GLOSSARY OF TERMS

The terms in bold in the leaflets are defined in the glossary.

Abrasion – an erosion process whereby bedrock is worn down by sand or pebbles which are carried by rivers, waves or glaciers.

Acid mine water – water which has absorbed iron and sulphur compounds from minerals in coal seams, particularly pyrite,which increase its acidity. Acid mine water precipitates iron compounds in streams and rivers, which give the channel beds an orange colour.

Adit – the horizontal entrance to a mine

Andesite lava – an igneous rock with a composition which is intermediate between rocks with a high proportion of iron and magnesium minerals and those which contain a high proportion of silica minerals. It is named after the Andes Mountains.

Anticline – an upfold of rock strata produced by pressure in the crust

Attrition – the process of erosion which occurs when pebbles or grains of sand knock against each other in rivers or on beaches, causing them to become smaller and less angular

Avalonia – a small continental tectonic plate which collided with the large continent of Laurentia when the Iapetus Ocean closed during the Ordovician and Silurian periods

Ballagan Formation – the oldest sedimentary rocks of the Carboniferous period in the Berwickshire district. The rocks are between 360 and 348 million years old and consist of layers of sandstones, siltstones, cementstones and mudstones.

Basement – ancient rocks which underlie more recent rocks. In the Berwickshire district, the basement rocks are of Lower Palaeozoic age and were intensely folded and faulted during the Caledonian mountain building period.

Basin – a saucer-shaped fold in sedimentary strata

Bedding plane – the break between separate beds of sedimentary rock. Bedding planes represent a period of time when there was no deposition on the sea-bed or when there was erosion between the deposition of one bed and the following bed.

Bedrock – solid rock which underlies more recent superficial deposits, such as river alluvium and glacial till

Beds of rock – layers of sedimentary rock (strata)

Berwick Monocline – a complex tectonic structure which combines a fold with only one limb (monocline) with several major faults. It was probably formed by pressure during the Variscan plate collision at the end of the Carboniferous period 300 million years ago, when Carboniferous sediments were pushed up against the basement rocks of the Southern Uplands and the Cheviot block.

Boundary Fault – the major fault which runs from north-west to south-east between basement rocks and the Berwick Monocline. The fault is largely hidden by more recent rocks, but its path follows the A1 between Berwick and Burnmouth, where it appears on the beach near Partanhall.

Brachiopod – a marine invertebrate with two shells attached at a hinge. Brachiopods were very common during the Carboniferous period, but are now nearly extinct.

Breccia – a sedimentary rock made of angular pebbles and gravel

Burrows – burrows in wet sediments are used by invertebrates of many types for protection and for feeding. They are common in many limestones, sandstones, siltstones and mudstones.

Calcite – a mineral with the chemical composition $CaCO_3$ (calcium carbonate)

Calcrete – lumpy concretions of the mineral calcite which form on the ground surface when calcite-rich groundwater is evaporated during dry periods, in areas with an arid or semi-arid climate

Caledonian mountain building event – a major tectonic event in several phases related to the closure of the Iapetus Ocean, starting about 560 million years ago and culminating in a plate collision 420 million years ago.

Caledonides - the mountain chain which stretched across thousands of kilometres of what is now eastern North America through to Ireland, northern Britain and Scandinavia.

Calyx – the cup-shaped part of a crinoid which held the soft body parts of the crinoid animal

Carboniferous period – the interval of geological time from 360 to 300 million years ago

Carbon-rich shales – a bed of black shale (mudstone) containing a high proportion of compressed plant material made from organic ooze which accumulated in swamps or lagoons. Water and gases are driven out of the plant material by pressure from sediments during burial, leaving black carbon in the shale.

Cementstone – a lime-rich crystalline rock, often tough and resistant to erosion, formed from the precipitation of calcite when lakes and wetlands evaporate in semi-arid climates

Clay particles – minerals with a complex chemistry of aluminium silicates and other elements. Most clay particles have a platy shape so they hold together by surface tension to form coherent rocks like clays.

Coal seam – a bed of rock which is composed of compressed plant material made from organic oozes which accumulate in swamps or lagoons. Water and gases are driven out of the plant material by pressure during burial by other sediments, leaving a high proportion of carbon.

Concretions – ovoid or rounded bodies which have a different composition from the sedimentary rocks in which they are found. Concretions form after sediment has been deposited and appear to have grown outwards from a nucleus so they often have concentric layers and rounded shapes, although they vary greatly in size.

Continental shelf – the shallow offshore waters, usually up to 100 – 200 metres deep, underlain by continental crust

Continental slope – the gentle slope between the continental shelf and the deep water of the oceans. The continental shelf appears to have a steep angle on many diagrams but in fact it slopes at only 2-3°.

Corals – corals are marine invertebrates that build protective structures around themselves from calcite and similar minerals. Some corals live in colonies of tiny animals on a skeletal framework, while others are much larger single organisms. Both are found in the Carboniferous limestones of the Northumberland coast, although the species are completely different from present-day corals.

Crater/vent – the top of a volcanic pipe/neck at the earth's surface, from which ashes and lavas are erupted during volcanic activity

Crests and **troughs** – the highest and lowest points of folds

Crinoids – animals which are related to present-day sea urchins but which developed a protective calyx and a stem which was attached to the sea-bed by an anchor-like holdfast. They are first found in the Cambrian period and flourished during the Palaeozoic and Mesozoic eras.

Cross-bedding – a sedimentary feature which is very common in channel sandstones and is formed by the movement of sand particles rolling along river beds in the current. Sandbanks are formed in river channels and the lee side (downstream) of each sandbank is preserved as a series of sloping beds of sand at about 15-20°, while the top of the sandbanks are eroded away by the river.

Crystals (crystalline) – the natural shape of a mineral defined by its atomic structure. If minerals have space to grow in a cavity they can produce a perfectly shaped crystal but if they are confined, the crystals grow together to give a crystalline texture.

Cup and ring marks – rock carvings consisting of circular cup shapes, often surrounded by concentric rings. They are archaeological features usually carved onto coarse sandstones or similar rocks, although archaeologists are not sure of their age or their purpose.

Cyclothem - a sequence of sedimentary rocks which may be repeated several times. The cyclothem of marine limestones, with deltaic mudstones and sandstones above and a coal seam at the top of the sequence, is common in the sedimentary rocks of Northumberland and was probably caused by sea-level changes due to fluctuations in a major ice-sheet over the continent of Gondwana, which was positioned close to the south pole during the Carboniferous period.

Dacite lava – a lava with a composition which includes a high proportion of silica and is therefore pale in colour

Deformation – structures formed in rocks by pressure or tension, commonly folding and faulting

Devonian period – the interval of geological time from 416 to 360 million years ago

Dipping rocks – rocks which have been tilted. The amount of dip is always measured from the horizontal.

Displacement – the amount of vertical and/or horizontal movement which occurs along a fault

Dolerite – an igneous rock with a low silica content and a high proportion of minerals containing iron and magnesium. Dolerite is often intruded into the upper few kilometres of the earth's crust to produce igneous features such as dykes.

Dome – an upfold of strata which dip in all directions away from the centre, like an upside-down saucer

Dyke – an igneous feature produced by magma which is intruded into the upper few kilometres of the earth's crust, cutting through other rocks

Earthquake waves – the energy given off during earth tremors when stresses in the Earth's crust increase beyond the strength of the rocks, which then break.

Earth's crust – the top layer of the Earth, lying above the mantle and core. The crust is about 35 km thick under continents and about 7 km thick under oceans.

Edge waves – sea waves breaking on the coast generate energy, some of which changes into a different kind of energy called edge waves, which travel along the shoreline and cause erosion on beaches

Eione monoliforme – a trace fossil made by an unknown invertebrate which moved through wet silt or mud feeding on the organic content of the sea bed and leaving behind beads of sediment

Erosion – the process of wear on the bedrock of the earth's surface by the movement of grains and pebbles carried by rivers, ice or wind

Euramerica – the large continent, also called Laurussia, which resulted from the collision of the continents of Laurentia, Avalonia and other continental masses about 420 million years ago, after the closure of the Iapetus Ocean

Fault – a break in the earth's crust where rocks which have been subjected to compression or tension have broken, giving off energy waves

Fault breccia – broken rock which is smashed when rock masses move against each other during faulting. A fault breccia is often cemented by minerals such as calcite or quartz which are carried by fluids through the faulted zone.

Fault plane – the plane along which rocks slide when they break under pressure or tension

Fault zone – a zone in the Earth's crust which is faulted in several places, perhaps during more than one tectonic event

Feldspar – a silicate mineral containing aluminium. There are several varieties of feldspar with slightly different compositions and therefore different physical features, although they generally have a cuboid crystal shape. Feldspars are pale in colour, sometimes white, pink or cream.

Felsite – a rock with a high proportion of silica, which gives it a yellow colour

Fireclay – the rock which represents a clay soil in which plants grew before they were buried and altered to carbon. Fireclays underlie coal seams or layers of carbon-rich shale and are the clay-rich equivalent of ganister. The term 'seat-earth' is used for fireclays and ganisters.

Fissile – the structure of mudstones (shales) which break very easily into flakes or thin layers along laminations

Flute marks – erosional features consisting of elongated impressions in the sea-bed formed by erosion by turbulent water eddies during turbidity flows. The impressions are usually filled with sand or mud after the turbidity flow loses energy and deposits its sediment.

Fold – a bend in rock strata, usually due to pressure (see anticlines and synclines)

Fossils – the remains of organisms or traces of their behaviour which can be found in rocks. Organisms with a skeleton, bones or shells are most likely to have been preserved and it is very rare to find fossils of the soft parts of organisms. Trace fossils preserve the activities of organisms.

Ganister – the rock which represents the sandy soil in which plants grew before they were buried and altered to carbon. Ganisters underlie coal seams or layers of carbon-rich shale and are the sandy equivalent of fireclays. The term 'seat-earth' is used for fireclays and ganisters.

Gigantoproductus – a large extinct brachiopod with two unequal sized shells (valves) found in Carboniferous rocks

Glacial events – an interval of time during an ice age when global temperatures are colder than average, allowing ice-sheets and glaciers to develop

Glacial till – the debris left as an ice-sheet or a glacier melts, often containing clay and pebbles and formerly called 'boulder clay'

Gondwana – a large continent which existed from the Cambrian period until it collided with Laurussia to form the supercontinent, Pangaea, at the end of the Carboniferous period. A huge ice-cap developed on Gondwana during the Carboniferous period when the continent was positioned at the South Pole.

Granite – a silica-rich igneous rock with a high proportion of quartz and feldspar minerals and minor amounts of iron and magnesium-rich minerals. Granitic magma is intruded into the crust and crystallises at depths of several tens of kilometres. Granites have crystals larger than 2mm because the magma has cooled slowly at depth.

Graptolites – colonies of tiny animals that lived on a skeleton of interconnected branches. They were marine creatures which lived from the Cambrian to the Carboniferous period. Some colonies were anchored to the sea bed although many could float in the oceans. Fossils of the branches look like pencil marks on rock surfaces.

Greywacke – a type of sandstone with a large component of rock particles and clay, often derived from the erosion of volcanoes

Holdfast – the structure at the base of the stem of a crinoid which anchored the animal to the sea-bed

Iapetus Ocean – the ocean which lay between the continents of Laurentia, Baltica and Avalonia, during the Cambrian, Ordovician and Silurian periods, before they collided forming the Caledonian mountain chain

Ice sheet – a mass of crystalline ice formed by the compaction of snow on continental areas over long periods of time

Intrusion – an igneous feature formed when magma is intruded into other rocks below the earth's surface

Igneous rocks – rocks formed when magma or lava cools and crystallises within or above the crust. The compositions and textures of igneous rocks are very variable.

Interglacials – an interval of time during an ice age when global temperatures are warmer than average

Ironstone – iron-rich rocks or nodules

Jasper – a mineral which is an impure form of quartz, commonly bright red in colour, but sometimes found in other colours. It is most commonly found associated with metamorphic rocks.

Joints – cracks in rocks caused by contraction as igneous rocks cool, or by removal of water in sedimentary rocks, or by tectonic stresses in any type of brittle rock

Laminations – bedding-planes which are closer together than 1 cm

Landslip – a movement of rocks and soil down a slope, possibly due to the removal of vegetation or to heavy rainfall

Laurentia – a large continent which existed during the Lower Palaeozoic era, consisting of areas of continental crust which are now part of the Canadian Shield, Greenland and north west Scotland

Laurussia – the new continent, also called Euramerica, formed by the final collision of the large continental mass of Laurentia with the smaller continents of Avalonia and Baltica after the closure of the Iapetus Ocean at the end of the Silurian period

Lava – liquid rock formed by partial melting of the rocks below the crust where temperatures are high and pressure is reduced

Law of Superposition – the geological idea that older rocks lie below younger rocks. This applies to sedimentary sequences in particular, but is not always applicable for rock sequences which have been folded.

Lepidodendron – a group of tree-size plants which formed extensive forests during the Carboniferous period. Fossils of *Lepidodendron* branches have typical diamond-shaped leaf scars.

Limb – the beds on either side of a fold

Lime mortar – a mortar made of lime, water and an aggregate such as sand, used in traditional buildings

Lime mud – microscopic calcite particles, often derived from dissolved marine shells and plankton skeletons, deposited on the sea bed

Limestone – a sedimentary rock which is largely composed of calcium or magnesium carbonates which are precipitated in shallow seas or lakes. It often contains the fossils of organisms which lived in warm, shallow water.

Lithified/lithification – the process of turning sediment into rock by pressure from burial and by the formation of cement between the grains of sediment

Magma – molten rock below the earth's surface from which igneous rocks are formed. If magma reaches the surface it is called lava.

Magma chamber – an area in the earth's crust where there is a higher proportion of molten magma than of solid rock, often found below volcanoes

Meltwater – water produced by the melting of ice sheets or glaciers

Metamorphic rocks – rocks which are altered in texture and/or composition by heat and/or pressure within the crust

Mineral – a natural substance with a fixed chemical composition and characteristic physical properties, such as crystal shape, the colour of the powdered mineral and the way it breaks

Monocline – a fold which has two horizontal sections with a dipping limb in between

Mountain chains – lines of mountains formed by plate tectonic activity

Mudstone (shale) – a rock made of clay particles. Mudstone is the general term, but the word 'shale' is used for mudstones which have many closely-spaced laminations which makes them break into flakes (fissile).

Nodules – rounded or elongated mineralised bodies found in sedimentary rocks, often along bedding planes. In north Northumberland iron nodules are common in shales.

Old Red Sandstone – the red sandstones and conglomerates which formed from sands and pebbles which were deposited in a dry climate on land, between about 420 and 360 million years ago during the Devonian period

Ossicles – the calcite plates (technically called columnals) which form the stems and branches of crinoids

Plate collision – the collision of tectonic plates, often related to the closure of an ocean and the formation of a chain of mountains

Plate tectonics – the theory which describes the movements of tectonic continental and/or oceanic plates and accounts for many features of the earth's crust, including mountain chains, volcanoes and rift valleys

Plunging folds – folds in which the axis of each crest and trough is tilted away from the horizontal

Pore spaces – the gaps between particles in sedimentary rocks. Pore spaces may hold water and, if they are interconnected, will allow water to pass through rocks.

Precipitation of minerals – the process whereby dissolved components of minerals settle out of water which is concentrated (saturated)

Quartz – a mineral composed of silicon dioxide (SiO_2) which crystallises with six-sided crystals and is a constituent of many igneous and metamorphic rocks. Quartz is harder than most other common minerals, so grains of quartz form sandy sediments, which may be lithified to become sandstone.

Raised beach – a shore line which is found above present sea level. Raised beaches sometimes have cliffs on the landward side of a flat pebble or shingle beach which often contains sea shells. They can develop because sea level has dropped or because the local land surface has risen. In the UK, raised beaches are often a result of a rise in land level because of the removal of ice by melting at the end of the last glacial event about 12,000 years ago.

Recrystallisation – changes in shape, size (texture) and composition of minerals in rocks when conditions of temperature and pressure alter

Ripple marks – wave-like bedding structure formed by currents of wind or water, seen on present-day beaches and often fossilised in sandstones and siltstones

Riprap – rocks which are placed on shorelines, in rivers or next to roads or bridges to protect these structures from erosion by waves or currents

Rip-up clasts – flakes of mudstone or shale which have been ripped up from a lake or river bed by strong water currents and become incorporated in new sediments as the current velocity decreases

Sandstones – sedimentary rocks made of sand grains from 0.06 -2 mm in size. The sand grains are often made of the mineral quartz but sometimes include rock fragments, for instance in greywackes.

Sedimentary rocks – most sedimentary rocks are made of particles of varying sizes which have been weathered from existing rocks, then transported by ice, waves, rivers or wind until they are deposited in beds (strata). Examples are mudstones (shales), sandstones, siltstones and conglomerates. Some sedimentary rocks, such as rock salt and limestones, are formed by the precipitation of minerals in water which is concentrated by evaporation in warm climates. Many sedimentary rocks include fossils and some are composed almost entirely of organic material such as coal (plant material) or chalk (a type of limestone) which is made of the tests of planktonic organisms.

Seismometer – an instrument that measures the motion of the ground caused by earthquakes, volcanic eruptions and explosions

Shale (mudstone) – a sedimentary rock made of microscopic clay particles with complex chemistry. Shales often have laminations and break into small flakes (fissile).

Silicates – most common minerals in rocks are silicates, composed of atoms of silicon, oxygen and other elements such as potassium, aluminium, iron and magnesium.

Siltstones – sedimentary rocks made of grains smaller than 0.06 mm. The grains are usually made of quartz.

Silurian period – the interval of geological time from 443 to 416 million years ago

Skerrs – rock exposures seen at low tide

Slickensides – grooves or polished surfaces found on resistant rocks during movement along faults under pressure. Slickensides give information about the direction of movement during the most recent faulting activity.

Soft sediment deformation – deformation (minor folding or faulting) of wet sediment as it starts to lose water and become consolidated, usually as a result of tremors in the crust shortly after deposition

Stigmaria – the fossil of a plant root, particularly the roots of swamp forest trees such as *Lepidodendron* which flourished during the Carboniferous period.

Syncline - an downfold of rock strata produced by pressure in the crust

Tetrapods – four-limbed vertebrates which became adapted to life on land during the early Carboniferous period. Their bones have been found at several sites in Berwickshire.

Trace fossil – a fossil which records the behaviour and activity of an organism, rather than its actual remains. Examples are footprints, burrows, feeding tracks and the resting places of organisms.

Trough-bedding – a variation of cross-bedding which shows the cross profile of river channels, outlined by sand or silt deposits which were deposited in the channel

Turbidity flows – rapid movements of turbid water which carry sediment from continental shelves down the continental slope into deep oceans. Flows of loose sediment are sometimes triggered by earth tremors. Fast-moving turbid water scours the sea bed creating depressions called sole marks, typically elongated flute marks.

Variscan mountain building/plate collision – the tectonic plate collision between Laurussia and Gondwana which culminated at the end of the Carboniferous period about 300 million years ago. The main result was the formation of a mountain chain across southern Europe, but Britain also experienced some effects, most noticeably in the south-west of England but also further north.

Veins – cracks in a rock containing crystalline minerals precipitated by warm fluids which have percolated through the rock. Veins are often an indicator that brittle rocks have been faulted.

Vent agglomerate – a rock found in the vent or the pipe/neck of a volcano and produced by volcanic eruptions. Materials such as volcanic ash and lava fall back into the vent and are mixed with surrounding rocks, often of very variable size and shape.

Vesicles – holes which contained hot gases in a volcanic lava. Sometimes vesicles are filled with new minerals when water drains through the lava while it is cooling. These crystal-filled vesicles are called **amygdales**.

Volcanic ash – when a volcano erupts explosively, magma and local rocks are broken into fine particles which are erupted forcefully into the atmosphere. Fine volcanic ash is sometimes blown high into the atmosphere and circles the earth but coarser volcanic ash falls back onto the slopes of the volcano.

Volcanic cone – a cone-shaped volcano formed during an eruption of lavas and ash. Complex volcanoes which erupt frequently do not usually have a perfect cone shape. The shape of a volcano also depends on the composition of the magma.

Volcanic neck – the pipe which connects a magma chamber in the crust to the earth's surface. During an eruption magma moves under pressure through the neck and may form a volcano on the surface.

Volcanic rocks – rocks which form during a volcanic eruption, such as lavas which crystallise on the surface or volcanic ash which falls back to the surface in layers.

Wave-cut notch – the notch at the base of a cliff at about high tide level, produced by storm waves carrying sand and pebbles which erode the bedrock, particularly if the cliff is formed from poorly cemented sandstone or chalk.

Weathering – the breakdown of rocks in situ by physical and chemical processes, which include freeze-thaw action, expansion-contraction in hot climates, carbonation of limestones by rain water and hydrolysis, which is the chemical breakdown of minerals.

Whalebacks – folds which have formed under pressure and subsequently tilted so that their crests and troughs dip at an angle to the horizontal