in section 1.1a:

Colour: to be observed in natural light.

Cleavage: to be observed and described in terms of number of cleavage planes.

Hardness: tested by scratching the specimen with fingernail/copper, coin/steel pin, observations can be checked using a hand lens. To be described in relative terms (harder than/softer than and link to figures e.g. if a mineral is not scratched by a fingernail, but is scratched by a copper coin then it will have a hardness of ~2.5–3.5).

If a mineral cannot be scratched by steel it has a hardness > 5.5.

Streak: the colour of a mineral's powder, to be obtained by rubbing a mineral specimen on an unglazed white porcelain tile/streak plate. To be described using the colour of the powdered mineral (e.g. white, red-brown, grey), or a negative result if the mineral is harder than the tile and scratches it (e.g. scratches streak plate).

Lustre: the way the mineral reflects light, to be observed and recorded using descriptive terms (e.g. glassy, pearly, metallic, dull).

Reaction with cold dilute (0.5 mol dm^{-3}) hydrochloric acid: this is to test the mineral for carbonates (calcite is the only carbonate in the specification). Observations to be described in terms of positive reactions (effervesces/fizzes) to identify carbonates, or no reaction to identify non-carbonate.

Health and Safety

If acid has been applied, then the specimen should be washed afterwards to remove any remaining acid.

1. Sulphide minerals e.g. galena should not be tested with acid.
2. Learners should wash their hands after handling mineral specimens.

Rock forming minerals listed (as specified on the mineral data sheet) in specification section 1.1a:

quartz, feldspar, mica, augite, olivine, halite, calcite, haematite, galena, garnet.

GCSE Geology Practical Guidance Sheet 2

Title: Measurement of the density of minerals

Specification reference: Appendix B. The requirement to perform a density test on minerals and to use appropriate apparatus to record a range of quantitative measurements including mass and volume, is stated in Appendix B.

Density can be investigated using the formula $\text{Density} = \frac{\text{Mass}}{\text{Volume}}$

Aim: To determine the density of minerals using the density formula.

Apparatus:

Samples of individual minerals (individual crystals or masses of crystals of one mineral)
Electronic balance
Water
Graduated (Measuring) cylinder

Method:

1. Select a mineral sample (individual crystal or mass of crystals all of the same mineral).
2. Determine the mass of the sample using an electronic balance. Record the result.
3. To determine volume there are 2 possibilities

A.

- immerse the specimen in the water in the graduated cylinder.
- measure how much the water rises (in ml). Record the result.
- convert to cm^3 . ($1\text{ml}=1\text{cm}^3$); record the result.

B. Where the mineral specimen has a regular shape (e.g. cuboid/rhombic crystals) the volume may be determined directly by measuring the length, width and height of the mineral.

Analysis:

1. Calculate the density of the sample using the formula $\text{Density} = \frac{\text{Mass}}{\text{Volume}}$
2. Compare the density value you have calculated with published results.

Teacher/Technician notes:

This method cannot be used for minerals embedded in a rock, but only for a single crystal or mass (learners could discuss the reasons for this).

Only the volumes of insoluble minerals can be tested by method A.

GCSE Geology Practical Guidance Sheet 3

Title: Jelly Lava Flow Simulation Experiment

Specification reference: 1.2d

Appendix B: The requirement to use appropriate apparatus to record a range of quantitative measurements including time, temperature and length is stated in Appendix B.

The requirement for the use of information and communications technology (ICT) such as computer modelling, or data logger to collect data, or use of software to process data is stated in Appendix B and processing of data can be undertaken using ICT.

Aim: To investigate factors, including viscosity and slope angle, affecting the length of lava flows using the 'Jelly lava flow' simulation experiment or equivalent.

Apparatus:

120 g pack Jelly or alternative
Heated water bath over a Bunsen burner
250ml beaker
Thermometer
Ruler
Timer
Smooth boards capable of being fixed at a variety of angles
Clinometer
Sticky labels
Dessert spoon

Method:

1. Prop up/fix a board and record its angle of slope (from the horizontal) using a clinometer.
2. Warm a beaker of jelly in a water bath over a Bunsen burner.
3. Place a thermometer in the jelly.
4. When the jelly begins to melt, record the temperature, and take out a dessert spoon of jelly.
5. Place the jelly at the top of the sloping board, start the timer and label the lava flow with a sticky label recording the temperature of the jelly when removed and the angle of slope.
6. After a set time record the length of the jelly lava flow.
7. The temperature of the water bath should be increased and a second dessert spoon of jelly removed at a known temperature.
8. Place the second sample of jelly at the top of the slope of the board, adjacent to first lava flow, start the timer and label this lava flow with a second sticky label.
9. Repeat the experiment for a number of jelly lava flows of varying temperature.
10. Repeat the experiment for jelly lava flows on boards of varying slope angle.

Analysis/Conclusions:

1. Present the recorded data (e.g. by using graphs).
2. Highlight any anomalies.
3. Interpret & analyse the data by recognising patterns and trends.
4. Recognise any sources of error and limitations.
5. Draw conclusions from your data.
6. Relate these conclusions to knowledge & understanding of the geological processes that have been simulated.

Extension:

Suggest improvements which would make to the method more reliable.

Suggest other factors that affect the length of lava flows and how these might be investigated in a jelly lava flow experiment.

Teacher/Technician notes:

There are many acceptable variations on the method outlined and teachers should feel free to use any variation they feel appropriate. A range of materials could be used in place of jelly. Materials could include honey, treacle, tomato sauce, mango chutney, washing up liquid and yoghurt. Materials could be tested from the fridge, at room temperature and after heating to a predetermined temperature.

This experiment provides a good opportunity for the use of ICT to process data, thereby fulfilling the requirement in Appendix B for the “Use of information and communications technology (ICT) such as computer modelling, or data logger to collect data, or use of software to process data”.

ICT could be used to tabulate data and to present the data in graphical forms.

GCSE Geology Practical Guidance Sheet 4

Title: Production of full rock description of macro and micro features from conserved hand specimens and unfamiliar field exposures

Specification reference: 1.2a, 1.3b, 1.3d, 1.4a, 1.4c

Appendix B. The requirement to produce full rock descriptions of macro and micro features from hand specimens and unfamiliar field exposures of igneous, sedimentary and metamorphic rocks is stated in Appendix B.

Aim: To produce a full rock description of macro and micro features from hand specimens and unfamiliar field exposures of igneous, sedimentary and metamorphic rocks.

Apparatus:

Hand lens or light microscope

Ruler

A sediment comparator

A range of igneous, sedimentary and metamorphic rocks

Method (igneous rocks):

1. Select a hand specimen of an igneous rock (or an unfamiliar field exposure of igneous rock).
2. Describe the texture of the rock:
 - crystalline
 - crystal size (s): coarse (>3mm), medium (1-3mm), fine (<1mm)
 - other textural features: equicrystalline, porphyritic
3. Describe and identify the minerals within the rock.
4. Observe any macro features from the igneous rock specimen/field exposure eg. pillow structures, columnar joints.

Method (sedimentary rocks):

1. Select a hand specimen of a sedimentary rock (or an unfamiliar field exposure of sedimentary rock).
2. Describe the texture of the rock:
 - clastic/fragmental/granular
 - grain size (s)
 - grain shape
 - the degree of sorting of the grains.
3. Describe features of the composition of the rock:
 - colour(s)
 - identify the minerals within the rock.
4. Observe and record any macro features in the sedimentary rock specimen such as sedimentary structures or fossil content.

Method (metamorphic rocks):

1. Select a hand specimen of a metamorphic rock (or an unfamiliar field exposure of metamorphic rock).
2. Describe the texture of the rock:
 - crystalline
 - foliated, including type of foliation (slaty cleavage, schistosity) or non-foliated
 - crystal size (s)
3. Describe and identify the minerals within the rock.
4. Observe any macro features from the metamorphic rock.

GCSE Geology Practical Guidance Sheet 5

Title: The use of photomicrographs to identify minerals and rock textures

Specification reference: 1.2a, 1.3b, 1.3d, 1.4c

Appendix B. The requirement to use photomicrographs to identify minerals and rock textures is stated in Appendix B.

Aim: To use photomicrographs to identify minerals and rock textures of igneous, sedimentary and metamorphic rocks.

Apparatus:

Photomicrographs or drawings of photomicrographs of a range of igneous, sedimentary and metamorphic rocks

Ruler

Mineral data sheet.

Method (igneous rocks):

1. Select a photomicrograph of an igneous rock.
2. Describe the texture of the rock:
 - crystalline
 - crystal size (s): coarse (>3mm), medium (1-3mm), fine (<1mm)
 - other textural features: equicrystalline, porphyritic
3. Describe and identify the minerals within the rock.

Method (sedimentary rocks):

1. Select a photomicrograph of a sedimentary rock.
2. Describe the texture of the rock:
 - clastic/fragmental/granular
 - grain size (s)
 - grain shape
 - the degree of sorting of the grains
3. Describe and identify the minerals within the rock.

Method (metamorphic rocks):

1. Select a photomicrograph of a metamorphic rock.
2. Describe the texture of the rock:
 - crystalline
 - foliated, including type of foliation (slaty cleavage, schistosity) or non-foliated
 - crystal size (s)
3. Describe and identify the minerals within the rock.

If petrological microscopes are available learners could be provided with thin sections of a variety of rock types which could be drawn and annotated.

Alternatively learners could draw and annotate images of thin sections using internet sources or learners could be provided with copies of images for annotation.

Websites containing thin section images of a variety of rocks include:

<https://goo.gl/MyKPRx>

<https://goo.gl/hy0iaS>

GCSE Geology Practical Guidance Sheet 6

Title: Distinguishing permeable from impermeable sedimentary rocks

Specification reference: 1.3c

Appendix B: The requirement to use appropriate apparatus to record a range of quantitative measurements including mass and volume is stated in Appendix B.

Aim: To determine the relative permeability of a range of sedimentary rock samples.

Apparatus:

Samples of sedimentary rocks
Electronic balance
Water
Graduated (measuring) cylinder

Method:

1. Select a sedimentary rock sample.
2. Determine the mass of the sample using an electronic balance. Record the result.
3. Determine the volume of the rock sample by:
 - immersing the specimen in water in the graduated cylinder.
 - measuring how much the water rises (in ml). Record the result.
 - converting to cm^3 ($1\text{ml}=1\text{cm}^3$). Record the result.
4. Soak the rock sample in water for approximately 24 hours.
5. Remove the rock sample from the water, dab the surface water from the sample.
6. Determine the mass of the soaked rock sample using an electronic balance. Record the result.
7. Repeat for a number of sedimentary rocks.

Analysis:

1. Calculate the volume of water taken in by the sample by calculating the weight gain of the sample after immersion in water. The volume taken into the rock in millilitres (ml) is the same as the gain in mass in grams (g) ($1\text{g}=1\text{ml}$). Record the result.
2. Calculate the volume of water taken in by the sample as a % of the volume of the rock using the following equation:

$$\frac{\text{volume of water taken in by the rock sample (ml)}}{\text{volume of the rock sample (cm}^3\text{)}} \times 100$$

The higher the %, the greater the permeability of the rock.

3. Compare the values for a range of sedimentary rocks.
4. Explain the variation of results for different sedimentary rocks.

Evaluation:

Consider any inaccuracies in the experiment and suggest improvements in the method.

Teacher/Technician notes:

A range of sedimentary rocks should be used, including limestone, shale, well sorted and poorly sorted sandstones. Chalk although not listed in section 1.3 of the specification could be used, forming a useful link to aquifers in section 4.2.

Soluble sedimentary rocks such as halite and gypsum cannot be used in this experiment.

A simplified version of the experiment could be undertaken by observing the effects of dropping water on specimens. Care should be taken to control the volume of water added and the timescale over which the observations are made.

GCSE Geology Practical Guidance Sheet 7

Title: The construction and application a classification system/key to identify the named sedimentary rocks

Specification reference: 1.3d

Appendix B: refers to the need to apply classification systems.

Aims: To construct an identification key for the following sedimentary rocks.
To apply an identification key for the following sedimentary rocks.

breccia, conglomerate, sandstone, shale, halite, gypsum, limestone

Apparatus:

A range of sedimentary rock samples

Method:

Learners should each construct their own identification key for the sedimentary rocks listed. The key may then be applied by fellow learners.

Teacher/Technician notes:

Factors to be considered in the construction of the identification key may include the presence or absence of grains, grain size, grain shape, sorting, presence or absence of fossils, colour and reaction with cold 0.5 mol dm^{-3} hydrochloric acid.

Ideally the rock samples used to devise an identification key by a learner should be different to those used by the same learner in applying another learners' identification key i.e. within the classroom it would be useful if there were two different sets of conglomerates, breccias, sandstones, limestones etc wherever possible.

GCSE Geology Practical Guidance Sheet 8

Title: The construction of graphic logs

Specification reference: 1.3e

Appendix B: refers to the need to construct graphic logs, to have knowledge and understanding of sampling and use of appropriate apparatus to record length.

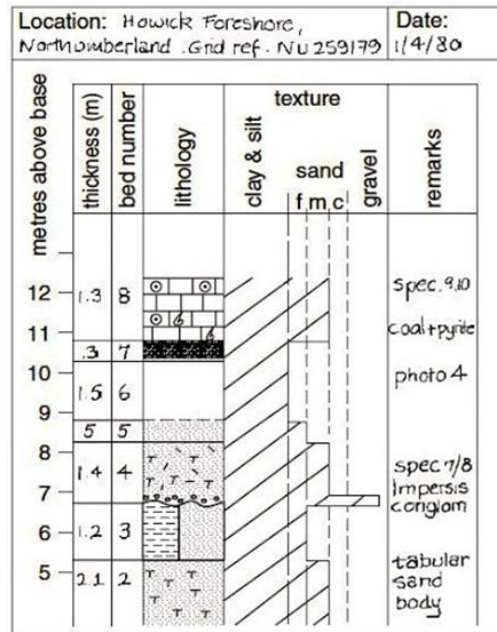
Aim: To construct a simple graphic log using appropriate scale and symbol sets for unfamiliar geological sequence and exposure.

Apparatus:

Tape measure
Sediment comparator
Hand lens
Graphic log template
Graphic log key
Pencil

Method:

1. Select a section of a sedimentary sequence to be logged. If relevant use a sampling method for locating the log, either systematic sampling or random sampling. Ideally the sequence will have continuous exposure. If not it may be necessary to move sideways along the section to find where the beds higher up the sequence are exposed so that a continuous record can be produced.
2. Decide on a vertical scale to be used e.g. 1:10 (1 cm to 10 cm).
3. Begin the graphic log at the base of the sequence.
4. Record the following features: bed or rock unit thickness, lithology (rock type), grain size, sedimentary structures, fossils and the nature of bed contacts (e.g erosive or sharp).



Geology In www.geology.com

Bed or rock-unit thickness

The bed thickness is measured with a tape measure. When the beds are dipping steeply and logging is taking place on a surface oblique to the bedding planes care must be taken to ensure that the true thickness of the beds is recorded.

Where thin beds of the same lithology occur together they can be grouped together into a single unit with one lithology on the log.

Where thin beds of different lithology rapidly alternate, e.g. interbedded sandstones and shales, they can be treated as one unit and notes made of changes in the relative thickness of these beds up the sequence.

Lithology (rock type)

On the graphic log, lithology is recorded in a column by using an appropriate shading in the key. If two lithologies are thinly interbedded, then the column can be divided in two by a vertical line and the two types of shading entered.

Texture (grain-size)

On the log there should be a horizontal scale for the grain size column. For many rocks this will show mud (clay + silt), sand (divided into fine, medium and coarse) and gravel. Having determined the grain-size of a rock unit, this is marked on the log and the area shaded (the wider the column, the coarser the rock).

Sedimentary structures and bed boundaries

Sedimentary structures within the beds can be noted in a "remarks" column.
e.g. cross bedding, graded bedding, ripple marks, desiccation cracks, lamination.

The bed boundaries can be recorded in the lithology column separating one bed from another. These boundaries may be

- erosive (shown as a wavy/irregular line)
- sharp (shown as a straight line)

Fossils

If fossils are found in the sequence, they can be noted in a “remarks” column.

e.g. corals, trilobite, ammonite, graptolite, plant, tracks, burrows.

The degree of fragmentation of the fossils may also be recorded in the “remarks” column.

‘Remarks’ column

This can be used for extra information regarding sedimentary structures, fossil content, amount of fossil fragmentation fossil, grain shape and sorting, as well as cross references to photographs or field sketches.

Analysis:

Each bed should be analysed to determine the environment of deposition of the sedimentary rock contained.

In this way, changes in the environment of deposition up the sequence (over time) can be determined.

Graphic logging is basically a list or diary of the rocks and their features in a “standard” format which enables interpretation of processes and environment and any changes.

Graphic logging may be practised in the laboratory prior to it being undertaken on fieldwork by construction of a “mock cliff face”.



A



B

This may be achieved by:

- **A** - a series of rocks are arranged in a length of gutter to build up a sequence or
- **B** - a 1 metre (or other) plastic tube (a suitably reinforced container that once housed a curtain pole is ideal) is filled with sediments of different types (to show a variety of mineralogy, textures and colours). To ensure a sharp, rather than a diffuse boundary between fine sediment overlying coarser sediment, it is best if the finer sediment is initially contained in a see-through plastic bag which prevents settlement into the open pore spaces in the coarser sediment below. With care, suitable sedimentary structures can be achieved e.g. load structures, graded beds, cross bedding.

An example of a graphic log template - GCSE

Location:			Date:			
Grid reference:						
thickness in metres	bed number	lithology	grain size			remarks/notes e.g sedimentary structures, fossils
			clay and silt	f sand	m c	

Lithology

Devise suitable symbols to use for any sedimentary rocks/sediments you find in your graphic log

Breccia	Shale	Coal
Conglomerate	Limestone	
Sandstone	Evaporite	
Devise others as required		

GCSE Geology Practical Guidance Sheet 9

Title: The measurement of dip and strike of planar surfaces or apparent dip of fold limbs at a field exposure using a compass clinometer

Specification reference: 1.5a

Appendix B: refers to the need to measure two and three-dimensional geological data across a range of scales such as dip and strike of planar surfaces or apparent dip of fold limbs at a field exposure using a compass clinometer.

Aim: To measure the dip and strike of planar surfaces or apparent dip of fold limbs at a field exposure using a compass clinometer.

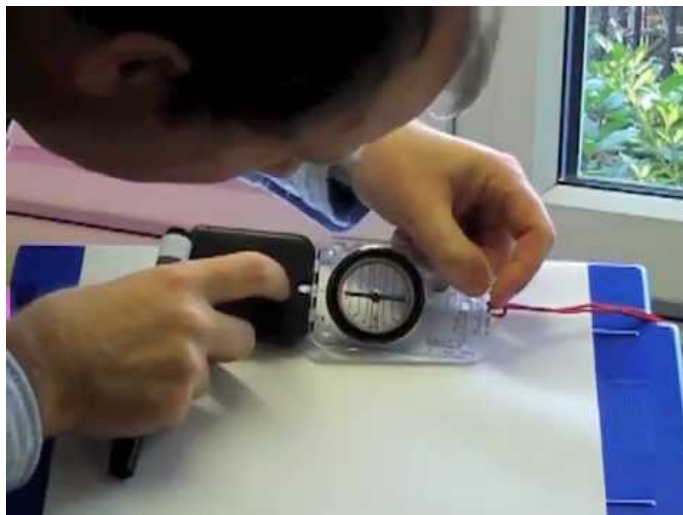
Apparatus:

Compass clinometer (or separate compass and clinometer)

Method:

1. Strike direction

- Set the compass clinometer to East-West by turning the bezel so that the values 90 and 270 intersect the markers on the compass which are often a pair of fluorescent dashes. This puts the compass clinometer in clinometer mode
- Hold the clinometer vertically and place it on its long edge on the plane (e.g. a bedding plane)
- Move the clinometer round, on its long edge, keeping it vertical, until the clinometer reading is zero



Havering sfc YouTube <http://bit.ly/2k6DqIC>



Geology In www.geology.com

- Draw a line on the plane, using chalk in the field. This line is the direction of strike
- Turn the compass clinometer horizontal, so that it is now in compass mode.



Geology In www.geology.com

- Point the long axis of the compass along the chalk line representing the direction of strike
- Turn the dial of the compass (the bezel) so that red suspended arrow overlies the red arrow in the base of the bezel



Geology In www.geology.com

- Read off the direction of the strike on the rim of the bezel where the rim intersects the “marker” which is often a fluorescent “dash”. There are two of these and it does not matter which is used. They will be 180 degrees apart
- Record the direction of strike as a 3 digit number. If the directions of strike are 8° and 188° , this is recorded as either 008° or 188° .

2. Angle of dip

- Put the compass clinometer into clinometer mode again. (Set the compass clinometer to East-West by turning the bezel so that the values 90 and 270 intersect the markers on the compass which are often a pair of fluorescent dashes)
- Hold the clinometer vertically and place it along its long edge on the plane. Move the clinometer around, on its long edge, keeping it vertical and in contact with the rock, until the clinometer reaches its maximum reading. This is the true dip reading and happens when the clinometer is pointing down the plane at 90 degrees to the direction of strike



Geology In www.geology.com

- Read off the dip angle by reading off where the arrow, which hangs down inside the bezel, intersects the scale in the inside of the bezel. The value will be between 0 and 90
- Record the angle of dip as a two digit number e.g. 42° .

3. Direction of dip

- The direction of dip will be at a bearing of 90° from the direction of strike
- It is the direction to which the plane loses height, the direction to which the angle of dip reading was taken
- It can be recorded as a compass direction e.g. S, W, NW, SE etc

A complete dip and strike reading for a planar surface such as a bedding plane should be recorded in the following way.

Strike direction (3 digits)/Dip angle (2 digits)/Dip direction (a compass direction)

e.g. **188/42/E**

4. Apparent Dip

On occasions it is not possible to place a compass clinometer on a 3-dimensional outcrop of a planar surface and only a 2-dimensional view of a dipping plane is visible e.g. in the face of a cliff. In such cases a plane can be seen to be dipping but it is not possible to determine the direction of strike of the plane, nor therefore to determine the true dip direction.

In these situations all that can be recorded is the angle at which the plane appears to be dipping (recorded as 2-digits) and the direction to which the plane appears to be dipping (recorded as a 3-digit bearing). These readings record the Apparent Dip of the plane rather than the True Dip of the plane and this must be noted alongside the readings.

e.g **32/185 Apparent Dip**

Repetition of readings: Planar surfaces in geology are often irregular. For this reason one reading of dip and strike may not be representative of a planar surface or of a series of planar surfaces.

It may be worth taking more than one reading of dip and strike on a plane or on a concordant series of adjacent planes in order to increase the accuracy of measurements.

Sampling: Where a series of dip and strike readings are to be taken for an investigation into a sequence of folds for example, a sampling method should be used to ensure that the readings are representative of those required for the investigation. The pros and cons of various sampling methods (random, systematic, stratified) should be considered before a sampling strategy is chosen.

Video examples of how to take dip angle, strike direction and dip direction can be found on Youtube e.g.

<https://www.youtube.com/watch?v=FbXhoadhZw>

<https://www.youtube.com/watch?v=VCN2q6xwTNk>

and also on video clips at

<http://www.esta-uk.net/fieldworkskills/video%20clips.htm>

GCSE Geology Practical Guidance Sheet 10

Title: Location of geological features in the field using traditional navigation and basic field survey skills and with the use of GPS

Specification reference: Appendix B. The requirement to have knowledge and understanding of the location of geological features in the field using traditional navigation and basic field survey skills and with the use of GPS is stated in Appendix B.

Aim: To locate geological features in the field using traditional navigation and basic field survey skills and with the use of GPS.

Apparatus:

Simple base map of field area
Compass
Smart phone
Pencil

Method (traditional navigation and basic field survey skills):

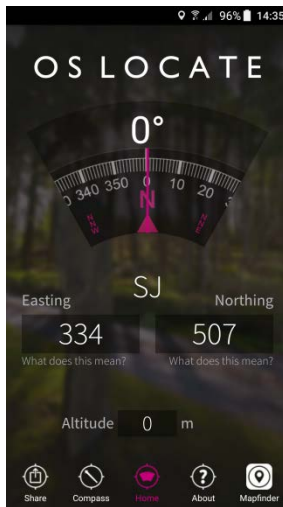
1. Determine the distance of a geological feature from prominent landmark e.g, a headland, river or bridge by measurement or by pacing. (This can only be undertaken if learners have calculated their typical stride length prior to fieldwork).
2. Determine the direction of a geological feature from prominent landmarks by taking bearings using a compass as follows:
 - Standing at the geological feature, point the direction of travel arrow of the compass (the long dimension of the compass) at the landmark
 - Turn the compass dial until the North arrow in the base plate of the dial lies under the red "hovering North arrow"
 - Place the compass on the map so that the orienting lines within the base of the compass dial are parallel to the map's North-South lines (meridians)
 - Move the compass across the map so that the top corner of one long edge ends at the landmark, keeping it aligned with the map's meridian
 - Draw a faint line on the map along the edge of the compass from the landmark. The geological feature is somewhere along this line
 - If a bearing is taken to a second landmark, and the process repeated, the geological feature should be at the point where the two faint lines meet on the map.
3. Locate the geological feature onto the base map using approximate distances and bearings from prominent landscape features.

Information on how to take a bearing can be found at:

<https://www.youtube.com/watch?v=BADUq3Magbo>

Method (using GPS):

Smartphones have a built in GPS facility. This can be used to locate geological features and describe their location in terms of a six-figure grid reference.



There are a number of Apps available for Android and Apple and are free. One of which is available at the following link:
<https://www.ordnancesurvey.co.uk/shop/os-locate>

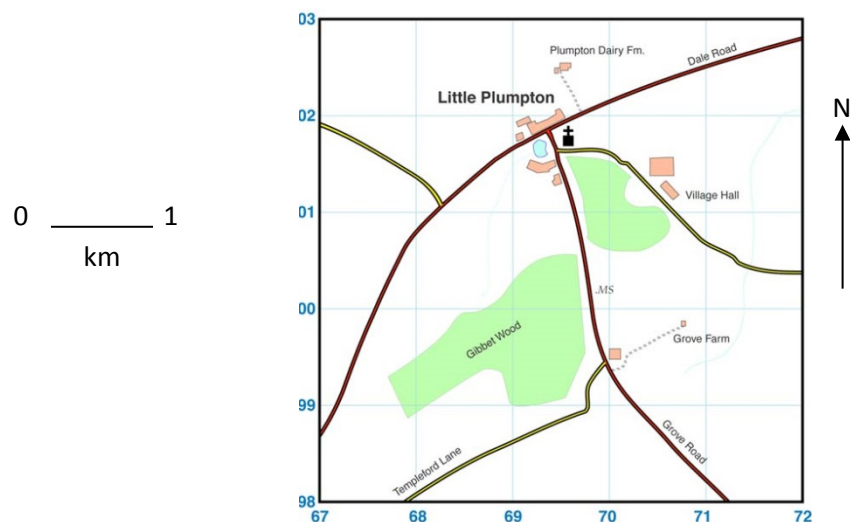
Learners may wish to use a Smartphone to locate **EarthCaches**. An **EarthCache** is a special geological location people can visit to learn about a unique feature of the Earth. **EarthCache** pages include a set of educational notes along with coordinates.

Ordnance Survey app, OS Locate www.ordnancesurvey.co.uk

Learners need to be able to locate a geological feature using a six-figure grid reference onto a base map. The method for this is outlined below.

Method:

1. Check that the map has grid lines running up and down the map (These lines are Eastings and increase in number the further to the right or East, assuming that North is orientated up the map).
2. Check that the map has grid lines running across the map (These lines are Northings and increase in number the further up the map, or North, assuming that North is orientated up the map).
3. The numbers along the bottom of the map are read first (the Eastings) and the numbers up the side of the map are read second (the Northings).
4. To locate a geological feature within a grid square, a six-figure reference is used e.g. the grid reference 698002 is found $\frac{8}{10}$ of the way across and $\frac{2}{10}$ of the way up the grid square 6900. The geological feature is adjacent to the Mile Stone MS.
5. The six-figure grid reference for geological features should be recorded in a field notebook and on any field sketches of the features.



Wikimedia Creative Commons
<http://bit.ly/2j7EIUC>

Analysis:

None required.

Teacher/Technician notes:

Simple base maps of field areas should be produced by the teacher prior to fieldwork activity.

These can be simple hand drawn maps, or derived from OS maps (or electronic versions) but all should have a scale and orientation.



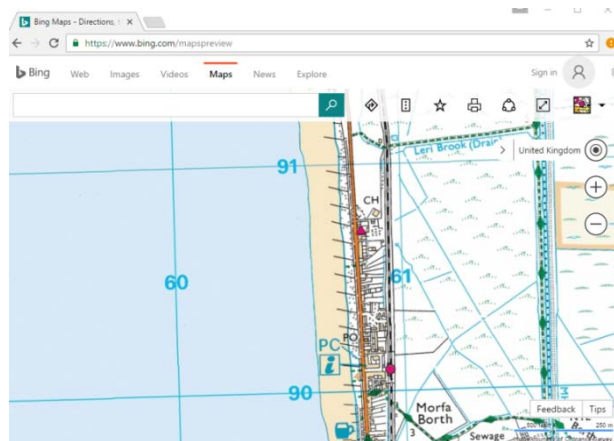
Maps can be derived from looking at map views online (or satellite views) or from traditional paper maps.

Electronic maps are available from Google Earth and Google Maps and Bing Maps. Although the more useful maps have OS map data (e.g. contour lines).

Bing <https://www.bing.com/mapspreview>

Ordnance Survey view should be selected (tool bar on the top right hand side), scale appears in the bottom right hand corner, and grid lines give orientation. Note that the grid lines often appear at an angle.

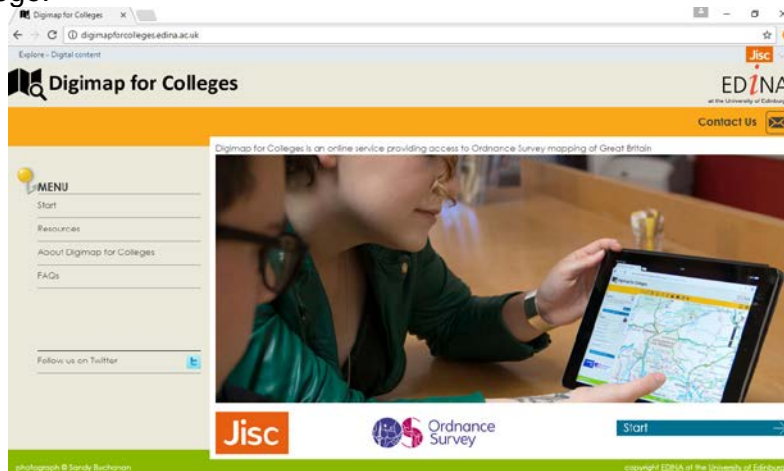
“Screen shots” or use of the “snipping tool” can give good base maps.



Microsoft Bing maps www.bing.com/mapspreview

It may be necessary to number the grid lines if they are not prominently labelled on the selected section.

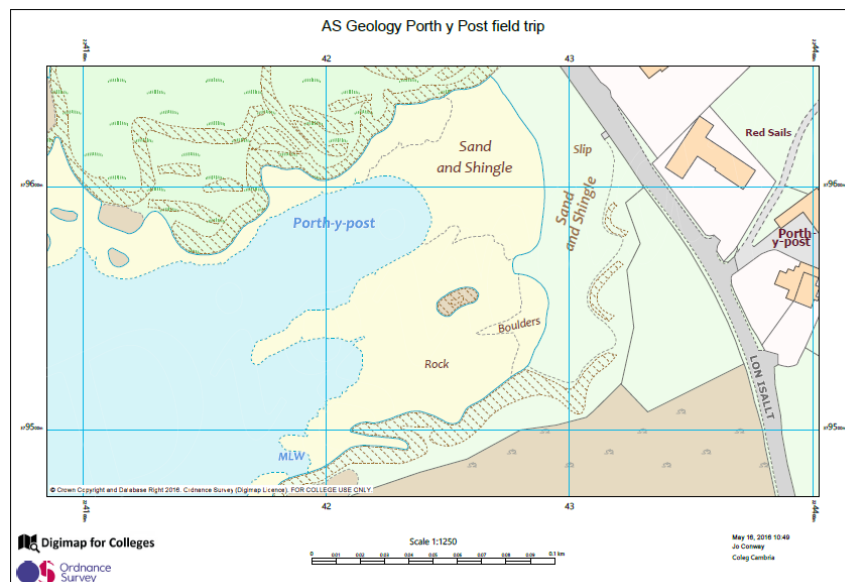
Many FE colleges have subscribed to the Edina program and have access to Digimap. <http://digimapforcolleges.edina.ac.uk/> However this is usually only available within your college.



Digimap for Colleges <http://digimapforcolleges.edina.ac.uk/>

Digimap is a range of Ordnance Survey digital maps, covering the whole of GB. Included are the most detailed maps OS make which show building outlines. These maps are suited to being used for local area studies, studying land use on the high street, locating businesses or planning a new construction site. They are digital versions of traditional OS maps that are commonly used for hill walking and outdoor activities, as well as street-level, road-atlas style and regional maps.

The maps are complemented by a range of tools that allow you to enhance the maps. Measurement tools, Annotation Tools (you can use to add points), Save (save any maps that you create to come back to later) and Print (to create printable PDF or JPG maps. Printable maps can be printed to make hard copies, saved to a computer drive).



Digimap for Colleges <http://digimapforcolleges.edina.ac.uk/>

Grid lines are parallel with the edge of the paper/box that the map appears in and scale bars are very sharp and easily used for distances.

“Screen shots” are useful for showing maps at alternative scales.

GCSE Geology Practical Guidance Sheet 11

Title: Producing annotated, scientific drawings

Specification reference: Appendix B. The requirement to produce annotated, scientific drawings is stated in Appendix B.

Field Sketches

Aim: To produce scaled, annotated field sketches at unfamiliar field exposures to record data.

Apparatus:

Field notebook or plain paper large enough to be able to include the required amount of drawn and written detail

Pencil (soft) and eraser

Clipboard / something to rest on

Metre rule or equivalent (to determine scale)

Compass (to determine orientation)

Method:

1. Consider the purpose of the field sketch, ie what you are aiming to show – decide on what is important to include and make prominent in your sketch. Make a list of terms first, then draw.
2. Find a comfortable sheltered position to work from, safe and easily accessible, (and gives the same perspective as the secondary data if needed), and is free from obstruction.
3. Identify a frame for the sketch – holding up a cardboard frame may help to do this. Alternatively define what will form the top and bottom of your sketch e.g. the skyline/top of a cliff and base of a cliff.
4. Orientate the paper so that it mirrors the dimensions of the sketch to be drawn e.g. orientate the paper in “landscape” for a sketch that will be wider than tall.
5. Draw a frame, or the features that will form the top and bottom of your sketch, onto the paper.
6. Draw the main features of the sketch which form the most prominent or important geological features first.
7. Draw geological features of finer detail.
8. Add labels and annotations for the geological features.
9. Add a scale for your field sketch.
10. Label the direction, bearing, grid reference and a short written description of the ‘view’.

Considerations

Scale – this can be difficult, particularly when sketching a large landscape area. Starting the sketch with the things furthest away and working towards you will help. Also, add labels to show things of known height (refer to map of the area to find this).

Slopes – drawing the correct angle of a slope can be problematic. Try holding a pencil away from you, towards the slope and then transfer it to the paper.

Weather – adverse conditions will have an immediate, preventative effect on your ability to carry out a field sketch!

Use photography to complement your field sketch. Photos can be used to add detail to your sketch later, which you may not have had the time to include or suitable conditions to achieve in the field.

The field sketch needs to be ‘fit for purpose’ to add value to your field notes – this takes

some thought and consideration.

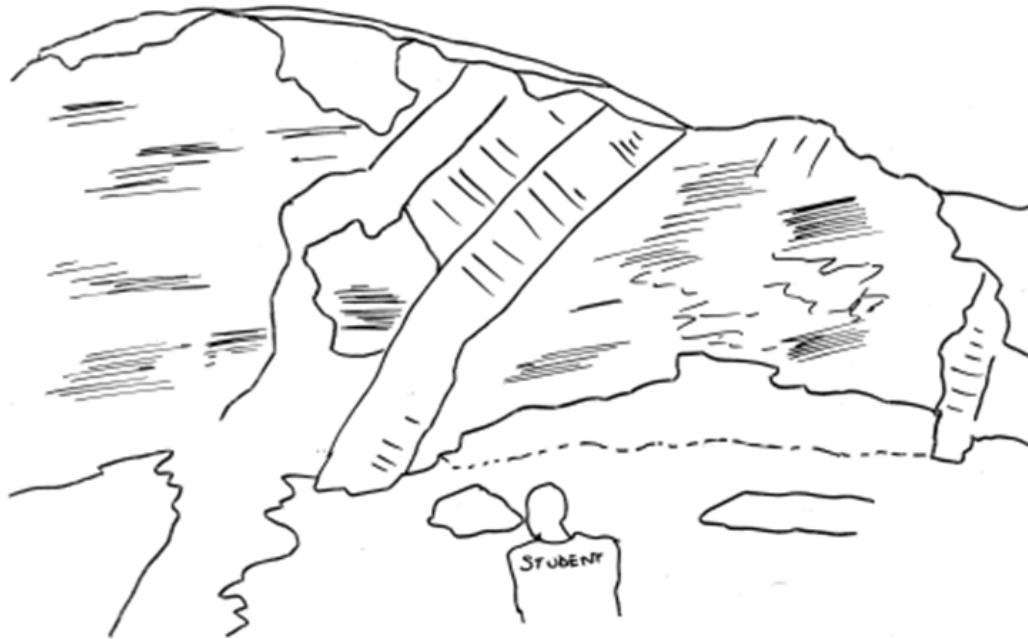
Labels should be used to pick out the main features, and annotations to comment on certain aspects in order to bring out the main 'message' you are trying to convey.

Learners may practice field-sketching in the classroom prior to fieldwork.

Task: In class situations, learners could use photographs to be given practice in how to produce a large field sketch, possibly using tracing paper or a transparency to help. See example below.



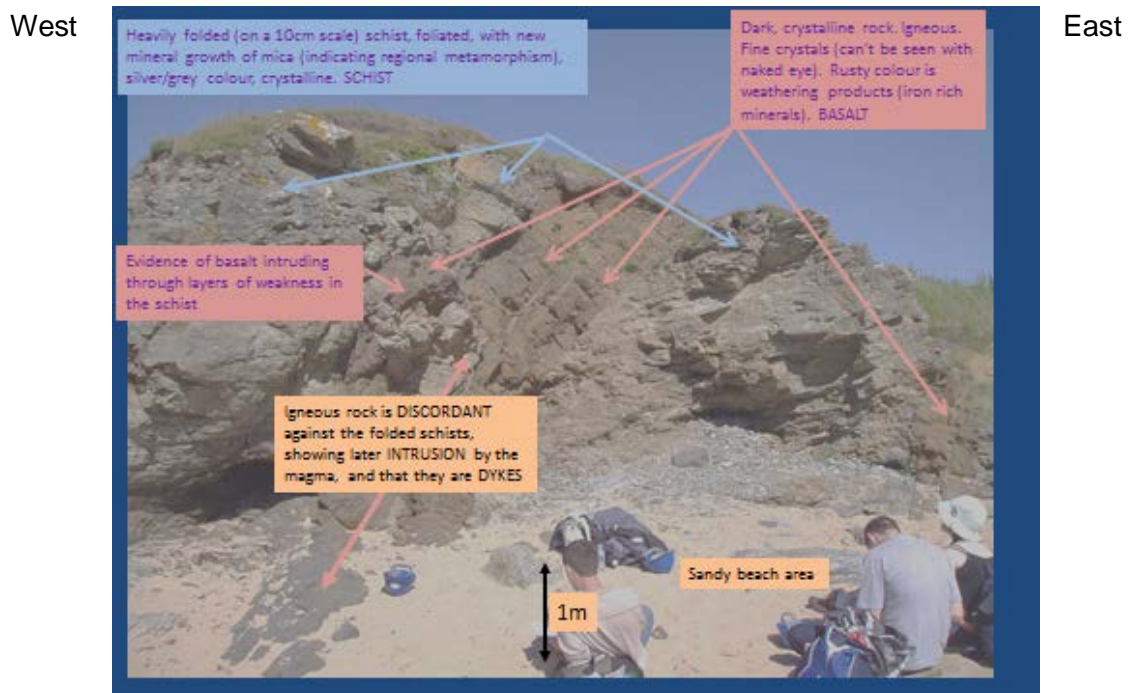
It might look something like this when finished.



From the following description, try to label and annotate your field sketch:

“the area was a beach, with some vegetation on the area behind. The exposure faced east. In the middle of the exposure there were two basalt igneous intrusions cutting across the country rock (which was a heavily folded schist with mica crystals). The contacts were sharp. There was another dyke to the right of the exposure.”

The labels/annotations might look something like this when it is finished



Further information on how to construct field sketches can be found at <http://www.esta-uk.net/fieldworkskills/tips.htm>

GCSE Geology Practical Guidance Sheet 12

Title: Constructing geological maps

Specification reference: Appendix B. The requirement to construct geological maps is stated in Appendix B.

Aim: To construct geological maps.

Apparatus:

Tape measure

Compass-Clinometer

Hand lens

Field notebook

Base map of area to be mapped e.g. school/college grounds, area of field site

Method (in the field):

An area of well exposed geology such as a wave cut platform should be selected to be mapped. It is important that the area to be mapped is not too large. A few tens of meters in one or more dimensions would be recommended.

The area should contain at least two geological features of interest such as an igneous body, fault, fold, unconformity, dipping beds of varying lithologies.

Learners should spend time investigating the “layout” of the features of the area before producing a rough sketch map onto the base map showing how the features relate to each other.

Detailed records of their observations should be recorded to include where relevant:

- dip and strike of planar structures e.g. bedding planes, faults, edges of igneous bodies
- widths of features e.g. of outcrops of lithologies, width of igneous bodies
- rock descriptions of the main lithologies

The map should be drawn up on return to the classroom.

Method (in the classroom/school or college grounds):

In preparation for, or as an alternative to field mapping if a field mapping site is not available, an area of geology can be “mocked up” on the classroom floor or school/college grounds.

e.g. a series of dipping beds of varying lithology can be represented by propping up trays/books/planar surfaces with rock samples next to them. In this way folds and unconformities can be modelled across the classroom floor and the rock samples described.

A dyke may be represented by a sample of basalt and vertical edge or even a written description of the outcrop.

Unseen faults can be simulated by “displacement” of features such as a dyke.

Learners should spend time investigating the “layout” of the features of the area before producing a rough sketch map showing how the features relate to each other.

Detailed records of their observations should be recorded to include where relevant:

- Dip and strike of planar structures e.g. bedding planes, faults, edges of igneous bodies
- Widths of features e.g. of outcrops of lithologies, width of igneous bodies
- Rock descriptions of the main lithologies

The map should then be drawn up.

GCSE Geology Practical Guidance Sheet 13

Title: The use of a geographic information system (GIS)

Specification reference: Appendix B. The requirement to have knowledge and understanding of the compilation and analysis of geological data sets through to visualisation using a geographic information system (GIS) is stated in Appendix B.

Aim: To use GIS to compile and analyse geological data sets.

A simplified example is shown below. Alternative uses of GIS are acceptable.

Apparatus:

e.g. British Geological Survey (BGS) website 3D geological models

Method:

The British Geological Survey (BGS) website has a set of 3D geological models, found at the link below.

<http://mapapps.bgs.ac.uk/geologyofbritain/home.html?mode=groundhog>

These models can provide virtual cross-sections and virtual boreholes which learners could use to answer geological questions.

e.g.

- Select “Ingleborough” from the “choose model” menu
- Select “Draw Cross-Section”
- Draw a cross-section line running NW-SE across the map from the NW corner to the SE corner by clicking where you want to start the cross-section, dragging the mouse and double clicking where you want the cross-section to end
- Produce the cross-section by clicking on the link to open the virtual cross-section
- Using this cross section, a task could be set that requires learners to consider the suitability of the three valleys for the site of reservoirs. Alternatively a shorter cross-section line could be drawn across one valley only. Clicking on the name of the rock units indicated in the key reveals their lithology and learners may use this to inform their decisions regarding permeability, or learners may be given suitable information regarding permeability.

e.g. If York is selected, a cross section W-E or a borehole located within the map area reveals information concerning the thickness and lithology of each layer. This could provide a data set that learners could use to consider the engineering issues faced by those developing foundations for the construction of tall buildings in the York area.

e.g. If Thurrock is selected and a N-S cross section drawn, questions such as “to what extent does the geology of the area support the development of a landfill site with minimal engineering design?” could be posed.