Tay Bank, Perth and Kinross

[NO 125 328]

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Introduction

This important site on the east bank of a meander loop of the River Tay south of Campsie (Figure 3.28) exposes Early Devonian (Lower Old Red Sandstone) sedimentary rocks and concretionary limestones of pedogenic origin (calcretes). It provides the type section of the Campsie Limestone Member and the best exposure of the Stanley Limestone, a group of calcretes in this member named from this locality. A concentration of mature calcrete soil profiles is developed at this stratigraphical level across the Midland Valley of Scotland, marking a period of river downcutting, floodplain stability and reduced sedimentation.

At the time of the original notification of the site in 1976, it was thought that comparison of this horizon with the similar Psammosteus Limestone in the Anglo-Welsh Basin might provide regional correlation and information on the climatic evolution of the British Isles during early Devonian times. The Stanley Limestone is, however, younger and may correlate with the Abdon limestones of the Anglo-Welsh Basin.

Description

The Lower Old Red Sandstone of the Strathmore region was described by Armstrong and Paterson (1970) and a compiled section of the rocks exposed in the river bed and both banks at the Tay Bank site was given by Armstrong *et al.* (1985). The lithostratigraphical classification of the succession was revised recently by Browne *et al.* (2002).

The rocks in the Tay Bank area belong to two formations — the Scone Sandstone Formation (of the Arbuthnott–Garvock Group) and the overlying Cromlix Mudstone Formation (of the Strathmore Group). The 2000 m-thick Scone Sandstone Formation consists largely of grey, yellow, brown, red, purplish and red-brown, medium- to coarse-grained, cross-bedded, arkosic to lithic sandstones characteristically containing intraformational mudstone and limestone clasts. Pebbles of metasedimentary and volcanic rocks are also present. Reddish brown or greenish grey silty mudstone and siltstone occur as impersistent interbeds, some more than 0.5 m thick. Pale grey, fine-grained limestone of pedogenic origin occurs as thin, lenticular beds, but more abundantly as reworked clasts, throughout the formation. Lava flows occur locally, as around Laurencekirk and west of Perth.

The Campsie Limestone Member forms the topmost part of the Scone Sandstone Formation. It is characterized by mature calcrete beds (the Stanley Limestone and equivalent Pittendriech Limestone) and conglomerates with intraformational and exotic clasts.

The Cromlix Mudstone Formation consists predominantly of bright red to brownish red, purplish brown and green, poorly sorted, soft, sandy and silty mudstones and siltstones. There are minor, poorly sorted, very fine-grained, argillaceous sandstones, and all of the mudstones and sandstones contain green reduction spots. The beds are typically massive and appear blocky as a result of pervasive fracturing, although weak planar bedding is common. Also present are thin beds of medium- to coarse-grained sandstone, and conglomerate sheets that pass into localized, very thick alluvial-fan bodies.

The Campsie Limestone Member, including the Stanley Limestone (Figure 3.29), is exposed on the banks of an incised meander in the River Tay just east of the village of Stanley (Figure 3.28). The strata lie on the north-west limb of an anticlinal inlier affected by minor NW-trending faults, the exposed beds dipping mainly about 20° to the north-west. The strata are accessible on the banks of the river, and in its bed when the water-level is low. The section compiled from the exposures by Armstrong *et al.* (1985) is shown graphically in (Figure 3.28). The lowermost beds of the Campsie Limestone Member, including conglomerates, sandstones and calcretes (the Stanley Limestone), are best seenin the

river bed and in the east bank [NO 124 327]. The clasts in the 7.5 m-thick conglomerate at the base of the Campsie Limestone Member include quartzite, felstone, greenstone, porphyrite, syenite and jasper (Armstrong *et at.,* 1985; J. Geikie, unpublished data). Geikie recognized a southerly direction of transport of the sediments based on imbrication of the clasts. The calcretes mainly occur in sandstone host rock, and are fine-grained, white, pale grey, pale greenish grey and pink, nodular limestones.

The uppermost beds of the Campsie Limestone Member, comprising intercalated sandstones and mudstones, dip below the basal beds of the Cromlix Mudstone Formation and are best seen on the west bank below Inchbervis Castle [NO 120 328]. On the north side of the peninsula made by the meander loop, the basal argillaceous strata of the Cromlix Mudstone Formation are exposed along the river bank for about 500 m upstream of their junction with the Campsie Limestone Member. About 200 m from the junction, the mudstones are cut by a 0.5 m-wide, ENE-trending basaltic dyke, and thin, irregular basaltic intrusions up to 0.3 m thick occur a little farther east.

Interpretation

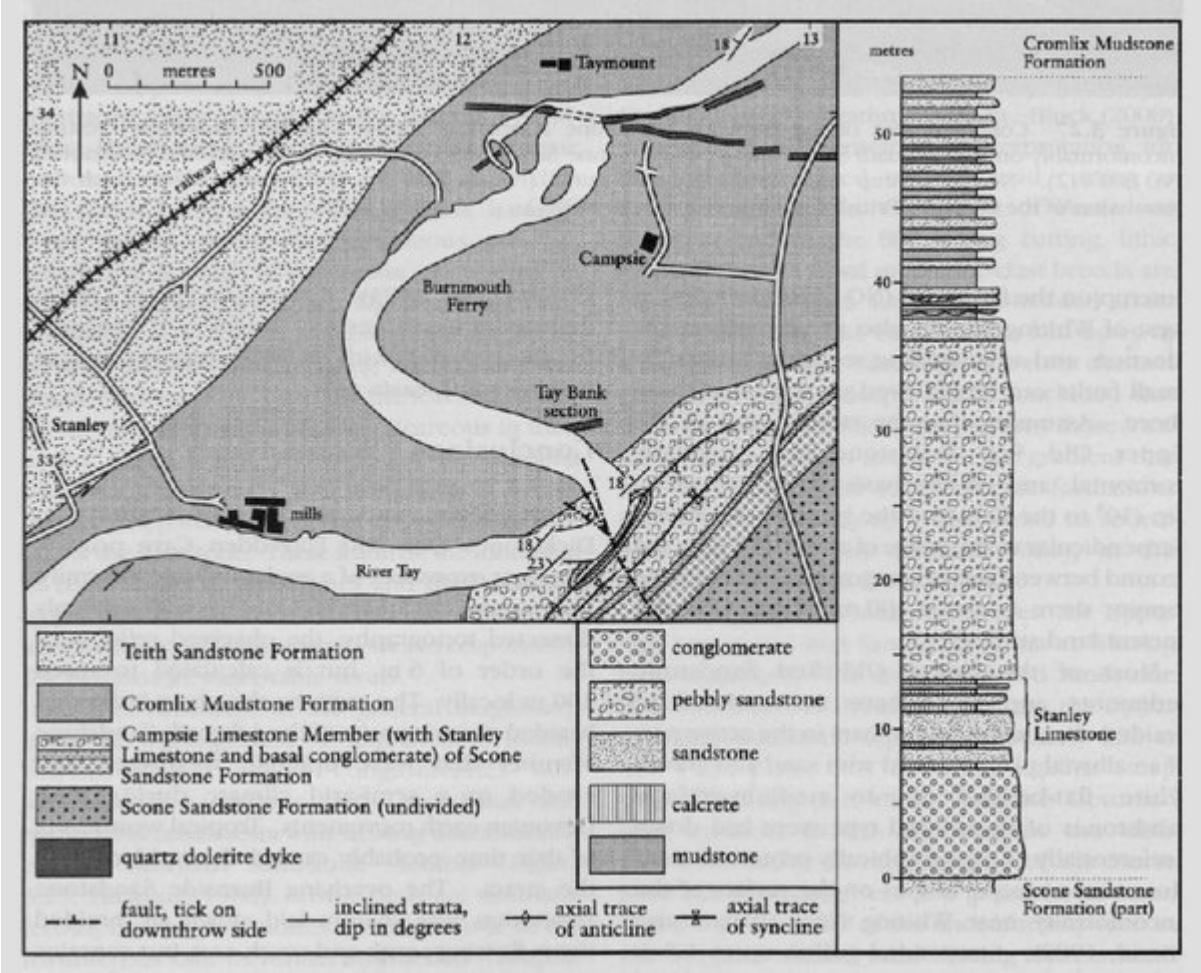
The sandstones of the Scone Sandstone Formation were deposited in a SW-flowing river system and are characterized by the presence of intraformational limestone clasts. The carbonate formed as concretionary soil (calcrete) nodules in floodplain silts and muds, reflecting a hot, seasonally wet, semi-arid climate appropriate to a location 10–20° south of the equator (Balin, 1993, 2000). Penecontemporaneous reworking of the floodplain deposits in migrating channels released the resistant carbonate nodules to become incorporated in the sandstones as clasts. However, the Campsie Limestone Member is rare in that the nodules and beds of calcrete in a horizon about 20 m thick largely escaped reworking, except for one or two conglomerate beds. Armstrong *et al.* (1978b) suggested that the calcretes formed during prolonged weathering when the previously well-developed axial river system was bypassed.

Further evidence of significant change in the basin's dispersal systems lies in the switch to the mudrock-dominated Cromlix Mudstone Formation. The formation does not appear to have been subjected to appreciable fluvial reworking (Armstrong *et al.,* 1978b). However, Phillips and Aitken (1998) suggested that the typical structureless silty mudstones in the formation are comparable with aeolian clay pellet deposits formed in landlocked basins in arid and semi-arid parts of south-east Australia (Dare-Edwards, 1984; Yang, 1997; Gibling *et al.,* 1998). The pellets form as pedogenic mud and silt aggregates in arid to semi-arid desert environments and are blown and deposited by winds.

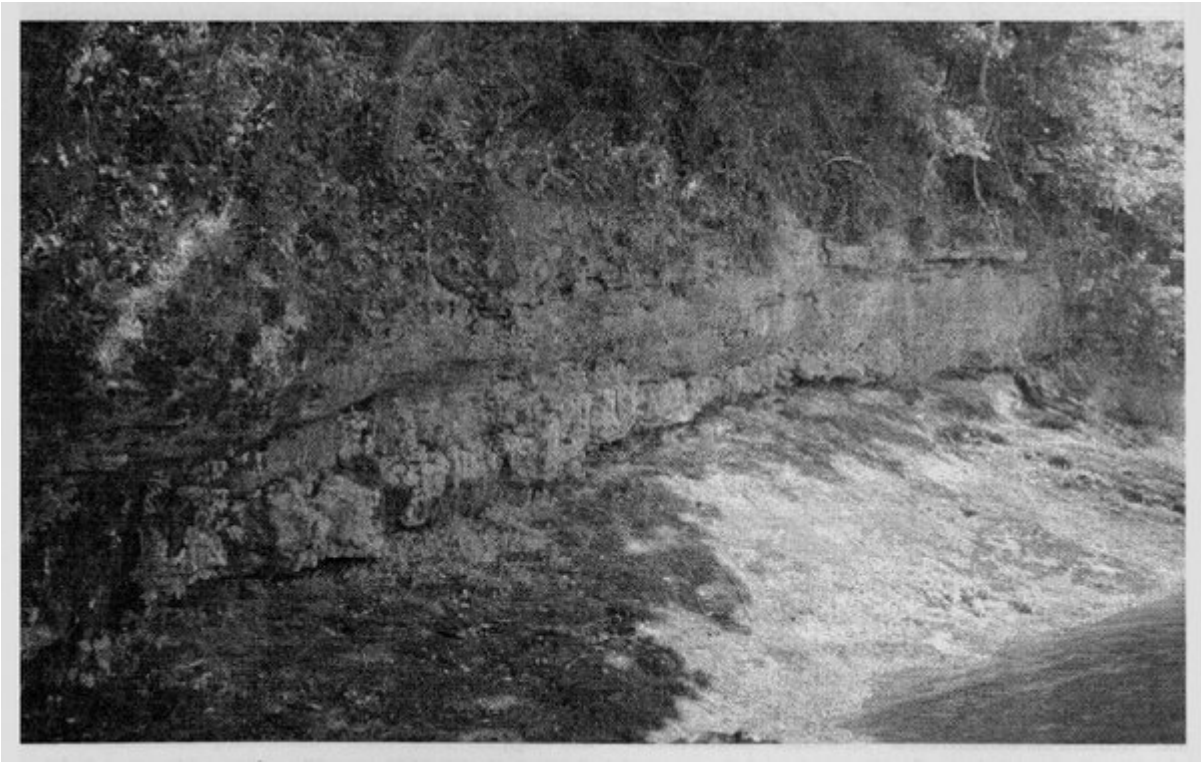
Conclusions

This site is important in providing the best section of the Stanley Limestone and the type section of the Campsie Limestone Member, a regional marker horizon that defines the boundary between the Arbuthnott–Garvock and Strathmore groups. The Stanley Limestone is a concentration of carbonate soil (calcrete) profiles that developed at this stratigraphical level across the Midland Valley of Scotland. The soils represent shut-down of the basin and mark an important change in sedimentation patterns, the earlier river systems being replaced by predominantly arid to semi-arid floodplain environments. Little detailed work has been carried out on the sedimentology and petrography of the rocks at this site and further study is warranted.

References



(Figure 3.28) Geological sketch map of the area around the Tay Bank section and log of the Campsie Limestone Member exposed. After Armstrong et al. (1985).



(Figure 3.29) The Stanley Limestone, a mature fossil soil carbonate (calcrete), exposed at the Tay Bank section. (Photo: M.A.E. Browne.)