12 Craignish Point

[NR 759 999]–[NM 765 005]

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12.1 Introduction

This GCR site is situated near the southern end of the Craignish peninsula, west of Aird, and consists of a narrow coastal outcrop of the Craignish Phyllite Formation (Easdale Subgroup), intruded by a thick metadolerite sill (Figure 2.27). These exposures are of national, verging on international, importance because of the presence of calcite pseudomorphs after gypsum that are not found elsewhere in the Dalradian Supergroup in such an excellent state of preservation, or exhibiting the same wide range of morphological types. The original gypsum crystals had twinned forms ranging in shape from butterflies to bow-ties (Figure 2.28) that are unique, and have not been reported previously from naturally occurring rocks or sediments worldwide. This occurrence is in contrast with the outcrop of the Craignish Phyllites elsewhere, where such features, if once present, are no longer preserved due to later deformation, metamorphism, and fluid flow (see the *Kilmory Bay* GCR site report).

Following early work by MacCulloch (1819), the ‘Craignish Phyllites’ were first mapped and named by Hill (1899) and Peach and Horne (1909). The Craignish peninsula was first mapped for the Geological Survey by H.B. Maufe in 1901, but it was Bailey (1913) who established the stratigraphical succession, which was subsequently confirmed by Allison (1941). The peninsula was later the subject of detailed sedimentological studies (Knill, 1959; Anderton, 1976) and structural studies (Knill, 1960). Lath-like pseudomorphs after gypsum were first reported from the country rocks beneath a metadolerite sill on Craignish Point by Anderton (1975). However, it was not until 1995 that the exceptional forms taken by the original twinned gypsum crystals were recognized by the author of this site report.

The sill-like nature of the basic meta-igneous bodies that are found in abundance throughout the Craignish Phyllites was first recognized by Jamieson (1860). Bailey (1913) noted that, in some cases, they are slightly transgressive, and that they are associated with ‘remarkable contact alteration’. The sills, which were emplaced prior to the deformation and regional metamorphism of the country rocks, can be many tens of metres thick. They generally have highly sheared and altered margins and less deformed and metamorphosed interiors (Graham, 1976). Recent research has shown that the alteration is due to the infiltration of a CO_2-rich fluid from the country rocks during the regional metamorphism (Graham *et al.,* 1985; Skelton *et al.,* 1995).

The Craignish peninsula lies on the north-west limb of the Loch Awe Syncline and the rocks were mildly deformed and metamorphosed to the greenschist facies during the Grampian Event. This part of the peninsula has almost entirely escaped any later deformations, including the development of conjugate sets of kink bands for which the surrounding area is well known. It is cut by Palaeogene dykes belonging to the Mull Swarm.

12.2 Description

The Craignish Phyllites are clearly exposed on a narrow rock platform backed by small cliffs, with areas of clean, tidally scoured rock. They are overlain conformably by a metadolerite sill that runs parallel to the coast and forms a positive topographic feature. The phyllites consist of a well-bedded sequence of grey-green phyllitic metasandstone and metasiltstone, with characteristic orange-brown-weathering layers of metacarbonate rock of varying thickness. Sedimentary structures such as parallel lamination, cross-lamination, graded bedding, convolute folds, and water-escape structures are common and well preserved. The rocks dip at 50–55° to the south-east, and at low Spring tide a maximum thickness of 20 m of metasedimentary rock is exposed at any point along the coast, within the GCR site. Sedimentary

logs of the sequence at four localities were given by Anderton (1975, figure 2, locations B–E).

Anderton (1975) carried out the first detailed sedimentological study of these rocks and identified four facies associations, namely:

1. Laminated silt/sand
2. Tabular sand facies.
3. Sheet sand facies.
4. Channel facies.

Facies 1 consists of finely laminated (0.1–2 cm) alternations of metasandstone and metasiltstone, and is host to most of the pseudomorphs. Facies 2, commonly found interbedded with Facies 1, is characterized by 5–40 cm-thick metasandstone beds, which are parallel-sided, have erosional bases, and commonly show sole markings, including flute marks. Parallel lamination is well developed in the metasandstones, and shows a transition to climbing ripples in some beds. Facies 3 consists of structureless metasandstones, over 5 cm thick, that lack the features of the Facies 2 beds; with a decrease in bed thickness it grades into Facies 1. In Facies 4, the metasandstones are coarser in grain size than those of the other facies, and have strongly discordant bases and an irregular cross-sectional geometry.

The pseudomorphs after gypsum were reported first from the Craignish Phyllites by Anderton (1975 plate 2, b and c) from his locality T2 [NM 761 002], which is within the area of this GCR site. The host rocks are grey-green phyllitic metasiltstones with thin, 1–2 cm-thick, orange-weathering carbonate bands and nodules, phyllitic calcsilicate rocks, laminated phyllitic metasandstone–metasiltstone units, and thicker metasandstone beds to 27 cm thick. The pseudomorphs are blade- and lath-shaped bodies 0.1–4.0 cm long, which are concentrated along certain bedding-parallel horizons that can be traced laterally for several metres. These horizons commonly occur at the interface between porous, coarse-grained metasandstone and an underlying finer grained, less permeable bed. Other localities with less well-preserved calcite pseudomorphs were reported by Anderton (1975).

Anderton likened the pseudomorphs to the ‘desert roses’ and isolated gypsum crystals found at the present day in tidal-flat environments in many places in the world, but failed to recognize the true geometry of the twinned crystals found, in particular, within the GCR site. There the pseudomorphs are preserved as cavities or impressions on the weathered rock surface. They vary from irregularly shaped pits 1–3 mm across, to randomly orientated acicular impressions from a few millimetres to over 3 cm long, to millimetre-sized cavities with a distinct bow-tie shape (Figure 2.28)a, and centimetre-sized ‘butterfly’ forms (Figure 2.28)b. All types of pseudomorph are most common on the bases of cross-laminated metasandstone beds that vary in thickness from 1–27 cm, and rarely contain nodular calcareous patches, and rare sediment rafts. It is particularly noticeable that different beds and bedding surfaces within the laminated phyllitic rocks are characterized by a particular size and form of pseudomorph. Thus, a horizon on which minute sub-millimetre-sized bow-ties are preserved is found adjacent to one on which only centimetre-sized butterflies are seen.

The precursor mineral to the pseudomorphs grew across and preserved the original sedimentary fabric of the rock, and this internal texture was inherited by the optically continuous calcite crystal that replaced it. In some cases, the pseudomorph displays areas, especially rims, that are clear of inclusions but it is not clear whether these inclusion-free areas formed during gypsum growth or during its replacement by calcite. Anderton (1976, figure 3) illustrated the situation where calcite pseudomorphs that grew along the interface between coarse silt and underlying silty clay, were all truncated at the base of the overlying bed. He concluded that, following the growth of the gypsum crystals across the bedding interface, less-saline fluid flowing through the more porous upper bed had caused dissolution of any parts of the gypsum crystals that had penetrated the upper bed, resulting in the observed truncation.

All of the metasedimentary rocks have been affected by orogenic deformation to some extent, as expressed locally in the field by the development of a penetrative, slaty cleavage in the thin metamudstone seams. This cleavage dips more steeply south-east than the bedding (Figure 2.27), in keeping with the location of the GCR site on the north-west limb of the Loch Awe Syncline.

12.3 Interpretation

In 1975, Anderton published the results of a detailed sedimentological study of the coastal strip that includes this GCR site, and concluded that the Craignish Phyllites in this part of the outcrop were deposited in a tidal-flat to shallow-marine environment. This interpretation, though prompted by the finely laminated, thinly bedded and fine-grained nature of the beds, was based largely upon the identification of gypsum in the rocks at Craignish Point, and thence by comparison with present day examples of similar gypsum-bearing sequences. Evidence or reasons to support the inference that the calcite pseudomorphs were derived specifically from the alteration of gypsum were not given, apart from there being a morphological similarity between the lath-like pseudomorphs and prismatic gypsum. Recent work by the author has confirmed that the precursor mineral could only have been gypsum, a finding which supports the environmental interpretation placed upon the four sedimentary facies by Anderton.

From the sedimentary logs and other field data, Anderton (1975) concluded that the tidal-flat sediments of the laminated Facies 1 were cut by meandering channels filled with the coarser sediments belonging to the channel Facies 4. The sheet (3) and tabular-sand (2) facies were more rapidly deposited, and Anderton suggested that the latter were flood-tide storm sediments deposited in a subtidal to low intertidal setting.

All of the features shown by the pseudomorphs indicate that the gypsum grew synchronous with, or shortly after, the sedimentation. This conclusion is supported by the observation that some of the pseudomorphs have been affected by pressure-solution corrosion associated with the development of the earliest cleavage in these rocks.

The excellent state of preservation of the pseudomorphs may be due to the shielding effect of (and contact metamorphism by?) the thick metadolerite sill that runs along the GCR site. The sill was emplaced before the regional deformation and metamorphism of the Dalradian rocks, and could have protected the gypsum-bearing rocks locally from the main effects of the Grampian deformation. An analogous situation is found locally at the *Kilmory Bay* GCR site, where sedimentary structures are well preserved in a narrow zone of slightly hornfelsed rock adjacent to a thick metadolerite sill (see Roberts, 1977c, locality 10).

12.4 Conclusions

The Craignish Point GCR site is one of those exceptional places where, despite the many pairs of eyes that have looked at the rocks since Jamieson first described them in l860, there still remain new features to discover and interpret.

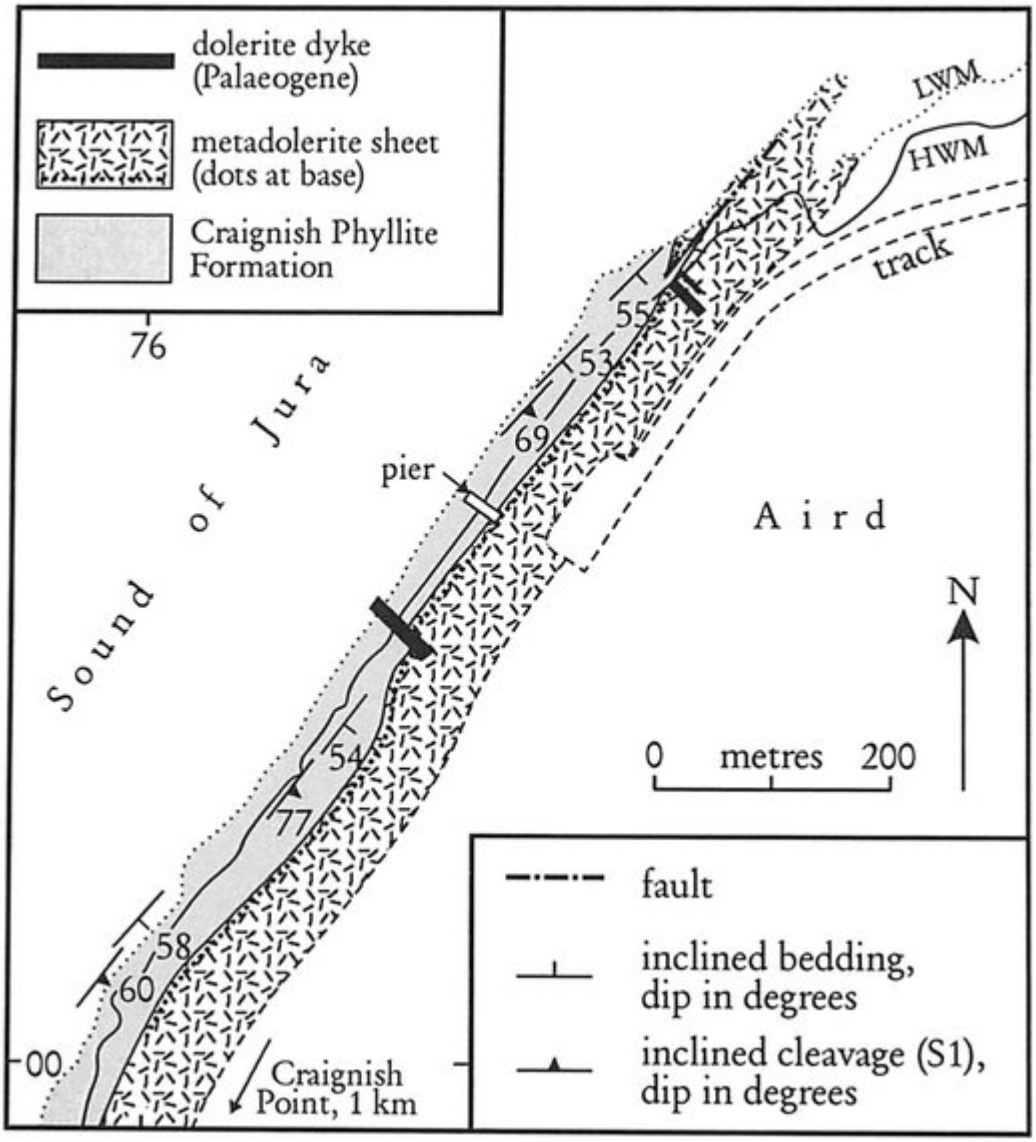
The main feature of the site is that it preserves valuable evidence that crystals of gypsum (hydrous calcium sulphate) grew in the muds and fine sands soon after they had been laid down in Neoproterozoic times, many millions of years before the rocks were intruded by an igneous body and involved in the Caledonian Orogeny. The fact that this mineral was able to crystallize from seawater signifies that there was a hot climate at that time. Combined with other field evidence, this suggests that the environmental setting was probably analogous to that found at the present day on tidal flats in regions such as the Persian/Arabian Gulf.

A 34 m-thick dolerite sill, which now overlies these rocks, protected them from much of the deformation that has affected the Craignish Phyllites throughout the rest of the outcrop (see the *Fearnach Bay* GCR site), so preserving the sedimentary structures, as well as the pseudomorphs.

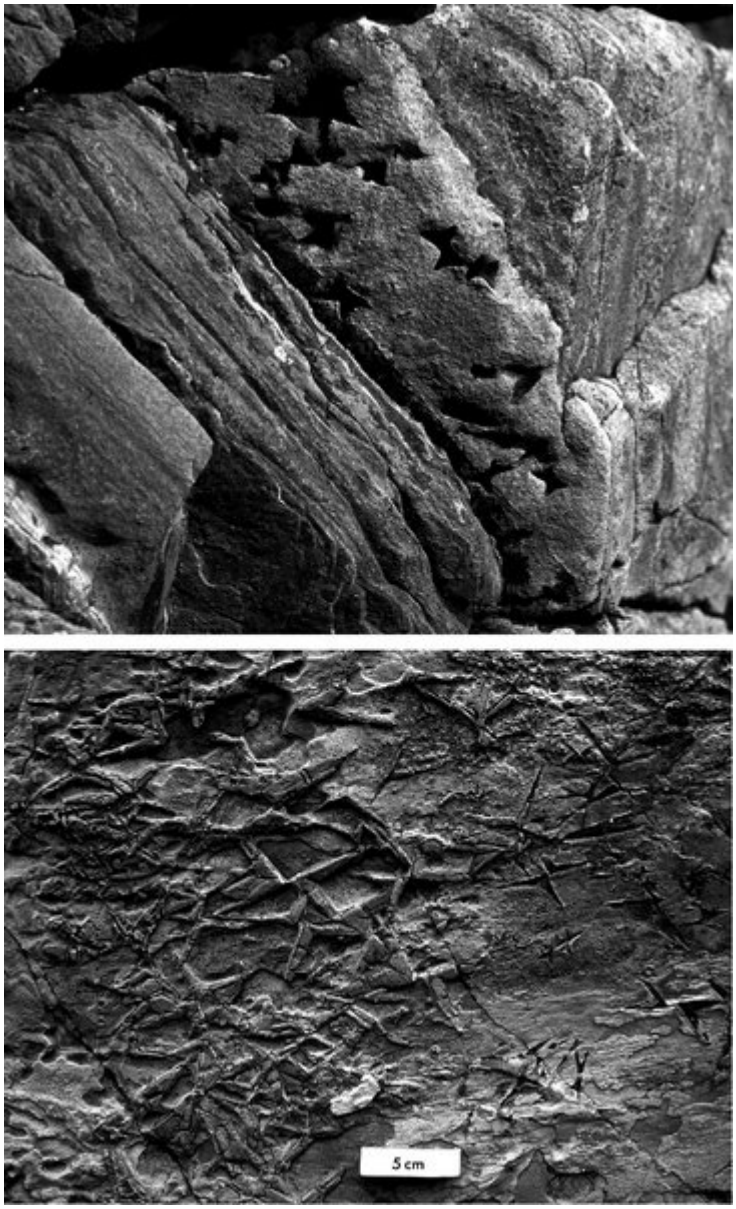
The aspect that gives this site a possible international, status is the extraordinary and unique forms shown by the former gypsum crystals (now replaced atom-for-atom by calcite). They display bow-tie and butterfly shapes, which reflect their internal structure, that of two crystals which have grown simultaneously to form an asymmetrical cross. They are aesthetically pleasing forms, but fragile and easily destroyed. Current research is aimed at determining whether they could be used as a more precise guide to the climatic and other physical conditions that prevailed at the time of their growth.

This GCR site also provides a representative section for a part of the Craignish Phyllite Formation, which in combination with other data, including those from the *Black Mill Bay* and *Fearnach Bay* GCR sites,can be used to model the original sedimentary architecture of the Easdale Subgroup.

References



(Figure 2.27) Map showing the outline geology of the Craignish Point GCR site.



(Figure 2.28) (a) Weathered-out cavities in metasandstone, previously occupied by calcite pseudomorphs of bow-tie gypsum, Craignish Phyllite Formation, Craignish Point. The bow-ties are 3–6 mm across. (b) Pseudomorphs of butterfly-twinned gypsum lying on a bedding plane in the Craignish Phyllite Formation, Craignish Point. The pseudomorphs are up to 5 cm across. (Photos: P.W.G. Tanner.)