

Moine geology of North Sutherland. Swordly Bay, Kirtomy Bay and Cnoc Mor - an excursion

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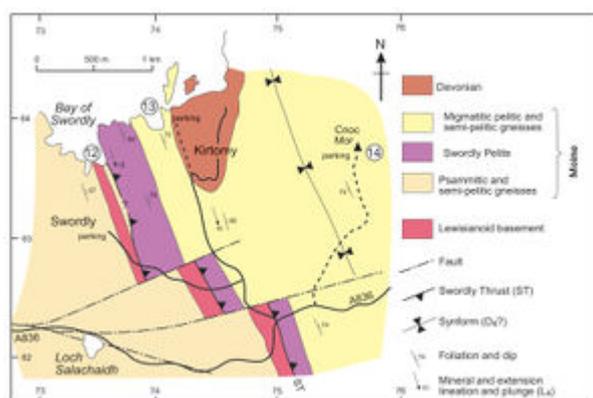


Fig. 13.10 Geological map of Localities 13.12, 13.13 and 13.14 (from Moorhouse et al., 1988 and Burns, 1994).



Fig. 13.11 Migmatitic gneisses at Locality 13.14, showing extensive partial melting.

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Excursion 13 North Sutherland. Swordly Bay, Kirtomy Bay and Cnoc Mor

Locality 13.12 Swordly Bay [NC 7354 6355]

Swordly Bay ([Fig. 13.10](#)). Swordly Lewisianoid basement inlier; Swordly Thrust and overlying migmatitic pelites reworked within the Torrisdale Steep Belt.

Turn off the A836 onto a minor road c.5km east of Bettyhill; after 300m take the left-hand fork and follow the road for 1.25km. Park with permission by the farm buildings at [NC 7356 6307] where there is sufficient space for a minibus or three to four cars. Allocate 1 hour for this locality. Walk northwards and turn to the right of a ruined building, passing through a gap in the stone wall and then head across the grass towards Swordly Bay. Cross the fence at a small stone stile and walk down to the beach [NC 7354 6355]. Exposures on the west side are of banded, mafic hornblende gneisses of the Swordly basement inlier that is thought to occupy the core of an early isoclinal fold within the Naver Nappe (Moorhouse, 1979; Moorhouse *et al.*, 1988). It has not at the time of writing been dated isotopically, but its basement affinities have been confirmed by detailed chemical studies (Burns, 1994). The gneissic fabric is deformed by upright, open (D_4 ?) folds. If the tide and sand levels are low, the eastern contact of the basement with psammitic gneisses is exposed in the centre of the bay. Walk to the east side of the bay, across the unexposed Swordly Thrust, to see the Swordly Pelite, comprising northeast-dipping, pelitic gneisses and schists with numerous sheets and pods of granitic material. This lithology is interpreted as a strongly deformed and mylonitized migmatitic gneiss; the granitic rocks are thought to represent melt layers, consistent with the local presence of garnet and sillimanite, and the abundant muscovite is most likely of retrogressive origin. A strong L_4 lineation plunges gently to the SSE. Pervasive shear bands and asymmetrically sheared boudins of granitic material indicate a dextral sense of shear parallel to the lineation. On the west side of a rocky knoll at the top of the beach, a low strain zone preserves a NW-trending mineral lineation (L_2 ?) that is variably sheared into parallelism with L_4 . This early lineation is interpreted to define the direction of tectonic transport along the D_2 Swordly Thrust prior to steepening within the Torrisdale Steep Belt. A $40\text{Ar}/39\text{Ar}$ muscovite age of c.423 Ma has been obtained from these mylonitic pelitic gneisses (Dallmeyer *et al.*, 2001).

Locality 13.13 Kirtomy Bay [NC 7413 6408]

Kirtomy Bay ([Fig. 13.10](#)). Moine gneisses within the Torrisdale Steep Belt and unconformably overlying Old Red Sandstone (Devonian) sedimentary rocks.

From the previous locality, drive back 1.25km to the fork in the road, turn sharp left and follow the road towards the small hamlet of Kirtomy. After 1km the road turns abruptly right; instead, carry on straight ahead on the grassy track and parking for a minibus or three to four cars is available at the end of the track [NC 7417 6401]. Allow ½-1 hour for this locality. **Do not** take the path to the right down to the small jetty; instead walk to the west side of the headland and descend down the grassy path on a narrow ridge westwards onto a stony beach. On the west side at [NC 7411 6399] are low polished beach outcrops of steeply-dipping banded semi-pelitic gneisses within the Torrisdale Steep Belt showing numerous shear bands and asymmetrically deformed leucosomes and melt pods that demonstrate a dextral sense of shear parallel to a gently-plunging L_4 lineation. Walk back 100m or so to the east and climb over the bottom of the grassy ridge that you descended into the next small bay [NC 7413 6408] to view the cliffs at the back of the beach that comprise Old Red Sandstone boulder conglomerates with thin sandstone layers. Look across the small bay to the north to see the irregular Moine-Old Red Sandstone faulted landscape unconformity completely exposed where sheets of conglomerate drape steeply-dipping gneisses. Boulders within the conglomerate are mostly of Moine migmatitic gneisses of the Kirtomy migmatites (Burns, 1994) and pink granites typical of the late Caledonian 'Newer Granite' Suite. Their rounded appearance most likely indicates fluvial erosion and transportation prior to deposition.

Faults bounding the basin trend NNW-SSE and N-S (the former reactivating basement fabrics) with a system of minor ENE-WSW faults appearing to accommodate along-strike variation in throw. The sedimentary rocks are also cut by various late, brittle faults which are attributed to dextral reactivation of the basin-bounding faults, probably during the Permian (Wilson *et al.*, 2010). Before leaving this locality, take a moment to look east across the bay to see the classic half-graben structure, with conglomerate units adjacent to the bounding fault grading into more blocky, moderately-dipping sandstone units outcropping across much of the bay, which then onlap basement exposures on the far hillside.

Locality 13.14 Cnoc Mor [NC 7567 6344]

Cnoc Mor ([Fig. 13.10](#)). Moine migmatites.

Turn off the A836 c.400m east of the minor road to Kirtomy, onto a small tarred track that leads up to the radio and mobile telephone masts on Cnoc Mor. Park in a large space below the mast at [NC 7567 6344]. There is sufficient space for minibuses and cars. Allocate ½ hour for this locality. Walk up the road and examine the first outcrops on the east side. These are of banded migmatitic gneisses with substantial layers of anatectic melt ([Fig. 13.11](#)). Some melt layers are concordant, whereas others are clearly discordant and have probably migrated locally from their source. Similar migmatitic gneisses along strike to the NNW at Kirtomy Point have yielded a U-Pb zircon (SHRIMP) age of 461 ± 13 Ma that is interpreted to date melting during the Grampian phase of the Caledonian orogeny (Kinny *et al.*, 1999). Two sets of folds are present at the present locality: (a) early syn-migmatite folds ($D_1N?$) that are commonly disharmonic and cut by discordant melt layers; and (b) later asymmetric folds ($D_4?$) associated with the steep foliation and development of the major upright synform located a few hundred metres to the east. Note that the gently-plunging L_4 lineation and its associated dextral shear indicators are now absent. A U-Pb monazite age of 431 ± 10 Ma has been obtained from the migmatites near here, indicating substantial reheating during the Scandian phase of the Caledonian orogeny (Kinny *et al.*, 1999). If weather permits, excellent views can be had from the top of the hill of the entire north coast of Sutherland, the south coast of the Orkney Islands, and various mountains inland.

References

At all times follow: [The Scottish Access Code](#) and [Code of conduct for geological field work](#)

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