
Excursion 2 The Northern Marginal Zone (NMZ)

Coire Dubh – Meall Breac – Am Màm– Priomh-lochs area

Highlights

This excursion will examine the rocks of Stage 1 exposed in Coire Dubh and on the low hills south of Kinloch (Cnapan Breaca, Meall Breac and Am Màm). The traverse, from Kinloch into Coire Dubh to the south, crosses in-situ Torridon Group rocks to the Main Ring Fault, then caldera breccias, rhyodacite ash flows and small intrusions of rhyodacite (with evidence of mixing of basaltic and rhyodacitic magmas). On Am Màm, a distinctive intrusive breccia is seen to predate intrusive rhyodacite. Further west, near the Priomh-lochs, Archaean gneisses are overlain by coarse sandstone belonging to the Fiachanis Gritty Sandstone Member (Torridon Group).

The distance for this excursion is about 10 to 15 km, depending on options chosen, and the highest point reached is nearly 350 m (Figure 13). Leave Kinloch by the path from the castle along the west bank of Allt Slugan a'Choilich. Once clear of the trees around Kinloch, sandstone belonging to the Scresort Sandstone Member is encountered, intruded by numerous south-west-dipping sheets of aphyric to sparsely feldspar-phyric basalt that form part of a cone-sheet swarm (Figure 14). Representatives of the swarm are well exposed in the bed of Allt Slugan a'Choilich, particularly above the altitude of 150 m where the resistant basalt sheets form a succession of small waterfalls. Follow the path or stream uphill towards Coire Dubh, noting the increased north to north-north-west dips of the sandstones.

Locality 2.1 Allt Slugan a'Choilich – steeply dipping, indurated mudstone within strands of Main Ring Fault [NM 3935 9835]

At a point where the path is close to the stream, water-worn slabs expose black mudstone cut by thin (< 1 m) basalt cone-sheets (Figure 14). The mudstone, which dips steeply to the north, belongs to the Laimhrig Shale Member (TCDL) and is thought to have been uplifted between the outer and inner components of the Main Ring Fault (Figure 13). Brecciation and extensive quartz veining can be observed locally.

Locality 2.2 Allt Slugan a'Choilich – Inner Main Ring Fault [NM 3932 9828]

At 195 m altitude, a small dam diverts Allt Slugan a'Choilich into the Kinloch hydro-electric pipeline. Sandstone (TCDF) exposed in the path about 40 m north of the dam appears spotted, due to thermal metamorphism.

Between the dam and the deer fence, a zone of crushed and sheared sandstone and siltstone marks the position of the inner Main Ring Fault. Inclined sheets are abundant in the stream below this point, but are virtually absent at higher levels, inside the inner fault. Upstream from the dam, the stream has eroded a steep-sided gorge along a north-north-east-trending fault and a later picrite dyke that cuts the Main Ring Fault.

Pass through the deer fence (close the gate) into Coire Dubh. Steeply dipping, current-bedded coarse sandstone (the Fiachanis Gritty Sandstone Member, TCDF) is exposed along the path for about 150 m. This is the lowermost member of the Torridon Group on Rum, and its presence indicates further uplift, this time within the inner Main Ring Fault. Note that the Torridonian beds are folded into a tight anticline that strikes approximately west-north-west and is cross-cut by the inner Main Ring Fault (Dunham and Emeleus, 1967).

Locality 2.3 Coire Dubh – basal Coire Dubh Breccia, with incipient fracturing in nearby sandstone [NM 3917 9807]

The boundary between slightly shattered sandstone and the Coire Dubh Breccia is seen close to the east bank of the stream, at 300 m altitude (cross the stream with caution). This spectacular breccia consists of angular and subrounded

fragments of gritty sandstone, sandstone, siltstone and indurated mudstone derived from the lowest members of the Torridon Group (TCDF, TCDL). The clasts are generally from 1 cm to over 30 cm in diameter and are in a matrix of finely comminuted sandstone and siltstone. Rare clasts of dolerite, basalt and gneiss occur, but the breccia consists essentially of Torridonian lithologies (Figure 15), (Figure 16).

Locality 2.4 Coire Dubh – tuffisite dyke cutting Coire Dubh Breccia [NM 3927 9794]

Follow the contact east and south-east for about 200 m to where it is cut by a 1 m-thick tuffisite dyke with fragments of sandstone and rhyodacite porphyry in a dark matrix (Figure 17).

Locality 2.5 Coire Dubh – 'mixed-magma': rhyodacite plug with mafic enclaves [NM 393 979]

A short distance to the east, a porphyritic rhyodacite plug intrudes the breccias (Figure 18). The rhyodacite contains abundant mafic enclaves and sandstone fragments. The former commonly show bulbous liquid-liquid contacts at outcrop and in thin section, representing a classic 'mixed magma' occurrence (Troll *et al.*, 2004). Continue uphill for 300 m in a south-east direction to the remains of a lochan [NM 3960 9763], in a shallow basin at 365 m altitude.

Locality 2.6 Cnapan Breaca – bedded breccias, sandstone and rhyodacite ash flows [NM 396 976]

The base of the Coire Dubh Breccias is exposed on the slopes south-east of the silted-up lochan where thinly bedded tuffs, including crystal tuffs and tuffs with coated lapilli, are interbedded with a much attenuated thickness of coarse breccias that extend to the south (Locality 2.6a). 150 m south of the lochan, extrusive porphyritic rhyodacite with streaky, variably attenuated fiamme, dipping south-west at 40–45°, overlies weakly bedded tuffs, which in turn overlie a thin, impersistent bed of epiclastic sandstone (ZSA on (Figure 19); (Figure 20)). Thin tuffs also occur within the rhyodacite close to its base (Locality 2.6b [NM 3955 9752]). To the south, the rhyodacites end against the Marginal Gabbro of the ELI, the line of contact being marked by scattered exposures of intrusion breccia that are thought to have formed by back-veining of rhyodacite into the intruding gabbro (Dunham, 1964). The resistant rhyodacite forms a ridge that extends to Cnapan Breaca [NM 393 975], but the Marginal Gabbro has largely decayed to gravel. This ridge and the Cnapan Breaca summit area offer magnificent views of Hallival and the Eastern Layered Intrusion (Figure 19), (Figure 20).

About 150 m south-west of the lochan, there is a well-exposed contact between a small gabbro plug and rhyodacite. About 50 m north-west of the plug a 30 to 40 cm-thick tuffisite sheet cuts the breccia, but not the rhyodacite, and at several places west of the lochan a thin, impersistent layer of epiclastic sandstone separates rhyodacite from the main tuff-breccia succession to the north-east (Locality 2.6c). The numerous basic dykes at this locality post-date the rhyodacite, breccia and tuffisite.

Continue to a point about 150 m west-north-west of the silted-up lochan (Locality 2.6c), where there is a north-facing cliff that extends for nearly 0.5 km to the west-north-west. The cliff is formed by porphyritic rhyodacite, which overlies bedded tuffs, epiclastic sandstone and Coire Dubh Breccia.

Locality 2.7 Coire Dubh – Epiclastic sandstone underlying tuffs at base of rhyodacite ash flows [NM 3933 9769]

The contact between the rhyodacite and the epiclastic sandstone crops out at several places along the base of the cliff (Figure 20). The sandstone may be up to 4 m in thickness. It is a coarse-grained gritty siliceous rock with very weak bedding and may exhibit some brecciation towards its base. The sandstone is overlain by bedded tuffs with suggestions of surge deposits; thin tuffaceous layers also occur within the lower part of the rhyodacite (Figure 21).

Locality 2.8 Coire Dubh – rhyodacite fiamme deformed by 'bombs' – c. [NM 3915 9775]

At the western end of Cnapan Breaca, rhyodacite, basal tuff beds, and bombs sagging into 'plastic' rhyodacite can be inspected, indicating beyond doubt that the rhyodacites of the Chapán Breaca sheet is extrusive in nature.

Descend into Coire Dubh, passing a small ruined dam [NM 3892 9782], and continue uphill for about 500 m in a west to west-north-west direction to the southern end of Meall Breac (at c. [NM 385 979]). The 100 to 150 m- wide zone of grass-covered gravel at the col exposes somewhat rotted Marginal Gabbro, bordered by the porphyritic rhyodacite of Meall Breac to the north and by layered ultrabasic rocks to the south (Figure 20).

Locality 2.9 South end, Meall Breac – intrusion breccia at rhyodacite/gabbro contact [NM 3845 9797]

At the south end of Meall Breac, at 350 m altitude, the Marginal Gabbro is separated from porphyritic rhyodacite by a zone of intrusion breccia and some hybrid rocks (Dunham, 1964). In a short north to south traverse, rhyodacite with a dull matt surface passes into a zone of intrusion breccia in which angular and subangular blocks of gabbro and rare feldspathic peridotite are enclosed by a network of pale-coloured felsic veins. Nearby, at [NM 3845 9798], a 1.5 m-wide, north-north-east-trending basalt dyke with conspicuous plagioclase phenocrysts (c. 1 cm diameter) is involved in the brecciation and veining. On approaching the contact zone from the north, the dyke changes colour from black to dull grey, there is a progressive increase in felsic veining, and eventually the dyke is seen to have disintegrated into large strips and blocks enclosed by rhyodacite. The dyke clearly intruded the porphyritic rhyodacite but it pre-dates the gabbros and ultrabasic rocks. Its progressive fragmentation in the intrusion breccia furnishes further evidence of local development of rheomorphic magma where felsic rocks have been intruded by hot, mafic magmas (see Summary of Geology). There are good views of the layered ultrabasic rocks on Hallival and on the northern slopes of Barkeval from this locality.

Locality 2.10 South-west Meall Breac – deformed fiamme in rhyodacite ash flow [NM 3837 9810]

Continue downhill in a west-north-west direction until, after about 150 m, flat ground is reached at 310 m altitude. Coire Dubh Breccia and pale grey epiclastic sandstone crop out, overlain by porphyritic rhyodacite. Near the base of the rhyodacite, conspicuous fiamme dip to the east at a low angle (Figure 22). At the north end of the outcrop, a thin tuffaceous layer within the rhyodacite is overfolded, indicating that some downslope rheomorphic flow has occurred (Figure 23).

Locality 2.11 Loch Gainmich – Am Màm Breccia underlying gabbro megablock [NM 3825 9874]

From Locality 2.10 walk north across wet, peaty ground to the eastern side of Loch Gainmich (Figure 13) where a low cliff exposes a distinctive breccia containing large gabbro clasts (Figure 24). The breccia has a pale cream-coloured, crystalline felsic matrix with scattered plagioclase and pyroxene crystals and small (1–2 cm diameter) rounded areas of a mafic rock. This breccia, termed the Am Màm Breccia, differs significantly from the Coire Dubh Breccia in that it has a distinctly igneous matrix and has a very varied clast population that includes abundant igneous material and gneiss. The breccia has a sharp contact against overlying gabbro, which crops out over an area 100 m across.

Locality 2.12 East of Loch Gainmich – gabbro/gneiss contact, megablock in Am Màm Breccia [NM 3825 9873]

100 m east of Loch Gainmich the gabbro has a fine-grained contact against a strip of thermally metamorphosed gneiss. This is probably a primary intrusive contact. The more abundant amphibolitic parts of the gneiss are altered to pyroxene hornfels, whereas the felsic parts show signs of partial melting. Hereabouts apophyses of dark-coloured porphyritic rhyodacite intrude the gneiss, gabbro and Am Màm Breccias.

Locality 2.13 Am Màm – Am Màm Breccia with gabbro, gneiss and sandstone clasts [NM 3830 9885]

The breccia should be examined on the north-east side of Am Màm (the 'Three Loch Hill' of Dunham, 1968) where large blocks of gneiss, gritty sandstone and gabbro (some of which are extremely coarse grained) are prominent constituents (Figure 24)a, (Figure 24)b,, together with smaller, finer grained mafic enclaves (Figure 24)c. A north-north-east-trending porphyritic basalt dyke intrudes the breccia and is offset dextrally by an east–west fault (splay of the MRF system?).

From this point a detour can be made to visit the Priomh-lochs area. This adds about 3 km to the day's walking. (See below, Localities 2.16–2.19.)

Locality 2.14 East of Am Mam – gabbro of megablock cut by Am Màm Breccia and rhyodacite [NM3856 9867]

Descend to the valley east of Am Màm where gabbro forms a knoll north of several shallow lochans (the 'Three Lochs' of Dunham, 1968). Porphyritic rhyodacite cuts the gabbro on its southern side, as do cream-coloured felsic veins and thin dykes similar in appearance to the matrix of the Am Màm Breccia, which again crops out on the north side of the knoll. This large area of gabbro (100 x 50 m) lacks any indications of fine-grained, chilled margins and appears to be a megablock within the breccias rather than a plug (cf. Dunham, 1968).

Locality 2.15 North Meall Breac – Am Màm Breccia cut by, and grades into, rhyodacite [NM 3870 9860]

Continuing east, follow a rough path that contours around the hillside to a shelf at 100 m altitude at the north end of Meall Breac. The steep western end of the shelf exposes a thin north–south dolerite dyke packed with dull, black, rounded fragments of pyroxenite, spinel-bearing feldspathic peridotite, peridotite and large magnesian olivines. The dark colour is caused by patchy brown clouding of the abundant olivine (cf. the picrite dyke at Locality 4.9). Am Màm Breccia crops out over much of the shelf and is cut by a broad, wedge-like dyke of porphyritic rhyodacite that tapers to the east. A short, shallow valley on the southern limit of the shelf is bordered on its south side by a gabbro plug and by a sloping outcrop of intrusive breccia to the north. The breccia contains fragments of fine-grained sandstone together with rounded to subangular gabbro clasts and rare pieces of feldspathic peridotite. Breccias towards the eastern end of the shelf are bordered by, and appear to grade into, porphyritic rhyodacite. To the north, the steep northern face of the shelf exposes much gneiss in an elongate (east–west) area. This possibly represents a sliver caught between parts of the Main Ring Fault or, alternatively, another large block entrained in the Am Màm Breccia.

To return to Kinloch, continue downhill in a south-east direction for about 450 m until the deer fence gate near the hydro-electric dam is reached (Locality 2.2), then follow the path down the glen. (Total distance is c. 7 km distance, of which 3 km are the walk back from Am Màm.)

OPTIONAL: Traverse west, towards Priomh-lochs

From the north-west side of Am Màm (Locality 2.13) traverse along the edge of Loch Gainmhich to gabbro crags at the north end of the loch.

Locality 2.16 Loch Gainmich – small intrusive plug of gabbro inside Main Ring Fault [NM 3805 9895]

A small plug of gabbro is situated just inside the Main Ring Fault. The gabbro is relatively unaltered and much finer grained than the gabbro involved with the Am Màm Breccia. Skirt the southern end of Loch Bealach Mhic Nèill (Figure 13) and follow the western shore for 200 m to a small gabbro mass surrounded by gritty sandstone, then walk north-west for 150 m to a prominent north–south ridge of feldspathic peridotite with excellent examples of steeply dipping matrix

banding (Dunham, 1965).

Locality 2.17 Ridge east of Priomh-lochs – 'matrix banding' in peridotite tongue [NM 3735 9900]

The ridge is formed by a tongue of peridotite that extends north from the Layered Centre to cut the Main Ring Fault (Figure 13). Follow the ridge to the south for about 250 m, observing variation in the matrix-banding structures (Dunham, 1965), then walk west over sandstone outcrops for about 250 m to a point 170 m east-north-east of the peaty ground between the Priomh-lochs (Figure 13).

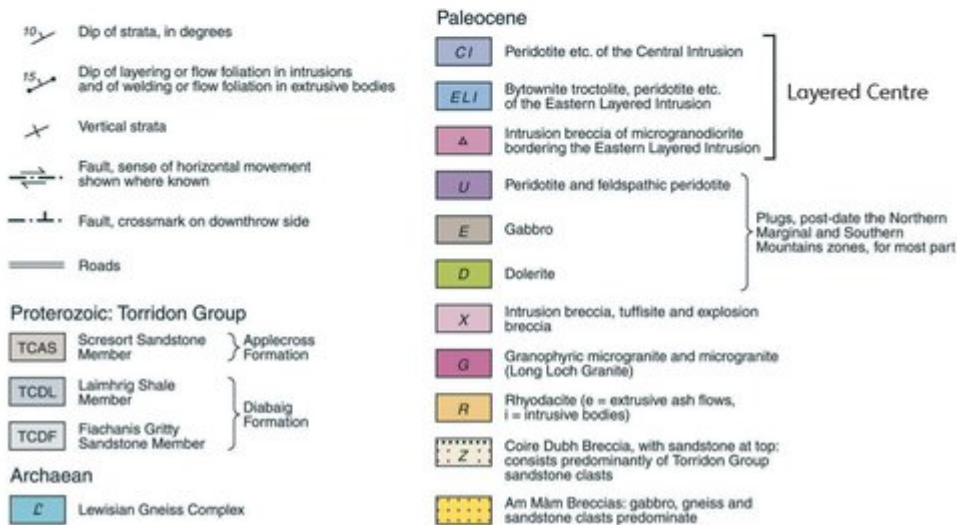
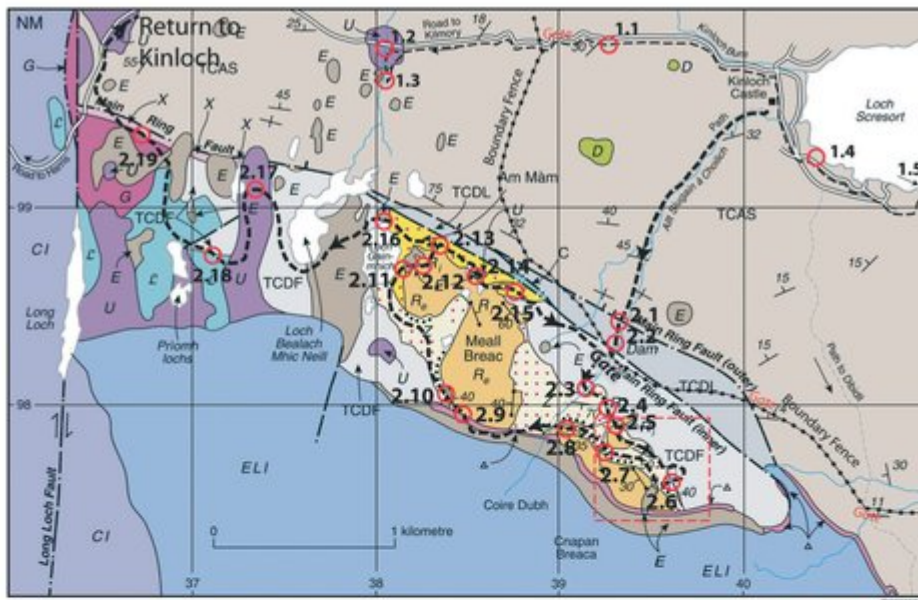
Locality 2.18 Priomh-lochs – faulted and unconformable relationships of gritty sandstone to gneiss [NM 3715 9876]

The coarse sandstone hereabouts belongs to the Fiachanis Gritty Sandstone Member (TCDF) and is in contact with gneisses, which form extensive exposures either side of the Priomh-lochs. The boundary is probably an unconformity, complicated by minor faulting. The gneisses nearest the peridotite tongue have been thermally metamorphosed with indications of some melting in the leucocratic variants. However, the deformation and contortion of gneissose banding seen in many exposures pre-dates the Paleocene (Holness and Isherwood, 2003; cf. Emeleus 1997; (Figure 25)).

Locality 2.19 North of Priomh-lochs – explosion breccia injected along line of Main Ring Fault [NM 367 994]

Pass to the north of the Priomh-lochs and continue in a north-west direction for about 700 m until a prominent west-north-west-trending ridge is reached. The traverse crosses extensive gneiss outcrops, together with gabbro and ill-exposed microgranite; the gabbros are of late date since they cut the Main Ring Fault. The ridge marks the position of a strip of explosion breccias parallel to, and just inside, the Main Ring Fault. The breccia differs from the Am Màm Breccia since it contains fragments of porphyritic rhyodacite in addition to gabbro. It is cut by small rhyodacite intrusions. From here, either return to the north side of Loch Gainmhich and resume the itinerary (see above), or continue a short distance downhill in a north-westerly direction to the track that leads back to Kinloch (which is about 4 km distant).

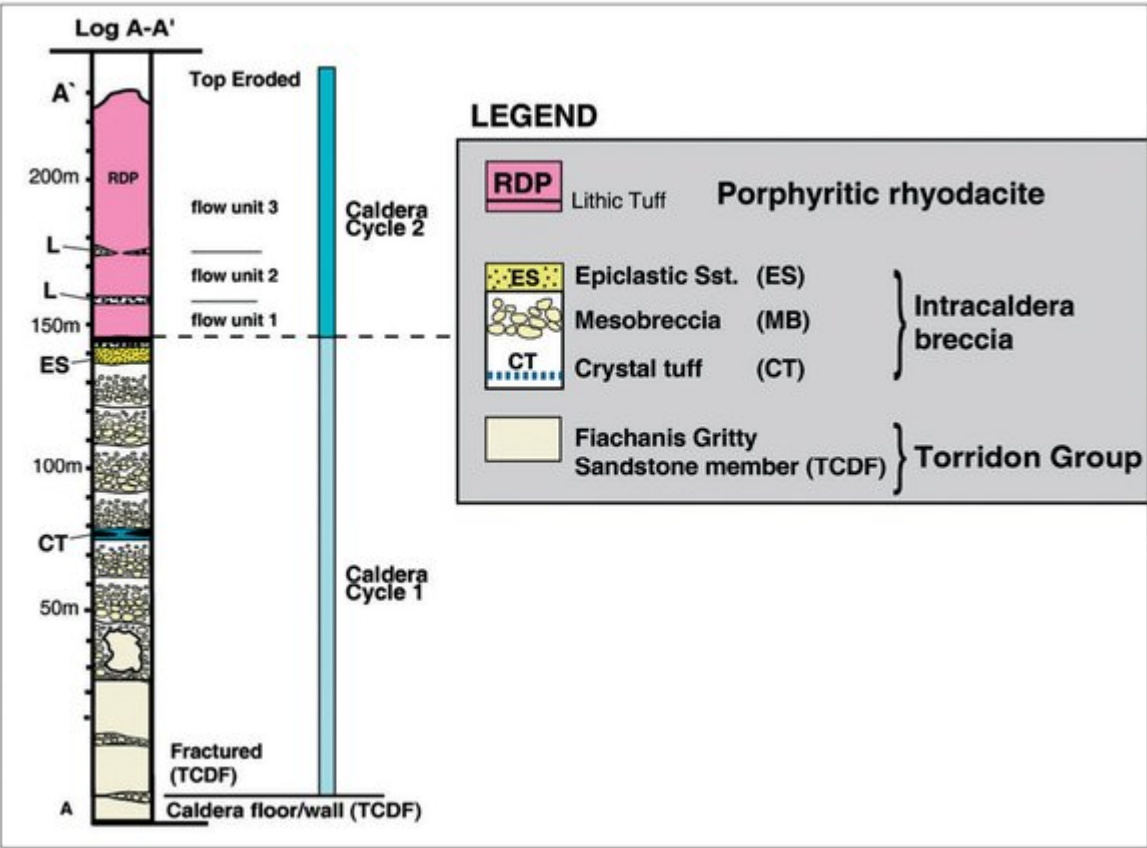
[References](#)



(Figure 13) Geological map of Excursion 2: the Northern Marginal Zone. Dykes and cone-sheets omitted. Modified after Emeleus and Bell (2005). (© NERC)



(Figure 14) Cone-sheet intruding Torridonian sandstone, Allt Sluga a'Choilich, beside the Coire Dubh path. Scale: hammer shaft 30 cm.



(Figure 15) Stratigraphical column of the Coire Dubh intra-caldera succession (simplified after Troll et al., 2000).



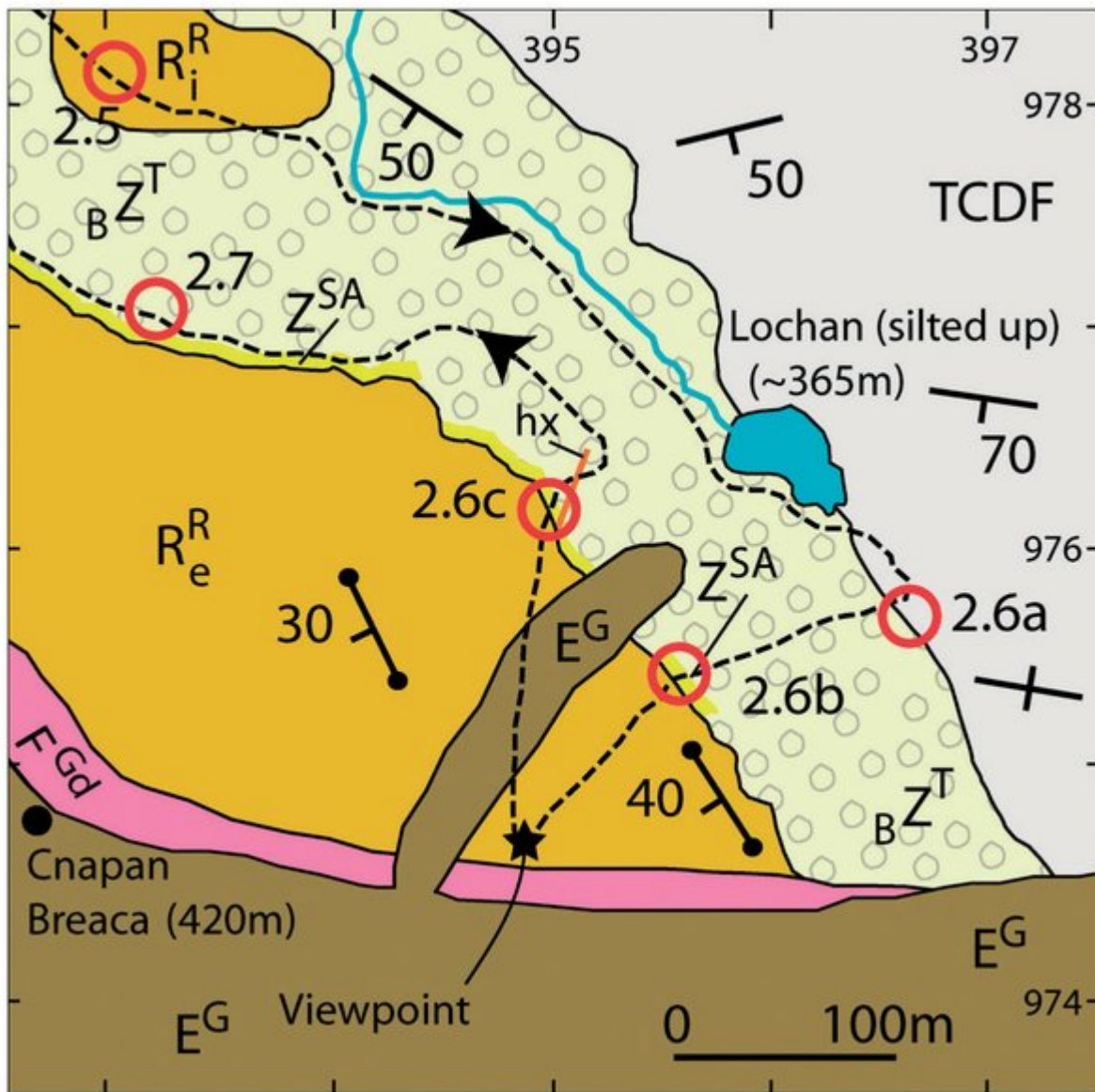
(Figure 16) Coire Dubh Breccias in Coire Dubh: chaotic assemblage of angular and subangular clasts mainly derived from the Fiachanis Gritty Sandstone Member of the Diabaig Formation. Scale: yellow tape-measure is 8 cm. diameter.



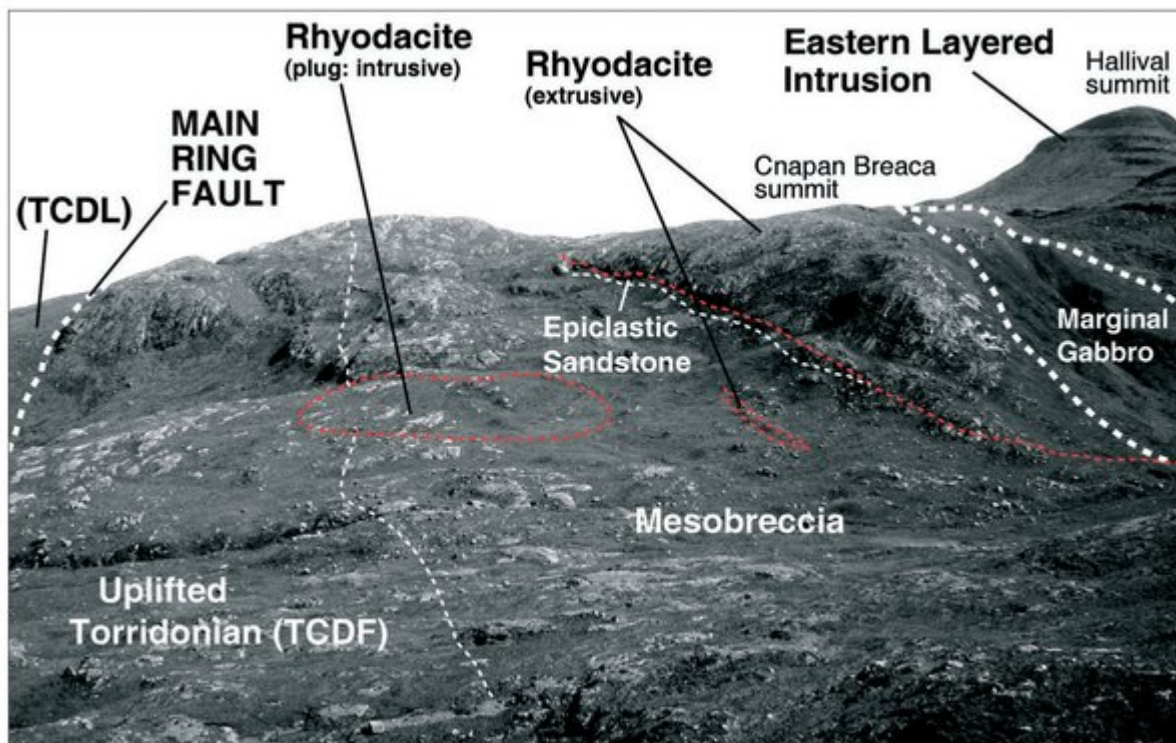
(Figure 17) Tuffisite dyke intruding Coire Dubh Breccias, Coire Dubh. Scale: tape-measure opened to 13 cm.



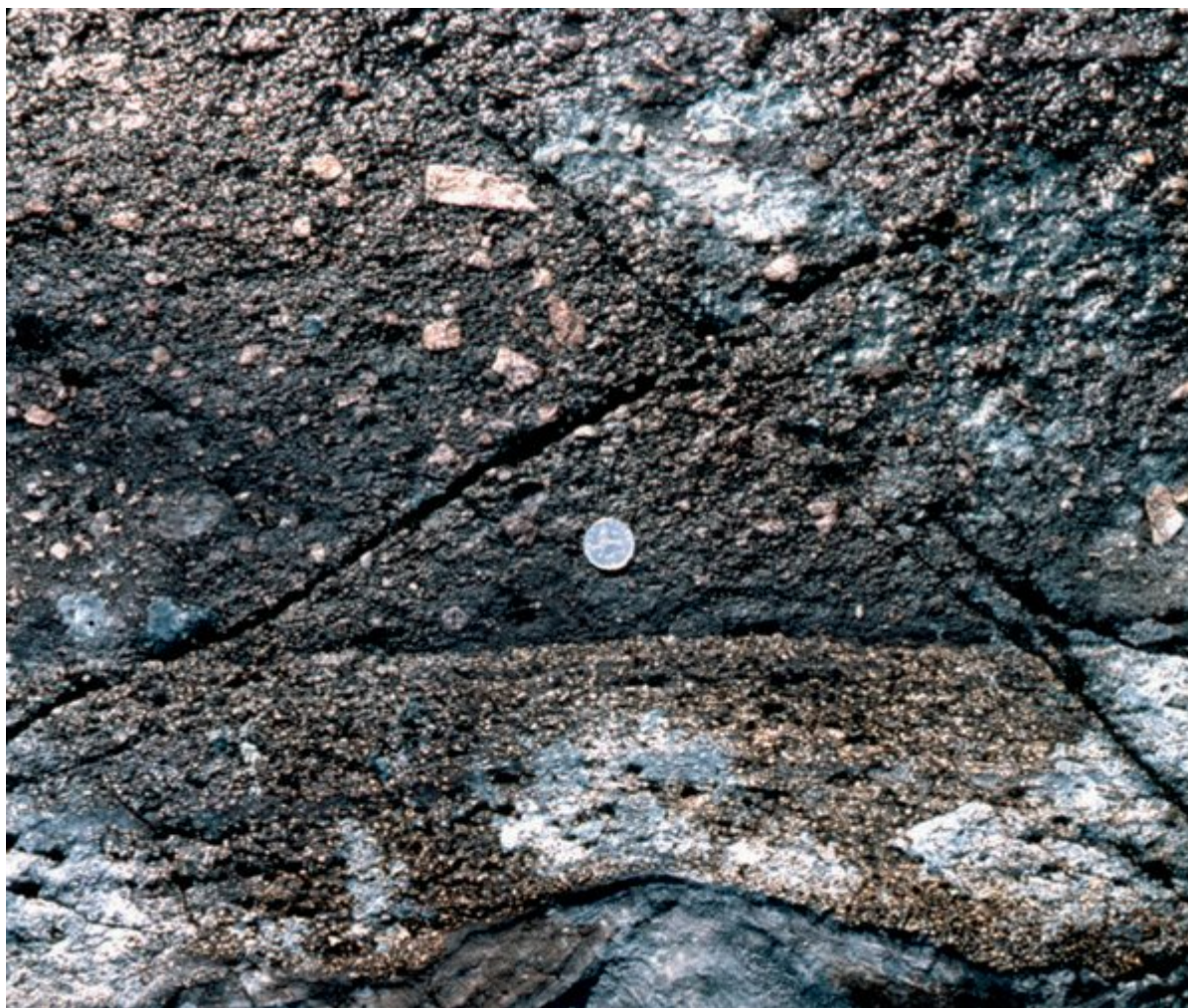
(Figure 18) Mixed-magma plug of rhyodacite with numerous basaltic to andesitic enclaves. Locality 2.3, north of Cnapan Breaca.



(Figure 19) Geological sketch map of the Coire Dubh Breccias at the eastern end of the Northern Marginal Zone. Relationships with rhyodacite are seen at localities 2.6 and 2.7 (Key).



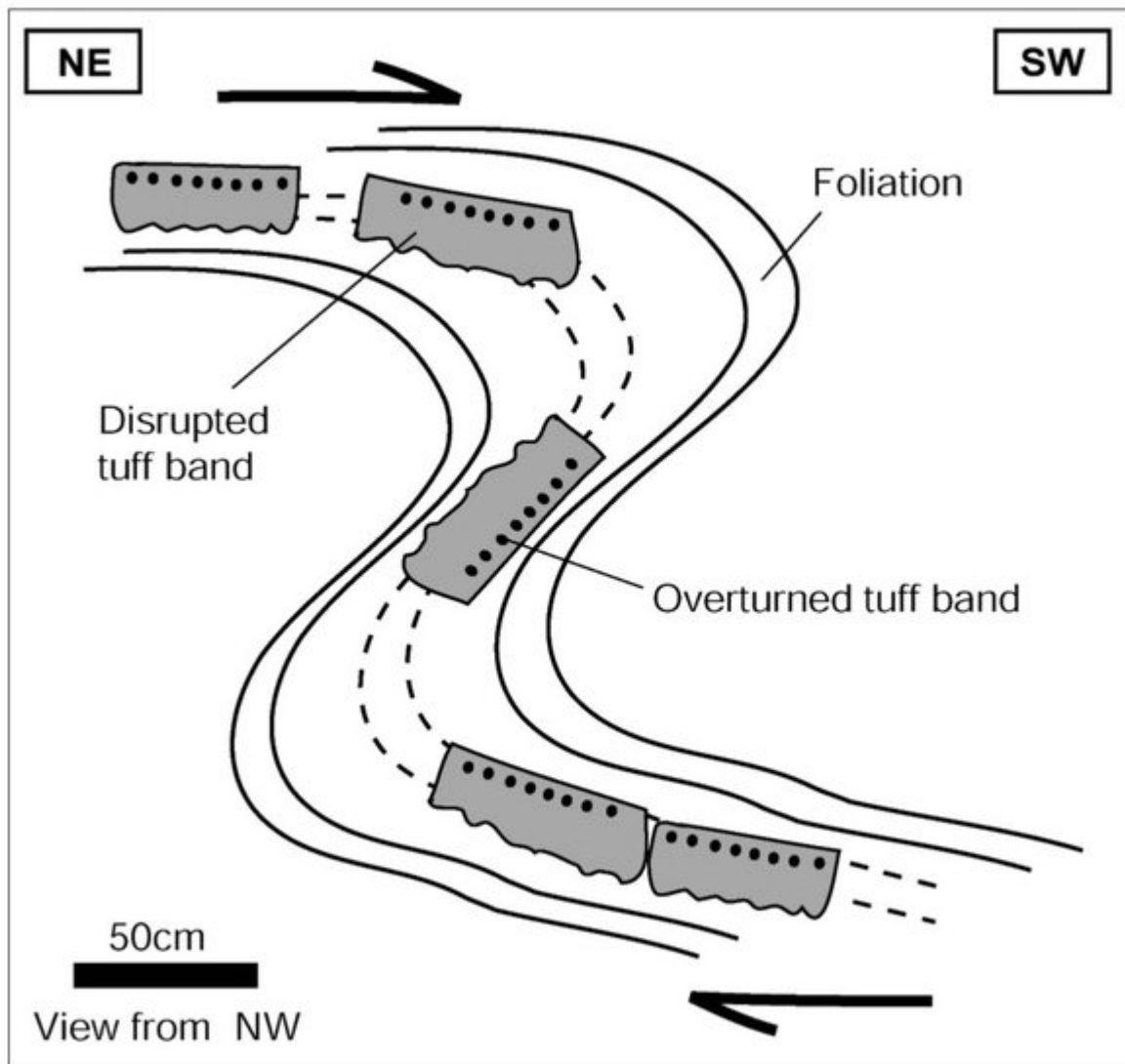
(Figure 20) View of Coire Dubh from Meall Breac, with elements of the Northern Marginal Zone and the Eastern Layered Intrusion marked (see also (Figure 4)a).



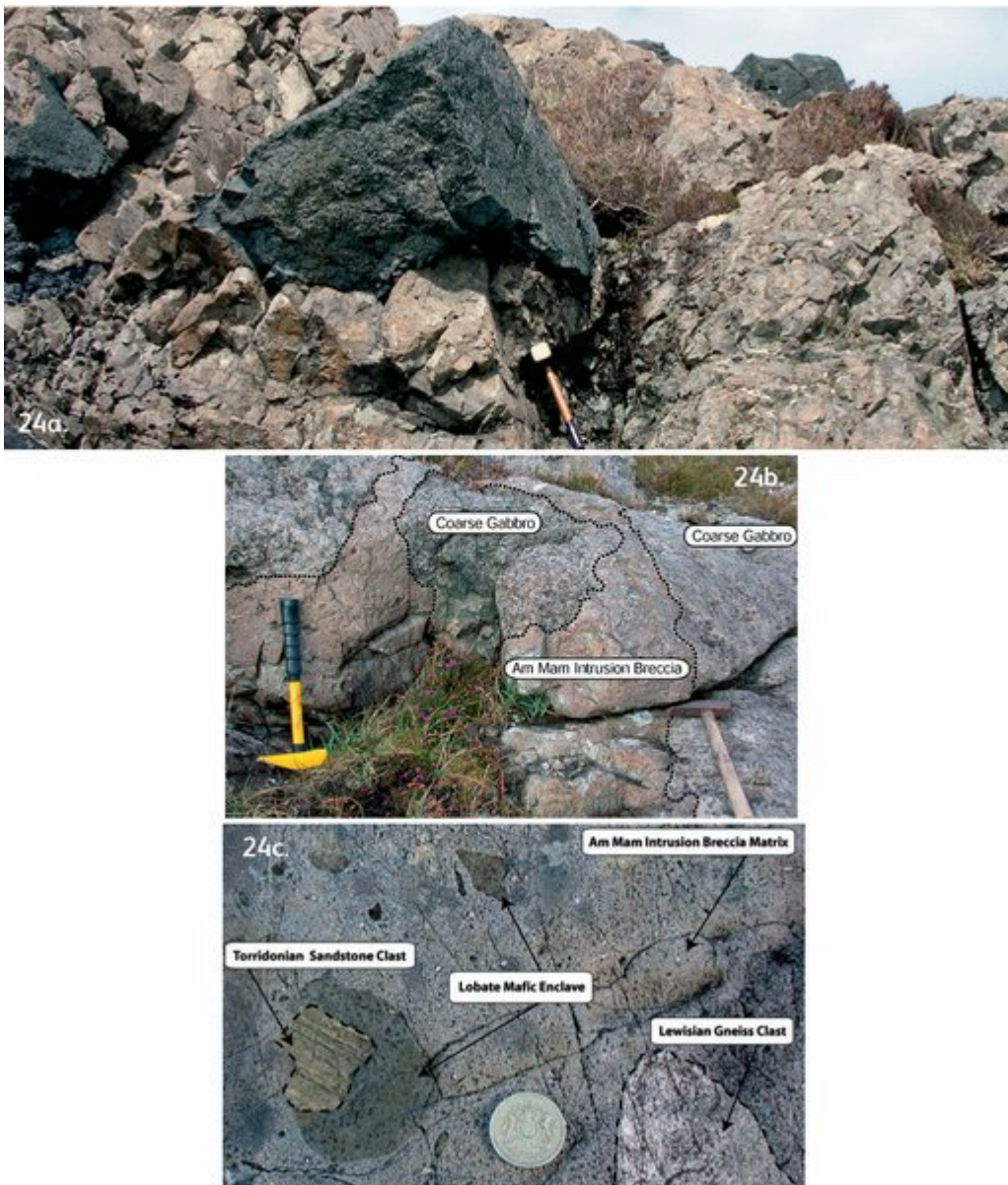
(Figure 21) Bedded tuffs at the base of the extrusive porphyritic rhyodacite, north side of Cnapan Breaca, Coire Dubh, near Locality 2.7. Scale: coin 2 cm diameter.



(Figure 22) Attenuated fiamme in porphyritic rhyodacite ash flow, south-west end of Meall Breac (Locality 2.10).



(Figure 23) Field sketch of a broken and overfolded tuff band in a rhyodacite ignimbrite sheet, south-west Meall Breac. Note grading in tuff band indicates overturning during rheomorphic flow. Near Locality 2.10.



(Figure 24) a. Portion of the Am Màm Breccias with blocks of coarse gabbro. Close to the north-east shore of Loch Gainmhich. NB: hammer at bottom centre. b. Block of gabbro intruded by dacitic matrix of the Am Màm Breccias, in between Meall Breac and Am Màm hills. Scale: hammer shaft c.30 cm. c. Representative view of Am Màm breccia matrix containing a variety of lobate enclaves and sedimentary and metamorphic xenoliths. Scale: coin is 2 cm in diameter.



(Figure 25) Banded Lewisian granodioritic biotite gneisses with amphibolitic layers, near Priomh-lochs. (Photo: Emeleus/ BGS© NERC)