Excursion 4 The Lower Old Red Sandstone and Helmsdale Granite of the Ousdale area

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Purpose

To examine the Ousdale Arkose and Ousdale Mudstones and associated sandstones of the Lower ORS. The Helmsdale Granite with minor mineralisation is seen in roadside cuttings and quarries. Excellent distant views are obtained of structures in the Helmsdale Boulder Beds at Navidale. The basal beds of the Middle ORS between Ousdale and Berriedale are covered in Excursion 5, localities 1 and 2, but could be added to this excursion if desired.

Access

Drive north from Helmsdale on the A9 as far as the parking place for locality 1 in a lay-by by a small hut [ND 065 199] at the southern end of Ousdale road cutting (Figure 4.1). Localities 2–6 can be visited on the return journey to Helmsdale. All localities are within a 9 km drive of Helmsdale, and are close to the roadside. The excursion need only take 2 hours, but can be extended to half a day if time is spent in detailed examination of the sedimentology and a search for trace fossils.

Introduction

The Lower Old Red Sandstone of the Ousdale area rests unconformably on the Helmsdale Granite, which is intruded into Moinian metamorphic rocks. In the Ousdale area, the Badbea Breccia (Excursion 5, Locality 1) at the base of the Middle ORS unconformably overlies Lower ORS (Figure 4.2), but further north at Sarclet only a disconformity is apparent (Collins and Donovan, 1977).

The Lower ORS of this area was previously assigned to a 'Basement Group' which Westoll (1951) suggested was of Early Devonian age. This age was confirmed on the basis of spores (Richardson 1967), and further strengthened by the greater variety of spores recorded by Collins and Donovan (1977) indicating an early Emsian age. Collins and Donovan (1977) also record the finding of *Porolepis* scales from Ousdale, which support an Emsian or early Eifelian age.

The Lower ORS sediments were deposited in a variety of alluvial environments bordering outcrop of the Helmsdale Granite. The granite appears to have been deeply weathered to form a 'grus' of granitic debris, and a precise erosive contact between the granite and arkose is not clearly seen on this excursion.

Minor uranium mineralisation is associated with the Helmsdale Granite (Tweedie, 1979), most being associated with hydrothermal and weathering alteration products. The uranium-bearing minerals kasolite, meta-autunite and meta-torbernite have been recorded from the area. Fluorite mineralisation is seen at locality 1 on this excursion.

Locality 1. Ousdale cutting [ND 066 201]

Locality 1 is a road cutting on a rather dangerous stretch of road. Park in the small lay-by (not big enough for coaches) by a small hut to the south of the cutting (Figure 4.1) and walk northwards down the road to the cutting.

The rocks in this area are not so easy to identify as first impressions might indicate. The western wall of the cutting is mainly Helmsdale Granite, but it is considerably fractured. Thin sections reveal that at least part of this rock is a coarse arkosic sediment. The large pink feldspar phenocrysts from the granite are fresh and angular, even when incorporated in arkose, and little transport can have taken place. These rocks lie very close to the unconformity surface between the Ousdale Arkose and the Helmsdale Granite, and it is probable that deep weathering and *in situ* granular disintegration of the granite took place to form a grus.

At the northern end of the eastern side of the cutting a small fault separates massive arkose and granite from strata which are clearly bedded and represent transported arkosic sediments (Figure 4.3). Armstrong *et al.* (1978) interpreted this feature as the unconformity surface, and even if a small fault is present, it is certainly close to the unconformity. These rocks are good examples of first-cycle sediments derived directly from granite. Pebbles of granite are present, but there is an abundance of angular pink feldspar grains derived from the granite. The beds are parallel-sided and up to about 50 cm thick; the poor sorting with granite clasts floating in a sandstone matrix indicates rapid deposition, probably by flash floods.

Some mineralisation is seen on the western side of the cutting, with purple fluorite coating fracture surfaces and forming thin veins. Patches of brown ferruginous alteration at this locality have minor uranium mineralisation.

Locality 2. Ousdale Mudstones quarry [ND 066 195]

Walk back south on the road, past the parking area and uphill until reaching the entrance to a quarry. There is a deer fence and a new metal gate at the entrance. The quarry has been disused for many years, but recently the entrance has been renovated and some excavation has taken place. The quarry is in Ousdale Mudstones (Figure 4.2) which are dominantly dark red mudstones and shales with subordinate fine-grained sandstones and a few coarse arkose beds. The coarser beds are best seen in the north wall of the quarry; a log of this exposure is given in (Figure 4.4).

The coarse beds have sharp erosive bases, with some scouring evident (Figure 4.5). The coarse material is arkosic and is clearly derived from the Helmsdale Granite, and the lack of rounding of large feldspar grains is indicative of a short transport distance. The coarse arkose contains some mudstone rip-up clasts. The beds grade abruptly to a medium- to fine-grained sandstone which shows the typical small-scale trough cross-lamination produced by migrating linguoid ripples. The ripple lamination generally grades up into siltstone and red mudstone, which contains polygonal desiccation cracks.

The arkose beds appear to have been the product of individual events, probably flash floods, which swept off the exposed granite area onto the surrounding mud flats, and deposited their load of coarse granitic debris and sand. As the floods waned, rippled sand and finally mud were deposited. Subsequently the muds dried out to give polygonal desiccation cracks which can be seen moulded on the bases of some beds (best observed on loose blocks).

An interesting aspect of this locality is the relative abundance of trace fossils in comparison to most ORS sequences. They are seen on smooth mudstone lamination surfaces and bases of thin sandstone beds. Many of the trackways have low relief and are difficult to see unless the sun is shining. The most abundant trace fossil present is a small U-shaped burrow (Figure 4.6) which should be referred to the trace-fossil genus *Diplocraterion.* These burrows were probably produced by small arthropods, and these and other arthropods were responsible for the variety of walking, swimming and burrowing traces illustrated in (Figure 4.6). The arthropods inhabited the alluvial plain sediments close to the Devonian outcrop area of the Helmsdale Granite, where a reasonable water supply was probably available. The presence of plant debris and abundant spores at locality 3 indicates that an early Devonian terrestrial plant and arthropod community was established in the Ousdale area.

Locality 3. [ND 066 192]

A lay-by with parking area formed by a short section of the old road is situated opposite locality 3. Exposures of ORS are seen at the roadside and in a small disused and overgrown quarry where only a few exposures remain. In the quarry, a prominent bed of arkose 50 cm thick is overlain by red mudstones with sandstone beds up to 30 cm thick. Some excellent examples of current ripple lamination and small-scale convolute lamination can be seen here. The burrow *Diplocraterion* is also present at this locality. Beneath the arkose bed, three beds show good examples of dominantly planar cross-bedding in sets of 10 cm amplitude. The currents that deposited those beds, and the rippled sandstones, were flowing to the east. At the roadside a similar-looking arkose bed to the one seen in the nearby quarry is underlain by green mudstones and overlain by laminated micaceous sandstones; thus there is probably rapid lateral variation in these rocks of fluvial origin.

Locality 4. [ND 062 190]

Locality 4 is a road cutting about 1 km north of the Sutherland–Caithness boundary and 500 m north of the point where power lines cross the road. If approaching from locality 3, continue south on the main road for about 100m and park in the next section of old road which forms a lay-by about 300 m long on the SE side of the main road; the exposures are on the NW side of the main road.

The cutting exposes sandstones and mudstones of the Lower ORS. At the SW end of the cutting, sandstones are medium-grained, micaceous and parallel laminated. Disc-shaped rip-up clasts of mudstone are present, and plant debris is abundant on some lamination surfaces. The plants are primitive terrestrial forms similar to *Psilophyton,* and *Pachytheca* (?alga) is also recorded (Collins and Donovan, 1977). Further along the cutting a sandstone unit is seen with a sharp erosive base and examples of planar and trough cross-bedding with sets to 30 cm thick; current ripple lamination is also present. Some beds contain coarse debris with pink feldspars derived from erosion of the Helmsdale Granite. In places a thin intraformational conglomerate of mudstone clasts is present at the base of the sandstone.

The sandstones were deposited in an alluvial channel and the mudstones represent alluvial plain deposits. Deposition was probably from individual floods which ripped up the mud flakes and transported the plant debris. Armstrong *et al.* (1978) considered a braided channel system to be the most likely environment. Transport direction was to the NE on the basis of cross-bedding and ripple lamination.

The combinations of lithologies, sedimentary structures and trace fossils have been interpreted in broad environmental terms in (Figure 4.7).

Locality 5. Viewpoint [ND 057 180]

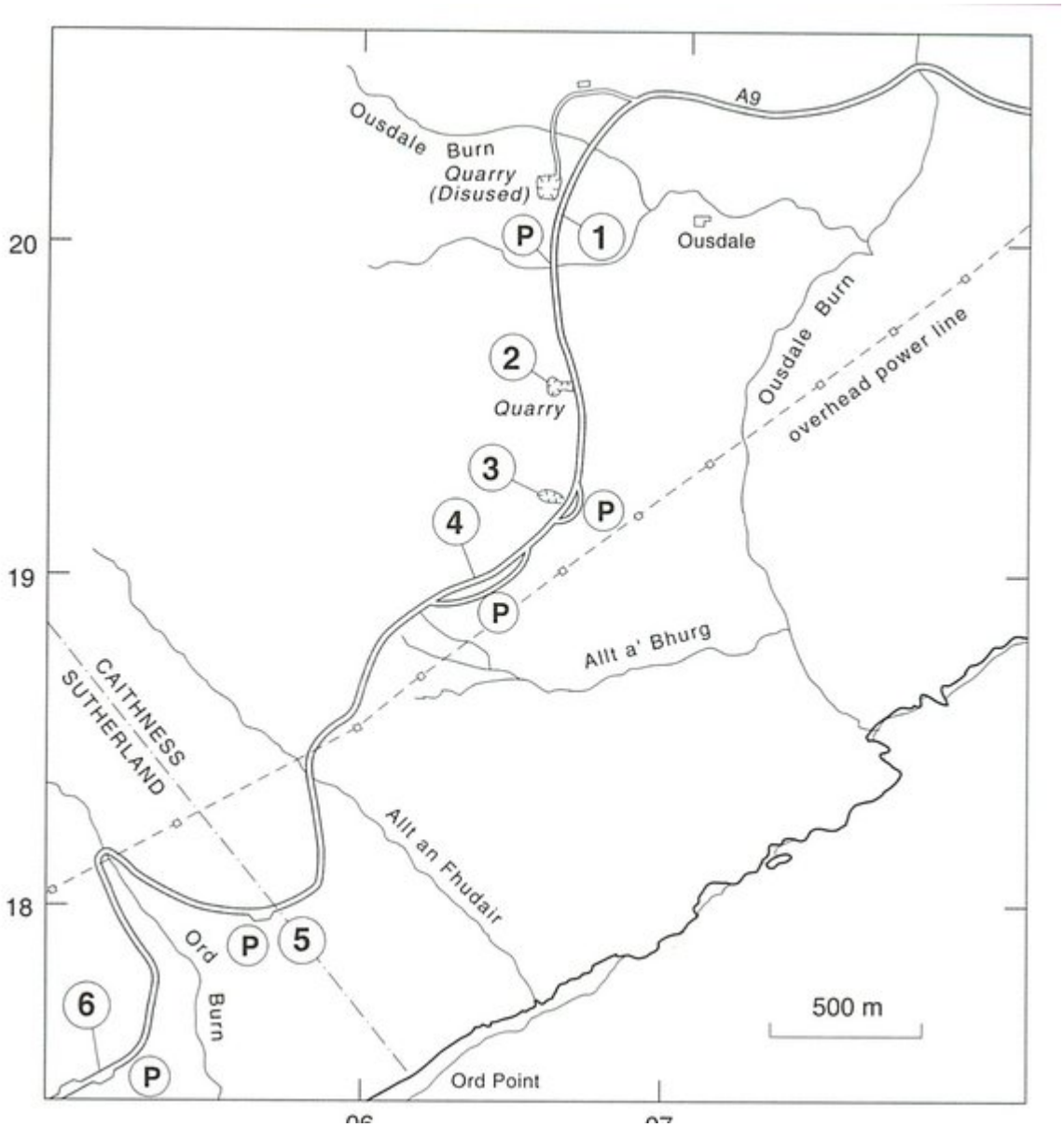
Stop at the lay-by and viewpoint on the Caithness/Sutherland border. On a clear day the production platforms of the Beatrice Oilfield, together with two wind turbines, can be seen some 30 km to the east. The oilfield produces from a succession containing sandstones of Early Jurassic to Callovian age which resemble the rocks seen in Excursions 1 and 2. The reservoir sandstones are overlain by Upper Jurassic shales which do not contain boulder beds. The boulder beds adjacent to the Helmsdale Fault probably only extend for a few kilometres offshore. The structure of the Beatrice Oilfield is a tilted fault block; details of the production history are given in the Geological History section of this guide. To the south Lothbeg Point and Brora stand out with the mountains of Easter Ross beyond. Tarbet Ness and lighthouse at the northern end of the Black Isle can be seen, and on a clear day the mountains to the south of the Moray Firth are visible.

Continuing south on the road, Helmsdale Granite crops out on the right before the road turns sharply over the Ord Burn, but the former lay-by at this point has been destroyed by roadworks. Granite was well exposed during road construction, but most has now been landscaped and grassed over.

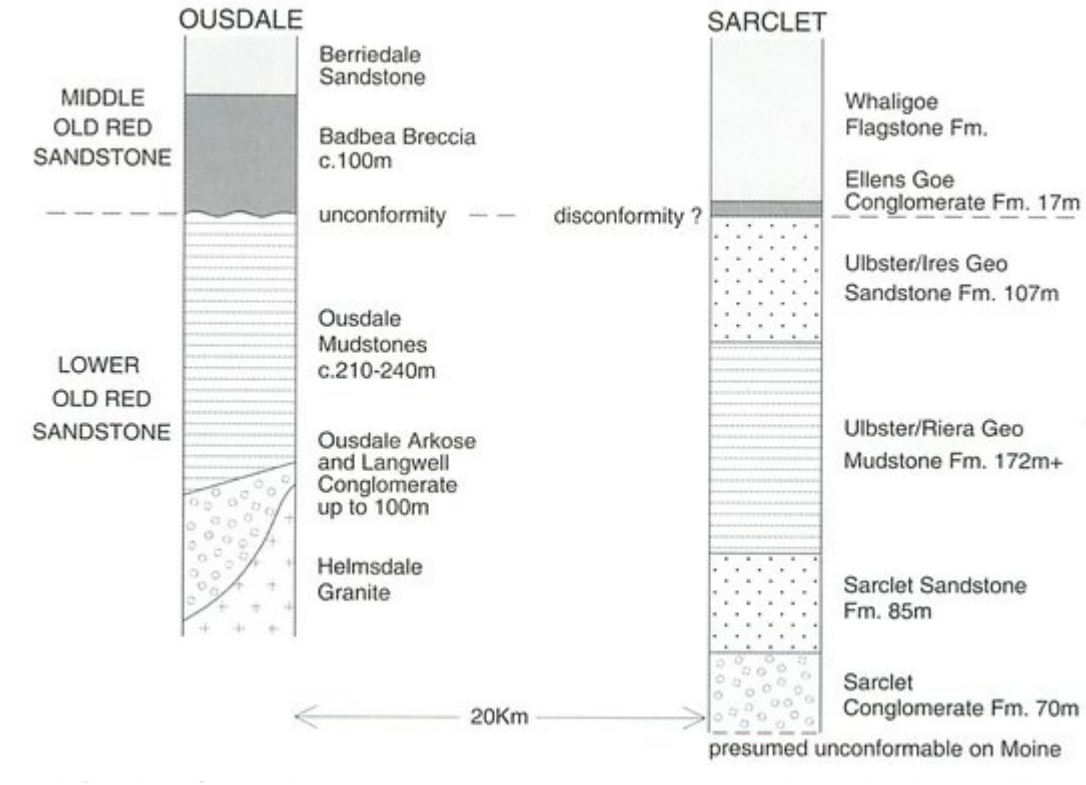
Locality 6. [ND 052 175]

The view from this locality is best seen from the lay-by on the southbound carriageway, but can be see from the lay-by on the northbound side by climbing up the steep roadside bank. If the tide is reasonably low (and weather fine) the structures in the Helmsdale Boulder Beds on the beach at Navidale can be observed. Anticlinal folds plunging seawards abut the Helmsdale Fault. It appears that these are tectonic folds rather than depositional fans of boulder bed lithologies. Thomson and Underhill (1993) relate these folds to stress set up by opposed strike-slip motion on the Helmsdale Fault (sinistral) and Great Glen Fault (dextral) during Tertiary times. The Helmsdale Fault passes under the Navidale House Hotel (white buildings in trees near point), and trends north-eastwards to the coast at Ord Point, which is due west of this stopping place. To the SW the line of fault coincides with the break in slope between the narrow coastal strip and the hills of Helmsdale Granite and Moine metamorphic rocks.

References

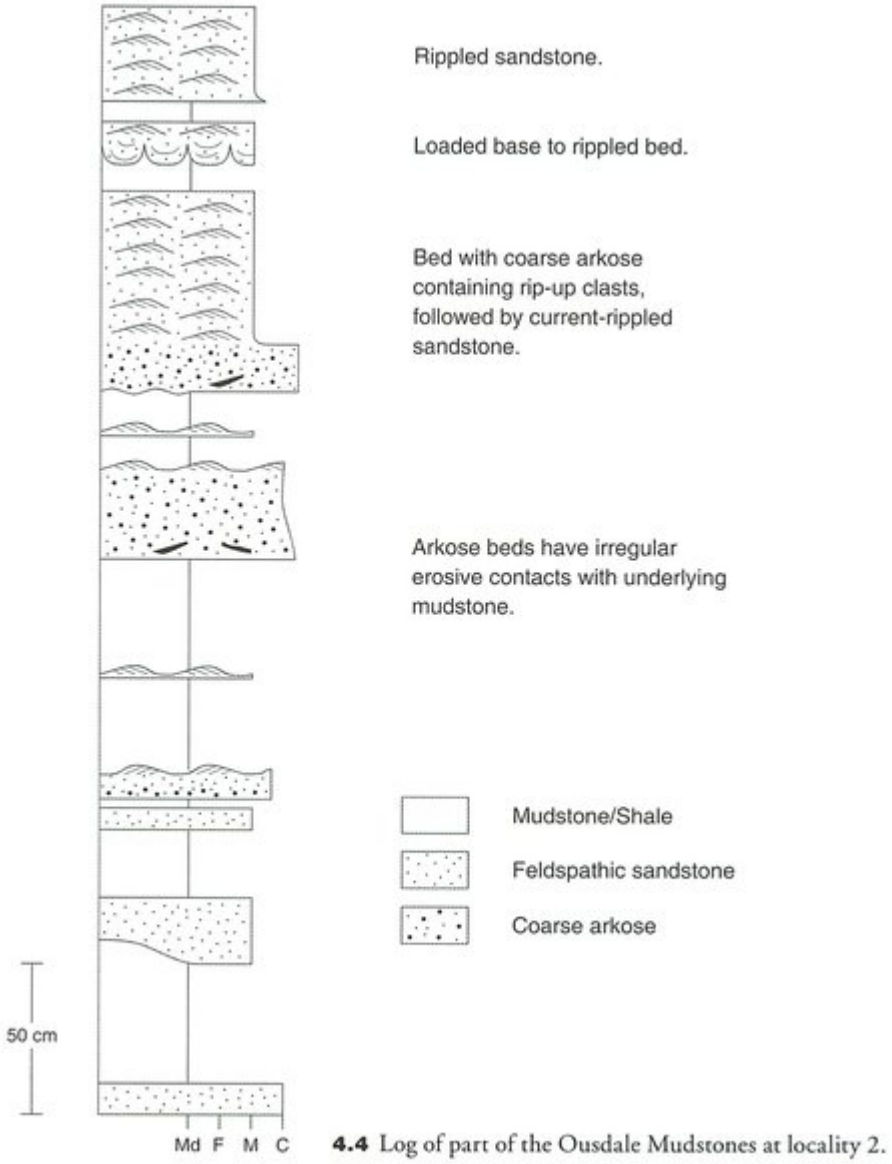


(Figure 4.1) Locality map for excursion 4, Ousdale area.



(Figure 4.2) Stratigraphic sections at Ousdale and Sarclet (see Excursion 5). Modified from Collins and Donovan (1977).

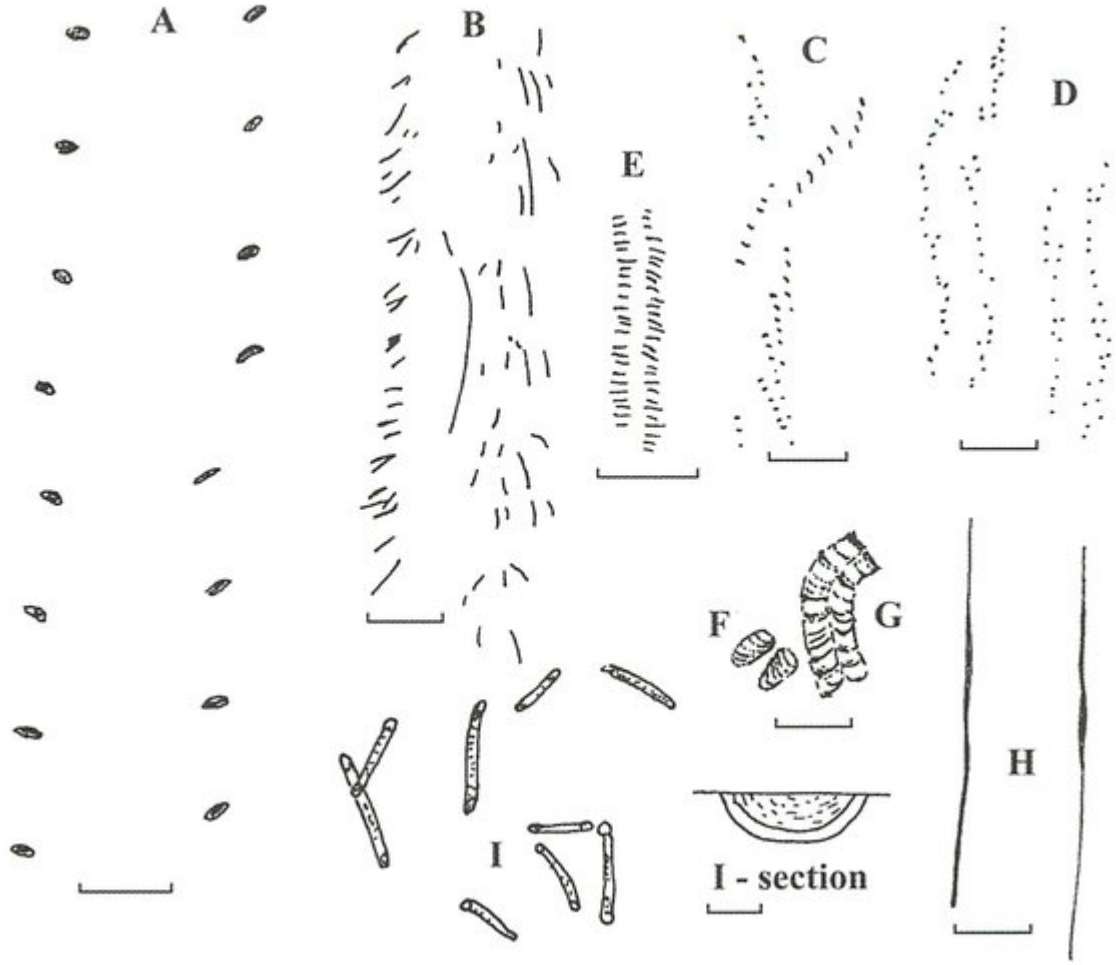
(Figure 4.3) Ousdale road cutting on the A9 (north end, southbound side) showing the junction between sheared granite and bedded arkose. (Locality now more overgrown with vegetation.)



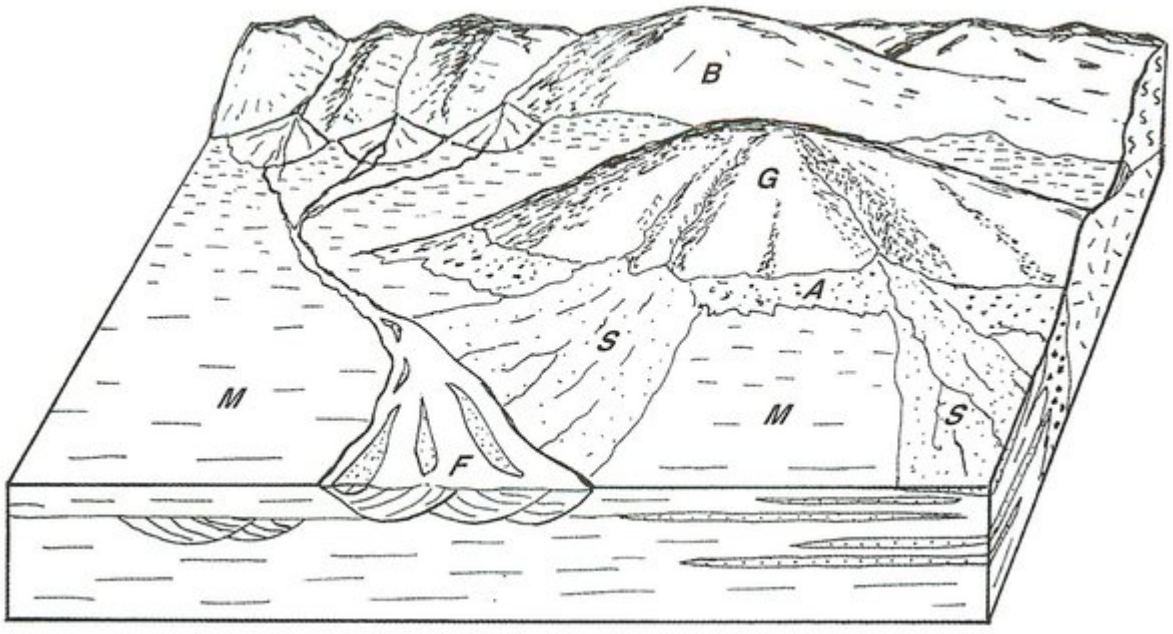
4.4 Log of part of the Ousdale Mudstones at locality 2.

(Figure 4.4) Log of part of the Ousdale Mudstones at locality 2.

(Figure 4.5) Sandstone beds with erosive bases within the Ousdale Mudstones. The upper bed has a coarse arkosic base. Ousdale Mudstone quarry, locality 2.



(Figure 4.6) Trace fossils from the Ousdale Mudstones at locality 2. The naming of arthropod trackways A–E is tentative, and follows the work of Carroll (1990) and Walker (1985). It is probable that all these trace fossils were made by arthropods. A. Merostomichnites; B. Allocotichnus; C. Merostomichnites, form with overlapping track series made by animal with at least six pairs of walking legs. D. Danstaria; E. Tasmanadia; F. Rusophycus, a coffee-bean shaped resting trace. G. Cruziana, a bilobed ribbon trace made by an animal ploughing through the surface. H. Beaconichnus, a double groove tramway-trace. I. Diplocraterion, a u-shaped burrow in plan and cross-section. Scale bars 1 cm long.



(Figure 4.7) Sketch reconstruction of depositional features associated with the Ousdale Arkose and Ousdale Mudstones. Eroding granite (G) supplies material for a fringe of arkose (A), and arkosic sheetflood deposits (S) that partly cover

alluvial plain mudstones (M). Fluvial channel deposits (F) are sourced from more distant metamorphic basement (B) and hence carry a variety of lithic clasts.