

SITE

Name: Meldon Aplite Quarry

Parish: Okehampton Hamlets

Local Authority: [Dartmoor National Park](#)

National Grid Ref: SX 566 919

OS Sheets: 1:50K, 191, 1:10K, SX59 SE

Locality Description: Meldon Aplite Quarry lies 6km south west of Okehampton on the northern edge of Dartmoor.

Nature and Status of Site: The site comprises two small disused quarries, underground workings and the associated spoil tips. It is a [Site of Special Scientific Interest](#) (SSSI).

Summary of Geological / Geomorphological Interests: The site consists of two quarries in the Meldon Aplite with an associated suite of rare minerals, several of which are not found elsewhere in Britain. The southern quarry shows a major dyke in hornfelsed shales and tuffs. The northern quarry comprises several dykes up to 2m in width with many offshoots into the surrounding cherts and shales. The more common minerals are also of interest in the more pegmatitic parts of the dyke. Red-a-Ven mine upstream from the quarries, including a variety of metamorphic minerals including rare tin-bearing garnets, which is only the second known locality in the world. The Red-a-ven valley shows a number of geomorphological features of interest including waterfalls and plunge pools and a boulder fan. The Meldon area also contains a wide range of features of industrial archaeological importance.

Safety Considerations: There are some steep high cliffs (in places unfenced) around the edge of the quarry and hard hats are appropriate.

Educational Age Groups: College/6th Form, University.

Parking and Access: The site is accessed from the minor road west of Okehampton that leads to Meldon Reservoir. It is recommended that vehicles are parked at Meldon Down car park. From here paths lead directly to the site. All exposures are accessible but permission to collect samples is required from [Natural England](#). The majority of the site is owned by the Duchy of Cornwall.

For further geological information on the Meldon area, please view the [Dartmoor National Park Authority Meldon Geology and Geomorphology case study](#). Additionally, a thematic trail (Keene 2006) is available for the site from Dartmoor National Park Authority (including in a downloadable form from their website) and from [Thematic Trails](#). Information boards providing additional geological information are now in place on Meldon Viaduct (an excellent vantage point for viewing the area) and at the Meldon Dam carpark.

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Detailed Geology (adapted from Page 2007; extract from Information Sheet1A): The Meldon area is situated on the north-west corner of Dartmoor granite massif, south-west of the town of Okehampton and is one of the most important geological locations in the UK. It demonstrates, *par-excellence*, the effects of contact metamorphism and mineralisation associated with the intrusion of a major granitic body, but is also famous for its structural geological features, including the well-known 'Meldon Anticline' - a southwards inclined antiform dating from the late Carboniferous Variscan Orogeny. A

range of other geological and geomorphological features are also well developed. In brief the Meldon area includes:

- The largest and most important exposures of the Lower Carboniferous, Lower Culm Group within the metamorphic aureole of the Dartmoor granite and the largest and most important exposures of the Variscan Greystone Nappe in Devon.
- The type locality of the Meldon Shale and Quartzite Formation, a valid stratigraphical name for equivalent rocks in western Devon currently included within the Greystone Formation.
- The most important area in Devon, and possibly south-west England, for demonstrating the effects of thermal metamorphism on a variety of rocks, including the development of skarn mineralisation
- The unique Meldon Aplite, with a remarkable range of rare igneous minerals, reflecting its highly unusual composition and enrichment in elements such as lithium. It was briefly worked to make glass, possibly the only such operation in the County.
- The highest area of England south of Yorkshire and the highest part of the Dartmoor granite massif at the Yes Tor-High Wilhays ridge (rising to 621 m).
- A geomorphologically important river system (the River Okement and its tributaries including the Red-a-ven Brook) with features related to the origin and evolution of a system on the high granite massif and stages in its evolution as it leaves the moor, including incision through the metamorphic aureole and then a rapid transformation into a more conventional lowland river towards Okehampton.
- The presence of potentially significant periglacial features on the granite massif, including well developed clitter slopes and apparently undescribed terrace-like features below Yes Tor.

Geological history and context: The solid geology of the area was classically and meticulously described by Dearman (1959) and Dearman and Butcher (1959), the former work containing remarkably detailed drawings of the faces observed in the active Meldon Quarry as it expanded from the late 1940s. The structural interpretation in these works reflected a 'conventional' interpretation of the geological evolution of south-west England with a simple double-anticline in the Meldon Quarry area, which passed eastwards into a single anticline. A similar view was maintained by the Geological Survey memoir of 1968 (Sheet 324; Edmonds *et al.*), but supported by a wealth of additional site-specific descriptions.

In the 1980s, however, following remapping of the Tavistock-Launceston district (Sheet 337; British Geological Survey 1994) and part of the adjacent Dartmoor sheet (Sheet 338; British Geological Survey 1995) by the University of Exeter under contract to the Geological Survey, a major reinterpretation of the evolution of the Variscides of south-west England was possible. The realisation that nappe tectonics dominated central and southern Devon and much of Cornwall, as described by Issac, Turner and Stewart (1982), radically altered perceptions of previously described structural features and stratigraphical relationships.

This model was applied to the Meldon area by Selwood and Thomas (1984) who demonstrated that the so called 'Meldon Anticline' included parts of two of the nappe structures recognised to the south-west, the Greystone and Blackdown nappes (with respectively Lower and Upper Carboniferous sequences) which had been folded together

by a later deformation event. In addition, they demonstrated that the Upper Carboniferous Culm Basin to the north had itself been thrust over the nappe sequence to the south. The latter, dominated by the Crackington Formation, forms the regional tectonically 'in-situ' *autochthon* – although this evidence of minor movement suggests a *paraautochthonous* character in part – with the Greystone and Blackdown nappes the moved *allochthon*.

The intrusion of the Dartmoor granite contact metamorphosed the Carboniferous sequences of the Greystone and Blackdown nappes, which lie entirely within a distinctive metamorphic aureole. In contrast, only the southernmost margin of the Carboniferous of the Culm Basin was similarly affected although this includes virtually all exposures within the Meldon area. The metamorphism included the release of fluids into the Lower Carboniferous country rock which reacted to form distinct garnet-rich skarn deposits in association with many rare and unusual minerals, some unique to the area in the UK. In addition, as part of the final stages of granite emplacement, several dykes of microgranite were also intruded, the most remarkable of which is the Meldon Aplite. The latter has anomalously high concentrations of elements such as lithium, caesium and beryllium and, consequently, also has a unique mineralogy, with pegmatitic lenses containing rare and unusual minerals.

In addition to the solid, bedrock geology, the area includes a wide range of landscape features and deposits associated with the Quaternary evolution of the current landscape. Of particular importance are periglacial features, such as tors and clitter slopes, and fluvial systems (some of which have certainly been modified by the former ice-age processes).

The Greystone Nappe in the Meldon Aplite quarries – Red-a-ven Mine area (extract from Information Sheet 1C):

The oldest rocks in the Meldon area are probably of very early Lower Carboniferous age, and assigned to the Lower Culm Group. A combination of tectonic shearing and contact metamorphism has, however, removed virtually all of their age diagnostic fossils: dating is primarily, therefore, based on lithostratigraphical correlations. Following Selwood and Thomas (1984), these rocks are considered to be part of the Greystone Nappe. Crucially, a closer re-examination of the apparent geological succession present in the Meldon- Belstone area, revealed that several levels in the sequence showed the effects of intense shearing and fragmentation associated with the emplacement of nappe. In particular, the authors demonstrated that quartzite lenticles in the lowest part of the Meldon sequence, formerly known as the Meldon-slate-with-lenticles '*Formation*', were mylonitic in origin, and that the whole unit was tectonically not sedimentologically formed by grinding, shearing and frictional heating as the Greystone Nappe slid northwards. Similar, narrower mylonitic bands are also present at higher levels in the Lower Culm Group in the Greystone Nappe, indicating that several other layers were being similarly sheared during movement. Based on interpretation, the following two geological units can be recognised in the Greystone Nappe of the Meldon – Okehampton Park district, above the basal mylonitic unit:

(a) *Meldon Shale and Quartzite Formation*: This unit forms the lowest part of the geological succession of the Greystone Nappe in the Meldon area, above the tectonically-generated 'slate-with-lenticles' unit. It is dominated by dark grey slates with interbedded thin, fine-grained sandstones, with an important sequence of explosive, acidic (i.e. relatively quartz-rich) volcanic rocks towards their middle, dominated by volcanic ashes ('tuffs') and 'agglomerate' – deposits full of blocks of lava and other rocks, fragmented by the eruptions (Edmonds et al. 1968). These rocks are equivalent to the Greystone Formation of the Mary Tavy–Launceston district although as the Meldon name has nomenclatural priority, the latter area should be considered as including the national type section for the unit.

As the Formation in the Meldon area lies entirely within the metamorphic aureole of the Dartmoor granite, it shows varying degrees of thermal alteration. Mudrocks are typically converted into hard hornfels, but locally black shales, as in Meldon Quarry, are spotted with growths of the aluminium silicate mineral, chiastolite. Commonly, however, the hornfels show spots of the iron sulphide pyrrhotite. Sandstones are typically welded into quartzites, and although the fragmentary texture of the volcanic rocks is often still visible, these rocks locally show a range of metamorphic minerals including biotite and garnets (Edmonds *et al.* 1968, p.130). The Formation is also injected by at least two doleritic dykes which are also folded and metamorphosed, indicating that they predate the emplacement of the Greystone Nappe. As with the host Formation, the dykes are also contact metamorphosed, with pyroxene minerals largely replaced by actinolite and hornblende, feldspars recrystallised and amphibole replaced by biotite (Edmonds *et al.* 1968, p.131).

The most extensive exposures of the Formation are in Meldon Quarry (Locality LC3), although access to working areas is restricted for safety reasons - elsewhere the Formation is well exposed in the West Okement river, Red-a-Ven Brook, the western Aplite Quarry at Meldon and the volcanic rocks form the prominent craggy ridge of South Down.

(b) *Firebeacon Chert Formation* (formerly 'Meldon Chert Formation'): Although described by Dearman (1959) as his '*Calcareous Group*' and later described by Edmonds *et al.* (1968) as the '*Meldon Chert Formation*', Sellwood and Thomas (1984) indicated that an appropriate name for the Formation, with priority, is the Firebeacon Chert Formation (named after Firebeacon Point, on the North Cornish Coast).

The formation is dominated by well bedded chert, typically pale greyish in colour at outcrop. Virtually the only traces of fossils known in the Lower Culm Group of the area are moulds of siliceous radiolarian plankton from these cherts, recorded from close to Meldon Quarry by Dearman (1959), which have been recrystallised to quartz by metamorphism. The cherts suggest deep water conditions, potentially below the Carbonate Compensation Depth (CCD) at which most calcium carbonate dissolves, the source of the silica being assumed to be largely derived from radiolarian skeletons.

The cherts often show well developed banding for instance in Meldon Quarry and in the northern Aplite Quarry and are interbedded with dark shales and silica-rich mudrocks. They also locally include bedded limestones, which are likely to have had a turbiditic origin, probably sourced from shallower water, platform areas. These limestones were once worked at Meldon Pool, a flooded limestone quarry, to produce agricultural lime and probably also mortar – remains of the kilns used to produce lime are still visible (Fletcher *et al.* 1997). The only indications of any fossils in the limestones are some vague references to the mussel-like bivalve shell *Posidonomya* from Meldon Pool, which probably lived attached to floating sea-weed. Away from Meldon, however, for instance near South Tawton, some ammonoids have been recorded which indicate that at least the higher levels of the cherts are of late Viséan Series age (Edmonds *et al.*, 1968).

As with the Meldon Shale and Quartzite Formation below, the Firebeacon Chert Formation lies entirely within the metamorphic aureole of the Dartmoor granite and consequently shows the effects of this extreme heating. Where the rocks are dominated by pure cherts, the effects of metamorphism are limited but where the cherts are calcareous, spectacular reactions occurred, in particular where alteration by circulating superheated mineral-rich fluids produced *skarn* deposits. In Meldon Quarry these reactions formed bands of fibrous white mineral wollastonite, mixed with many other new minerals, including axinite. Elsewhere, reactions with chemical-rich fluids produced deposits with other metamorphic minerals such as garnets and the very rare tin-containing sphene malayite – probably known from only one other locality in the British

Isles. In addition, where the fluids were rich in metals such as copper and iron, economically viable 'bedded' ore deposits were formed as at Red-a-ven/Meldon Mine, Forest Mine and Homerton Mine. Fuller listings of minerals recorded in the area are can be found in Page (2007, Information Sheet 1C).

Meldon Quarry shows the largest exposures of the Formation, although its characters are also well seen in Red-a-ven Brook, the northern Aplite quarry and around Meldon Pool (although largely inaccessible due to flooding).

The Meldon Aplite (extract from Information Sheet 1E): Occasionally discrete veins of microgranite – or aplite – are present within the Dartmoor granite and are probably relatively late intrusions. The most famous of these is the 'Meldon Aplite', although mineralogically it is quite different from all others known, representing a remarkable late-stage distillation of unusual elements such as lithium, fluorine, phosphorous and possibly beryllium, within the granitic magma. As a result, a unique range of rare and unusual minerals developed, especially in relatively coarse 'pegmatitic' lenses.

Whereas the main granite contains orthoclase and black biotite, along with the ubiquitous quartz, feldspars in the aplite are dominated by albite – with minor orthoclase - and micas by lilac coloured lithium-containing lepidolite. Minor topaz and elbaite are also present. The aplite has also yielded a unique range of accessory minerals including lithium-containing petalite and pink and green tourmalines, also apatite (calcium phosphate), pollucite (containing caesium), fluorite (calcium fluoride), the clay montmorillonite, boron-containing datolite, the zeolites heulandite and stilbite, also prehnite, axinite, cordierite, bavenite (containing beryllium), palygorskite, columbite (containing niobium) and spodumene (Chaudry and Howie 1973, 1976; Dearman and Claringbull 1960; Edmonds et al. 1968; Floyd et al. 1993; Knorring 1951; Knorring and Condliffe 1984, Mackenzie 1972; McLintock 1923). Records of the beryllium mineral amblygonite-montebrazite, beryl, beryllonite, chrysoberyl, eudidymite, milarite and rhodizite by Kingsbury (1961, 1964 and 1970), however, need re-confirmation as the author is now known to have fabricated at least some of his results....

With such a rich and varied mineralogy, it is not surprisingly, therefore, that the outcrops of the Meldon Aplite have for many years been the focus of intense mineral collecting activity, and despite being protected by national law within the Meldon Aplite Quarries Site of Special Scientific Interest, are still regularly being attacked by rogue collectors...

The Aplite forms a dyke like body up to 12m wide which crosses the Red-a-ven Brook and has been worked in two quarries, a small northern quarry and a larger southern quarry. In the former the dyke splits into several smaller bands, and is well seen at the back of the quarry cutting banded cherts. In the latter the body is much thicker, but surviving wall rocks, where it has been removed, show thin seams and veins penetrating cracks in the surrounding hornfels. Beyond this quarry, to the west, there has been much debate as to whether the dyke continues, some believe it crosses the West Okement valley, others believe it peters out very quickly.

The outcrops of the aplite have been described by Edmonds et al (1968) and a useful summary of the petrology is found in Von Knorring and Condliffe (1984). The upper level of the large quarry on the west side of the Red-a-Ven Brook contains well-developed axinite in large vugs that have developed at the aplite contact. In the small northern quarry, three types of aplite can be distinguished:

1. A bluish, marginally chilled facies of fine-grained albite and quartz with minor apatite, tourmaline, orthoclase and colourless lepidolite mica (blue aplite)

2. A light-grey variety containing albite, quartz and pinkish lithian mica (white aplite)
3. A coarser-grained variety with more quartz and pink to brown lepidolite. Orthoclase perthite replaces albite to varying degrees in this variety.

Pegmatitic segregations are developed in planar structures and Chaudhry and Howie (1973) recognised two types which may overlap in composition:

1. Orthoclase-quartz-lepidolite-albite-tourmaline.
2. A micaceous type containing orthoclase, lepidolite, quartz, topaz and petalite.

The relatively low iron content of the Aplite meant it was briefly exploited for glass making in the 1920s, and piles of broken glass were once visible near the former site of the works, immediately to the north – these have now been ‘tidied up’, however, so very little trace of this activity survives... The buildings which are present therefore represent a later phase of working, for aggregate from the 1940s to the early 1970s (Fletcher et al. 1997).

Red-a-ven Mine (extract from Information Sheet 1F) : Some of the most remarkable metalliferous mineral deposits in south-west England are present in the Meldon area. Unlike most other deposits in region, which are conventional hydrothermal veins, those between Meldon and Sticklepath to the east, exploited mineralised skarn deposits within the Lower Culm Group of the Greystone nappe (apparently primarily within Firebeacon Chert Formation). Three small mines in the Meldon area were worked on a small scale for copper in the nineteenth century, from west to east, Homerton Mine, Forest Mine (now under Meldon Reservoir) and Red-a-ven or Meldon Mine (Dines 1956, Edmonds et al. 1968, Hamilton-Jenkyns 1981, Fletcher et al. 1997).

The Meldon mines worked what is presumed to be the same mineralised bed, the primary ore being chalcopyrite, typically associated with other sulphides including pyrrhotite (iron sulphide), löllingite (iron arsenide) and arsenopyrite (iron sulph-arsenide) and a rich association of metamorphic minerals. Conspicuous amongst the latter are green garnets and locally axinite – other typical minerals include epidote, chlorite, sphene (including the very rare tin-containing form malayite), apatite and scapolite. Wollastonite and hedenbergite also recorded (Dearman and El Sharkawi 1965a, b; El Sharkawi and Dearman 1966; Edmonds et al. 1968). There are some suggestions in De la Beche (1839) and Dines (1956) that tin might also have been produced by Forest Mine, but this requires confirmation, not least the nature of the ore worked within such unusual deposits. The location of this mineralisation is also very significant as it is developed in a zone of flexure which is probably related to the intrusion of the Dartmoor granite.

Geomorphology (extract from Information Sheet 1H): The Red-a-ven Brook is a good example of stream system which has cut through several terrace-like features as it leaves the granite massif and descends towards the West Okement valley near Meldon Viaduct. The stream initiates in blanket bog high on the granite, then passes through a steep section as it crosses the margins of High Willhays-Yes Tor massif and thence into the metamorphic aureole of Dartmoor granite, where a steep sided middle portion includes a broad, level, alluvial fill. Downstream, the course steepens dramatically and associated terrace/alluvial features narrow as the Brook crosses the Lower Culm Group outcrop, often with waterfalls. The junction with the West Okement river is marked by boulder rich fan, possibly periglacially modified and certainly at a higher level than the current West Okement.

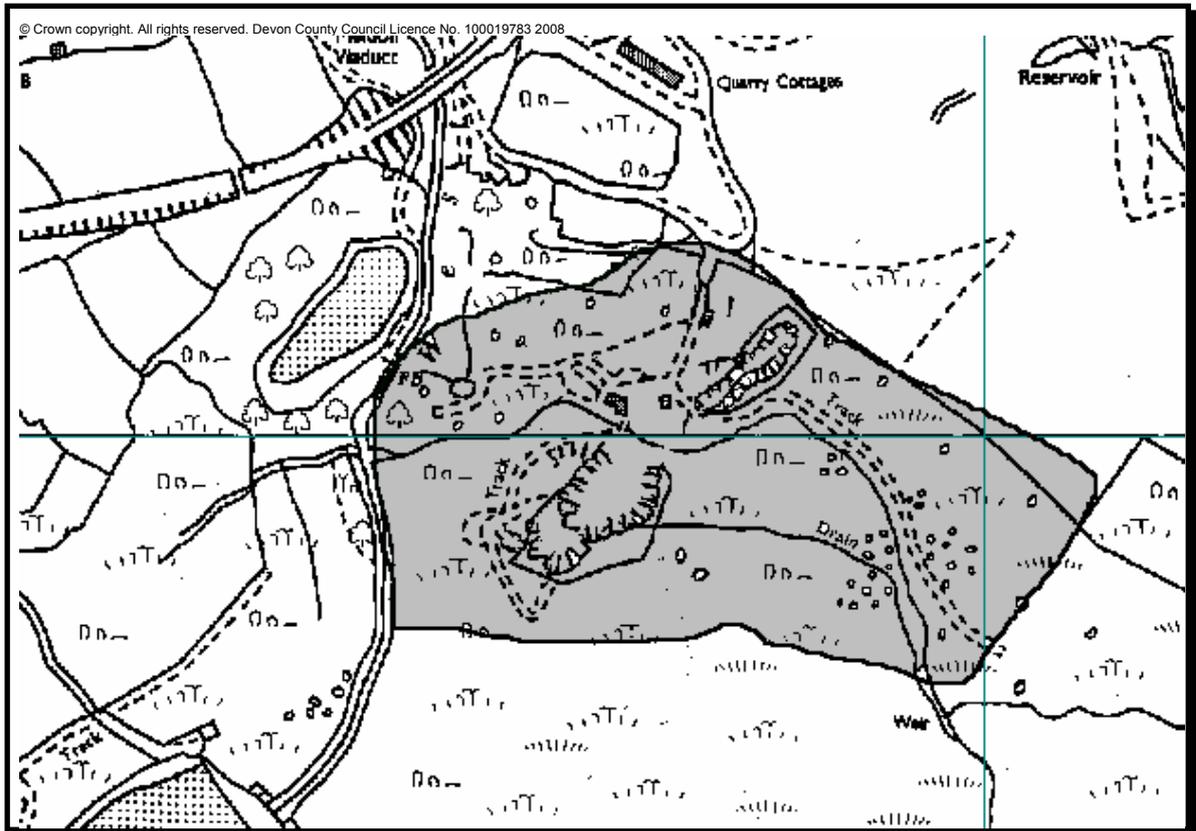
Suggested Questions

1. Draw and label the dyke system in either the southern or the northern aplite quarry, noting the contact margins.
2. Draw, label and identify the larger minerals that can be seen in the aplite.
3. The Red-a-Ven stream and the Aplite quarries show a sequence of metamorphosed Carboniferous rocks. Can you tell what sort of rocks these were before they were altered?
4. The geomorphology of the Red-a-ven brook is quite distinctive. Can you deduce how and even when the various associated landforms have been formed.

SITE PLAN

MELDON APLITE QUARRIES OKEHAMPTON HAMLETS, DARTMOOR NATIONAL PARK

National Grid Ref: SX 566 919



Approx. S.S.S.I Boundary

Scale 1:7000

Main Points of Interest:

- Dyke of aplite (rare fine grained granite) with coarse grained pegmatite with unusual minerals.
- Interesting metamorphic rocks and minerals.
- Industrial Archaeology, including sites of old glass factory, quarries and mines.

MELDON APLITE QUARRIES



Lower Culm Group geology of the Greystone Nappe, dissected by the West Okement and Red-a-ven valleys. The southern Aplite quarry, to the left, exposes hornfels, South Down ridge (to the right), is controlled by a belt of volcanic rocks (both form part of the Meldon Shale and Quartzite Formation) [from Page 2006]



The southern and larger aplite quarry and some of the surviving buildings, with Meldon Dam beyond [from Page 2007]



Meldon Pool – flooded limestone quarry in the Firebeacon Chert Formation [from Page 2006]



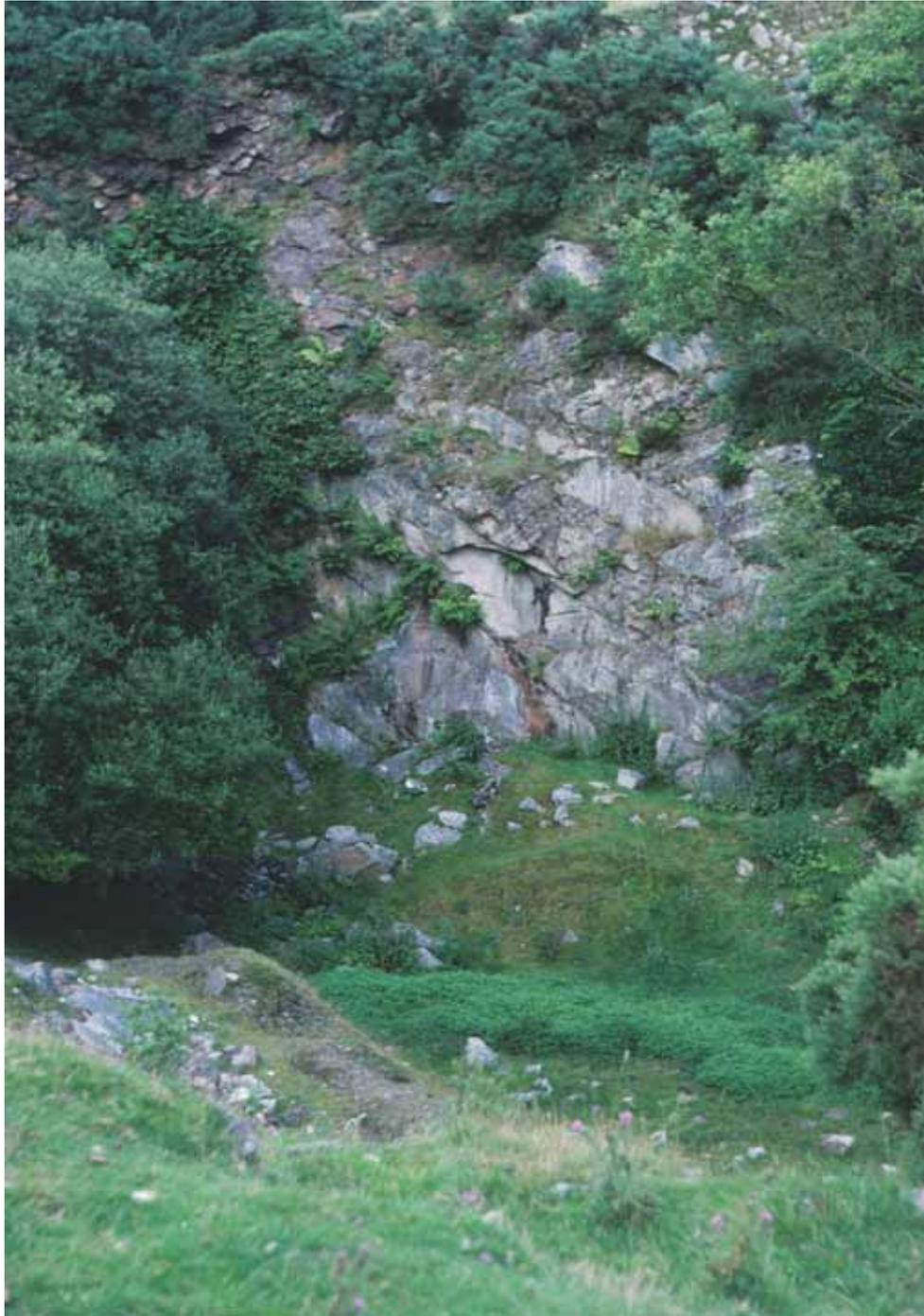
Old limekiln on the opposite side of the river to the limestone quarry [from Page 2007]



White aplite exposed in the southern wall of the southern Meldon Aplite quarry, with dark hornfels to the left [from Page 2006]



The northern margin of the aplite dyke in southern Aplite Quarry (Locality A1), showing white aplite penetrating cracks in the adjacent Lower Culm Group hornfels [from Page 2007]



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Meldon Aplite Quarry (north), showing aplite veins crossing banded cherts. Photograph taken in 1999, view now obscured by vegetation.



The tips of Red-a-ven copper mine – also known as Meldon Mine [from Page 2006]

