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# Pennan, unconformity within The Old Red Sandstone

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## Purpose

This short itinerary demonstrates the nature of the unconformity between the Lower Old Red Sandstone Crovie Group and Middle Old Red Sandstone Findon Group at one of the most easily accessible localities. It can be visited in conjunction with excursions to Gamrie Bay and New Aberdour.

## Access

Pennan village, midway between Gardenstown and New Aberdour off the B9031, is situated at the foot of a narrow road with hairpin bends not recommended for vehicles larger than a minibus. It is best to start the excursion at Mill Shore, the bay west of Pennan (Figure 1). A coach can wait at the main road [NJ 839 658] and parking is available at the beach for smaller vehicles. Low tide is essential for rounding the points between the bays, and walking and scrambling distance on rocky shores is a maximum of 2 km. The area is covered by O.S. 1:50,000 sheet 30 (Fraserburgh) and Geological Survey 1:63,360 sheet 97 (Fraserburgh).

## Introduction

The Old Red Sandstone of Pennan, New Aberdour and Gamrie is part of the fill of the Turriff Basin which extends inland for 30km and has a N–S orientation. The basin is generally fault bounded on the western margin (the Afforsk Fault at Gamrie Bay), and at the eastern side the ORS rests unconformably on Dalradian (seen east of New Aberdour), but faulted contacts are also seen at the eastern basin margin. The ORS fill of the basin is a little over 1 km thick (Ashcroft and Wilson 1976), and consists of Lower ORS Crovie Group which is unconformably overlain by the Middle ORS Findon Group. There is a marked change in the composition of clasts between the Crovie and Findon groups. The former contains much granitic and felsitic debris, but the latter is dominated by angular clasts derived from the Dalradian Macduff Slates.

The reader is referred to the introduction to the New Aberdour excursion and the description of locality 5 of the excursion to Gamrie Bay for further information. Impressive coastal cliff scenery is developed in this area, controlled by faults and joints in the breccias and conglomerates.

## Itinerary

### Locality 1 [NJ 840 658]

Mill Shore is a beach backed by a pebble storm ridge through which the stream cuts at the west of the bay. Well-developed beach cusps are frequently seen on the beach. The cliffs on either side of the bay (Figure 2) are formed of the Findon Group of the Middle ORS and are mainly breccias with the majority of clasts angular or subangular fragments of Dalradian rocks. Very little matrix is present, but the breccias are crudely bedded with sub-parallel beds distinguished by changes in pebble size and sorting. Orientation and imbrication of the pebbles is common, and a calcite cement, probably deposited as a result of groundwater evaporation in a semi-arid climate, is present in patches (Figure 3).

Only a few beds of red sandstone are present, which are usually lensoid in section and were probably deposited in channels. Similar lens-shaped sections of coarser conglomerate also appear to occupy channels. The angularity of the clasts points to extremely local derivation and short transport distance; probably from rocks uplifted as a result of local faulting following Lower ORS deposition. The depositional environment is interpreted as alluvial fans derived directly from

outcrop of the Macduff Slates.

Much minor faulting is seen in the cliffs, leading to well developed lines of weakness which are exploited by the waves to produce spectacular coastal scenery with caves, arches and blowholes as can be seen in the cliffs around Cullykhan Bay, on Castle Point and Lion's Head.

### **Locality 2 [NJ 842 658]**

Walk east from Mill Shore through Windy Cave and around the point. This locality affords good views of the village of Pennan, with the red sandstones of locality 4 beyond the harbour ((Figure 6) below). In the small bay a fault which can be traced across the shore and into the cliff throws conglomeratic sandstones of the lower, Crovie Group of the ORS against Findon Group breccias. A complex angular unconformity is seen in the lower part of the cliff. The lower, Crovie Group strikes N–S and dips 50°W and the upper, Findon Group breccias strike 080° and dip 20°S. The major features of the exposure are illustrated in (Figure 4) and (Figure 5) above.

The conglomeratic sandstones (A on (Figure 4)) of the Crovie Group are similar to those seen at New Aberdour, consisting of red sandstone with abundant granitic debris. Beds and lenses of conglomerate are concentrated in small channels with erosive bases ((Figure 7) below). Faults (B) cut these beds but do not all appear to affect higher beds. Conglomerate (C) overlies the Crovie Group unconformably and fills hollows which had been eroded along the previously existing faults; thus it appears that the lower group was faulted and eroded prior to deposition of conglomerate (C). This conglomerate contains rounded pebbles of quartzite, felsite, Dalradian psammities and other resistant lithologies, and also rare blocks of sandstone derived from the underlying beds. This conglomerate is overlain by red sandstones (D) in beds with limited lateral persistence which are succeeded by the breccias of the Findon Group (E) consisting largely of angular clasts of slates as described above at locality 1. This complex unconformity can be traced down to shore level where it cuts through a laminated sandstone bed producing a spectacular angular relationship. However a recent cliff fall obscures part of the exposure at present (Aug 2008).

### **Locality 3 [NJ 843 656]**

Another fault again brings the unconformity into view on the east side of the next small bay. Again a complex relationship is present with an irregular development of the conglomerate with rounded pebbles (C) above the lower group (A) and below the breccia (E). The cliff of red sandstones and thin conglomerates of the Crovie Group shows small conglomerate-floored channels with cross- bedding and also well-developed water escape structures in a bed with deformed cross-bedding.

### **Locality 4 [NJ 848 657]**

The Crovie Group is again exposed by the harbour at the east end of Pennan village. Brick red sandstones in beds up to 1m thick and showing cross-bedding form most of the cliff. Current directions are generally to the NW. These rocks appear to be massive fluvial sandstones which, when traced along the beach, are succeeded upwards by conglomeratic sandstones with numerous rounded pebbles, mainly of quartzite. Sedimentary structures are similar to those in the conglomeratic sandstones seen previously at locality 2. These conglomeratic sandstones are the deposits of an alluvial fan, but this fan was supplied with material of greater maturity in comparison to that seen in the Crovie Group at New Aberdour.

The clifftop above is capped by the Findon Group breccia of which blocks are present on the shore. Thus it can be seen that the succession present beneath the breccia differs from that present at localities 2 and 3 to the west. This provides further evidence that considerable faulting and erosion preceded deposition of the Findon Group. Faulting could also have controlled sedimentation of the Crovie Group, which would account for the rapid local variation seen in lithology and thickness.

## **Figures**

(Figure 1) Locality map of Pennan area.

(Figure 2) Findon Group breccias with crude bedding in cliff at east side of Mill Shore. Archway provides access from shore to Locality 2.

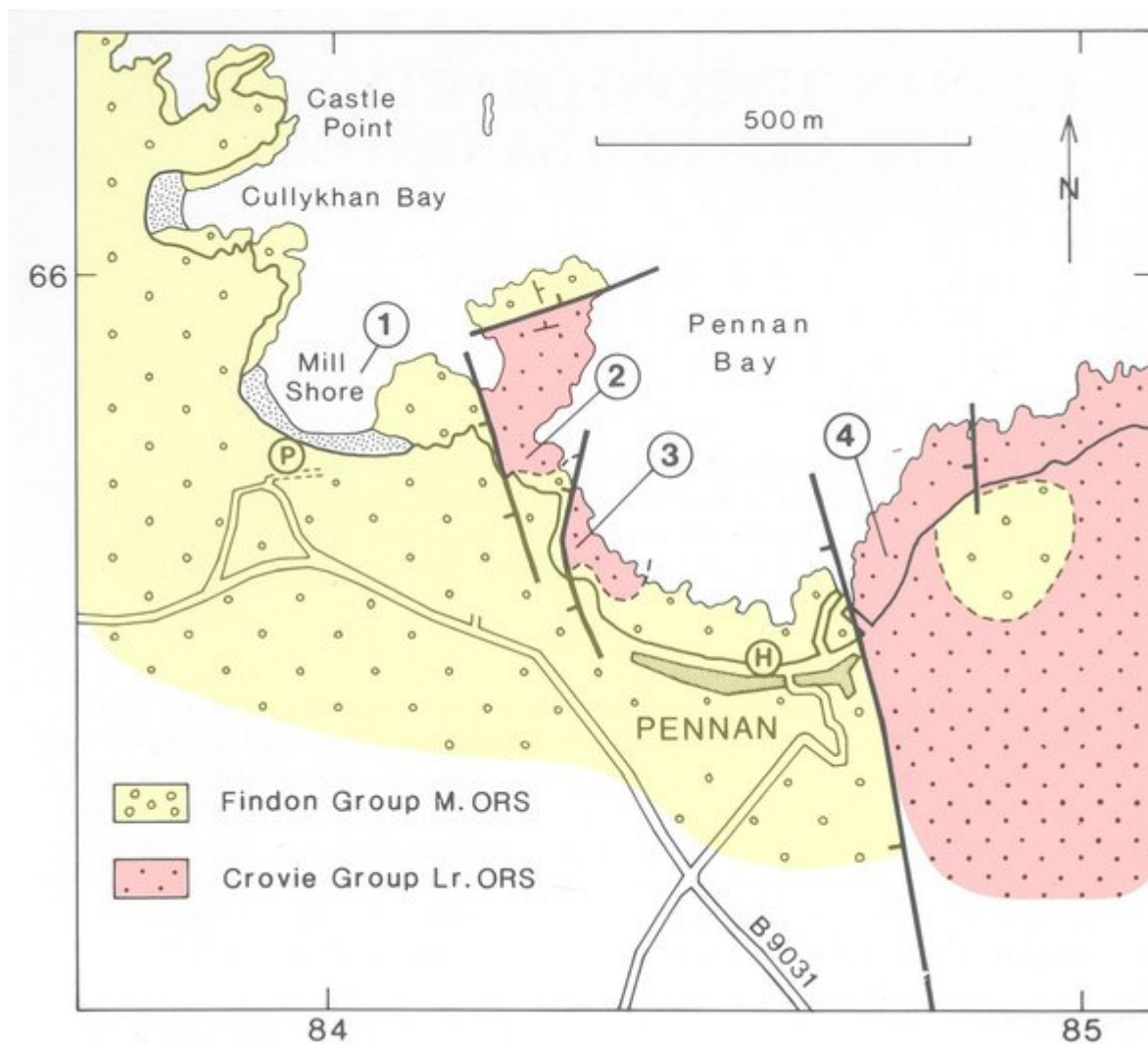
(Figure 3) Findon Group breccia at E end of Mill Shore with angular clasts of the Dalradian Macduff Slates, and patches of sparry calcite cement repositied between clasts. There is very little sandy matrix to the breccia which was locally derived.

(Figure 4) Field sketch of lower part of cliff at locality 2. Pennan. Unconformity between Lower Old Red Sandstone (Crovie Group.) and overlying Middle Old Red Sandstone (Findon Group.). A. Crovie Group. Conglomeratic sandstones B. Faults affecting Crovie Group C. Conglomerate filling hollows on erosion surface D. Red lenticular sandstones E. Breccia of Findon Group X-X Unconformity surface

(Figure 5) View of the unconformity between the Crovie Group of the Lower ORS and the Findon Group breccias of the Middle ORS. Compare details with the field sketch (Figure 4) above.

(Figure 6) View of Pennan and cliffs of Crovie Group red sandstones of Locality 4 beyond the harbour. View from Locality 2.

(Figure 7) Crovie Group conglomerates and red sandstones at Locality 2.



(Figure 1) Locality map of Pennan area.



*(Figure 2) Findon Group breccias with crude bedding in cliff at east side of Mill Shore. Archway provides access from shore to Locality 2.*



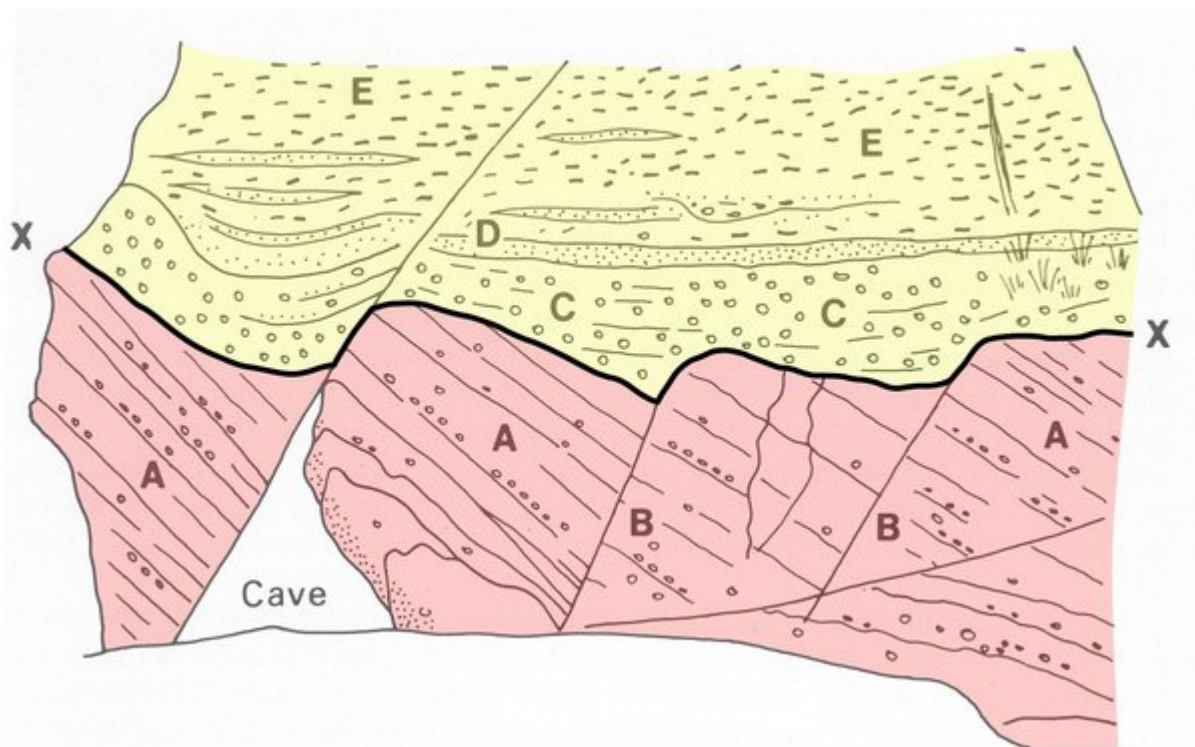


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(Figure 6) View of Pennan and cliffs of Crovie Group red sandstones of Locality 4 beyond the harbour. View from Locality 2.



(Figure 4) Field sketch of lower part of cliff at locality 2. Pennan. Unconformity between Lower Old Red Sandstone (Crovie Group.) and overlying Middle Old Red Sandstone (Findon Group.). A. Crovie Group. Conglomeratic sandstones B. Faults affecting Crovie Group C. Conglomerate filling hollows on erosion surface D. Red lenticular sandstones E. Breccia of Findon Group X-X Unconformity surface





*(Figure 5) View of the unconformity between the Crovie Group of the Lower ORS and the Findon Group breccias of the Middle ORS. Compare details with the field sketch (Figure 4) above.*



*(Figure 7) Crovie Group conglomerates and red sandstones at Locality 2.*