Skiag Bridge

[NC 234 256]–[NC 240 237]

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Introduction

At Skiag Bridge, atypically for the Assynt district, the lowest imbricate zones and Sole Thrust of the Moine Thrust Belt are clearly displayed and readily accessible, lying close to the A894 road (Figure 5.23)a. The area was originally mapped for the Geological Survey (Peach *et al.,* 1907 ; and has been much visited since (e.g. MacGregor and Phemister, 1948; Johnson and Parsons, 1979). The importance of the area, as recognized by Elliott and Johnson (1980), is that it links the rather weakly developed imbricate systems in the footwall to the Glencoul Thrust in its type area farther north-east with the much more-extensive imbricate systems around Inchnadamph to the SSE.

Coward (1984b) remapped the site area as part of a major research programme that re-assessed the evolution of the Moine Thrust Belt. By tracing thrust linkages and establishing the internal arrangement of imbricate thrusts and major detachments, Coward identified three main duplexes (Figure 5.23)a,b). The upper one consists of imbricated Durness carbonate rocks and lamprophyre sills. The floor thrust to this system lies a few metres above the base of the carbonate rocks and it acts as a roof to the underlying middle duplex, formed in Fucoid Beds, Salterella Grit and involving a few metres of Durness carbonate rocks. The lowest duplex contains a few metres of Pipe Rock and Fucoid Beds and its floor is the regional Sole Thrust. A few minor thrusts occur beneath the Sole Thrust, within the underlying Pipe Rock, and some of these have been the focus of microstructural investigations aimed at studying processes of cataclastic faulting in quartzites (Lloyd and Knipe, 1992; Knipe and Lloyd, 1994). All thrust structures show substantial variations along strike; the site provides an excellent illustration of the lateral variations in thrust belts.

Coward (1984b) also mapped out thrust-related folds. These are particularly well developed within the carbonate rocks of the upper duplex where the fold axes trend NNW–SSE and the structures face SSW, highly oblique to the inferred thrusting direction. Coward interpreted these as forming within an important lateral ramp zone, which gave rise to a wrench-shear component of deformation during thrusting.

Description

Unlike the imbricate systems that are readily seen on the sparsely vegetated mountains of Arkle, Foinaven and Conamheall in northern Sutherland, those of western Assynt are not well appreciated from distant views. The Skiag Bridge GCR site lies astride a major strike swing in the thrust belt, from NNE–SSW and perpendicular to the inferred direction of thrusting on the southern side of the Glencoul GCR site, to NNW–SSE, parallel to the north-eastern shore of Loch Assynt. This swing coincides with a major variation in the content of imbricate slices that can be best appreciated by considering three transects along well-exposed stream sections (Johnson and Parsons, 1979).

The northern stream section [NC 234 256]–[NC 237 257] is dominated by Fucoid Beds. Coward (1984b) recognized ten repetitions of this member. Presumably the floor thrust to this system lies just within the Fucoid Beds and the section must intersect rather deep levels in the duplex. Only towards the upper, eastern reaches of the stream do carbonate rocks dominate the outcrop. Coward (1984b) suggested that this region contains the major detachment horizon that acted as a roof to the duplex (his 'system B') and a floor to an overlying duplex (his 'system A'). Overall there is a tendency within the imbricate slices of 'system B' to attain steeper bedding dips up-section. This implies that a process of back-steepening occurred during thrust stacking, as predicted by the 'piggy-back' thrusting model.

The central stream section [NC 235 249]–[NC 238 255] is the best transect in which to appreciate stratigraphical repetition through thrust imbrication in this segment of the thrust belt. Coward (1984b) recorded 15 such repetitions, in which the Salterella Grit (with a stratigraphical thickness of less than 8 m) is encountered 13 times in 1 km on the ground.

This geometry (Middle Duplex or Coward's 'system B') underpins the generalized cross-section of (Figure 5.23)b.

The southern stream section (Allt a' Chalda Beag; [NC 241 237]–[NC 243 243]) contains only imbricated Durness Group carbonate rocks and lamprophyre sills of Coward's 'system A. The strata and thrusts occur in folds that face southwest and have NNW-trending axes. Both the Ghrudaidh and Eilean Dubh formations are represented, the former dominating the lower outcrops while the latter is more prevalent at higher structural levels. These observations suggest that the duplex has a floor just a few metres up into the Ghrudaidh Formation and a roof within the Eilean Dubh Formation. The floor thrust level is maintained farther south in the ground around Inchnadamph (e.g. the Stronchrubie Cliff GCR site) suggesting that these lowest parts of the Durness Group carbonate succession acted preferentially as a weak detachment horizon during thrusting.

Interpretation

The stratigraphical content of the three duplex systems within and adjacent to the Skiag Bridge GCR site varies laterally along the thrust belt. Overall, the Sole Thrust climbs up the stratigraphical section to the south. At the Stronchrubie Cliff GCR site, 3 km to the SSE, the imbricate slices contain only carbonate rocks of the Eilean Dubh Formation. In contrast, for the areas north of the Skiag Bridge GCR site it is the base of the Fucoid Beds that is the principal basal detachment horizon. The major lateral ramp inferred from the stratigraphical content of duplexes at Skiag Bridge is mirrored in a zone of folds that are well displayed by Coward's 'system A'. The SW-facing folds appear to be rotated counterclockwise and their development may reflect a component of sinistral wrenching. These folds, presumably formed at the oblique tips of propagating thrusts, are especially well displayed just east of the Allt a' Chalda Beag [NC 243 239]. Elsewhere, folds in the carbonate rocks may be related to underlying thrust stacks, for example the lateral culminations in Coward's imbricate 'system B' [NC 239 248]. These culmination-related folds also have axes that trend oblique to the thrusting direction. However, the fact that the higher imbricate system is folded by underlying imbricate zones is supportive of a 'piggy-back' thrusting sequence.

Apart from the thrusts and related folds, a series of steep, apparently wrench faults and minor extensional structures also occur within the Skiag Bridge GCR site. The nature and significance of these structures is unclear, but collectively they appear to form part of a WNW-directed array traced by Coward (1982, 1984b) that developed towards the end of regional thrusting. Coward interpreted these as the edges of kilometre-sized gravitational slides ('surge zones') that are much more clearly developed within the overlying Glencoul Thrust Sheet.

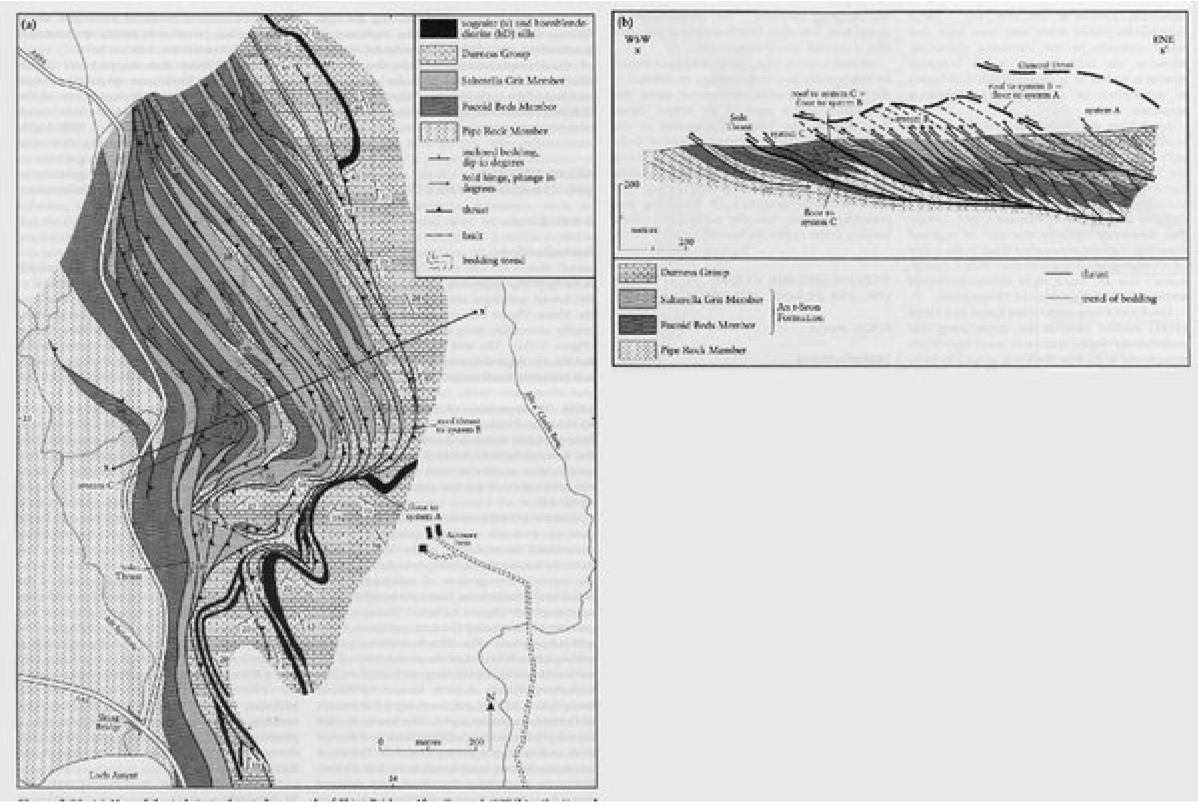
Lloyd and Knipe (1992) and Knipe and Lloyd (1994) studied parts of the thrust array that underlies the duplex systems in detail, specifically those found in the Pipe Rock (e.g. at [NC 236 243]). These late thrusts developed by brittle processes but grain-fracturing processes were accompanied by crystal plasticity and pressure solution. These studies have underpinned subsequent microstructural analyses of upper crustal faults, particularly from oil-prone sedimentary basins.

Conclusions

The Skiag Bridge GCR site provides easily accessible exposures of thrust-related stratigraphical repetitions and related folds. There are over 12 repetitions of individual units exposed in stream sections, giving rise to complex thrust-belt geometries. The structurally higher imbricate systems are folded by the underlying ones, suggesting an overall foreland-directed ('piggy-back') thrusting sequence. Comparisons between different transects through the site imply that an important lateral ramp exists on the regional Sole Thrust, climbing up-section from north to south, from the base of the Fucoid Beds of the An t-Sron Formation to just within the Ghrudaidh Formation of the Durness Group. This ramp zone was long-lived during the formation of thrust structures hereabouts and has strongly influenced the geometry of thrust-related folds, inferred thrust ramps, and associated culminations, which are all aligned oblique to the thrusting direction. The overall sense of movement was thus WNW-overshear together with a sinistral lateral component.

All fault zones at Skiag Bridge are characterized by brittle cataclastic deformation, in contrast to the ductile mylonites that occur along the structurally higher parts of the Moine Thrust Belt (e.g. at the Stack of Glencoul in the Glencoul GCR site). Detailed studies of faults within the Pipe Rock Member have been particularly important internationally for their contribution to the understanding of microstructural processes of fracturing and cementation that typically accompany brittle faulting in the upper continental crust.

References



(Figure 5.23) (a) Map of the imbricate thrust slices north of Skiag Bridge. After Coward (1984b). (b) Cross-section through the Skiag Bridge GCR site. Location x-x' on (a). Note that the line of secton is oblique to the direction of thrusting.