Hilton Beck, Cumbria

[NY 720 206]

Introduction

Hilton Beck contains a number of natural exposures in marginal facies of the lower Permian Penrith Sandstone, with 'brockrams', and the Eden Shales, including the Hilton Plant Beds. The Penrith Sandstone is exposed in vertical cliff faces and comprises a relatively thin sequence of aeolian dune deposits, interbedded with brockrams of alluvial fan origin, which reflect the proximity of this site to the Pennine Boundary Fault. Hilton Beck is important as the type locality of the Hilton Plant Beds, a series of fine-grained sands containing plant remains. This is a key site for studies of Permian palaeogeography, palaeoenvironments, and the contemporary flora.

The Hilton Beck Permian sections have been described by Harkness (1862), Eastwood (1953), Meyer (1965), Burgess and Wadge (1974), Burgess and Holliday (1979), and Arthurton *et al.* (1978), and petrography of the Penrith Sandstone by Waugh (1965, 1970a,b, 1978) and Burgess and Wadge (1974). The plants were described by Stoneley (1956, 1958), and partially revised by Schweitzer (1986), and miospores were documented by Chaloner and Clarke (1961) and Clarke (1965b).

Description

Sedimentology

The lowest sedimentary unit exposed in Hilton Beck comprises breccias (brockrams), which reach a maximum thickness of approximately 150 m. The sediments are commonly dolomitized and contain a range of clast types, dominantly Carboniferous Limestone, though Roman Fell Quartzite is also a significant component and indicates a provenance in the nearby Pennine escarpment area (Waugh, 1970b; Arthurton *et al.,* 1978; Burgess and Holliday, 1979). The breccias are generally arranged in wedge-shaped units.

The overlying Penrith Sandstone has a distinctive red coloration and is a texturally and chemically mature sandstone. Individual grains are well rounded, may have frosted surfaces, and have a thin coating of iron oxide, giving the rock its characteristic colour. Between 90 and 95% of the grains are quartz, and the remainder comprise feldspar and lithic fragments. Accessory minerals, such as zircon, tourmaline, rutile, garnet, magnetite and limonite, also occur. Much of the sandstone is cemented by silica, deposited in optical continuity with the quartz grains; feldspar overgrowths also occur on some of the orthoclase and microcline feldspars (Waugh, 1965, 1970a,b, 1978). The Penrith Sandstone exhibits large-scale cross-bedding in sets of high-angle wedge-planar, tabular-planar, and lenticular trough cross-strata. The angle of dip of the foresets ranges from 20° to 33°. A few ventifacts have been recovered from these strata (Waugh, 1970b).

The uppermost beds of the Penrith Sandstone are best seen in the stream sections of the Hilton Beck, to the north of Ellerholme [NY 715 203], where the transition from the Penrith Sandstone to the overlying Eden Shales is seen. The Penrith Sandstone consists of evenly bedded 'millet seed' sandstones, with thin interbedded breccio-conglomerates that are often associated with erosional channels (Burgess and Wadge, 1974; Burgess and Holliday, 1979). The clasts in the conglomerate are mostly of Carboniferous Limestone and may be hollow; sandstone and siltstone also occur, and may show signs of imbrication. Many of the sandstone clasts originated from rocks exposed to the east, in the nearby Roman Fell.

The Eden Shales are best known from the Hilton borehole (Burgess and Holliday, 1974); exposures are poor. An exposure west of the Hilton Bridge [NY 719 205] shows the Hilton Plant Beds (Figure 2.25)a, which comprise some 30 m of yellowish, thinly bedded dolomitic sandstones, interbedded with grey and black, plant-bearing siltstones, at the base of the Eden Shales. These grey mudstones have yielded an extensive flora and microflora (Stoneley, 1956, 1958; Chaloner

and Clarke, 1961; Clarke, 1965b; Burgess and Holliday, 1979, p. 73; Schweitzer, 1986).

The Hilton Plant Beds are overlain by 50 m of purple or wine-coloured sandy mudstone and shale. Above these is the Belah Dolomite, some 5 m thick, and well exposed in the stream sections. It is succeeded by collapse breccias thought to represent the D-Bed gypsum-anhydrite proved in the Hilton Borehole but dis solved out at outcrop. The overlying strata are poorly exposed but comprise perhaps 40 m of red sandstone with green reduction spots, composed of well-rounded frosted 'millet seed' clasts in a red argillaceous matrix. The top of this sandstone is well cemented with calcium carbonate. The top of the Eden Shales at this locality consists of red, thinly bedded, rippled sandstones and siltstones, which are overlain in places by the lower Triassic St Bees Sandstone Formation (Burgess and Wadge, 1974; Burgess and Holliday, 1979).

The term 'Hilton Plant Beds' has had a variety of meanings. At first it was applied to all of the Eden Shales below the Belah Dolomite (Goodchild, 1893; Stoneley, 1958), or to all of the beds below the 'B dolomite' (Hollingworth, 1942). It is now generally restricted simply to the plant-bearing strata (Meyer, 1965; Burgess and Holliday, 1979).

Palaeontology

Plant remains, including leaves, wood, and cones, are recorded from the grey or yellowish shales and sandstones of the Hilton Plant Beds (Harkness, 1862; Stoneley, 1958; Schweitzer, 1986). Taxa include *Sphenopteris* cf. *bipinnata, 'Strobilites bronni', Lepidopteris martinsi, Pseudovoltzia liebeana, Ullmannia bronni,* and *Ullmannia* cf. *frumentaria.* The microflora recovered from the Hilton Plant Beds resembles assemblages from Zechstein sequences in Nottinghamshire and Germany (Clarke, 1965b), indicating a uniform Europe-wide parent flora.

A few marine fossils, the bivalve *Scbizodus obscurus* and calcispheres (Burgess and Holliday, 1979, p. 69), recovered from the Belah Dolomite at Hilton Beck, confirm equivalence in age to the Seaham Formation of the Teesside Group (EZ3) in the Zechstein sequence in northeast England.

Interpretation

The succession exposed in the Hilton Beck sections illustrates a series of changes in depositional conditions. The Penrith Sandstone was deposited in a large desert area in a contemporaneously subsiding sedimentary basin. The sediments show many features indicative of aeolian processes, for example large-scale cross-bedding and well-rounded grains with frosted surfaces (Waugh, 1970a,b). The associated interbedded brockram facies was deposited by periodic flash floods discharging on to large alluvial fans, on the edges of the sedimentary basin (Figure 2.25)b.

The succeeding Eden Shales represent a change from aeolian desert sedimentation to continental sabkhas, which are also characteris tic of arid climates (Figure 2.25)b. The grey and reddish, thinly bedded sandstones and siltstones, with associated gypsum–anhydrite evaporites, are typical of sabkha regions (Burgess and Wadge, 1974; Arthurton *et al.,* 1978). The Belah Dolomite represents a period of marine incursion, and probably equates with the Seaham Formation (EZ3; Arthurton *et al.,* 1978; Smith *et al.,* 1986). The lower part of the Belah Dolomite was deposited under supratidal conditions, and the upper part represents an intertidal environment (Burgess and Holliday, 1974). This was followed by a return to continental sabkha conditions. 'Millet seed' grains in these sediments were probably reworked from the Penrith Sandstone around the margins of the sabkha plain (Burgess and Wadge, 1974; Arthurton *et al.,* 1978).

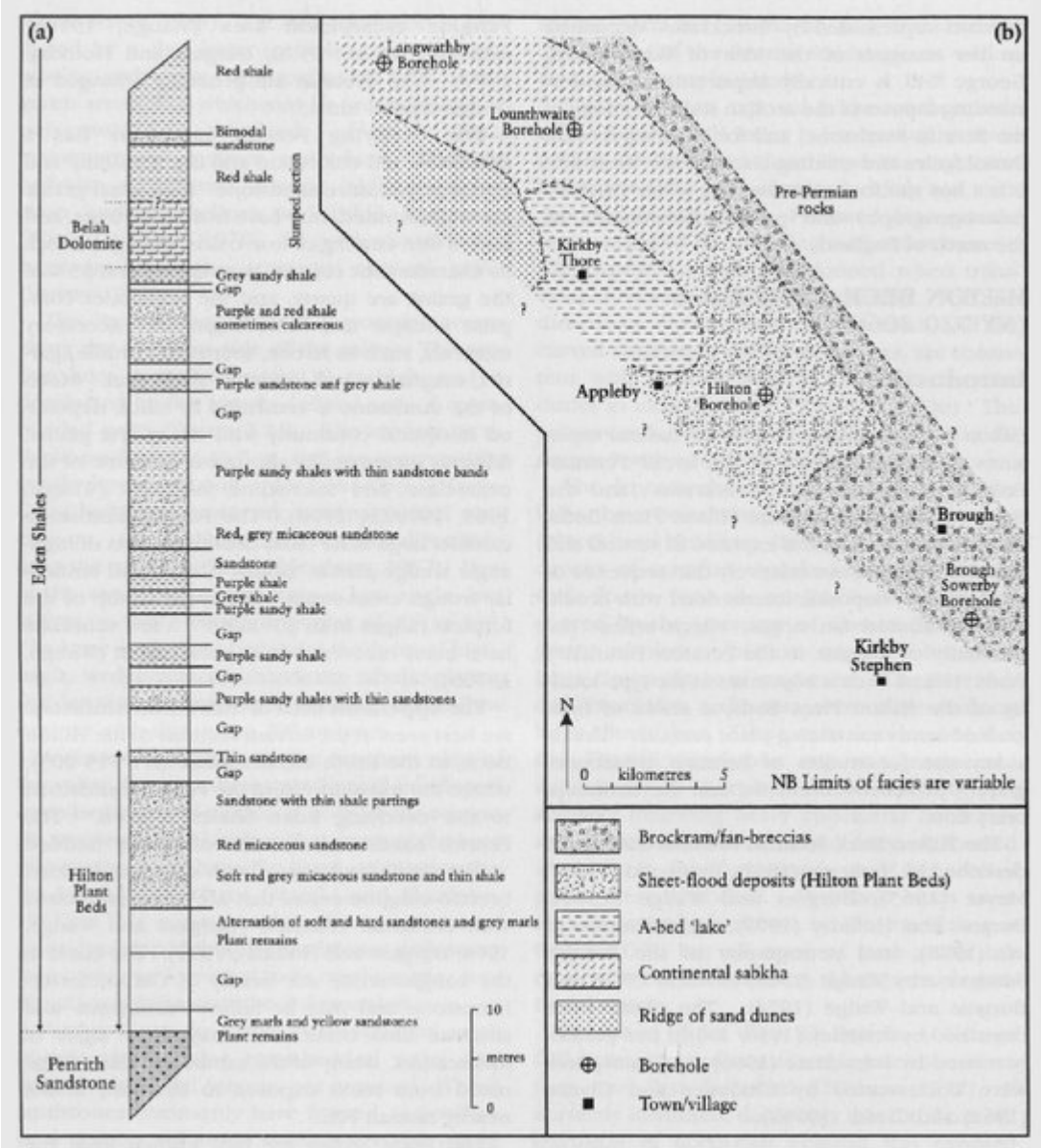
The Eden Shales succession is hard to interpret in natural exposures since the evaporite units dissolve out and leave gaps. A borehole at Hilton Beck [NY 7284 2056] proved the complete sequence, including the anhydrite and gypsum beds (Burgess and Holliday, 1974, 1979).

Conclusions

The exposures along Hilton Beck provide an important source of information concerning Permian palaeogeography and environments. The sediments reflect a change from an aeolian desert, with sandstones and fluvial fan breccio-conglomerates of the Penrith Sandstone, to continental sabkhas, subject to brief marine incursions, represented

by the Eden Shales. The Hilton Plant Beds at this locality provided material for the principal study of British late Permian plants, and for early work on the palynology of the Late Permian Epoch. This site is critically important for documenting the continental and marine successions of the Vale of Eden Basin during the Mid and Late Permian epochs.

References



(Figure 2.25) The geology of the Eden Shales. (a) Sedimentary log taken in Hilton Beck. (b) Palaeogeography of the southern end of the Vale of Eden during deposition of the Hilton Plant Beds. (After Clarke, 1965b, and Burgess and Holliday, 1979.)