Hapland Burn, Dumfries and Galloway

[NS 887 023]–[NS 889 025]

Introduction

In the Thornhill Basin, the small stream sections of Hapland Burn, and nearby water courses such as Carron Water, expose a continuous section from the Lower to Middle Permian Carron Basalt Formation, upwards through the breccias of the Durisdeer Formation, and the succeeding Thornhill Sandstone Formation, into the Locherben Breccia Formation. The deposits comprise a relatively thin sequence of coarse-grained sediments with boulders up to 1 m in diameter, followed by a fining-upward sequence of sandstones and sporadic siltstones and mudstones. Hapland Burn is the type locality for the Durisdeer Formation. The site encompasses exposures of a succession from high-energy fluvial deposits at the base to aeolian deposits near the top. The Hapland Burn sections form part of the Carron Water and Hapland Burn Site of Special Scientific Interest (SSSI).

The Permian succession of the Thornhill Basin has been described by Simpson and Richey (1936), Craig (1965), Brookfield (1978, 1981, 1984, 2000), McMillan and Brand (1995), and Stone (1996).

Description

The basal unit of the Permian sequence is the Carron Basalt Formation, a series of weathered, olivine-rich, amygdaloidal basalts interbedded with sandstones, greywackes, and breccias. The basal bed is a sandy, fine-grained breccia containing many clasts of basalt and greywacke. It is succeeded by three basalt flows, which have lower aphanatic and upper amygdaloidal layers. The tops of the flows are marked by substantial cracks, infilled with the overlying laminated sandstones and fine breccias. In the southern part of the Thornhill Basin the Carron Basalt Formation directly overlies Carboniferous sediments (Brookfield, 1978, 1980).

The Durisdeer Formation consists of approximately 70 m of tabular sandy breccias, medium-to fine-grained sandstones, and subordinate siltstones and mudstones (Figure 2.10). Small lenses of aeolian sandstones have also been recorded within this sequence. The breccias commonly contain large numbers of amygdaloidal basalt clasts up to 0.8 m in diameter and commonly with well-developed wind-faceted and polished surfaces (Brookfield, 1978, 1980). Other clast types include greywacke, chert, mudstone, acidic intrusive igneous material, limestone, and contact metamorphic rocks (slate and hornfels). The matrix of the breccias includes up to 10% aeolian sand grains. The breccias occur in beds approximately 1 m thick and commonly display graded bedding, rare clast imbrication, and cut-and-fill structures. Individual beds of breccia are overlain by thin layers of poorly sorted, granular, silty sandstone, or by particularly coarse breccias, comprising material reworked from the underlying bed. The fine- and medium-grained sandstones are arranged in tabular units and show a range of sedimentary structures, including parallel and low-angle cross-laminations.

The Durisdeer Formation grades upwards into the Thornhill Sandstone Formation (Brookfield, 1978). The latter comprises a basal coarse-grained, laminated, red-green quartz sandstone which grades up into a well-sorted, fine-grained, cross-stratified quartz sandstone arranged in tabular and wedge-shaped cross-stratified sets; beds of coarse- and fine-grained sandstone occut throughout the sequence.

The Locherben Breccia Formation consists of approximately 10 m of reddish, sandy breccia. The sediments are arranged in tabular units between 0.2 and 0.5 m thick, and are generally massive. Some of the beds preserve rare examples of pebble imbrication and cut-and-fill structures. The breccia clasts are from 0.02 to 0.1 m in diameter, and comprise fragments of greywacke, argillite, and purple amygdaloidal basalt. The matrix is composed of subangular to well-rounded quartz grains and some 'millet seed' sand (Brookfield, 1978).

Interpretation

The sandstones and breccias of the Durisdeer Formation represent episodic deposition during a series of sheetflood events, and more longterm deposition in a complex pattern of braided stream channels (Brookfield, 1978, 1980). These sediments are interbedded with very well-sorted and well-rounded sandstones that indicate aeolian processes, and possibly represent the localized development of wind shadow dunes, which may have formed on the lee side of upstanding masses of basalt of the Carron Basalt Formation.

The overlying sediments record a change in sedimentary environment from braided streams to sheetflood events and desert floor ephemeral sheetflood deposits. Aeolian sandstones are interbedded throughout the fluviatile succession, and represent more arid climatic phases. Eventually the pediment was buried by aeolian and fluviatile materials (Brookfield, 1980, 2000).

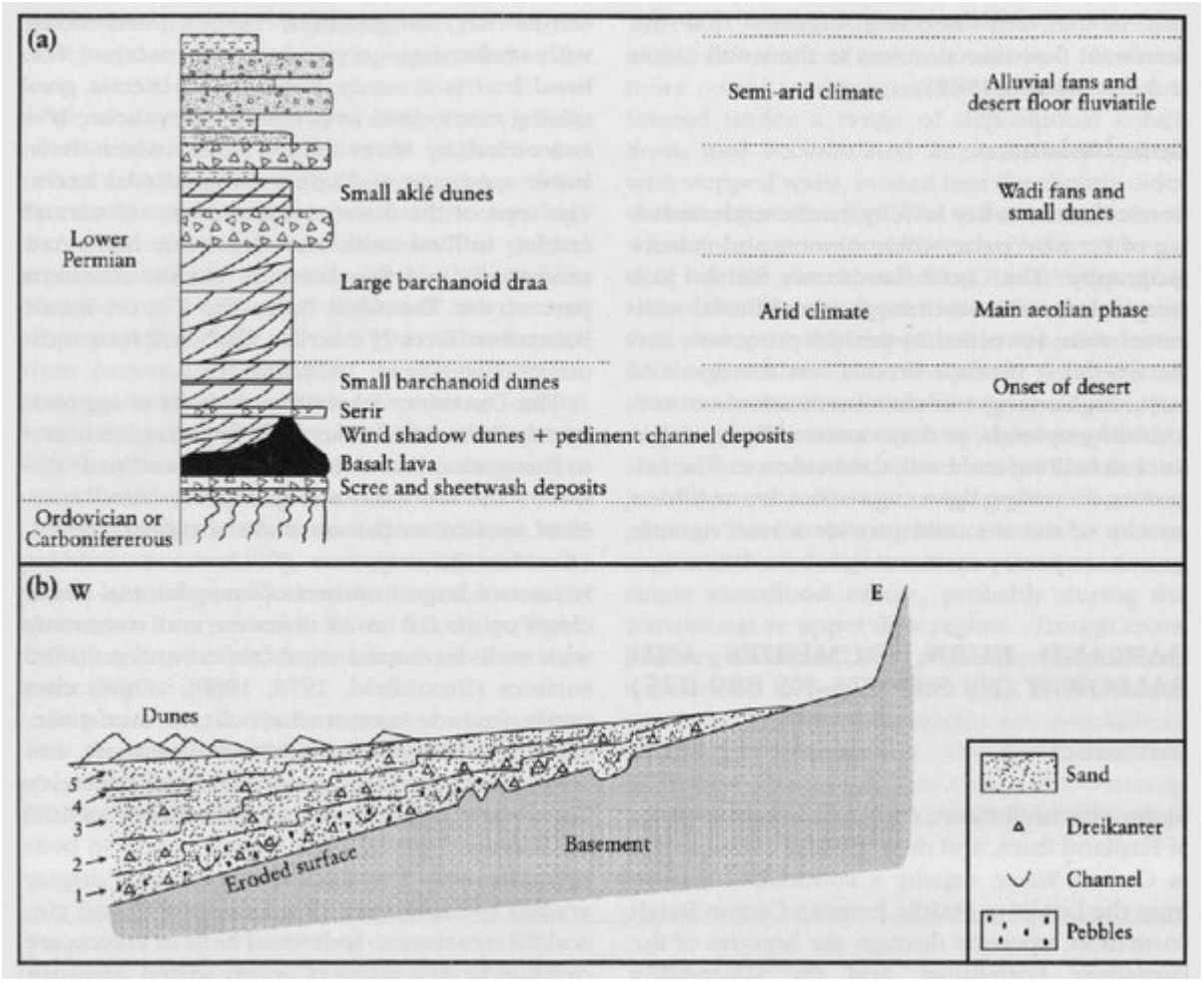
The Thornhill Sandstone Formation, typified by well-sorted, well-rounded coarse- to fine-grained quartz sandstones with tabular and cross-bedded units, represents aeolian dunesedimentation, though it is not clear which type of desert dune forms are represented (Brookfield, 1978).

The Locherben Breccia Formation, comprising reddish, sandy breccias with few sedimentary structures, is thought to represent fluid debris flows and sheetflood deposits that are commonly associated with wadis. The finer-grained deposits from the upper part of this formation were deposited in low-sinuosity braided streams (Brookfield, 1978).

Conclusions

The exposures in the banks of Hapland Burn provide an excellent section across the boundary between the Carron Basalt Formation and the lower Permian Durisdeer Formation breccias. The sedimentary succession preserves details of a complex desert environment, including evidence of pediment breccias with cross-bedded sandstones and silty mudstones indicative of flooding episodes, interdune temporary lakes and overbank flood deposits. Sandstones with aeolian characteristics are interbedded with the breccias and fluvial sediments.

References



(Figure 2.10) Sedimentology of the Hapland Burn locality. (a) Generalized sedimentary log, with palaeoenvironmental interpretations. Either Ordovician or Carboniferous rocks are present beneath the unconformity at different parts of the site. (b) Reconstructed cross-section of the main units through the east side of the Thornhill Basin. In (b), main palaeoenvironments are numbered: 1, braided stream, sandy breccia, and trough cross-beds; 2, sheet flood; 3, ephemeral stream; 4, temporary lake/siltstone; 5, aeolian sand. (After Brookfield 1980, 1984.)