7 Garva Bridge

[NN 524 953]

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Published in: The Dalradian rocks of the northern Grampian Highlands of Scotland PGA 124 (1–2) 2013
https://doi.org/10.1016/j.pgeola.2012.07.010 Also on: NORA

7.1 Introduction

The environs of Garva Bridge, in the upper catchment of the River Spey, are the type area for the Glenshirra Subgroup, the oldest part of the Dalradian Supergroup. The sedimentological detail preserved at this GCR site in the lower stretch of the Allt Coire Iain Oig, together with the lithological features observed in the surrounding area, are highly pertinent to interpretations of basin evolution for the lower part of the Grampian Group.

The Glenshirra Subgroup crops out in a near-circular inlier covering approximately 30 km^2 and informally referred to as the Glenshirra Dome (Figure 5.18), (Figure 5.19). This dome dominates the outcrop pattern in the north-west corner of the BGS 1:50 000 Sheet 63E (Dalwhinnie, 2002). It is cut by The Allt Crom Complex in the north-east and by the Corrieyairack Pluton in the south-west. The stratigraphy was originally described by Haselock *et al.* (1982), who recognized four formations in the north of the dome, and Okonkwo (1988) who recognized two formations in the south. Recent detailed surveying has replaced these with a single formation, the Garva Bridge Psammite Formation, containing a distinctive pebbly psammite (the Gairbeinn Pebbly Psammite Member). Haselock and Leslie (1992) demonstrated the distinctively strong magnetic nature of the Gairbeinn Pebbly Psammite Member and used that characteristic to help define lithological boundaries in unexposed ground. Any discrepancies between the published map and the earlier studies result largely from previously unrecognized fold repetition.

The boundary between the Garva Bridge Psammite Formation and the overlying Coire nan Laogh Semipelite Formation of the Corrieyairack Subgroup was recognized as a zone of high strain referred to as the Gairbeinn Slide (Haselock *et al*., 1982; Okonkwo, 1988). However, recent investigations have concluded that the high strain is focused at the boundary between contrasting lithologies within a conformable succession (Smith *et al*., 1999). Comparative geochemical studies (Haselock, 1984) and sedimentological analysis (Glover *et al*., 1995; Glover, 1998; Banks and Winchester, 2004) have emphasized the distinctive immature fluviatile to shallow-marine nature of the Glenshirra Subgroup, which is in sharp contrast to the deeper marine, turbiditic nature of the succeeding Corrieyairack Subgroup. Banks and Winchester (2004) identified this change in sedimentary environment as a sharp sequence boundary, recording a major reorganization of basin architecture. They considered this to be so significant as to warrant elevation of the Glenshirra sequence from subgroup to group status. However, this has not been adopted in this special issue.

7.2 Description

The Garva Bridge Psammite Formation consists mainly of psammite with lesser amounts of micaceous psammite and thin beds of semipelite. The formation is well exposed in the north bank tributaries to the River Spey, including the Allt Coire Iain Oig and Allt a' Ghamnha, and in hillside exposures around Gairbeinn [NN 46 98]. On Creag Mhor [NN 488 974] the succession is relatively more micaceous with common thin beds of semipelite. The base of the formation is not exposed and therefore the 2 km observed thickness provides a minimum estimate only. The following detailed descriptions are based largely on those of Glover (1998).

The formation comprises two lithological associations; a psammite association that occurs near the base of the succession and a heterolithic association of psammite, micaceous psammite and semipelite. The heterolithic association is dominant and, while it occurs both above and below the psammite association, it broadly overlies the psammite association; the relationships are well exposed in the Allt Coire Iain Oig section [NN 519 979 to] [NN 524 949], which

includes the designated Garva Bridge GCR site at [NN 524 953].

Rocks of the psammite association are typically pink and range from well bedded with cross-bedding in the Allt a' Ghamnha section [NN 491 958] to [NN 483 975], to massive and, in places, flaggy and coarse grained with increasing deformation and recrystallization in the Allt Coire Iain Oig [NN 519 979] to [NN 524 949]. In the Allt a' Ghamnha, where the association is approximately 500 m thick, individual gently lensoid psammite bodies up to several metres thick are stacked vertically and are inferred to overlap laterally. Each psammite body is made up of a number of cross-bedded sets arranged into thinning upwards packages. Tectonic flattening has greatly reduced intersection angles, both at set-bounding surfaces such that cross-bedding is not prominent and at psammite body boundaries (Glover, 1998).

The heterolithic association in the Allt Coire Iain Oig shows interdigitation of psammite, micaceous psammite and semipelite on centimetre to metre scales (Figure 5.20)a. Sedimentary structures are widely preserved in spite of the metamorphic recrystallization, largely as a result of original mud drapes which, as thin semipelitic or pelitic selvedges, now accentuate relict bedding structures. Psammite-dominated parts of the association show small-scale cross-bedding and planar bedding, ripple cross-lamination and local features thought to be hummocky cross-stratification. Feldspar augen are interpreted as metamorphic overgrowths on originally smaller detrital grains. In the muddier parts of the association, sharp-based white or pale-grey psammites pass gradually upwards and downwards into progressively more-micaceous (originally muddier) lithologies in stacked metre-scale cycles. The gradual change occurs through a series of sharp-based thin and medium beds (3 to 50 cm). These show a variety of sedimentary structures including ripple cross-lamination and cross-bedding, scour and gutter casts, convolute laminations and local normally graded bedding.

The Gairbeinn Pebbly Psammite Member is restricted to the north-western part of the Glenshirra Dome and is best seen on the slopes of Gairbeinn [NN 464 985]. The member is lithologically similar to the remainder of the formation but also includes coarser grained beds, which become pebbly towards the top of the formation (Figure 5.20)b. The pebbles are composed entirely of quartz and, whilst now significantly flattened, are interpreted to have been originally up to 3 cm in diameter. Pebbles occur within beds of micaceous psammite and less commonly in psammite, with bed thickness typically less than 0.3 m but locally up to 1 m. Pebbly beds typically account for 10% of the member.

The Garva Bridge Psammite Formation thickens markedly towards the north-west. This is largely a result of the much greater thickness of the psammite association and is enhanced by the spatial restriction of the pebbly psammite member referred to above. The heterolithic association generally overlies the psammite association, albeit with some possible interdigitation in the south-east.

The contact between the Gairbeinn Pebbly Psammite Member and the overlying Coire nan Laogh Semipelite Formation is almost continuously exposed along the eastern slopes of Gairbeinn [NN 462 986]. Within 60 m of the contact, the Gairbeinn Pebbly Psammite is platy with both intense flattening and elongation of pebbles down dip to the north-west. The base of the Coire nan Laogh Semipelite Formation is represented by an abrupt change to schistose to gneissose semipelite with quartzofeldspathic layers and lenses up to a few millimetres across. A few lenses of quartzite occur in the lower few metres of the formation, but otherwise the semipelite is homogeneous. The upper parts of the formation are marked by an increase in the proportion of psammite layers. These form the lower parts of composite psammite-semipelite beds which reflect graded bedding. The incoming of psammite layers marks a progressive transition into the overlying dominantly psammitic Loch Laggan Psammite Formation (see the *Rubha na Magach* GCR site report).

Deformation and amphibolite-facies metamorphic recrystallization are variably intense. The succession is generally the right way up, although SE-verging small-scale fold structures are present locally, and a SW-closing and SE-verging medium-scale reclined fold-pair in the Creag Mhor area [NN 486 970] repeats part of the succession.

Structures related to three phases of deformation can be recognized across the area. An intense schistosity is developed parallel to bedding planes in micaceous lithologies during the D1 phase and, although no discrete F1 folds have been recognized, this bedding-parallel schistosity is crenulated in the hinge-zone of F2 folds. The majority of the minor F2 folds have a consistent south-easterly vergence; where abundant as on Creag Mhor, the F2 folding is accompanied by intense crenulation of the S1 schistosity. These crenulations, and a rodding in quartzofeldspathic segregations, give rise to a

prominent L2 lineation; the dominant planar schistosity is probably in reality a composite D1-D2 structure and lies parallel to lithological layering. The shape of the Glenshirra Dome is controlled by a major antiformal F3 fold. Minor open folds of probable D3 age occur at [NN 4936 9660] and intersecting crenulations occur in many semipelite exposures. Distinguishing S2 and S3 crenulations is however difficult due to the variable orientation of the S2 axial surfaces and the lack of any significant development of a crenulation cleavage in either the D2 or the D3 phase of deformation.

7.3 Interpretation

A combination of lithological associations, bedforms and sedimentary structures, albeit modified by deformation and metamorphic recrystallization, allow an interpretation of the depositional environment of the Glenshirra Subgroup. Cross-bedding within the psammite association demonstrates that these strata were deposited largely from traction-dominated currents. The stacking of sandstone bodies, each comprising thinning upward sets, is consistent with deposition as bedforms and barforms within a fluvial setting. The absence of intervening primary mud deposition suggests little preservation of overbank material. This could have been due either to a braided-river environment or the lack of vegetation available in the Neoproterozoic to bind overbank material.

The variety of sedimentary structures in the heterolithic association, including ripple cross-lamination and cross-bedding, scour and gutter casts, hummocky cross-stratification, convolute laminations and local normally graded bedding point to deposition in a shallow-marine storm-influenced environment. The cleaning and muddying upward cycles are interpreted as having been controlled by changes in relative sea level (Glover, 1998).

The depositional environment of the Gairbeinn Pebbly Psammite Member cannot be well constrained because of the absence of well-preserved sedimentary structures. It is inferred to have been dominantly fluvial, with the muddy pebbly rocks possibly the product of mass flow rather than traction (Glover, 1998).

The overall geometry of the depositional basin (Figure 5.21) can be inferred from the gross disposition and thickness of the lithological associations outlined in (Figure 5.19). A number of features suggest that the north-western part of the dome represents a more-proximal environment. These include a greater thickness of both the psammite association and of the succession as a whole. Additionally, the Gairbeinn Pebbly Psammite Member is only present in the north-west, whereas the heterolithic association is dominant in the south-east. These observations reflect a lateral facies change from dominantly fluvial in the north-west to shallow-marine, storm-dominated facies in the south-east.

The overall evolution of the Glenshirra Subgroup is interpreted as a gradual north-westwards backstepping of fluvial facies and a concomitant increase in the distribution of shallow-marine sedimentation (Glover, 1998) with a renewed phase of more-extensive fluvial deposition close to the top of the formation.

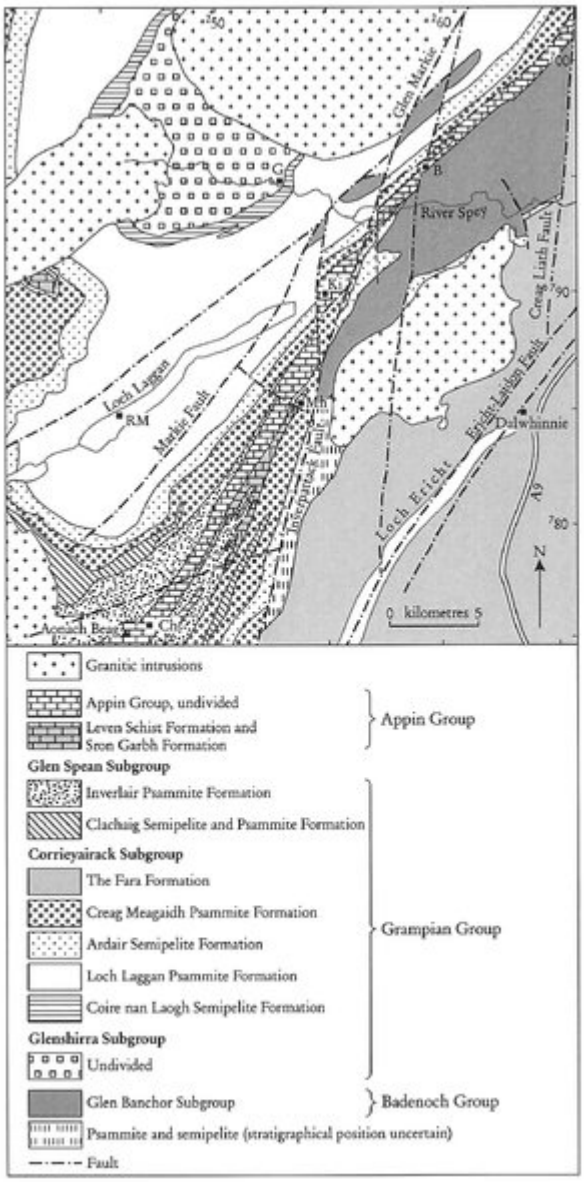
The abrupt change from psammites that represent fluvial deposits to semipelite derived from muddy sediments at the base of the Coire nan Laogh Semipelite Formation, is interpreted as representing a major basin-flooding event (Banks and Winchester, 2004). This starved the basin of coarse clastic material and led to the deposition of offshore mud. Progressive basin deepening led to the onset of deposition by turbidity currents in the upper part of the formation. Quartz-rich lenses near the base of the semipelite may represent reworking of the underlying originally sandy deposits in an offshore environment.

7.4 Conclusions

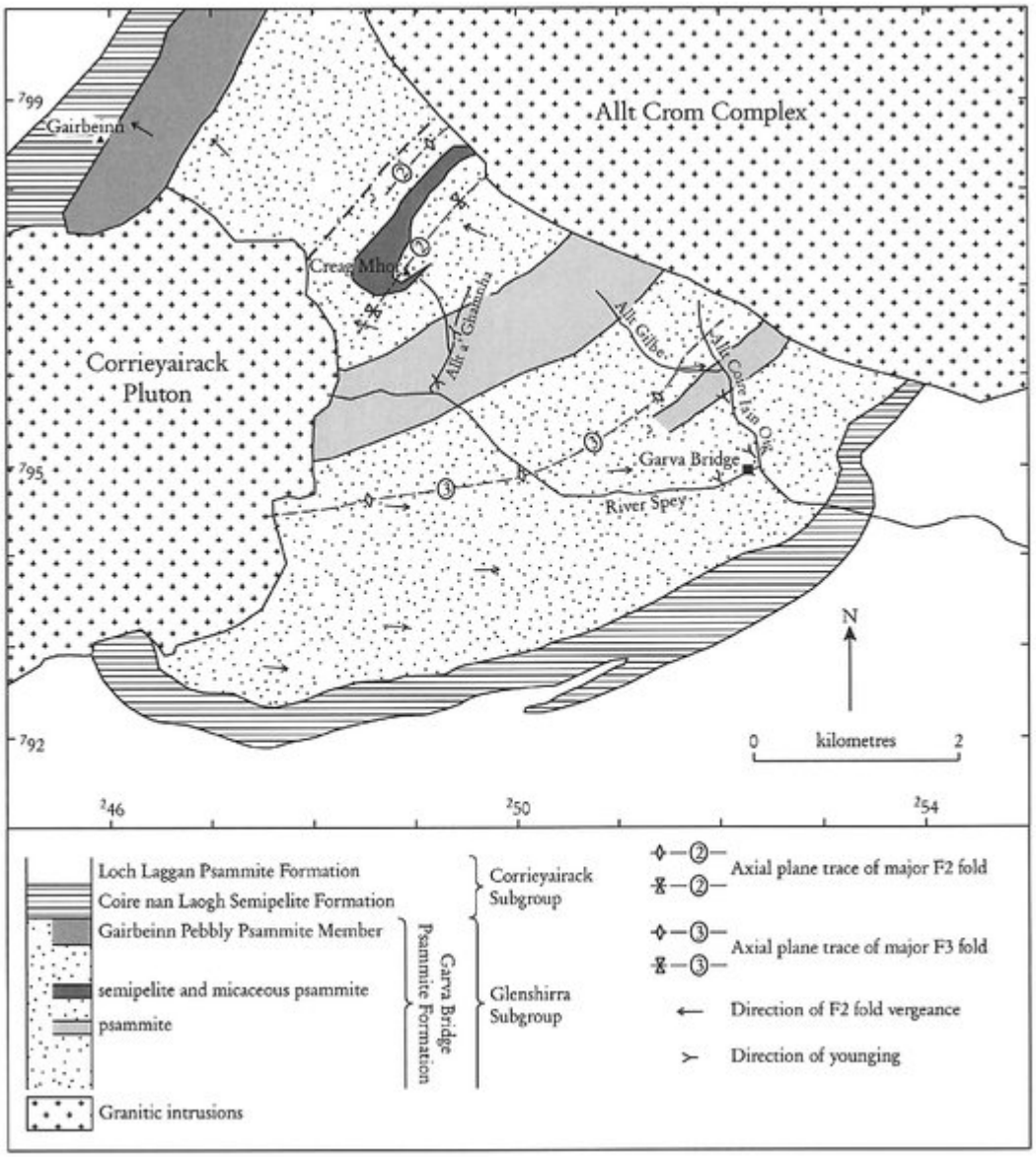
The Garva Bridge GCR site represents the original type-area for the Glenshirra Subgroup and preserves evidence relating to the depositional environment and basin geometry of the lowest exposed part of the Dalradian succession. The combination of lithological associations and sedimentary structures in the Garva Bridge Psammite Formation demonstrate that fluvial sediments passed laterally to the south-east into shallow-marine, storm-influenced sediments. Through time, the area of fluvial deposition back-stepped towards the north, to be replaced by more-extensive shallow-marine deposition. A major flooding event marked by an abrupt change of lithology at the base of the Coire nan Laogh Semipelite Formation cut off the sand-grade sediment supply. This was probably related to basin deepening,

which resulted in the onset of deposition from turbidity currents.

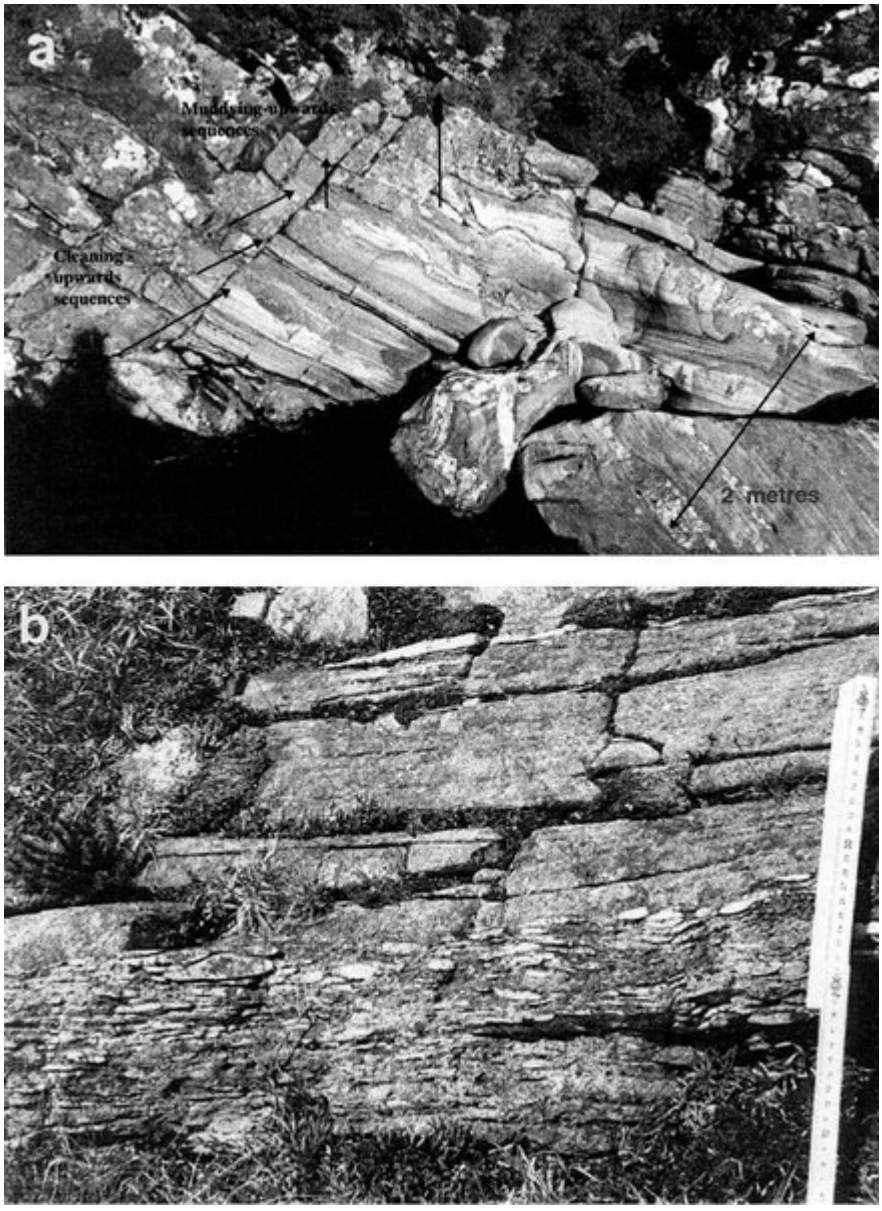
References



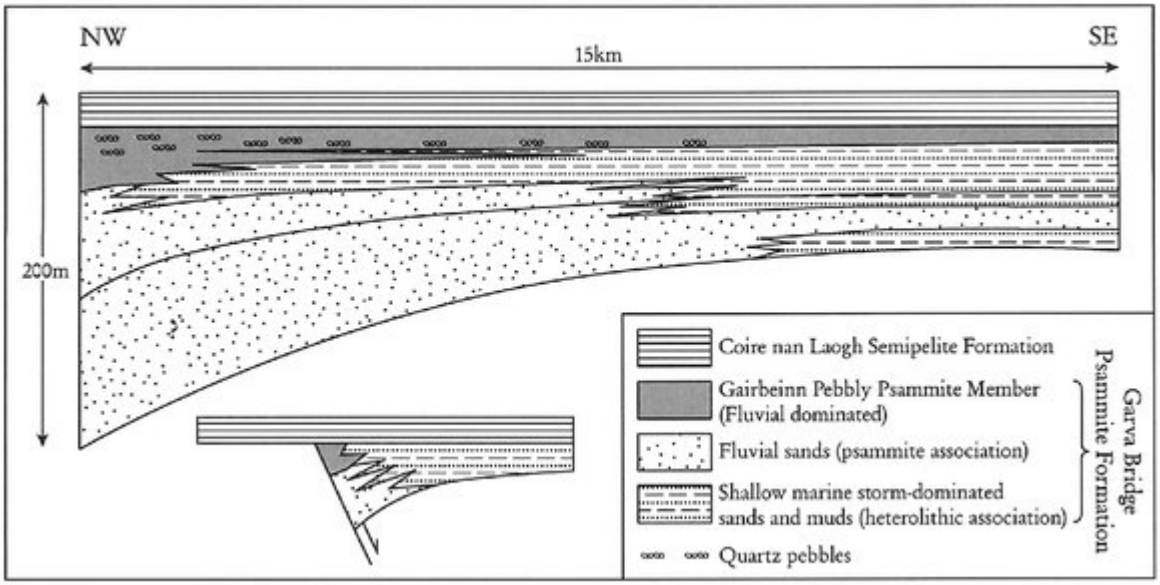
(Figure 5.18) Map of the area around the Geal Charn–Ossian Steep Belt after Robertson and Smith (1999), with GCR sites superimposed. B Blargie Craig, Ch Coire Cheap, G Garva Bridge, Ki Kinloch Laggan, Mh Allt Mhainisteir, RM Rubha na Magach.



(Figure 5.19) Map of the Glenshirra Dome and the area of the Garva Bridge GCR site. The overall geological setting is given in (Figure 5.18).



(Figure 5.20) (a) Heterolithic association, Garva Bridge Psammite Formation, Allt Coire Iain Oig. Cleaning and muddying upwards cycles. The clean sand component of each cycle is invariably ripple cross-laminated. The more-muddy parts of each cycle contain thin planar beds of psammite (originally clean sand) or small gutter casts filled with heterolithic sand and mud. (b) Numerous elongate quartz pebbles within micaceous psammite in the Gairbeinn Pebbly Psammite Member of the Garva Bridge Psammite Formation, Gairbeinn. The parting present in the psammite above this pebbly bed is tectonic rather than original bedding. (Photos: B.W. Glover.)



(Figure 5.21) Schematic cross-section through the Glenshirra Subgroup illustrating the proposed lateral facies changes and the possible basin configuration. After Glover (1998).