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# Ord

[NG 605 126]–[NG 691 125]

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## Introduction

The Ord Window on the Sleat peninsula of southern Skye is a structural inlier of Cambro-Ordovician and Torridonian rocks of the foreland sequence (Figure 5.59). The inlier is surrounded by structurally overlying Torridonian rocks that lie on the lower limb of the recumbent Lochalsh Syncline in the Kishorn Nappe, the lowest and most westerly part of the Moine Thrust Belt on Skye. The window is one of the best examples of a tectonic inlier in the British Isles, but is characterized by complicated outcrops of folded, steeply dipping, fault-bounded slivers. The detailed structure is difficult to elucidate and, despite several published studies and countless student exercises, there is still no overall satisfactory solution.

Clough was part of the Geological Survey team that mapped the Moine Thrust Belt in the 1890s, and reached Skye in 1896. He envisaged the Ord structure as a tectonic window with two thrusts that were both folded into relatively open antiforms (see Peach *et al.*, 1907). Both thrusts were interpreted as lying structurally beneath the Kishorn Nappe. Bailey (1939, 1955) re-interpreted Clough's work, and suggested that the two thrusts were lower and upper branches of the Kishorn Thrust, and effectively regarded the core of the Ord Window as part of the foreland. In contrast, Potts (1983) reinterpreted the Ord Window as a recumbent fold, analogous to, but at a lower position than, the Lochalsh Syncline. He suggested that thrust faults at the western, leading edge of the window, in combination with normal faults at the eastern, trailing edge, had brought the recumbent fold to higher structural levels. In this interpretation, the Ord Window is not a classic thrust window, and the structure is perhaps best referred to as the 'Ord Inlier'.

The Ord Window contains the southernmost outcrops of the Cambro-Ordovician succession of the Moine Thrust Belt. The immediate surroundings of Ord are also a GCR site for Cambro-Ordovician stratigraphy (Rushton *et al.*, 2000), which demonstrates the remarkable north–south uniformity of shallow-water sedimentation on the margin of Laurentia.

## Description

The Ord GCR site encompasses a large but irregular area (c. 23 km<sup>2</sup>) in the central part of the Sleat peninsula extending south and east from Loch Eishort for several kilometres. The minor road to the small village of Ord traverses the undulating terrain but the area is devoid of paths. The upper slopes are heather-clad with grass areas, but deciduous woods occur on the lower north-western slopes and in the narrow valleys. The area contains several prominent rocky ridges; Sgiath-bheinn an Uird (294 m), Sgiath-bheinn Tokavaig (216 m) and Sgiath-bheinn Chrossavaig (255 m) are formed of Cambrian quartzites, but Torridonian sandstones form more-subdued topography around Sgòrach Breac (299 m).

The Cambro-Ordovician rocks of the Ord Window include the Eriboll Sandstone Formation, the An t-Sron Formation and the lower part of the Durness Group; in essence the same sequence as that on the mainland of northwest Scotland (see also Ord GCR site report in Rushton *et al.*, 2000). However, the carbonate rocks are typically highly altered so that division into formations is not easy.

The structures of the Ord Window are best described from west to east, starting outside the window itself.

West of the Ord Inlier, Torridonian rocks are folded into the open Tarskavaig Synform (Figure 5.59) that also folds the Tarskavaig nappes (see Tarskavaig GCR site report, this chapter). Within the Tarskavaig Synform, close to Ord, the sequence is inverted as the Kinloch Formation (Sleat Group) overlies the Applecross Formation (Torridon Group), which in turn overlies the basal Cambrian False-bedded Quartzite Member. The inverted unconformity of the basal Cambrian

quartzite, locally marked by pebbly layers, can be seen clearly close to the low-water mark in Ord Bay and farther along the coast to the south-west. Clough (in Peach *et al.*, 1907) noted the inversion and attributed it to an early phase of recumbent folding. The axial trace of an early recumbent anticline was later located by means of sedimentary structures in the Torridon Group sandstones and siltstones (Bailey, 1939; Karcz, 1963; Potts, 1983). Potts (1983) named this structure the 'Eishort Anticline' (Figure 5.59) and followed the axial trace from Tarskavaig Bay north-eastwards around the Tarskavaig Synform to where it is truncated by the Ord Thrust (see below).

The eastern limb of the Tarskavaig Synform is truncated by the steep, roughly N-trending reverse fault that Bailey (1939, 1955) and Potts (1983) termed the 'Ord Thrust'. Clough (in Peach *et al.*, 1907) termed this structure the 'Sgiath-bheinn Tokavaig Thrust' and envisaged it as bounding the Ord Window. Later work showed that the 'thrust' does not continue around the window, certainly on its eastern and north-eastern side. Hence, the terminology of Bailey and Potts is adopted here (Figure 5.60). Immediately east of the Ord Thrust, which forms the western boundary of the Ord Window, the Cambro-Ordovician succession is folded into a tight syncline, the Ord Syncline. Its western limb and axial trace are truncated by the thrust, which is manifest as a complex fault-zone on the foreshore at Ord [NG 616 133]. However, detailed relationships are difficult to unravel and a single discrete surface of displacement cannot be recognized.

Within the Ord Window are two outcrops of Cambro-Ordovician rocks separated by Torridonian rocks. On the western side of the window in the Ord Syncline the overall sequence youngs and dips steeply to the west, although in parts the bedding is locally vertical and even overturned to dip steeply east. The sequence ranges from Applecross Formation to Durness Group carbonate rocks, which on the coastal section north-east of Ord contain abundant black and grey chert nodules and lenses. Small-scale imbrication can be seen locally (e.g. west of Cnoc na Fuarachad, [NG 621 131]) and in coastal outcrops northeast of Ord (at [NG 621 139]) (Bell and Harris, 1986). As the axial trace of the Ord Syncline lies close to the Ord Thrust, the plunge of the fold is difficult to define, but it appears to be moderately steep.

To the east is the Western Fault (Potts, 1983), a steep NNE-trending structure that juxtaposes the eastern outcrop of Torridonian and Cambro-Ordovician rocks against those of the Ord Syncline (Figure 5.59), (Figure 5.60). Clough (in Peach *et al.*, 1907) termed this structure the 'Sgiath-bheinn an Uird Thrust'. This eastern sequence again youngs towards the west. Near to Loch Eishort, the beds dip gently west and are right-way-up, but towards the south-east dips increase, and south-east of the Allt a' Coile Moire the beds are steeply east dipping and overturned. Potts (1983) interpreted these bedding orientations as defining a recumbent, W-facing, gently SSW-plunging syncline (analogous to the Lochalsh Syncline), with the northern exposures in the lower, right-way-up limb, and the southern exposures in the upper, inverted limb. Near the southern end of Sgiath-bheinn an Uird the syncline is offset by a N-S-trending fault, termed the 'Eastern Fault' (Potts, 1983), which appears to have a normal downthrow towards the east.

The eastern outcrop of Cambro-Ordovician rocks is bounded to the east by a further fault (see (Figure 5.60)). This structure is variously termed the 'Sgiath-bheinn an Uird Thrust' (Clough in Peach *et al.*, 1907), the 'lower branch of the Kishorn Thrust' (Bailey, 1939), or the Allt a' Chinn Mhoir Fault' by Potts (1983) who regarded it as a normal fault. The fault can be traced along the Allt Dearg, across the south-east slopes of Sgiath-bheinn an Uird, and along the valley of the Allt a' Chinn Mhoir. In the steep northern section of the Allt a' Chinn Mhoir, the dip of the fault increases northwards over a horizontal distance of c. 150 m from 28° to 70° to the ESE, suggesting that it has a listric geometry. Cambrian quartzites form the footwall of the fault, whereas the hangingwall comprises Applecross Formation rocks and, in the northerly reaches of Allt a' Chinn Mhoir, includes rocks of the underlying Kinloch Formation. Bedding in the Applecross and Kinloch formations is commonly highly oblique to the fault surface, whereas in the Cambrian quartzites bedding is generally sub-parallel to the fault surface. Breccias and vein systems are developed widely along this section, not only close to the fault plane, but also in the adjacent rocks.

To the south of the Ord River the boundary between the Eriboll Sandstone Formation and the Applecross Formation appears to be unmodified and to represent the original unconformity. East of the Allt a' Chinn Mhoir Fault lies a 2 km-wide outcrop of Torridonian rocks that is dominated by red-brown-weathering, convolute stratified sandstones of the Applecross Formation, but contains some Kinloch Formation. The strata dip gently to the south-east or north-west. The contact with the main outcrop of grey-weathering sandstones and minor siltstones of the Kinloch Formation stretches from Sgùrr na h-Iolaire [NG 617 091] in the south-west to the Loch an Eilean Fault to the north-east. It was taken as the south-eastern limit of the Ord Window by Clough and Bailey, but the interpretation of this contact is controversial.

Exposure is poor along the major part of the eastern trace; it is best constrained between the Loch an Eilean Fault and An Cruachan [NG 656 122], but even there the formations are rarely exposed within 10 m of each other. Brecciated zones up to 75 m in strike length that dip at about 30° to the ESE are developed locally in exposures of the Applecross Formation. They contain arrays of quartz-filled veinlets, although this does not necessarily indicate faulting, as rocks distant from the contact are comparably veined. South-west of An Cruachan, the degree of exposure is very poor, and delineation of this south-eastern contact of the window is largely conjectural.

Some features of the Ord Window can be recognized on the north side of Loch Eishort. On Torr Mòr [NG 629 164], a small outcrop of basal Cambrian quartzite rests with an angular unconformity of about 10° on Applecross Formation sandstones. The basal quartzite and the unconformity are in turn unconformably overlain to the west by Jurassic limestone. This outcrop appears to be a continuation of the Cambrian quartzites of the western outcrop of the Ord Window; the nature of the termination of the eastern outcrop is unclear.

## Interpretation

The structure of the Ord Window is complex, and the generally poor quality of inland exposure has hampered detailed mapping. The area remains controversial and three very different interpretations have been published (Figure 5.60).

Clough (in Peach *et al.*, 1907) considered that the window was composed of two thrust sheets that were envisaged to have been folded after thrusting, resulting in a dome-shaped antiformal culmination (Figure 5.60)a. The lowest thrust (the Sgiath-bheinn an Uird Thrust) was thought to form a roof thrust to the eastern outcrop of Cambro-Ordovician and Torridonian rocks in the window. The upper thrust, named the 'Sgiath-bheinn Tokavaig Thrust', was thought to envelop the western package of Cambro-Ordovician rocks and a large swathe of mainly Applecross Formation strata on the east side of the window. A corollary of this interpretation is that the hangingwalls of both the Sgiath-bheinn Tokavaig and the Sgiath-bheinn an Uird thrusts would show down-dip displacements on their steeply dipping western limbs. Clough also concluded that the inversion of Cambrian and Torridonian strata west of the Ord Window was probably caused by a large-scale recumbent, isoclinal fold, but did not delineate the hinge zone of this fold (the Eishort Anticline).

Bailey (1939, 1955) retained the basic model of the Ord Window as an antiformal culmination exposing lower thrust sheets in its central part, but he incorporated various ideas on fold nappe formation into his interpretation. He renamed the westernmost thrust the 'Ord Thrust' and envisaged it as the sheared upper limb of the Ord Syncline (Figure 5.60)b, hence defining this structure as an antiform. The W-dipping Ord Thrust was considered to be structurally higher than the thrusts that crop out farther to the east. Bailey equated the eastern thrusts with the Kishorn Thrust, splitting it into a lower and upper branch on the eastern side of the window. The point of divergence of the two branches would be located at the southernmost outcrop of Cambrian quartzite, just east of Creagan Dubh [NG 610 102]. Bailey suggested that the Ord Thrust cuts the lower branch of the Kishorn Thrust just north of Creagan Dubh (Figure 5.59). In this interpretation, the eastern package of Cambro-Ordovician rocks would be part of the foreland, whereas all other rocks would be part of an internally complicated Kishorn Nappe. It is interesting that Bailey (1939) suggested that the 'Ord Inversion', i.e. the inverted Cambrian and Torridonian strata west of the Ord Window itself, became right-way-up near Tarskavaig, but that this inversion 'probably does not correspond with the Loch Alsh Inversion'.

Potts (1983) suggested a more-radical reinterpretation of the geology. He postulated that the window is effectively the result of large-scale recumbent folds that were subsequently faulted by both reverse and normal faults to produce the current outcrop (Figure 5.60)c. In ascending structural order the three folds in the area are the Ord Syncline, the Eishort Anticline and the Lochalsh Syncline. The later E-dipping Ord Thrust thus juxtaposes the hinge zone of the Ord Syncline in its hangingwall virtually against the hinge zone of the Eishort Anticline in its footwall. In contrast to the previous interpretations, the Cambro-Ordovician sequence in the western part of the Ord Window was thought to be in the hangingwall, rather than in the footwall of the Ord Thrust. All the faults east of the Ord Thrust were regarded as extensional. Potts (1983) also regarded the outcrops of the Kinloch and Applecross formations east of the Allt a' Chinn Mhoir Fault as part of the right-way-up, lower limb of the Lochalsh Syncline. Thus, the eastern boundary of the Ord Window (inlier) is taken along the Allt a' Chinn Mhoir Fault, rather than along the Kinloch Formation-Applecross Formation boundary, some 2–3km farther to the south-east. Potts (1983) argued that this latter contact dips to the

north-west and hence is more-or-less a normal stratigraphical contact, albeit modified locally by folding and minor thrusting. It follows from this interpretation that the axial trace of the Eishort Anticline, which would be duplicated by thrusting along the Ord Thrust, must have been excised by extension, supposedly along the Allt a' Chinn Mhoir Fault. This fault brings the right-way-up, lower limb of the Lochalsh Syncline in its hangingwall, down onto the inverted upper limb of the Ord Syncline.

The contact between the Applecross and Kinloch formations is a major point of difference between Potts and Clough and Bailey, in that it radically changes the size of the Ord Window dependent on which interpretation is favoured. Clough named this contact the 'Sgiath-bheinn Tokavaig Thrust' and envisaged it as a coherent regional structure underlying the Kishorn Thrust. Bailey saw it as an upper branch of the Kishorn Thrust. Coward and Potts (1985) showed it as a normal fault, whereas Potts (1983, and pers. comm., 1997) regarded it as a normal stratigraphical contact. The solution to this conundrum depends partially on whether the Kinloch Formation dips underneath the Applecross Formation (required for a stratigraphical contact) or whether the Kinloch Formation lies at a structurally higher level than the Applecross Formation, as shown on the cross-sections of Clough and Bailey. The poor exposure and generally shallow dips make the nature of this boundary unclear, but further fieldwork may clarify relationships.

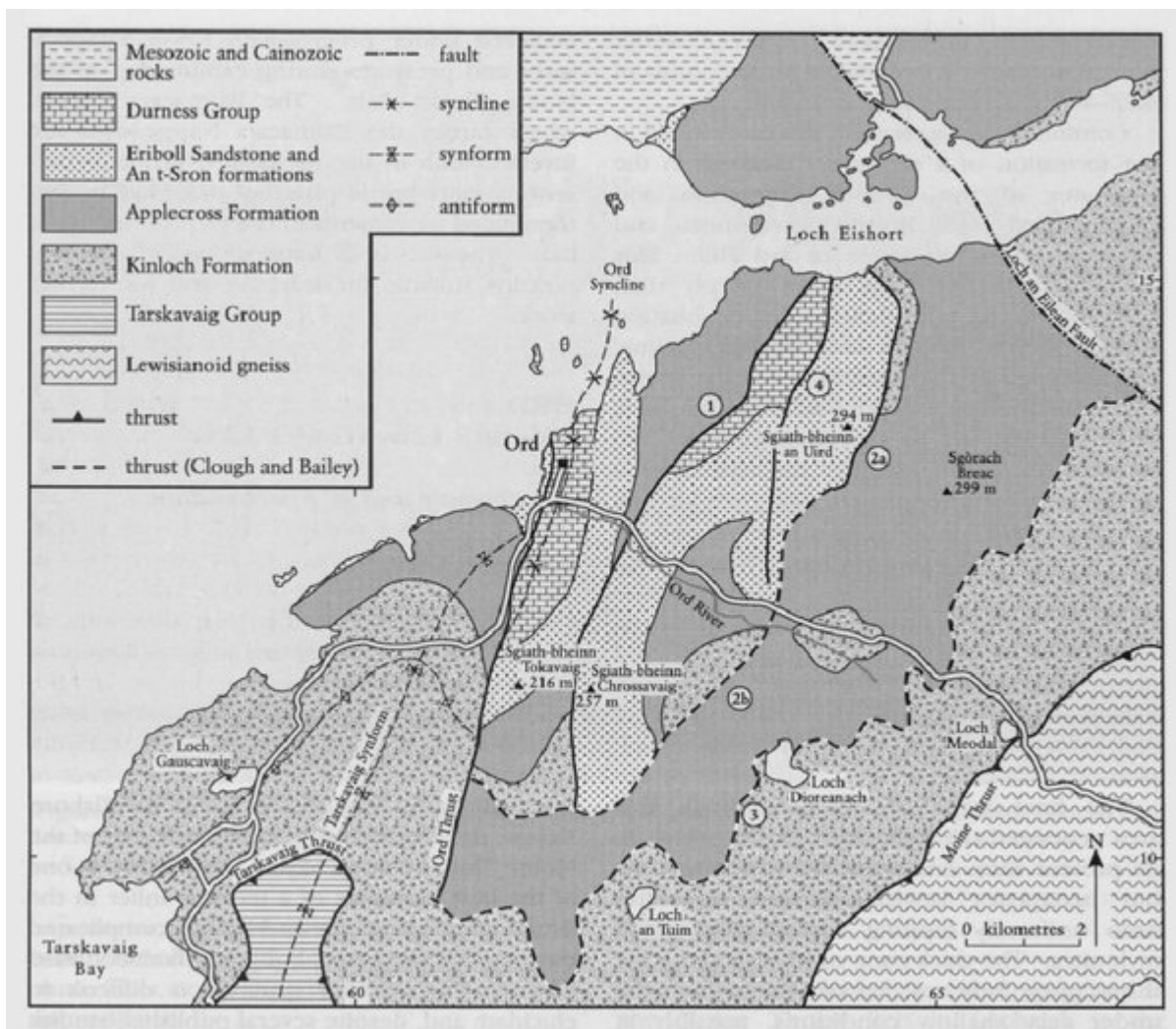
## Conclusions

The Ord Window comprises Cambro-Ordovician and Torridonian strata of the foreland succession that form a structural inlier within the Kishorn Nappe in the southern Moine Thrust Belt. The window itself has been interpreted as an anti-formal culmination exposing lower thrust sheets beneath the lower parts of the Kishorn Nappe. However, it contains steep faults and tight folds that show complex and contentious relationships, geometries quite different from the low-angle imbricate thrust systems that dominate the Moine Thrust Belt on most of the mainland.

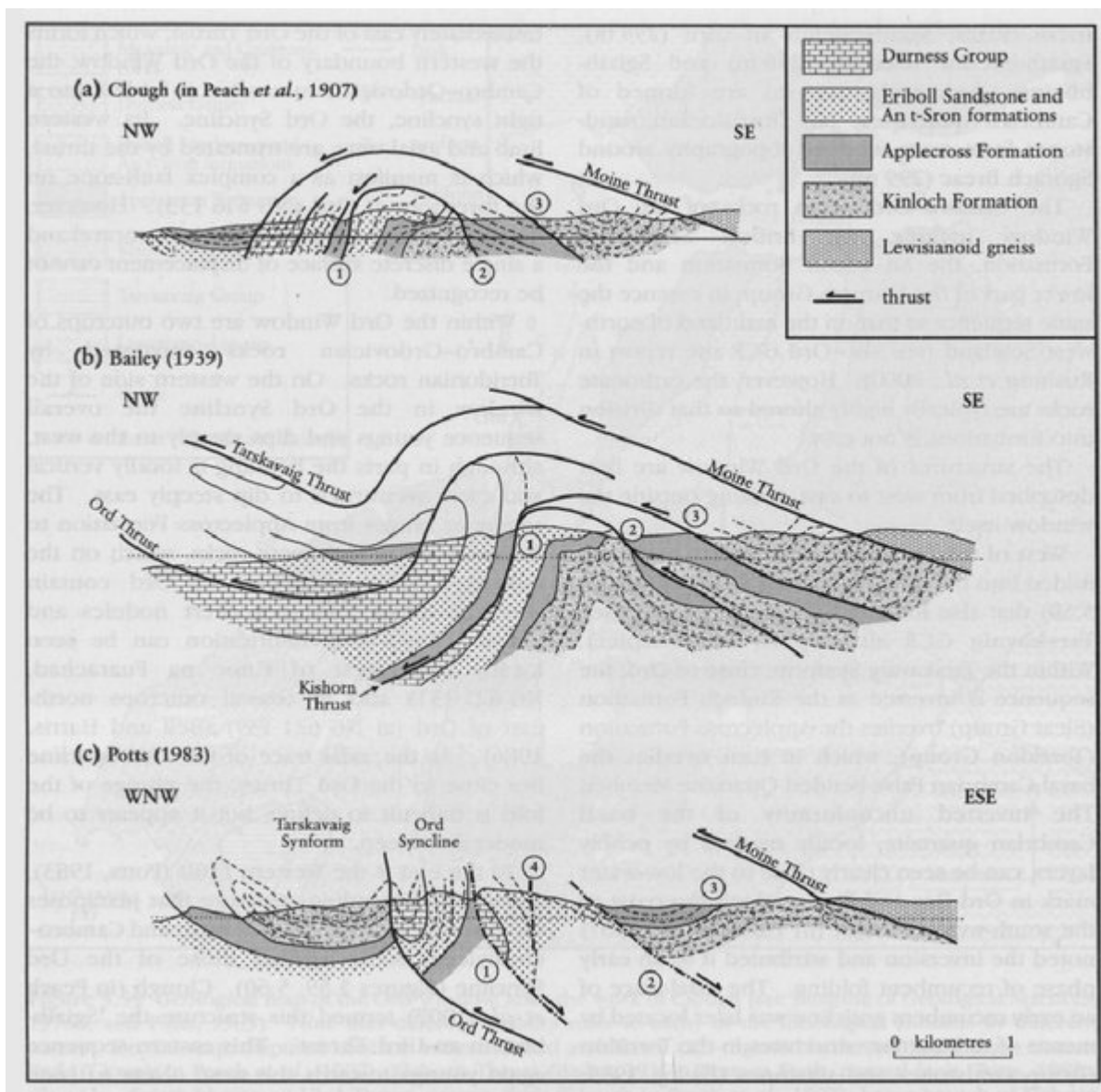
Three very different structural interpretations of the structure have been proposed. The original explanation by C.T. Clough (in Peach *et al.*, 1907) portrays it as a tectonic window through two thrust sheets, whereby all the rocks remained essentially right-way-up. The second interpretation by E.B. Bailey (1939, 1955) involved a large pair of recumbent folds with associated inversion of strata, dissected by thrusts, with the overall edifice then refolded in a regional antiform and synform. The most recent model of Potts (1983) envisages the interplay between thrusts and extensional faults to drop down an originally higher package of folded strata.

There is no consensus as to which of the above models is (most) correct; indeed, none is wholly satisfactory. The Ord Window is clearly a structural inlier and contains distinctly different structures to other parts of the Moine Thrust Belt. However, it remains one of the few places where the actual geometry of the various structures remains enigmatic, and until the basic geometry is known, the mechanics of the thrust system cannot be assessed. The Ord GCR site is undoubtedly of national importance, but remains eminently suitable for further detailed work.

## [References](#)



(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 5.60) Cross-sections through the Ord Window. (a) After Clough (in Peach *et al.*, 1907). (b) After Bailey (1939). (c) After Potts (1983). Sections (a) and (b) follow the same line, but section (c) lies farther south-west. Several contacts, interpreted as thrusts by both Clough and Bailey, have been re-interpreted as normal stratigraphical contacts or as extensional faults by Potts. The Ord Syncline has been interpreted as an antiform by Bailey, but a synform by Potts. For explanation of numbered contacts, see Figure 5.59.