12 Port Selma, Ardmucknish

[NM 902 381]

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12.1 Introduction

The Port Selma GCR site consists of a small rocky headland, and the ridge inland from it, crowned by the ancient vitrified hill fort of Dun MacSniachan. It lies south of Port Selma, near Benderloch (Figure 3.27), and is well known for its excellent coastal exposures of the Selma Breccia. Port Selma is one of a handful of localities in the Dalradian Supergroup from which possible microfossils have been reported.

The Selma Breccia belongs to the Easdale Subgroup and has been correlated with the Scarba Conglomerate on Jura (see the *Lussa Bay* and *Kinuachdrach* GCR site reports). It consists of five metabreccia units, the uppermost of which contains numerous blocks of limestone of a type that is exotic to the local area. It was from this unit, and the interbreccia bed beneath it, that Litherland (1975) recorded the presence of the fossil remains for which the locality is best known. These microfossils, called oncolites and catagraphs, are of uncertain origin but could be fossil algae or bacteria.

This GCR site provides an important insight into the nature of the depositional environment found at the margin of the Dalradian basin during early Argyll Group times, shortly after a major late Neoproterozoic (Port Askaig) glacial episode. It also serves as an excellent case study for establishing the criteria that may be used for distinguishing between breccias of sedimentary and tectonic origin, a topic of considerable debate wherever such rocks occur worldwide. The present case is of particular significance and interest because the breccia has been deformed and metamorphosed subsequently during an orogenic event, so obscuring some of its original sedimentary features, and making diagnosis more difficult. It was first described by Flett (in Kynaston and Hill, 1908) who interpreted it as a ‘crush breccia’, a rock formed by the in-situ brecciation of originally intact rock layers. A detailed field and microscopic study of the formation was made subsequently by Litherland (1970, 1975) who concluded that it had formed by submarine slumping of sediment.

12.2 Description

The rocks at this GCR site consist of the Selma Black Slates overlain by the stratigraphically younger Selma Breccia (Litherland 1970, 1975); the regional geological setting is shown on (Figure 3.24). The rocks are affected by several upright folds of bedding, but overall the succession dips and youngs to the south-east.

The Selma Black Slates, make up the northern part of the site (Figure 3.27), and consist largely of slaty pelites that contain thin layers and lenses of metamorphosed siltstone, sandstone, calcareous gritty sandstone and limestone, with some of the carbonate lenses being of possible diagenetic origin. The bedded metasediments commonly show the effects of slump folding, with folds reaching over a metre in amplitude; in places such movements culminated in the formation of ‘balled-up’ masses. The synsedimentary origin of these structures is, in some cases, confirmed by the observation that the base of an overlying bed cuts across the eroded tops of the slump structures. In addition, their pretectonic nature is revealed by the fact that both limbs of such folds are seen in thin section to be transected by the early (S1) cleavage.

A package of gently dipping gritty metasandstone beds, each up to 30 cm thick and showing clear, right-way-up graded bedding is found at [NM 902 381]. The dark slaty metamudstones making up the lower part of this member pass up into a thick unit of pebbly metamudstone (Figure 3.27). The metamudstone contains fine, barely visible, silty laminations and some lenses of gritty metasandstone, as well as isolated boulders up to 24 cm across.

The succeeding Selma Breccia was subdivided by Litherland (1970, 1975) into 5 metabreccia units separated by 4 interbreccia units, which have a total thickness of up to 100 m. They are right way up, and dip to the south-east at 33–64° ((Figure 3.27), units 1–5). The lowest metabreccia has a conformable contact with the underlying pebbly metamudstone. The clasts in the three metabreccia beds are angular to rounded in shape, and vary from microscopic in size to over 3 m across (Figure 3.28). They range in original composition from homogeneous or laminated slaty mudstone, some with sandy layers, to finely banded siltstone, sandstone, quartzite, and homogeneous pale- to dark-grey limestone. The relative proportions of the different clast types varies upwards in the sequence from 60% of fine-grained quartzite clasts and 3% limestone in the lowest metabreccia, to 15% of fine-grained quartzite clasts and 60% limestone in the highest metabreccia; the other constituents making up the remaining 25–37% of the population are relatively constant in amount (Litherland, 1970). Thus the proportion of limestone clasts increases markedly up-sequence as the quartzite clasts diminish in number. Many of the clast types may be matched lithologically with underlying units such as the Selma Black Slates and Selma Quartzite, and the clasts of pale-grey limestone resemble metalimestones from the Appin Group, which crop out on Islay and on the Appin Peninsula. No exotic clasts of igneous or high-grade metamorphic origin have been identified.

The problematical microfossils occur in angular dark-grey limestone clasts (to 60 cm across) in the topmost metabreccia (B5 of (Figure 3.27)), and in the underlying interbreccia unit, IB4, exposed inland. Oncolites are seen in hand specimen as rusty-weathering spots 1–4 mm across, and are found in thin section to have a concentric internal structure; their morphology has been described in detail by Litherland (1975). The acccompanying catagraphs are up to 7 mm across and have a more disordered internal structure. Bryozoan-like fossils were also reported by Litherland. Of particular interest are 0.05–0.2 mm-diameter tubes that penetrate the clasts and, although they are now filled with sparry calcite, could represent burrows formed by parasitic algae (Litherland, 1975).

Bedding in these rocks has a north-easterly strike and the Selma Black Slates have been affected by a series of upright folds with axes plunging gently to either the north-east or the south-west. These folds are associated with the development of a steeply dipping to vertical slaty cleavage that trends north-east, dips to the south-east, and is accompanied by a gently curvilinear bedding-cleavage intersection lineation. This cleavage also affects the matrix, together with the more-argillaceous clasts in the Selma Breccia. The slaty cleavage in the Selma Black Slates and locally in the metabreccia is cut, and in places strongly overprinted by, a spaced crenulation cleavage, which dips to the north-west at a low angle.

The slaty cleavage is evident in the argillaceous matrix of the metabreccia beds, and the clasts have been tectonically deformed to varying degrees depending upon their lithology. Slaty fragments and mud wisps have been moderately flattened in the cleavage, with quartzite clasts being least deformed, as would be expected. The slaty cleavage is refracted around some of the more-competent boulders and pebbles, and in some cases faint ‘strain shadows’ are developed. Minor folds and corrugations of the internal bedding laminations are noted in a number of clasts. Where seen on the flat, clean exposures of the metabreccia in the intertidal zone, these folds have axial traces that are parallel to the 055–065° trend of the penetrative cleavage that affects the enclosing matrix (Figure 3.28), and also to the crude alignment shown by the longest dimensions of the clasts. Contractional deformation has resulted in the formation of internal folds in thosee clasts in which the lithological layering was initially at a high angle to the trace of the slaty cleavage. However, where such bedding laminations were originally at a small angle to, or parallel with, the orientation of the slaty cleavage, the laminations are stretched, disrupted and boudinaged but never folded. These relationships are a demonstration of the fact that the folds preserved in the clasts developed after the breccia was deposited. An analogous situation holds for the folds in the country rock xenoliths enclosed in the Ben Vuirich Granite (see the *Ben Vuirich* GCR site report in Stephenson et al., 2013b).

A major NE-trending fault cuts the Selma Black Slates and causes a displacement of the metabreccia outcrops (Figure 3.27).

12.3 Interpretation

Minor sedimentary structures show clearly that the Selma Black Slates and Selma Breccia form a single, conformable sequence. These units are part of the Easdale Subgroup and are correlated with the Jura Slate Member (see the *Kilnaughton Bay* GCR site report) and the Scarba Conglomerate Formation (see the *Lussa Bay* and *Kinuachdrach* GCR site reports), respectively. There is evidence throughout this succession for increasing instability of the basin margin, as witnessed by the occurrence of slump folds, large isolated clasts and rafts of disorientated sedimentary rock enclosed in mudrock. Coarse-grained, graded beds are found in the Selma Black Slates and breccia units up to 6 m thick occur in the overlying Selma Breccia.

Early workers identified the Selma Breccia and interpreted it as a ‘crush conglomerate’ (Flett in Kynaston and Hill, 1908), but subsequent workers are agreed that it is of sedimentary origin (Kilburn *et al*., 1965). Litherland (1970, 1975) referred to it as a ‘sedimentary slide tilloid’ but did not discuss the reasons for this interpretation.

The critical evidence for the origin of the Selma Breccia may be summarized as follows:

(i) The underlying sequence shows evidence of soft-sediment deformation and mass-flow deposits, forerunners of the more-extensive and distinctive breccias above.

(ii) The metabreccias form a bedded sequence consisting of 9 separate units, which are laterally continuous. The interbreccia units contain large isolated boulders of original sedimentary rock.

(iii) The first metabreccia unit shows a normal sedimentary contact with the underlying bed, with large boulders at the base preserved in the act of sinking into the underlying mudrock.

(iv) The metabreccia beds consist of a varied assemblage of angular original sedimentary clasts set in an originally muddy to sandy matrix. The clasts appear to have been lithified, and in the case of some of the limestone blocks, bored by organisms, before being transported to their final resting place.

(v) Although there is a random admixture of clast types in all of the metabreccia units, blocks of limestone only appear in the upper beds and are dominant in the top metabreccia unit. Some blocks consist of breccia, suggesting that earlier brecciated material has been reworked in the flows.

(vi) There is evidence of local fracturing and brecciation of clasts *in situ*.

(vii) All of the clasts are deformed in the S1 slaty cleavage but there is no evidence that the bedding in the source rocks was folded prior to their disruption, and incorporation into, the Selma Breccia.

(viii) There is a lack of cataclastic or mylonitic rocks, or evidence for intense shearing, within or between the metabreccia units.

From the above features it is clear that the deposit originated as a synsedimentary slump deposit, and did not form by the in-situ brecciation, shearing or cataclasis of lithified, bedded strata. Bedding in the clasts was not folded at the time of deposition. Another important conclusion that can be drawn from this study is that there is no evidence for either a major stratigraphical or structural break at this level in the Dalradian succession.

Although possible microfossils such as oncolites and catagraphs found in the metabreccias resemble forms that have been reported by Russian workers from the Ediacaran-age strata of Spitzbergen (Litherland, 1975), none of these forms provide reliable evidence for the stratigraphical age of the rocks. However, the tube-like structures that penetrate the oncolites and their binding matrix, were interpreted by Litherland as the burrows of parasitic algae. If this is correct then it indicates that the limestone clasts were lithified and colonized by algae whilst they were accumulating on the basin margin, prior to their transportation into the sedimentary basin by slumping. Litherland (1975) speculated that the source for these exotic limestone clasts might be the Cambro-Ordovician Durness Group on the North-west foreland of Scotland, but more-recent work (see Rushton *et al*., 2000) on the age of the Durness Group shows that it is much too young to have provided sediment to the Dalradian basin.

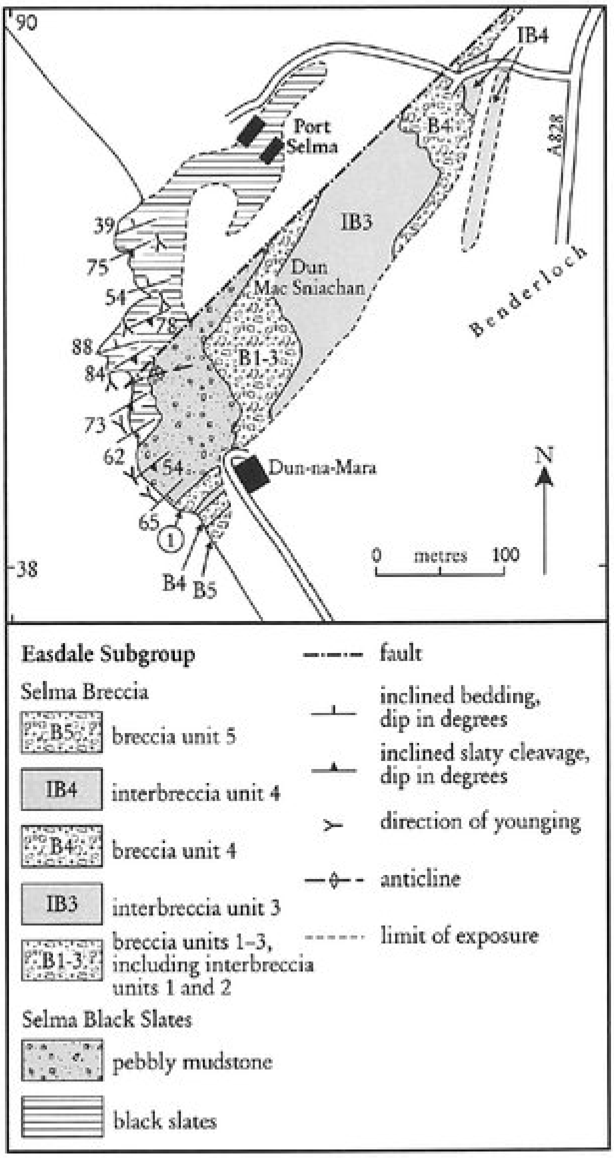
12.4 Conclusions

The Selma Breccia, which is magnificently exposed at this site, is a classic example of a rock formed by the large-scale slumping of poorly sorted and very coarse-grained sediment into a marine basin. Sedimentary units formed in this way are not easy to identify with certainty, and their interpretation is commonly controversial. This is especially so where the deposit has been deformed and folded subsequently. The low grade of metamorphism and relatively low strain at Port Selma make this an exceptional locality for studying and interpreting such a metasedimentary deposit, and for this reason alone it warrants consideration as a site of national importance.

The metabreccias consist of angular blocks of rock, ranging in size from pebbles to boulders up to 3 m across, enclosed in what was originally a muddy or sandy matrix. A variety of different rock types are seen in the metabreccia, some of which can be matched in the local, or neighbouring, Dalradian sequences of slightly older age.

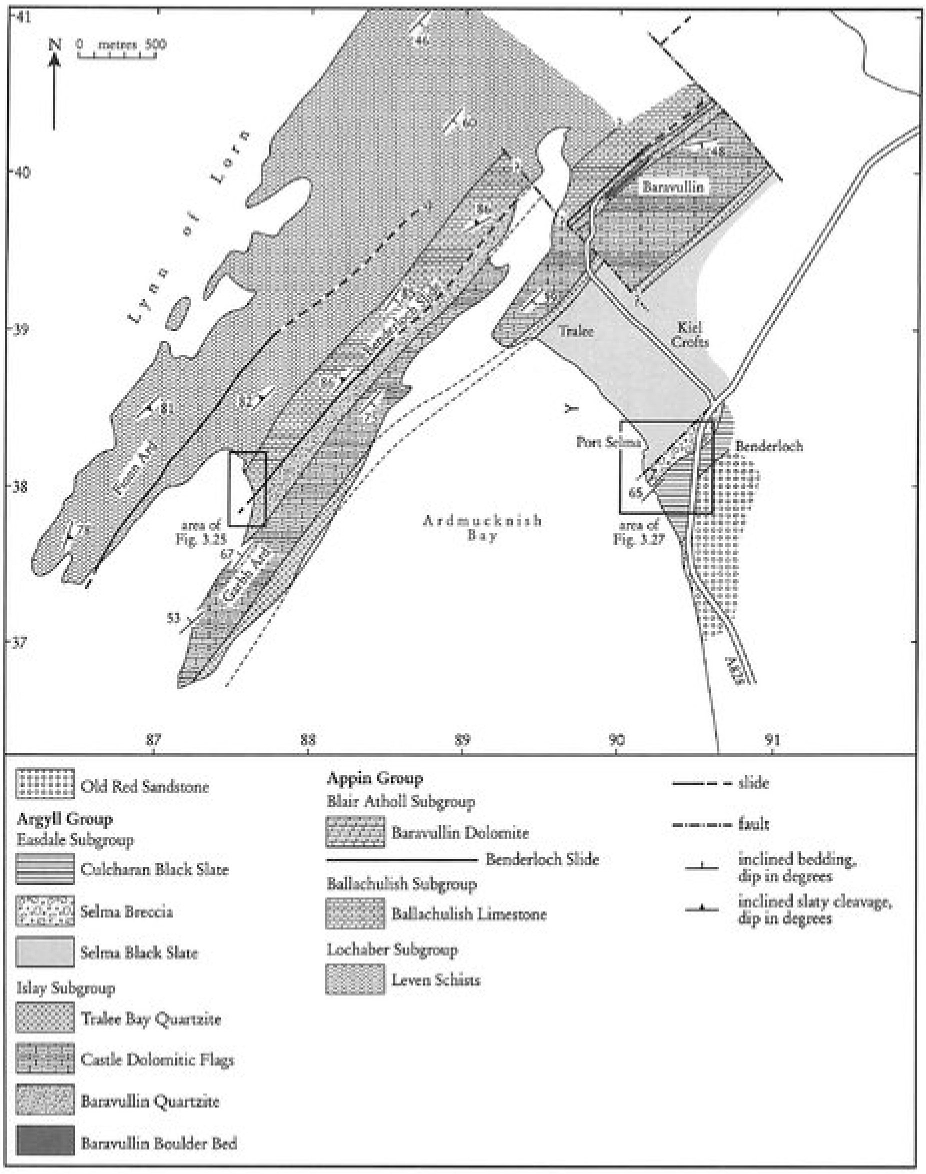
Port Selma is also well known for the minute fossil remains, a few millimetres across, which are found in the limestone blocks at the top of the sequence. Unfortunately these fossils are not sufficiently diagnostic to tell us the age of the rock that provided much of the material for the original sedimentary slide breccia, and hence place a maximum age on the metabreccia itself, but they do provide some potential clues as to the likely source area.

References

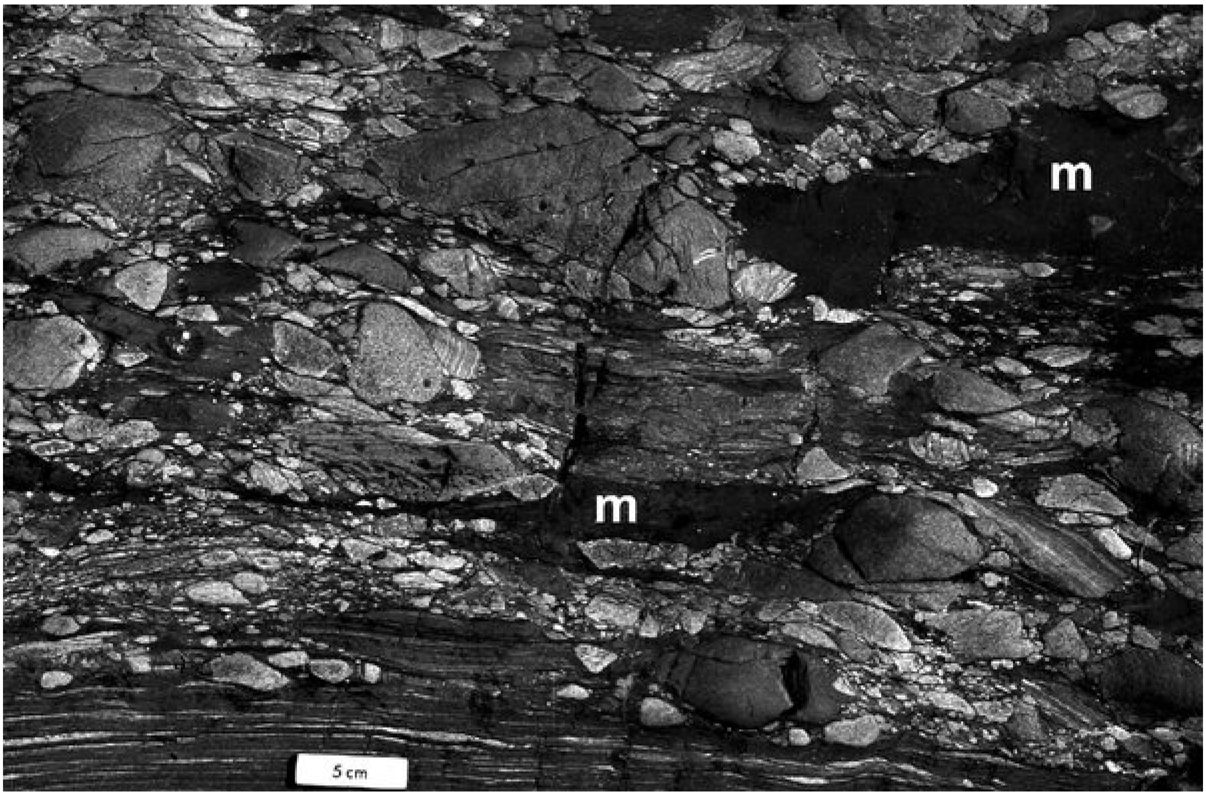


(Figure 3.27) Map of the Port Selma, Ardmucknish area showing the distribution of breccia (B1-5) and interbreccia (IB3, IB4) beds belonging to the Selma Breccia, and their relationship to the Selma Black Slates (modified from Litherland,

1982). Structural interpretation by P.W.G. Tanner.



(Figure 3.24) Map of the Lochnell Peninsula and adjoining area, north of Oban, modified from BGS 1:50 000 Sheet 45E (Connel). It shows the regional setting of both the Camas Nathais and Port Selma, Ardmucknish GCR sites (labelled inset boxes), and the line of the Benderloch Slide.



(Figure 3.28) The Selma Breccia as seen on the coast at locality 1, (Figure 3.27), showing the variations in clast type and shape within part of breccia units B1-B3 (m, mudstone raft). The direction of view is to the south-east, with the longest dimensions of the clasts being generally aligned parallel to the NE-trending slaty cleavage. (Photo: P.W.G. Tanner.)