Loch Borralie, Smoo Cave and Sangro Bay, North-west Highlands - an excursion

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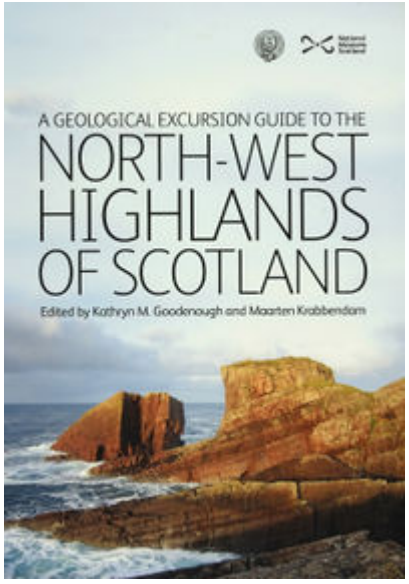

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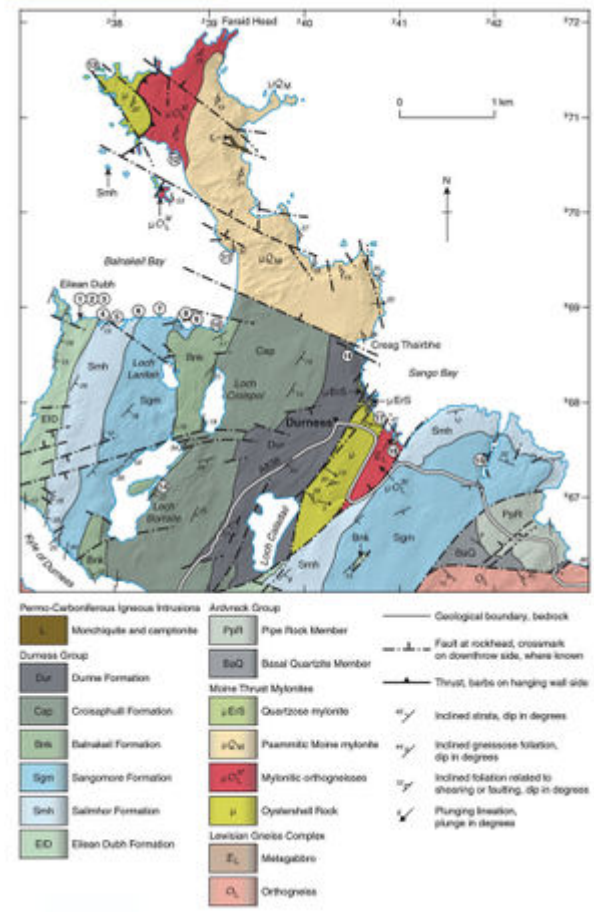

Simplified geological map of the Durness area, after British Geological Survey (2002a), showing the localities described in

Excursion 14.

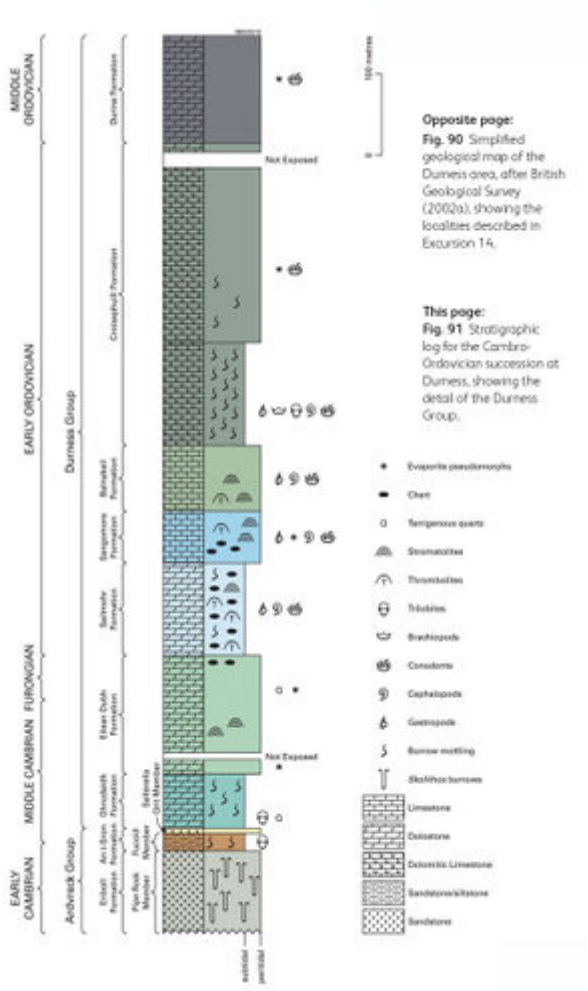

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Fig. 90 Simplified geological map of the Durness area, after British Geological Survey (2002a), showing the localities described in Excursion 14.

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Fig. 91 Stratigraphic log for the Cambro-Ordovician succession at Durness, showing the detail of the Durness Group.

Stratigraphic log for the Cambro-Ordovician succession at Durness, showing the detail of the Durness Group.

File:EGS NWH FIG 100.jpg

A stack of shallowing upward parasequences in the upper Sailmhor Formation at Pocan Smoo, Locality 14.15. Within each parasequence there is a thick dark grey subtidal base overlain by a thin lighter grey peritidal cap. The Sailmhor–Sangomore formation boundary is marked by the prominent white chert at the cliff top, adjacent to the fence. (Photograph: © M. P. Smith) Locality 14.3 [NC 3769 6880]

File:EGS NWH FIG 101.jpg

Roadside exposure of sub-vertical carbonate-cemented red breccia-sandstone (?Permo-Trias) and white carbonate vein infill of cavity in Durness Group dolostone oriented parallel to the Sangobeg Fault, Locality 14.16. View looking north. (Photo-graph: © R. E. Holdsworth)

By Robert Raine, Paul Smith, Bob Holdsworth and Rob Strachan

Excursion 14B from: Goodenough, Kathryn M. and Krabbendam, Maartin (Editors) A geological excursion guide to the North-west Highlands of Scotland. Edinburgh : Edinburgh Geological Society in association with NMS Enterprises Limited, 2011.

Information about this excursion:

Durness, Balnakeil Bay and Faraid Head, North-west Highlands - an excursion

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Locality 14.14 The Croisaphuill Formation at Loch Borralie. [NC 384 670]

The upper part of the Durness Group is not visible in Balnakeil Bay, and the Croisaphuill Formation, which overlies the Balnakeil Formation, is best examined on the east side of Loch Borralie. Park at the Cape Wrath Hotel [NC 380 662] and cross the field to the north, towards Loch Borralie. Proceed along the eastern side of the lake, crossing the end of one wall that descends to the loch, until a second wall in poorer repair is met where the strait between island and shore is at its narrowest [NC 3844 6709]. This point is very close to the base of the Croisaphuill Formation, which extends down-dip for over half a kilometre to the east.

The lower part of the Croisaphuill Formation comprises burrow-mottled limestones with abundant brown cherts. The burrow fills were pene-contemporaneously dolomitised (Morrow, 1978), and in places evidence of this can be seen where dolomite burrow-fills are reworked into parallel and ripple lamination (as in the ribbon-rock lithofacies of the Balnakeil Formation). Following the wall up to the cairned summit of the small hill provides a discontinuous but representative section through the

lower 90m of the formation. Cherts become less abundant, but otherwise this part of the Croisaphuill Formation is remarkably uniform. This is the most macro-fossil rich part of the Durness Group, and close searching will reveal a variety of dolomitised and silicified gastropods, several species of the silicified snail operculum Ceratope*a* and a moderately diverse cephalopod fauna, including both coiled and orthoconic forms. Conodonts indicate that the unit is of basal Arenig age, and the base of the formation marks a major shift away from the microbially dominated Middle Cambrian–Tremadocian part of the group. This change in depositional architecture was caused by a eustatic rise in sea-level that flooded most of Laurentia and which constitutes one of the highest sea-level stands in the Phanerozoic.

There are excellent views from the summit cairn of the down-faulted outlier of Durness Group that constitutes the east side of the Kyle of Durness, surrounded by Precambrian and Lower Cambrian rock units.

Locality 14.15 Smoo Cave. [NC 418 671]

Smoo Cave, a short distance east of the main village of Durness, is well signposted and has a small car-park. Walk eastwards from the car-park through the picnic area and down the slope to a series of swallow holes. At the top of the opposite slope, turn left at the T-junction and turn northwards along the cliff top on the east side of Smoo inlet. The path doubles back and descends into the inlet, affording an excellent view of the large entrance (approximately 40m wide and 15m high) – the cave results from the interaction of coastal processes with a karst drainage system. At the rear of the entrance chamber is a large fan of vegetated flowstone (undated) and there is some flowstone on the walls. A covered walkway leads to a second chamber where Allt Smoo descends a shaft into a large pool. Boat trips into a third chamber are sporadically available.

The accessible part of Smoo Cave is developed entirely within the Sangomore Formation, but the inlet shows good sections across the Sailmhor–Sangomore formation boundary (See image). Two prominent chert bands run down the length of the inlet, offset half-way down by a small fault, and the formation boundary lies 3 metres above the base of the lower chert. The upper part of the Sailmhor Formation comprises a series of parasequences that consist of dark, burrow-mottled subtidal carbonates overlain by thin, pale, laminated peritidal carbonates. The shallowing-upward parasequences form part of a classical, lower order, shallowing upward succession in which the subtidal portions of the parasequences progressively thin upwards, and there is a concomitant decrease in the subtidal-peritidal balance of each parasequence. This aspect is clearly illustrated from a distance by the proportion of dark subtidal to pale peritidal carbonate. A closer view of these parasequences can be safely gained by following the cliff top path to the end of the inlet on the northern side.

Locality 14.16 [NC 4100 6740] Sangobeg Fault.

Park at the Tourist Information Centre in Durness [NC 4070 6775] overlooking Sango Sands. From the car-park, view the steep wall of Durness Group dolostone *c*.400m to the SE; this lies along the Sangobeg Fault, one of the main bounding normal faults of the Durness outlier of the Moine Thrust Sheet (Holdsworth *et al*., 2006). Walk *c*.300m east along the road to roadside exposures in the Durness Group at [NC 4100 6740], which lie in the immediate footwall of the Sangobeg Fault. Here, a series of carbonate-cemented red sandstone-breccia infills and carbonate veins are preserved in sub-vertical fractures trending NNE–SSW, approximately parallel to the trend of the adjacent normal fault (See image). The sedimentary material – which is most likely to be of Permo-Triassic age – is thought to have infilled tectonically active open fractures in the limestone that formed synchronously with normal faulting activity. This suggests that this phase of extension was

associated with sedimentation, although most of the basin infills have subsequently been eroded. Similar red-bed infills are common in the region between Durness and Cape Wrath. Clast types are mainly Durness Group, but isolated examples of mylonite and Cambrian quartz arenite are also preserved (see Wilson *et al.*, 2010 for details).

Locality 14.17 Sango Bay. [NC 4080 6770 to 4070 6800]

Return to the car-park and walk down onto the beach via the wooden steps. East of the base of the steps is a prominent headland, which comprises outcrops of banded quartzo-feldspathic and amphibolitic Lewisianoid basement gneisses. These are thought to lie close to the base of the Moine Thrust Sheet (Holdsworth *et al.*, 2006). Creamy-pink acidic gneisses and dark green metabasic sheets are cut by pegmatitic and quartz veins. The gneisses contain greenschist-facies mineral assemblages (chlorite, actino-lite, epidote) indicative of retrogression; the dominant banding dips east and carries an ESE-plunging mineral and extension lineation.

The gneisses are probably bounded to the west by a normal fault that separates them from upstanding outcrops in the central part of the bay of a green chlorite phyllonite. These phyllonites are correlated with the 'Oyster-shell Rock' identified within the mylonite belt of the Moine Thrust Zone at Loch Eriboll (see Localities 14.12–14.13, and Excursion 15). They contain numerous lunate quartz segregations and pervasive shear bands that indicate a top-to-the-west sense of displacement parallel to an E–W-trending lineation that is particularly well developed in the lenticular quartz-bearing layers.

Walk towards the rocky headland at the north-western limit of the beach. Look up towards the cliffs to the left to see further outcrops of the Oystershell Rock. These contain thin mylonitized pegmatitic veinlets; a set of intrafolial isoclinal folds can be identified, as well as later folds that deform the mylonite fabric. The structurally lowest rock unit on the headland is rather fractured, pink-purple weathering recrystallised dolostone of the Durine Formation, the youngest unit of the Durness Group. This is separated by a gently-inclined thrust from a 2–3m-thick slice of quartz mylonite, which is itself overlain by another thrust above which is a more coherently laminated group of mylonites (derived from both the Oystershell Rock and, locally, Lewisian gneiss). Walk up onto the headland to examine these thrust contacts in detail, and then follow them around to the west into the next bay. Note that the continuity of the thrust contacts is very much disrupted by the effects of later carbonate veining, located mainly in the footwall of the lowermost thrust, and also due to offsets along numerous, steeply-dipping normal faults (Hippler and Knipe 1990; Holdsworth *et al.*, 2006). Care should be taken on this path if conditions are wet. An alternative route into this bay is to retrace the route back to and up the wooden steps, and walk westwards along the main cliff top, parallel to the boundary fence of the campsite.

One interpretation of these outcrops is that the lowermost thrust corresponds to the Lochan Riabhach Thrust, which was thought by Holdsworth *et al.* (2006) to underlie the mylonite belt at Loch Eriboll (see Excursion 15) and interpreted by them as a separate structure from the Moine Thrust, which is exposed at a higher structural level at Faraid Head (see above). The alternative view is that the lowermost thrust does in fact correspond to the Moine Thrust (Peach *et al.*, 1907; Butler 2009).

Locality 14.18 Creag Thairbhe. [NC 4040 6850]

Return to the top of the cliff and, following the fence, walk approximately 500m north-west along the cliffs of Durness Group towards the cliffs extending inland from Creag Thairbhe [NC 4040 6850]. The steep cliffs here define the trend of the WNW–ENE-trending Faraid Head Fault that down-faults

the main Faraid Head outlier of Moine rocks and the Moine Thrust Zone mylonites that outcrop to the north (Holdsworth *et al.*, 2007; Wilson *et al.*, 2010). Most of the cliff comprises variably brecciated carbonate, but at its western end where the upper parts of the cliff can be accessed from the sand dunes, carbonate-cemented red sandstone-breccia infills are preserved in a series of sub-vertical fractures trending parallel to the main fault. These are virtually identical to those exposed at Locality 14.13, and are also thought to represent sedimentary material that has infilled tectonically open fractures in the limestone formed synchronously with normal faulting activity. The dominant clast types are Durness Group carbonates, but clasts of Moine psammite, mylonitized Lewisian gneiss and quartzite mylonite are also present. At least two units of infill are recognised based on differences in grain-size and sorting.

The ages of the sedimentary infills at Localities 14.13 and 14.15 – and hence the age of extension – are uncertain, but a Permo-Triassic age seems likely given the timing of sedimentary basin formation in the West Orkney Basin that lies immediately offshore and to the north (see Wilson *et al.*, 2010, and references therein). Detailed studies of the normal faulting along the north coast in the Durness–Cape Wrath area (Wilson *et al.*, 2010) suggests that the NNE-and WNW-trending normal faults are likely to be contemporaneous, forming a complex transfer zone that defines the southern margin of the West Orkney Basin. Return to the vehicles, retracing your steps along the cliff top.

References

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