Department for Education

Geology

GCSE subject content

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Contents

The content for geology GCSE

Introduction

1. The GCSE subject content sets out the knowledge, understanding and skills for GCSE specifications in geology, to ensure progression from key stage 3 national curriculum science requirements and provide a sound basis for further study, including at A level. It provides the framework within which awarding organisations create the detail of the subject specifications.

Aims and objectives

2. GCSE study in geology provides the foundations for understanding the science of 'how the Earth works': its structure, evolution and dynamics, and its mineral and energy resources.

3. Understanding and application of Earth science is vital to the future quality of life and prosperity of the world's population; from supplying the ever-growing demand for mineral, energy and water resources to mitigation of natural hazards by improved engineering and prediction techniques.

4. GCSE geology specifications should enable students to:

- develop knowledge and understanding of rock types, geological structures, geochronology, the rock cycle and plate tectonics as the key ideas of geology
- develop understanding of the nature, processes and methods of geology, through the different types of scientific enquiry used to answer questions about how the Earth works
- develop and learn to apply observational, practical, modelling, enquiry and problem-solving skills, both in the laboratory and in the field, and extend their competence in a range of fieldwork skills, including those required in understanding 3D geological data
- develop their ability to evaluate claims based on science through critical analysis of the methodology, evidence and conclusions, both qualitatively and quantitatively

Subject content

5. GCSE geology specifications must build on the knowledge, understanding and skills set out in key stage 3 national curriculum requirements for science and mathematics.

Knowledge, understanding and skills

6. GCSE geology specifications must require students to demonstrate knowledge and understanding of the content set out below:

Minerals

- the physical properties of minerals
- modes of formation of common rock-forming minerals
- modern laboratory techniques in the study of minerals (scanning electron microscope, electron microprobe)
- the uses of a minimum of three minerals (at least one in construction, one in industrial manufacturing and one in energy generation)

Igneous rocks

- diagnostic textures and mineralogy of igneous rocks
- characteristics of a minimum of four igneous rocks (one ultramafic, one mafic, one intermediate and one silicic)
- the effect of magma cooling rates on crystal size
- the effect of viscosity of magma on the type of volcanic activity and morphology of the volcano
- the characteristics of passive and violent eruptions
- structures within igneous bodies (columnar joints and pillow structures)
- the forms of igneous bodies (lava flows, sills, dykes and plutons)
- the characteristics of igneous bodies (textures, structures and field relationships) in hand specimen/rock exposures, simple geological maps, diagrams and photographs

Sedimentary rocks and their fossil content

- diagnostic textures and mineralogy of sedimentary rocks
- characteristics of a minimum of four sedimentary rocks (at least one of clastic, one of chemical and one of organic origin)
- the relationship between sedimentary textures (size, shape and sorting of the grains) and processes within the rock cycle
- the structures within sedimentary rocks (lamination/bedding, graded bedding, cross bedding, ripple marks and desiccation cracks)
- the influence the degree of compaction and cementation of sedimentary grains on porosity and permeability of sedimentary rocks
- sedimentary rock type and fossil content as evidence of the environment of deposition (marine and terrestrial) over geological time
- the characteristics of sedimentary rocks (textures, structures and fossil content) in rock exposures, simple geological maps, diagrams and photographs
- morphology of a minimum of three fossil groups (including corals and plants)

- the significance of major fossil discoveries (including Burgess Shale fauna)
- the morphology of modern reptiles and birds (the link with macro fossil evolution - Archaeopteryx)
- the incomplete nature of the fossil record
- features of early hominids ('Lucy')

Metamorphic rocks

- diagnostic textures and mineralogy of metamorphic rocks
- characteristics of a minimum of two metamorphic rocks (one contact and one regional metamorphic)
- the relationship between metamorphic textures (crystal size and orientation) and processes within the rock cycle
- the formation of metamorphic rocks as a result of heat and/or pressure on pre-existing rocks
- foliated textures (slaty cleavage and schistosity)
- the characteristic features of a metamorphic aureole on simple geological maps/diagrams
- the characteristics of metamorphic rocks (textures and reaction with acid) in hand specimen/rock exposures, simple geological maps and diagrams, and photographs

Structures

- the evidence of tectonic activity in the rock record
- the concept of dip and strike of 3D planar surfaces
- the characteristics of rock structures (folds, faults and unconformities) in field exposures, simple geological maps and diagrams, and photographs
- folding caused by compressional stresses
- characteristic features of folding (antiforms/synforms and axial plane traces) in field exposures, simple geological maps, and diagrams and photographs
- processes and causes of faulting in compressional, tensional and strike-slip dominated regimes
- characteristic features of faulting (normal/reverse, thrust and strike-slip displacement) in field exposures, simple geological maps, and diagrams and photographs
- unconformities as breaks in the rock record
- the characteristics of unconformities in the field, in photographs, and in diagrams and on geological maps
- unconformities in interpreting geological history

Planetary geology

- the similarities and differences (rocks, landscapes, atmosphere, temperature, pressure and gravity) between the Earth and its planetary neighbours

- meteorite evidence for the composition of the Earth
- the impact that meteorites/comets may have had on the Earth's evolution
- planetary features as analogues for unseen Earth processes (e.g. Moon impact craters)
- the use of space imagery and exploration technology in obtaining planetary exploration data (e.g. Moon and Mars)

Geochronological principles and stratigraphy

- the principle of uniformitarianism
- the concepts of original horizontality, lateral continuity and superposition
- the relative dating of rocks based on included fragments, crosscutting relationships and fossil assemblages
- stratigraphic principles in interpreting the geological history of rock exposures in the field, and in diagrams and photographs
- radioactive decay rates and radiometric age determinations
- the development of the concept of deep time (The Bible, Hutton, Kelvin, Joly and Holmes)

Rock cycle

- the differing rates of rock cycle processes ('seconds' – catastrophism, compared to 'millions of years' – gradualism)
- the rock cycle linked to igneous, sedimentary and metamorphic processes over geological time (energy transfer)
- the relevance of weathering and erosion to sedimentary characteristics (size, shape and sorting) and geological history

Plate tectonics

- the structure of the Earth in terms of its chemical properties (crust, mantle and core) and mechanical behaviour
- the concept of a "tectonic plate" (related to its mechanical behaviour – lithosphere and asthenosphere)
- the evidence for plate tectonics theory (maps and seismic, magnetic, heat flow, fossil and Global Positioning System (GPS) data) and the related plate movement
- the type of magmatism, seismic activity, deformation and topographic features associated with different plate boundaries
- plate theory as being continually re-evaluated in the light of new evidence

Past global temperature and sea level changes

- the major sources of carbon dioxide in the atmosphere (volcanic emissions and burning of fossil fuels)

- the evidence for changes in climate through geological time (icehouse to greenhouse conditions) and sea level from sedimentary rocks (tillite, limestone and drowned forests)
- the evidence for changes in atmospheric carbon dioxide levels over geological time (sedimentary rock and ice cores)
- the effect on climate of the northward movement of the British area from the Lower Palaeozoic to the Cenozoic
- the positive and negative controls on the long term carbon cycle (subduction, volcanic emissions, chemical weathering and marine storage)
- the effect of global temperature change on ice sheets and sea levels over geological time
- carbon sequestration as a geological strategy for reducing atmospheric carbon dioxide

The origin and development of life

- the probable origin of life in the oceans ~3500 Ma (black smokers/hydrothermal pools)
- simple evolutionary tree diagrams (cladograms)
- the evolutionary change in zone fossils over time
- the diversity in the evolution of life from the fossil record
- major extinction events which punctuate the evolution of life on Earth as exemplified by the Cretaceous/Palaeogene [K-T] mass extinction

Earth hazards and their mitigation

- the concept of a geological hazard as a risk to life and property
- the distribution, measurement and possible causes of earthquakes, volcanic eruptions, landslides and associated tsunamis (as part of an Earth systems approach)
- a minimum of two techniques used in natural hazard prediction (e.g. correlation spectrometer (COSPEC) in volcanic eruption prediction)
- the limited accuracy of natural hazard prediction

Earth resources and engineering

- the use of mapping (including micropalaeontology) and geophysical techniques (seismic, magnetic and ground penetrating radar) and geochemical techniques (soil and river sediment analysis) in prospecting for new resources
- the characteristic structures of potential gas/oilfield resources (on-shore and off-shore)
- the role of porosity and permeability in the accumulation and migration of oil and gas from source beds to reservoir rock
- the main types of oil and gas traps (anticline, fault, unconformity and salt dome)

- the technological difficulties and environmental issues involved in the exploration and exploitation of hydrocarbon deposits (including fracking)
- the suitability of different rock types as aquifers (porosity and permeability)
- the monitoring and restoration of polluted water and contaminated ground
- the potential impact of domestic and hazardous waste disposal on vulnerable aquifers
- the geological and engineering issues involved in waste disposal and the long term storage of hazardous waste
- the geological factors affecting the siting of engineering projects such as reservoirs, dams, tunnels and cuttings (permeability, stability of bedrock, dip of strata, presence of joints and faults)

7. GCSE geology specifications must require students to demonstrate the following skills in the context of the knowledge and understanding set out in paragraph 6:

- use theories, models and ideas to develop geological explanations and present geological arguments
- use appropriate methodology to answer geological questions and solve geological problems
- evaluate methodology, evidence and partial data sets, and resolve conflicting evidence

8. GCSE geology specifications must require students to demonstrate the following skills and techniques:

- recording observations
- use of photomicrographs to identify minerals and rock textures
- constructing graphic logs
- applying classification systems
- producing annotated scientific drawings
- constructing geological maps
- constructing geological histories

9. GCSE geology specifications must require students to demonstrate knowledge and understanding of the following skills and techniques:

- location of geological features in the field using traditional navigation and basic field survey skills, and with the use of GPS
- identification of geological structures in the field
- measurement of 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 exposed on a hillside or cliff section using a compass clinometer
- sampling

- production of full rock description of macro and micro features from conserved hand specimens and unfamiliar field exposures
- use of appropriate apparatus to record a range of quantitative measurements (mass, time, volume, temperature and length)
- use of physical and chemical testing to identify minerals:
    - density test
    - Mohs hardness test
- use of methods to increase accuracy of measurements, such as timing over multiple observations, or use of a set square or plumb line
- compilation and analysis of geological data sets through to visualization using a geographic information system (GIS)
- use of information and communications technology (ICT) such as computer modelling, or data logger to collect data, or use of software to process data

10. The knowledge, understanding and skills required in paragraphs 8 and 9 should be developed through regular hands-on practical activities undertaken in the classroom and in the field. GCSE geology specifications must ensure that students undertake a minimum of two days of work in the field, during which they should have at least one opportunity to carry out a directed investigation to answer a geological question.

11. GCSE geology specifications must require students to demonstrate the mathematical skills set out in appendix 1.

Appendix 1

Mathematical skills

Arithmetic and numerical computation

- recognise and use expressions in decimal form
- recognise and use expressions in standard form
- use ratios, fractions and percentages
- calculate squares and square roots

Handling data

- use an appropriate number of significant figures
- find arithmetic means
- construct and interpret frequency tables, bar charts and rose diagrams
- understand the principles of sampling as applied to geological data
- use a scatter diagram to identify correlation between two variables
- make order of magnitude calculations

Algebra

- understand and use the symbols =, <, <<, >>, >, $\propto$ and ~
- change the subject of an equation
- substitute numerical values into algebraic equations using appropriate units for physical quantities
- solve simple algebraic equations

Graphs

- translate information between graphical and numeric form
- plot two variables from experimental or other data
- draw an appropriate trend line onto plotted data
- interpret data presented in graphical form
- determine the slope of a graph
- calculate the rate of change from a graph showing a linear relationship
- draw and use the slope of a tangent to a curve as a measure of rate of change

Geometry and trigonometry

- use angular measures in degrees
- visualise and represent 2D and 3D forms including two dimensional representations of 3D objects
- calculate areas of triangles and rectangles, surface areas and volumes of cubes

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