18 Tempar Burn

[NN 691 575]–[NN 696 562]

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18.1 Introduction

This GCR site, off the Kinloch Rannoch road on the south side of Strath Tummel, includes part of the Tempar Burn and exposures along an adjacent track that together comprise one of the classic sections through the Schiehallion Boulder Bed Formation (the local equivalent of the Port Askaig Tillite Formation), at the base of the Argyll Group (Table 1). The particular interest of this formation is that it is interpreted as having been deposited from a grounded ice-sheet, which carried material on to a shallow continental shelf. The tillite generally consists of a gritty matrix, in which are scattered clasts of various underlying rock types a few centimetres in length. Most spectacularly, in the upper half, are boulders of pink granite up to 30 cm across. The site also includes a section through the Schiehallion Quartzite (the equivalent of the Jura Quartzite), which originated as shelf sands above the tillite, and through a metaconglomerate of reworked tillite. The Schiehallion Boulder Bed Formation is possibly the most important 'marker' horizon that has enabled stratigraphical correlation within the Dalradian outcrop from the west of Ireland to Banffshire. It has also been a key horizon in the correlation of the Dalradian with Neoproterozoic successions in Greenland and Scandanavia.

Although this section through the formation was first described by Bailey (1917) and was correlated by him with the Port Askaig 'Conglomerate' of Islay, it was Anderson (1923) who first discussed the arguments for its glacial origin. The formation has also been described by Treagus (2000). Together with the classic localities of the Port Askaig Tillite (see the *Caol Isla* and *Garvellach Isles* GCR site reports), the site has attracted wide international interest in the ongoing investigations and debate on the evidence for and implications of Neoproterozoic glaciations.

18.2 Description

The Schiehallion Boulder Bed Formation, where most fully developed and exposed as in this section, may be divided into a sequence of lower calcareous metadiamictites with dominantly calcareous clasts and an upper sequence of quartz-rich metadiamictites with a mixture of clast-types, including distinctive pink granitic rocks. The two metadiamictite sequences are generally separated by discontinuous units of quartzite (Figure 3.44). Exposures and loose material immediately south of East Tempar Farm (at [NN 691 575]) and along the track to [NN 696 564], are especially good and accessible, illustrating both calcareous and granitic metadiamictites, as well as the intervening quartzites (Figure 3.44). Further exposures are seen in the tributary of the Tempar Burn downstream of where it crosses the track at [NN 6958 5628].

The sequence of the lower calcareous metadiamictites, up to 50 m thick, is best seen 100 m east of the sheep dip [NN 6938 5737] and 100 m east of the track at [NN 6954 5705]. Exposures of the tremolitic and dolomitic metalimestone that underlies the tillite (the Drumchastle Pale Limestone, equivalent to the Islay Limestone of Islay) can be seen in the grassy hollow some 20 m to the north-east of these exposures, but the contact is not seen. Individual metadiamictites are separated by beds of schistose calcareous rock free of clasts; bedding is not otherwise observed, except for rare thin (0.5–12 mm) beds of cream-coloured schistose dolomitic metalimestone, and tremolitic psammite.

The matrix of these lower metadiamictites is a schistose calcareous (dolomitic) rock, locally rich in amphibole (radiating blades of white tremolite or pale green actinolite and large hornblende porphyroblasts) and generally rich in a phlogopitic biotite. The matrix, commonly weathering to a rusty-brown, characteristically shows a regular network of depressions, owing to small patches of carbonate minerals, which are possibly small clasts. According to Bailey and McCallien (1937) 'lime-rich' scapolite and diopside occur locally in the matrix. The dominant clasts in the lower metadiamictites are 1–20 cm diameter, disc-shaped fragments of schistose dolomitic limestone or limestone, elongate parallel to the schistosity. Although commonly completely weathered out, vestiges of the clasts can be seen at the rims of the holes. Biotite-muscovite semipelite clasts, which are less common, are very elongate and up to 20 cm in length, and the rarer quartzite and granitic clasts, are up to 25 cm long but less elongate (ratios of 2:1 or 3:1) and more angular; these clasts become more common upwards.

Two discontinuous units of quartzite, each up to 50 m thick and occurring at slightly different levels, are seen east of the track around [NN 6945 5709] and [NN 6963 5678]. These quartzites are not as clean as the Schiehallion Quartzite above, being sugary and feldspathic; they are generally massively bedded and locally they are strongly schistose. Although bedding-plane laminations have been observed, cross-stratification has not been widely detected.

The younger part of the Schiehallion Boulder Bed Formation, up to 70 m thick, is best seen on both sides of the track above the small burn that crosses at [NN 6956 5672]); exposure is particularly good around [NN 696 565] (Figure 3.45). Clasts of grey or pink granite and microgranite are the most common, followed by pink and white quartzite, biotite-muscovite semipelite, and dolomitic limestone (least common). The pink granite is the 'nordmarkite 'of Bailey and McCallien (1937). Clasts are rarely in contact and spacing appears to be random. Within the clast-rich metadiamictites, the proportion of the rock composed of clasts (greater than 5 mm in length) varies from 70% to zero. Some beds, up to several metres thick, are free of obvious clasts (greater than 5 mm in length) but still have the gritty, feldspathic texture of the metadiamictite matrix. The maximum length of clasts, which might be somewhat flattened in the schistosity, is 0.5–30 cm. The more-rare biotite-muscovite semipelite and dolomitic limestone clasts are the smallest, the most strongly deformed (flattened) and consequently appear to be more rounded. The more-common quartzite and microgranite clasts seldom exceed 10 cm, but might display very irregular, angular and non-flattened shapes; the clasts of the granite are typically the largest and display similar variations. Clasts might show pressure-shadow fringes of quartz, carbonate minerals and mica. As with the lower metadiamictites, there is no evidence of sorting by size or composition, although some beds that are several metres thick are clearly free of clasts.

The contact with the Schiehallion Quartzite is not exposed, but evidence elsewhere in the district shows that it is sharp (Treagus, 2000). A thin bed of metadiamictite with reworked granitic clasts is present near the base of the quartzite in the East Tempar track exposures at [NN 6953 5631]. Clean exposures of the lower part of the Schiehallion Quartzite are exposed in the Tempar Burn downstream of the tributary at [NN 6942 5643]; scattered clasts of granite and quartzite are present and of particular interest is a 30 m-thick metaconglomerate that is well exposed in the burn at [NN 6935 5654]. The quartzitic matrix of the metaconglomerate is very similar to the Schiehallion Quartzite itself, but with a somewhat more-gritty appearance. The rock types and sizes of the clasts are much as in the metadiamictites, described above, but they are more-obviously rounded and locally they are in contact with one another. Clasts of grey or pink granite and microgranite are the most common, together with pink and white quartzite, biotite-muscovite semipelite and carbonate rocks.

The metaconglomerates have great potential for both sedimentological and strain studies. Where measured, in the Tempar Burn section, the proportion of clasts to matrix is very variable over a few square metres, from 1% with isolated single clasts, usually granite, to approximately 70%, with crowded clasts of a mixture of rock types. The clasts are deformed into disc shapes within the dominant cleavage, which is very close to the bedding; observation of shape is difficult, but most clasts display approximately circular sections. Deformation appears to be more pronounced than in the metadiamictites; measured on surfaces perpendicular to the bedding, granite clast length:width ratios, range between 10.4:1 and 2.1:1, but are commonly about 5:1 and longest dimensions ranged from 2 to 47 cm. Semipelite clast ratios are from 5 to 13:1, and sizes range from 3 to 18 cm.

Downstream, after a further few metres of quartzite, the burn and banks provide excellent exposure of the Tempar Dolomitic Member, the probable equivalent of the Bonahaven Dolomite of Islay.

18.3 Interpretation

Subsequent to Bailey's (1917) correlation of the Schiehallion Boulder Bed with the Port Askaig 'Conglomerate', Anderson (1923) discussed the arguments for its glacial origin. He pointed out that the uniform, unbedded nature of the matrix and the haphazard arrangement of the clasts strongly suggest an origin as a till. He noted the similarity of the carbonate-rock and the quartzite clasts to the underlying 'Pale Limestone' and 'Banded Group' formations respectively (now the Drumchastle Pale Limestone and Cnoc an Fhithich Banded Semipelite formations of Treagus, 2000), which are exposed to the east of the GCR site. He used this correlation to demonstrate the order of superposition. He further pointed out that the granitic ('nordmarkite') clasts have no likely local source in Britain and must be far travelled. He noted that the base of the Schiehallion Quartite closely approaches the 'Blair Atholl grey limestone' (now the upper calcitic metalimestone of the Blair Atholl Dark Schist and Dark Limestone Formation) in the north of the district, but accepted the possibility that this might be due to either erosion of the sub-quartzite surface, or to later tectonic movements. He noted that the presence of amphibolite clasts suggests a period of igneous activity that pre-dated the diamictites. The present investigation, however, has failed to reveal clasts of true amphibolite, as against green-amphibole (actinolite)-bearing mica-schist.

More-recent discussion concerning the depositional environment of the diamictites in general has concentrated on evidence from the superior exposures of the Garvellach Islands and Islay, e.g. Kilburn *et al.* (1965), Spencer (1971, 1981, 1985), Eyles and Eyles (1983), Eyles (1988). These authors considered that the diamictites represent a major glacial event of global extent and that they may be correlated with the Varanger tillites of Scandanavia and East Greenland (but see Stephenson et al., 2013a for more-recently suggested correlations with other global glacial events). It is generally accepted that the geographically extensive, though discontinuous, distribution of the deposits in the British Isles favours a glacial origin, as opposed to sedimentary slide deposits of a more-local character. The general evidence, throughout their outcrop in the Dalradian, of the mixture of locally derived and exotic clasts, the random distribution and size of the clasts, the lack of bedding within the ill-sorted matrix, the record of dropstone structure and the particular evidence of other glacially-related structures in the South-west Grampian Highlands, makes the glacial origin indisputable.

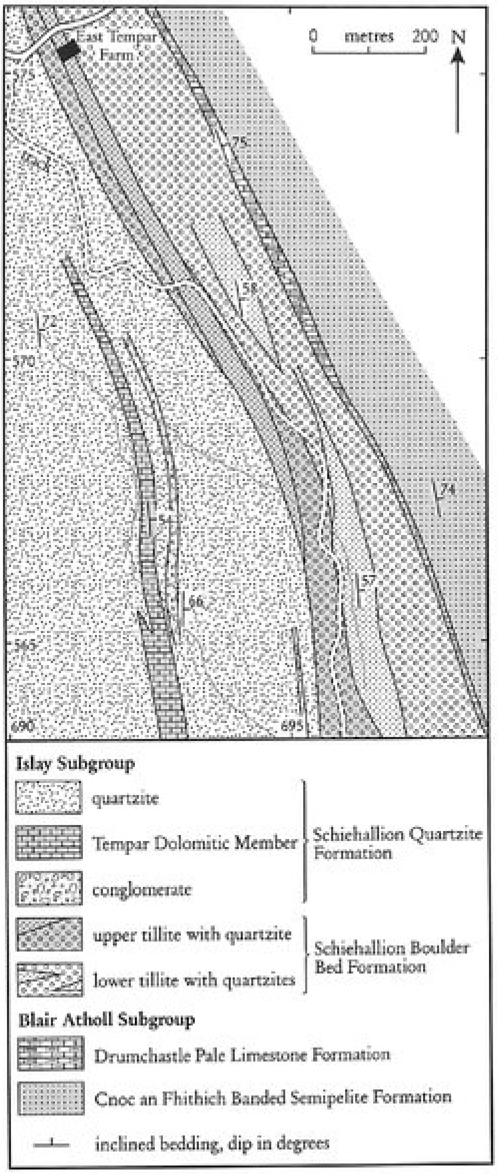
In the Schiehallion district, the massive nature of the diamictites, their inclusion of stratified, sorted sands, and the subrounded shape of some clasts, supports the interpretation of a marginal glaciomarine environment (Edwards, in Reading, 1986). The local thinning and probable absence of the formation from some areas and the inclusion of clasts of at least two of the preceding formations in the lower diamictites, strongly suggests an unconformable base. The distinctive sedimentary structures attributed to tillites and present in some exposures of the Port Askaig Tillite (see the *Caol Isla* and *Garvellach Isles* GCR site reports) have not been observed at this GCR site. Possible dropstone structures have been recorded, but it is difficult to exclude the effect of the strong tectonic deformation. The clasts show no evidence of having been sorted or of having had their distribution controlled by water movement.

There are two beds of metaconglomerate, within the Schiehallion Quartzite, that have clasts of identical lithologies to those in the metadiamictites (Anderson, 1923; Treagus, 2000). The significant difference between the metaconglomerates and the metadiamictites is that there appears to be a more strongly bimodal size distribution in the metaconglomerates, such that the intermediate 1–5 cm sizes are missing; in addition the clasts are less dispersed, although rarely in contact, and they are significantly more rounded. This supports the interpretation of Anderson (1923) that these rocks represent reworked diamictite material derived by fluviatile or marine erosion.

18.4 Conclusions

The Tempar Burn GCR site is of international importance for its clear exposures of a Neoproterozoic glacial deposit. The 'boulder beds' (metadiamictites) that make up the Schiehallion Boulder Bed Formation are composed of blocks and pebbles up to almost a metre across, sitting isolated in a matrix that was originally sand and silt. The blocks and pebbles can only have been dropped from floating ice. They include a wide range of rock types, including some derived locally from underlying formations, but particularly significant, are the commonly occurring 'stones' of a type of granite that does not crop out in Britain and therefore might have been carried a great distance across an ocean. The GCR site is thus of great importance for the light it sheds upon climate and sedimentary processes in the late Precambrian, but it is also celebrated for its significance in the correlation of Dalradian formations across the British Isles, as well as with possibly equivalent deposits in Greenland and Scandinavia. Studies of the deformed shapes of the 'stones' are important for estimating the strains that the Dalradian rocks were subjected to during the Caledonian Orogeny.

[References](#)



(Figure 3.44) Map of the Tempar Burn area based on mapping of P.A.R. Nell (BGS 1:10 000 sheet NN65NE).

(Figure 3.45) Exposure of a boulder bed close to the Tempar Burn track at [NN 696 565], showing elongation of stones parallel to a vertical cleavage; the holes are weathered-out dolomitic clasts, whilst the stones that are proud are of granite, quartzite and biotite-muscovite semipelite (e.g. large clast to the right of the hammer shaft). Hammer shaft is 30 cm long. (Photo: J.E. Treagus.)