Excursion 10 South and Central Sutherland

Rob Strachan, Bob Holdsworth, Maarten Krabbendam, Graham Leslie and Jack Soper.

Purpose:	To examine various phenomena within the Moine, including basement-cover relationships, Caledonian ductile thrusts, migmatites, and minor syn-tectonic igneous intrusions.
Aspects covered:	Lewisianoid basement inliers; metasedimentary rocks and structures of the Morar and Glenfinnan groups; Sgurr Beag and Naver thrusts; Naver Nappe migmatites; the Vagastie Bridge Granite.
Useful information:	Hotel and B&B accommodation are available in Lairg and Bonar Bridge (camping is also available in Lairg). Vehicular access to Locality 10.2 requires permission from Alan Wyatt, Caplich Estate (Tel: 01549 441356). Permission to access the Airde of Shin should be sought from Mrs Parrot, The Croft House, West Shinness, Lairg, IV27 4DN (Tel: 01549 402095).
Maps:	OS*:* 1:25,000 sheets 443 Ben Klibreck and Ben Armine, 440 Glen Cassley and Glen Oykell, 438 Dornoch and Tain; BGS: 1:50,000 sheets 93E Alness, 102E Loch Shin, 108E Loch Naver.
Type of terrain:	Stream sections, moorland, lochside and coastal exposures.
Distance and time:	The complete excursion involves driving some 180km, assuming overnight accommodation in either Lairg or Bonar Bridge. The total distance covered on foot is *c.*28km. 2½ days should be allowed for the whole excursion. See each locality for suggested times.
Short itinerary:	A shorter excursion could include Locality 10.1 and then either Locality 10.3 or 10.4. Locality 10.5 could be visited en route to North Sutherland if travelling from Lairg.

The large and often remote tract of ground that forms south and central Sutherland (Figure 10.1) is generally poorly exposed, but forms a critical link between the hitherto better-known areas of northern Ross-shire and north Sutherland. Recent remapping of some of this ground, partly in association with the production of revised British Geological Survey maps, has drawn attention to this area which contains some key sections for demonstrating the nature of basement-cover relationships as well as the existence of regional-scale Caledonian ductile thrusts (Strachan & Holdsworth, 1988).

Locality 10.1 Oykell Bridge [NC 3859 0086]

Oykell Bridge (Figure 10.1). Mullion structures within Moine psammites.

Parking is available (with permission) at the car park of the Oykell Bridge Hotel [NC 3843 0083]; allocate 1 hour for this locality. Walk east to the road bridge [NC 3859 0086]. Below the bridge, and easily accessible from the banks, are Morar Group psammites which are generally fine-grained and composed of variable proportions of quartz, feldspar, muscovite and biotite. Impressive mullion structures ((Figure 10.2); Wilson, 1953) plunge to the ESE parallel to the hinges of mainly reclined, tight to open, asymmetric folds. A well-developed mineral elongation alignment lies parallel to the axes of the mullions: this is the regional lineation, designated L_2 (e.g. Strachan & Holdsworth, 1988). A weak axial planar schistosity is associated with an intersection lineation that plunges sub-parallel to the mullions.

In the gorge section, the Moine rocks strike ESE and are generally inclined steeply to the SSW; cross-bedding indicates that the beds also young in that direction. The rocks show abundant small-scale and meso-scale folding and lie on the northerly long limb of a kilometre-scale, tight, asymmetrical, ESE-plunging antiformal F_2 fold. The opposing SSE-dipping overturned limb is exposed along the River Einig to the west with the major hinge coincident with the confluence of the rivers Oykell and Einig. Note that in the Oykel Bridge area, the Moine rocks are inverted and face downwards and the antiform is informally termed the Einig Syncline (Leslie *et al*, 2010). The mullions are developed on the steep eastern limb of this fold a short distance from the hinge zone, but are absent from the moderately-dipping short limb.

The origin and tectonic significance of these mullion structures were controversial for many years. Were the mullions developed parallel to the 'b-axis' of monoclinic symmetry, that is normal to the kinematic transport direction according to the German 'symmetrological' school, or parallel to the tectonic 'a-axis' defined by the regional stretching direction and the Moine Thrust movement direction (Howarth & Leake, 2002)? It is now clear that the ESE-plunging linear fabrics in the Moine rocks define the principal extension direction of the main Caledonian (Scandian?) deformation (e.g. Holdsworth & Grant, 1990 and references therein). The regional D_2 folds and the locally developed mullions were formed within this regional strain/ displacement field. Statistical parallelism of the fold axes and the lineation is thought to be due to passive rotation of the axes towards the extension direction during NW-directed overthrusting (e.g. Strachan & Holdsworth, 1988; Holdsworth, 1989a; Alsop & Holdsworth, 2004a & b). The bulk finite D_2 deformation at Oykell Bridge was constrictional, within an overall prolate (cigar-shaped) strain ellipsoid. The precise mechanism by which the mullions developed into discrete but interlocking structures is not, however, fully understood.

Locality 10.2 Glen Oykell [NC 3399 0512] to [NC 3457 0613]

Glen Oykell (Figure 10.1). Polyphase deformation and mullion structures within Moine psammites and semi-pelites.

Drive west along the track that leaves the main road just east of Locality 10.1 and runs along the north side of the River Oykell valley. Parking is available for two to three cars at [NC 3407 0520]. Allocate 2 hours for this locality which involves 2-3 km of walking. Walk east to 2A in the river bed beneath the suspension bridge at [NC 3399 0512]. Moderately thickly bedded Morar Group psammites are deformed by close, non-cylindrical D_3folds with Z-geometry that plunge mainly steeply to the SE, sub-parallel to the regional L_2 lineation. Weakly developed mullion structures are present in some psammite layers. Within semi-pelitic layers it can be seen that a schistosity (S_2?) is folded and crenulated in the hinges of the folds.

Walk north along the eastern bank of the River Oykell, noting shallowly-plunging mullions within psammites at [NC 3416 0573]. Keep following the east bank until the Allt Rugaidh is reached at [NC 3415 0606]. Locality B comprises a traverse up this stream section. Follow the stream upwards (wellingtons useful, small waterfalls can be bypassed on the banks). At [NC 3241 0605] incipient mullions can be studied in psammite and semi-pelite. In sections normal to the mullions, an early fabric (S_2?), axial planar to cm-scale minor (D_2?) folds is seen, especially along the contacts between psammite and semi-pelite. This early fabric is deformed by a younger set of (D_3?) folds that are clearly associated with the mullions. Traverse further upstream, noting excellent mullions at [NC 3424 0604]. At [NC 3457 0613] siliceous psammite shows excellent cross-bedding indicating that strains are still overall relatively low, despite the presence of variably developed mullions. Study of semi-pelitic layers again provides evidence for polyphase deformation. An early (S_2?) mica fabric is emphasised by concordant quartz segregations; these are tightly folded and the early fabric crenulated and variably transposed. Minor folds of the quartz segregations plunge parallel to the mullions. In contrast to Locality 10.1, the development of mullion structures at these exposures is apparently associated with F_3 folding. Elsewhere within the western Moines and Moine Thrust Zone of Sutherland (see Excursions 11 and 13), D_2 and D_3folds are regarded as having developed during continuous progressive deformation associated with NW-directed overthrusting. The association of similarly-oriented fold mullions with both sets of folds in the Glen Oykell/Oykell Bridge area is consistent with this interpretation.

Locality 10.3 Airde of Shin [NC 5219 1542] to [NC 5297 1291]

Airde of Shin (Figure 10.1), (Figure 10.3). Infolded Lewisianoid basement within Moine psammites.

Parking is available for two to three cars by the side of the A838 road NW of Lairg at [NC 5231 1600]. Alternatively, parking for a coach and four to five cars is possible at [NC 5281 1543]. Allocate 3-4 hours minimum for this locality which involves 7km of walking, some of it over rough ground. Walk to the gate at [NC 5249 1579]. Go through the gate and head SSW across rough ground to cross another gate at [NC 5232 1551]. Keeping the fence to the left, walk down to the stream at the base of the valley.

Exposures in the stream at 3A [NC 5219 1542] (Figure 10.3) are of Morar Group micaceous psammites with cm-scale clasts of vein quartz. Possible cross-bedding indicates that the psammites are right way-up. A strongly developed S_2 schistosity dips north-northeastwards more steeply than bedding. These psammites are interpreted to lie structurally above the Loch Shin basement inlier.

Head southwards to reach the shore of Loch Shin. Cross a low-lying fence and traverse SE along the shore to reach the exposures at 3B [NC 5194 1439] (Figure 10.3). These are strongly foliated, platy blastomylonitic Moine psammites with numerous quartz veins. Most are attenuated parallel to schistosity and apparently highly deformed, while others are crosscutting. An intense grain shape fabric is defined by quartz ribbons, quartz-feldspar aggregates and aligned muscovite grains. Cross a small beach to [NC 5196 1433] to view exposures of gently-dipping muscovite schists with abundant lunate quartz segregations and attenuated quartz veins. These are interpreted as blastomylonitic 'tectonic schists' derived from the intense shearing of basement lithologies (Peacock, 1975; Strachan & Holdsworth, 1988). A strong mineral and extension lineation plunges eastwards. The schists contain numerous tight-to-isoclinal D_2 folds that deform a strong S_1 schistosity, so that the dominant fabric is a composite S_0 /S_1/S_2 foliation. The schists are underlain by banded Lewisianoid hornblende gneisses; distinctive dark, hornblende-rich layers range in thickness from a few cm to over a metre. Metre-scale pods of amphibolite and ultrabasic lithologies are common and in places form elongate trains of boudins (Figure 10.4). The majority of D_2 folds of gneissic banding have Z-geometry and S_2 is anticlockwise of S_0 /S_1 (Strachan & Holdsworth, 1988). Traverse eastwards to the limit of exposure at [NC 5209 1409].

Continue eastwards, walking around the small bay and noting the old lime kiln on the hillside to the southeast. The headland at 3C [NC 5208 1388] (Figure 10.3) exposes layers of white marble, calc-silicate rocks and rusty-brown mica schists that are interpreted as metasedimentary components of the basement inlier. The calc-silicate rocks consist mainly of tremolite, diopside, calcite, quartz and titanite (Read *et al*., 1926). These metasediments are underlain by hornblende-garnet gneisses that contain concordant, foliated quartz-feldspar pegmatites, varying in thickness from 10-20cm to just over a metre. A strong mineral and extension lineation plunges to the east. Tight-to-isoclinal D_2 folds have S-geometry and S_2 is clockwise of S_0 /S_1. The change of vergence of D_2 folds, and the relationship of S_2 to S_0 /S_1 across the Loch Shin inlier implies that it occupies the core of a major D_2 fold (Strachan & Holdsworth, 1988). Traverse eastwards across more basement gneisses that extend as far as [NC 5214 3181] and then extensive boulder fields with no exposure.

A traverse through the Moine psammites that structurally underlie the basement inlier commences at 3D [NC 5258 1313] (Figure 10.3) at the back of the beach where platy, high strain Moine psammites contain numerous deformed quartz veins and are very similar to those immediately above the inlier at 3B. These continue to the SE with numerous surfaces showing high strain, platy blastomylonitic fabrics that wrap elongated and boudinaged veins of granitic pegmatite. Despite the generally high strains, deformed but readable cross-bedding is preserved at three localities [NC 5280 1293]; [NC 5282 1292]; [NC 5297 1291] where in all cases the psammites are inverted. The location of the Loch Shin basement inlier in the core of a major (D_2) fold is thus clearly demonstrated on both structural and sedimentological grounds. Exposures at [NC 5309 1285] are notable for the development of layers of pseudo-conglomerate, apparently as a result of the boudinage and extreme flattening of quartz veins.

Return along the coast to [NC 5214 3181] and then head across the hillside, going through the gate at [NC 5217 1489], along the north coast of the Airde of Shin to Locality 10.3A, and back to the vehicles.

Locality 10.4 Creich Peninsula [NH 6400 8839] to [NH 6504 8802]

Creich Peninsula (Figure 10.1), (Figure 10.5). Infolded Lewisianoid basement within Morar Group psammites; Sgurr Beag Thrust; Glenfinnan Group gneisses.

This locality requires low tides, and parties are advised to take particular care on the seaweed-covered rocks. Allocate 3-4 hours for this locality which involves *c.*4km of walking. From Bonar Bridge, follow the A949 eastwards parallel to the north shore of the Dornoch Firth. Turn off the A949 at [NH 6433 8910] onto a small track. Parking is available for up to three cars at the first bend in the track at Creich Mains [NH 6424 8879]. If the group is larger than can be transported in three cars, extra vehicles could be parked at the cemetery beside the A949 [NH 6354 8933] and members of the party ferried to Creich Mains. From the vehicles, walk along an overgrown track that leads southwards. After 350m the track branches to the right; follow it down through the woods to the shoreline, emerging by an old ruin at [NH 6418 8813].

Walk NW along the shoreline to the prominent outcrops at 4A [NH 6400 8839] (Figure 10.5) that comprise blastomylonitic Morar Group psammites. These psammites lie within the wide ductile shear zone associated with the structurally overlying Sgurr Beag Thrust (Strachan & Holdsworth, 1988; Grant & Harris, 2000). Sedimentary structures are absent, presumably as a result of the high strains, although common orange K-feldspars may represent original detrital grains. A pervasive mm-scale schistosity defined by aligned micas and quartz plates dips moderately eastwards and is accompanied by an ESE-plunging mineral and extension lineation. The schistosity is axial planar to mesoscopic tight to isoclinal folds that plunge sub-parallel to the lineation. Numerous cm-scale concordant quartz veins are present and are mostly strongly foliated and/or boudinaged. Retrace your steps southeastwards to 4B [NH 6402 8835] (Figure 10.5) where at the back of the beach Morar Group psammites are separated by a thin layer of highly tectonized pelite from banded blastomylonitic Lewisianoid gneisses (Grant & Harris, 2000). These are composed of quartz, feldspar and biotite; the banding is less continuous than that within the Moine rocks and is interpreted as a highly sheared metamorphic segregation fabric. Traverse SE, noting metre-scale sheets of pink, mylonitic pegmatite and/or acid gneiss [NH 6406 8830] and metabasic sheets now mostly composed of retrogressive biotite [NH 6407 8830]. Similar lithologies are exposed east of the ruin, although here there is a higher proportion of variably retrogressed metabasic sheets and pods, some of which preserve hornblende. Strongly foliated hornblende gneisses occur at [NH 6432 8811]. Throughout the basement inlier, the dominant foliation dips moderately eastwards and the associated mineral and extension lineation plunges to the ESE.

At 4C [NH 6437 8812] (Figure 10.5), the eastern margin of the basement inlier is exposed under the low branches of a large tree. The contact with the highly deformed Morar Group psammites to the east is sharp and concordant. The psammites display essentially the same lithological and structural features as those listed above for Locality 10.4A. The symmetrical disposition of Moine lithologies either side of the basement inlier suggests that it might lie within the core of an isoclinal Caledonian (D_2) fold, and thus has a similar structural setting to the Loch Shin basement inlier. However, this is difficult to demonstrate conclusively due to the lack of minor fold structures and the high tectonic strains that have obliterated sedimentary structures within the Moine rocks. An alternative interpretation is that the lower boundary of the basement sheet is a ductile thrust that was responsible for interleaving the gneisses with the Moine cover (Grant & Harris, 2000).

Traverse eastwards to 4D [NH 6483 8805] (Figure 10.5) where the Sgurr Beag Thrust is exposed as a sharp, concordant, east-dipping contact between Morar Group psammites and strongly foliated pelitic schists of the Glenfinnan Group. The regional metamorphic contrast across the thrust is not immediately apparent as a result of intense strain and retrogression of the Glenfinnan Group lithologies. A mineral and extension lineation plunges to the ESE, and shear bands indicate a general top-to-the-west sense of overthrusting parallel to the lineation. Continue eastwards, noting garnets as well as occasional lenticles and layers of quartzo-feldspathic material within the pelites that are interpreted as the sheared remnants of an older migmatitic segregation fabric. The pelites pass transitionally eastwards into coarse, striped psammitic and semi-pelitic gneisses with cmscale quartzo-feldspathic migmatitic layers, well exposed at [NH 6504 8802]. Only a few km to the SW, on Ben Wyvis, migmatization of the Glenfinnan Group has been assigned to a Neoproterozoic prograde event as it pre-dates emplacement of the *c.*730 Ma Carn Gorm pegmatite (Hyslop, 1992). On that basis, migmatization within the Glenfinnan Group rocks of the Creich Peninsula is also tentatively assigned to the Knoydartian event. Return westwards along the shore to the ruin, and then back to the vehicles.

Locality 10.5 Vagastie Bridge [NC 5324 2712]

Vagastie Bridge (Figure 10.1), (Figure 10.6). Syn-tectonic granite sheets intruding Moine psammites in the footwall of the Naver Thrust.

Park adjacent to the A836 in the large parking place immediately south of Vagastie Bridge [NC 5324 2712] (Figure 10.1). There is sufficient space for a coach if necessary. Allocate ½-1 hour for this locality. The Vagastie Bridge granite represents one of the larger members of a series of deformed igneous intrusions that occur in Central Sutherland (Read, 1931), the Vagastie suite (Soper, 1971; Soper & Brown, 1971). The granite is not a single body, but a series of sheets that intrude Morar Group psammites. A detailed description of the petrology and field relationships of these granitic sheets is presented by Holdsworth & Strachan (1988) and only the most important points are covered here.

Walk to the bridge and examine the outcrops of a pink, coarse-grained augen granite by the banks of the stream on the east side of the bridge. A strong tectonic foliation defined by recrystallized feldspar augen dips gently to the ESE and carries a SE/SSE-trending mineral and extension lineation. NW-dipping shear bands are occasionally present and demonstrate a general top-to-the-NW sense of displacement parallel to the lineation. A sample of the augen granite collected a few metres NE of the bridge yielded a U-Pb zircon age of 424 ± 9 Ma, interpreted as dating intrusion of the igneous protolith (Kinny *et al*., 2003b). It therefore follows that the deformation that affects the granite must have occurred either during or after granite intrusion.

Cross the road and descend to the outcrops in the stream immediately beneath the bridge to examine the relations between the granite and its host Moine psammites. The psammites are deformed by a metre-scale, open-to-close, SW-overturning D_2 fold pair, the upper hinge and short limb of which are cut by the base of the lowest granite sheet (Figure 10.6). Contacts between the granite and its psammitic host are sharp and well-defined. Three important observations can be made: (1) the granite sheet is not folded; (2) it carries a foliation that is oblique to its margins and sub-parallel to D_2 axial planes and S_2 in the psammites; and (3) the SE/SSE-trending lineation within the granite is sub-parallel to the dominant (L_2) lineation within the psammites. Granite-Moine contacts elsewhere display the same structural relations (e.g. [NC 5329 2726]) (Figure 10.6).

Given that the granite sheets are not folded by D_2, but nonetheless carry S_2 and L_2, the simplest interpretation is that granite intrusion occurred during D_2 (Holdsworth & Strachan, 1988). Intrusion must have post-dated folding, but predated the later stages of fabric development. The U-Pb zircon age obtained for the Vagastie Bridge Granite thus demonstrates that D_2 and correlative structures in this part of Central Sutherland occurred during the Scandian phase of the Caledonian orogeny (Kinny *et al*. 2003b).

Locality 10.6 Loch Naver [NC 6288 4048] to [NC 6537 3925]

Loch Naver (Figure 10.1), (Figure 10.7). Interfolded Morar Group and Lewisianoid basement; Naver Thrust; Naver Nappe migmatitic gneisses.

If driving north from Vagastie Bridge, turn right at Altnaharra onto the B873 signposted to Syre and Bettyhill. Drive eastwards for *c*.13km and park by the roadside either side of the bridge at [NC 6405 3867]. There is space for four to five cars; allocate 6-7 hours for this locality, which involves *c*.14km of walking over hillsides and rough ground.

Follow the Allt Gruama Beg NW as far as Loch Morlach. Walk around the north shore of the loch to the small stream that enters the loch at [NC 6305 3925] and head northwards across moorland to Cnoc Liath. Lowlying exposures at 6A [NC 6288 4048] (Figure 10.7) are massive to coarsely-foliated garnet-pyroxene gneisses of the Naver basement inlier. Although the igneous protoliths of this inlier are undated at the time of writing, a late Archaean age seems likely by comparison with the Borgie inlier just a few kilometres to the north (Friend *et al*., 2008). The high-grade metamorphic event that resulted in formation of the garnet-pyroxene gneisses has been correlated with the Scourian event in the Caledonian foreland (Moorhouse, 1976), but a much younger age cannot be ruled out (see also Locality 13.7, Excursion

13). Late retrogressive shear zones, defined by narrow bands of hornblende schist, cut these high-grade gneisses. Other exposures within a radius of 100m are of banded hornblende gneisses with concordant amphibolite sheets, more typical of large tracts of the Naver inlier. Gneissic banding dips to the ESE and carries a down-dip mineral lineation commonly defined by aligned hornblende. The hornblende gneisses were probably derived, at least in part, from retrogression of the garnet-pyroxene gneisses. Additional outcrops of relic garnet-pyroxene gneisses are present a little further to the north on a small hillock at [NC 6276 4070].

Traverse NE across numerous other low-lying outcrops of hornblende gneisses. The Morar Group rocks that structurally underlie the Naver basement inlier are exposed at 6B [NC 6356 4197] (Figure 10.7) on a series of north-facing crags. These lithologies are banded, fine-grained psammites with thin semi-pelite bands. Note the lack of any evidence for high-grade metamorphism and migmatization, in contrast to those to be seen later above the Naver Thrust. The banding is interpreted as tectonically modified bedding; sedimentary structures are absent, but detrital feldspar grains are common. A mesoscopic, reclined D_2 fold with S-geometry plunges to the SSE, parallel to a mineral and extension lineation defined by aligned micas and quartz-feldspar aggregates. Walk eastwards along strike, noting several metre-scale, foliated and boudinaged sub-concordant granite sheets, possibly members of the same suite as those seen at Vagastie Bridge.

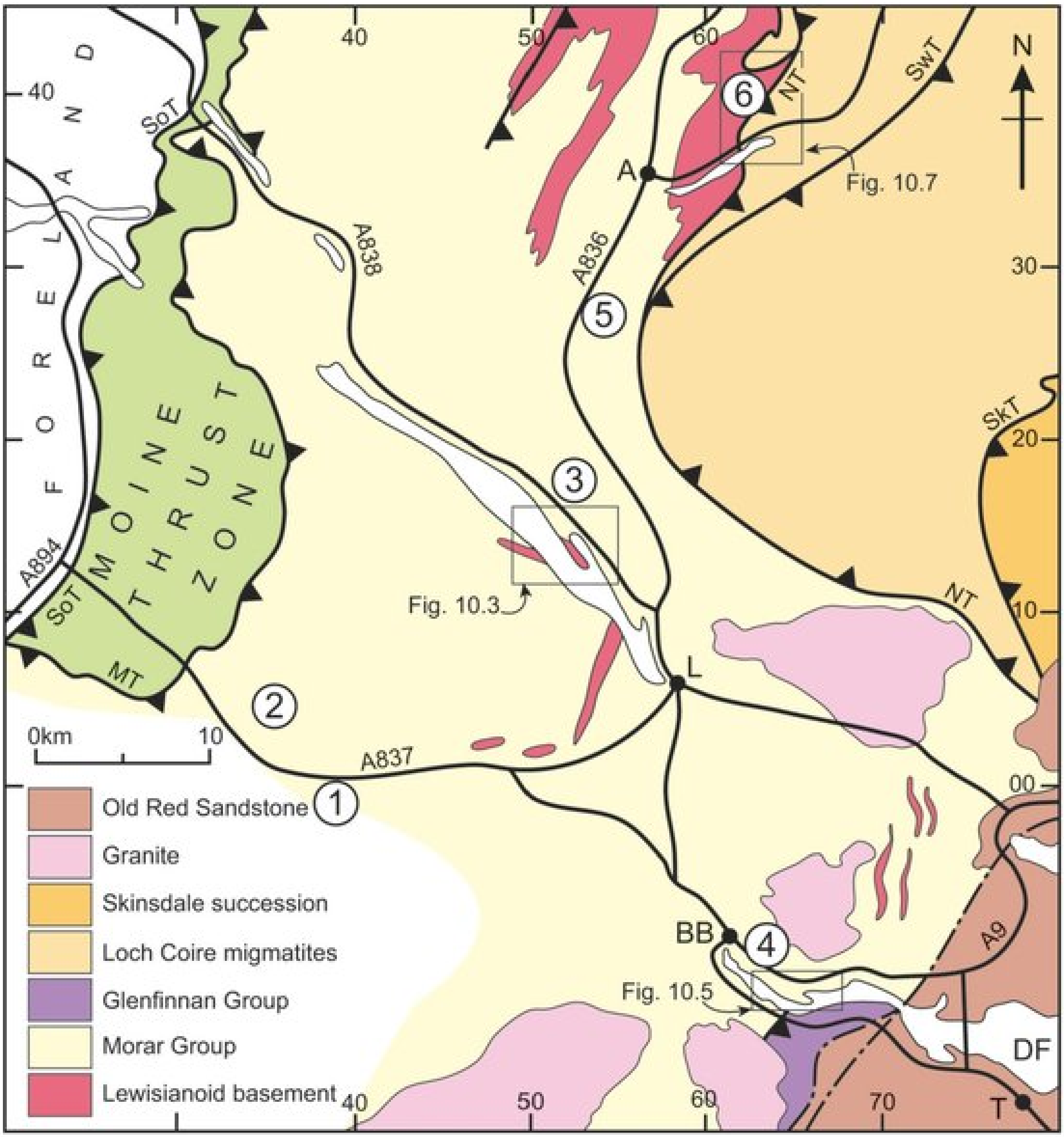
Head eastwards across the moorland to the two lochs labelled 'Loch Bad na Fheoir' on the 1:25,000 scale OS map (Figure 10.7). On the east side of the smaller of the two lochs at 6C [NC 6481 4191] are exposed very flaggy Morar Group psammites and semi-pelites. The high-strain fabric dips gently to the SE and carries a down-dip mineral and extension lineation that is inferred to lie parallel to the direction of tectonic transport along the overlying D_2 Naver Thrust. Walk around to the SE side of the larger loch to [NC 6495 4184] where similar high-strain psammites are cut by thin, discordant pegmatites. A sharp contact separates these psammites from overlying biotite schists that are interpreted as highly retrogressed basement gneisses near the northern termination of the Naver inlier (Figure 10.7). A series of low-lying exposures to the south (e.g. [NC 6495 4181]) show rather less-retrogressed, banded hornblende gneisses.

Walk upslope to 6D [NC 6501 4178] (Figure 10.7), crossing the unexposed Naver Thrust, and traversing into extensive outcrops of banded psammitic, migmatitic gneisses of the Naver Nappe. These are deformed by highly attenuated isoclinal D_2 folds of banding and open, asymmetric D_3 folds, both plunging sub-parallel to the SSE-trending mineral and extension lineation. The gneisses are intruded by numerous concordant and boudinaged granitic pegmatites. Migmatization in Central Sutherland is thought to have occurred during the Ordovician Grampian phase of the Caledonian orogeny (*c*.470-460 Ma; Kinny *et al*., 1999). Traverse to the top of Cnoc Bad an Fheòir through similar lithologies, and then head east from the summit of the hill for *c*.1km to the next set of exposures on the west side of an unnamed hill.

A prominent set of outcrops at 6E [NC 6602 4166] (Figure 10.7) comprise flaggy garnet-biotite schists that overlie the Torrisdale Thrust, a tectonic break within the Naver Nappe (Figure 10.7). The thrust is not exposed here, but near the summit of Ben Klibreck to the SW is associated with interleaving of basement orthogneisses with Moine metasedimentary gneisses of the Naver Nappe (Strachan & Holdsworth, 1988). The garnet-biotite schists are intruded by a series of pegmatites that vary from early, foliated types to late, discordant and undeformed sheets. Traverse upslope through SE-dipping, banded psammitic and semi-pelitic gneisses with numerous concordant sheets and pods of foliated amphibolite, and abundant pegmatite. A SSE-plunging mineral and extension lineation is present locally. Head southwards from the top of the hill to reach the Allt Dail a'Thuraich.

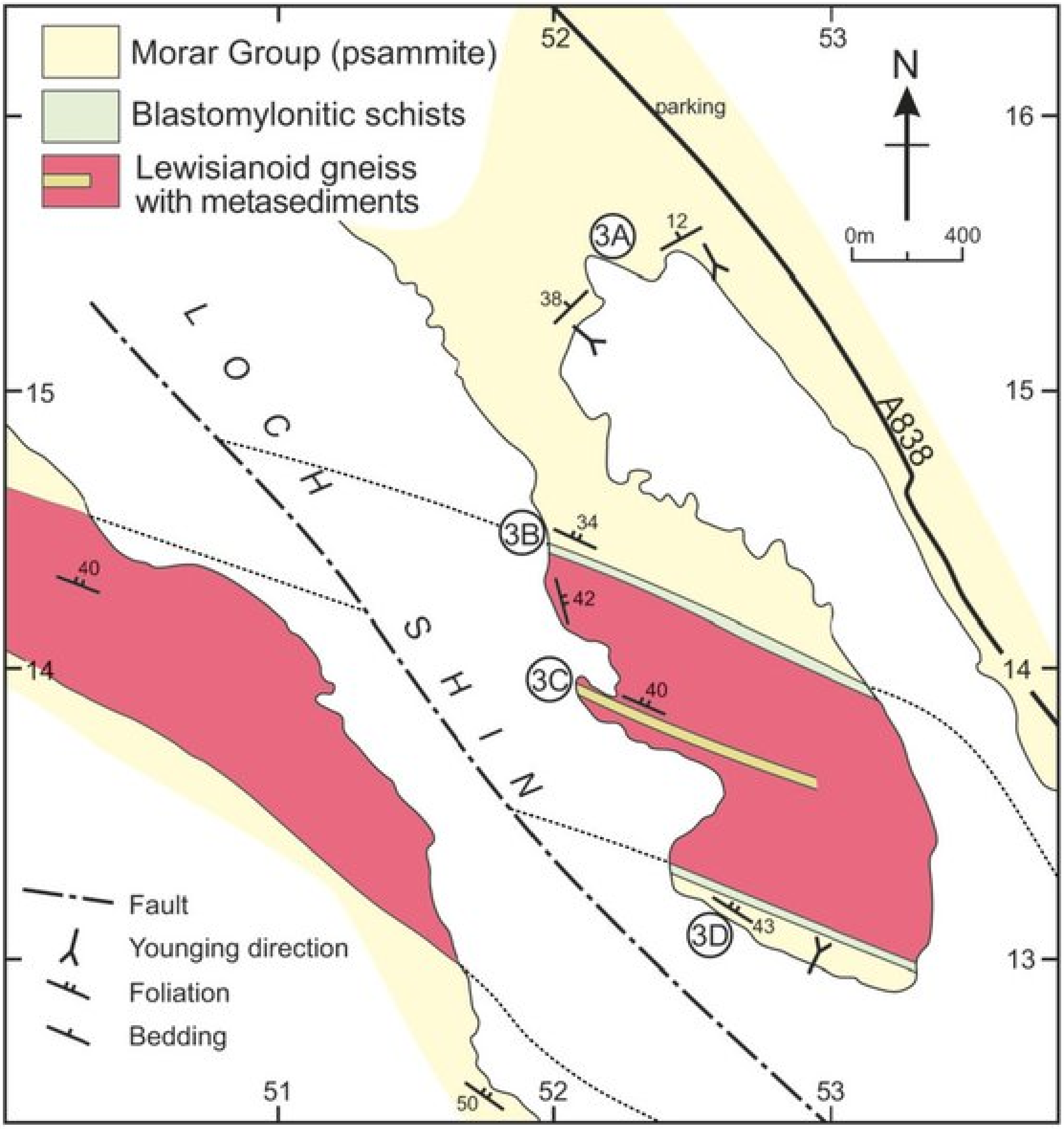
Follow the stream southwards to 6F [NC 6537 3925] (Figure 10.7) where coarse migmatitic pelites with abundant concordant pods and layers of coarse pegmatitic material are exposed in the stream bed. Follow the stream southwards to the main road, and then walk westwards for *c*.1km back to the vehicles.

References



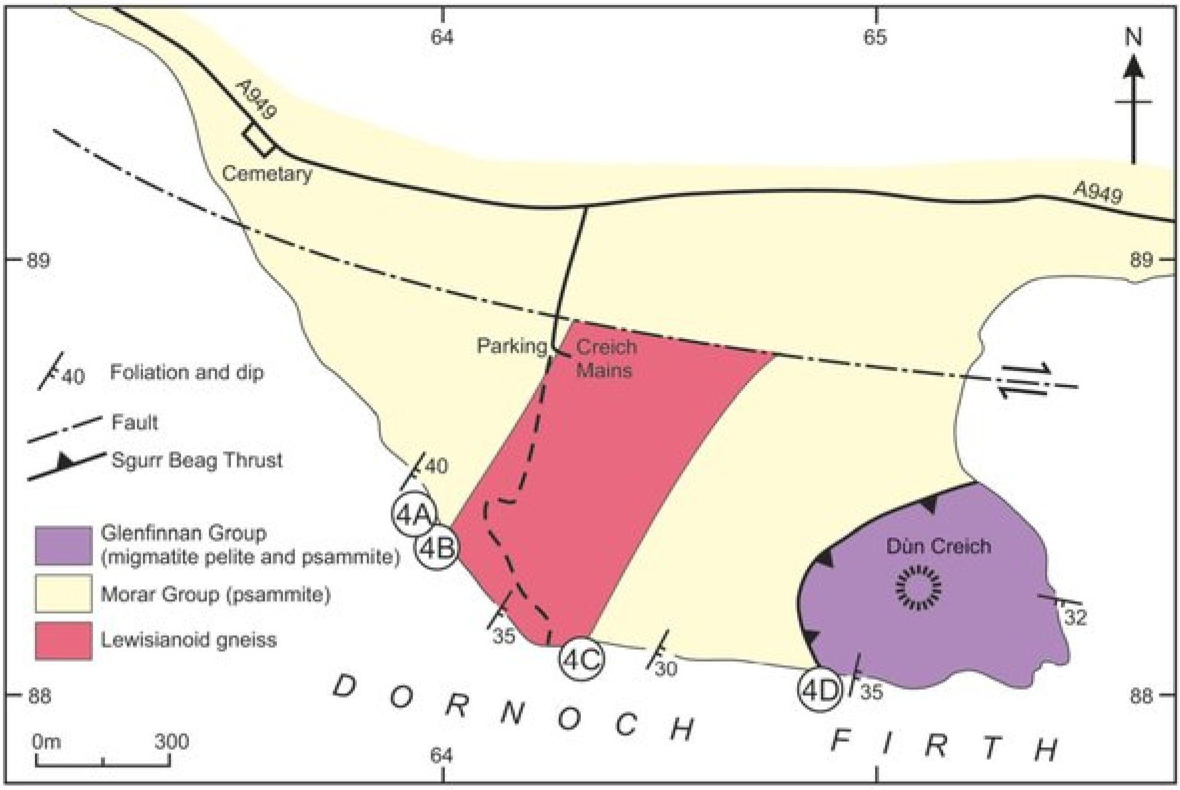
Simplified geology of south and central Sutherland together with the localities for the excursion. A = Altnaharra; BB = Bonar Bridge; DF = Dornoch Firth; L = Lairg; T = Tain; ST = Sole Thrust; MT = Moine Thrust; NT = Naver Thrust; ST = Swordly Thrust; SKT = Skinsdale Thrust

Well-developed mullions plunging parallel to the regional L_2 lineation at Oykell Bridge (Locality 10.1).

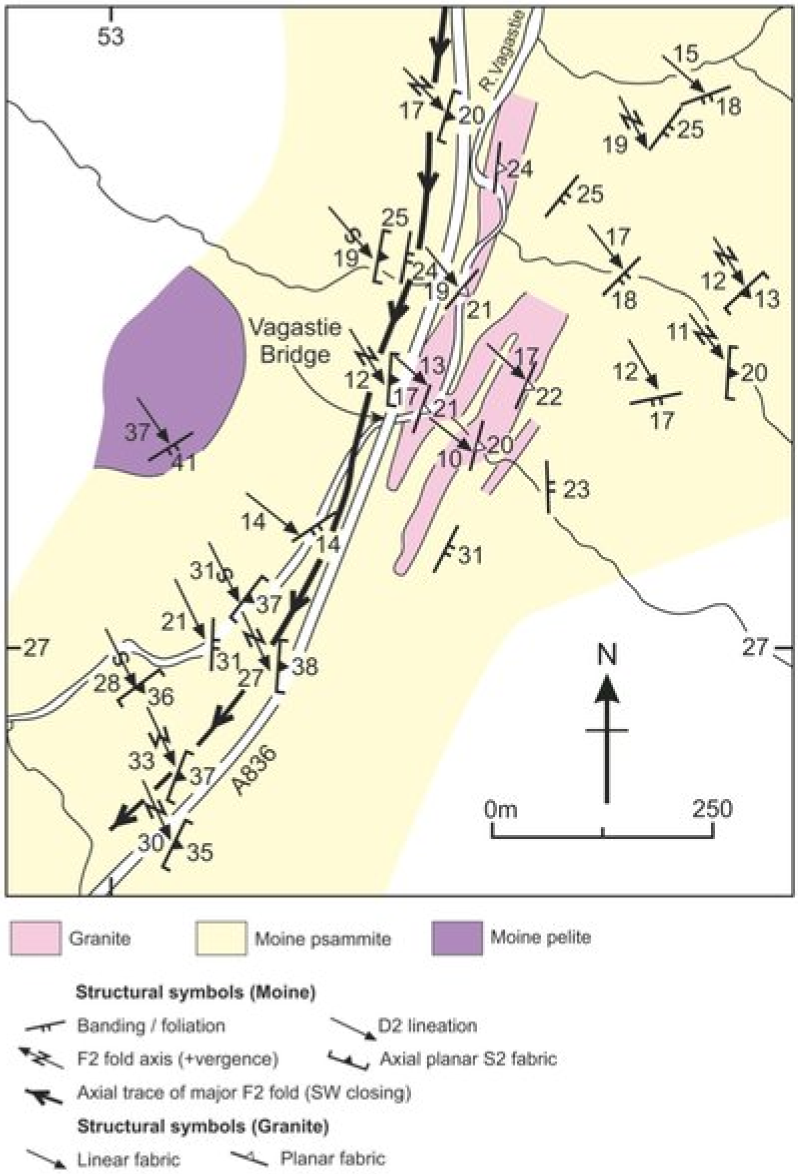


Geological map of Locality 10.3, the Airde of Shin.

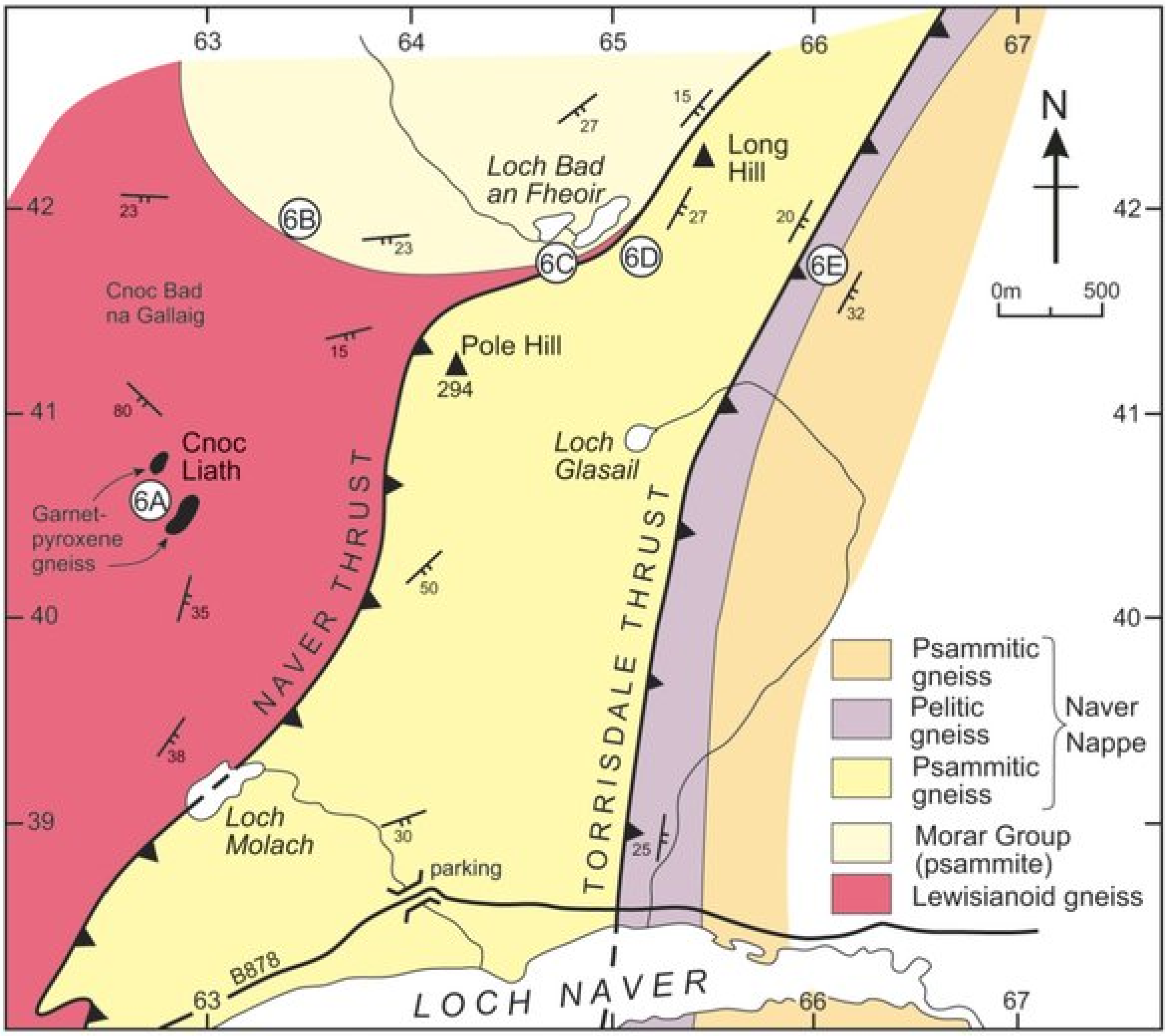
Boudinaged mafic pods within strongly deformed intermediate to felsic gneiss of the Loch Shin basement inlier at Locality 10.3B.



Geological map of Locality 10.4, the Creich Peninsular (from Strachan & Holdsworth, 1988 & Grant and Harris, 2000).



Detailed geological map of the area around Vagastie Bridge (from Holdsworth & Strachan, 1988).



Geological map of Locality 10.6, the Loch Naver area.