Tarskavaig

[NG 583 097]–[NG 572 064]

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Introduction

The large GCR site that extends south from Tarskavaig Bay, in the south-western part of the Sleat peninsula on the Isle of Skye, contains three distinctive Tarskavaig nappes that lie between the Kishorn Nappe and the Moine Thrust. The nappes provide the only exposures of the Tarskavaig Group, a distinctive clastic metasedimentary sequence that has features in common with both the Torridonian and the Moine sequences but cannot be directly correlated with either. It is the only part of the possible 'Moine' sequence that occurs below and to the west of the Moine Thrust itself, and its origin and history remain something of an enigma. In addition, it appears that the thrusts exposed here do not conform to the foreland-propagating thrust sequence model, which dominates in the Moine Thrust Belt on the mainland (Figure 5.61).

The Kishorn Nappe is the dominant structure of Lochalsh and eastern Skye, and its included Torridonian sequence is folded into a large W-facing syncline, the Lochalsh Syncline. However, south of Ord the apparent structural simplicity within the Kishorn Nappe breaks down and the area contains an array of thrusts, large folds and listric normal faults, whose complex geometry, origin and timing are more obscure. The geology of south-east Skye, between Loch Eishort and the Sound of Sleat, consists of four structural units. The highest unit is the Moine Thrust Sheet, mainly composed of Lewisianoid gneisses with minor Moine metasedimentary rocks. Below the Moine Thrust are the Tarskavaig nappes, which in turn overlie the southern continuation of the Kishorn Nappe, composed mainly of sandstones of the Sleat and Torridon groups. The Kishorn Nappe overlies the complex 'Ord Window', described in the Ord GCR site report (this chapter).

The three Tarskavaig nappes are, from the top down, the Loch Lamascaig Nappe, the Caradal Nappe, and the Tarskavaig Nappe itself (Figure 5.61). The Tarskavaig Thrust juxtaposes the Tarskavaig Nappe onto Sleat Group rocks of the Kishorn Nappe; both nappes are folded by the tight, locally recumbent Tarskavaig–Caradal Synform whose axis plunges gently southwards and trace trends NNE (Karcz, 1963; Coward and Potts, 1985). The trend of this fold is perpendicular to the WNW transport direction of the Moine and Tarskavaig thrusts (Law and Potts, 1987). All three Tarskavaig nappes are characterized by basal thrusts immediately overlain by mylonites of Lewisian or Lewisianoid affinity; which are succeeded by tightly folded sequences of dominantly quartzofeldspathic metasedimentary rocks of the Tarskavaig Group. Similar folding occurs in the Sleat Group rocks of the Kishom Nappe, which are folded by the earlier Gillean–Eishort Anticline some 2 km north of Tarskavaig. This tight, recumbent structure is probably complementary to the underlying Lochalsh Syncline (see also Ord GCR site report, this chapter, and (Figure 5.59)).

Rocks of the Tarskavaig Group occupy an intermediate lithological, stratigraphical, tectonic and metamorphic position between rocks of the Moine Supergroup *sensu stricto* (lying east of the Moine Thrust), and Torridon and Sleat groups in the Kishorn Nappe and the foreland farther north. This problem is exacerbated by the definition of the Moine Thrust as the western limit of the Moine Supergroup: if the Tarskavaig rocks are truly Moine, then the Moine Thrust is a different structure on Skye to that on the mainland.

Charles Thomas Clough undertook the first systematic mapping of the Moine Thrust Belt in Skye for the Geological Survey. Working southwards along the belt, Clough reached Skye in 1892 and in the next five years he recognized and documented all of the main lithologies and structures, although questions regarding the structural interpretations remained. Clough's fieldwork in Skye was completed in 1897 and was formally described in both the North-west Highlands memoir (Peach *et al.,* 1907) and the Glenelg (Sheet 71) memoir (Peach *et al.,* 1910). Considerably later, Cheeney and Mathews (1965) divided the Tarskavaig metasedimentary rocks into three lithostratigraphical 'groups', now formally defined as formations: (from the top) the Aruisg Psammite Formation (feldspathic psammites), the Laidhe na Greine Formation (mixed pelites and psammites), and the Capistal Psammite Formation (psammites with locally

quartzitic pebble beds, subsidiary semepelites). In the vicinity of Tarskavaig Bay, nearly all of the Tarskavaig Group rocks belong to the uppermost formation; the two lower formations possibly occur within the mylonitized rocks close to the Tarskavaig Thrust. The rocks lie in the greenschist facies, mostly at biotite grade, but with some garnet-grade rocks present in the most south-easterly exposures, near the Ard Thurinish–Port na Long) GCR site (Bailey, 1939, 1955).

Description

The GCR site extends south from Tarskavaig Bay to An Garbh-allt and eastwards to Loch Ic Iain [NG 602 067]. The topography of the southwest part of the Sleat peninsula is one of low rounded hills, mainly between 150 m and 200 m above sea level and only rarely exceeding 250 m. West of the Moine Thrust, rock exposure is locally good, as glaciation has left an ice- moulded and plucked landscape with a NNW grain, irregularly covered with drift deposits and scattered with peaty hollows and numerous lochans. The coastline is rocky throughout, with near-continuous bedrock exposure that offers few difficulties of physical access. The area has no roads and only a few tracks.

The Tarskavaig Thrust, the Sleat Group in the footwall and the mylonitic Lewisian or Lewisianoid gneisses and Tarskavaig Group rocks in the hangingwall are all exposed at Tarskavaig Bay.

On the north side of Tarskavaig Bay, the Kinloch Formation (Sleat Group) shows abundant folds, mostly with angular hinges, which are especially clear in the argillaceous units. Sedimentary way-up structures show that the rocks here are right-way-up. On the south side of the bay (around [NG 583 085]), strongly folded Sleat Group sandstones crop out in cliffs just below the well-exposed Tarskavaig Thrust (Figure 5.62). The thrust plane itself can be traced southwards in c:;ff sections around Rubha Sloc an Eòrna for over 1 km, where it dips gently to the ESE. About 1 km south of Rubha Sloc an Eòrna (at [NG 576 077]), spectacular recumbent folding occurs in Sleat Group rocks just below the thrust plane. In contrast, the foliation of the overlying mylonites and Tarskavaig Group rocks is generally parallel to the thrust surface. This relationship — near-conformable above, but markedly discordant beneath — appears common to thrusts throughout Sleat and is reproduced at all scales. Above the thrust, there is a thin (1–30 m-thick) layer of greenish-grey, chlorite-and epidote-bearing mylonite with abundant red quartzofeldspathic streaks that is derived from 'Lewisian' gneisses (Clough in Peach *et al.,* 1907; Bailey, 1955). Locally, tight to isoclinal folds occur within these mylonites. This locality is a good example of a thrust that has not developed along the obvious rheological contrast of cover and basement. Above the mylonitic 'Lewisian' gneisses there follows about 30 m of mixed semipelitic, pelitic and psammitic rocks, all highly sheared. These mylonitic rocks pass up gradually into feldspathic psammites that are less deformed and locally contain cross-bedding, but which are still lineated, foliated, and crosscut by numerous quartz veins. These last rocks probably belong to the Aruisg Psammite Formation.

At a small bay just south of Rubha Sloc an Eòrna at [NG 578 081], a vertical lamprophyre dyke of probable Caledonian affinity cuts across the Tarskavaig Thrust. The dyke in the hanging-wall is recorded as having moved 'a few feet *southward'* with respect to the footwall (Bailey, 1955), opposite to the general WNW-directed thrust movement.

Although the Tarskavaig Thrust plane itself is not exposed south-east of Tarskavaig Bay, the same mylonites and transition to less-deformed Tarskavaig Group psammites can be found on the eastern slopes of Sìthean Mòr around [NG 598 081] (Bell and Harris, 1986). From here, the mylonites can be followed to Sgurr Breac and further to Loch a' Ghlinne (Figure 5.61), where, the mylonitic foliation has an easterly dip of 35° with Sleat Group rocks structurally *above* it. Assuming that the mylonitic foliation lies parallel to the thrust, the Tarskavaig Thrust here must be overturned on the eastern limb of the Tarskavaig Synform.

Farther south, the Caradal Nappe and the Loch Lamascaig Nappe structurally overlie the Tarskavaig Nappe. In the Tarskavaig Group rocks of the Loch Lamascaig Nappe an early NNE-trending isoclinal fold pair occurs, named the 'Capistal Anticline' and 'Capistal Syncline' by Cheeney and Matthews (1965). Apart from these internal folds, the structure of the nappes appears relatively simple, each exhibiting a synformal shape, defined by the Tarskavaig and Caradal synforms. Whilst the synform is relatively open in the case of the higher Loch Lamascaig Nappe, the rocks of the Tarskavaig Nappe, along with the Tarskavaig Thrust, have been deformed into a tight fold, with the eastern limb overturned.

Interpretation

Early geologists, notably Clough and Bailey, had already noticed the rather unusual lithological characteristics of the Tarskavaig rocks, with respect to the Torridonian on the one hand and the Moine on the other. Clough (in Peach *et al.,* 1907) suggested that both the Moine and the Tarskavaig rocks once formed a single mass in which metamorphism increased towards the south-east, and hence that the Moine rocks had been transported a greater distance on the Moine Thrust than the Tarskavaig rocks had been transported on the Tarskavaig thrusts. The problem of the stratigraphical position of the Tarskavaig Group is interesting in the light of recent age dating of Moine and Torridonian rocks. Rb-Sr dating of the possible time of diagenesis (Turnbull *et al.,* 1996), re-dating of the West Highland Granite Gneiss Suite that intrudes the Moine successions (Friend *et al.,* 1997), and detrital zircon ages (Rainbird *et* ed., 2001) all contribute to constrain the deposition of both the Torridonian and the Moine sequences to between *c.* 1000 Ma and 870 Ma. Hence, it is feasible that the Tarskavaig Group rocks could have been deposited in an intermediate position between the Torridonian and Moine basins or depocentres (Strachan and Holdsworth, 2000).

The age relationships of the thrusts around Tarskavaig are particularly interesting. Clough observed that, south of Loch a' Ghlinne, the Loch Lamascaig Thrust cuts across an already inverted Tarskavaig Thrust, as well as the Caradal Thrust. The order of thrusting appears to be constrained by such cross-cutting relationships (albeit in rather poorly exposed ground), and also from the observation that the rocks in the lowest nappe (the Tarskavaig Nappe) are the most steeply inclined and most tightly folded, with progressively less folding and gentler inclinations higher up in the structural pile, so that the Moine Thrust is a rather planar, gently inclined structure. In the light of these observations, Bailey suggested that the sequence of emplacement of the thrust units was: Tarskavaig, Caradal, Loch Lamascaig and, lastly, Moine.

Cheeney and Matthews (1965) supported this sequence of structural emplacement. They suggested that the first deformation events produced the isoclinal Capistal folds and the mylonites of the Tarskavaig Nappe. Further movement along the Tarskavaig Thrust plane occurred in a brittle manner, followed by development of the Tarskavaig and Caradal synforms, which fold and locally overturn the Tarskavaig Thrust. Movement along the Caradal and the Lamascaig thrusts truncated the overturned Tarskavaig Thrust and folds. These late thrusts appear to lack mylonites above them, in contrast to the Tarskavaig and Moine thrusts. Last of all the Moine Thrust partially truncated earlier, lower structures.

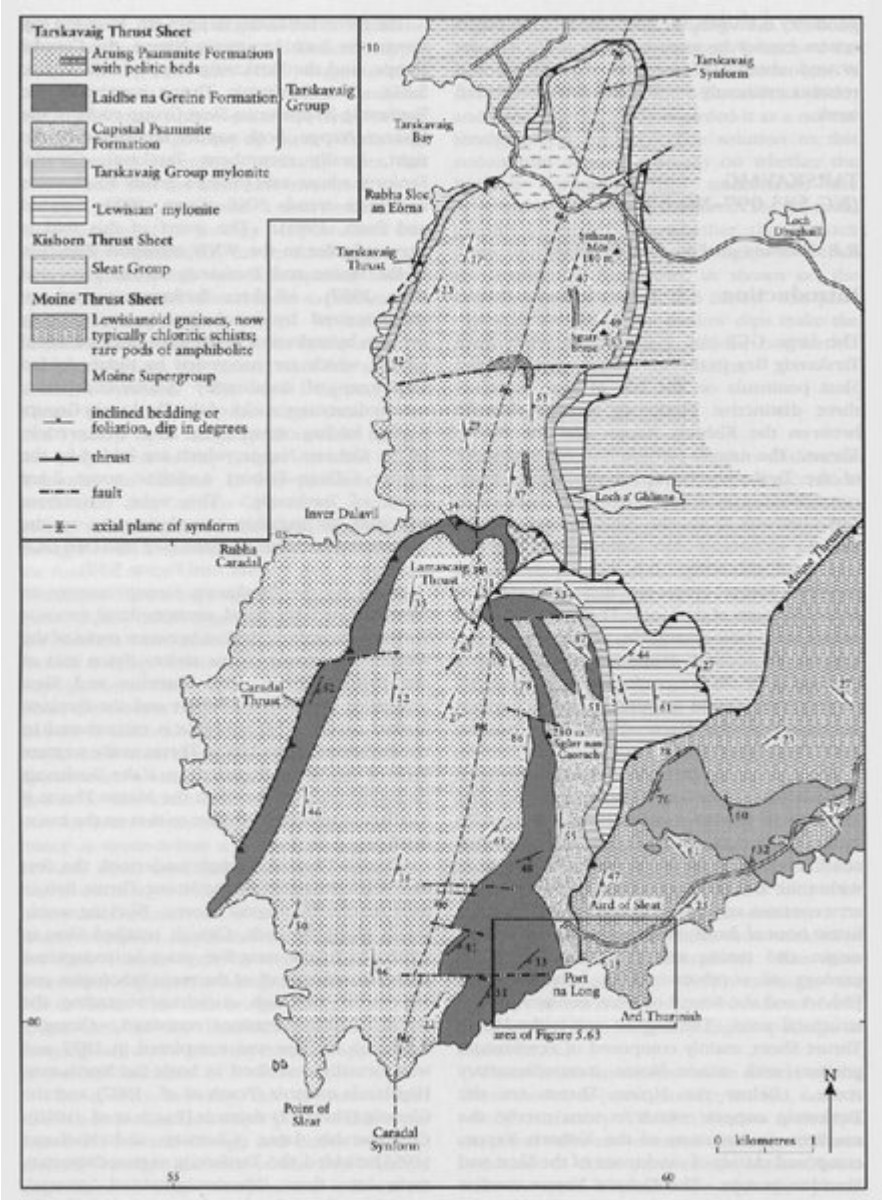
It should be noted that all of these studies pre-dated the work of Dahlstrom (1970) in the Canadian Rockies, and of Elliott and Johnson (1980) in Assynt who both showed that many thrust belts are characterized by foreland-propagating thrust sequences, in which the lowest thrust moved last. Thus, at Knockan Crag for instance, the Moine Thrust plane itself is an out-of-sequence, late brittle thrust. If the structural sequence in the Tarskavaig area is really lowest first and uppermost last, as described by Clough and Bailey, then the area is doubly interesting in effectively representing a hinterland-propagating thrust sequence — an entire array of out-of-sequence thrusts.

Conclusions

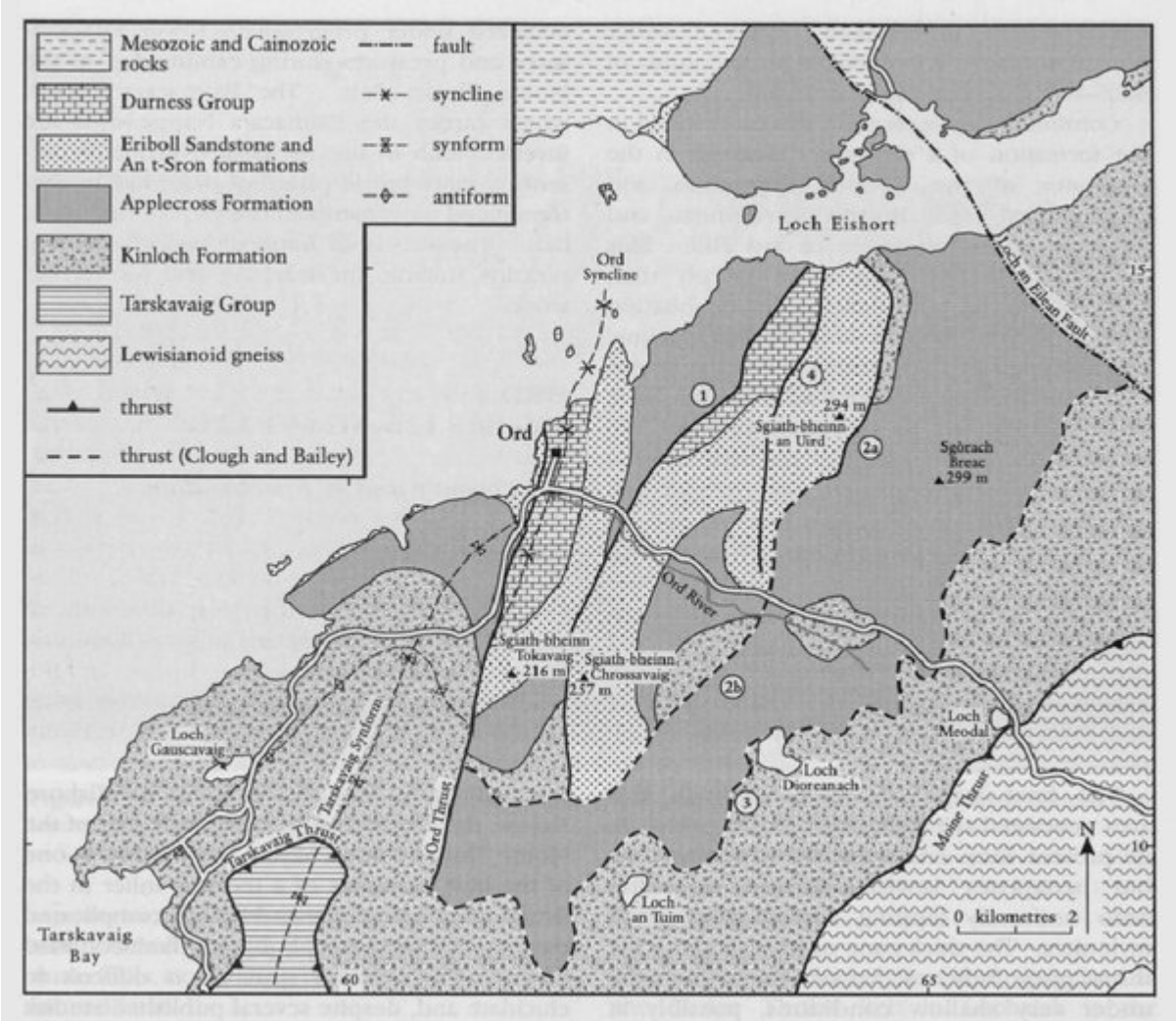
Together with the GCR site at Ord, the Tarskavaig GCR site provides valuable insights into major features of the southernmost section of the Moine Thrust Belt. The site focuses on three separate nappes, the Tarskavaig, Caradal and Lamascaig nappes, which are sandwiched between the overlying Moine Thrust and the underlying Kishorn Nappe. Each nappe contains Tarskavaig Group rocks with minor thrust slices of Lewisian or Lewisianoid gneisses. The thrusts and nappes are folded, with the intensity of folding dying out upwards. The higher thrusts also appear to truncate the lower thrusts and folds. This thrust geometry suggests that the order of thrusting was from lowest to highest, in marked contrast to the 'foreland-propagating', 'piggy-back' thrust sequence that is dominant on the mainland. Some of the major features can be seen in excellent exposures in Tarskavaig Bay.

South-west Sleat is the only place where the Tarskavaig Group rocks occur. These rocks show lithological characteristics that are intermediate between the structurally lower Torridonian sequence and the structurally higher Moine Supergroup rocks and may yet prove to be some of the key lithologies for deciphering Neoproterozoic basin evolution in Scotland. These unique lithologies, together with the thrust geometries, make the Tarskavaig GCR site of national importance.

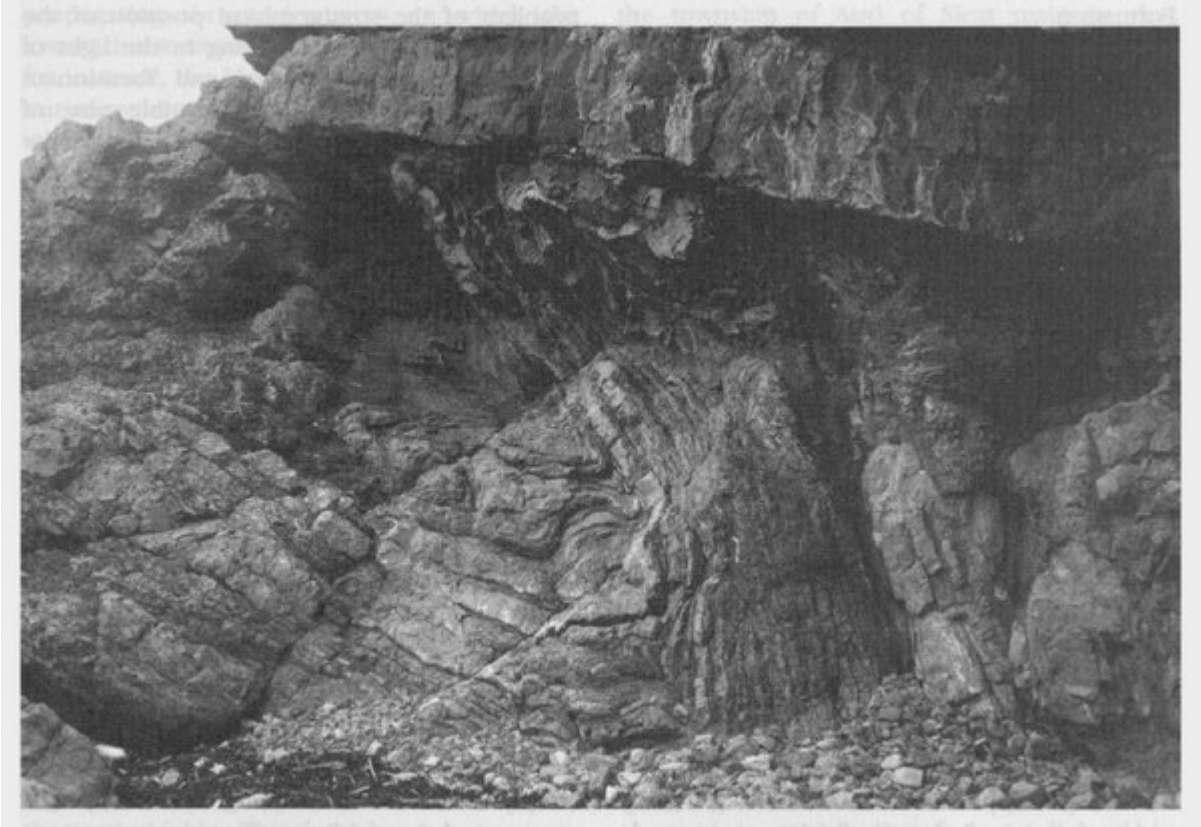
References



(Figure 5.61) Geological map of the Tarskavaig nappes in south-east Skye. After Cheeney and Mathews (1965).



(Figure 5.59) Geological map of the Ord Window, after the work of Clough (see Institute of Geological Sciences, 1976b; and Potts, 1983). Note that different authors refer to many of the lithological contacts by different names. On the map, disputed contacts are numbered as follows: (1) — Sgiath-bheinn an Uird Thrust, eastern limb (Clough in Peach et al., 1907); Kishorn Thrust (Bailey, 1939); Western Fault, normal fault (Potts, 1983). (2) a+b — Sgiath-bheinn an Uird Thrust, eastern limb (Clough in Peach et al., 1907); lower branch of Kishorn Thrust (Bailey, 1939); (2a) Allt a' Chinn Mhoir Fault, normal fault; (2b) normal stratigraphical contact (Potts, 1983). (3) — Sgiath-bheinn Tokavaig Thrust, eastern limb (Clough in Peach et al., 1907); upper branch of Kishorn Thrust (Bailey, 1939); normal stratigraphical contact (Potts, 1983). (4) Eastern Fault (Potts, 1983).



(Figure 5.62) The Tarskavaig Thrust at the south side of Tarskavaig Bay. Tarskavaig Moine rocks lie above the thrust with folded Torridonian Sleat Group rocks below. (Photo: K.M. Goodenough.)