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## 'Alpine-type' veins cutting Caradoc and older sedimentary and igneous rocks

In addition to the diverse range of metalliferous veins present in the Welsh Caledonides, non-metalliferous veins, dominated by quartz, occur commonly. These fall into two broad groups: firstly there are the 'Regional veins' (Fitches, 1987) which typically manifest themselves as the flat-lying arrays of massive milky quartz veining that are often conspicuous on rocky mountainsides in Snowdonia; and secondly there are what have become known by mineralogists as 'Alpine-type veins', which contain a diverse range of well-crystallized and often rare minerals.

The regional veins have been recorded from all stratigraphical levels from Cambrian up to Silurian and in all lithotypes. They are commonly bedding-parallel, are typically from 1 mm up to 50 cm in thickness, and vary in length from a few centimetres to over 25 m. Dense arrays, with individual veins separated by just centimetres of strata, are commonly observed, with rarer bedding-normal veins linking them. As well as quartz, they may contain carbonates, chlorite, occasional pyrite, stilpnomelane and feldspar: their composition broadly reflects that of the host rock so that pyrite is most likely to occur in veins hosted by dark, pyritic mudstones, while siderite and stilpnomelane are both known from veins hosted by sedimentary ironstones. The veins are locally seen to be folded, cleaved and boudinaged, all indications of their pre-tectonic development with respect to the Acadian deformation. Exposures of such veins are a common sight, especially in rocky areas such as the mountains of Snowdonia; the Coed Llyn y Garneidd GCR site features numerous examples. The veins are considered to be products of hydraulic jacking by overpressurized pore-fluids during burial-related metamorphism (Fitches, 1987), and as they formed during progressive burial of the various lithologies of various ages, they are clearly diachronous.

The 'Alpine-type' veins are widespread but more localized in occurrence. They are partially open, vuggy fissures formed in competent and brittle lithologies as a response to Acadian deformation: thus, they occur in boudin necks in slate-hosted dykes at the Penrhyn Quarry GCR site, in larger igneous intrusions at numerous sites across Snowdonia including the Manod Quarry GCR site, and in boudin necks in the lodes of the Dolgellau Gold-belt, as seen at the Friog Undercliff GCR site. They are dominated by quartz and albite, often finely crystallized, but they contain a variable and diverse suite of accessory minerals, comprising anatase, brookite, rutile, titanite, hematite, chlorite, epidote, clinozoisite, monazite-(Ce), xenotime-(Y), synchysite-(Ce) and apatite, all of which are typically well-crystallized. One locality, Prenteg, near Tremadog, where 'Alpine-type' veins are hosted by a dolerite sill, formerly produced brookite specimens that are still regarded as world-class (Starkey and Robinson, 1992). However, as a scientific study site for this suite of veins, the Manod Quarry GCR site near Blaenau Ffestiniog is of particular note (Green and Middleton, 1996), due to the quantity of material still remaining *in situ* and on the tips. In addition to the typical 'Alpine-type' vein minerals, the mineralized boudin necks at the Penrhyn Quarry GCR site also carry an unusual assemblage of chalcocite, altered in places to chrysocolla and accompanied by siderite and calcite.

### [References](#)