Abhainn Gleann nam Fiadh (Glen Affric)

[NH 194 259]

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Introduction

The Abhainn Gleann nam Fiadh GCR site provides clean-washed sections through psammites of the Glenfinnan Group in which sedimentary structures are well seen. Cross-bedding and convolute bedding are locally common within psammite lithologies in the Moine Supergroup, and this GCR site is representative of the style and nature of these sedimentary structures. Although the Moine rocks in the Glen Affric area have been highly deformed and metamorphosed by both Neoproterozoic and Caledonian tectonic events, original sedimentary features are locally preserved, particularly in low-strain areas, albeit in a considerably modified state. In the Glen Affric region, metamorphism attained lower-amphibolite facies.

The Abhainn Gleann nam Fiadh section lies immediately west of the hinge zone of a sideways closing, tight F3 antiform whose axial plane here trends north–south (Figure 7.10). The well-defined sedimentary structures lie within the Cannich Psammite Formation. The effects of F2 and F3 deformation on the cross-bedding and slump folding are to oversteepen the angular relationships on this western limb of the fold. Similar features are folded and flattened on the complementary eastern limb. The area was mapped as part of the geological survey of the Glen Affric district (British Geological Survey, 1986; Peacock *et al.,* 1992).

Description

The lithologies at the Abhainn Gleann nam Fiadh GCR site are dominantly thinly bedded, micaceous and feldspathic psammites, with minor semipelite and pelite units and siliceous psammite ribs. Ca1c-silicate lenses and thin layers typically 2–4cm thick are present. Quartz and minor granitic pegmatite veining is common in the semipelite and pelite units. Separate phases of veining can be distinguished, but the main phase occurred either prior to or at a very early stage of the D2 deformation and is folded by the F2 folds and boudinaged in the S2 cleavage. The later D3 deformation results in rodding of the veins and some minor folding.

Psammite units along the 550 m section of the Abhainn Gleann nam Fiadh locally show excellent cross-bedding and slump-structures (Peacock *et al.,* 1992). (Figure 7.11) illustrates one of the best examples at [NH 1950 2593]. Typically cosets are 5–15 cm thick with foreset cut-off angles up to 30°. The foresets are defined now mainly by biotite concentrations reflecting the original mud drapes. The cross-beds range from parallel cross-lamination, to small-scale troughs (10–30 cm across, and about 10 cm deep), and ripple-drift lamination in some of the more-micaceous units. Slump folds, convolute bedding, and dewatering structures are present, with the sedimentary features truncated by the overlying planar bed. Some of the minor folds of the cross-bed foresets have been interpreted as a product of current drag (Peacock *et al.,* 1992). Rotational effects associated with the D3 deformation have enhanced the angular bedding-foreset relationships where the initial geometry has been favourably orientated.

In the F3 hinge zone that is exposed in the vicinity of the waterfall near the eastern end of the section (Figure 7.10), open to tight folds occur, with a locally penetrative, N- to NW-trending subvertical axial-planar crenulation cleavage. The fold axes plunge very steeply to the north. Peacock *et al.* (1992) assign the main fold to F3, noting that it refolds tight to isoclinal small- and medium-scale F2 folds and their associated penetrative cleavage. F3 structures normally have axial planes that trend NNE to north-east, but here they are refolded about E–W-trending F4 axes, and an accompanying weak, steeply dipping, crenulation cleavage, S4, is developed.

East of the F3 hinge, downstream from the site, the section passes through the eastern limb of the fold, once more exposing the Cannich Psammite Formation. Cross-beds and slump structures are again well seen, but show evidence of

attenuation. Although deformation has been preferentially taken up in the semipelite units, thus preserving the sedimentary, structures in the psammites in a less-deformed state, the foresets commonly show minor folding. Where close small-scale F3 folds are present (e.g. at [NH 2009 2570]), the vergence of the folded cross-bed foresets varies systematically around the F3 hinge so that they show S- and Z-asymmetry on adjacent limbs.

Interpretation

The sedimentary structures and lithology of these Glenfinnan Group rocks are typical of shallow-water marine deposits, deposited both by traction currents and from suspension. They imply that the beds young towards the F3 antiformal hinge, i.e. towards the east along the stream section west of the hinge, and regionally towards the south and south-east. The detailed mapping of the area (British Geological Survey, 1986; Peacock *et al.,* 1992) shows that the psammite-pelite-semipelite sequence is folded into large-scale, tight to isoclinal F2 folds, refolded by the F3 structures. Ductile thrusts are also present. South-west from the site area the Cannich Psammite Formation defines a tight and near-vertically plunging F2 fold, whose hinge lies just south of the eastern part of Loch Affric. Hence the Abhainn Gleann nam Fiadh section lies on the eastern limb of a regional F2 fold but a western limb of an F3 antiform. Undoubtedly D3 deformation has tightened the earlier F2 fold but it seems that the cross-bedding and slump structures have avoided substantial tectonic modification owing to their initial geometry and fortuitous position relative to the F2 and F3 hinge zones. On the eastern limb of the F3 structure some D3 flattening effects are evident.

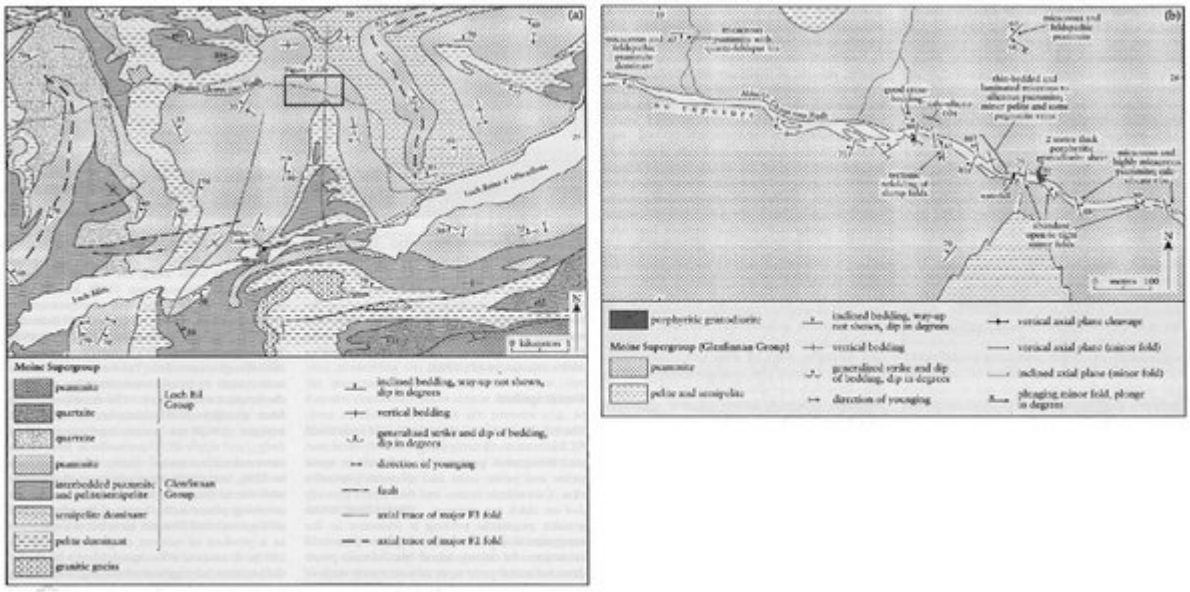
Ramsay (1967) documented the variations in angle between truncated foresets and bedding around a tight fold in psammite from the Northern Highlands of Scotland. He showed that the maximum angle is not found along the axial trace of the fold (i.e. in the hinge zone), but on one of the fold limbs where the bedding lies at 45°–55° to the axial trace. Dependent on the original geometry of the foresets, they may be flattened or oversteepened on opposite limbs. This is in line with theoretical predictions for the deformation of pre-existing angular structures around tight folds formed by a combination of simple shear followed by pure shear. Internal rotation of sedimentary features within individual psammite units can modify this geometry dependent on the local strain pattern and the variations in lithology of the folded sequence.

Conclusions

Within the well-exposed and clean-washed section of the Abhainn Gleann nam Fiadh, cross-bedding, convolute bedding and slump structures are preserved in the Cannich Psammite Formation. The psammite unit lies within a strongly deformed and metamorphosed sequence of Neoproterozoic Glenfinnan Group psammites, semipelites, pelites and subsidiary quartzite units. The sediments were originally part of a shallow-marine, possibly tidally influenced, succession of sands, silts and muds with some thin reworked clean-washed sand lenses. Despite the strong deformation and lower amphibolite-grade metamorphism, the sedimentary structures are clear and eminently recognizable, and unequivocally show the direction of younging. They are by no means unique in the Moine Supergroup, but the Abhainn Gleann nam Fiadh section is of regional importance and shows an excellent representative example of these features.

The sedimentary structures owe their preservation to a combination of favourable circumstances. The psammite occurs on the limb of a major F2 fold in a position where original bedding-foreset angles were preserved or possibly rotated to slightly steeper angles during D2 deformation. Subsequently, a near-vertically plunging F3 major fold developed. The sedimentary structures on both the western and eastern limbs of this F3 fold have been affected differently. Those on the western limb are little deformed, with their original angles slightly oversteepened, whereas those on the eastern limb have been flattened and locally folded by the D3 deformation.

References



(Figure 7.10) (a) Map of the Abhainn Gleann nam Fiadh site area and surrounding geology.(b) Detailed map of the Abhainn Gleann nam Fiadh site area and surrounding geology.

(Figure 7.11) Cross-bedding and slump structures in psammite with micaceous laminae. Succession youngs to the east (top of photo). The hammer is 37 cm long. Abhainn Gleann nan Fiadh [NH 1945 2591]. (Photo: British Geological Survey, No. P219449, reproduced with the permission of the Director, British Geological Survey, © NERC.)