Banc-y-Warren

Highlights

Complex fluvioglacial sediments here have afforded evidence of sedimentation during ice wastage at the end of the Devensian. A complex pattern of stream, lake and delta deposition, and collapse above melting entrapped ice has emerged.

Introduction

Banc-y-Warren [SN 204 475] is an important site in south-west Wales that has attracted interest for over sixty years. The site is geomorphologically striking, consisting of a group of steep-sided conical hills made up of sands and gravels that rise some 50m above the northern flank of the lower Teifi Valley. Banc-y-Warren is the most prominent of these hills. Both the origin and dating of the deposits have proved controversial. The Pleistocene deposits were first studied by Jehu (1904), and the sediments and their included fauna were described in some detail by Williams (1927). The site was mentioned by Charlesworth (1929), Wirtz (1953), Mitchell (1960, 1962, 1972), Synge (1963) and Jones (1965), and, in the late 1960s, much interest was stimulated by radiocarbon dates from the sediments (John 1967, 1968c, 1970a; Brown et *al.* 1967; Shotton 1967; Boulton 1968; John and Ellis-Gruffydd 1970). More recently, the site has been referred to by John (1969, 1973), Unwin (1969), Bowen (1971b, 1973a, 1974, 1977b) and Bowen and Lear (1982). Detailed accounts of the stratigraphy and sedimentology of the site were provided by Helm and Roberts (1975) and Allen (1982), and the available dating and sedimentological evidence from the site was reviewed by Worsley (1984). Amino acid ratios have been given by Bowen (1984).

Description

Glacigenic sands and gravels can be examined in pits at Cnwc-y-Seison and Cil-maenllwyd, and these constitute the Banc-y-Warren exposures referred to by early workers. The sediments form a continuous sheet that extends from Alma Grange [SN 210 460] through Banc-y-Warren to Aberporth (Helm and Roberts 1975). In detail, the succession varies laterally but may be generalised as one of fine current-bedded sands overlain by coarser sands and gravels exhibiting cross-bedding and slump structures. These in turn are overlain by very coarse, poorly stratified gravels. The gravels contain erratics from both Welsh and Irish Sea sources including Cambrian sandstones, Old Red Sandstone, flint, Chalk and a variety of igneous rock types. The finer grained, yellow sands yield whole marine shells and shell fragments, scattered nodules and layers of organic debris (Unwin 1969), and pollen and wood fragments (John 1969). The sediments exhibit complex patterns of small-scale faulting and the whole sand and gravel sequence is thought to overlie till (Williams 1927; Jones 1965). Fossil ice-wedge casts up to lm deep were noted in the sands at Banc-y-Warren by John (1973). Williams (1927) mapped the extent of the sands and gravels. He also provided a general account of the sedimentology, noting the presence of cross-stratification, the water-worn appearance of the gravel clasts which included a mixture of Irish Sea and Welsh rock types, faunal details of the comminuted shallow marine molluscs and the presence of numerous small faults.

Interpretation

Although the deposits at Banc-y-Warren were mentioned by Jehu (1904), Williams (1927) made the first thorough description and interpretation of the succession as part of his synthesis of Pleistocene stratigraphy in western Cardiganshire. He classified the beds as part of the Intermediate Sands and Gravels division of his tripartite sequence. He concluded that the beds were deposited as fluvioglacial outwash from the margin of the Irish Sea ice-sheet, and interpreted the mounds as kames. The faults were believed to have been caused by the melting of buried ice masses (Williams 1927).

Shortly after, Charlesworth (1929) in his classic paper *The South Wales end-moraine,* briefly referred to the deposits at Banc-y-Warren. These he interpreted, largely on the basis of their external form, as end-moraines of the 'Newer Drift' ice-sheet, and constructed his 'Newer Drift' limit around them accordingly. Wirtz (1953) noted the fresh appearance of the beds at Banc-y-Warren, and also interpreted them as marking part of the 'Newer Drift' ice limit, although he envisaged that only a small tongue of the Irish Sea ice had impinged upon north Preseli and south Ceredigion in the area of the lower Teifi Valley.

The deposits at Banc-y-Warren were also noted by Mitchell (1960, 1962, 1972) who, unlike Charlesworth (1929), regarded the deposits as fluvioglacial outwash from a retreating Irish Sea ice-sheet of Gipping age.

Jones (1965) considered that the deposits had been laid down in a lake. He noted that the deposits were flat-topped, that they ended in steep southwest facing slopes and that the sequence coarsened upwards from fine sands to gravels. He interpreted the deposits as having been formed in a delta built into a deep proglacial Lake Teifi which, at that time, stood at the level of the postulated Llantood (Llantwyd) overflow. In the discussion following Jones' paper, however, Bowen argued that the supposed overflow channels were in fact subglacial in origin.

Banc-y-Warren attracted much attention in the late 1960s when radiocarbon determinations were attempted. Three radiocarbon assays were undertaken on organic material from the sands: and these gave dates of 31,800 +1,400 -1,200 BP (I2559) (Brown *et al.* 1967); 33,750 +2,500, -1,900 BP (I-2564) (John 1967); and > 39,900 BP (1–2802) (John and Ellis-Gruffydd 1970). The radiocarbon determinations were used to support John's (1965b) and Bowen's (1966) earlier concept of an extensive Devensian glaciation in the Irish Sea Basin and Preseli. John (1967) suggested that pollen and radiocarbon evidence from Banc-y-Warren indicated a period of forest growth probably during a Middle Devensian interstadial, and that these organic remains had been incorporated into the kamiform deposits by fluvioglacial processes during the Late Devensian. However, he noted the occurrence of reworked Carboniferous and Mesozoic spores in the pollen assemblage, together with pieces of Tertiary lignite, acknowledging that the remains had most likely been reworked from a variety of older deposits. Indeed, strong reactions to the validity of the radiocarbon dates were forthcoming (Shotton 1967; Boulton 1968), but whereas certain difficulties in interpreting the organic remains and dates were acknowledged, the original interpretation was maintained by John (1968c, 1969, 1970a) and John and Ellis-Gruffydd (1970).

Subsequent reviews (for example, Unwin 1969; Bowen 1971b, 1973a, 1974, 1977b; Bowen and Lear 1982) have noted the equivocal nature of the faunal and radiocarbon dated evidence from the site. A Late Devensian age for the deposits, however, was still favoured by Bowen and Bowen and Lear on stratigraphical grounds. Recent amino acid ratios from fossil marine molluscs at Banc-y-Warren are consistent with the succession being of Late Devensian age (Bowen 1984), and show that the derived shell content of the deposits ranges in age from Early Pleistocene to Devensian; a discovery which invalidates all previous radiocarbon dates on bulk shell samples.

Helm and Roberts' (1975) detailed sedimentological account of the exposures interpreted the deposits as a complex of three large lake deltas formed in variable but substantial water depths, with thick cross-bedded gravels representing the foresets, and the sands the bottomset beds. Gravel channel fillings amongst the sand bottomsets were considered to have been cut and filled by turbidity currents which originated as slumps from the foresets. They discounted Williams' (1927) suggestion that faulting in the sequence had occurred from the melting of included ice masses, and, instead, they interpreted the faults as having been formed as a result of slope instability. Concurring with Jones (1965), Helm and Roberts associated one of their deltas with the Llantood (Llantwyd) overflow channel.

In a sedimentological study, Allen (1982) concluded from the lenticular gravels and the fault system at Banc-y-Warren that the deposits had accumulated as a fluvioglacial outwash spread on top of a downwasting ice-lobe in the Teifi Valley. He accepted the possible deltaic nature of the large gravel foresets but considered that they had probably been deposited in a restricted waterbody unrelated to a 'proglacial Lake Teifi'. He believed that extensive faulting of the sediments had occurred due to the downwasting of a single extensive prismatic wedge of ice beneath the entire sedimentary suite. Perhaps the most conclusive evidence in favour of a subaerial outwash origin for the sediments was the unlithified sand clasts described in some detail by Allen. Worsley (1984) considered that despite the enigmatic nature of much of the sedimentological data, it was difficult to resist the conclusion that these 'clasts' must have been frozen

immediately prior to deposition, and that this evidence, in conjunction with the highly irregular form of the channel margins, suggested at least seasonal freezing of the aggrading sedimentary surface. He concluded that such a mechanism could not be reconciled with a deep water environment (Jones 1965; Helm and Roberts 1975).

A deltaic origin for part of the sequence at Banc-y-Warren seems possible, but the surviving evidence tends to support an origin as subaerial outwash for the bulk of the sequence. The site is also important for the developing Late Pleistocene chronology of south-west Wales, and is one of only very few sites where both radiocarbon and amino acid time-scales are available. Although the radiocarbon dates are misleading, amino acid ratios from the site provide strong evidence to suggest a Late Devensian age for the sequence. Banc-y-Warren forms part of an integral network of stratigraphic sites in south-west Wales that reveal major environmental variations during the Late Pleistocene. Although sequences associated with Late Pleistocene interglacial conditions (for instance, Poppit Sands, West Angle Bay, Porth Clais, Marros Sands), glacial conditions (for instance, Abermawr, Traeth-y-Mwnt, Druidston Haven) and periglacial conditions (for instance, Porth Clais, Marros Sands) are better developed elsewhere in south-west Wales, Banc-y-Warren is arguably the most important reference site for fluvioglacial processes and events in the region. The combination of excellent stratigraphic detail and the morphology of landforms, makes Banc-y-Warren of outstanding geomorphological interest. It is one of very few sites in Wales where detailed sedimentological techniques have been applied to interpret Pleistocene sequences. During the protracted history of investigations at the site, a number of radically different models of sedimentation has been proposed. The most recent evidence indicates that the majority of the succession was deposited as subaerial outwash with a subordinate proportion of the sequence originating as delta front sediments deposited in small, ephemeral water bodies. The site also provides important evidence for the dating of Late Pleistocene events in south-west Wales, particularly for establishing that the last glaciation of northern Preseli and southern Ceredigion occurred in the Late Devensian.

Conclusions

Banc-y-Warren is an outstanding site that has been subjected to the most detailed sedimentological investigations. It is generally agreed that there are elements in the internal composition of its landforms which suggest that some of the deposits were laid down in a lake during the last ice age, about 18,000 years ago.

References