Yorkshire rocks and landscape: a field guide

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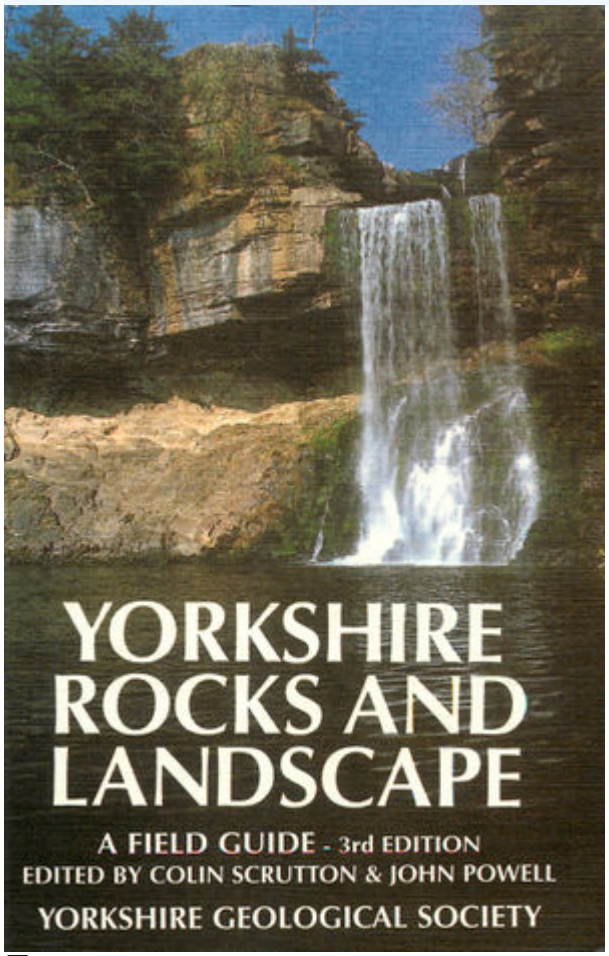

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Preface to the Third Edition

This field guide is mostly written and edited by members of the Yorkshire Geological Society. Publication of the Third Edition, which has been out of print for many years, was prompted by the successful publication of the Second Edition of the sister volume, *Northumbrian Rocks and Landscape* in 2004. The Third Edition includes minor revisions to the text, including logistical details since a number of the access routes and contact details have changed over the last decade. An appreciation of the British landscape and its underlying geology is becoming increasingly popular with walkers, naturalists and the general public, in addition to geologists who have always appreciated the link. We hope the new edition will encourage you to get out and explore the countryside with even greater enthusiasm.

The Yorkshire Geological Society wishes to thank the following for their financial support towards printing the Third Edition of the Guide: English Nature, especially Dr Jonathan Larwood; Dr C. T Scrutton; the late Dr. J. G. Capewell; and M. E. Broad of Cleveland Meat Co. Ltd. I should also like to thank Colin Scrutton, Editor of the original guide, for his help with the revisions to this edition. Thanks also go to the authors for their revisions to the text of the latest edition.

The Society has a long and distinguished history, having been founded in 1837. From small beginnings among amateurs with an interest in Yorkshire geology, it has grown to have influence well beyond the boundaries of the county and a membership of over 800 from all over the world. It brings together professional geologists of all descriptions, from universities, surveys and companies, together with amateur geologists who still form a significant proportion of our membership. The Society publishes a prestigious journal, the *Proceedings,* which has a major part of its original papers based on the geology of Yorkshire and northern England. The original aims of the Society are still observed in the lecture meetings held approximately monthly from October to March, and particularly in the programme of field excursions in the spring and summer months. The lectures are a mixture of original work, mainly on the geology of Yorkshire and northern England, and general reviews often of much wider scope. Field excursions range all over the region and offer an opportunity to demonstrate new observations and interpretations of the geology and geomorphology to beginners and professionals alike.

Many of you using this guide may already be members of the Yorkshire Geological Society. If you are not, and would like to know more about this fascinating subject, why don't you join us? We would be pleased to welcome you.

John Powell, President, Yorkshire Geological Society

Introduction

In the choice of excursions, an attempt has been made to provide a broad coverage of Yorkshire both geographically and geologically. Whichever part of the county you are in, we hope there will be something to interest you. However, Yorkshire is a large place (defined here on its pre-1976 boundary), and to keep this book to a comfortable size a selection has had to be made from among its many sites of geological interest.

An introductory chapter outlines the geological history of the Yorkshire area, providing a framework for the details of the local geology. Each excursion begins with general information on the geology and/or geomorphology covered in the itinerary. Brief notes cover access, parking and walking distances, together with lists of useful Ordnance Survey (O.S.) and British Geological Survey (B.G.S.) maps. In many excursions the background information or itinerary includes notes on the historical exploitation of geological resources, and on other related matters. A section towards the end of the book lists museums in Yorkshire that have geological displays or collections.

All excursions have certain basic requirements for both safety and enjoyment. These include stout shoes or walking boots, sensible clothes and appropriate maps. On higher ground, it may be much colder and more windy than in the valleys, and low cloud may not just spoil appreciation of geological and geomorphological views of the landscape, but may present a danger if you become lost. On foreshores, wellington boots may be a suitable alternative but, whatever your footwear, wet rocks can be very slippery.

For more specific dangers, notes are given in the introductions to the relevant excursions. However, it is worth repeating some general points. In locations near quarry or cliff faces, a safety helmet should be worn. Always look at the state of steep faces and, if in doubt about their safety, do not approach them. When using a hammer, it is advisable to wear safety goggles and to make sure that fragments you chip off do not hit other people. In any coastal situation, the state of the tide may be crucial, not only to your view of the geology but to your safety. Always check on the time of low tide and do not start an excursion on a rising tide where access to and from the foreshore is limited.

Some excursions include visits to Sites of Special Scientific Interest. These are designated not only to conserve our geological heritage but also to protect other features such as the flora. Please observe any specific requests not to hammer rocks or collect fossils.

As far as possible, excursion routes follow public rights of way and keep to open land or the foreshore. Where localities are on private land, permission for access should be sought *beforehand*. We have given as much information as possible to facilitate this. In general, observe the Countryside Code and avoid damage to walls, gates or property. The Geologists Association have published a Code for Geological Field Work, which outlines good practice in the field and can be obtained from the Executive Secretary, The Geologists Association, Burlington House, Piccadilly, London W1J 0DU.

We hope that anyone with an interest in geology and geomorphology will be able to follow the excursions in this guide. However the technical level does vary from one to another, depending on the character of the rocks and the complexity of the area. As an aid, a limited number of technical terms are highlighted in **bold** where first used in each Section and are briefly defined in a Glossary at the end of the book. For more information on any term, or for terms not covered in the Glossary, reference should be made to a geological dictionary (see Bibliography). Bibliographic entries are placed towards the end of the book and are mainly general works. A very few more specific references are included where these have value for a particular excursion.

Finally, we would like to thank all those who have helped us in the compilation of this guide, our colleagues on the Council of the Society for their advice, and the authors for their contributions.

Colin Scrutton, past President, Yorkshire Geological Society and John Powell, British Geological Survey.

Note

The details of routes given in this guide do not imply a right of way. Users of this guide are responsible for seeking permission where necessary to use footpaths and for access to any private land.

Every effort has been made to ensure that the information in this book is accurate and up-to-date. However, information on any changes to footpaths or exposures, or on threats to any S.S.S.I., would be welcomed by the Society.

Notes on safety have been included but it is the responsibility of the user to take all necessary precautions for their own safety and that of third parties. The Society takes no responsibility for any accident or injury sustained on any of these excursions.

Glossary

Acadian Orogeny *See* **orogeny.**

adit More-or-less horizontal tunnel to mine.

agate Variety of **quartz** with distinctive concentric colour banding.

alga (pl. algae) Primitive plant-like organism. Some may secrete calcium carbonate and algal mats may play a role in sediment accumulation in some environments. *See* **stromatolite.**

ammonite Extinct Mesozoic marine ammonoid **mollusc** (cephalopod), secreting a chambered shell of calcium carbonate, usually planispirally coiled (*See* **goniatite).**

anhydrite $CaSO_4$ White to grey, rock-forming **evaporite** mineral.

anticline *See* **fold.**

argillaceous Describing silt to clay-grade sediments (grains less than 0.0625 mm in diameter).

arkose Sand-grade rock containing 25% or more **feldspar.**

aurichalcite $(Zn,Cu)_5,(CO_3)_2,(OH)_6$, Bright turquoise-blue mineral in radiating aggregates of thin pearly crystals. A secondary mineral in oxidized zones of zinc and copper bearing **veins.**

azurite $Cu_3(CO_3)_2(OH)_2$ Deep azure blue mineral associated with the oxidized zone of copper deposits.

baryte/barytes $BaSO_4$ Baryte is a colourless to white mineral, crystals commonly tabular, noticeably heavy. A common **gangue** mineral. Barytes is the commercial product.

barytocalcite $BaCa(CO_3)_2$ Colourless to white or pale cream mineral.

basalt Dark, often almost black, fine-grained volcanic rock, low in silica (no **quartz)** and relatively rich in iron, magnesium and calcium.

belemnite Extinct **mollusc** (cephalopod). Internal skeleton consists of a solid calcium carbonate bullet-shaped 'guard' (part usually preserved), with chambered structure (phragmocone) in conical cavity at one end.

benthonic (benthic) Describing bottom-living organisms. **bioclastic** Limestone composed of shells or skeletal fragments.

biostratigraphy Use of fossils to date and correlate rock sequences.

biostrome Sheet-like accumulation of fossil shells or skeletons.

bioturbation The destruction of primary structures (i.e. bedding) in an unconsolidated rock unit by burrowing organisms; hence **bioturbated.**

biozone Fundamental unit of **biostratigraphy.**

bivalve Marine to fresh-water **mollusc** in which the plane of symmetry of the bi-valved calcium carbonate shell is in the plane of opening of the two valves (as in cockles and mussels).

blastoid Extinct Palaeozoic stalked **echinoderm** with a bud-like theca showing distinct pentameral symmetry.

bornite Cu_5FeS_2 (peacock ore) Reddish-brown to purplish-blue mineral, iridescent on tarnished surfaces; crystals often rough cubes.

brachiopod Solitary marine animal with bi-valved calcite shell. The plane of symmetry is perpendicular to the plane of opening of the valves.

breccia Coarse clastic rock in which the **clasts** are angular. *See* also **fault.**

bryozoa Small colonial animal with a calcite skeleton consisting of large numbers of tiny tubular or box-like chambers. Colonial form very variable.

calcite $CaCO_3$ Colourless or white mineral which is the main constituent of limestone. Crystals when formed (i.e. in **veins)** may be tabular or prismatic.

Caledonian Orogeny *See* **orogeny.**

carbonate rocks Limestones or **dolostones (dolomites).**

carnelian Reddish-white cryptocrystalline **quartz.**

chalcopyrite $CuFeS_2$ (copper pyrites) Brass-yellow mineral with an iridescent tarnish. Most common copper mineral. Crystals usually tetrahedra.

chalk Very fine-grained, white to pale grey, carbonate rock principally formed of **coccolith** ooze. Characteristic of the European Upper Cretaceous.

chamosite (berthierine) $(Fe_5Al)(Si_3Al)O_{10}(OH)_8$ Greenish-black mineral often found in sedimentary

iron ores. Berthierine is the primary deposit which is converted to chamosite at moderate temperatures and pressures.

chert Nodules, lenses or impersistent bands of cryptocrystalline **quartz,** usually black, grey or red in colour, usually of diagenetic origin in sedimentary sequences.

chronostratigraphy Arrangement of rock sequences in terms of time.

cinnabar HgS Most common mineral of mercury, scarlet to brownish red.

clast Rock fragment; hence **clastic rock.** The principal clastic rocks are distinguished on grain size thus: **conglomerate** >2 mm > sandstone > 0.0625 mm > siltstones >0.004 mm> mudstone/shale.

Clast fabric (imbrication) may indicate direction of water flow where platy/tabular casts lean in the direction of the current.

cleavage A close-spaced, regular fracture or fabric imposed on strongly-**folded** beds and best developed in weaker, fine-grained rocks.

coccolith Minute calcium carbonate plate or disc, usually less than 0.02 mm in diameter, part of the covering of a microscopic marine, planktonic, unicellular alga. Coccolith ooze is a major component of **chalk.**

cone-in-cone Fabric of adjacent sets of vertically nested cones, each about 3 cm or more in diameter, caused by precipitation of $CaCO_3$ under pressure in a mud-grade rock.

concretion Spherical or ellipsoidal, resistant mass formed by local early cementation of the sediment.

conformable Sequence of rocks in apparently continuous succession.

conglomerate Coarse **clastic rock** in which the clasts are rounded. An **intraformational conglomerate** is one formed of locally derived clasts from a recently deposited source.

conodont A microscopic phosphatic, tooth-like fossil, part of the jaw apparatus of an extinct group of primitive vertebrates. Very useful in **biostratigraphy.**

coprolite Fossilised excreta.

coquina A (lenticular) bed consisting principally of shells.

coral A polyp or polyps (anemone-like) with a basal skeleton of calcium carbonate. Corals may be solitary or colonial, the latter varying from flat, tabular masses to clusters of branching tubes.

crinoid (sea lilies; feather stars) **Echinoderm** with a plated cup bearing feeding arms, supported in sea lilies by a stalk. The disc-shaped ossicles or columnals of the stalk are a major constituent of Palaeozoic limestones, hence **crinoidal limestone.**

cross-stratification, cross-bedding, cross-lamination Sedimentary structure in which the migration of the slip face of ripples, dunes or bars produces a series of inclined laminae **(foresets)** between sub-horizontal bedding surfaces. Different types are: **planar,** when the laminae are flat; **trough,** when the laminae are scoop-shaped; and **hummocky,** when individual **sets** of cross-beds cut across each other, leaving hummocky bounding surfaces.

cyclothem A sequence of beds, repeated again and again in vertical succession. Particularly notable in the Carboniferous.

dating, radiometric Rocks are dated by using the fixed rate of decay of parent isotopes of various radioactive elements to daughter products. The resulting age may be quoted with the parent isotope used, as in 'cC yrs', etc.

diagenesis The changes that take place in the conversion of a sediment to a rock.

diamicton An unsorted sediment with a mixture of larger **clasts** and a mud-grade matrix. **Diamictite** is the resulting rock.

dip The maximum angle of inclination of a planar surface, usually bedding. Measured in the vertical plane at right angles to the **strike.**

disconformity A break in the succession where the beds above and below are parallel.

disharmonic *See* **fold.**

dolomite $CaMg(CO_3)_2$ White, colourless, yellowish or brown mineral, in rhombic crystals with curved faces. Term also used for the characteristically brownish-yellow rock composed mainly of the mineral, but more correctly termed **dolostone.**

downthrow *See* **throw.**

drift Any superficial, unconsolidated sediments of the Quaternary.

drumlin Smooth, streamlined, oval mound of **till** (boulder clay), usually in groups (drumlin field or swarm), formed beneath an advancing ice sheet. The long axis of the drumlin is parallel to the direction of advance.

dyke More or less vertical, cross-cutting intrusion.

echinoderms Marine invertebrates including **echinoids, crinoids, blastoids,** starfish and brittle stars. Characterized by a fundamental pentameral symmetry.

echinoid (sea urchin) **Echinoderms** with body enclosed in a globular or discoidal test. Symmetry either pentameral radial (regular echinoids) or pentameral bilateral (irregular, burrowing, echinoids).

epicontinental On continental crust, as in epicontinental sea.

epiplanktonic Organism living in plankton by attachment to other planktonic organisms or floating objects.

erratic Glacially transported rock derived from outside the local area.

esker Long, sinuous, steep-sided ridge consisting of sands and gravels, formed either in an englacial tunnel or at the edge of a retreating ice sheet.

eustatic World-wide change in sea level.

evaporite Rock or mineral formed by precipitation of salts from natural brines by evaporation.

facies Features of a rock or rock sequence that reflect the environment of deposition.

fault A more or less planar fracture in a rock mass along which relative displacement of adjacent blocks has occurred. The **hade** is the inclination of the fault plane relative to the vertical. The face of the block above an inclined fault plane is the **hanging wall,** that below is the **footwall. In** most faults the direction of movement is known or assumed to be predominantly vertical. In a **strike-slip** or **wrench** fault, the direction of movement is predominantly horizontal. A **thrust** fault has a subhorizontal plane of displacement. Fractured rock on the fault plane caused by movement between adjacent blocks is a fault **breccia.**

feldspars Important group of rock-forming silicate minerals, common in igneous rocks and usually broken down quickly on weathering. Hence **feldspathic.**

fireclay *See* **seatearth.**

flat A lenticular zone of mineralization parallel to bedding.

flint A variety of cryptocrystalline **quartz** commonly present as grey or grey/black nodules and bands in **chalk.** It probably formed as a gel from organic silica **(sponge** spicules), and may fill or replace fossil tests, shells and burrows.

fluorite CaF_2 Colourless to translucent yellow, green, blue or purple, more rarely red or black mineral commonly crystallizing in cubes. **Fluorspar** is the commercial product.

flute cast (flute mark) *See* **sole structure.**

fold A bend in bedded rocks or any planar rock mass. An **anticline** is arched upwards with older rocks in the core. A **syncline** is bent downwards with younger rocks in the core. An **isoclinal fold** has subparallel fold limbs. The dip of the fold axis is the **plunge** of the fold. Folds are **disharmonic** when they change shape and/or size when traced into adjacent beds.

footwall *See* **fault.**

foraminifera Microscopic single-celled organism with a chambered, usually calcium carbonate, test.

foresets *See* **cross-stratification.**

galena PbS Lead-grey mineral crystallizing in cubes and octahedra.

gangue Bulk mineral in **veins,** formerly of no commercial importance, with which ore minerals are associated (i.e. **quartz, fluorite, baryte). ganister** See **seatearth.**

garnet Silicate mineral of variable composition, often deep reddish-brown in colour, found in **igneous** and **metamorphic** rocks.

gastropod Mollusc with a usually helically coiled calcium carbonate shell (snail) or naked (slug).

gelifluctate Rock material derived from flow of water-saturated sheets of rock debris over perennially frozen ground (cold climate variety of **solifluction).**

glaciofluvial Sediments or landforms produced by meltwater from a glacier.

glauconite Silicate clay mineral, characteristically green, formed in some marine sediments.

gneiss Coarse-grained, banded rock formed under high-grade **metamorphic** conditions.

goniatite Palaeozoic ammonoid. Goniatites are the direct ancestors of the **ammonites.**

graben A linear tract of country, lowered between two bounding **faults.** A **half-graben** is fault-bounded on one side only.

graptolite Extinct group of marine, pelagic, colonial organisms with an organic skeleton.

gypsum $CaSO_4.2H_2O$ **Evaporite** mineral, usually white, as tabular crystals or massive. A transparent variety **(selenite)** may be precipitated within sediments under some conditions.

gyttja Rapidly accumulated organic-rich muddy deposit.

hade *See* **fault.**

half-graben *See* **graben.**

halite (rock salt) NaCl Common salt, an evaporite mineral, usually white; crystals usually cubes.

hanging wall *See* **fault.**

hemimorphite (calamine) $Zn_4(Si_2O_7)(OH)_2.H_2O$ White, grey, green-brown or pale blue ore ofzinc, small tabular crystals but normally radial or earthy masses.

hummocky cross-stratification *See* **cross-stratification.**

igneous Rocks crystallized or solidified from a molten state.

inlier Area of older rocks surrounded by younger rocks.

intermontane basin Sedimentary basin being infilled from erosion of surrounding mountains.

interstadial A period of increased warmth or retreating ice between **stadials.**

intraclast Carbonate fragment derived from the erosion of a nearby sediment and redeposited within the same area.

joint Fracture in rock, usually occurring in more or less regularly spaced sets, along which little or no movement can be detected.

kame Steep-sided mound of bedded glaciofluvial sand and gravel associated with stagnant ice. A **kame terrace** is a continuous linear feature formed between an ice mass and a valley wall. Subsequent ice melt may result in signs of marginal slumping.

kettle hole Depression in glacial drift, possibly containing a lake, left by the melting of an included mass of ice.

lacustrine Sediments or processes associated with lakes.

laterite Crust of mainly hydrated iron and aluminium silicates produced by the weathering of certain rocks in tropical, humid conditions.

limonite $FeO(OH).nH_2O$ Yellowish-brown earthy mineral derived from the weathering of iron minerals in rocks.

lithology Physical features of a rock. Hence **lithostratigraphy,** the stratigraphic ordering of different rock types.

loess Unconsolidated, wind-deposited, mainly silt-grade sediment.

Ma Abbreviation for 'million years'.

magma A hot, liquid or semi-liquid melt within the Earth's crust; the source for all **igneous** rocks and processes.

malachite $Cu_2CO_3(OH)_2$ Bright green mineral usually found in banded spheroidal aggregates. A common secondary mineral in oxidized zone of copper deposits.

marcasite FeS_2 Pale bronze-yellow mineral, often occurring in spherical masses of radiating crystals in **chalk.**

marl A calcareous clay with 35–65% soft calcium carbonate.

meltwater channel Channel cut by the action of meltwater from a glacier or snow. Usually unrelated to the present drainage pattern.

mesothem An approximately 5 **Ma** cycle of **eustatic** rise and fall of sea level. In the Carboniferous, many **cyclothems** may form sequentially within a mesothem.

metamorphic Rock formed by the alteration of a pre-existing rock by changes in temperature and/or pressure.

mica One of a group of silicate minerals characterized by a platy habit.

microfossil Any fossil too small to be studied without a microscope.

mineral veins *See* **veins.**

mollusc One of a very diverse invertebrate group including the **bivalves, gastropods,** cephalopods **(ammonites, goniatites, belemnites** and **orthocones)** and **scaphopods.**

moraine An unsorted deposit of rock debris associated with the actions of a glacier.

nannofossil Extremely small fossil derived from nannoplankton, generally less than 0.05 mm in size, for example a **coccolith.**

non-sequence Any (usually) minor break in the rock sequence.

nunatak Rocky summit standing above a surrounding ice sheet during glaciation.

oncolite Spherical or sub-spherical particle, up to 50 mm in diameter, formed by the action of algae in trapping sediment on the surface of a mobile grain.

onlap *See* **overlap.**

ooid (oolith) Spherical to sub-spherical particle, less than 2 mm in diameter, formed by the

concentric deposition of rings of (usually) calcium carbonate around a mobile grain.

oolite Rock formed largely of **ooids.** Characteristic of high-energy, shallow-water environments.

orogeny Process of mountain building by the lateral compression of thick rock sequences. The **Caledonian Orogenic Cycle** refers to a series of orogenic events in the Lower Palaeozoic of which the **Acadian Orogeny** (Lower Devonian) was the last. The **Variscan Orogeny,** whose main effects are seen in southwest England and Central Europe, spanned the late Devonian to late Carboniferous.

orthocone Extinct cephalopod **mollusc** with a straight, tapering, chambered shell.

outlier Area of younger rocks surrounded by older rocks.

overflow channel, spillway Channel carved by the overflow from an ice-dammed lake. Usually unrelated to the present drainage pattern.

overlap Relationship where successive beds of rock deposited by a transgression extend further than the one below, to rest in turn on **(onlap)** the surface of unconformity.

overstep Relationship where a bed deposited by a **transgression** rests on the eroded ends of several beds below the plane of **unconformity.**

paraglacial Subaerial processes acting on sediments and landforms produced by glaciation.

pelagic Organisms living in the body of the water, either floating (planktonic) or swimming (nektonic).

piedmont Tract of country at the foot of a mountain range.

pisolith Spherical to sub-spherical inorganic carbonate particle characterized by internal concentric lamination, usually several mm in diameter.

plate A part of the Earth's rigid outer shell (lithosphere), internally relatively free of earthquakes and volcanic activity but bounded by more or less continuous zones of earthquakes and volcanoes where the plates move against each other. **Plate tectonics** describes the processes and effects of plate motions and interactions.

plunge *See* **fold.**

pluton A large **igneous** intrusion.

progradation The outward extension of a sedimentary deposit, such as a delta building out from a shoreline.

pyrite FeS_2 (fools gold) Common pale brass-yellow mineral, often crystallizing in cubes.

pyromorphite $Pb_5(PO_4)_3Cl$ Green, yellow or brown mineral, often with hollow prismatic or barrel-shaped crystals. A secondary mineral occurring in the oxidized zones of lead deposits.

quartz SiO_2 Very common mineral, usually transparent or white but may be variously coloured. Occurs in many **igneous** and **metamorphic** rocks, is the main constituent of sandstones and siltstones and a common **gangue** mineral in **veins.**

regression Withdrawal of the sea from the land area due to a relative fall in sea level.

rock-salt *See* **halite.**

scaphopod Marine **mollusc** with a tusk-shaped hollow shell.

seatearth A fossil soil with root traces found immediately below a coal seam. A **fireclay** is a pure clay seatearth, whilst a **ganister** is a pure quartz sand seatearth.

selenite *See* **gypsum.**

septarian Nodules or concretions with a series of internal mineral-filled (usually **calcite**) cracks.

siderite $FeCO_3$ Grey to grey-brown mineral widespread in certain sedimentary rocks, particularly sedimentary ironstone deposits and Coal Measures sequences.

siliciclastic Clastic rocks formed predominantly of **quartz,** other silicate minerals and rock fragments.

sill A tabular igneous intrusion, mainly concordant with bedding, although it may cut across beds from one level to another.

slickensides A lineation on a **fault** or bedding plane caused by the relative movement of rock masses on either side. The surface is often coated by fibrous crystals, usually of **quartz** or **calcite,** aligned in the direction of movement.

smithsonite (calamine) $ZnCO_3$ Grey, brown or greyish-white mineral, usually occurring as spherical aggregations or stalactitic masses.

sole structure Sedimentary structure cut into an underlying mudstone by a turbidity current and infilled by the overlying **turbidite** bed. Preserved as a cast on the base of the turbidite. **Flute cast (mark):** ovoid scoop-shaped structure caused by turbulent water flow, preserved as a lobe on the base of the turbidite.

solifluction Downhill movement of surface layer of unconsolidated weathered material when saturated by water.

sphalerite (blende) ZnS Commonly a brown or black mineral with a resinous lustre and variable form. Most common ore for zinc.

spillway General term for **meltwater** or **overflow channels.**

sponge Primitive invertebrates with an often asymmetrical body supported by spongin and/or siliceous or calcareous spicules.

S.S.S.I. Site of Special Scientific Interest.

stadial A period of increased cold or advancing ice.

strike Intersection of a bedding plane, or other planar surface, with the horizontal.

strike-slip *See* **fault.**

stromatolite A carbonate rock with a fine horizontal, domal or columnar banding, reflecting the control of deposition by an **algal** mat or microbial community living on the surface of the sediment.

strontionite $SrCO_3$ White to pale green, grey or pale yellow mineral, usually with prismatic or needle-like crystals.

stylolite An irregular, suture-like contact, most common in limestones, produced by solution of the rock under high pressure.

subduction The process whereby oceanic crust descends into the interior of the Earth beneath oceanic or continental crust at a convergent **plate** margin.

syncline *See* **fold.**

tectonic Caused by deformation of rock masses, as in mountain-building episodes.

tholeiitic basalt A type of **basalt** oversaturated in silica, so that small amounts of **quartz** are present.

throw Description of vertical component of movement on a **fault** plane. **Downthrow** emphasises the relative downward displacement ofa block on one side of the fault, **upthrow** (less commonly used) emphasizes the relative upward displacement of a block.

thrust *See* **fault.**

till (boulder clay) Collective term for the group of unsorted sediments laid down by direct action of ice.

trace fossil A structure, such as a burrow or a grazing trail, resulting from the activity of an animal.

transgression An advance of the sea over the land, caused by a relative rise in sea level.

tufa Rock formed by the deposition of calcium carbonate (more rarely silica) as a sometime porous and/or banded mass around saline springs, or associated with stalactites and stalagmites.

turbidite Rock deposited from a turbidity current, a fast-flowing current charged with a high sediment load, initiated by the disturbance of soft sediment on a slope. A turbidite is poorly sorted but may show grading and **sole structures** on its base.

unconformity Surface of contact between two groups of rocks resulting from the tilting or folding and erosion of the lower group (often in an **orogenic** event) before the deposition of the upper group.

Variscan Orogeny *See* **orogeny.**

vein A fracture, usually sub-vertical, which is mineralized, often with **quartz** or **calcite. A mineral vein** implies the presence of ore minerals.

witherite $BaCO_3$ A white or grey mineral, crystals six-sided prisms and pyramids. Notably heavy.

Yoredale Name applied to repeat cycles of limestone-shale-sandstone(-seatearth-coal) **(cyclothems)** in the Carboniferous (Dinantian, early Namurian), derived from the old name for Wensleydale, where they are typically developed.

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