Glossary

This glossary aims to provide simple explanations of the geological terms used in Chapter 1 and in the 'Introduction' and 'Conclusions' sections of site descriptions. It also includes many of the more important terms encountered in other sections of the volume. *The explanations are not intended to be comprehensive definitions, but concentrate instead on the way in which the terms are used in this volume.* Bold typeface indicates a further glossary entry.

Chronostratigraphical names not listed in the glossary are given in (Figure 1.2) (Chapter 1). For the names of minerals and non-igneous rock-types, the reader is referred to standard textbooks. The names of most common crystalline igneous rocks are better explained by means of classification diagrams (Figure G1), (Figure G2), (Figure G3), (Figure G4), (Figure G5), (Figure G6), all simplified after Le Maitre (2002) to include only rock names encountered in this volume). Names of igneous or igneous-related rocks that do not fit easily into these classification diagrams are included in the glossary, as are the names of most fragmental volcanic rocks, which require extended explanations commonly involving their mode of formation.

The classification and nomenclature of crystalline igneous rocks used in this volume follow the recommendations of the International Union of Geological Sciences (IUGS) Subcommission on the Systematics of Igneous Rocks (Le Maitre, 2002). Slight modifications follow the classification scheme of the British Geological Survey (BGS) (Gillespie and Styles, 1999), in which an attempt is made to distinguish 'root names' (i.e. largely those which figure on the main classification diagrams) from variants, mostly indicated by mineral qualifiers as prefixes to the root names. This is achieved through a strict use of hyphens:

- Compound root names, usually involving an *essential* mineral, are hyphenated (e.g. quartz-syenite, olivine-gabbro).
- Mineral qualifiers are hyphenated together (e.g. biotite-hypersthene andesite).
- Mineral qualifiers are *not* hyphenated to the root name, whether compound or not (e.g. biotite-hornblende trachyte, biotite quartz-trachyte, fayalite-augite nepheline-syenite).

Fragmental volcanic rocks are also classified and named according to the IUGS scheme, with minor modifications from the BGS scheme. Two points should be -noted in particular: the term 'volcaniclastic' is applied to all fragmental rocks that occur in a volcanic setting, including *both* rocks that have been fragmented by volcanic processes (i.e. pyroclastic rocks) *and* sedimentary rocks that comprise reworked fragments of volcanic rocks. The terms 'volcanogenic' and 'epiclastic', which are commonly used elsewhere in an inconsistent and confusing manner, are not used in the BGS scheme or in this volume.

The Carboniferous and Permian basic lavas of Scotland are almost invariably porphyritic to varying degrees. This feature was utilized by MacGregor (1928) to devise a nomenclature based in part on phenocryst size (microporphyritic or macroporphyritic) and in part on the phenocryst assemblages (ol + cpx, ol + cpx + pl, pl ± ol). They were assigned type locality names (e.g. 'Craiglockhart type for macroporphyritic ol + cpx-phyric basalts, and 'Hillhouse' type for micro-porphyritic ol + cpx-phyric basalts). This scheme was widely used on Scottish maps for many years as a convenient 'shorthand' way of representing the wide range of petrographical types that are distinctive in the field and hence form mappable units. It also enabled lavas such as the feldspar-phyric 'Markle' and 'Jedburgh' types, which commonly range in composition from basalt to hawaiite, to be assigned a name without the need for an analysis. The scheme has now fallen into disuse in favour of less parochial descriptions, but the 'MacGregor' names are given in some places in this volume in addition, especially where they enable comparison with existing literature (Table G1). Other local names for distinctive rock-types and obsolete names are explained where they occur in the main text.

Aa: lava with a rough, clinkery surface, broken into angular blocks.

Acid: descriptive of light-coloured igneous rocks relatively enriched in silica.

Aeolian: descriptive of sediments or landforms formed under the action of the wind.

Age: a geological time unit (cf. **chronostratigraphy**), usually taken to be the smallest standard division of geological time, of shorter duration than an **epoch.**

Agglomerate: a **pyroclastic** rock with predominantly rounded **clasts** greater than 64 mm in diameter.

Alkali basalt: a type of **basalt,** parental to a suite of **silica-saturated** to **-undersaturated** igneous rocks characterized by high alkalis relative to silica, formed dominantly in extensional within-plate settings (see (Figure G5) and (Figure G6).

Alkaline: descriptive of igneous rocks that contain more sodium and/or potassium than is required to form feldspar and hence contain, or have the potential to contain (i.e. in the **norm**), other alkali-bearing minerals such as feldspathoids, alkali pyroxenes and alkali amphiboles.

Amygdale: a gas bubble cavity in an igneous rock that has been infilled later with minerals.

Andesite: a fine-grained, **mafic, intermediate** igneous rock (see (Figure G1) and (Figure G5).

Aphyric (or **non-porphyritic)**: a textural term, applied to igneous rocks that lack relatively large, conspicuous crystals **(phenocrysts)** compared with the grain size of the ground-mass.

Aplitic: descriptive of relatively finer-grained areas, typically **veins**, within an igneous rock (contrast with **pegmatitic**).

Assimilation: the addition of solid material such as **country rock** to a **magma,** changing its composition.

Asthenosphere: a weak layer within the Earth's **mantle** and immediately below the **lithosphere.**

Back-arc basin: the region adjacent to a **subduction-related** volcanic arc, on the opposite side of the arc from the trench and subducting plate. Stresses in the back-arc region are typically extensional.

Basalt: a fine-grained, **mafic, basic** igneous rock (see (Figure G1), (Figure G5) and (Figure G6)).

Basanite: a fine-grained, **mafic, basic** or **ultrabasic** igneous rock with the mineralogy of a **basalt** but with the addition of a feldspathoid mineral (see (Figure G1), (Figure G5) and (Figure G6)).

Basement: the oldest rocks recognized in a given area; an assemblage of metamorphic and/or igneous rocks that underlies all the sedimentary formations.

Basic: descriptive of an igneous rock relatively rich in the 'bases' of early chemistry (MgO, FeO, CaO, Fe_2O_3); silica (SiO_2) is relatively low (nominally 45–52%).

Basin (i.e. sedimentary basin): a region of prolonged subsidence of the Earth's surface, typically formed either by stretching of the **lithosphere** under extensional forces, or by **flexural subsidence.**

Bed: in **lithostratigraphical** terms, a subdivision of either a **member** or a **formation;** the smallest unit within the scheme of formal **lithostratigraphical** classification. Also used informally to indicate a stratum within a sedimentary rock succession.

Bedding: a feature of sedimentary rocks, in which planar or near-planar surfaces known as 'bedding planes' indicate successive depositional surfaces formed as the sediments were laid down.

Benmoreite: a fine-grained, **mafic, intermediate** igneous rock, belonging to the **alkali basalt** suite (see ((Figure G1), (Figure G5) and (Figure G6)).

Bentonite: a light coloured rock, mainly composed of clay minerals and colloidal silica, produced by **devitrification** and chemical alteration of glassy fine ash (see also **tonstein**).

Biostratigraphy: the stratigraphical subdivision and correlation of sedimentary rocks based on their fossil content.

Blastomylonite: an extremely sheared (mylonitic) rock in which some recrystalliza-tion and growth of new minerals has taken place during deformation.

Block: a **pyroclastic** rock fragment, more than 64 mm in diameter, with an angular to sub-angular shape, which indicates that it was formed by the breaking of solid rock.

Bole: a fine, earthy, compact red-brown clay formed by tropical weathering and leaching of a **lava** surface (see **laterite).**

Bomb: a **pyroclastic** rock fragment, more than 64 mm in diameter, which has a 'streamlined' shape or surface indicating that it was erupted as a mass of molten or partially molten **lava** that then cooled during flight.

Breccia: a rock composed of angular broken fragments greater than 2 mm in diameter; can be **pyroclastic,** sedimentary or fault-related.

Brockram: a term used in Cumbria for a sedimentary **breccia** of Permian age; commonly red or purple.

Caldera: a circular, basin-shaped depression, usually many times greater than the size of any individual volcanic **vent,** caused by collapse of the roof of an underlying **magma chamber** following an eruption; also refers to the underlying volcanic structure.

Caledonian Orogeny: a major period of **orogenesis** that took place during the **Palaeozoic Era,** associated with the closure of the ancient Iapetus Ocean that was situated between Scotland and the rest of present-day Britain.

Camptonite: an **alkaline** variety of **lamprophyre,** in which the **phenocrysts** are various combinations of olivine and titanium-bearing amphibole, augite and biotite. The ground-mass consists of the same minerals (except olivine) together with plagioclase, and possibly subordinate alkali feldspar and/or feldspathoids.

Carbonatite: a magmatic carbonate rock.

Carboniferous Period: a geological time division (**period**; cf **chronostratigraphy),** ranging from 354 to 290 million years ago. It precedes the **Permian Period.**

Chilled margin: that part of an igneous rock adjacent to a contact with an older rock, where the **magma** has been cooled rapidly (chilled), forming a zone of fine-grained rock.

Chronostratigraphy: the correlation and subdivision of rock units on the basis of relative age — a hierarchy of sequential units to which the layers of sedimentary rocks are allocated, through the study and interpretation of their stratigraphy. The hierarchy of principal chronostratigraphical units is erathem, **system, series** and **stage,** which are related, respectively, to the geological time units of **era, period, epoch** and **age.**

Cinder cone: a small volcanic cone built almost entirely of loose volcanic fragments, ash and **pumice** (cinder/scoria).

Clast: a fragment in a **pyroclastic** or sedimentary rock.

Cleavage: a plane of incipient parting in a rock, produced by the alignment of platy crystals, such as mica, in response to confining pressure during deformation.

Columnar jointing: the division of an igneous rock body into columns by cracks (**joints**) produced through thermal contraction on cooling. The columns form perpendicular to the cooling surface.

Comagmatic: a term applied to igneous rocks that are considered to have been derived from the same parent **magma,** or at least from the same source region, at the same time and under identical physical and chemical conditions.

Complex: used herein to refer to a large-scale, spatially related assemblage of igneous rock units possibly, but not necessarily, with complicated igneous and/or **tectonic** relationships and of various ages and diverse origins.

Composite: used to refer to an igneous intrusion or **lava** flow that has formed from two or more different pulses of **magma,** each pulse differing slightly- from the others in mineralogy, texture and/or chemistry.

Concretion: a hard, compact mass, usually rounded, in a sedimentary rock, formed by precipitation of a cementing mineral around a nucleus during or after deposition.

Conglomerate: a sedimentary rock, a significant proportion of which is composed of rounded pebbles and boulders, greater than 2 mm in diameter.

Country rock: rock that has been intruded by an igneous rock.

Crust: the outermost layer or shell of the Earth, above the **Moho** and **mantle.** It consists of two parts: a **basic** layer, which forms the oceanic crust and underlies the continents at depth; and a layer of dominantly **acid** rocks, which forms the thickest, upper part of the continental crust.

Cryptocrystalline: very finely crystalline, such that individual crystals can only be distinguished under very powerful magnification (e.g. electron microscope).

Crystal fractionation: see **fractional crystallization.**

Cumulate: an igneous rock formed by crystals that precipitated early from a **magma** and accumulated due to gravitational settling, current activity or other magmatic processes, without modification by later crystallization.

Depleted mantle: **mantle** that has been depleted in **incompatible elements,** through **partial melting.**

Deuteric: descriptive of the reactions between primary minerals and the water-rich fluids that separate from the same body of **magma** at a late stage in its cooling history.

Devitrification: the conversion of glass, e.g. in the interstices of a volcanic or **hypabyssal** rock, to **cryptocrystalline** or crystalline material.

Diagenesis: the process of mineral growth and/or recrystallization leading to lithification of unconsolidated sediment to form rock.

Diapir: a dome-shaped body of **magma** or mobile rock that has risen through **country rocks** due to its lower density and/or greater plasticity.

Diatreme: a **breccia-filled** volcanic pipe formed by a gaseous explosion.

Dinantian sub-System: a **chronostratigraphical** division; equivalent to the Lower Carboniferous in Europe, dated at 354–327 Ma. It precedes the **Namurian Series,** and comprises the **Tournaisian** and **Visean series.**

Diorite: a coarse-grained, **mafic, intermediate** igneous rock (see Figure G2).

Distal: far from the source.

Dolerite: used herein as a synonym of micro-gabbro (see Figure G2).

Dyke: a tabular body of igneous rock, originally intruded as a vertical or steeply inclined sheet. **Dyke-swarm**: a collection of **dykes.**

Effusive: descriptive of an eruption as **lava** rather than as **pyroclasts.**

Enclave: an inclusion **(xenolith)** within an igneous rock, usually of some other igneous rock that may or may not be related.

En échelon: descriptive of a series of linear features, such as **dykes** or **faults,** which follow roughly the same trend but are 'stepped'.

Enriched mantle: **mantle** that has been enriched in **incompatible elements,** through the introduction of partial melts and **metasomatism.**

Epoch: a geological time unit (cf. **chronostratigraphy**), of shorter duration than a **period** and itself divisible into **ages.**

Equigranular: a texture in which all the crystals are approximately the same size.

Era: a major geological time unit (cf. **chronostratigraphy**), which is divisible into **periods.**

Euhedral: descriptive of a mineral grain, such as a **phenocryst,** with well-formed crystal faces.

Exsolution: the process whereby an initially homogeneous mineral separates into two distinct and commonly intergrown crystalline phases on cooling without a change in the bulk composition.

Extrusive: descriptive of igneous rocks that have been extruded onto the Earth's surface, rather than being intruded beneath the surface **(intrusive).**

Facies: the characteristic features of a rock unit, including rock-type, mineralogy, texture and structure, which together reflect a particular sedimentary, igneous or metamorphic environment and/or process.

Fault: a fracture in the Earth's **crust** across which the rocks have been displaced relative to each other.

Felsic: descriptive of light-coloured minerals (feldspar/feldspathoid and silica); or of an igneous rock containing substantial proportions of these minerals; the opposite of **mafic**

Felsite: a field term for glassy and fine-grained **felsic** igneous rocks.

Fissure eruption: a volcanic eruption where **lava** wells up through fissures in the Earth's **crust.** Often involves very fluid **basic lavas,** and can spread over very large areas.

Flexural subsidence: the downward bending of the **lithosphere** due to loading, for example by the weight of sediment (as in a **foreland basin)** or by **tectonic** overthrusting.

Flood basalt: a widespread sheet or layer of basaltic lava erupted from a fissure-type eruption.

Fluidization: mobilization resulting from passage of a fluid (usually a gas) through a granular solid.

Fluvial: referring to a river environment.

Foidite: a general term for fine-grained igneous rocks in which the **felsic** minerals include more than 60% feldspathoids.

Foidolite: a general term for coarse-grained igneous rocks in which the **felsic** minerals include more than 60% feldspathoids.

Foliation: the planar arrangement of components within a rock.

Foreland basin: a sedimentary **basin** developed by depression of a convergent continental margin due to the weight of sediment accumulating in front of the orogenic belt.

Formation: a **lithostratigraphical** unit, hierarchically higher than **'member'** and lower than **'group'.** A named 'Formation' represents an assemblage of strata that have a common characteristic useful for mapping.

Fractional crystallization: the process in which the early formed crystals in a **magma** are removed or otherwise prevented from equilibrating with the residual liquid, which consequently becomes progressively more evolved in composition (i.e. more fractionated).

Gabbro: a coarse-grained, **mafic, basic** igneous rock (see (Figure G2) and (Figure G3)).

GCR: Geological Conservation Review, in which nationally important geological and geomorphological sites were assessed and selected with a view to their long-term conservation as SSSIs.

Glomeroporphyritic: a **porphyritic** rock containing clusters of **phenocrysts.**

Gneiss: a coarse-grained, inhomogenous rock, common in relatively high-grade metamorphic terranes, characterized by banding or layering.

Gneissose: a metamorphic texture, which has a 'stripy' appearance due to the segregation of the component minerals into compositionally distinct lenses.

Graben: an elongate, down-faulted crustal block, commonly with a marked topographic expression.

Granite: a coarse-grained, **felsic, acid** igneous rock (see Figure G2).

Granoblastic: a metamorphic texture in which recrystallization has formed essentially equi-dimensional crystals.

Granulite tacks: the temperature and pressure conditions typical of high-temperature and moderate- to high-pressure regional metamorphism.

Group: a **lithostratigraphical** unit consisting of one or more **formations,** important for local and regional **lithostratigraphical** correlation.

Hanging wall: the upper side of an inclined **fault** or other dislocation.

Harzburgite: a **peridotite** consisting mainly of olivine and orthopyroxene (see (Figure G4)).

Hawaiian eruption: a type of eruption characterized by the flow of basaltic **lava** from an eruptive centre or centres without appreciable explosive activity.

Hawaiite: a fine-grained, **mafic, intermediate** igneous rock, belonging to the **alkali basalt** suite (see (Figure G1), (Figure G5) and (Figure G6)).

Hornfels: a well-baked, hard, splintery rock resulting from thermal (contact) metamorphism.

Hyaloclastite: a **pyroclastic** rock composed of angular fragments of glass, formed when **magma** is rapidly quenched and shattered on entering water.

Hybridization: the intermixing of two or more **magmas,** which crystallize as a single rock, commonly having a heterogeneous texture and complex mineralogy.

Hydroclastic: descriptive of fragmentation of **magma** or hot rock by its interaction with water (see also **hydrovolcanic** and **phreatomagmatic).**

Hydromagmatic: descriptive of processes driven by the interaction of **magma** with water.

Hydrothermal alteration: changes in mineralogy and chemistry in rocks resulting from the reaction of hot water with pre-existing minerals (cf. **metasomatism**).

Hydrovolcanic: descriptive of volcanic processes driven by the interaction of **magma** with water.

Hypabyssal: descriptive of an igneous intrusion, or its rock, emplaced at a depth intermediate between **plutonic** and volcanic.

Incompatible elements: trace elements that are not readily accepted into the crystal structure of common rock-forming minerals during the crystallization of **magma** and hence are concentrated preferentially into the remaining liquid. They are also concentrated in the first liquids produced during **partial melting.**

Intermediate: descriptive of igneous rock that is transitional in chemical composition between **acid** and **basic** (see Figure G5).

Intrusive: descriptive of igneous rocks that have been intruded into older rocks beneath the Earth's surface, rather than being extruded onto the surface (**extrusive**).

Joint: a fracture in a rock across which there has been no noticeable displacement. Common types of joints in igneous rocks are cooling joints, formed through thermal contraction as the **magma** cools.

Juvenile: descriptive of volcanic fragments that have been derived directly from **magma.**

Laccolith: an igneous intrusion, roughly circular in plan and concordant with the structure of the **country rock;** it generally has a flat floor, a shallow domed roof and a dyke-like feeder beneath its thickest point.

Lamprophyre: the name used for a distinctive group of largely **hypabyssal** rocks characterized by abundant **phenocrysts** of **mafic** minerals, with **felsic** minerals confined to the groundmass.

Lapilli-tuff: a **pyroclastic** rock in which 25–75% of the **clasts** are between 2 and 64 mm in diameter (lapilli), and are set in a finer-grained matrix.

Lava: molten rock at the Earth's surface (contrast with **magma**).

Lava tube: a hollow space beneath the solidified surface of a **lava,** formed by the draining out of molten **lava** after the **crust** had formed.

Laterite: a red subsoil, rich in hydrous oxides of iron and/or aluminium and commonly with kaolinite and silica that develops as a residual product of weathering in tropical and subtropical climates.

Leucocratic: descriptive of light-coloured igneous rocks containing few **mafic** minerals.

Lherzolite: a **peridotite** consisting mainly of olivine, clinopyroxene and orthopyroxene (see Figure G4).

Lithosphere: the outer layer of the solid Earth, including the **crust** and upper part of the **mantle,** which forms tectonic plates above the **asthenosphere.**

Lithostratigraphy: the stratigraphical subdivision and correlation of rocks based on their lithology. Units are named according to their perceived rank in a formal hierarchy, namely supergroup, **group, formation, member** and **bed.**

Maar: a broad, low-rimmed volcanic crater formed by collapse within a shallow cone produced by **phreatic** or **Phreatomagmatic** eruptions. Generally composed of less **juvenile** material than a **tuff-ring.** Commonly contains a lake, also termed a maar.

Mafic: descriptive of dark-coloured minerals, rich in magnesium and/or iron (Fe), or an igneous rock containing substantial proportions of these minerals, mainly amphibole, pyroxene or olivine; the opposite of **felsic.**

Magma: molten rock beneath the Earth's surface.

Magma chamber: a large body of **magma** that has accumulated within the Earth's **crust** or upper **mantle.**

Mantle: part of the interior of the Earth, beneath the **crust** and above the core.

Mass-flow: the transport, down slope under the force of gravity, of large, coherent masses of sediment, **tephra** or rock; commonly assisted by the incorporation of water, ice or air.

Megacryst: any crystal in a crystalline rock that is very much larger than the surrounding groundmass.

Mélange: a chaotic rock unit, characterized by a lack of internal continuity of contacts between component blocks and including fragments of a wide range of composition and size.

Melanocratic: descriptive of dark-coloured igneous rocks rich in **mafic** minerals.

Member: a **lithostratigraphical** unit, hierarchically higher than **'bed'** and lower than **'formation'.**

Mesocratic: descriptive of igneous rocks intermediate between **leucocratic** and **melanocratic** in colour.

Mesostasis: the groundmass in an igneous rock.

Meta: prefix added to any rock name to indicate a metamorphosed variety, e.g. metabasalt is a metamorphosed **basalt.**

Metaluminous: degree of alumina-saturation in igneous rocks in which the molecular proportion of $A1_20_3$ is greater than that of $Na_2O + K_2O$, but less than that of $Na_2O + K_2O + CaO$.

Metasomatism: a process involving fluids that introduce or remove chemical constituents from rock thus changing its chemical and mineralogical composition without melting.

Mid-ocean ridge: a continuous median mountain range within the oceans along which new oceanic **crust** is generated by volcanic activity.

Mid-ocean ridge basalt (MORB): a type of **tholeiitic basalt,** generated at **mid-ocean ridges.** A worldwide, voluminous **basalt** type widely used as a fundamental standard for comparative geochemistry.

Miospore: a fossil spore or pollen grain that is less than 200 microns in diameter.

Moho (=Mohorovicic Discontinuity): the boundary surface within the Earth below which there is an abrupt increase in seismic velocity; marks the base of the **crust** above the underlying **mantle.** Geophysical and petrological criteria define slightly different positions for the boundary:

Monchiquite: an **alkaline** variety of **lamprophyre,** similar to **camptonite** except that the groundmass is feldspar-free, being composed almost entirely of glass and feldspathoids.

Mugearite: a fine-grained, **mafic, intermediate** igneous rock, belonging to the **alkali basalt** suite (see (Figure G1), (Figure G5) and (Figure G6).

Namurian Series: a **chronostratigraphical** division; the lowermost **series** of the **Silesian** (Upper Carboniferous) **sub-System** in Europe, dated at 327–315 Ma. It follows the **Visean Series** and precedes the **Westphalian Series.**

Neck: the feeder 'pipe' of an ancient volcano, which has been infilled with collapsed material from the surface **vent** and commonly intruded by further **magma** to form a **plug,** after the cessation of eruption. Exposed due to subsequent erosion.

Norm: a recalculation of the chemical composition of an igneous rock to obtain a theoretical mineralogical ('normative') composition; useful for classification purposes and for comparison with experimental studies of **magma** crystallization.

Ocean island basalt (OIB): a compositionally diverse type of **basalt,** ranging from **tholeiitic** to **alkali basalt,** characteristic of within-plate oceanic settings.

Orogenesis: crustal thickening following the collision of tectonic plates and resulting from magmatism, folding, thrusting and accretion, leading to regional uplift and mountain building.

Pahoehoe: **basalt lava** with a smooth, ropy surface.

Palaeosol: an ancient or 'fossilized' soil.

Palaeozoic Era: a geological time division (**era;** cf. **chronostratigraphy**),ranging from 545 to 248 million years ago. The **Carboniferous** and **Permian periods** occur at the end of this **era.**

Partial melting: the incomplete melting of a rock to produce a **magma** that differs in composition from the parent rock.

Pegmatitic: textural description of an area within an igneous rock that is notably more coarsely crystalline and commonly forming **veins** and **dykes** (contrast with **aplitic).**

Pelean: a volcanic eruption characterized by gaseous ash clouds associated with the growth and collapse of volcanic domes.

Peperite: a **breccia** characterized by isolated blocks and lobes of igneous rock, commonly chilled and mixed with **fluidized** host sediment; typically present at the margins of high-level **sills** intruded into water-bearing sediment.

Peralkaline: the degree of alumina-saturation in igneous rocks in which the molecular proportion of M_20_3 is less than that of $Na_2O + K_2O$.

Peraluminous: **the** degree of alumina-saturation in igneous rocks in which the molecular proportion of $A1_20_3$ is greater than that of $Na_2O + K_2O$.

Peridotite: a coarse-grained, **ultramafic, ultra-basic** igneous rock consisting predominantly of olivine with varying amounts of orthopyroxene and clinopyroxene (see (Figure G3) and (Figure G4)).

Period: a geological time unit (cf. **chronostratigraphy**), of shorter duration than an **era** and itself divisible into **epochs.**

Permian Period: a geological time division (**period;** cf. **chronostratigraphy),** ranging from about 290 until 248 million years ago. It follows the **Carboniferous Period** and precedes the Triassic Period.

Petrogenesis: the origin and evolution of rocks. **Petrography**: the study of the mineralogy, texture and systematic classification of rocks, especially under the microscope.

Petrology: the study of the origin, occurrence, structure and history of rocks; includes **petrography** and **petrogenesis.**

Phenocryst: a crystal in an igneous rock that is larger than those of the groundmass, usually having crystallized at an earlier stage.

Phonolite: a fine-grained, felsic, silica-under-saturated igneous rock containing significant amounts of feldspathoid minerals (see (Figure G1) and (Figure G5)).

Phreatic: descriptive of a volcanic eruption or explosion of steam, not involving **juvenile** material, that is caused by the expansion of groundwater due to an underlying igneous heat source.

Phreatomagmatic: descriptive of explosive volcanic activity caused by the contact of **magma** with large volumes of water, producing intensely fine ash and abundant steam.

Phreatoplinian: a rare type of explosive volcanic eruption and its deposits produced by **phreatomagmatic** processes (contrast with **plinian)**

-phyric: as in 'plagioclase-phyric', a **porphyritic** rock containing **phenocrysts** of plagioclase.

Picrite: a term originally used to describe a variety of **dolerite** or **basalt** extremely rich in olivine and pyroxene. Now defined chemically as a group name for rocks with SiO_2 < 47%, total alkalis < 2% and MgO > 18%.

Pillow lava: subaqueously erupted **lava,** usually basaltic in composition, comprising an accumulation of smooth pillow shapes and **lava tubes** produced by rapid chilling.

Playa: a flat plain on the coast or at the centre of an inland drainage basin found in arid areas.

Plinian: a type of explosive volcanic eruption and its deposits; **magma** is fragmented through the release of magmatic gas and released at high velocity to form an eruption column that extends high into the Earth's atmosphere.

Plug: the solidified remains of a cylindrical intrusion of **magma,** commonly **intrusive** into, or associated with, a volcanic **neck.**

Pluton: an intrusion of igneous rock, emplaced at depth in the Earth's **crust.**

Plutonic: descriptive of igneous rocks formed at depth in the Earth's **crust.**

Poikilitic: a textural term for an igneous rock in which small crystals of one mineral are enclosed within a larger crystal of another mineral.

Porphyritic: a textural term for an igneous rock in which larger crystals (**phenocrysts**) are set in a finer-grained or glassy groundmass.

Porphyroblast: a large, well-formed crystal that grew *in situ* during metamorphic recrystal lization and typically encloses finer-grained crystals that formed earlier.

Porphyry: a field term for an igneous rock that contains **phenocrysts** within a fine-grained groundmass of indeterminate composition; usually preceded by a mineral qualifier indicating the type of **phenocryst** present, e.g. feldspar porphyry.

Protolith: the source rock from which an igneous rock was formed, most commonly by melting.

Proximal: near to the source.

Pseudomorph: a replacement product, composed either of a single mineral or an assemblage of minerals, that retains the distinctive overall shape of the parent crystal.

Pumice: light-coloured **pyroclast** of generally **acid,** highly vesicular, glass foam.

Pyroclast: a fragment (**clast**) ejected from a volcano; the terms ash, lapilli, and **block** or **bomb** are used to describe pyroclasts that are respectively less than 2 mm, 2–64 mm and more than 64 mm in diameter.

Pyroclastic: descriptive of unconsolidated deposits (**tephra**) and rocks that form directly by explosive ejection from a volcano.

Pyroclastic breccia: a rock comprising predominantly angular **pyroclasts** with an average size greater than 64 mm in diameter.

Pyroclastic fall deposit: **tephra** deposited by fall-out from a volcanic eruption cloud.

Pyroclastic flow: a volcanic avalanche; a hot density current comprising **pyroclasts** and gases, erupted as a consequence of the explosive disintegration of **magma** and/or hot rock; also describes the deposit from this eruption.

Pyroclastic surge: similar to a **pyroclastic flow** but turbulent and less dense.

Pyroxenite: a coarse-grained, **ultramafic** igneous rock consisting predominantly of orthopyroxene and clinopyroxene, with lesser amounts of olivine in varying proportions (see (Figure G3) and (Figure G4)).

Radiometric age: the age in years calculated from the decay of radioactive elements.

Red beds: a collective term applied to continental sedimentary successions that are predominantly red in colour owing to the presence of iron oxides and hydroxides formed in a highly oxidizing environment.

Restite: the material remaining after **partial melting.**

Rhyolite: a fine-grained, felsic, acid igneous rock (see (Figure G1), (Figure G5) and (Figure G6)).

RIGS: Regionally Important Geological/geomorphological Sites.

Rifting: the thinning, and rupture along faults, of the lithosphere under extensional stress, commonly accompanied by upwelling of hot material from the **asthenosphere** below.

Scoriaceous: descriptive of **lavas** that are very highly vesiculated, giving them a 'clinkery' appearance.

Seismic profile: a cross-section of the **lithosphere,** constructed by creating artificial earthquakes using explosives or other vibrating devices, and then recording the vibrations that pass through the Earth to an array of instruments at a range of distances along a predetermined line.

Series: a **chronostratigraphical** unit; it comprises all the rocks formed during an **epoch** and can be divided into **stages**.

Serpentinization: **hydrothermal alteration** of **ultramafic** rocks in which the **mafic** minerals are replaced by a range of hydrous secondary minerals, collectively known as 'serpentine'.

Shearing: the deformation of a rock body by the sliding of one part relative to another part, in a direction parallel to their plane of contact.

Sheet flood: a broad expanse of rapidly moving water and debris, not confined to a channel and usually of short duration due to rapid run-off in an arid area.

Silesian sub-System: **a chronostratigraphical** division; equivalent to the Upper Carboniferous in Europe, dated at 327–290 Ma. It is preceded by the **Dinantian sub-System,** and comprises the **Namurian, Westphalian** and **Stephanian series.**

Silica-saturation: a measure of the amount of silica available to form the major mineral components of an igneous rock, usually calculated from the **norm.** Silica-oversaturated rocks may contain free silica as quartz; silica-under-saturated rocks may contain feldspathoids in addition to feldspars.

Silicic: alternative term to **acid.**

Sill: a tabular body of igneous rock, originally intruded as a sub-horizontal sheet and generally concordant with the **bedding** or **foliation** in the **country rocks.**

Slickensides: linear grooves and ridges formed on a fault surface as rocks move against each other along the fault plane.

Spheroidal weathering: a type of weathering commonly found in **mafic** and **ultramafic** rocks; also known as 'onion-skin' weathering, because it leads to the formation of a flaky, weathered zone around a central, unweathered, spherical core.

Spherulite: a spherical mass of acicular crystals, commonly feldspar, radiating from a central point; commonly found in glassy silicic volcanic rocks as a result of **devitrification.**

Stage: a **chronostratigraphical unit**; it comprises all the rocks formed during an **age,** and is usually taken to be the smallest standard unit.

Stephanian Series: a **chronostratigraphical** division; the uppermost **series** of the **Silesian** (Upper Carboniferous) **sub-System** in Europe, dated at 303–290 Ma. It follows the **Westphalian Series** and precedes the **Permian Period.**

Stock: a small, discordant igneous **intrusion,** usually sub-cylindrical and with steep margins.

Stoping: the emplacement of **magma** by detaching pieces of **country rock** which either sink through or are **assimilated** by the **magma.**

Stratovolcano: a cone-shaped volcano with a layered internal structure.

Strike-slip: see **transcurrent.**

Strombolian: type of volcanic eruption and its deposits characterized by continuous small explosive 'fountains' of fluid basaltic **lava** from a central crater.

Subduction: the process of one **lithospheric** plate descending beneath another during plate convergence.

Syenite: a coarse-grained, **felsic, intermediate** igneous rock (see (Figure G2)).

System: a **chronostratigraphical** unit; it comprises all the rocks formed during a **period,** and can be divided into **series.**

Tectonic: referring to the movements and deformation of the **crust** on a large scale.

Tectonic inversion: a change in the relative elevation of a block of **crust** (e.g. a **basin** becomes a basement high or vice versa), brought about by the reversal of movement direction along structures such as **faults,** due to a change in regional forces.

Tephra: an unconsolidated accumulation of **pyroclasts.**

Terrane: a fault-bound body of oceanic or continental **crust** having a geological history that is distinct from that of contiguous bodies.

Thermal subsidence: subsidence caused by the sinking of the **lithosphere** as it thickens and cools through heat conduction to the surface, after the end of a period of extension and active **rifting.**

Tholeiitic: descriptive of a suite of **silica-oversaturated** igneous rocks, characterized chemically by strong iron enrichment relative to magnesium during the early stages of evolution of the **magma;** formed in extensional within-plate settings, at constructive plate margins and in island arcs.

Tonstein: a term used, especially in central Europe, for thin beds of kaolin-rich clay in coal-bearing strata, possibly of **volcaniclastic** origin (see **bentonite).**

Tournaisian Series: a **chronostratigraphical** division; the lowermost **series** of the **Dinantian** (Lower Carboniferous) **sub-System** in Europe, dated at 354–342 Ma. It follows the Devonian Period and precedes the **Visean Series.**

Trachyte: a fine-grained, **felsic, intermediate** igneous rock (see (Figure G1), (Figure G5) and (Figure G6)).

Transcurrent (or **strike-slip)**: a large-scale, steeply dipping **fault** or shear, along which the movement is predominantly horizontal. Movement may be either left-lateral (sinistral) or right-lateral (dextral).

Transgression: used herein to refer to the point where a sill 'steps up' or 'steps down', in changing from one stratigraphical horizon to another.

Transitional basalt: a **basalt** that is intermediate between an **alkali basalt** and a tholeiite.

Transpression: crustal shortening as a result of oblique compression across a **transcurrent** fault or shear zone.

Transtension: crustal extension as a result of oblique tension across a **transcurrent** fault or shear zone leading to localized rifts or **basins.**

Trap topography: descriptive of the typical terrain found on predominantly basaltic **lava fields,** in which layers of resistant **lava** form cliffs or steep slopes, separated by flat or gently sloping ledges representing more easily weathered material. The ledges form either on the tops and bottoms of flows, or on interflow sedimentary and **pyroclastic** rocks.

Tuff: a rock comprising **pyroclasts** with an average grain size less than 2 mm.

Tuff-breccia: a **pyroclastic** rock in which between 25 and 75% of the **pyroclasts** are greater than 64 mm in diameter.

Tuffisite: an **intrusive tuff,** which can be formed by the mechanical breakdown of rocks close to a rock fracture, due to the passage of volcanic gasses.

Tuffite: a tuffaceous sedimentary rock, i.e. one that contains a significant proportion (2575%) of **pyroclastic** fragments in addition to sedimentary **clasts.**

Tuff-ring: a shallow cone of **pyroclastic** deposits formed by **phreatic** or **phreato-magmatic** eruptions. Generally composed of a higher proportion of **juvenile** materials than a **maar** volcano and lacking the broad collapse crater.

Turbidite: a clastic rock formed through deposition from subaqueous sediment-laden density currents (turbidity currents) that move swiftly down slope under the influence of gravity.

Ultrabasic: descriptive of an igneous rock with a silica content less than that of **basic** rocks (less than 45% SiO_2).

Ultramafic: descriptive of an igneous rock in which dark-coloured minerals (amphibole, pyroxene, olivine) comprise more than 90% of the rock.

Variscan Orogeny: a period of **orogenesis** that occurred during the **Carboniferous Period** and affected rocks in south-west England, south Wales and southern Ireland.

Vein: a term frequently used for an intrusion of igneous rock, commonly irregular, which is narrower than a **dyke** or a sill, i.e. a few cm wide or less. This contrasts with general usage, e.g. for mineral veins that can be of any width.

Vent: that part of a volcano at which the **lava** and/or **pyroclastic** rocks are erupted onto the surface.

Vesicle: a gas bubble cavity, usually in a **lava** or shallow intrusion.

Visean Series: a **chronostratigraphical** division; the uppermost **series** of the **Dinantian** (Lower Carboniferous) **sub-System** in Europe, dated at 342–327 Ma. It follows the **Tournaisian Series** and precedes the **Namurian Series.**

Vitroclastic: descriptive of a **pyroclastic** rock characterized by fragments of glass.

Volcaniclastic: generally applied to a clastic rock containing mainly material derived from volcanic activity, but without regard for its origin or environment of deposition (includes **pyroclastic** rocks and sedimentary rocks containing volcanic debris).

Volcanotectonic fault: **fault** along which the displacement occurred through sub-surface movement of **magma** or during its eruption.

Vug: a cavity in a rock, with a lining of crystalline minerals.

Websterite: a **pyroxenite** consisting mainly of orthopyroxene and clinopyroxene with little olivine (see Figure G4).

Wehrlite: a **peridotite** consisting mainly of olivine and clinopyroxene (see Figure G4).

Welded tuff: a glass-rich **pyroclastic** rock in which the grains have been welded together because of heat and volatiles retained by the particles and the weight of the overlying material (not synonymous with ignimbrite though many ancient ignimbrites are welded).

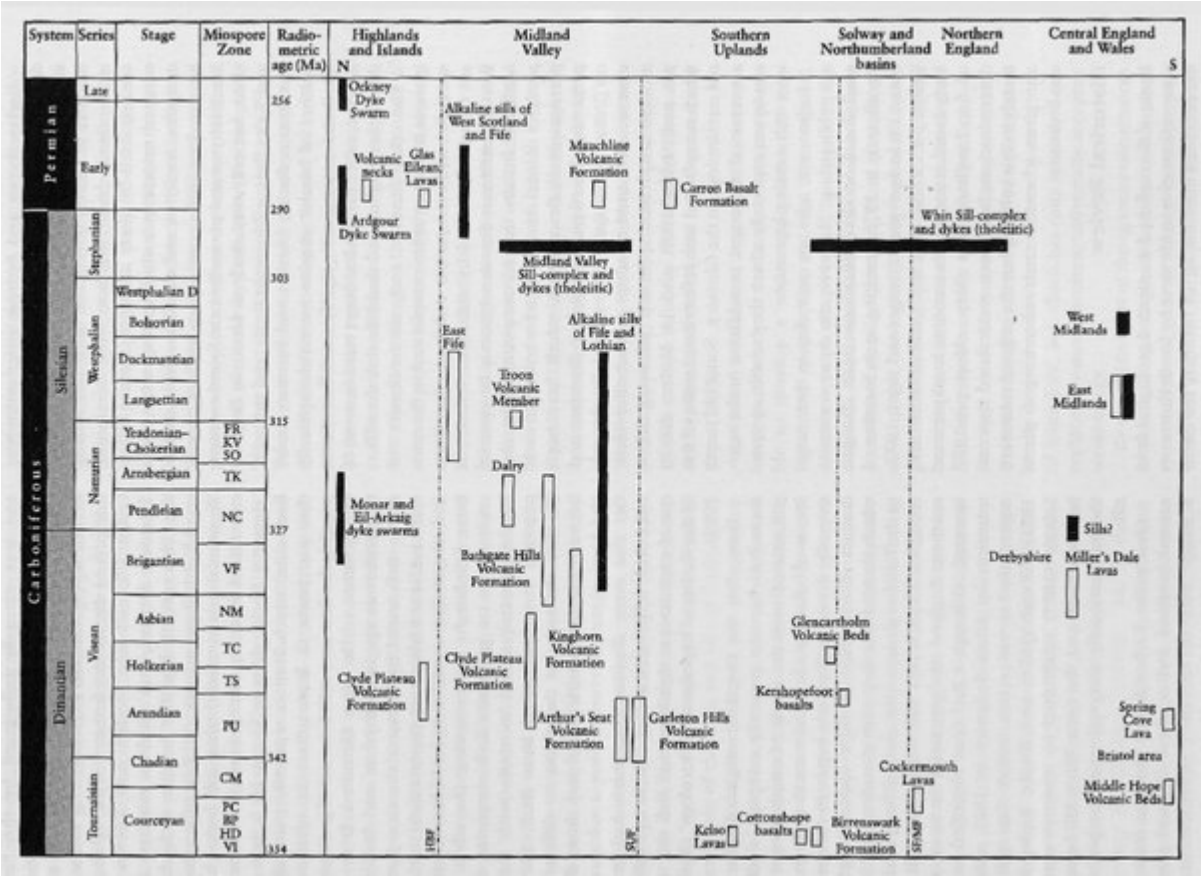
Westphalian Series: **a chronostratigraphical** division; the middle **series** of the **Silesian** (Upper Carboniferous) **sub-System** in Europe, dated at 315–303 Ma. It follows the **Namurian Series** and precedes the **Stephanian Series.**

Xenocryst: a crystal, like a **phenocryst,** but which is foreign to the igneous rock in which it is found.

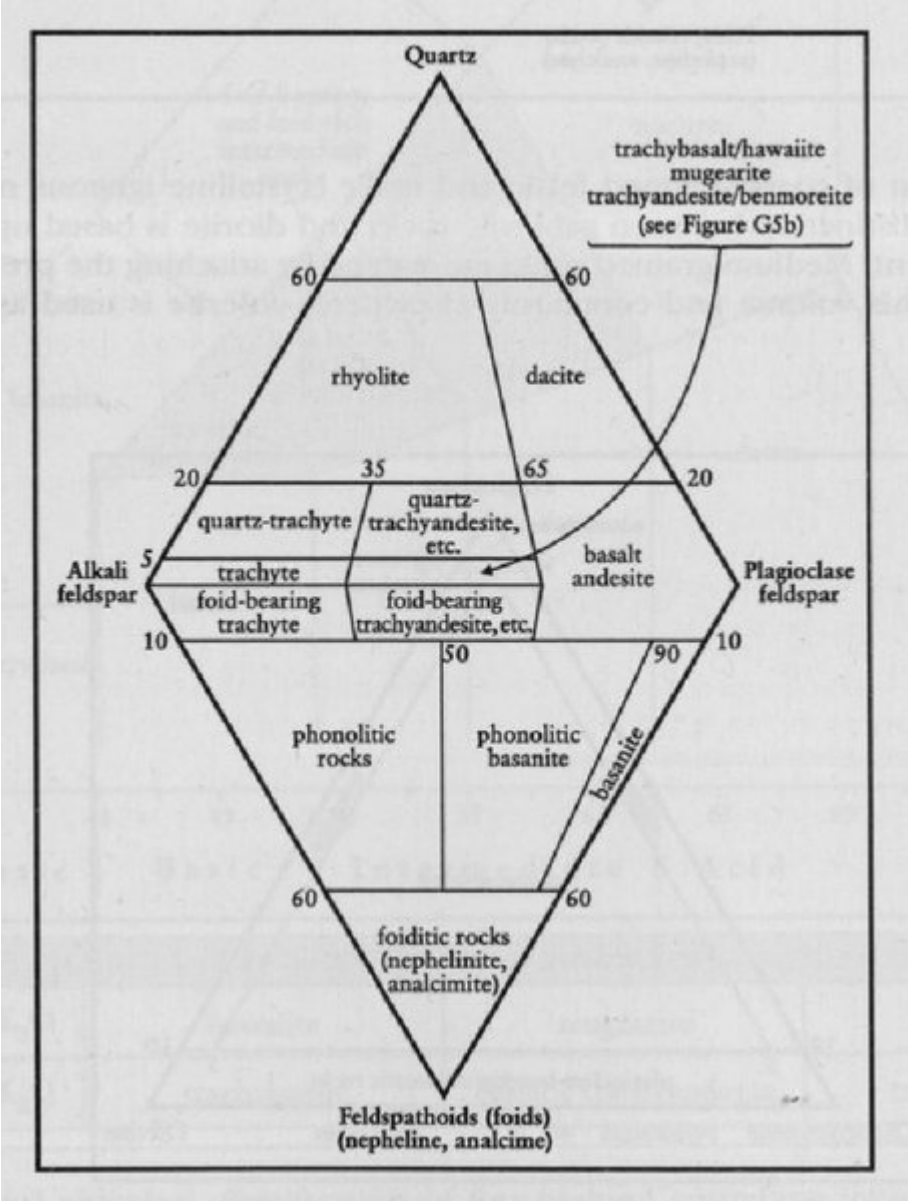
Xenolith: a rock fragment that is foreign to the igneous rock in which it is found.

Zeolites: a group of hydrous alumino-silicate minerals formed at relatively low temperatures, particularly during the later stages of cooling of volcanic rocks.

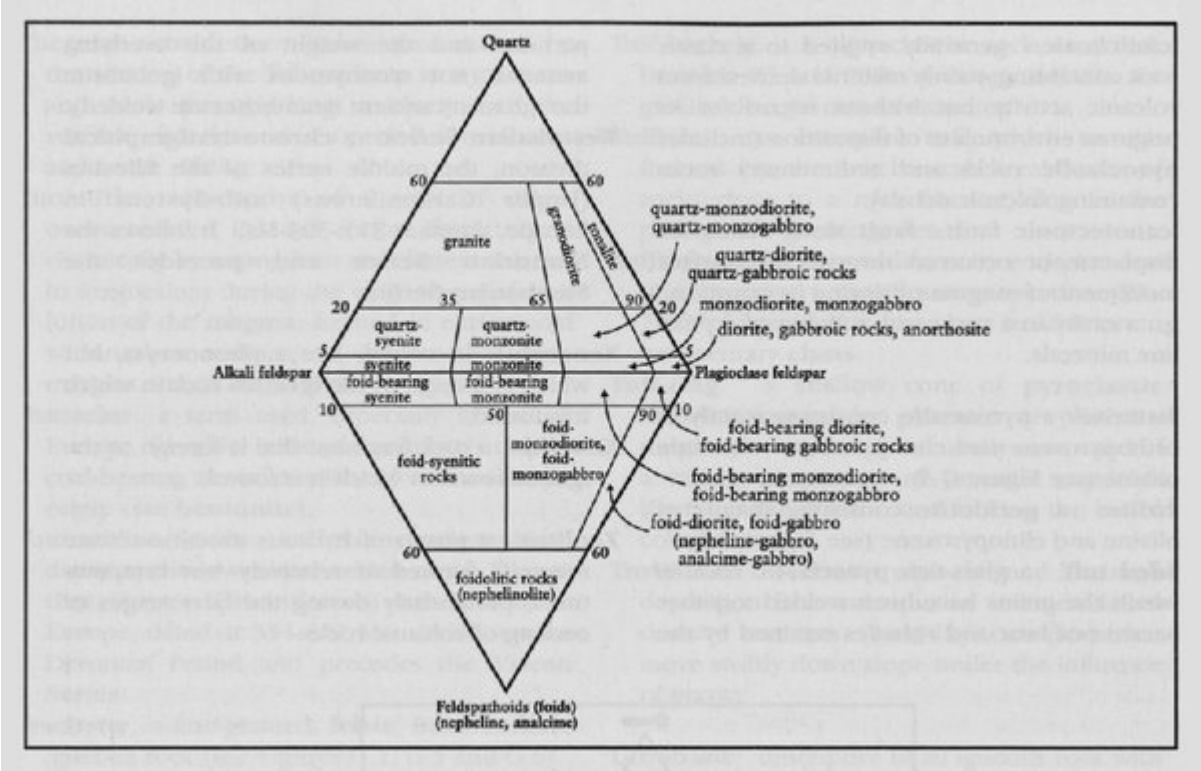
References



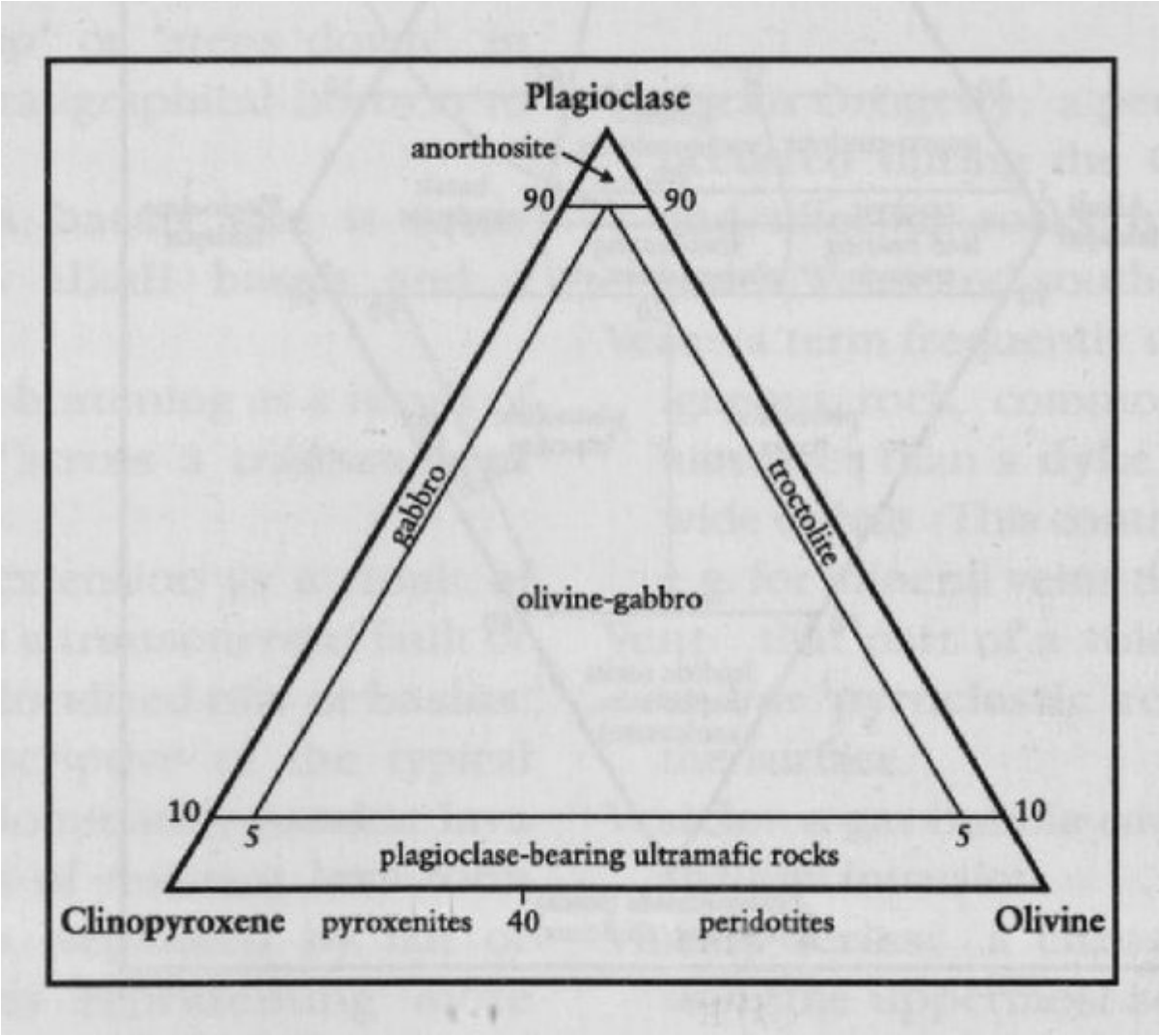
(Figure 1.2) Stratigraphical distribution of British Carboniferous and Permian extrusive rocks (open bars) and intrusive rocks (solid bars). Timescale after Gradstein and Ogg (1996). See individual chapters for more detailed stratigraphical charts. (HBF = Highland Boundary Fault; SUF = Southern Upland Fault; SF = Stublick Fault; MF = Maryport Fault.)



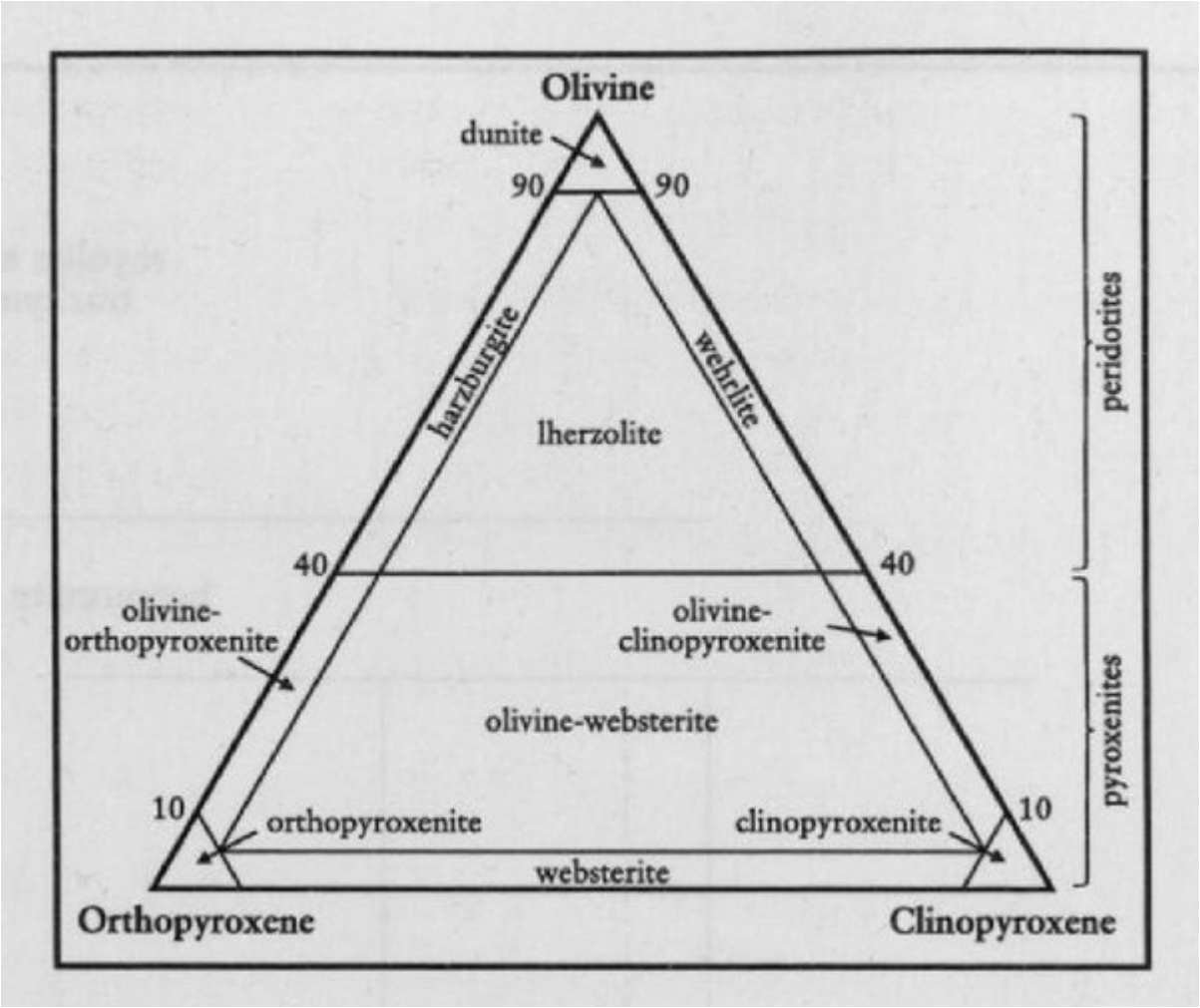
(Figure G1) The classification of fine-grained felsic and mafic crystalline igneous rocks, based upon their felsic mineral content. The distinction between basalt and andesite and between trachybasalt and trachyandesite is based on the composition of the plagioclase feldspar present. For divisions of the trachyandesite + trachybasalt fields, see Figure G5b.



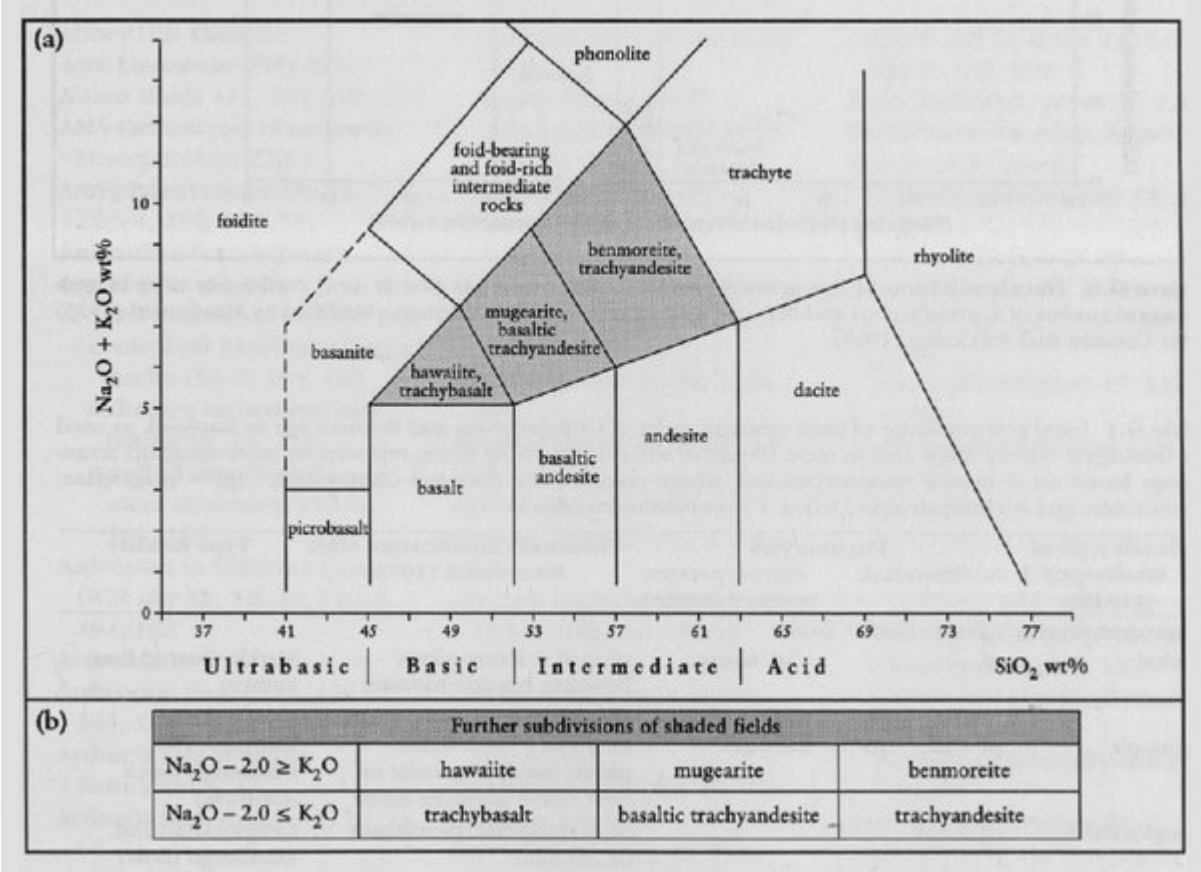
(Figure G2) The classification of coarse-grained felsic and mafic crystalline igneous rocks, based upon their felsic mineral content. The distinction between gabbroic rocks and diorite is based upon the composition of the plagioclase feldspar present. Medium-grained rocks are named by attaching the prefix 'micro', for example microsyenite. However, in this volume and commonly elsewhere, dolerite is used as a synonym for micro-gabbro.



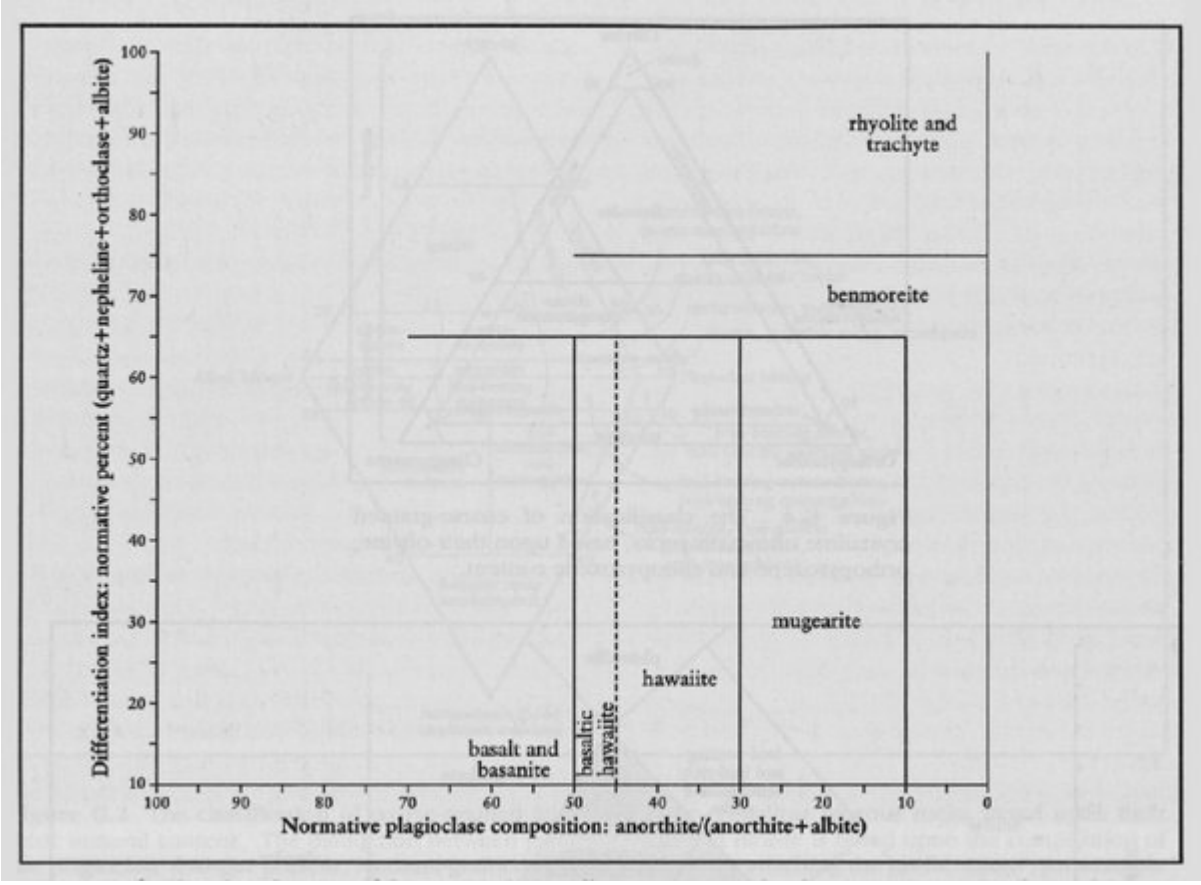
(Figure G3) The more detailed classification of coarse-grained mafic crystalline igneous rocks, falling in the gabbroic rocks field of Figure G2, based upon their plagioclase, olivine and clinopyroxene content. Note that other varieties of gabbroic rock, containing orthopyroxene, do not occur in this essentially alkaline igneous province, except as lower crustal xenoliths (see Chapter 1).



(Figure G4) The classification of coarse-grained crystalline ultramafic rocks, based upon their olivine, orthopyroxene and clinopyroxene content.



(Figure G5) The most usual chemical classification of fine-grained crystalline igneous rocks (e.g. Le Maitre, 2002), used when it is not possible to classify according to their mineralogy due to very fine grain size. Note that alteration can result in the loss or addition of highly mobile elements such as sodium (Na) and potassium (K), with consequent changes in silica (SiO_2) and inaccuracies in classification. (a) Total alkalis ($Na_2O + K_2O$) versus silica (SiO_2). (b) Rocks in the shaded area of (a) can be subdivided according to their Na_2O/K_2O ratio. However, most Dinantian igneous rocks of Great Britain fall close to the dividing line between sodic and potassic affinities and hence are difficult to classify. In much of the older literature (before c. 1975), without the benefit of analyses, the terms 'trachybasalf and 'trachyandesite are commonly used in a general sense for both sodic and potassic types.



(Figure G6) The classification of fine-grained crystalline igneous rocks that is most commonly used in geo-chemical studies of Carboniferous and Permian igneous rocks of Great Britain. Modified by Macdonald (1975) after Coombs and Wilkinson (1969).

Basalt type of MacGregor (1928)	Phenocrysts abundant	Phenocrysts may be present in lesser amounts	Chemical classification after Macdonald (1975)	Type locality
Macroporphyritic (phenocrysts > 2mm)				
Markle	pl	± ol, fetiox	pl ± ol ± fetiox-phyric hawaiite, basaltic hawaiite or basalt	Markle Quarry, East Lothian
Dunsapie	pl + ol + cpx	± fetiox	ol + cpx + pl ± fetiox-phyric basaltic hawaiite or ol + cpx + pl-phyric basalt	Dunsapie Hill, Edinburgh (neck intrusion)
Craiglockhart	ol + cpx		ol ± cpx-phyric picrobasalt or basanite	Craiglockhart Hill, Edinburgh (flow)
Microporphyritic (phenocrysts < 2mm)				
Jedburgh	pl	± ol, fetiox	pl ± ol ± fetiox-phyric hawaiite, basaltic hawaiite or in some cases basalt	Little Caldon, Stirlingshire (plug). Also in Jedburgh area
Dalmeny	ol	± cpx, pl	ol ± cpx-phyric basalt	Dalmeny Church, West Lothian (flow)
Hillhouse	ol + cpx		ol ± cpx-phyric basalt or basanite	Hillhouse Quarry, West Lothian (sill)

(Table G1) Local nomenclature of basic igneous rocks of Carboniferous and Permian age in Scotland, as used on Geological Survey maps and in most literature since 1928. Now being replaced by more-standard terminology based on dominant phenocrysts and, where possible, the chemical composition. (pl = plagioclase, ol = olivine, cpx = clinopyroxene, fetiox = iron-titanium oxides.)