Precambrian Rocks of England and Wales

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In this reference list the arrangement is alphabetical by author surname for works by sole authors and dual authors. Where there are references that include the first-named author with others, the sole-author works are listed chronologically first, followed by the dual author references (alphabetically) followed by the references with three or more authors listed *chronologically*. Chronological order is used within each group of identical authors.

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Glossary

This glossary is not exhaustive, but provides brief explanations of some of the more technical terms used in the introductions to the chapters and in the 'conclusions' sections of the site reports. These explanations are not intended to be full scientific definitions, but are intended to help the general reader, and many are abridged or modified versions of the descriptions given in the Concise Oxford Dictionary of Earth Sciences (Allaby and Allaby, 1990), and other similar works, to which the reader is referred for further details. Many of the more commonplace sedimentary and volcanic rocks are classified or qualified according to their mineral constituents and/or their grain size, as indicated by Table 1. The application of many igneous rock names is, however, commonly based on rock chemistry rather than by reference to precise mineral content. Only major groups of the rock-forming minerals are included. A word printed in **bold** is cross-referenced to a further glossary entry.

- of evening	SEDIMENTARY ROCKS		VOLCANICLASTIC ROCKS			rimoo beer a
Grain size (mm)			Epiclastic (25-75% pyroclasts)	Pyroclastic (>75% pyroclasts)		IGNEOUS ROCKS
256	CONGLOMERATE		loni adoiste. /	Bombs AGGLOMERATE Blocks VOLCANIC BRECCIA		o desta esta desta esta desta esta esta esta esta esta esta esta
monh	And		VOLCANICLASTIC			Very coarse-grained
oldehibb	BRECCIA		CONGLOMERATE,	montal al-dation		no-post settences
64	the sedimentary and for		BRECCIA,	LAPILLI TUFF		server have over
16	editi early doments bieles		GRANULESTONE etc.			and a factor
2	GRANULESTONE		didgen riccalifi die			Coarse-grained
1-2	Very coarse-	wit-snittene	alodulgha fale	ral Mor	photogicalia	ate angiala ata
1-0.5	Coarse-	C series. G	pelifique all	pa noisen	a bornen kyllen	Medium-grained
0.25-0.5	Medium-	SANDSTONE	TUFFACEOUS SANDSTONE	techeorean	intor berook	rained, dark o
0.125-0.25	Fine-	C BARBARA	(coarse, medium, fine etc)	Coarse	TUFF	DENSE STORES
0.032-0.125	Very fine- grained	orte (com	not develop the second	ally strice	nei opagnisia	Fine-grained
0.004-0.032	SILTSTONE		TUFFACEOUS SILTSTONE	- Fine	al an	Very fine-grained
< 0.004	MUDSTONE		TUFFACEOUS MUDSTONE			Cryptocrystalline

 Table 1 A simplified comparative grain-size and grain-compositional chart for sedimentary, volcaniclastic and igneous rock types. The volcaniclastic rock classification is modified from Fisher (1961) and Fisher and Schmincke (1984).

Detailed stratigraphical terms are omitted as they are given context within the tables and figures, but as a general rule the naming of rock-stratigraphical units follows accepted procedures, for example as laid down by the North American Commission on Stratigraphical Nomenclature (1983). Thus for formally named stratiform sequences 'supergroup' is the highest-ranking term, followed in descending order of rank by group, formation, member and bed. The term 'complex' is commonly used for those igneous and metamorphic rock masses showing no coherent internal stratigraphy, and which are thus capable of only informal subdivision.

- Accretionary lapilli: Spherical to ellipsoidal pyroclastic fragments, usually in the 2–10 mm size range, possessing an internal tangential arrangement of individual pyroclasts about a nucleus, the structure commonly being emphasized by concentric zoning defined by differing grain-size.
- Accretion (of continents or terranes): The addition of crustal material to the edge of an existing continent, thus enlarging it. Continents thus grow by the tectonic addition (accretion) of terranes, initially coherent bodies of rock, which can collide, slide, rotate and be dismembered before finally being 'sutured' into place.
- Accretionary prism (or wedge): In active subduction systems this is an imbricated thrust mass mainly consisting of deformed sediments, which is situated immediately above the downgoing oceanic plate, on the landward-side of the trench. In developed systems basic and ultrabasic (ophiolitic) rocks, mélanges and blueschist facies rocks may be found in association with accretionary prisms.
- Acid (igneous or volcanic rock): A rather loosely used compositional term commonly reserved for rocks crystallized from magmas with an excess of 67% silica (SiO₂).
- Alluvial: Applied to the environments, action, and products of rivers or streams. Alluvial deposits are composed of clastic material deposited in the river floodplain.
- Amphibole: Group of minerals, usually black or dark green in colour, that have double silicate anionic chains.
- Amphibolite: Generally a medium- or coarsegrained, dark coloured, foliated metamorphic rock mainly composed of amphibole and plagioclase feldspar.
- Andesite: Fine-grained volcanic or shallow-level intrusive rock containing plagioclase feldspar in the oligoclase-andesine range, accompanied by pyroxene and/or amphibole together with accessory silicate or oxide minerals. It contains more than 53 wt% SiO₂ and with increasing silica content grades to highsilica andesite (57–63 wt% SiO₂).
- Aplite: A pale-coloured, fine-grained, equigranular igneous rock, composed of quartz and alkali feldspar grains, and found as late-stage veins in granitic bodies.
- Arthropod (Arthropoda): Diverse phylum of jointed-limbed animals, which includes crus-

taceans, arachnids and insects. Fossil arthropods include the extinct trilobites.

- Ash (volcanic): Unconsolidated deposit consisting of pyroclastic material (glass shards, crystals etc.) less than 2 mm in size. In consolidated rocks the term is commonly used to denote the size of individual volcaniclastic fragments (e.g. coarse-ash grains and fine-ash grains).
- Ash-flow tuff (pyroclastic flow): A general term for a lithified deposit formed from a hot, high-concentration flow of pumice or lithic clasts, entrained and transported within a fluidized ash-rich matrix.
- Autobreccia: A breccia in which all of the fragments are identical in lithology to the main mass of the rock; literally, a rock that has undergone 'self-brecciation'.
- Axial planar: Term applied to a cleavage that strikes parallel to the axial plane of a fold.
- **Basalt**: A dark coloured, fine-grained **extrusive** or shallow-level intrusive rock mainly composed of plagioclase feldspar, pyroxene and iron-titanium oxides and containing not more than 53 wt% SiO₂
- **Basic** (igneous or volcanic rock): A loosely used compositional term for rocks with relatively high concentrations of iron, magnesium and calcium, and with 45–53% of silica (SiO₂) by weight; includes gabbro (coarse-grained) and **basalt** (fine-grained variety).
- **Basin**: A depression, usually of considerable size, in which sedimentary and/or volcanic strata may be laid down.
- **Blue-amphibole**: Term for the sodic (Na) amphibole forming the glaucophane-riebeckite amphibole series. Glaucophane with a distinctive blue colour is a high-pressure mineral found in metamorphic rocks (schists and gneisses).
- Blueschist: Metamorphic rock that has undergone metamorphism at low temperatures and high pressures. Blueschists contain abundant blue glaucophane amphibole, and are associated with convergent plate boundary environments. They are formed by the metamorphism of a basic **protolith**, such as **gabbro** or **basalt**.
- **Braidplain**: An alluvial tract that is generally much wider than that occupied by meandering rivers, composed of anastomosing channels divided by islands or bars of alluvium.
- **Clastic**: Applied to the texture of fragmental sedimentary rocks (see also **volcaniclastic**).

- **Cleavage**, (in rock): Generally a finely developed tectonic **foliation**, penetrating throughout the rock, produced by intense deformation that has caused a partial recrystallization of platy minerals (e.g. clays and silts) perpendicular to the compressive forces; bedding and other primary features are commonly preserved.
- **Cnidaria**: (Coelentereta) Phylum comprising the sea anemones, jellyfish and corals, which is known from the late Precambrian (see **Ediacaran**).
- **Conglomerate**: Coarse-grained rock with rounded clasts (granules and pebbles) that exceed 2 mm in size (see Table 1).
- **Convergence, convergent margin**: A boundary between two lithospheric plates that are moving towards each other. Some are marked by a **subduction zone** whilst others are zones of collision between plates; zones of strikeslip faulting are the norm in cases where one plate converges at an acute angle, relative to the other (oblique convergence).
- **Crenulation** (of earlier cleavage): Structure caused by a **cleavage** that has been microfolded by a cross-cutting **foliation** that was superimposed during a later deformation.
- **Cryptodome**: A high-level **igneous** intrusion that causes up-doming of overlying unconsolidated sediments or rocks. They are commonly associated with zones of magma-wet sediment interaction that give rise to **peperite**.
- Crystal-lapilli tuff: A very coarse-grained rock rich in crystals and other pyroclastic fragments greater than 2 mm in size (see also, lapilli).
- **Dacite**: Extrusive or fine-grained intrusive rock containing $63-70 \text{ wt\% SiO}_2$ as well as plagioclase feldspar and quartz (commonly as phenocrysts), minor alkali feldspar and hornblende as essential minerals.
- **Debris flow:** A category of sediment gravity flow composed of a slurry of large and small rock fragments that generally depend upon the buoyant and/or cohesive properties of a saturated muddy matrix for sediment support.
- **Delta:** A discrete, roughly triangle or apronshaped body of sediment formed where a sediment-laden current enters an open body of water. At this point there is a reduction in velocity resulting in rapid deposition of sediment to form the delta.

Devitrification: The development of crystals or

crystalline aggregates, such as spherulites, in glassy **igneous** rock.

- Diorite: A coarse-grained **igneous** rock of **intermediate** composition, containing up to 5% quartz, plagioclase **feldspar** in the oligoclase/andesine compositional range and widely varying proportions of ferromagnesian silicate minerals such as pyroxene and hornblende.
- **Dolerite**: A medium-grained **basic igneous** rock with a similar mineralogy to **gabbro**.
- **Dome**, **volcanic**: An extrusion of magma that is largely solidified but still hot (see also **cryptodome**, **pyroclastic block flow**).
- **Ductile**: The response to stress of certain rocks or materials that undergo permanent deformation without fracturing.
- **Dyke**: Discordant, or cross-cutting, tabular **intrusion**, commonly with a vertical or near-vertical attitude.
- Ediacaran fossils: Precambrian fossils, named for their type locality in Australia, whose upper age limit is currently in dispute but which are commonly regarded as ranging between 570–543 Ma, with elements of the faunas also recorded from Cambrian strata younger than 543 Ma.
- **Epiclastic**: Term denoting origin, for example of volcanic fragments whose origin *as fragments* is a direct result of sedimentary processes. Used as a term of origin to qualify a sedimentary rock, or packages of strata, that may occur in **volcaniclastic** sequences where **pyroclastic** rocks are also present (see also Table 1).
- **Euhedral**: Morphological term referring to grains in **igneous** rocks, which have a regular crystal shape.
- **Eutaxitic**: A term applied to the discontinuous, streaky structure of certain welded **tuffs** and other **pyroclastic** rocks.
- **Extension**: A type of process, or a tectonic environment, characterized by normal faulting, graben formation and sometimes volcanism, developed where the crust is being stretched (extended), generally as a result of regional-scale plate movements.
- **Extrusive**: Applied to all ejected material of volcanic origin, including lava flows and domes; sometimes used for sequences that also include a **pyroclastic** component.
- Feldspars: An important group of rock-forming silicate minerals, which are essential constituents of many igneous rocks. Variations in

composition divide the feldspars into two series, the 'alkali feldspars', with end-members albite (Na-rich) and orthoclase (K-rich), and the plagioclase feldspars with end-members albite and anorthite (Ca-rich).

Floodplain: The part of a river valley that is made of unconsolidated river-borne sediment, and periodically flooded.

Fluvial: Pertaining to a river.

- Foliation: A continuous, sub-planar rock fabric commonly formed by the preferred orientation of minerals with a general platy or tabular habit. The layers in foliated rocks can be related to the original bedding (commonly designated as S_0), or to **cleavage** or gneissosity (see **gneiss**).
- Fore-arc basin: The part of the fore-arc (arctrench gap) adjacent to the volcanic arc but lying behind the high-point of the accretionary prism or wedge. It is partly infilled by sediments derived from the volcanic arc or uplifted plutonic-metamorphic basement.
- **Frontal arc**: In arc systems, a narrow topographical ridge located immediately behind the fore-arc region. It commonly contains the active **volcanic arc**, but in those systems that have experienced changes to the angle or position of the **subduction zone** it may be volcanically inactive.
- **Frontal arc sliver**: A narrow, fault-bounded slice detached from the leading edge of the frontal arc as a result of **transcurrent** movements generated by oblique **convergence**.
- **Gabbro:** A coarse-grained **basic igneous** rock that generally forms large **intrusions**. It consists largely of plagioclase **feldspar**, commonly in the labradorite-anorthite range, pyroxene(s) ± olivine (see also **dolerite**).
- **Gneiss**: Term applied to a coarse-grained, inhomogeneous rock, common in relatively highgrade metamorphic terranes, characterized by a coarse **foliation** or layering more widely spaced, irregular or discontinuous than that in a **schist**.
- **Grading, graded bedding:** Sedimentary beds that display a size-sorting effect, commonly with coarse-grade material (sand, pebbles) at the base and fine-grade material (silt, mud) at the top. The opposite relationship is known as **reverse grading**.
- Granite: a pale-coloured, coarse-grained igneous rock, commonly occurring as large intrusions but also found in veins. It consists of between 20 and 40% essential quartz, and

at least two-thirds of the **feldspars** are alkali feldspar; increased proportions of plagioclase feldspar occur in varieties transitional to granodiorite. Accessory minerals may include mica and zircon, but **amphibole** is commonly absent.

- Granitoid: A general term used to encompass unspecified coarse-grained, quartz-rich igneous rocks that may include compositional types such as granite, tonalite and granodiorite.
- **Granophyre**: A fine-scale intergrowth of quartz and either alkali **feldspar** or plagioclase commonly patchily developed and found as an interstitial, late-stage crystallization product in certain **granites** or quartz **diorites**. This textural term has also been used as a rock name or qualifier.
- **High-density turbidite**: Sediment gravity flows made up of clasts of various sizes, up to pebbles and cobbles, in which the particle (grain) support is dependent upon particle concentrations.
- **Hornfels**: A massive, finely crystalline contact metamorphic rock commonly showing a conchoidal fracture.
- **Igneous rocks**: Rocks that have crystallized from a magma.
- Ignimbrite: A type of large-volume, pumiceous ash-flow tuff.
- Intermediate (igneous or volcanic rock): A term used somewhat loosely to qualify rocks whose chemical composition lies between those of acid and basic end members.
- Intraformational breccia: Breccia (see Table 1) formed by the contemporaneous erosion and redeposition of a bed of sediment previously deposited, and commonly one that is not fully consolidated (see also soft sediment deformation).
- **Intrusion**: A body of **igneous** rocks that has been introduced into pre-existing rocks, commonly along a structural feature (joint or fault).
- Island arc: A commonly arcuate belt of emergent or partly-emergent volcanoes that is developed above a subduction zone, generally within an oceanic setting. See also volcanic arc, magmatic arc.
- **Isoclinal fold**: A fold in which the two limbs are parallel.
- **Isotopic dating**: Pertaining to the use of isotope abundance ratios, in whole rocks or separated minerals, in order to determine the

absolute age of a rock, which is generally expressed in millions of years (Ma). Isotope abundances are also measured in **igneous** rocks to elucidate the provenance and/or differentiation path of magmas.

- Juvenile pyroclastic material: Particulate material that directly owes its fragmentation to a volcanic process; commonly this will include (hot) radially jointed blocks and bombs, variably vesiculated glassy debris (e.g. shards) or blocky glass debris, and in some cases discrete **euhedral** crystals or angular fragments of formerly **euhedral** crystals.
- Keratophyre: A traditional term for a finegrained **igneous** rock consisting of albite or oligoclase (i.e. sodic) **feldspar**, sometimes with unaltered augite phenocrysts but with a mineralogy that is almost entirely secondary. Keratophyres are found on the ocean floor and in **ophiolite** complexes, commonly associated with **spilites**.
- Lamina, (plural: laminae): The finest sedimentary layer, less than 1 cm in thickness.
- Lapilli, (singular: lapillus): Pyroclastic fragments of any shape with a mean diameter of 2–64 mm (see Table 1).

Lava: Molten rock erupted by a volcano.

- **Lineation**: Any linear feature that appears on the bedding or **foliation** surface of a rock. Lineation may be formed during deformation by the parallel alignment of fossils, pebbles or minerals, the latter in extreme cases producing a **rodding structure**.
- Lithic fragment: The dense or crystalline components of a **pyroclastic** deposit. They can include ejected fragments of crystallized magmatic material, pieces of the country rock or clasts picked up locally during pyroclastic flowage.
- Low-density turbidite: Sediment gravity flows made up largely of clay to medium-sand size grains and in which sediment support is largely independent of particle concentration.
- Ma: Abbreviation for *mega annos* meaning 'million years ago'.
- Magmatic arc: An alternative term for volcanic arc, generally used in geological belts that contain only plutonic igneous rocks, the calc-alkaline chemistry of which indicates their generation above a subduction zone.
- Marginal basin: Also known as back-arc basins, these represent zones of volcanism and accelerated sedimentation that are usually associ-

ated with crustal extension or transtension developed behind the volcanic arc. They may occur in fully oceanic settings, or form by rifting of volcanic arc crust.

- Medusoid fossils: Imprints of roughly circular or ovoid organisms. Some forms are interpreted as the forerunners of modern jellyfish, but certain other circular imprints may represent the basal attachments, or floats, of frondose organisms.
- **Mélange**: Mappable body or rock composed of broken rock fragments of all sizes and many origins, in a sheared matrix.
- Meta-: Prefix commonly used to indicate that a rock has been affected by low-grade metamorphism, while still retaining many recognizable features of its origin (e.g. metasediment).
- **Metamorphic rock**: An aggregate of minerals formed by the recrystallization of pre-existing rocks in response to a change of pressure, temperature or volatile content.
- Metamorphism: The process of changing the characteristics of a rock in response to changes in temperature, pressure, or volatile content.
- Metasediment: A sedimentary rock that has undergone metamorphism.
- **Microgabbro**: A dark-coloured, mediumgrained granular **basic** rock, mainly composed of plagioclase and pyroxene, generally found in small **intrusions** or as **igneous** sheets.

Mudrock: A lithified mud.

- Muscovite: A rock-forming hydrous aluminosilicate mineral found in a variety of **igneous** and sedimentary rocks and especially common in **schists**. Due to its perfect basal **cleavage** it readily forms flakes when the rock is rubbed across the skin.
- Mylonite: Rock produced in tectonic zones where the precursor rocks have been mechanically broken down and suffered extreme grain-size reduction, producing a commonly 'laminated' (finely foliated) lithology.
- Normal grading: As for grading, graded bedding.
- Oceanic crust: The oceanic rocks, which are the upper part of the oceanic lithosphere. They commonly consist of a thin sedimentary capping to basaltic **pillow** lavas, which were originally generated at the oceanic ridge volcanic system. The pillow lavas are in turn

underlain by a **dyke** complex, which passes down into **plutonic** rocks (see **ophiolite**).

- Olistostrome: A sedimentary deposit, which consists of a chaotic mass of rock and contains large clasts composed of material older than the enclosing sedimentary sequence. Where the clasts are of gigantic proportions they are called 'olistoliths'.
- Ophiolite: Sequence of rock types, consisting of deep-sea sediments lying above basaltic pillow lavas, dyke complex, gabbros and ultramafic rocks such as peridotite. Some are remnant tectonic slivers of oceanic crust, others of crust formed in back-arc or marginal basins.
- **Paragneiss**: As for **gneiss**, but with a mode of occurrence and/or mineralogical composition allowing the observer to conclude that sedimentary processes formed the original rock (protolith).
- **Pegmatite**: Very coarse-grained **igneous** rock, commonly but not always of granitic composition, with individual crystals at least 2.5 cm long.
- **Peperite**: Rocks produced by fragmentation upon the injection of magma into soft, water-soaked sediments.
- **Pillow lava**: Piles of elongate basaltic lava pods, resembling stacked series of stone pillows, providing good evidence for submarine eruption of the lava.
- **Pluton**: General term applied to a body of intrusive **igneous** rock, regardless of shape, size or composition.
- **Plutonic**: Descriptive term for **igneous** bodies that have crystallized at depth and commonly have coarse grain sizes.
- **Polarity**: A term with many separate uses in geology, but here used in the plate tectonic context to describe the direction of outward-facing of a volcanic arc or island arc, i.e. the 'viewing' direction if one is standing on the volcanic axis and looking 'outwards' towards where the trench/**subduction** system is situated.
- **Porphyritic**: Textural term for a volcanic or intrusive rock containing large and often well-formed crystals (phenocrysts) set in a finer-grained groundmass or matrix.
- **Protolith**: A term derived from the Greek 'protos', meaning 'first', and commonly used as a synonym for the original lithological precursor(s) to rocks whose present appearance and mineralogy have resulted from **meta**-

morphism or alteration.

- **Proximal**: Applied to a sediment or sedimentary environment (or volcanic products) close to the origin or source of the material forming the deposit.
- **Pseudotachylite**: A rare, glassy rock produced by frictional melting during extreme dynamic metamorphism in a fault or thrust zone.
- **Pyroclastic**: Term denoting origin, for example of volcanic fragments (glass shards, **euhedral** or fragmented crystals, 'accidental' or 'cognate' lithic blocks) generated as a direct result of explosive volcanic action. Can be used as a term of origin to qualify a rock, or packages of strata, whose content of pyroclastic fragments is in excess of 75% of the whole (see Table 1).
- **Pyroclastic block and ash flow**: A hot massflow of pyroclastic debris with a high proportion of angular to subangular volcanic blocks (see table).
- **Pyroclastic flow**, **subaqueous pyroclastic flow**: A term commonly used loosely, but which should be restricted to describe primary, hot gas-rich mass-flows of pyroclastic debris either on land or within bodies of standing water (subaqueous pyroclastic flows); most are the result of explosive volcanic eruptions.
- Quench-brecciation: Non-explosive type of fragmentation process occurring in response to thermal and dynamic stresses generated within a body of magma as it cools during emplacement into wet sediments (see also peperite).
- Radiometric: A general term used for those techniques that measure isotopic abundances in whole rocks or minerals.
- **Repetitive grading**: A series of beds, stacked in vertical sequence, each of which constitutes a graded depositional unit (see **grading**).
- **Remnant** arc, marginal basin etc.: Term denoting a volcanic belt in which magmatic activity has ceased, usually due to major changes in the tectonic configuration of the arc-**subduction** system.
- **Reverse grading**: Sedimentary beds that display a size-sorting effect, commonly with finegrade material (silt, mud) at the base and coarse-grade material (sand, pebbles) at the top. The opposite relationship is known as **normal grading**, graded bedding.
- Rhyolite: A fine-grained extrusive igneous rock consisting of essential quartz, alkali

feldspar and one or more ferromagnesian minerals. Many rhyolites are **porphyritic**, with quartz and alkali feldspar phenocrysts.

- **Rodding structure**: A very coarse **lineation** of minerals or rock streaks, seen as cylindrical structures, or circular to ovoid structures when viewed end-on, which develops in strongly deformed rocks.
- Schist: A metamorphic rock of pelitic (aluminous) composition, with a grain size greater than 1 mm, that displays a strong foliation (schistosity) that is commonly defined by mica alignment. See also blueschist.
- **Shard**: Fragment of volcanic glass, may be filamentous, blocky or vesicular with angular or cuspate margins, a major juvenile constituent of **pyroclastic** rocks.
- **Shear zone**: A region, narrow when compared to its length, within which the rocks are intensely deformed.
- **Sheetflood**: A brief but powerful surge of water over a surface, generally caused by heavy rainfall of short duration.
- Silicification: The process of introducing silica into a rock, either by filling pore spaces or by replacing other minerals.
- **Soft sediment deformation**: A process causing the disruption, usually by folding, faulting or slumping, of sediments that are not completely consolidated.
- Spilite: A low-grade, sodium-rich metamorphic rock, generally containing abundant albite, chlorite and epidote, formed by sea-floor metasomatism of mid-ocean ridge basalts ('spilitization').

Strike-slip fault: See transcurrent fault.

- **Subaerial**: Refers to environments and processes occurring within the confines of landmasses.
- Subduction zone: The zone, at an angle to the surface of the Earth, down which a lithospheric plate descends. Most present-day subduction zones extend from trenches on the ocean floor. Andesitic volcanoes generally form along the volcanic arc, approximately 100 km above the subducting plate, or slab. Marginal basins are other manifestations of subduction-related magmatism, accompanied by rifting of the crust, behind the volcanic arc.
- **Terrane**: 'earth'; a small crustal plate or fault bounded fragment of a larger plate, with distinctive characteristics, which can be displaced considerable distances from its origi-

nal site and added to another plate during plate tectonic movement.

- Tonalite: a silica-oversaturated, coarse-grained igneous rock consisting of 20–60% essential quartz, and plagioclase feldspar in the oligoclase-andesine compositional range. Mafic minerals may include hornblende and/or biotite mica.
- **Transcurrent fault** (strike-slip fault): A fault in which the major displacement is horizontal and parallel to the strike of a vertical or subvertical fault plane. Localized zones of deformation due to pressures and tensions across the fault occur at bends in the fault and can give rise to conditions of **transtension**. The latter process may cause the formation of rhombic-shaped basins, graben, or **marginal basins** that may be the focus of rift-related volcanic activity.
- **Transecting cleavage**: Term applied to a cleavage whose strike trend is oblique to the axial plane of a fold, i.e. the cleavage cuts across the fold axis.
- **Transpression**: A tectonic regime that combines both **transcurrent** (strike-slip) movement with oblique compression.
- **Transtension**: A particular type of tectonic regime, characterized by the formation of extensional zones manifested as rift valleys or certain types of **marginal basin**, that developed along major **transcurrent faults** or anastomosing systems of such faults.
- **Tuff**: A collective term for all consolidated **pyroclastic** rocks (see Table 1).
- **Tuffaceous** (mudstone, siltstone, sandstone etc.): A prefix used to denote consolidated **epiclastic** rocks containing between 25 and 75% of **pyroclastic** fragments (see Table 1).
- **Turbidity current**: Sediment flows, commonly along the floors of lakes or seas, flowing as a result of excess density and in which the grains are suspended by turbulence.
- **Unconformity**: Surface of contact between two groups of unconformable strata, which represents a hiatus in the geological record due to a combination of erosion, tectonism and a cessation of sedimentation.
- **Undercooling**: The state whereby a magma must be cooled to well below its solidus temperature, before crystallization is initiated.
- **Volcanic arc**: Generalized term for a narrow, commonly gently arcuate belt containing many active, dormant or extinct volcanoes. These originated above a **subduction zone**

Glossary

along the edge of a convergent plate boundary, either in an oceanic (**island arc**) or continental margin plate tectonic setting. The term can also be applied to associations of ancient volcanic or plutonic (**magmatic arc**) rocks, which show chemical features indicative of a subduction zone involvement in their genesis.

- **Volcanic breccia**: Term for a **pyroclastic** rock composed of volcanic rock fragments whose mean diameter exceeds 64 mm, which have an angular or subangular shape indicating they were solid during transport.
- **Volcanic centre**: The region of a volcano containing the main conduit(s) through which the magmas were expelled.

- **Volcaniclastic**: A general term to include the entire spectrum of clastic materials (see Table 1) composed in part or entirely of volcanic fragments originating from a variety of particle-forming mechanism (e.g. **pyroclastic**, **epiclastic**).
- **Volcanogenic**: A general term applicable to rock sequences, individual rocks or constituents thereof that have originated from volcanic processes.
- Welding: A process common in thick, rapidly deposited **pyroclastic** sequences that have retained their heat, whereby individual pyroclasts are fused together, and at times compressed, to produce a highly compacted lithology.

238

Note: Page numbers in **bold** and *italic* type refer to **tables** and *figures* respectively

Aber-Dinlle Fault 3, 140 Absolute ages (radiometric techniques), Precambrian rocks 5, 8 Aethwy Terrane 3, 6, 13, 145 blueschists 13, 147-8, 157-8, 171 Amphibole, blue glaucophanic 157, 158, 171 Amphibolite 150–1 amphibolitic gneisses 89 sills/dykes 151 Amphibolite-diorite reaction, Tank Quarry 72 Andesite 40-2 Bardon Breccia 41 Benscliffe Breccia Member 37-8 Charnwood Lodge Volcanic Formation 38 Andesitic Ash, in Longmyndian Supergroup 107, 107 Andesitic domes, Grimley type 40 Bardon Breccia 43 Anglesey 145-73, 146 Arfon-type pyroclastics 129 basement and post-Cambrian cover 166 terranes in 6, 12-13, 145-148 Arc magmatic complexes on immature continental crust 11 subduction-related 9

see also Volcanic arcs Arc volcanism, calc-alkaline 12 Arfon Group 138 Caldecote Volcanic Formation 56 Charnian Supergroup 21-2 Pebidian Supergroup 133 Archaean 4 Arenicolites 206 Arfon Group 3, 8, 12, 129, 130, 146 environment of deposition 15, 140 Llyn Padarn 136-41 Arumberia 195 Ash fall accumulations 95 Ashes Hollow Quarry, Precambrian fossils 99, 193-5 **Burway Formation 193** Ashes Hollow-Devil's Mouth 98-103 Burway Formation 98–103 environment of deposition 98 Stretton Shale Formation 98 Askrigg Block 208 magnetic anomaly 210 Aspidella 183 Autobrecciation 38, 40, 122, 126, 133, 134, 136 Avalonia 15 see also Eastern Avalonia Avalonian belt, on Gondwana plate margin 9-11 Avalonian Composite Terrane 9 amalgamation of 13–15 British Avalonian terranes 9–12, 6–7 evolution of 13–15, 14 Menai Strait Fault System 3, 9 Monian Composite Terrane 12–13, 6, 3, 145–149 subdivision of 9 Avalonian microcontinent, palaeogeography 9, 10 Avalonian subduction system, late Precambrian evolution 9, 14, 155 Avalonian Volcanic arc 10

Bangor Formation 140 Bardon Breccia 40, 41-2, 42-3 Bardon Hill 40-3 Bardon Breccia 41-2, 42-3 Bardon Hill Volcanic Complex 22, 24, 40 Maplewell Group 42 Peldar Porphyritic Dacite 40-1 Bardon Hill Volcanic Complex 22. 24. 40 Charnian volcanic centre 42, 43 source of clastic material in Beacon Hill or Bradgate formations 43 Bardsev Island 145 Baron Hill Formation 12, 15, 129, 146

Batch Volcanic Beds, Volcanics 83, 86, 87 Long Batch-Jonathan's Hollow 106, 106, 107-8 The Pike 103, 104 Bayston-Oakswood Formation 83.97 braidplain conglomerates in 87, 98 rejuvenation 114 Hawkham Hollow 112, 113, 114 Lyd Hole 97, 97 Beacon Hill 30-2 Beacon Tuff Member 31, 32 Beacon Hill Formation 22, 24, 30 Bradgate Park 33, 34 fossils in 185, 185, 187 Outwoods Breccia Member, Outwoods-Hangingstone Hills 43, 44 Beacon Tuff Member 22 Beacon Hill 30-2, 30 **Beckermonds Scar Borehole** 210 Beltanelloides 195 Beltanelloides soichevae 195 Benscliffe Breccia Member 22, 37 pyroclastic block and ash flows 39 Benton Group 130 dacitic to rhyolitic tuffs in 87 Bergaueria 195 Berw Shear Zone 3, 13, 129, 146, 147 tuffaceous rocks tectonically incorporated 12 Blackbrook Group 22, 25, 26, 28 fossils in 187 Blackbrook Reservoir 28-30 **Ives Head Formation 29** South Quarry Breccia Member 28-9 Blackbrook Reservoir Formation 22, 28 Blackbrookia oaksi 186, 187, 192 Bladder Stone 89 'Blue Hole Intrusive Series' 57, 63 Blueschists

Aethwy Terrane 13 association with transcurrent movement fault 158 Eastern Schist Belt (Anglesey) 147-8 interpretation of 13, 15, 157 Marquis of Anglesey's column 156-8 Penrhyn Nefyn 170, 171 Bodbury Hill 104 'Bomb Rocks' volcanic breccia 37-8, 38, 39 Boon's Quarry 55, 57-60 basaltic-andesite sheets 59 Caldecote Volcanic Formation 56, 57-60 Precambrian-Cambrian unconformity 55, 59 Bouma sequences 36, 59, 102, 160 Bradgate Formation 22, 25, 33-7, 40 Bradgate Park 34, 33-7 Charnwood Lodge-Warren Hills 38 Cliffe Hill Quarry 48, 185 Precambrian folding 51 Precambrian fossils in 191 sedimentary sequence 52 fossil horizons 185, 185, 188-92 intruded by South Charnwood Diorites 23, 25, 50 Outwoods-Hangingstone Hills 43, 44, 44 sedimentary cycles 44, 46, 48 turbidite deposits 47 vitric clasts 47 Bradgate Park 33-7 Hallgate Member 33, 34 Hanging Rocks Formation 35-6 Memorial Crags, Precambrian fossils 35, 185, 188 Old John Member 33 measurements of cleavage/ fold transection 36 Sliding Stone Slump Breccia 33, 34, 35, 188 South Charnwood Diorites 36

see also Stable Pit, Bradgate Park Bradgatia aff. linfordensis 190, 192 Bradgatia linfordensis 186, 188, 189, 190, 192, 193 Braich y Pwll to Parwyd 174-9 Braich y Pwll to Porth Felen 174-7, 177 Gwna Group mélange 174 Gwyddel Beds 174, 176 Pared Llech-y-menyn to Parwyd 177-8 Llŷn shear zone 178 Mélange 177-8 'Penmynydd Zone of Metamorphism' 177-8 Parwyd 178 Parwyd Gneiss 178 Porth Felen to Pared Llech-ymenyn 177 Gwna Group mélange and Sarn Complex relationship 178 'The Brand' 203-8 Brand Hills Formation 204, 204, 207 erosional unconformity 208 Lower Cambrian age controversy 204, 207 Precambrian-Cambrian unconformity position 204 sandstone composition 207 Stable Pit Member 205-6, 205, 207 Swithland Camp Member 204-5 granophyric clasts 207 Swithland Formation 204, 204, 206-7 Acadian penetrative cleavage 204, 207 Teichichnus burrows 206, 207 Brand Group 22, 34 Bradgate Park 32 now considered as probably Cambrian 21, 24, 202, 207 significance of granophyre pebbles 25 Stable Pit 201-3 'The Brand' 203-8 Brand Hills Formation 7, 22, 185

Bradgate Park 34 Stable Pit 201-3 see also 'The Brand' Breccia autobreccia 122, 133 basaltic breccias at Llangynog 122, 126 breccia texture of Grimley Andesite 38 Bardon Breccia 41, 41-2 dacitic, Peldar Porphyritic Dacite- Bardon Breccia contact 40-1 lapilli-tuff 61, 93 late fault brecciation 171-2 lava-and-limestone, Gwna mélange 168, 170 sediment-raft breccias 61, 64 South Quarry Breccia Member 28-9, 29 volcanic, andesitic 37, 39 see also Slump breccia **Bridges Formation 83** British Avalonian terranes 9, 11-12 see also Avalonian **Composite** Terrane Broad Down, Warren House Formation sites 77-9 Clutter's Cave 78-9 **Reservoir Quarry 79** Bryn Meurig Shear Zone 13 Bryn-teg Borehole 3, 130, 137 Bryn-teg Volcanic Formation 137 calc-alkaline island arc succession 138 Buck Hills Member 22, 44 Burgess Shale, Middle Cambrian, Ediacaran-type fossils 184 Burway Formation 83, 86-7 Ashes Hollow Quarry, Precambrian fossils 193-5 Ashes Hollow-Devil's Mouth 99 channel-fill sandstones 102 deltaic facies 99, 101, 103 depositional environments 98 pro-delta facies 99, 100-101, 103 turbidite facies 99, 100,

101, 102-3 Buxton Rock 83, 98, 99, 99, 101 - 2volcanic origin of 99, 101 Bwlch Gwyn Tuff 12, 15, 129, 146 tectonic incorporation within Berw Shear Zone 148 Cadomian terranes 9 Caer Caradoc 83, 84 Cae'r Sais 164-5 New Harbour Group, metagabbro and serpentinite 164-5 Cr content 165 serpentinite protoliths 164 tholeiitic chemistry 164 Caerbwdy Group 131, 132 Caerfai Group 6 Caldecote Volcanic Formation 3, 7, 55, 55, 56 age 56 Boon's Quarry 55, 56-60 contorted bedding 64 crystal-lapilli tuff facies 56, 57, 60, 61, 62, 64 Judkins' Quarry 60-4 porphyritic inclusions in 57, 60, 61 subaqueous deposition 56 subaqueous pyroclastic flow origin 64 tuffaceous siltstone facies 56, 58-9, 61, 62, 63 accretionary lapilli 61, 64 Cardingmill Grit 83, 87, 98 Ashes Hollow-Devil's Mouth 99, 101-3 Carreg Cennen Fault 3, 130 Carmel Head Thrust System 146, 147 Nebo and Gader inliers 149 Carn Rhosson, Rhosson Group 132, 134 Castell Cogan 122, 123 Castell Cogan Rhyolite Member, Llangynog inlier 123-4, 123, 126, 130, 196 Cataclasite, Anglesey 13 **Central Anglesey Gneiss** (Gneiss Complex) 6, 15, 147, 154

Central Anglesey Shear Zone 3, 6, 13, 146, 154, 156 Charnia grandis 186, 188, 189, 193 Charnia masoni 184, 186, 187, 190, 191, 193 Charnian Supergroup 3, 7, 8, 21, 24-5 age 23, 193 Charnwood Forest 11, 21 depositional environment 24-5 major and trace element data 21, 23 volcanic derivation 24 Charniidae 192 Charniodiscus 198 Phanerozoic counterparts 184 Charniodiscus concentricus 186, 188, 190, 191, 192 **Charnwood Diorites** 7 see also North Charnwood Diorites; South **Charnwood Diorites** Charnwood Forest Precambrian outcrops 21-52, 22 see also Charnian Supergroup Charnwood Lodge Nature Reserve 37 Charnwood Lodge Volcanic Formation 22, 30, 37, 39, 40 Benscliffe Breccia Member 37, 38 volcanic breccia 37-8, 38, 39 Warren Hills exposures 38 Charnwood Lodge and Warren Hills 37-40 Grimley Andesite 37, 38 see also Charnwwod Lodge Volcanic Formation Charnwood Terrane 3, 7, 11, 55 beneath Worcester Basin and the South Midlands 11 **Church Stretton Fault System** (Zone: Lineament) 3, 83, 83, 84, 89, 114 Precambrian terrane boundary 118-19 Cleavage axial planar, Rhoscolyn 161,

162

and bedding, Portway Formation, 114 Charnian, refraction of 36 Charnian, anticlockwise transection of fold 23, 36 cleavage and slates in Ingleton Group 210, 211 Lilleshall Hill 95, 96 penetrative in Charnian Supergroup 23-4, 27, 29 age determination of Charnian cleavage 24 crenulation of Charnian cleavage, Morley Quarry 27 Cliffe Hill Quarry 48-52 see also Bradgate Formation see also South Charnwood Diorites Clutter's Cave, 78-9 see also Warren House Formation Cnidaria 192 Coalbrookdale Formation 115. 116 Cochlinus 197, 198 Coed Cochion, Precambrian fossils 196-8 see also Coed Cochion Volcaniclastic Member Coed Cochion Volcaniclastic Member, Llangynog inlier 123, 124-5, 126, 196-8 Coedana Complex 145-7, 146 gneisses 147 Tyddyn Gyrfer 149-51 age of metamorphism 150 correlation with Rosslare Complex 149, 151 gneisses, hornfels and granite relationships 149 interpretation as frontal arc sliver 15 mineralogy 150 paragneisses, crustal residency age 151 upper amphibolite facies metamorphism 149, 151 see also Coedana Granite, Coedana Terrane Coedana Granite 8, 13, 15 age of 147 'Avalonian' chemical signa-

ture 134-55 belonging to Avalonian event 2, 156 calc-alkaline, subduction zone affinity 147 calc-alkaline volcanic arc granite 156 crustal residency age 156 Gwalchmai exposures 153-6 isotopic (U-Pb) age dating 154 Coedana Terrane 3, 6, 13, 145 Colony Reservoir, lapilli tuff 38 Comley Sandstone, Upper and Lower 7 Conglomerate 35, 37 basal Cambrian conglomerate 64, 91, 135 Castell Cogan Volcaniclastic Member 124 Coed Cochion Member 125 Hanging Rocks Formation 33, 37, 46, 204 Radlith Conglomerate 97 tuffaceous 89 Coomb Volcanic Formation 3, 7, 12, 87, 130 bi-modal volcanic suite 11, 15, 87, 123 Llangynog inlier 122-6 geochemical data/studies 122-3, 126 shallow water to sub-aerial deposition 87 Crustal thickening, Charnian volcanic arc 52 Cryptodomes 43 Cyclomedusae 192 Cyclomedusa 183, 197, 198 Cyclomedusa cf. davidi 186, 189, 192, 193 Cyclomedusa cliffi 186, 191, 192, 193 Cymru Terrane 3, 12, 173 correlation between Arfon and Pebidian divisions 138 interleaved with Monian **Composite Terrane 129** Sarn Complex component of 12

Dacite 29, 41, 126 as pebbles in Hanging Rocks Formation 46–7

Peldar Porphyritic Dacite 40-1, 42 Deformation Acadian 9, 24, 210, 212 associated with Precambrian blueschist metamorphism in Anglesev 147 brittle 147, 153, 155 compressional, post-Arenig in Llŷn 179 ductile 147 and brittle fracturing, Penrhyn Nefyn 171 Coedana Granite 155 Stretton Group 114 non-penetrative phase, Ives Head Formation 27 polydeformation Monian Supergroup 12 Rhoscolyn 161-3 polyphase 8, 149 Precambrian folding of Bradgate Formation 50-1, 52 shear deformation south Malverns Complex 76 Urconian of Lilleshall Hill 95 see also Berw Shear Zone, Central Angelsey Shear Zone Variscan 69 Desiccation cracks 104 Destructive plate margins long-lived 13 and subduction-related arc magmatic complexes 9 mélanges typical of 174 Devitrification 32, 61, 77, 89, 94 Dingle Quarry 69, 72-3, 77 dolerite dyke 73 microdiorite sheet 73, 73 Dinorwic Fault 3, 140 Diorite Malverns Complex 70, 70-1 see also Granophyric diorite; North and South **Charnwood Diorites** Dish structures (cuspate loaded bases) 101 Dolerite

Stanner-Hanter Intrusive Complex 119-20, 119, 120 see also Dykes, dolerite **Dolwen Formation 137** Dolyhir Limestone 115, 116 Dolyhir and Strinds quarries, Old Radnor Inlier 114-18 Dolvhir Quarry faulting 116-17 Wenlock unconformity 116 see also Yat Wood Formation Strinds Quarry Dolyhir Limestone 116 Strinds Formation 116 Dome collapses 40 Dorothea Grit 6 Ductile shear zones 13 associated phyllonitic and mylonitic rocks 70, 74 in Menai Strait Fault System 170 pseudotachylite occurrence 75 Dykes basaltic 60 basaltic-andesite 57 basic 70 Twistleton Glen 212 dolerite 73, 91, 168, 168, 175, 202, 203 felsic 75 Later Dolerite 121 microdiorite 72, 73 neptunean, Horton-in-**Ribblesdale 209** Earnslaw Quarry microdiorite 73, 74 pink granite 71, 73 trachyte intrusion 73-4, 77 Earthquake clusters, sourced in neotectonic activity 4 Eastern Avalonia 10 turbidite fan development 212 Eastern Schist Belt (Anglesey) 146, 147-8 age of 147 blueschists 13, 15, 147-8 as part of accretionary prism 14, 147, 148 MORB signature, basic rocks

147

Ediacara 197, 198 Ediacara fauna 23, 84, 87, 122, 183-4, 196 affinities of 184, 192-3 age range 186 fossils of Charnwood Forest 187-93 fossils of Coed Cochion 196-8 fossils of the Long Mynd 193-5 relationship to Cambrian fauna 184 relationship tp earlier fauna 184-5 Epidiorite 71, 76 Epidotic aggregates 107, 108 Epidotization 41, 42 The Ercall, granophyre pluton 91 Ercall Granophyre 7, 85, 88, 92 age 92 U-Pb zircon date for emplacement 11, 86 Uriconian magmatism 86, 92 Ercall Quarries, granophyre and Wrekin Quartzite 91 Exotic crustal slices 4-5 Fachwen Formation 6

conglomeritic base 139, 140 contact with Padarn Tuffs 140 Llyn Padarn 137, 139, 141 Fault zones, ductile 145 Fault-bound blocks, Malvern Hills 69, 69 Faults exposed 4 Bardon Hill Quarry 42 Dolyhir Quarry 116-17, 117 **Gullet Quarry 75** Judkins' Quarry 63-4 strike-slip 84 importance to basement geology 173 Fenland Terrane 3, 7, 11 boreholes 11 chemically distinct from Charnian rocks 11 comparable calc-alkaline volcanism to Cymru Terrane 12 in Glinton, Orton, Oxendon

Hall boreholes 11 Fining-upwards sequences 35, 44 Bradgate Formation 44, 46, 48 Burway Formation 100, 101, 102 Stable Pit Member 205, 205 Flow-banding, in pseudotachylites 75 Fold-cleavage geometry 36, 159 developed during transpressional deformation 84 Rhoscolyn 161-3 studies to constrain cleavage age 24, 85 Folding anticlinal, Charnian Supergroup 21 asymmetric drag-folds 31 fold cascades Rhoscolyn 161–2 South Stack 159 isoclinal, Ingleton Group 208, 209, 211-12 Long Mynd Syncline 84 Malverns Complex 71 parasitic folds 159 Precambrian age of 23, 50-1 recumbent, Gwyddel Beds 174, 176 slump-folding 44 synclinal, Beacon Hill sequence 31 Foliation Aethwy blueschists 13 flow-banding 89 mylonitic, Lilleshall Hill 95 welding, Padarn Tuff Formation 138-9, 139 Fossils 3-4 algal microfilaments, Lightspout Formation 110 arthropod-like impressions 186-7, 189 style of preservation 192 cryptarchs, Strinds Formation 116 disc and disc-like impressions 186 discoid 32, 46, 187, 191 Aspidella 183 Ediacaran see Ediacara fauna

filamentous microfossils, Yat Wood Formation 117 frondose 37, 46, 183, 186, 188, 193 interpretation of 192 complex frondose colonies 186, 192, 193 indicate deposition in marine environment 36 medusoids 183, 187, 189, 194 pennatulacean coelenterate, Charnia 184 problematica 187, 192, 195 ring-like markings 190 stromatolites 183 Gwna mélange 165-6 trails 187, 190, 198 Fownhope Borehole 3 see also Teichichnus trace fossil, Teichichnus 206, 207 Fractional crystallization 122-3, 165 Furness-Ingleborough-Norfolk Ridge, magnetic basement rocks 210 Fydlyn Group see Gwna Group Gabbro, quartz-free, Hanter Hill 120-1 alteration 121 nature and emplacement age 121 Gader Inlier 149 Geochemical patterns, and nature of magmatic suites 5 Geochemistry, role in terrane characterization 5 bimodal suites 5 calc-alkaline suites 5 **Glass shards** Beacon Tuff Member 32 Caldecote Volcanic Formation 59-60 devitrified 61.93 Glinton Borehole 3, 7, 11 Precambrian rocks dated by U-Pb method 23 Gneiss 89, 174 Coedana Complex 147, 149-51 see also Central Anglesey Gneiss Complex; Parwyd

Gneiss; Primrose Hill Gondwana 9, 10 'Good Rock' see Bardon Breccia Graded bedding Caldecote Volcanic Formation 59 Old John Member 33 South Stack Group 159 Stable Pit Member 205, 206 Grading, normal 26, 35, 56, 59, 102 Granite cutting and enclosing Coedana Complex hornfels 152 Malvern Complex 70, 71, 73, 74 see also Coedana Granite; Stanner-Hanter Intrusive Complex Granophyre gneissified 87 see also Ercall Granophyre; St David's Granophyre Granophyric diorite 7, 11, 25, 48 Judkins' Quarry 56, 57, 60-1, 62, 63 see also South Charnwood Diorites Greisen veins 7 Grimley Andesite 37, 38, 40 autobreccia facies 38 within the Whitwick Volcanic **Complex 38** Gullet Quarry 75-7 microdiorite sheet 75 pre-Llandovery unconformity 75 Gwalchmai 145, 146, 153-6 Coedana Granite 153-6 aplite veins 155-6 Gwna Group mélange 6, 12-13, 129, 148, 178 Braich y Pwll to Parwyd 174-9 jaspery pillow lava-andlimestone mélange 177 chaotic texture 166 oceanic pillow basalts in 168, 169, 175 with deep-water cherts and limestones 148-9

Llanddwyn Island 167-8, 169 Ogof Gynfor Coast 165-6 age of red cherts 168 'Spilitic Lavas' 168 stromatolitic limestones in 165-6 Penrhyn Nefyn jaspery basaltic breccias/lavas 170 shear zones containing mylonitic greenschist 170 - 1separated from Sarn Complex by shear zone 178 stratigraphical interpretation 174 transition from mélange to schist 178 Gwna Group mélange-Ordovician unconformity 165, 166, 167 Gwyddel Beds 174 Haddon Hill Grit 110-11 Hallgate Member 190 Bradgate Park 34, 35, 188 Hanging Rocks Formation 22 age controversey 47, 48 Bradgate Park 34, 35-6, 37, 203 Outwoods-Hangingstone Hills 46-7, 48 accompanying volcanism 47 possible affinity to true Charnian sequences 47-8 Hanging Stone 37, 38 Hanter Hill, Stanner-Hanter Intrusive Complex 118-22 Hartshill Sandstone Formation 7, 201, 202 equivalence to part of Brand Group 207-8 Judkin's Quarry 62, 63 Hawkham Hollow 112-14 Bayston-Oakswood Formation 112, 113 Portway Formation 112, 113 Stretton and Wentnor groups local disconformity 114 unconformity or result of

tectonism 112-13 Heath Farm Borehole 3 Hiemalora 197, 198 Hell Gate, rhyolites with flowbanding 90 Holyhead Formation South Stack 159, 159 turbidite fan associations 160 Rhoscloyn 161, 162 Holyhead Quartzite see Holyhead Formation Hornfels, Coedana Complex 149, 151-3 Horton-in-Ribblesdale inlier 209, 212 Hyaloclastites 41, 41-2, 122, 126 Hydrothermal activity 121 Peldar Porphyritic Dacite 42 Hydrothermal alteration 77, 72 Ignimbrites 136-7 Ingleton Group 209 correlation 208-9 Craven inliers 208 evidence of age from **Beckermonds Scar** Borehole 210 turbidite sedimentation 212 Inliers Craven inliers 208 distribution, controlled by major crustal lineaments 4 Horton-in-Ribblesdale 212 Llangynog inlier 122-6, 196 Nebo and Gader inliers 149 Nuneaton Inlier 23, 55-65 Radnor Inlier 114-18 Shropshire, Radnor and Llangynog 83, 84 Wrockwardine 85-6 see also Stanner-Hanter Intrusive Complex; Thornton and Twistleton Glens, Chapel-le-Dale inlier Intrites punctatus 195 Intrusions Earnslaw Quarry, trachyte body 73-4, 77 Ercall Granophyre 7, 11, 85, 86, 88, 92 Judkins' Quarry

basaltic-andesite and microdiorite sheets 62, 63.64 lamprophyre sheet 62 Llangynog Inlier, basic intrusions 125-6 Malverns Complex 70, 76 acid intrusions 71 diorite, tonalite and granite 71 microdiorite, within-plate chemistry 70, 71, 73 North Charnwood Diorites 21, 22, 25 Nuneaton Inlier, intermediate to basic 57 South Charnwood Diorites 21, 22, 25, 48-50 Ives Head Formation 22, 28, 185 Blackbrook Reservoir 29 fossils in 185, 185, 187, 188 Morley Quarry 25, 26, 27-8 sedimentation processes 27-8 Ives Head, Shepshed, Precambrian fossils 185, 185, 187, 188 Ivesbeadia lobata 186, 187, 192

Johnston Complex 3, 6, 8, 12, 14, 130 compared to Malvern Complex 11–12, 87 Johnston Thrust 6 Judkins' Quarry 23, 55, 60–5 *see also* Caldecote Volcanic Formation; granophyric diorite

K-Ar radiometric technique 8 Kempsey Borehole *3*, 11 Keratophyres 77 Kink bands 162

Lavas autobrecciated 134, 136 basaltic 122, 125 basic 131 epidotized 134 potassic rhyolites 85 Uriconian, the Wrekin 92 rhyolitic 77, 89, 122

and dacitic 92 silicified 124 silicified 134 spilitic basalt 77 Lawrence Hill Quarry dolerite dykes 91 upper part of Uriconian sequence 91 Leinster-Lakesman Terrane 210, 212 Lightspout Formation 83, 110 Lightspout Hollow 109 braidplain deposits 112 Haddon Hill and Lightspout grits 110–11 Huxter Conglomerate 111, 112 sedimentary structures 111 sheet flood 111-12 transition from Synalds Formation 109 Long Batch-Jonathan's Hollow 106, 106, 108 multiple sheet flood events 87 siltstone and silty mudstone, colour-banded 109 Lightspout Hollow 109–12 see also Lightspout Formation Lilleshall Hill 93-6 Uriconian Group, northernmost outcrop of 93.93 see also Urconian Group Little Hill 89 see also Primrose Hill Gneiss Llanbadrig area see Ogof **Gynfor Coast** Llanberis Slate 6 Llanddwyn Island 167-9 see also Gwna Group mélange Llanddwyn Spilitic Formation 168, 169 Llandyfaelog Fault 3, 130 Llangynog inlier 122-6 see also Castell Cogan Rhyolite Member; Coed **Cochion Member; Coombe** Volcanic Formation; Coed Cochion, Precambrian fos-

sils Llyn Padarn 130, 136-41 see also Arfon Group; Fachwen Formation; Padarn Tuff Formation Llŷn (Lleyn Peninsula) 145, 146 Braich y Pwll to Parwyd 174-9 Llŷn Shear Zone 3, 129, 146, 171, 171 Llyn Traffwll Fault Zone 3, 6, 13.146 Load structures 32, 104 Long Batch-Jonathan's Hollow 106 - 9see also Batch Volcanic Beds; Lightspout Formation; Synalds Formation Long Mynd 83, 83, 98, 103 major syncline in 85, 86 Longmyndian Supergroup 3, 7, 8, 12, 83, 83, 86-7 depositional setting 86-7, 108 organic nature of impressions 183 relationship with Uriconian Group 86, 108 strata deposited in rapidly subsiding basin 12, 15 stratigraphy, progradational succession 105, 108 Lower Comley Sandstone (Cambrian) 88, 93 Lower Pebidian (Supergroup) 131, 132, 133 subduction-zone magmatism 135-6 Lyd Hole 96-8 basalt intrusion 97 see also Bayston-Oakswood Formation; Radlith Conglomerate Uriconian-Longmyndian contact 96, 97-8 vitric lapilli tuffs 97

Maen-gwyn Farm 146, 151–3 Coedana Complex hornfels 151–3 banding 152 low-grade greenschist

metamorphism 153 pre-intrusion history 152 - 3Coedana Granite emplacement mechanism and effects 152, 153 intrusive relationship with low-grade hornfels 151 Magma mixing, Stanner-Hanter Intrusive Complex 119, 121, 122 Magma-wet sediment interactions, Bardon Hill Complex 42, 43 Magmas basaltic/andesitic 64 basic 60 calc-alkaline high-K 11, 21, 23, 51, 64 volcanic arc 21 dacitic 64 phenocryst-rich 60 late generation, comparable to within-plate basalts 76 parental calc-alkaline, Charnian Supergroup 24 porphyritic 51 rhyolitic 95 Magmatic arc 14, 151 Magmatic stoping 51 Magmatism bi-modal 129 Uriconian Group 11, 12, 85 calc-alkaline Arfon Group and Pebidian Supergroup 129 felsic 12 subduction-related 14, 15 Charnian, age of 23 diachronous, Uriconian Group 86 Pebidian Supergroup, intrusion of granophyre 136 Precambrian, final phase 56 silicic 126 subduction-zone, St David's 135-6 'Main Magmatic Event' 14-15 Malvern Hills 69-79 Malvern Lineament 3, 7, 78 may separate Charnwood and Wrekin terranes 11

Malvern Quartzite 7 Malverns Complex 3, 7, 8, 11, 14 alteration of 70 calc-alkaline igneous complex 69 calc-alkaline magmatic suite 70 enriched in LIL elements 70 episodic Precambrian tectothermal history 76 geochemical analysis 70 history of intrusion and deformation 71 interpreted as magmatic root of volcanic arc 76, 77 isotopic age dating 71-2 petrography 70-1 TDM model 71 thermal reactivation dated 72 Malverns Complex-Warren House Formation contact, tectonic 77 Maplewell Group 22, 24, 42, 48, 56 Bradgate Formation sedimentation 51 Bradgate Park 32, 34 Margins, cuspate, 'pseudo-pilloidal' 41 Marker horizons Benscliffe Breccia Member 37 Buxton Rock 101-2 South Quarry Breccia Member 28 Markfieldite see Granophyric diorite, Judkins' Quarry; South Charnwood Diorites Marquis of Anglesey's Column 146, 156-8 blueschist 157 Medusinites 197, 198 Mélange 174, 179 see also Gwna Group mélange Menai Strait Fault System 3, 4, 6, 9, 130, 146 emplacement of blueschist 8, 17, 147, 148 major Precambrian crustal boundary 129 major terrane boundary 145

a suspect terrane boundary 9, 12 Mercia Mudstone Group 42 Metamorphism 8, 63, 76 blueschist facies 6, 147 greenschist facies 6, 24, 153 low-grade 125-6 upper amphibolite facies 147 see also Thermal metamorphism Metasomatism contact-related 50 Malvern Complex 71 Microdiorite 7 Judkins' Quarry 62, 63, 64 Malvern Complex 70, 73, 73, 74, 75, 76 sheared 79 Midlands Microcraton 4 Migmatites, injection 151 Minffordd Formation 6 relationship to Padarn Tuffs 140 Mistaken Point Formation 87 Monian Composite Terrane 3, 6, 12-14, 130, 145, 173 Aethwy Terrane 13 and British type-Avalonian terrane-arc-trench system 13 - 14Coedana Granite 156 Coedana Terrane 13 Monian Supergroup 12-13 similarities to the Rosslare Complex, south-east Ireland 12, 13 terrane accretion and dispersal 8 Monian Supergroup 3, 6, 8, 12-13, 146 age controversy 4, 145, 148 Cambrian 13, 148, 167, 201 Anglesey and Lleyn Peninsula 148-9 fossils 167 interpreted as fragment of accretionary prism 15 polyphase deformation 149 represents fill of trench-forearc basin 12, 14 Monian Terranes, suspect 12 Monzogranite 156

Morley Lane Volcanic Formation 25 Morley Quarry 25–8 Ives Head Formation 25, 26, 27–8 Myddfai Steep Belt 3 Mylonites 7 Mynydd y Gwyddel, Gwyddel Beds 175, 177

Nama Group 195 frondose organisms 183 Nant Ffrancon Formation 6 Nebo Inlier 149 Needle's Eye 89 Neoproterozoic 4 New Harbour Group 6, 148 Cae'r Sais 164-5, 165 subduction-related tectonic setting 148 North Charnwood Diorites 21, 22, 25, 57, 60, 63 North Craven Fault 209, 210 North East Charnwood Boundary Fault (postulated) 3,7 North Hill quarries, range of dioritic rocks 71 North Quarry, Charnwood Golf Course Precambrian fossils 190 'Ring Pit' Quarry 190 volcaniclastic siltstones 44-6 Nuneaton Inlier 23, 55-65 Boon's Quarry 55, 57-60 Judkins' Quarry 55, 60-5

Ogof Gynfor Coast 165-7 Gwna Group mélange 165-6 Gwna Group mélange-Ordovician unconformity 165, 166, 167 Ogof Henllys 130 Treginnis Group 133 Ogofgolchfa **Ogofgolchfa Group 134** unconformity with basal Caerfai Group 134 Ogofgolchfa Group 131, 132 basaltic volcanism 136 Old John Member 22 Bradgate Park 33, 34 Precambrian fossils 187 Old John Tower 33, 34

Old Radnor Inlier 114-18 faults of the Church Stretton System 116 setting of and age 118 Orton Borehole 3, 7, 11 Precambrian rocks U-Pb dated 23 **Outwoods Breccia Member 22** Outwoods-Hangingstone Hills 43, 44 instability within the sedimentary pile 47 Outwoods-Hangingstone Hills 43-8 Brand Group 43 Charnwood Golf Course, Hanging Rocks Formation 46-7 fossil impressions 43, 46, 48 Hanging Stone **Bradgate Formation 44 Outwoods Breccia** Member 44, 44 Maplewell Group 43, 48 North Quarry, volcaniclastic siltstones 44-6 Outwoods outcrop Bradgate Formation 43, 185 **Outwoods Breccia** Member 43 Swithland Formation 43 The Outwoods, Precambrian fossils 188-9 Overthrusting, Variscan 12 Oxendon Hall Borehole 3, 11 Padarn Tuff Formation 6, 12, 15, 136-7

15, 136–7 age of 138 pyroclastic flows 140 Bouger gravity anomaly, association with 140 welded tuffs 138–9, 141
Palaeontology, Precambrian 183 see also Fossils
Palaeopaschichnus 197, 198
'Pannotia', rifting during latest Neoproterozoic 9
Park Hill Member 202
Parwyd, positions of schists 174
Parwyd Gneiss 3, 12, 129, 149

Parwyd 175, 178, 179 Pebidian Supergroup 3, 6, 8, 129 calc-alkaline volcanism 12 correlations 136 placed within Avalonian Event 2 136 St David's Peninsula 130, 131, 132, 133-6 Pedwardine inlier 117-18 Pegmatite gabbro 121 Malvern Complex 70, 71, 74 thermal rejuvenation 72 Peldar Porphyritic Dacite, Bardon Hill Quarry 40 complex contact zone with Bardon Breccia 40-1 Penbiri Diorite 132 'Penmynydd Zone of Metamorphism' Pared Llech-menyn to Parwyd, represents a shear zone 178 Pared Llech-y-menyn to Parwyd 177 Penrhyn Nefyn, greenschist facies assemblage 171 Pennatulacea 192 Pennine Inlier rocks 4 Penrhiw Group 133 Penrhyn Nefyn 146, 170-3 basic schists and mylonitic mica schists 171 Gwna Group mélange 170 'Penmynydd Zone of Metamorphism' 171 pivotal position within Menai Strait Fault System 170 Sarn Complex 170 terrane boundary, structural transition Sarn Complex to Gwna Group 173 Penrhyn Nefyn shear zone, reactivation of 171-2 Peperites 43 Petalonamae 192 Phenocrysts alkali-feldspar 155 feldspar 107, 108 olivine and plagioclase 134 plagioclase 52, 125 quartz and sodic plagioclase

138 The Pike 103-6 Synalds Formation 103-6, 103 Plutonic suites 8, 14 Pontesford Fault System (Lineament) 3, 11, 83, 83, 84, 114 Porth Clais, Precambrian-Cambrian unconformity 135 Porthaflod, autobrecciated horizons 133 Portway Formation 83, 110 alluvial floodplain sedimentation 87, 113 Hawkham Hollow 112, 113 conglomeratic horizons, braidplain deposition 113-14 mudstones, siltstones and sandstones 113 Pound Quartzite, Ediacara 183-4 Precambrian rocks determination of absolute ages 5, 8 generalized chronological sequence for 8-9 north and west of Menai Strait Fault System 8-9 south and east of Menai Strait Fault System 8 scientific framework for 4-9 Precambrian site networks, and rationale of site selection 15 - 17Precambrian-Cambrian unconformity 85 Boon's Quarry 55, 59 Judkins' Quarry 55, 61 Ogofgolchfa 134 Porth Clais 135 Wrekin Range 91, 93 Precambrian-Triassic unconformity **Charnwood Forest 21** Morley Quarry 25, 27 palaeovalleys, Cliffe Hill Quarry 48 Primrose Hill Gneiss(es) 7, 87, 88,93 inlier of Malvernian-type basement 89

resemblance to Ercall Granophyre 91 Primrose Hill metamorphic suite 11 'Prograde transition hypothesis', disputed 172 Proterozoic 4 Pseudotachylites, Wyche Cutting 74, 75, 75 consistent with fractional melting 77 Pseudovendia charnwoodensis 187, 189, 192, 193 Pteridium 183 **Purley Shale 7** Pyroclastic flows 47, 140 'heavies' 95 sub-aqueous 39, 64 crystal-enriched 56, 60 Pyroclastic surge deposits 95

Quartz in Batch Volcanics 108 primary morphology modified, Coedana Granite 155 Quartzite 70, 159, 162 white, clasts in Gwna Group mélange 174, 176 Quench textures 125, 125 'Quench-brecciation' processes 42–3

Radiometric techniques, for absolute ages of volcanic rocks 8 Radlith Conglomerate 97, 97, 98 Ramsey Sound Group 131, 132, 136 Carn ar Wig and Porthlysgi Bay 133-4 Raven's Bowl 89 silicified rhyolitic lavas 90 **Rb-Sr** isotopic system 8 Rb-Sr whole-rock system 8 Reservoir Quarry, Warren House Formation 79 crystal-lithic tuffs 79 sheared microdiorite 79 Retrogression, Coedana Complex 147, 150, 151 Rheic Suture 9 Rhoscolyn 146, 161-3 Holyhead Formation 161,

162 Rhoscolyn Formation 161, 162, 162, 163 South Stack Formation 161, 162 Rhoscolyn Anticline 161-3, 162 psammites and pelites 161 Rhoscolyn Formation 161, 162, 162, 163 environment of deposition 162 Rhosson 132, 134 Rhosson Group 131, 132, 134 basaltic volcanism 136 Rhyolite Castell Cogan Rhyolite Member 124, 126 flow-banded 91 spherulitic, Lyd Hole 96 the Wrekin 89-90, 90 flow-banded, devitrified 89 Rifting, of arc terranes 15 Rip-up clasts 116 Rodding fabric, Coedana Granite 153, 155, 155 Rushton Schist (metamorphic suite) 7, 11, 87 St David's Granophyre 6, 12, 131, 132 placed within Avalonian Event 2 136 Porthlysgi Bay and Porth Clais 135 U-Pb zircon age 131, 133 St David's Head Gabbro 132 St David's Peninsula 130, 131-6 Carn ar Wig and Porthlysgi Bay 133-4 Ramsey Sound Group 134 geochemical studies 135-6 Ogofgolchfa 134 Porthlysgi Bay and Porth Clais 135 Rhosson and environs 134 stratigraphical relationships 131 Treginnis-Porthaflod sites 132, 133 Lower Pebidian sequences 133 St Non's Bay 132, 133

Sandstone Burway Formation 101, 102, 193 Hanging Rocks Formation 46.47 Lightspout Formation 110 Longmyndian, Lyd Hole 97 micaceous, Old Radnor Inlier 116 Strinds and Yat Wood formations, derivation of 117 Synalds Formation 104 tuffaceous 38, 59 volcaniclastic 29, 29, 35-6 Bardon Breccia 41 Bradgate Formation, Hanging Stone 43, 44, 45 **Outwoods Breccia** Member, Hanging Stone 44 Outwoods outcrop 43 Sarn Complex 3, 6, 8, 12, 129, 130, 146, 149, 172 belongs to different terrane from Gwna Group 173 calc-alkaline plutonic rocks 129 magmatic age 129 Parwyd Gneisses 12 Schists chloritic 94, 95 greenschist-blueschist transition 171 metasedimentary 70 micaceous and metabasic interdigitated 171 see also Blueschists; Eastern Schist Belt (Anglesey) Schlieren, xenolithic 72 Scouring, intraformational 31 Sediment gravity flows 27, 36 Sedimentary cycles Bradgate Formation 44, 46 graded 33-5 Blackbrook Group 26 Sedimentary load structures 31 caused by dewatering 105 downward penetration of 32, 36, 44 and inferred younging, Lilleshall Hill 94 Sedimentary structures Burway Formation 100, 101 Coed Cochion Member 124,

197, 198 indicating sub-aqueous deposition 56, 60 Ingleton Group sandstones 210 - 11Lightspout Formation 110 subaerial and shallow water 111 ripples, symmetrical 31, 32 sole marks 100, 101 South Stack Group 159, 162 Synalds Formation, subaerial and shallow water 101 unusual 51 Wispy lamination 99-100, 101, 102 Sericitization 71 Serpentinite-metagabbro complexes, unusual in Britain 164 Shear zone lithologies, recognition of importance of 178-9 Shear zones greenschist-blueschist transition 171 importance of to basement geology of southern Britain 172-3 Lilleshall Hill 96 strike-slip 202, 202 Tank Quarry 72 see also Ductile shear zones Shearing ductile 8 Malverns Complex ductile 71 ductile and brittle 69-70, 74 retrogressive shearing Sheet floods 105 Shepshedia palmata 186, 187, 188, 192, 193 Shropshire, Radnor and Llangynog 83–126 Church Stretton Fault system 83 inliers 83, 84 Longmyndian Supergroup 83, 86-7 Pontesford Fault system 83 Uriconian Group 83, 85-6 Siltstone tuffaceous

Caldecote Volcanic Formation 56, 58-9, 61, 63 Fachwen Formation 139 rythmically-bedded 133 volcaniclastic Cliffe Hill Quarry 51 Llangynog inlier 125, 126 North Quarry 44, 45, 46 Skerries Group see Gwna Group Skiddaw Group 4, 210, 212 Slickensides 72, 97, 116, 202, 202 Sliding Stone Slump Breccia Bradgate Park 33-5, 34, 37 contorted sedimentary rafts 35 coarse-grained basal facies 36 fossil impressions 35, 188 Slump breccia Sliding Stone Slump Breccia 33-5, 34 South Quarry Breccia Member 30 Sm-Nd technique 8 Soft-sediment deformation Caldecote Volcanic Formation 56 Charnian Supergroup 25 Old John Member 33 Uriconian, Wrekin Range 95 Soft-sediment disruption, Beacon Tuff Member 32 South Charnwood Diorites 21, 22, 25, 34 Bradgate House 36, 37 cf. Judkins' Quarry granophyric diorite intrusion 23 Cliffe Hill Quarry 48, 48-50 intrusion of 52 intrusive contact with **Bradgate Formation 50** Precambrian folding 50-1 range of compositions 50 enriched in LIL elements 21 represent end-stage Charnian activity 51, 207 similarity to Nuneaton intrusion 51, 63 South Quarry Breccia Member 22, 28-30

a slump breccia 30 South Stack 146, 158-61 Holyhead Formation 159, 159, 160 South Stack Formation 159, 160 South Stack Formation Rhoscolyn 161, 162 South Stack 159 vertically stacked fan lobes 160 South Stack Group 6, 148 age 160 submarine fan 148 supposed Skolithos burrows 148, 159 type locality at South Stack 159 South Wales, Ediacaran fauna 184 Stable Pit, Bradgate Park 201-3 quartzose sandstone 201, 203, 203 Stable Pit Member Bradgate Park 34, 201 transition into Swithland Formation 202 The Brand 205-6, 205 fining-upwards trend 205 greywackes 206 Stanner-Hanter Intrusive Complex 3, 7, 8, 11, 14, 72, 84, 116 bimodal magmatic complex 121, 122 Hanter Hill 118-22 age 118, 119, 122 fault-bounded inlier 118-19 'Fine Dolerites' 119-20, 119, 120, 121 gabbros, quartz-free 120, 120, 121 granite, granophyric and biotite-microcline 120 granophyric quartz porphyry 121 porphyritic gabbros 120 rock types and order of intrusion 118, 121 Roxiana quarry, 'Later Dolerites' 121 Stiperstones Quartzite 7 Stretton Group 83, 103,

112-13 Ashes Hollow-Devil's Mouth 98.99 major regressive sequence 86 Stretton Shale Formation 83, 86 Ashes Hollow-Devil's Mouth 98 Strinds Formation 115, 116 correlated with Bayston-Oakswood Formation 117 Stromatolites, limestone clasts, Gwna mélange 165-6 Subsidence, through crustal extension, Arfon Basin 140, 141 Swithland Formation 7, 22, 48, 185 base exposed on Charnwood Forest Golf Course 47 Bradgate Park 34, 202 The Brand 204, 204, 206-7, 208 Teichichnus type burrows 185-6, 206, 207 in bioturbated beds 207 Synalds Formation 83, 99, 110 alluvial flood plain environments 87, 103, 108 Ashes Hollow-Devil's Mouth 101 fossil impressions 195 Long Batch-Jonathan's Hollow 106-8, 106 Andesitic Ash 107, 107 White Ash 107 The Pike 103-6, 103 early diagenetic features 105 repeated sub-aerial exposure 104-5 ripple cross-lamination 104.106 sandstone-siltstone-mudstone couplets 104 Tank (North Hill) Quarry 72 diorites and granites with shear zones 72

Teichichnus 6, 7, 185, 207

Tension fractures, Ives Head

Formation 29 Terranes concept 4, 5 criteria used 5 ductile shear-zone rocks 170 exotic, suspect 157 Textures eutaxitic 133, 134, 136, 138 granophyric 25 inequigranular 36 migmatite 151 parataxitic 124 pokilitic and ophitic 164 quench 125 saccharoidal 156 spherulitic 41, 43 Thermal metamorphism 63 Thermal spots 50, 52 Thornton and Twistleton Glens, Chapel-le-Dale inlier 208 - 12asymmetric syncline 211 Ingleton Group 208–12 developed on margins of Midland Platform 210 differs from Skiddaw Group 210 folding 208, 209-10, 212 probable Arenig age of 210, 212 turbidite sandstones and siltstones 208, 212 Thornton Glen 210-11 Acadian slaty cleavage 210 isoclinal syncline 212 sub-Carboniferous unconformity, Thornton Force 211, 211, 212 turbidite sandstones 210 - 11**Twistleton Glen** Beezley Falls, sandstone with siltstone interbeds 211 isoclinal folds, Baxengill Gorge 212 Thringstone Fault 7 Thrusting 74-5 post-Ordovician 179 Variscan 71 Tollgate Quarries 74, 77 Lower microdiorite sheet 74 pink granite 71, 74 range of fine- to coarse-

grained rocks 74 ultramafic rocks 71 Upper, pink granite 74 Tonalite 70, 77 Tourmalinization 121 Trachyte intrusion, Earnslaw Quarry 73-4, 77 Transpression late Precambrian 84 Variscan 77 Treginnis Group, columnar jointing and autobrecciation 133 Treginnis-isaf, basaltic tuffs 133 Treglemais Group 133 Triassic, Morley Quarry, breccia with Charnian fragments 27 Trondhjemite 135 Tuffites 139, 140 Tuffs aphanitic-quartz-phyric pebbles 47 ash-flow acidic 129, 136-7, 139 ignimbritic 11 shardic 122, 124, 124, 126 silicic 133 coarse-grained 38 crystal-lapilli, Caldecote Volcanic Formation 56, 57, 58, 61 crystal-lithic Andesitic Ash 107 Wrekin Range 89, 90-1, 91 dacitic 30 to rhyolitic 87 fine-grained 94, 108 Buxton Rock 99, 101-2 lapilli 37, 38 lithic lapilli Lilleshall Hill 93, 95 Synalds Formation 107 Wrekin Range 89, 90, 92 pumice lapilli, Lilleshall Hill 95.96 rhyodacitic 30 rhyolitic 125 sericitized, Ramsey Sound Group 134 silicified acid, Lyd Hole 96 vitric 32, 89 Caldecote Volcanic Formation 61, 64

vitric lapilli 97 vitric-crystal 89, 91 Turbidites 5, 36 Bradgate Formation 51 Burway Formation 100, 101, 102 - 3Hallgate Member 36 Ives Head Formation proximal facies 27 suspension-sedimentation stage 28 traction-sedimentation stage 28 South Stack Group, submarine fan environment 160 Turbidity currents 32, 37 Tyddyn Gyrfer 146 Coedana Complex gneisses 149-51 Tyfry Formation 168, 168 U-Pb dating system 8 dated Warren House Formation 78 used for age of Malverns Complex rocks 71 Ultramafic rocks, Malvern Complex 70 Unconformities base Bangor Formation 140 Gwna Group mélange-Ordovician 165, 166, 167 Maplewell-Brand groups inferred 47 pre-Llandovery, Gullet Quarry 75 Precambrian-Cambrian Boon's Quarry 55 Judkins' Quarry 56 Wrekin Range 91, 93 sub-Carboniferous, Thornton Force 211, 211, 212 Uriconian Group-Cambrian 85 Uplift, Charnian volcanic system 48 Uriconian Group 3, 7, 8, 12, 15, 83, 83, 85-6, 94, 96 bimodal magmatism 11, 12, 85, 91 eruption in a fault-controlled ensialic marginal basin 85

eruptive age 85-6, 92 geochemistry and age of lavas 85, 91-2 Lilleshall Hill 93-6 basic rocks 94-5, 96 bedding attitudes 95 tuffs 93-4, 95, 96 Lyd Hole 96-8 overlap with the Longmyndian succession 86 spherulitic rhyolites 96 Wrekin Range 86-03 Variscan Front 3 Veins aplite 72, 155-6 chlorite 155 felsic 75, 76 granite/granitic 75, 89, 152 leucogranite 150 pegmatite 7, 72, 76, 89 pseudotachylite 75 quartz 97 folded 162 Vendobionta 192 Vitroclasts 61 Volcanic arcs affinities of rocks from St David's 136 Avalonian Volcanic arc 10 Charnian Volcanic arc 11, 12 Nuneaton equivalent 61 on oceanic or attenuated continental crust 56 young analogues 64 see also Arc volcanism Volcanic suites, transtensional and marginal basin 15 Volcaniclastic rocks accumulated sediments in the Arfon Basin 140 Bryn-teg Volcanic Formation 137 Caldecote Volcanic Formation 56

Charnian Supergroup 11, 24, 25, 43 Coed Cochion Member 124-5 subaqueous sedimentary sequences 21 Volcanism Bardon Hill 43 Charnian 21 close to active centres 39 contemporary, in Beacon Tuff Member 32 explosive 64, 92, 95, 126, 141 possibly subaerial 97 subaerial in Urconian Group 83 intermittent, in Longmyndian Supergroup 102

Warren Hills, Charnwood Lodge Formation 38 Warren House Formation 3, 7, 8, 15, 69, 76-7, 77-9 basalts originally tholeiitic lavas 79 Clutter's Cave 78-9 dated by U-Pb system 78 lavas keratophyres 77 rhyolitic 77 spilitic basalt 77 trace element geochemistry of 77-8 pillow structures 77, 78 Reservoir Quarry 79 Way-up criteria use of 145, 148, 159-60, 163 Welsh Borderland Fault System 4,7 early movement on, Lilleshall Hill 93, 95 Gondwanan terrane boundary 84 late Precambrian tectonic

event 84 strike-slip displacements 84 Wentnor Group 83, 112, 112-13, 117 White Ash 107, 107 Whitwick (Volcanic) Complex 22, 24 Willstone Hill Conglomerate 118 Withycombe Farm Borehole 3, 11 Wrekin Quartzite 7,88 **Ercall Quarries 91** Wrekin Range 91 Wrekin Range 87-93 Uriconian Group 87, 89-91 Wrekin Quartzite 91 Wrekin Terrane 3, 7, 11-12, 84 crustal extension 79 Malverns Complex 11, 70 Stanner-Hanter Intrusive Complex 11 Wrekin, The 83, 83 Wrockwardine inlier, age of Urconian Group 85-6 Wyche Cutting 74-5 mylonites 74-5 pseudotachylites 74, 75, 75, 77 shearing, brittle superimposed on ductile 74

Xenoliths dolerite 120 cuspate rims 121 'Fine Dolerite' 121 in granophyric diorite 63 green dioritic 74 hornfels xenoliths in Coedana Granite 152

Yat Wood Formation 115, 116 correlation with part of Stretton Group 117