Godrevy

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Highlights

Excellent sections through interglacial marine deposits, blown sand and periglacial head, make Godrevy one of the South-West's most important Pleistocene sites. Part of its raised beach deposit is tentatively ascribed to Oxygen Isotope Stage 7, leaving the possibility that some overlying head deposits and associated periglacial structures were formed during several Pleistocene cold stages.

Introduction

Godrevy has long been regarded as a reference site for raised beach, blown sand and head deposits. The site was mentioned in early studies by De la Beche (1839), Whitley (1866, 1882), Ussher (1879a), Reid and Flett (1907), Rogers (1910) and Davison (1930). It has featured in more recent studies of Pleistocene chronology by Robson (1944), Stephens (1961a, 1966a, 1970a), Everard *et al.* (1964) and Mitchell (1972). The sediments and stratigraphy have also been described by Hosking and Pisarski (1964), James (1975b, 1994, 1995), Hosking and Camm (1980), Sims (1980), Scourse (1985a, 1996a, 1996c), Goode and Taylor (1988) and Morawiecka (1993, 1994). Bowen *et al.* (1985) provided amino-acid ratios from shell in the raised beach deposits.

Description

Continuous sections through Quaternary sediments extend from Magow Rocks [SW 582 423] almost to Godrevy Point [SW 581 430]. The Quaternary sequence rests on a well-developed shore platform cut across Devonian (Mylor) slates (James, 1975b), mainly highly contorted blue (hard) and yellow (soft) slates intersected by quartz veins (Figure 6.9). The platform lies between 4 and 10 m OD (Scourse, 1996c) and in places is as much as 100 m wide. It is notched at a level of *c.* 8 m OD (James, 1975b) and, locally, its surface is fragmented (Stephens, 1966a). The following succession can be generalized from the descriptions given by Stephens (1966a), James (1975b) and Scourse (1985a, 1996c):

5. Soil

4. Silty sand (up to 1.0 m) (Holocene)

3. Head of various facies (up to 5.0 m)

2. Sand, cemented in places, with clay bands — 'sandrock' (up to 3.5 m)

1. Basal pebbles consisting mainly of local rocks, but with greenstone and chalk flints and mixed with sand in places. Occasionally cemented by iron and manganese oxides (up to 2.0 m)

Shore platform

Clay bands are common in the lower part of bed 2, especially at its junction with bed 1. They vary in thickness from 2–5 cm, form an undulating pattern and fill troughs between sand ripples (James, 1975b). In places, thicker and more numerous clay bands occur in the sand, especially below the junction with the overlying head (bed 3), which interdigitates with the non-indurated sand of bed 2 (James, 1975b, 1994). This junction is sometimes marked by a convoluted band of manganese-cemented sand. Where the sand is cemented, as at Godrevy Point, it is usually made up of pale yellow, shelly, medium to coarse sand, more than 60% of which consists of shell. Some of these sediments are characterized by large-scale, planar cross-beds (James, 1975b; Scourse, 1985a, 1996c).

In places, the sand (bed 2) is penetrated by vertical pipes (cf. St Agnes Beacon and Trebetherick Point) with an average diameter of 12.5 cm and a depth of over 1 m. Many of these pipes are now empty but others, filled with brown uncemented sand, have been observed (James, 1975b). These dark sands also form a thin layer on top of the cemented sands and beneath the overlying head. Texturally and petrologically, this sand is identical to that elsewhere in bed 2; it differs only in being decalcified (James, 1975b).

The head (bed 3) consists of a highly variable breccia of slate and quartz fragments and can be subdivided, in places, into a lower festooned bed and an upper less disturbed bed (Stephens, 1966a, 1970a). James (1994), however, notes that nearly all of the clearly observed quartz clasts are vertically aligned, indicating significant post-depositional disturbance to the upper layer. Occasionally, some stratification is present within the head (Scourse, 1985a, 1996c). Stephens (1966a) noted that the raised beach deposits, at one locality, were also underlain by a thin development of head.

Interpretation

Whitley (1882) was one of the first to describe the sections at Godrevy in any detail. He regarded bed 1 as an alluvial deposit, since it was thickest where exposed in the central part of the valley mouth, and claimed that … it becomes obvious that the gravel bed is not a sea beach, but a valley deposit, cut back and exposed by the action of the sea.' (Whitley, 1882; p. 134). Reid and Flett (1907), however, regarded the Godrevy sections as showing raised beach deposits overlain by blown sand and head. Although most subsequent authors (e.g. Robson, 1944; Everard *et* al., 1964; Stephens, 1966a) have accepted this broad classification, significant differences of opinion have arisen regarding the age of the beds.

Stephens (1961a, 1966a, 1970a) used Mitchell's (1960) framework of Pleistocene events in south■west Britain to interpret the sediment succession at Godrevy. He argued that the lowest head deposit (recorded at one locality beneath raised beach deposits) and the frost-shattered surface of the shore platform recorded a periglacial event of unspecific, but broadly 'Early Pleistocene' age. The raised beach deposits (bed 1) were believed to have accumulated on the shore platform (and locally above head deposits) at a time of high relative sea level and during temperate conditions in the Hoxnian Stage. The overlying dune sand (bed 2) was believed to indicate falling sea level and the onset of cold conditions at the beginning of the Wolstonian (Saalian Stage). Stephens (1966a) divided the overlying head (bed 3) into two distinct facies: an upper, relatively undisturbed head; and a lower, thicker, much weathered and cryoturbated head. The lower unit was interpreted as a typical periglacial solifluction deposit which was both deposited and cryoturbated during the Saalian. Temperate conditions in the ensuing Ipswichian Stage were invoked to account for weathering of the bed. The upper part of bed 3 (Stephens' upper head) was assigned to a separate phase of periglacial conditions in the Devensian, while the silty sand of bed 4 (a mixture of blown sand and slope-wash deposits) was thought to have accumulated in Holocene times. This chronology was also adopted by Sims (1980).

James (1975b) provided new evidence for the depositional environment of the sand (bed 2). In places, the sand differs in grain size through the bed, reflecting that the basal layers may be marine, the upper aeolian (James, 1975b): occasional well-rounded pebbles are found at least 1 m above the base of the sand bed. James suggested that the clay bands found towards the base of the bed had been deposited by slow-moving water, the clay having infilled ripples on the surface of the underlying marine sand. This material was believed to have been washed from surrounding slopes prior to the deposition of wind-blown sand. James (1975b) assigned bed 4 to the Holocene but made no age ascriptions for the other beds.

Hosking and Camm (1980) suggested that the iron oxide cementing agent of the Godrevy raised beach conglomerate showed that swampy conditions had prevailed in the adjoining valley prior to the accumulation of solifluction deposits. It is likely that the iron and manganese oxides were leached from the valley bedrock and transported to the sites of oxide deposition, in the raised beach sediments, as organic complexes (Hosking and Camm, 1980).

Bowen *et al.* (1985) presented three amino-acid ratios derived from a single specimen of *Patella vulgata*Linné collected from the raised beach deposits (bed 1) by H.C.L. James. This shell yielded an average ratio of 0.175 ± 0.021, a value similar to those derived from shells in the Inner Beach at Minchin Hole Cave, Gower (Bowen *et al.,* 1985; Bowen *et al.,* 1989; Campbell and Bowen, 1989). Similar results were provided for the Godrevy raised beach deposits by Davies (1985). Such ratios, and others from raised beach deposits elsewhere in southern Britain (e.g. Butterslade and Horton Upper Beach, Gower; Saunton, north Devon; and Fistral Beach, north Cornwall), have been correlated with high relative sea levels in Oxygen Isotope Stage 7 (Bowen *et al.,* 1985) and calibrated by Uranium-series techniques (e.g. Davies, 1983) to around 210 ka BP. These shells are therefore believed to be significantly older than those characteristic of raised beaches ascribed to the Pennard D/L Stage (Ipswichian Stage/Oxygen Isotope Stage 5e) (Bowen *et al.,* 1985; Bowen and Sykes, 1988) (see Portland Bill). James (1995), however, notes that the preparation methods used by Davies (1983, 1985) and earlier workers, produced amino-acid ratios consistently higher (and therefore 'older') than the methods currently in use. He raises the possibility, therefore, that Davies' ratios from Godrevy could be taken to indicate a Stage 5e age for the raised beach deposits, and cites preliminary Infra-red Stimulated Luminescence (IRSL) dates (Richardson, 1994) in support of this Stage 5e ascription (see also Pendower; this chapter).

Scourse (1985a, 1996c) re-examined the Godrevy sections in detail. The excellent development of raised beach deposits and associated dune sands led him to use Godrevy as a regional type-site for such sediments and the deposits were classified as the Godrevy Formation. Scourse used palaeocurrent vectors derived from foreset laminae to show that the sands (bed 2) had been deposited by northwesterly winds. The overlying head (bed 3) was confirmed as a typical periglacial solifluction deposit (assigned to the Penwith Formation; Scourse, 1985a, 1996c).

Morawiecka (1993, 1994) presented details of 'pipe' phenomena developed in the calcareous sandstone (bed 2) at Godrevy. Most of the pipes occur in the upper and middle parts of the 'sandrock' profile, but none extends down to the level of the rock platform. Morawiecka concludes that the pipes developed after the overlying head (bed 3) had been deposited (cf. West, 1973). She raises the possibility that solution of the 'sandrock' occurred, perhaps quasi-catastrophically, under cold conditions close to the Devensian/Holocene transition, thus making this the youngest palaeokarst demonstrated in the UK.

Although the models of Pleistocene chronology applied to sequences in the South-West by Stephens (1966a, 1970a, 1973) and Mitchell (1960, 1972) have been criticized as unnecessarily complex (e.g. Kidson, 1971, 1977; Bowen, 1973b), recent amino-acid measurements show clearly that raised beach deposits of significantly different ages are present around the coast of south-west Britain. As far as the limited amino-acid data from Godrevy can show, the site provides a fine example of a raised beach deposit that has been ascribed to Oxygen Isotope Stage 7 (but see James, 1995). If this dating is confirmed, then the overlying head could have accumulated during several different Pleistocene cold stages, perhaps equivalent to Stages 6, 4 and 2 of the deep-sea record. James (1994, 1995), however, believes that the bulk of raised beach deposits at Godrevy date from Stage 5e, implying that the overlying head is entirely Devensian in age.

The sequence also provides a comprehensive record of Quaternary environments. Whereas the raised beach conglomerate and the head facies show extremes of climatic change in the region (from temperate high sea-level conditions, to cold periglacial environments), the intervening sands probably reflect conditions towards the end of an interglacial and before the establishment of a full periglacial regime. These sediments clearly record a fall in relative sea level and deflation of sand, probably from an exposed sea floor. The clay bands found in the sand bed may show that sheet-washing of sparsely vegetated hillslopes occurred before the onset of more severe (periglacial) conditions when the overlying head(s) accumulated. (Similar sands at Belcroute and Portelet, Jersey, contain palaeosols indicative of temperate Stage 5c- and 5a-type conditions (Keen *et al.,* 1996).)

Importantly, the Pleistocene sediments exposed at Godrevy show no direct evidence for glacial activity in this area. Some reworked erratics found in the raised beach deposit may attest to an earlier glacial event of considerable age, but otherwise the sections demonstrate that the site, and probably its immediate environs, lay in the periglacial zone during a variety of Pleistocene cold stages. The site therefore shows no tangible evidence to corroborate the reconstructed ice-sheet limits proposed by a variety of workers (e.g. Mitchell, 1960, 1972; West, 1968, 1977a; Jones and Keen, 1993).

Conclusion

Godrevy provides one of the most informative Pleistocene sequences in Cornwall. Its raised beach sediments, blown sand and solifluction deposits (head) are referred to in many important texts on the Pleistocene. Fossil shell material in the raised beach deposits here has been dated by amino-acid geochronology; a tentative correlation with Oxygen Isotope Stage 7 (warm) of the oceanic record is suggested. A fall in relative sea level and cooler climatic conditions are recorded by the overlying sand, some of which was blown inland from an exposed sea floor by north-westerly winds. The head deposits at Godrevy record a further deterioration of climate. These deposits are arranged in distinct layers which may have accumulated during different cold, periglacial phases of the Pleistocene — possibly equivalent to one or more of Stages 6, 4 or 2 of the deep-sea record. The site shows that this part of Cornwall was probably not overrun by glaciers. '

References

(Figure 6.9) Coastal exposures near Godrevy Cove, showing shore platform overlain by raised beach cobbles, sand and various head facies. (Photo: S. Campbell.)