8 Rubha na Magach

[NN 4603 8495]–[NN 4660 8522]

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8.1 Introduction

The Grampian Group rocks that underlie much of the Northern Grampian Highlands have been divided by Harris *et al.* (1994) into the Glenshirra (oldest), Corrieyairack and Glen Spean (youngest) subgroups. The Corrieyairack Subgroup attains its greatest thickness (*c.* 5.5 km) in the area surrounding Loch Laggan (Figure 5.22). Smith *et al.* (1999) postulated that this might represent the depocentre of an intercratonic rift basin, which they termed the Corrieyairack Basin.

Clean water-washed sections on the north shore of Loch Laggan at Rubha na Magach, provide some of the most informative exposures of the Loch Laggan Psammite Formation, which account for some 3.6 km thickness of the Corrieyairack Subgroup. Details of primary sedimentological features are commonly preserved in the micaceous psammites and semipelites of this formation, despite simple upright F2 folding and the effects of metamorphic recrystallization under amphibolite-facies conditions (*c.* 500–600°C, 5–8 kbar, Phillips *et al*., 1999). Sedimentological analysis of excellent exposures in an area of low tectonic strain at Rubha na Magach allows characterization of the depositional systems for the postulated basin depocentre.

The exposures at Rubha na Magach [NN 4618 8492] were first described by Winchester and Glover (1988), who noted the extraordinarily detailed preservation of such sedimentary structures as cross-bedding, rip-up clasts and convolute bedding. Subsequent descriptions by Glover (1989) and by Glover and Winchester (1989) incorporated palaeo-environmental interpretations. A useful field description with maps and photographs was provided by Winchester and Glover (1991). The site is included within BGS 1:50 000 Sheet 63E (Dalwhinnie, 2002).

8.2 Description

The Loch Laggan Psammite Formation comprises grey psammite and micaceous psammite with subordinate thin semipelite. These lithologies occur in the form of massive and graded beds. The graded bedding and several observation of cross-lamination indicate that the formation is the right way up.

The most-informative localities can be seen on the Rubha na Magach promontory [NN 4618 8492] and at a lochside exposure 300 m to the east at [NN 4653 8516]. Both exposures lie on the south-east limb of the F2 Laggan Antiform; bedding and a bedding-parallel foliation dip at *c.* 60°to the south-east and bedding is the right way up. Measured logs of both exposures are provided in (Figure 5.23). A heterolithic association of interbedded psammite, micaceous psammite, and dark micaceous psammite with semipelite is exposed. Beds commonly have tabular, parallel-bedded forms and are laterally persistent on the scale of the exposures. Coarse-grained metamorphic recrystallization of the semipelitic component has resulted in scant preservation of sedimentary detail so that it is only possible to infer that it is likely to represent original mudstone. In contrast, the micaceous psammite has well-preserved and commonly very intricate sedimentary structures (Figure 5.24).

The most-common sedimentary structure is normal grading. Recrystallization during metamorphism has affected the mineralogy and grain size so that original grading is defined by an upward increase in mica content. Psammitic beds consequently have a pseudo-coarsening-upward appearance as they grade into semipelite. Most psammitic beds have graded tops but some massive psammite does occur. A discontinuous planar lamination is also very common and is

usually confined to the micaceous psammites.

Climbing ripple (ripple-drift) cross-lamination is beautifully preserved in the micaceous psammites at Rubha na Magach (Figure 5.24)a. Both stoss-side preservation (so that cross-laminae are continuous) and stoss-side erosion surfaces are preserved. Packets of cross-laminae are commonly *c.* 10 cm thick and occur at discrete horizons in individual beds. As with the planar lamination, these are most commonly found in the micaceous psammites.

Convolute lamination can be viewed where thick psammite beds overlie originally planar-laminated micaceous psammite (Figure 5.24)b. Rare beds of micaceous psammite with convolute lamination show bulbous basal projections thought to be load structures (best seen at [NN 4653 8516]). Such structures are only very rarely preserved in the Loch Laggan Psammite Formation, any such basal projections typically having been removed by shearing along bedding surfaces during folding.

Low-angle scours that cut off the underlying sedimentary structures occur in a number of places and many beds have a very sharp base. The scours are also marked in places by lines of rip-up clasts. Small rip-up clasts, 5-10 cm long and several centimetres thick, have been found at [NN 4618 8492]. The clasts are usually of dark micaceous psammite or semipelite within more-psammitic beds. Some clasts show original lamination, twisted concordantly with the shape of the clast. These are usually seen at the interface between two psammite or micaceous psammite beds suggesting that significant amounts of bed amalgamation might have occurred.

Okonkwo (1985) noted a common repetitive sequence of sedimentary structures, similar to that reported by Bouma (1962) for the deposits of turbidity currents. Okonkwo (1985) described a basal massive sandy layer overlain in turn by a lower planar laminated horizon, then a cross-laminated horizon, then an upper planar laminated horizon and finally by a mud corresponding respectively to the Ta, Tb, Tc, Td and Te divisions of the Bouma sequence (Bouma, 1962).

Two principal lithofacies associations are present at Rubha na Magach and are shown in the sedimentary logs of (Figure 5.23). The first consists of thick-bedded massive psammite, micaceous psammite and thin semipelite, forming complete Bouma (i.e. Ta–e) and base-missing Bouma (i.e. Tb–e, Tc–e, Td–e) sequences. These have very well-developed sedimentary structures and are well graded. The second lithofacies consists of thin-bedded micaceous to highly micaceous psammite interbedded with more-thickly developed semipelite. This second lithofacies usually shows planar lamination and good grading. Taken together, the two lithofacies form *c.* 15 m-thick packages. The thick-bedded lithofacies association commonly shows a crude thinning and fining upwards into the thinner bedded one.

These localities have several other notable features. Prominent white calcsilicate pods, originally diagenetic calcareous concretions, have the assemblage garnet-hornblende-clinozoisite-andesine-quartz, thus indicating that amphibolite-facies conditions were attained during regional metamorphism (Winchester, 1974). The metasedimentary rocks are cut by several suites of pegmatitic veins and felsic dykes (the Loch Laggan Vein-complex), some of which are quite spectacular, as in the road cuttings at [NN 4760 8615] and [NN 4721 8593].

8.3 Interpretation

The abundant sedimentary structures in the psammites and micaceous psammites suggest deposition by high-energy, fast-flowing and turbulent currents. In contrast, the semipelitic lithologies suggest a quieter environment of deposition dominated by the settling out of suspended fine sediment. These interpretations, along with the identification of Bouma sequences, support the interpretation of Okonkwo (1985), that these sediments were deposited by turbidity currents.

The grain size of the original sediment (sand to mud grade) and the sedimentary structures present are consistent with a turbidity current origin. The thicker bedded, coarser grained lithofacies association represents relatively high-density, sand-laden turbidity currents and possible tractional processes. As these high-density turbidity currents could scour the existing substrate and deposit sand on top of it, the resultant beds are sharp based and commonly show amalgamation with the underlying sand beds. Rapid deposition is suggested at Rubha na Magach by scouring, rip-up clasts and convoluted lamination. The overlying, thinner bedded and muddier lithofacies association was deposited by much less-dense turbidity flows. Between periods of turbidity flow, periods of quiescence allowed sediment to fall out of

suspension and form a silt or mud layer (now semipelite).

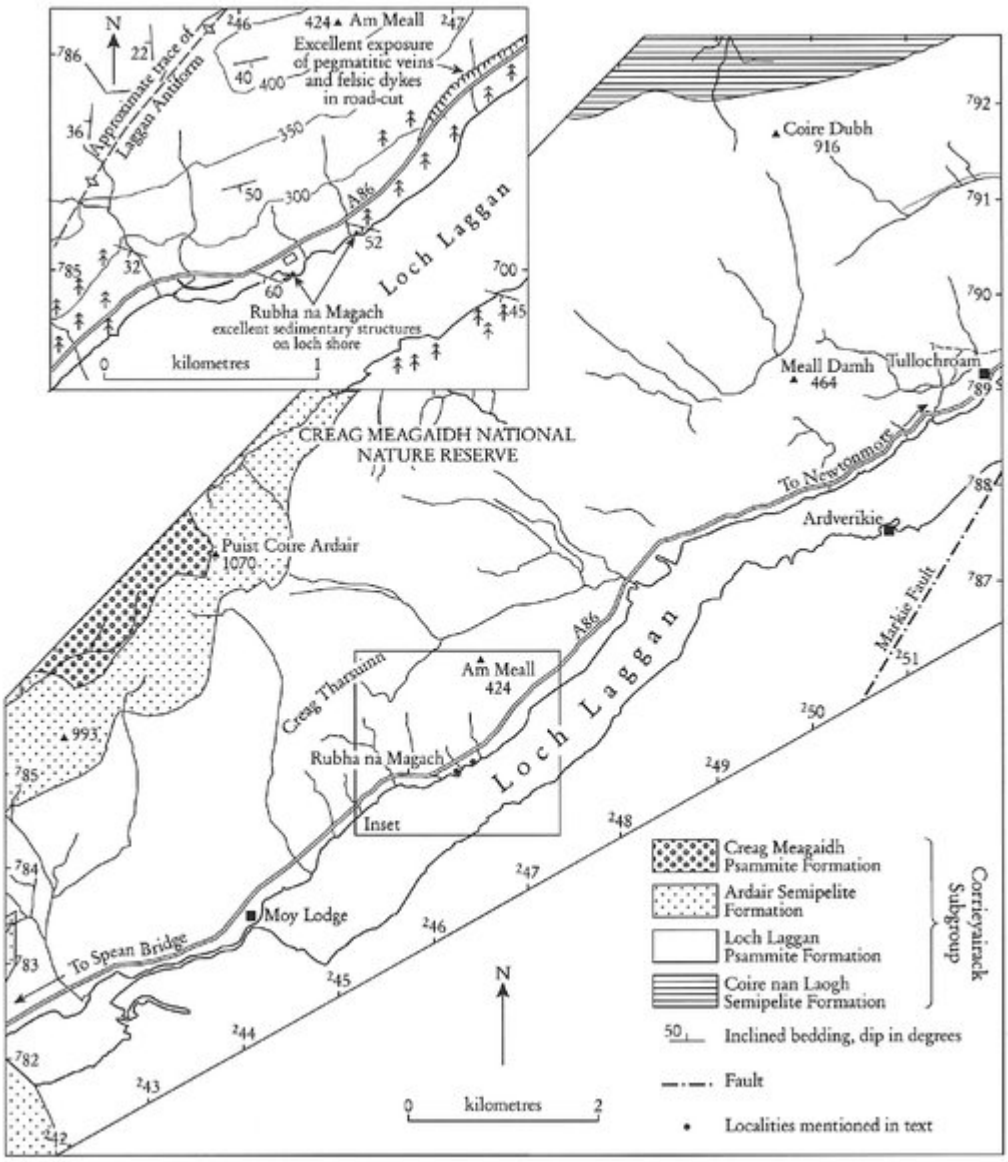
Glover (1989) and Glover *et al.* (1995) assigned these metasedimentary rocks to more-specific turbidite elements (*sensu* Mutti and Normark, 1987) and concluded that the Loch Laggan Psammite Formation represents an inner fan channel system. Mutti and Normark (1987), comparing multiple examples of ancient and modern turbidite successions, decribed similar lithofacies associations to the Loch Laggan Psammite Formation in channel systems where erosional and depositional processes took place. Such channels acted as conduits for powerful high-density turbidity currents, such as those inferred here for the thicker lithofacies association in the Loch Laggan Psammite Formation. More-dilute and less-powerful flows dominated the inter-channel areas. Inter-flow times were marked by a laterally persistent mud blanket (semipelite). Thus, in broad agreement with Glover *et al.* (1995), the lithofacies associations observed at Rubha na Magach are interpreted here as inner fan in-channel- and channel-related deposition. The complex channel systems were of mixed erosional–depositional type.

8.4 Conclusions

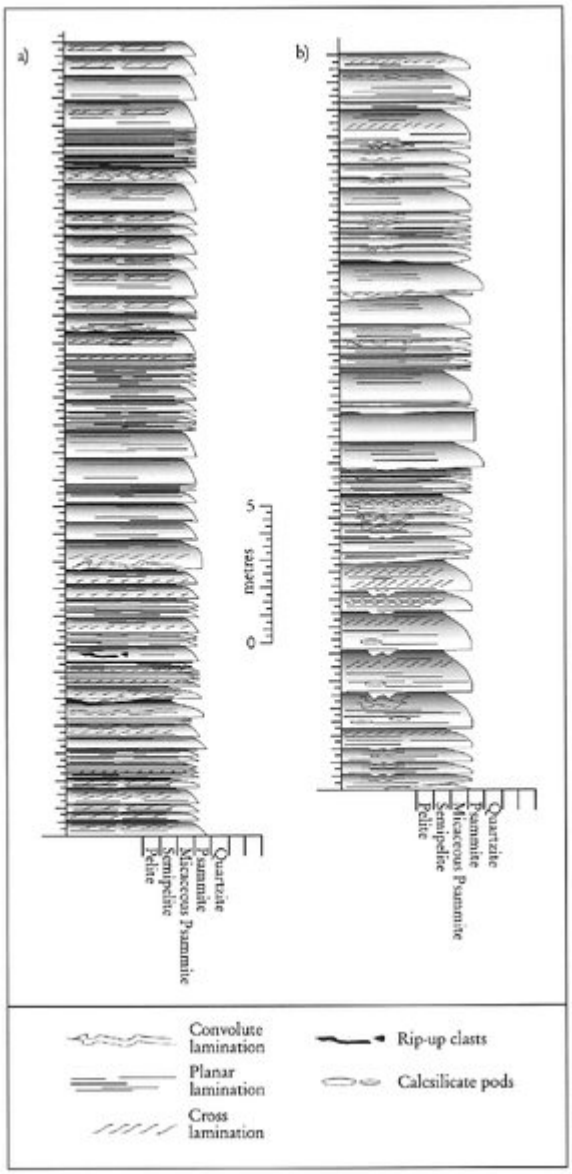
Rubha na Magach is a nationally important site for its excellent exposures of Neoproterozoic turbiditic sequences in the Grampian Group. These are the most-instructive exposures of the Loch Laggan Formation, the dominant formation of the Corrieyairack Subgroup and are particularly important in developing an understanding of the overall palaeo-environment of the basin depocentre, which was situated in the Loch Laggan area. The more-typical complex deformation and metamorphism of the Northern Grampian Highlands are less well developed here, enabling the application of sedimentological techniques that are more readily applied to undeformed Phanerozoic successions.

A vertical sequence of sedimentary structures, comparable with that of Bouma (1962), is well preserved. This consists of a basal massive division (Ta) overlain in turn by a lower planar-laminated division (Tb), a cross-laminated division (Tc), an upper planar-laminated division (Td) and is capped by semipelite (mud, Te). The preservation of rip-up clasts, scours and the sharp-based nature of the beds indicate that these turbiity currents were of very high density and it is concluded that the Loch Laggan Psammite Formation was deposited by turbidity currents in a sub-marine channel system.

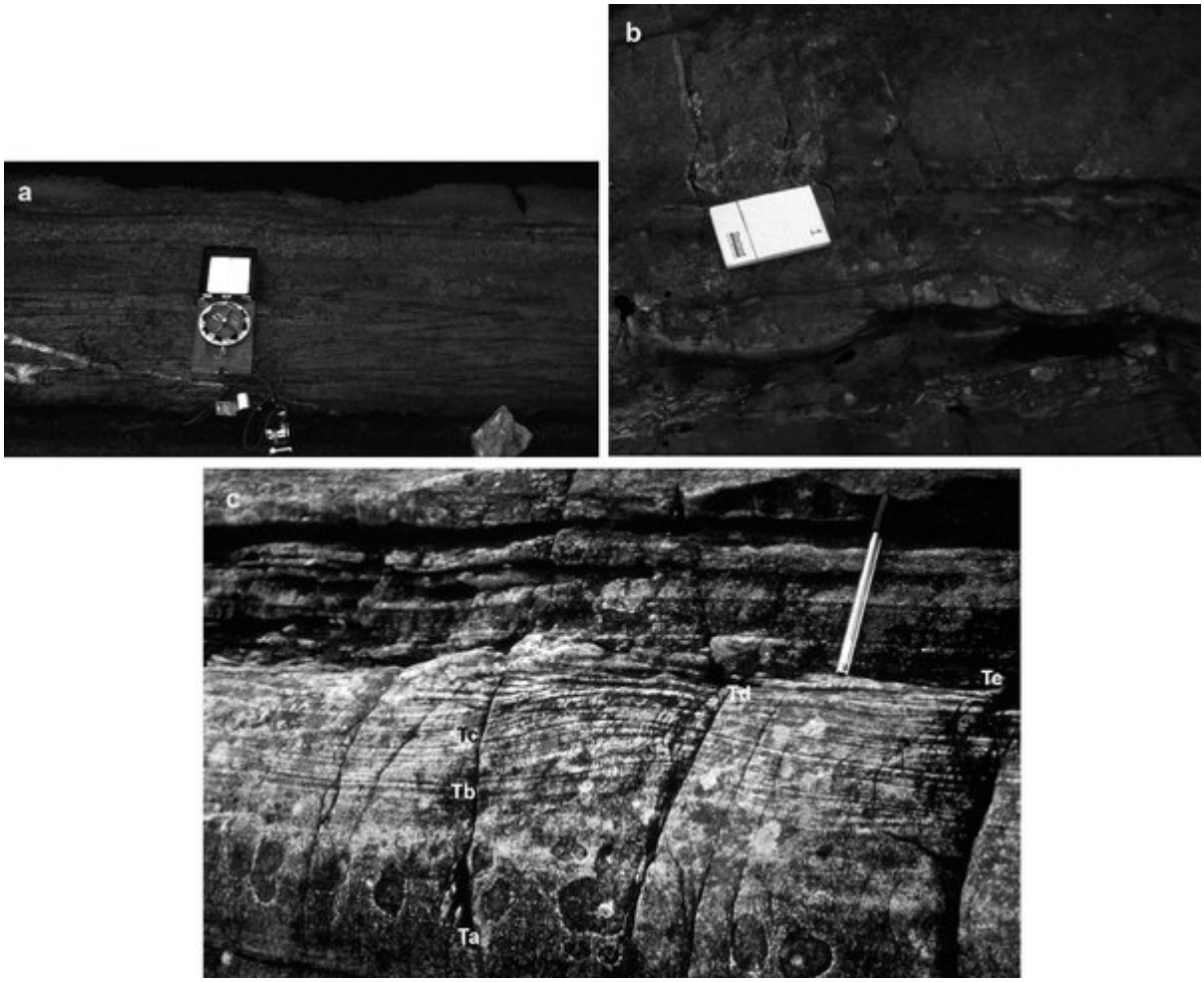
References



(Figure 5.22) Map showing the location of the Rubha na Magach localities and the general geology of the area to the north-west of Loch Laggan. The overall geological setting is given in (Figure 5.18).



(Figure 5.23) Measured sedimentary logs for: (a) Rubha na Magach [NN 4618 8492]. (b) lochside exposures at [NN 4653 8516]. Note the crude thinning and fining-upward cycles from thick-bedded psammite, micaceous psammite and semipelite up into thinner bedded micaceous psammite and semipelite, shown to illustrate the lithofacies present. Log (a) is c. 50 m higher in the stratigraphy than log (b).



(Figure 5.24) (a) Complex ripple-drift cross-lamination in a thick bed of micaceous psammite at Rubha na Magach [NN 4618 8492]. Open compass is 17.5 cm long. (Photo: C.J. Banks.) (b) Loading and convolute lamination on a thick micaceous psammite grading into semipelite. Also shows a calcsilicate pod below the notebook. Lochside exposure at [NN 4653 8516]. Notebook is 20 cm long. (Photo: C.J. Banks.) (c) Bouma units Ta to Te in a thick psammite to semipelite bed on the Rubha na Magach promontory at [NN 4618 8492]. A basal massive psammite (Ta) passes into a lower plane bed (Tb), a cross-laminated horizon (Tc), an upper plane bed (Td) and is finally capped by semipelite (Te). Pen is 15 cm long. (Photo: J.A. Winchester.)