

Caledonian Igneous Rocks of Great Britain

Compiled and edited by

D. Stephenson
British Geological Survey, Edinburgh

R.E. Bevins
National Museum of Wales, Cardiff

D. Millward
British Geological Survey, Edinburgh

A.J. Highton
British Geological Survey, Edinburgh

I. Parsons
University of Edinburgh, Edinburgh

P. Stone
British Geological Survey, Edinburgh

and

W.J. Wadsworth
University of Manchester, Manchester

GCR Editor: **L.P. Thomas**



**British
Geological
Survey**

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

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Glossary

This glossary aims to provide simple explanations of all but the most elementary 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 face indicates a further glossary entry.

Chronostratigraphical names are given in the correlation charts of Chapter 1 and the chapter introductions. 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 (Figures G1 to G6, all simplified after Le Maitre, 1989 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. Obsolete names and local names for distinctive rock-types are explained where they occur in the main text.

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, 1989). 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 that 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 'epi-clastic', which are commonly used elsewhere in an inconsistent and confusing manner, are not used in the BGS scheme or in this volume.

The terms 'ignimbrite' and 'ash-flow tuff' are synonymous. In Britain their use tends to be regional, reflecting the preferences of recent workers. Both are used in this volume ('ash-flow tuff' in Wales and 'ignimbrite' elsewhere), so as to conform with previous literature in each area.

Glossary

- A-type:** refers to an igneous rock, usually a granite, with **alkaline** characteristics; an alkali granite.
- Aa:** **lava**, usually **basic**, typified by a spiny, clinkery scoriateous surface.
- Accretionary lapilli:** concentrically layered, spherical, **lapilli-sized** volcanic **clasts** that form as moist aggregates of ash in eruption clouds.
- Accretionary prism:** a complex structural juxtaposition of inclined strata formed above an active **subduction** zone by the underthrusting of successively younger units of oceanic crustal rocks, which become attached to the leading edge of the overlying tectonic plate.
- Acid:** describes igneous rocks rich in silica (SiO_2 more than 63%).
- Agglomerate:** a **pyroclastic** rock with predominantly rounded **clasts** greater than 64 mm in diameter.
- Albitization:** replacement of a feldspar by the sodic plagioclase, albite.
- Alkaline:** describes 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.
- Aphyric:** textural term, applied to igneous rocks that lack relatively large, conspicuous crystals (**phenocrysts**) compared with the grain size of the groundmass (or non-**porphyritic**).
- Aplitic:** describes relatively finer grained areas, or typically veins, within an igneous rock (contrast with **pegmatitic**).
- Appinitic:** describes a heterogeneous suite of coarse-grained **ultramafic**, **mafic** and **intermediate** igneous rocks, characterized by **shoshonitic** geochemical affinities and the presence of abundant hydrous minerals, particularly **euhedral** amphibole.
- Ash-fall tuff:** lithified **pyroclastic fall deposit** with grain size less than 2 mm in diameter.
- Ash-flow tuff:** equivalent to **ignimbrite**; term used typically in North America and, in this volume, in descriptions of volcanic rocks of Wales.
- 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**.
- Aureole:** a zone around an igneous intrusion in which the texture, mineralogy and/or composition of the country rocks has been changed by heat and fluids from the intrusion.
- Autobreccia:** **breccia** caused by fragmentation of the chilled crust of **lava** or intrusion by continued flow of its fluid interior.
- Basic:** describes igneous rocks relatively rich in the 'bases' of early chemistry (MgO , FeO , CaO , Fe_2O_3); silica (SiO_2) is relatively low (nominally 45–52%).
- Batholith:** a very large discordant igneous intrusion or coalescing mass of related intrusions that extends to great depth in the Earth's crust.
- Bentonite:** a light coloured rock, mainly composed of clay minerals and colloidal silica, produced by devitrification and chemical alteration of glassy fine ash.
- Block lava:** **lava**, usually **intermediate to acid**, typified by a coarse, angular blocky surface.
- Blueschist:** a schistose rock containing blue sodic amphiboles, indicative of high pressure metamorphism.
- Breccia:** rock composed of angular broken fragments greater than 64 mm in diameter; can be **volcaniclastic**, sedimentary or fault related.
- 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.
- Calc-alkaline:** describes a suite of **silica-over-saturated** igneous rocks, characterized chemically by the steady decrease in iron content relative to silica during evolution of the **magma**; typical of magmas generated during **orogenesis** at destructive plate margins.
- Carbonatite:** an igneous rock that contains more than 50% primary carbonate minerals.
- Clast:** a fragment in a rock.
- Cleavage:** plane of incipient parting in a rock, produced by the alignment of platy crystals such as mica in response to confining pressure during deformation.
- Cognate xenolith:** an inclusion in an igneous rock to which it is genetically related, for example as an earlier crystallized product of the same **magma**.

Glossary

- 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.
- Coulée:** a thick viscous **lava** of limited length with blocky, very steep flow fronts; intermediate in shape between elongate **lava** flow and equidimensional **lava** dome.
- 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.
- Deuteric:** describes 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.
- 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 as a result of its lower density and/or greater plasticity.
- Diatreme:** a breccia-filled volcanic pipe formed by a gaseous explosion.
- 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.
- Dynamothermal:** type of metamorphism involving directed pressure and shear stress as well as a wide range of confining pressures and temperatures.
- Effusive:** describes eruption as **lava** rather than as **pyroclasts**.
- Enclave:** an inclusion (**xenolith**) within an igneous rock, usually of some other igneous rock, which may or may not be related.
- Euhedral:** describes a mineral grain, such as a **phenocryst**, with well-formed crystal faces.
- Eutaxitic:** textural term describing elongate fiamme and glass shards, and produced through compaction and welding in an **ignimbrite/ash-flow tuff**; gradational to **parataxitic**.
- 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.
- Felsic:** describes light-coloured minerals (*feldspar/feldspathoid* and *silica*) or an igneous rock containing abundant proportions of these minerals; the opposite of **mafic**.
- Felsite:** a field term for glassy and fine-grained **felsic** igneous rocks.
- Fenitization:** **metasomatism** by alkali-rich fluids.
- Fiamme:** dark, devitrified lenses in **welded tuff**, typically formed from the collapse of **pumice** during welding.
- Flaser-banded:** streaky layering with platy mineral aggregates surrounding lenticular bodies of granular material.
- Fluidization:** mobilization resulting from passage of a fluid (usually a gas) through a granular solid.
- 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.
- Fractional crystallization:** 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).
- Glomeroporphyritic:** a **porphyritic** rock containing clusters of **phenocrysts**.
- Graben:** an elongate down-faulted crustal block, commonly with a marked topographical expression.
- Granitization:** the theory of the origin of granites by the chemical transformation of rock in its solid state by liquids and/or gases.
- Granophytic texture:** texture of an **acid** igneous rock in which quartz and alkali feldspar penetrate each other, having crystallized together.
- Greenschist facies:** the temperature and pressure conditions characteristic of hydrous low-grade regional metamorphism.
- Greisen:** a quartz-muscovite rock formed from the **hydrothermal** alteration of granite.
- Hornfels:** a well-baked, hard, splintery rock resulting from thermal (contact) metamorphism.
- Hybridization:** the intermixing of two or more **magmas**, which crystallize as a single rock, commonly having heterogeneous texture and complex mineralogy.

Glossary

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

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

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

Hypersolvus: describes granites and syenites in which a single type of alkali feldspar crystallized, rather than separate sodic and potassic feldspars.

I-type: refers to an igneous rock, usually a granite, that formed by the **partial melting** of some other igneous or meta-igneous rock, e.g. in the **mantle** or lower crust (contrast with **S-type**).

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**.

Ignimbrite: the rock, typically silicic and pumiceous, formed by deposition from a **pyroclastic flow**; may partly or wholly comprise **welded tuff** (see also **ash-flow tuff**).

Intermediate: applied to an igneous rock that is transitional between **acid** and **basic** (i.e. SiO_2 between 52% and 63%).

Juvenile: applied to volcanic fragments that have been derived directly from **magma**.

Klippe: an isolated thrust-bound structural unit that is an erosional remnant of a large thrust sheet or **nappe**.

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

Lag breccia: coarse **breccia** of rock fragments, associated with **ignimbrite**; occurs typically near to the eruption site.

Lamprophyre: name used for a distinctive group of largely **hypabyssal** rocks character-

ized by abundant phenocrysts of **mafic** minerals, with **felsic** minerals confined to the groundmass. See Figure G5 for subdivisions.

Lapilli-tuff: pyroclastic rock predominantly comprising **clasts** with an average size of between 2 and 64 mm in diameter.

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.

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

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

Mafic: describes 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 (contrast with **lava**).

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.

Megabreccia: a **breccia** of blocks so large that the brecciated nature of the rock may be obscured; commonly formed during collapse to form **calderas**.

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

Megacryst: any crystal (**phenocryst** or **xenocryst**) in a crystalline rock that is very much larger than the surrounding groundmass.

Melanocratic: describes dark coloured igneous rocks rich in **mafic** minerals.

Mesobreccia: **breccia** in which the **clasts** are visible within a single exposure; commonly used to describe tabular sheets in the upper and middle parts of **pyroclastic** deposits filling **calderas** (see also **megabreccia**).

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

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

Glossary

- metamorphosed basalt.
- Metaluminous:** degree of alumina-saturation in igneous rocks in which the molecular proportion of Al_2O_3 is greater than that of $\text{Na}_2\text{O} + \text{K}_2\text{O}$, but less than that of $\text{Na}_2\text{O} + \text{K}_2\text{O} + \text{CaO}$.
- Metasomatism:** 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):** type of tholeiitic basalt, generated at mid-ocean ridges. A world-wide, voluminous basalt type widely used as a fundamental standard for comparative geochemistry.
- Migmatite:** a partially melted rock generally consisting of light-coloured layers of igneous-looking felsic minerals and darker layers, richer in mafic minerals and having a metamorphic appearance.
- 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.
- Molasse basin:** a sedimentary basin in an orogenic mountain belt within which thick sequences of coarse clastic sediments accumulate.
- Nappe:** a coherent body of rock, that has been moved a considerable distance away from its original location on a near-horizontal surface by thrusting or recumbent folding.
- 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.
- Obduction:** the over-riding/overthrusting of oceanic crust on to the leading edge of continental lithosphere during plate collision.
- Olistostrome:** a sedimentary deposit consisting of a chaotic mass of intimately mixed heterogeneous materials, commonly including very large blocks, and formed by submarine slumping of unconsolidated sediment.
- Ophiolite:** an ordered sequence of related ultramafic rocks, gabbros, sheeted dykes and basalt lavas that originated through the generation of oceanic crust.
- Orogenesis:** crustal thickening following the collision of tectonic plates and resulting from magmatism, folding, thrusting and accretion, leading to regional uplift and mountain building.
- Outflow tuff:** rock formed from pyroclastic flows that extend beyond the confines of a caldera.
- Pahoehoe:** basalt lava with a smooth,ropy surface.
- Parataxitic:** textural term, similar to eutaxitic, but where the fiamme and glass shards are extensively streaked out.
- 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).
- Peléan:** a volcanic eruption characterized by gaseous ash clouds associated with the growth and collapse of volcanic domes.
- Peperite:** describes 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:** degree of alumina-saturation in igneous rocks in which the molecular proportion of Al_2O_3 is less than that of $\text{Na}_2\text{O} + \text{K}_2\text{O}$.
- Peraluminous:** degree of alumina-saturation in igneous rocks in which the molecular proportion of Al_2O_3 is greater than that of $\text{Na}_2\text{O} + \text{K}_2\text{O}$.
- 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.
- Phreatic:** describes a volcanic eruption or explosion of steam, not involving juvenile material, that is caused by the expansion of ground water due to an underlying igneous

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- heat source.
- Phreatomagmatic:** describes explosive volcanic activity caused by the contact of **magma** with large volumes of water, producing intensely fine ash and abundant steam.
- Phreatoplhinian:** 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.
- Pillow lava:** subaqueously erupted **lava**, usually basaltic in composition, comprising an accumulation of smooth pillow shapes and **lava tubes** produced by rapid chilling.
- Plinian:** 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.
- Pluton:** an intrusion of igneous rock, emplaced at depth in the Earth's crust.
- Plutonic:** describes igneous rocks formed at depth in the Earth's crust.
- Poikilitic:** a texture of an igneous rock in which small crystals of one mineral are enclosed within a larger crystal of another mineral.
- Porphyritic:** textural term, for an igneous rock, in which larger crystals (**phenocrysts**) are set in a finer grained or glassy groundmass.
- 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.
- Pumice:** light-coloured **pyroclast** of generally acid, highly vesicular, glass foam.
- Pyroclast:** a fragment (**clast**) ejected from a volcano; ash, **lapilli** and block or bomb are pyroclasts that are respectively less than 2 mm, 2 to 64 mm and more than 64 mm in diameter.
- Pyroclastic:** describes 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.
- Radiometric age:** the age in years calculated from the decay of radioactive elements.
- Restite:** the material remaining after **partial melting**.
- Rheomorphic:** describes a very densely **welded tuff** that is characterized by folds and shears as evidence of the plastic deformation of the welding foliation by **mass flow**.
- Rodinite:** a rock that has suffered extensive calcium **metasomatism**; used here for veins rich in calcic pyroxene and garnet within serpentinite.
- S-type:** refers to an igneous rock, usually a granite, that formed by the **partial melting** of sedimentary or metasedimentary rocks (contrast with **I-type**).
- Serpentinization:** hydrothermal alteration of **ultramafic** rocks in which the **mafic** minerals are replaced by a range of hydrous secondary minerals, collectively known as serpentine.
- Sheeted dykes:** closely spaced **dykes** intruded parallel to each other; a major component of an **ophiolite**.
- Shoshonitic:** describes a suite of igneous rocks common to continental destructive plate margins with higher values of K₂O than **calc-alkaline** rocks.
- 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-undersaturated 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.
- Spherulite:** spherical mass of acicular crystals, commonly feldspar, radiating from a central point; commonly found in glassy **silicic** volcanic rocks as a result of devitrification.

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Spilitization: the pervasive alteration of a basalt, commonly in a submarine environment; the dominant process is **albitization**, together with other hydrous mineralogical changes.

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

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.

Subsolvus: describes granites and syenites in which both sodic and potassic feldspars crystallized simultaneously.

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.

Tholeiitic: describes 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.

Transcurrent: a large-scale, steeply dipping fault or shear, along which the movement is predominantly horizontal.

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.

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

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

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

Ultrabasic: describes an igneous rock with a silica content less than that of **basic** rocks (less than 45% SiO₂).

Ultramafic: describes an igneous rock in which

dark-coloured minerals (amphibole, pyroxene, olivine) comprise more than 90% of the rock.

Ultrametamorphism: metamorphic processes at a temperature and pressure high enough to partially or completely fuse the affected rock and produce a rock with an igneous-looking texture.

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

Vitroclastic: describes 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 subsurface movement of **magma** or during its eruption.

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. (This is not synonymous with **ignimbrite** though many ancient ignimbrites are welded.)

Xenocryst: a crystal, like a **phenocryst**, but one that 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.

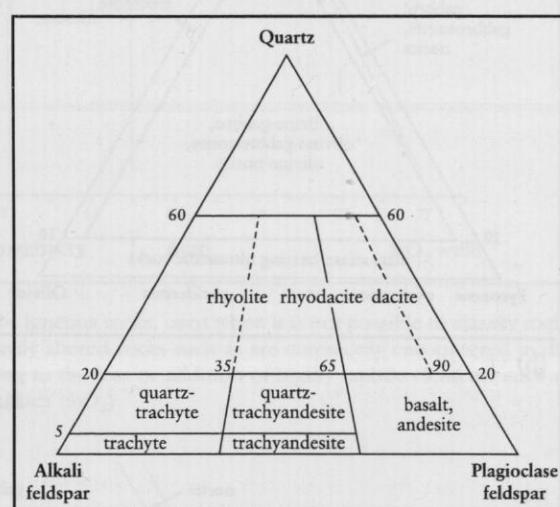


Figure G.1 The classification of fine-grained **felsic** and **mafic** crystalline igneous rocks. The distinction between basalt and andesite is based on the composition of the plagioclase feldspar present.

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Figure G.2 The classification of coarse-grained **felsic** and **mafic** crystalline igneous rocks. 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' e.g. microgranite.

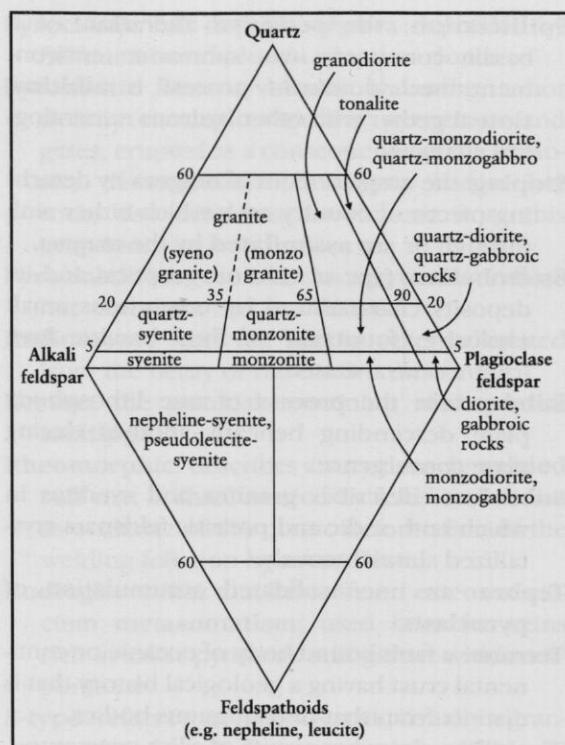
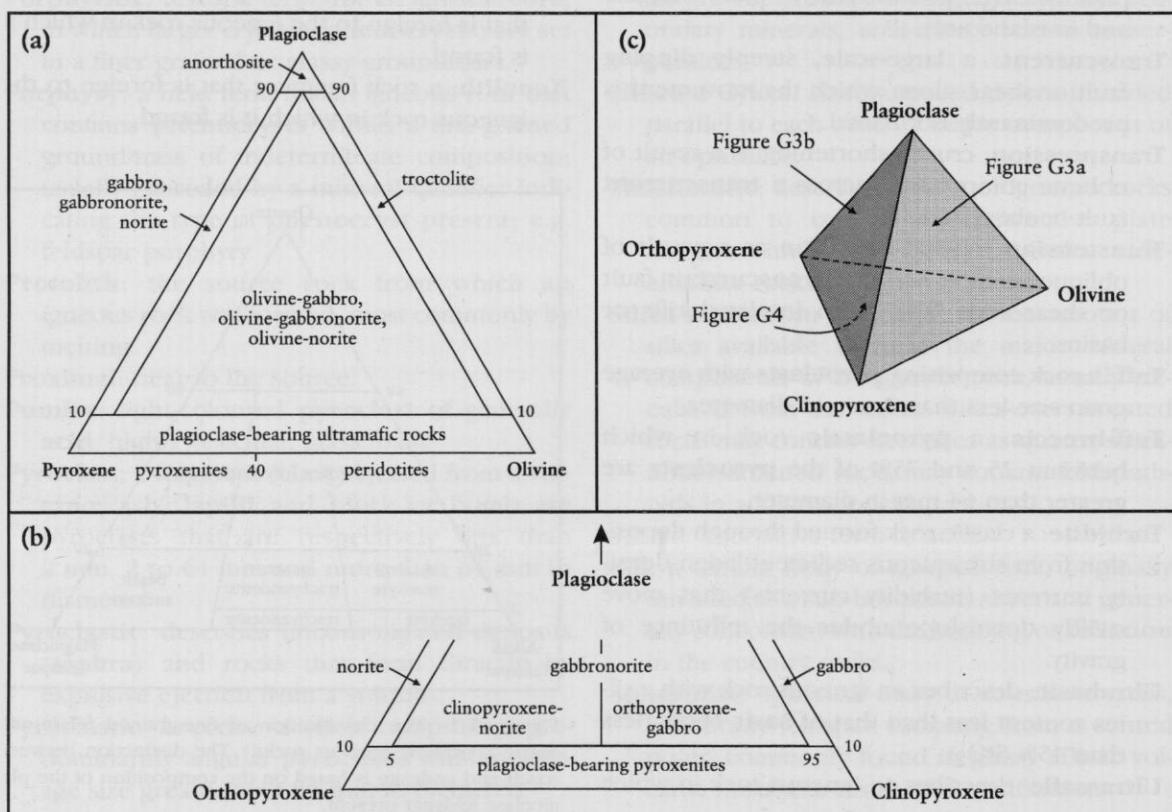


Figure G.3 The more-detailed classification of coarse-grained **mafic** crystalline igneous rocks, falling in the gabbroic rocks field of Figure G2. (a) Based upon the plagioclase, total pyroxene and olivine content, (b) based upon the plagioclase, orthopyroxene and clinopyroxene content, (c) figures (a) and (b) combine in three dimensions if necessary to form a tetrahedron.



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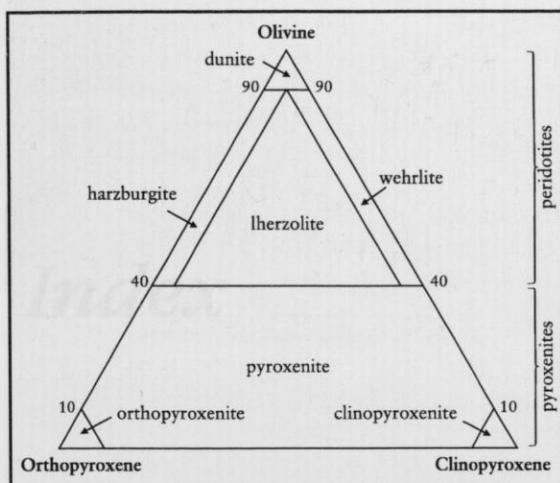


Figure G.4 The classification of coarse-grained crystalline ultramafic rocks. **Ultramafic** rocks also include 'hornblendite' for rocks with more than 90% hornblende.

Feldspar	Predominant mafic minerals	
	biotite, diopsidic augite, (± olivine)	hornblende, diopsidic augite, (± olivine)
	minette	vogesite
more orthoclase than plagioclase	kersantite	spessartite

Figure G.5 The classification of lamprophyres encountered in this volume.

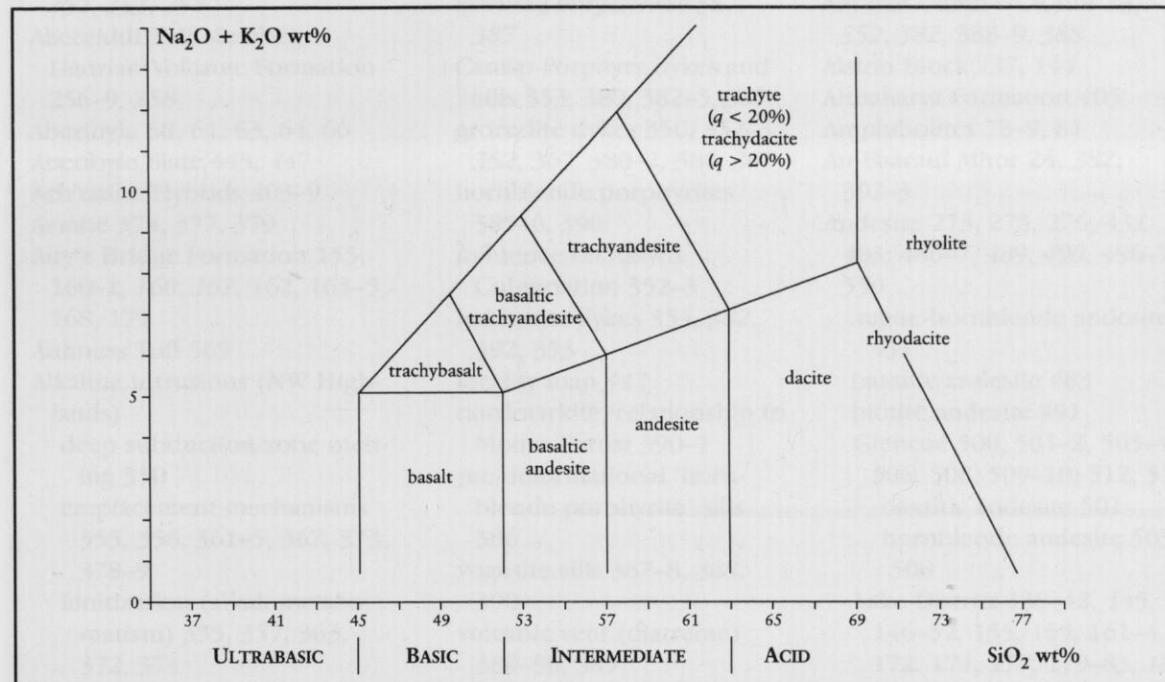


Figure G.6 The chemical classification of fine-grained crystalline igneous rocks, used when it is not possible to classify rocks according to their mineralogy due to very fine grain size. Heavily altered rocks such as are commonly encountered in the Caledonian Province can be difficult to classify chemically owing to the loss or addition of highly mobile elements such as sodium (Na) and potassium (K) and accompanying changes in silica (SiO_2).

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