Doniford

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Highlights

Doniford displays the finest sections through Quaternary periglacial river and associated mass movement deposits in South-West England. Its sequence of loams, sands and gravels has yielded artefacts and mammal bones, and exhibits well-developed periglacial structures.

Introduction

This site shows Quaternary sediments, including fluvial deposits and head, formed in a periglacial environment. The deposits were first described by Ussher (1908) and mapped by Thomas (1940). Accounts of archaeological and mammalian remains from the site were given by Wedlake (1950) and Wedlake and Wedlake (1963). A detailed stratigraphic interpretation was provided by Gilbertson and Mottershead (1975) and the site has also been referred to by Norman (1975, 1977), Kidson (1977), Mottershead (1977a), Edmonds and Williams (1985) and Campbell *et al.* (in prep.).

Description

Quaternary sediments crop out more or less continuously for 2 km along the north Somerset coast. They are particularly well exposed between Helwell Bay [ST 078 434] and the Swill [ST 091 433], and occupy a valley which runs eastwards from Watchet Station [ST 072 433], through Helwell Bay to the Swill (Figure 7.22). To the east, gravels are exposed continuously on the foreshore as far as grid line 100 and, beyond there, discontinuously (Mottershead, 1977a).

In Helwell Bay, the gravels rest on a platform of Liassic shale and limestone beds (Figure 7.23). In the western part of the bay, the rock surface reaches 10–12 m OD, and the overlying Quaternary deposits are only about 2 m in thickness. This rock platform falls in height eastwards to *c.* 5 m near the concrete jetties [ST 082 431] and to around 3 m OD at the Swill where the junction between the platform and gravels is obscured by beach and recently tipped materials. Here, the entire cliftline was formerly cut in Quaternary sediments some 5 m in thickness (Gilbertson and Mottershead, 1975). *In situ* Quaternary sediments are also present along the now overgrown western bank of the Swill (Figure 7.24). The Doniford exposures are constantly affected by marine erosion, and several stretches of the coastline have been obscured in recent years by coast protection works. Although the present sections are very different to those decribed by Gilbertson and Mottershead (1975), the same basic sequence can be seen (maximum bed thicknesses in parentheses):

6. Brown loam — generally structureless with occasional pebbles and sometimes thinly bedded (0.6 m)

5. Red clay-silt (red loam) — with marked prismatic fracture and frequent angular pebbles of Liassic material (0.6 m)

4. Buff silty loam (buff loam) — with less well-defined prismatic structure and with layers and lenses containing angular stones (0.6 m)

3. Red sandy silt — thinly laminated with fine gravel throughout (0.3 m)

2. Cobbly gravels — partially rounded to angular cobbles and boulders, often split, in a matrix of platy pebbles and fine silt; generally poorly bedded and sorted (2.9 m)

1. Rock platform (Lias)

Although the stratigraphy is complex, several more or less continuous beds can be traced along the coast, the cobbly gravels (bed 2) being the most distinctive and extensive. While they usually show little bedding, some stones lie with their

long-axes in the horizontal plane (Gilbertson and Mottershead, 1975). In addition, lenses of well-sorted, cross-stratified sand and gravel occur in the otherwise massive beds; near the Swill, particularly in the river sections, channels up to 8 m across contain cross-stratified deposits (Gilbertson and Mottershead, 1975; (Figure 7.24)).

These coarse gravels (2–60 mm), with common cobbles (60–200 mm) and occasionally boulders (> 200 mm), comprise mainly purple and green slates, sandstones and cherts derived from Devonian strata in north-west Somerset (Gilbertson and Mottershead, 1975). Blocks of Lias clay have also been recorded from bed 2 (one measuring 2 m x 0.3 m). Most clasts are subangular to sub-rounded, although fresh fractures on otherwise rounded cobbles suggest post-depositional breakage. Clast long-axis measurements show a dominant orientation in the range between *c.* 320–360°, but there is no clear-cut pattern of clast orientation in relation to the directions of local slopes, and clast dip values appear random (Gilbertson and Mottershead, 1975). Many clasts, however, give the impression of lying with their long-axes vertical, and the lower *c.* 2 m of the bed is sometimes affected by involutions. At the west end of Helwell Bay, large involutions (1–2 m in wavelength and amplitude) affect the surface of the Lias platform and the cobbly gravels above, and also disturb the overlying loams (Gilbertson and Mottershead, 1975). At one locality, a 'raft' of Lias clay has been suspended in a large involution.

The cobbly gravels (bed 2) have yielded the remains of tusks and molars of *M. primigenius* (woolly mammoth) (Wedlake, 1950). Over the last 60 years or so, this bed has also yielded a substantial number of Palaeolithic artefacts, collected mainly between high and low water marks from the surface of the gravels exposed to the east of the Swill (Wedlake, 1950). These include over 20 hand-axes of Acheulian Culture made mostly from Greensand chert, and some large flakes. All the implements are heavily rolled. More recently, Norman (1975, 1977) discovered flint artefacts in *situ* in gravel (bed 2) exposed in cliff sections near the Swill. The largest was an incomplete blade (10.5 cm in length) found in a lens of fine, well-sorted gravel. The smallest was another segment of a large blade found at the junction of the same lens with the more poorly sorted overlying gravels.

The succeeding beds (3–6) comprise sandy silt and loam and can be distinguished by colour, structure and stone content. These beds are discontinuous but are best seen to the west of the old lime kiln [ST 087 431]. The red sandy silts (bed 3) are often thinly laminated, and contain fine gravel throughout, including many strongly weathered clasts of Jurassic sediment (Gilbertson and Mottershead, 1975). The overlying buff silty loam (bed 4) is highly calcareous (nearly 32% calcium carbonate) and contains scattered lenses and seams of angular chips and fragments of Lias limestone. The deposit has a prismatic structure, although not so pronounced as the succeeding red loam (bed 5). The latter contains up to 27% clay in a matrix which supports sand and gravel, apparently derived from Devonian strata, and which itself appears to have been derived from more local Triassic rocks. Clasts in this bed show a marked preferred orientation downslope; mean values change progressively as the beds are traced around the variable local slopes. The orientation values are stronger in this bed than in the cobbly gravels (bed 2) (Gilbertson and Mottershead, 1975).

Finally, a brown loam (bed 6) lies with marked unconformity on the lower deposits. It incorporates fragments of weathered local limestones, and has yielded profuse Mesolithic artefacts. These include microliths, scrapers, burins and a crude tranchet axe (Wedlake, 1950; Norman, 1975, 1977).

Beds 3–6 are frequently affected by involutions and, in several places, the loams are let down into the cobbly gravels (bed 2) in pipes and V-shaped wedges; dislocated boulders and gravel clasts sometimes occur within these pipes ((Figure 7.22); Gilbertson and Mottershead, 1975).

Interpretation

Although mapped, described and interpreted by Thomas (1940) as river gravels, the Quaternary deposits at Doniford were first studied in detail by Gilbertson and Mottershead (1975); a précis of this work was given by Mottershead (1977a) with an accompanying account of the archaeological finds by Norman (1977).

Since far-travelled erratics found in northern Somerset have been used as evidence for ice sheets moving eastwards up the Bristol Channel, and penetrating well inland near Weston-super-Mare (Hawkins and Kellaway, 1971), Gilbertson and Mottershead (1975) reinvestigated the Doniford sections to ascertain if glacier ice had played any part in their formation.

They found that no clasts in either the gravel (bed 2) or overlying loams (beds 3–6) were foreign to the area. Apart from local Jurassic and Triassic rocks, only those of Devonian age were found, even these implying a not too distant source. A glacial origin was therefore ruled out for any part of the sequence, and analyses of the sediments and structures indicated that the beds were most likely periglacial in origin, consisting of a series of alluvial gravel, head and slopewash sediments (Gilbertson and Mottershead, 1975; Mottershead, 1977a).

Gilbertson and Mottershead (1975) argued that the gravels occupied a valley running from the west beyond Watchet Station, through the Memorial Ground and Helwell Bay and then parallel with the Doniford coast to the Swill. The gravels are believed to occupy an ancestral valley of the Washford River which once had a confluence in the area of the present Swill, this valley system having now been dismembered by marine erosion causing the Washford River to flow directly into the sea at Watchet (cf. Mottershead, 1967). The gravels of the former river system are therefore exposed in cross-section at the west end of Helwell Bay and in the Swill river sections, and in long-profile along the Doniford coast as far as the Swill (Gilbertson and Mottershead, 1975; Mottershead, 1977a).

The cobbly gravels, however, cannot simply be regarded as fluviatile sediments since they also display characteristics of periglacial mass movement. Fluvial characteristics are clearly shown by the degree of bedding, including cross-stratification and sorting in parts of the bed. The gravel clasts are also significantly more rounded than typical periglacial head deposits in the region (Mottershead, 1976). Similarly, their non-local (but not distant) provenance also mitigates against an origin solely as periglacial head. Alternatively, Gilbertson and Mottershead suggested that parts of the gravel bed showed little evidence for sorting, having undergone mixing and reworking in a periglacial environment. In places, clast orientation measurements showed a preferred orientation downslope, indicating possible mass movement of gravels from higher ground located to the south of the sections. The evidence for fluvial activity is strongest near the Swill, where well-sorted, cross-stratified sands pick out channels presumably cut and filled by surface streams. In this area, deposition was effected by streams trending generally north, perhaps running off local hillslopes, but primarily by a forerunner of the present Doniford stream (Gilbertson and Mottershead, 1975). The presence of Lias 'rafts' incorporated into the overlying gravels, the intimate contortion of the Lias platform with the gravels, cryoturbation and vertical stone structures found at all levels elsewhere in the beds and the presence of many cracked clasts (Mottershead, 1977a) were taken to show that periglacial conditions had predominated throughout the accumulation of the sequence.

Gilbertson and Mottershead (1975) noted that loams (beds 3–6) which overlie the gravels, although differing in composition and structure, are also poorly sorted and show a consistent downslope orientation of clasts, characteristic of solifluction deposits. These sediments form an 'apron' sloping off adjacent hillsides, the red loam (bed 5) probably having been derived by erosion and subsequent redeposition of adjacent red Triassic rocks, and the buff loam (bed 4) consisting largely of redeposited (highly calcareous) Lias clays and Jurassic and Rhaetic limestone fragments. Thin bedding in some of these sediments suggests local deposition by slopewash, probably in a sparsely vegetated, periglacial environment.

Dating of the beds is more problematical. The capping brown loam (bed 6), interpreted as hill-wash sediment (Gilbertson and Mottershead, 1975), is the stratum from which the Mesolithic artefacts were recovered. Norman (1975, 1977) has argued that these artefacts are probably divisible on typological grounds, and may represent both earlier (*c.* 10 000–8500 BP) and later (*c.* 8500–6000 BP) Mesolithic industries in the area. There is every likelihood, therefore, that the brown loam, upon which the modern soil has developed, is Holocene in age.

The artefacts and mammalian remains from the cobbly gravels (bed 2), however, only give a vague maximum age for these deposits. Lower Palaeolithic material of Acheulian Culture has traditionally been regarded as of Hoxnian and early Wolstonian' (Saalian) age. (Recent evidence from Waverley Wood, Warwickshire, shows that the Acheulian Culture extends back to pre-Anglian times (Shotton *et al.,* 1993).) The highly abraded and rolled condition of the artefacts shows that they are derived and renders them of limited use for dating the gravels, which must simply be 'no older'. Similarly, woolly mammoth remains elsewhere are first recorded in deposits assigned to the Wolstonian Stage (*sensu* West, 1968). The species was also present in the latest Ipswichian and became more common in the Devensian (West, 1968). It is impossible, in the absence of reliable absolute dates, to assign the remains at Doniford with certainty to any of these stages. There are, however, other indirect clues as to the age of the sediments (beds 2–5). If the upper loam (bed 6) is ascribed to the Holocene, as seems likely, and the underlying sediments are accepted as representing a cold

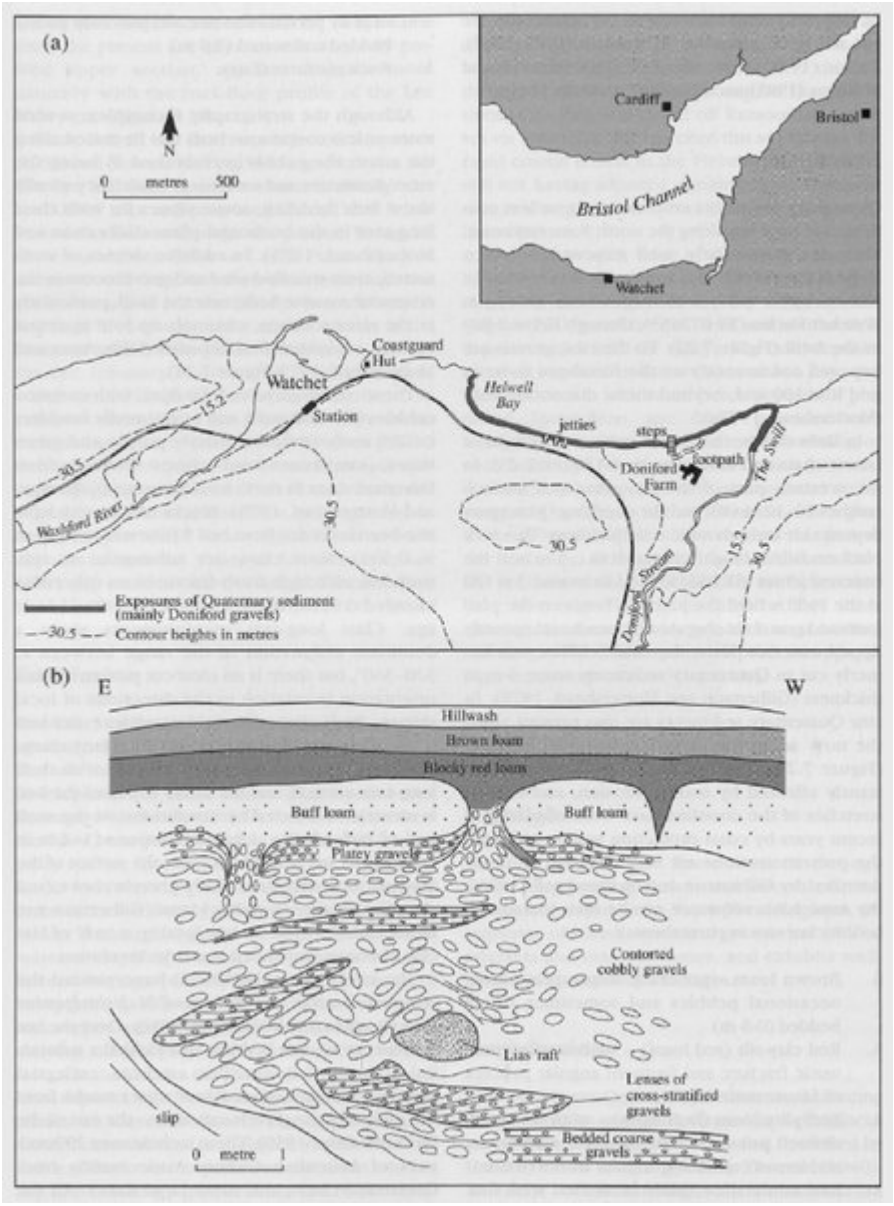
environment, then a pre-Devensian age (?Saalian) would mean that considerable breaks in sedimentation occur in the sequence. The sedimentological data show no evidence for such a protracted hiatus (Gilbertson and Mottershead, 1975). Under such circumstances, it is most likely that beds 2–5 (the gravels and most of the loam sequence) at Doniford were formed during cold conditions in the Devensian when sea levels were lower (Gilbertson and Mottershead, 1975; Mottershead, 1977a).

Conclusion

The Doniford sections show a classic example of deposits and structures formed by fluvial and mass movement processes in a periglacial environment, probably during the Devensian. The sediments lie along the former course of the Washford River and consist largely of reworked river gravels including Devonian material probably brought from the Brendon Hills by an ancient Washford river (Gilbertson and Mottershead, 1975). The sediments, now exposed by marine erosion, show a complex interaction between fluvial, mass movement and freeze-thaw processes. There is clear evidence that much of the sediment has been subject to solifluction, although the lenses and channel-fills of better-sorted sediment, particularly near the Swill, demonstrate reworking of deposits by small, temporary streams running over the aggrading sediment surface (Gilbertson and Mottershead, 1975). As such, Doniford is an excellent fossil analogue of modern periglacial environments, where spring meltwater release plays an important role in reworking deposits of previous seasons (e.g. McCann *et al.,* 1972). The sediments at Doniford also confirm that glacier ice did not reach the north Somerset coast during the Devensian.

Finally, the site is notable for the discoveries of mammal remains and artefacts. The remains of *M. primigenius* (woolly mammoth) are an important palaeontological record, but are of little use for dating the sequence. Similarly, the Lower Palaeolithic artefacts recovered provide important evidence for the Acheulian Culture in this part of Somerset. They too, however, provide little additional evidence regarding the age of the sediments. The later Palaeolithic artefacts, however, raise the interesting possibility of human activity in the Doniford Valley in latest Devensian times. Discoveries of Mesolithic artefacts in the sections at Doniford are significant, showing two distinct typological assemblages and fixing a Holocene age for the uppermost bed of the sequence.

References



(Figure 7.22) (a) The location of the Doniford gravels. (b) Typical section through the Doniford gravels west of the footpath. (Adapted from Gilbertson and Mottershead, 1975.)

(Figure 7.23) The Doniford gravels overlying Liassic bedrock at the eastern end of Helwell Bay. (Photo: S. Campbell.)

(Figure 7.24) Quaternary deposits (mainly fluvial cobbly gravels; bed 2) exposed on the western bank of the Swill in 1980. (Photo: S. Campbell.)