Whiting Ness, Angus

[NO 679 432]–[NO 659 409]

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Introduction

First notified as an SSSI in 1961, this important GCR site (Figure 3.26) shows non-marine, Devonian sedimentary fluvial rocks. Extensive sea-cliffs expose late Devonian (Upper Old Red Sandstone) sandstones and conglomerates about 370 million years old resting with irregular unconformity on early Devonian (Lower Old Red Sandstone) sandstones about 410 million years old belonging to the Scone Sandstone Formation of the Arbuthnott–Garvock Group. The site shows the contrast between the far-travelled, early Devonian sandy alluvium and the locally derived pebbles in the late Devonian rocks. The basal breccias of the Upper Old Red Sandstone contain combinations of bedding types that show the control of topography of the underlying unconformable surface on braided stream morphology. The site is important in demonstrating that the Old Red Sandstone of the Midland Valley was formed during two separate episodes of sedimentation separated by a break that represents the entire Mid-Devonian period. It is an important site in studies of the lithostratigraphy and palaeogeographic evolution of the Midland Valley. The constituent formations of the Arbuthnott–Garvock Group consist mainly of cross-bedded sandstones. These contain clasts of metamorphic and igneous rocks, as well as soil carbonate (calcrete) clasts of intrabasinal origin (cf. Balin, 2000; see Milton Ness GCR site report, this chapter), which are especially characteristic of the upper part of the group. There are interbedded conglomerates in the Arbroath area, and the topmost unit in Strathmore (the Scone Sandstone Formation) contains a persistent conglomeratic horizon with lenticular beds of nodular calcrete.

Description

The Arbroath Sandstone Member of the Scone Sandstone Formation consists of cross-bedded, fine- to medium-grained sandstones. These overlie the Auchmithie Conglomerate Member and are the youngest known strata of early Devonian age on the south-east limb of the Sidlaw Anticline. Named by Hickling (1908) and given formational status by Armstrong and Paterson (1970), the Arbroath Sandstone is now accorded member status (Browne *et al.,* 2002). It is at least 365 m thick, and consists of bright purple-red sandstones on the coast near Arbroath, where it is overlain with marked unconformity by the Upper Old Red Sandstone. Near Carnoustie, however, 3 km to the south-west, the sandstones are generally green or purplish grey. The red colour at Arbroath may be due to the proximity of the mid-Devonian unconformity, with deep weathering prior to the deposition of the Upper Old Red Sandstone. The Arbroath Sandstone Member dips to the south-east at about 20° on extensive wave-cut platforms north-east of Carnoustie and at Arbroath. Trough-cross-bedding is well displayed, with elongate troughs trending parallel to the strike of the rocks and showing predominantly SW-directed palaeocurrents.

The sandstones contain abundant pebbles and boulders (up to 0r.3 m across) of nodular limestone at many levels. These clasts are considered to have originated as carbonate soil nodules (caicrete) in argillaceous overbank deposits that were subsequently almost completely destroyed as the result of river channel migration. The carbonate clasts commonly have the appearance of slightly abraded concretions and may not have been transported far before being incorporated in the sandy channel deposits. In some clasts, the carbonate appears to enclose mudstone that represents part of the original mud host. Intact mudstone beds are rare in the Arbroath Sandstone Member but one example with carbonate nodules may be observed at the foot of the cliffs [NO 662 412] 200 m east of Whiting Ness. It underwent partial penecontemporaneous erosion, producing a 'trail' of limestone clasts into an adjacent channel sandstone. The larger limestone clasts tend to occur at the base of the sandstone co-sets, probably representing lag deposits, the smaller ones tend to lie along the foresets. Many co-sets are relatively hard and calcareous in their upper parts, which protrude on the abraded wave-cut platforms. Their top surfaces locally display polygonal jointing that does not penetrate below the hard zone. These features, the formation of concretions in mudstones and the hardened upper calcareous

zones in the sandstones are attributed to pedogenic processes in response to fluctuations in water-table levels.

East of Arbroath, in the general neighbourhood of Whiting Ness, a sequence of mainly red-brown and yellow conglomerates with subordinate sandstone beds and basal and marginal breccias rests with striking unconformity on the Arbroath Sandstone Member ((Figure 3.27); Hicking, 1908). These beds are unfossiliferous, but the sandstones resemble those in the fossiliferous Late Devonian Stratheden Group in Stratheden and the Carse of Gowrie, and a Late Devonian age seems probable. The absence of calcrete ('cornstone), suggesting a stratigraphical position below the lower Carboniferous Kinnesswood Formation of Fife, is consistent with this conclusion. The strata can be assigned to the Burnside Sandstone Formation, the lowest unit in the Fife succession. A general direction of transport towards the south and south-east is apparent (Ramos and Friend, 1982). Distinctive breccias composed of angular fragments of the Arbroath Sandstone Member, and clearly derived from the ancient bedrock slopes, accumulated in lenticular bodies. In places they rest on the unconformity, but elsewhere occur at a higher level and are intercalated with the overlying sandstones, or fill channels cut in them. In the area of the Steeple Rock [NO 6585 4095] SSW of Whiting Ness, blocks of the Arbroath Sandstone Member up to 2.5 m in length occur immediately above the unconformity.

Interpretation

The sedimentary rocks of the Arbroath Sandstone Member are typical of the Scone Sandstone Formation in the Strathmore Basin. Bluck (2000) provided a sedimentological interpretation for the formation based upon a road cutting at Crossgates–Burnside, south-west of Perth. At the west end of the 800 m-long cutting, lithic arenites above a basal mudstone-clast breccia are overlain by a single set of cross-bedded strata over 12 m thick. The complex was laid down in a single bar at least 12 m high in a river channel probably 15–20 m deep. Bluck concluded that the river was substantially deeper than those local (internal) streams of much steeper gradient that had deposited older conglomeratic formations in the Midland Valley up to that time. Its source was external to the Midland Valley, in the Scandian Orogen to the north-east.

The angular discordance between the Upper and Lower Old Red Sandstone strata at Whiting Ness is marked. The Lower Old Red Sandstone dips south-east at about 25°, whereas the Upper Old Red Sandstone dips approximately ESE at 10°. The latter was deposited against steep slopes forming part of the sub-late Devonian land surface, as can be seen in the cliffs [NO 6510 4100] on the east side of the Horse Shoe east of Whiting Ness. It is probable, however, that the palaeorelief of the unconformity seen in the irregular surface near Whiting Ness is small compared to that elsewhere in this area. The western limit of the Upper Old Red Sandstone outcrop on the foreshore [NO 6510 4100] 900 m west of Whiting Ness is also an unconformable junction, and an ascending sequence broken by small faults can be followed on the intervening shore. Assuming that the stratification of the Upper Old Red Sandstone was originally horizontal, and on the basis of the prevailing dip (10° to the ESE) and the breadth of outcrop perpendicular to the strike of about 450 m in the ground between the two exposures of the unconformity, there is about 100 m of relief on the ancient land surface.

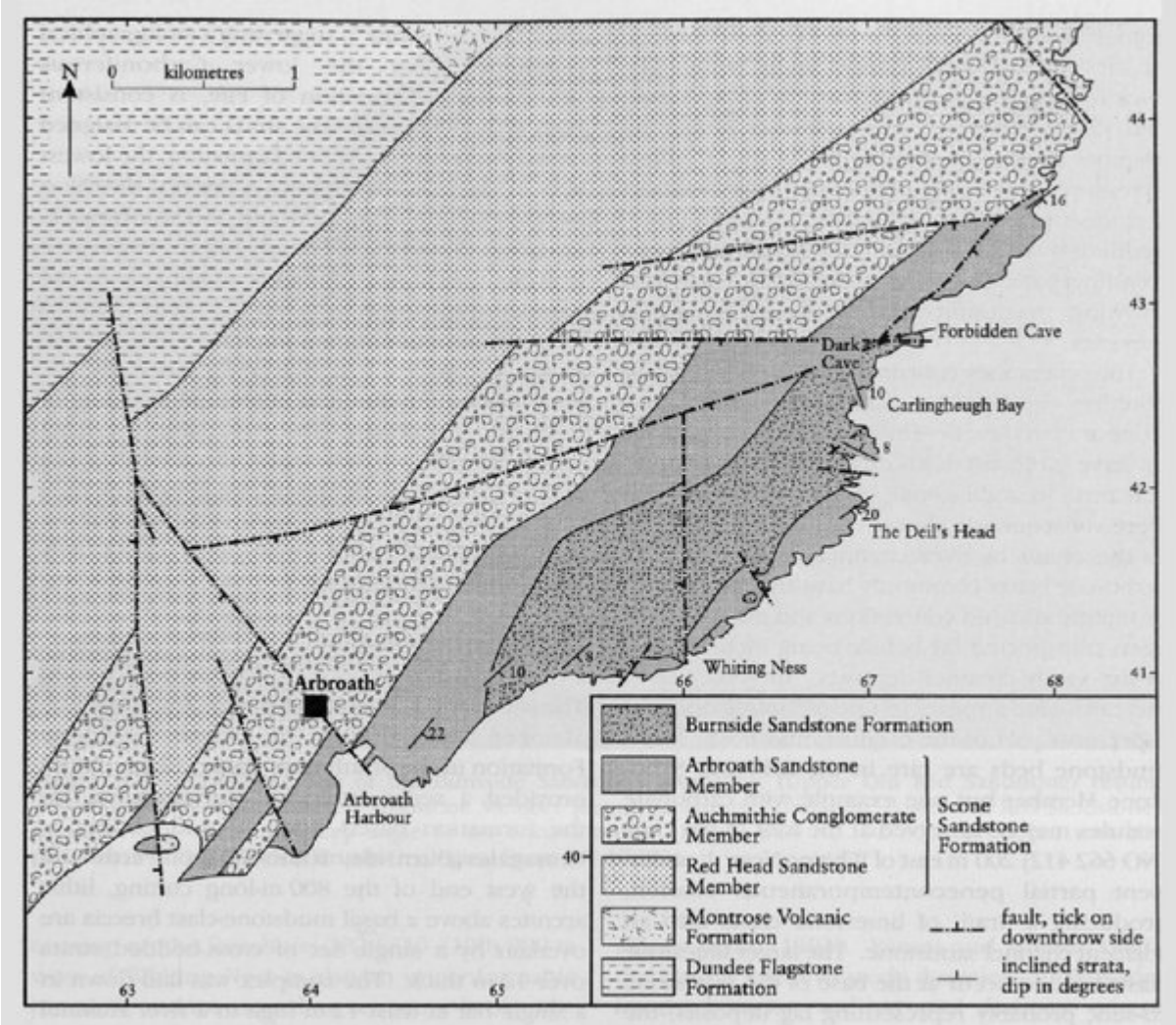
Most of the Upper Old Red Sandstone sediments appear to have accumulated in braided channels as lateral bars in the active part of an alluvial plain covered with sand and gravel. White, flat-bedded, fine-to medium-grained sandstones of sheet-flood type were laid down preferentially in topographically protected areas close to the steeper slopes on the surface of the unconformity near Whiting Ness (Ramos and Friend, 1982). Steep-sided gullies up to 1.5 m deep cutting into these beds are mostly filled with breccia derived from the adjacent steep slopes (Balin, 1993). Ramos and Friend (1982) deduced a south-westerly direction of transport for the breccias, with an axial drainage system flowing south-eastwards.

Conclusions

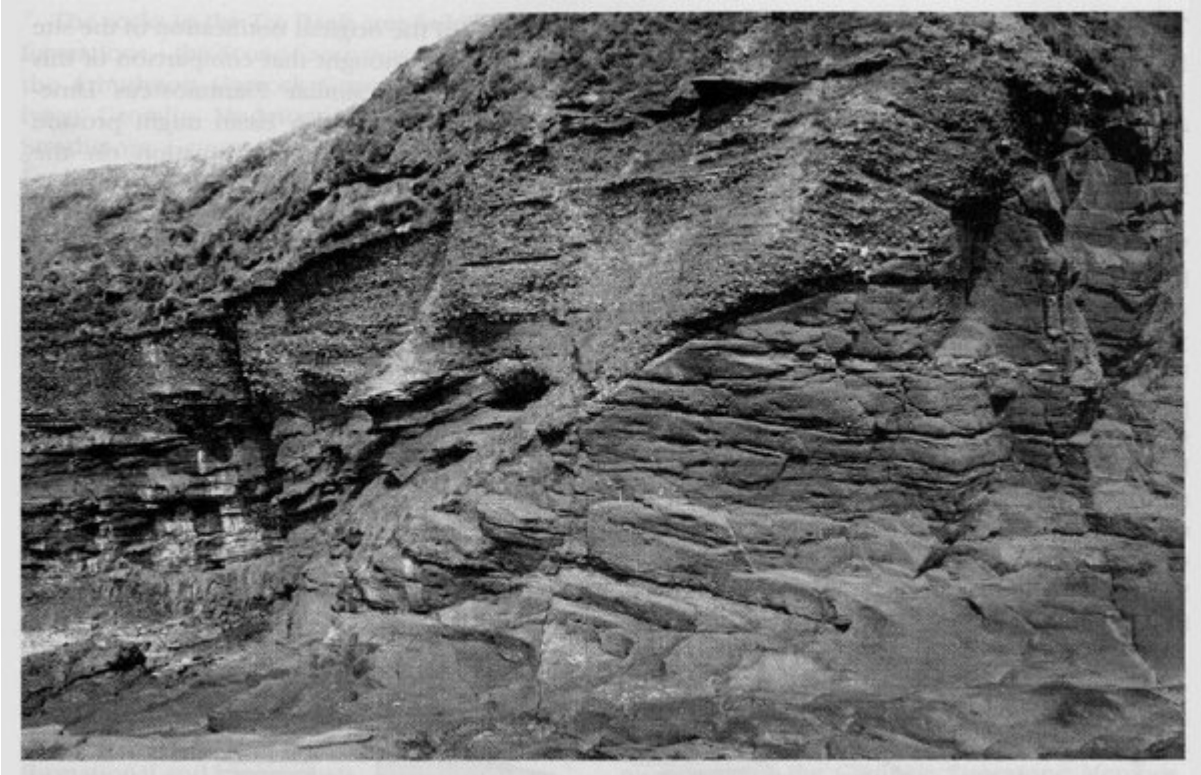
Whiting Ness and nearby cliff sections at Dickmont's Den and Forbidden Cave provide excellent exposures of a geological unconformity. This represents an ancient surface with a steeply dissected topography; the observed relief is of the order of 6 m, but is calculated to reach 100 m locally. The sections also show indurated braided river deposits of the Arbroath Sandstone Member that were uplifted, weathered and eroded in a semi-arid climate during mid-Devonian earth movements. Tropical weathering at that time probably caused the reddening of the strata. The overlying Burnside

Sandstone Formation was mainly laid down by braided rivers flowing south and south-east, but contains breccias that were deposited by streams flowing south-west at the basin margin.

References



(Figure 3.26) Geological sketch map of the bedrock geology of the area around Whiting Ness.



(Figure 3.27) Conglomerates of the Burnside Sandstone Formation (Upper Old Red Sandstone) resting unconformably on the Arbroath Sandstone Member (Scone Sandstone Formation; Lower Old Red Sandstone) [NO 660 412]. Note the steep angle of the unconformity. (Photo: BGS No. D2730, reproduced with the permission of the Director, British Geological Survey, NERC.)