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# Meall a' Ghiubhais

[NG 975 656]–[NH 022 619]

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## Introduction

The Meall a' Ghiubhais GCR site lies at the eastern end of the Torridon hills, within the Beinn Eighe National Nature Reserve and overlooking Loch Maree (Figure 5.40), itself a GCR site for its well-preserved record of Holocene vegetation (Birks in Gordon and Sutherland, 1993). The Torridon district is renowned for its magnificent mountain scenery and exhibits some of the most dramatic thrust structures in the British Isles. Excellent exposure combined with the good fortune of being largely formed of the distinctive red-brown-weathering Torridonian sandstones and the white- to pale-grey-weathering Cambrian quartzites, makes the geological structure spectacularly visible in the landscape views. The site contains a klippe, largely composed of Torridonian sandstones and part of the regionally important Kinlochewe Thrust Sheet, together with well-exposed folds and thrusts in the underlying Cambrian sedimentary rocks. The site also offers spectacular views across Loch Maree onto the southern flanks of Slioch and Meallan Ghobhar, which display in cross-section the structural relationships between Lewisian, Torridonian and Cambrian strata of the foreland together with the far-travelled Lewisian and Torridonian of the Kinlochewe Thrust Sheet (Figure 5.40) (see Slioch–Heights of Kinlochewe GCR site report, this chapter).

The primary source of information on this GCR site lies within the memoir of the Geological Survey (Peach *et al.*, 1907), together with the 1:63 360 map (Sheet 92, Inverbroom) (Geological Survey of Scotland, 1913a). Peach *et al.* (1907) documented the units within the Kinlochewe Thrust Sheet and noted that it was folded by underlying imbricate structures. Since that work, there has been little published research. The Meall a' Ghiubhais Klippe is regularly an objective of student mapping projects and was remapped as part of a major analysis of thrust system geometry in the Torridon area by Matthews (1984; Butler *et al.*, 2006, 2007).

## Description

Meall a' Ghiubhais (878 m, [NG 977 637]), the chief focus of the GCR site (Figure 5.43), is a conical rocky hill with a summit edifice consisting of 250 m of Torridonian sandstone. This represents a tectonic outlier (klippe) of the Kinlochewe Thrust Sheet and rests upon a plinth of Cambrian strata (Figure 5.44). The southern half of the klippe is separated from the coherent Cambrian succession of its plinth by a detached slice of Cambrian quartzite. In contrast, on its western side the footwall rocks form part of the foreland. On the east, the footwall contains a spectacular array of folds and thrusts, part of the extensive lower imbricate system that dominates the geology of neighbouring Beinn Eighe. Note that on the opposite side of Loch Maree and northwards to Dundonnell, these imbricate structures are not developed. The site thus contains important structural transitions: from the foreland into the Beinn Eighe imbricate stack and the lateral (northern) termination of this imbricate stack (Butler *et al.*, 2007).

## Meall a' Ghiubhais Klippe

The klippe is composed mainly of a normal, right-way-up succession of Torridonian strata, comprising the older, Diabaig Formation and the younger, Applecross Formation. The succession is repeated by minor imbricate thrusts, well displayed on the northern slopes of the summit cone of Meall a' Ghiubhais. Small bodies of Lewisian gneisses decorate the base of the klippe, locally forming the basement to the overlying Torridonian (Butler *et al.*, 2006). The largest of these is exposed on the south-west corner of the klippe at [NG 971 633], where a 200 m-long slice of Lewisian gneisses has been thrust over a thin slice of Torridonian sandstones (Figure 5.43). The gneisses are bounded above by the sub-Torridonian unconformity. More Lewisian rocks are found along the northern edge of the klippe [NG 982 653]. These small pips, again bounded above by the sub-Torridonian unconformity and below by the Kinlochewe Thrust, are most plausibly interpreted as palaeohills in the Precambrian landscape, planed off by the Kinlochewe Thrust.

## Detached thrust slice

The Kinlochewe Thrust carries the Meall a' Ghiubhais Klippe onto the foreland so that, above Glen Grudie, Torridonian strata overlie gently dipping Fucoïd Beds that here underlie a broad shelf (Figure 5.44). However, at Creag Bhan [NG 971 633], (Figure 5.43) the klippe is directly underlain by an un-named thrust slice of quartzites of the Pipe Rock Member. The overlying Kinlochewe Thrust has been folded during formation of the underlying thrust slice.

The detached slice of quartzites may be traced eastwards in the immediate footwall to the Kinlochewe Thrust around to the Allt Bhanabhaig (Butler *et al.*, 2007). Here it is composed of the False-bedded Quartzite Member and again clearly appears to have bulged up the higher thrust sheet. Cross-bedding within the quartzites shows that they young upwards towards the overlying Torridonian and thus have a tectonic contact with the klippe. However, the stratigraphy of the quartzite slice changes from east to west beneath the klippe so that the footwall to the Kinlochewe Thrust and the hangingwall to the un-named sub-slice thrust can be inferred to have climbed up the stratigraphical section in their transport direction (Figure 5.45).

## The imbricate system

The folds and thrusts that repeat the Cambrian succession on the east side of the Meall a' Ghiubhais Klippe form the northern part of the Beinn Eighe imbricate stack (Butler *et al.*, 2007). This major thrust system differs from those found farther north in the Moine Thrust Belt (e.g. at the Eriboll and Skiag Bridge GCR sites) in that the individual imbricate slices are notably thick. Imbricate thrusts climb up, via single ramps, through the thick Torridonian succession that typifies this part of the Caledonian Foreland (Figure 5.45). Within the site, the deeper parts of the thrust system are exposed in profile on the slopes above the head of Loch Maree (Figure 5.40). However, at the current erosion level the Pipe Rock Member is dominant. The imbricate slices, ramps, and particularly the associated folds are very well exposed on the ground around Loch Allt an Daraich (Figure 5.43). Although consisting of frost-shattered blocks and pavements, this awkward terrain is rendered easily accessible by way of the nature trail. An array of anticlines and synclines with NE-trending axes provide spectacular bedding-plane outcrops, which display exemplary sections through the ubiquitous trace fossils of the Pipe Rock Member. Of the two common trace fossils present, *Monocraterion* shows very weak strain, while *Skolithos* is virtually undeformed. Originally circular pipe sections now show weakly elliptical shapes with axial ratios typically less than 1.2: 1. These very low strains are characteristic of most of the lower parts of the Moine Thrust Belt here (but contrast with the Heilam area in the Eriboll GCR site) and imply only minor bedding-parallel shortening, presumably associated with incipient thrust growth.

## Nature of the Kinlochewe Thrust

The Kinlochewe Thrust is marked by a few metres of mylonite with E–W-trending stretching lineations. The mylonitic foliation is generally sub-parallel to the thrust surface. The thrust is folded by the accreted, underlying quartzite slice on the southern and eastern sides of the klippe. These are both folded above the imbricate zones of Pipe Rock just to the west of Loch Allt an Daraich (Figure 5.43).

Outcrops around the north side of the Meall, a' Ghiubhais Klippe show that the footwall to the Kinlochewe Thrust changes its stratigraphical horizon (Figure 5.43). In upper Allt Bhanabhaig [NG 989 640] the footwall lies in quartzites, but to the north, at Cnoc na Gaoithe [NG 990 647] it is in Fucoïd Beds. The thrust continues to climb up-section to the north-west into the lower part of the Durness Group, but still farther west, it drops back down onto Salterella Grit. These relationships define a near-perfect lateral ramp in the footwall to the Kinlochewe Thrust. A similar ramp may be inferred to lie on the south side of the klippe [NG 977 630], where an imbricate system in the footwall contains Durness Group carbonate rocks together with units of the An t-Sron Formation. These imbricate slices probably represent the remnants of an otherwise eroded duplex at the base of the Beinn Eighe imbricate stack.

## Interpretation

The Meall a' Ghiubhais Klippe is an outlier of the Kinlochewe Thrust Sheet, a major detached unit of Lewisian and Torridonian rocks which directly underlies the Moine Thrust. Using balanced cross-sections, Butler *et al.* (2007) estimated that this part of the thrust belt, including the Kinlochewe Thrust, contains a minimum of 15 km of shortening. This figure is probably a gross underestimate of the true amount of thrust displacement.

The Kinlochewe Thrust Sheet was emplaced prior to imbrication in its footwall, as its base is folded by the underlying imbricate zones. The Kinlochewe Thrust shows subtle variations in its geometry around the klippe, with the stratigraphical level of its footwall ranging from the top of the Pipe Rock to the lowest part of the Durness Group. Around the klippe these relationships may be explained by lateral and frontal ramps, with the thrust cutting up-section in its transport direction.

The outcrops of the Kinlochewe Thrust at Meall a' Ghiubhais raise significant mechanical issues for thrust localization and displacement (Butler *et al.*, 2006). Theoretical analyses of fault mechanics commonly assume that thrust trajectories are primarily controlled by the anisotropy of well-layered sedimentary rocks. Yet the Kinlochewe Thrust cuts back and forth across the irregular Torridonian–Lewisian unconformity rather than follow bedding in the cover sedimentary rocks, and it also appears to have cut gently down-section across the Cambrian stratigraphy.

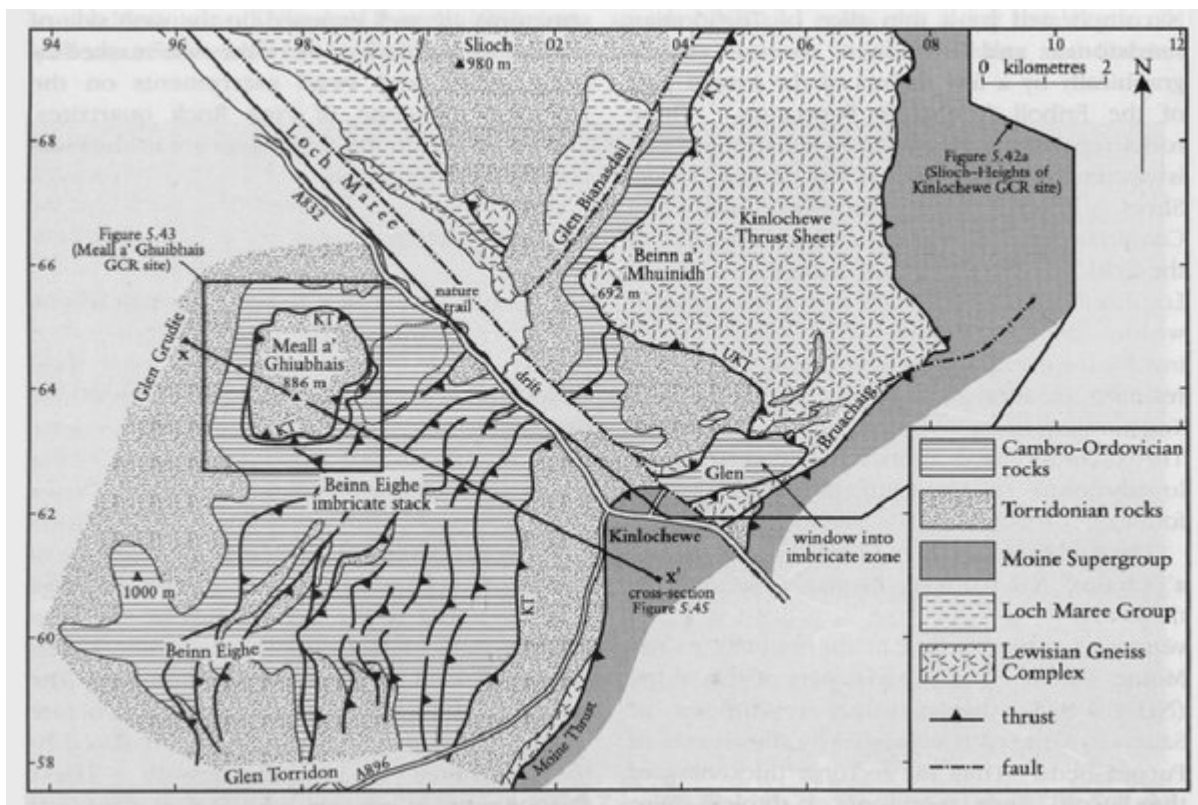
The imbricate zones underlying the Kinlochewe Thrust Sheet, which form the Beinn Eighe system (Figure 5.45), are restricted to the southern side of Loch Maree. These structures involve considerable thicknesses of Torridonian sandstones and imply the presence of a Sole Thrust that is substantially deeper than elsewhere in the Moine Thrust Belt. The relatively abrupt termination of these structures to the north can be explained by consideration of the Precambrian geology across the area (Figure 5.40). The NW-trending Loch Maree Fault displays a component of south-westerly down-throw, thus preserving a much greater thickness of Torridonian sedimentary rocks on its southwest side. As a result, in the Meall a' Ghiubhais and Torridon areas thrusts were able to cut deep into the Torridonian sandstone succession, building up a thick thrust stack, as seen for example on Beinn Eighe (Butler *et al.*, 2007). To the north the Torridonian is virtually eliminated towards the east by the overstep of the sub-Cambrian unconformity, inhibiting thrust development.

## Conclusions

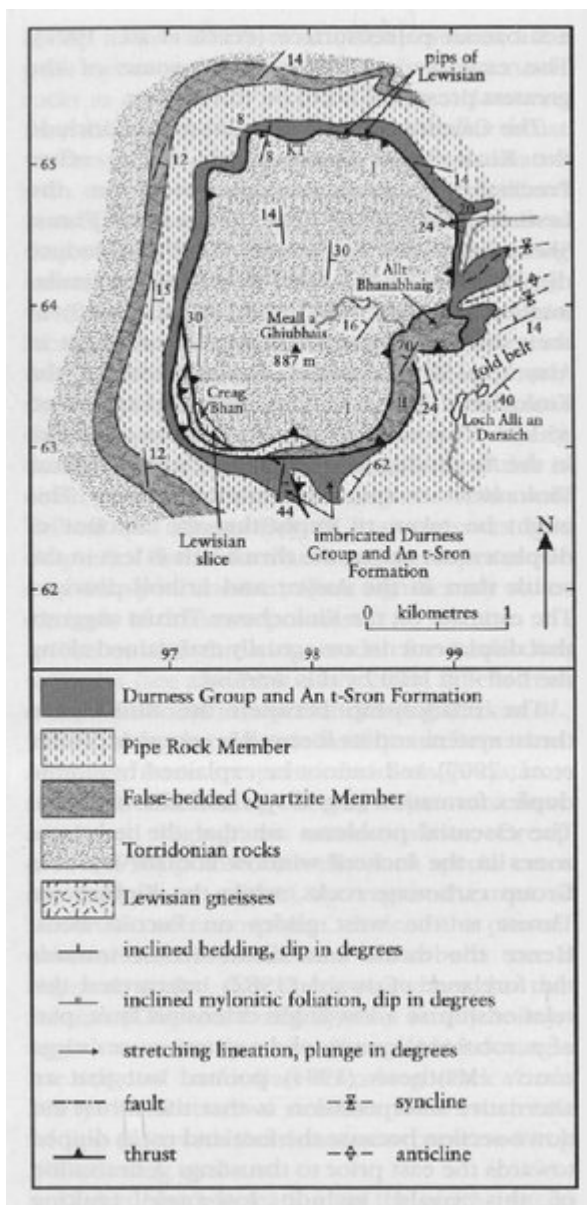
The Meall a' Ghiubhais GCR site, within the Beinn Eighe National Nature Reserve, offers spectacular views of major thrust sheets, together with smaller more-detailed thrust structures, both within the site itself and across to the famous landscapes on the north side of Loch Maree (see Slioch–Heights of Kinlochewe GCR site report, this chapter). The fine exposures have attracted numerous geological visitors, largely to obtain views. The geology within the site is nationally important for understanding how major and minor thrusts link up with, and relate to one another, and also raises important issues concerning the mechanics of thrusting and faulting.

The Kinlochewe Thrust can be demonstrated to have formed early and to have been folded during the formation of underlying thrust structures. These types of observation are fundamental in the reconstruction of the timing and geometrical evolution of different parts of a thrust belt. The rocks in the hangingwall of the Kinlochewe Thrust alternate between Torridonian and Cambrian sedimentary rocks and Lewisian basement gneisses, all of which have radically different mechanical properties. Narrow zones of mylonitization associated with the thrust are undoubtedly localized in the more-massive rocks that lacked obvious bedding or a strong foliation. Hence studies of thrust geometry at this site, like those at the Glencoul GCR site, have much to contribute to the debate about differences in thrust mechanics between regions of deformed cover sedimentary rocks and those involving crystalline basement.

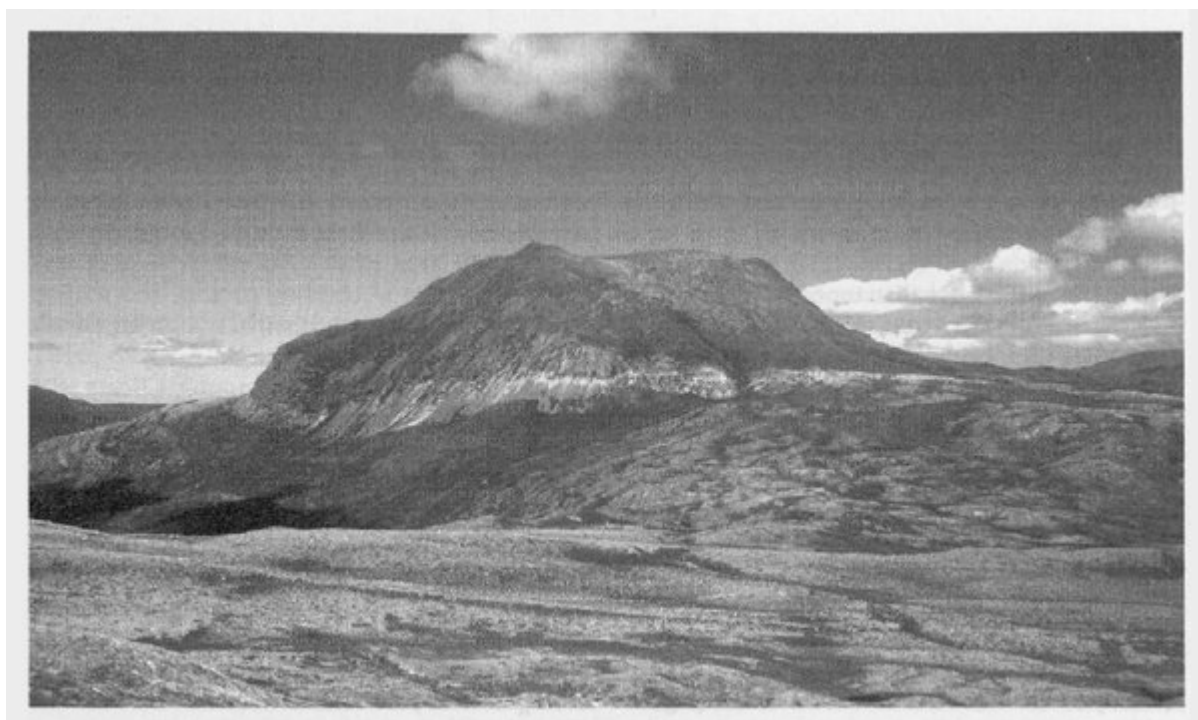
## [References](#)



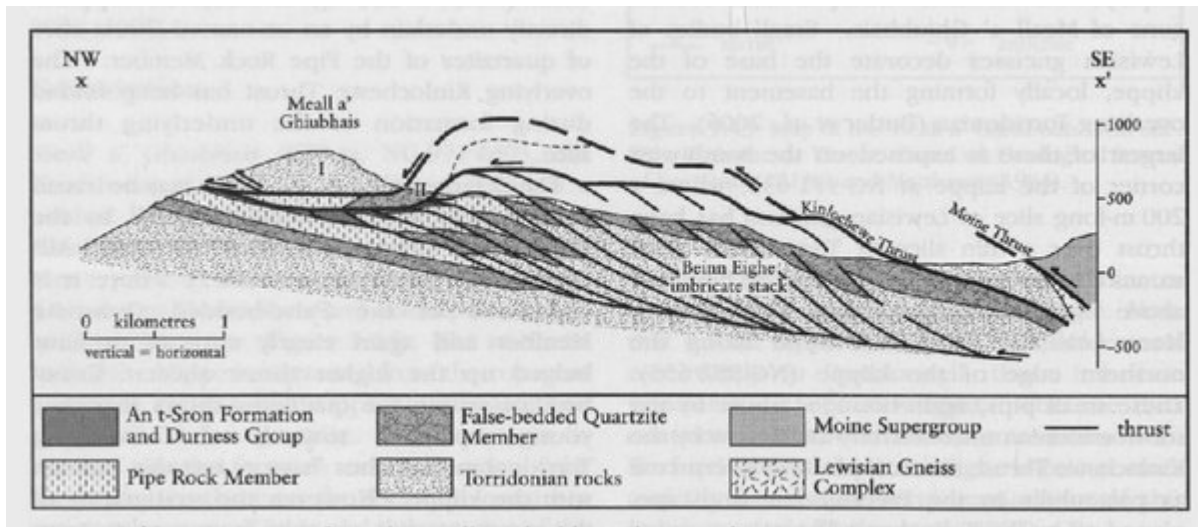
(Figure 5.40) Map of the Slioch–Meall a' Ghuibhais–Beinn Eighe area, showing the regional geological setting of the Slioch–Heights of Kinlochewe GCR site (north-east of Loch Maree) and the Meall a' Ghuibhais GCR site. KT = Kinlochewe Thrust; UKT = Upper Kinlochewe Thrust. Locations of Figures 5.42a and 5.43 are indicated. Based on Geological Survey of Scotland (1913a) and Matthews (1984).



(Figure 5.43) Map of the Meall a' Ghiubhais GCR site. KT — Kinlochewe Thrust. Based on Geological Survey of Scotland (1913a) and Matthews (1984).



(Figure 5.44) Looking north to the Meall a' Ghiubhais Klippe from Beinn Eighe. The darker, upper part of the hill is made up of Torridon Group rocks in the Kinlochewe Thrust Sheet. The Kinlochewe Thrust occurs just above the pale Cambrian quartzites, which lie in a separate thrust sheet. In the foreground are imbricated thrust slices of Torridonian sandstones and Cambrian quartzites. (Photo: R.W.H. Butler.)



(Figure 5.45) Cross-section from the Meall a' Ghiubhais Klippe to the Moine Thrust Belt (location indicated on Figure 5.40). After Butler et al. (2007).