

SHORE PLATFORMS AND RAISED BEACH DEPOSITS AT PORTHLEVEN AND THE MOST SOUTHERLY POINT, WEST CORNWALL



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At Porthleven and the Most Southerly Point, there is evidence for two former sea levels at elevations of 8-10 m and 2-4 m O.D. The higher and older shore platform is undercut by caves and gullies associated with the lower platform, which itself is being reduced during the current sea level to form rocky intertidal platforms seawards of the coastal cliffs. The occurrence of two vertically separated former raised beaches at the same locality is unusual in West Cornwall. Typically a single raised beach unit overlies the raised shore platform, cut into slates. The preservation of distinct former high sea levels at the two localities is attributed to the presence of more resistant lithologies and closely spaced seaward striking extensional faults, which once eroded, formed protective niches for former beach sediment. Large boulders comparable in size to the famous Giant's Rock erratic at Porthleven occur on the inner shore platform at the Most Southerly Point. Clearly derived from the Man of War Gneiss outcrops immediately seaward, there is some evidence that this gneissic material was present near the coast during the formation of an older and higher raised beach.

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INTRODUCTION

Coastal shore platforms worldwide are generally acknowledged to be an under-researched geomorphological entity (Trenhaile, 1980; Stephenson, 2000). Recently Trenhaile *et al.* (1999) have highlighted the role of Middle to Late Pleistocene rises in sea level in the development of shore platforms. In West Cornwall coastal platforms have been frequently referred to in Quaternary literature, (e.g. Kidson, 1971; James, 1974; Scourse, 1996; Campbell *et al.*, 1998) but discussion has tended to concentrate on the overlying sedimentary sequence, which typically comprises a single raised beach, head and finally loess, and the age of these units.

The purpose of this paper is to discuss two localities which unusually show evidence (shore platforms, raised beach deposits, former caves, abrasion notches and wave moulded surfaces) of two vertically separated sea levels, and the origin of the rocky intertidal platforms immediately seaward. Such platforms are widely developed in Mount's Bay. Field observations have been supported by a levelling exercise to the Newlyn O.D. The junction between the shore platform and the base of palaeo-cliff abrasion notches and their associated sedimentary fill was measured, using an EDM instrument. Additional heights were taken on the various platforms and contemporary abrasion notches.

PORTHLEVEN

Geomorphological/geological setting

The coastal section discussed lies between Porthleven Harbour and Parc Trammel Cove to the north-west (Figure 1). The section is dominated by the southeast dipping Devonian Mylor Slate Formation with locally more weathering resistant dolerite sills which are particularly well developed in the vicinity of Porthleven Harbour and at Tregear Point and form prominent headlands at these two localities. The cliffs range in height from 25-30 m O.D. Head deposits are poorly developed and comprise slate fragments, clearly derived from the weathered slates in the area. A thin layer of loess overlies the head. The shore platform ranges from 50-150 m in width, and is rock dominated and relatively high, compared to lower lying modern beaches developed east of Porthleven towards Loe Bar and in the northwest towards Parc Trammel Cove. Vestiges of a higher raised platform can still be recognised well above HWM.

Previous work in the area has been confined to the Pargodonnell Rocks area (Figure 2a), a relatively low-lying embayment between Porthleven Harbour and Tregear Point and well known for the occurrence of the Giant's Rock microcline gneiss erratic on the shore platform and the presence of fragmentary raised beach deposits at the back of this platform. Most attention has been focussed on the Giant's Rock and its origin. Most workers accept that it was delivered to its present position by floating ice, sometime between the Early and Middle Pleistocene (Campbell *et al.*, 1998). Flett and Hill (1912, 1946), Stephens (1973, 1980) and Hall (1974) have commented on the fragmentary remains of raised beach sediment at the back of the shore platform. Flett and Hill (1912) noted that they occurred in a gully and a cave, an observation that has been confirmed by, and built upon, in this paper.

Pargodonnell Rocks

The fragmentary remains of iron-cemented raised beach deposits occur plastered on the sides of smoothed abrasion notches (Figure 2b) at elevations of 3-5 m. O.D. The grain size of the raised beach sediments ranges from granules to cobbles up to 45 cm in diameter. Larger sized (1 m or >) free standing rounded to sub-rounded boulders are present immediately seaward of the beach deposits. Whether these have been eroded out of the latter is not clear. The notches associated with the raised beach deposits are developed on the sides, and at the landward ends, of: (a) two prominent gullies, ranging in length from 25-30 m and widening seawards from 4 m to 10 m. The distribution of raised beach deposits in the eastern gully indicates that this widening had occurred prior to their deposition, (b) two sea caves, 15 m long and 3-7 m wide and (c) numerous oval-shaped hollows, with approximately equal width and length, varying from 1.5-8 m. Both the caves and the gullies are aligned along faults. The close proximity of these features over a 200 m long coastal stretch (Figure 1) strongly suggests that they are related in origin and they are interpreted to represent former sea caves in different degrees of preservation.

The present shore platform is lower than the remains of the platform, associated with palaeo-notches and raised beach deposits, and is being actively down cut. This is particularly well illustrated by the occurrence of modern caves undercutting palaeo-caves and contemporary abrasion notches (Figure 2b) and wave moulded surfaces, developed at least 1 m below the

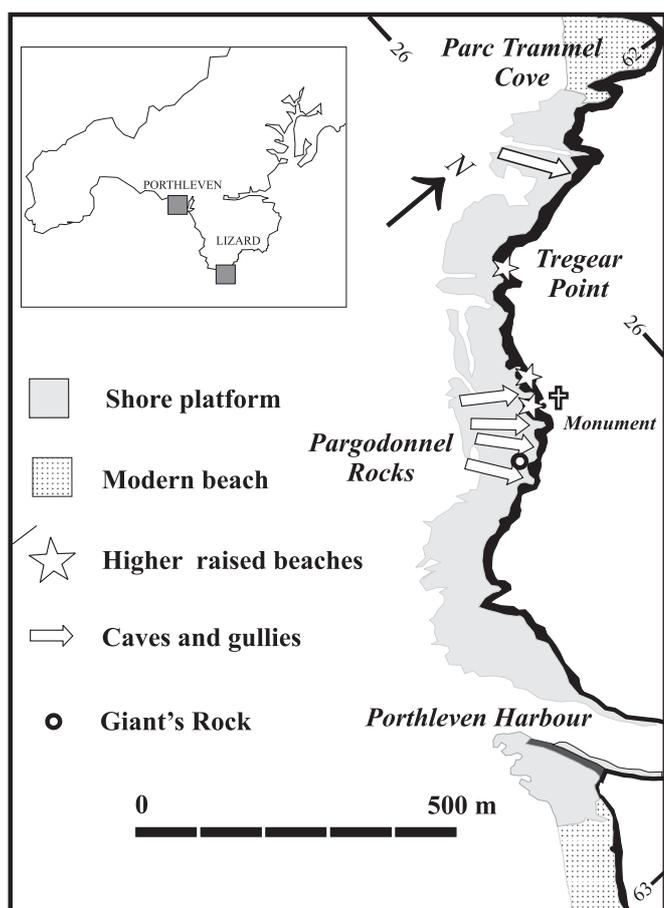


Figure 1. Portbleven location map.

raised beach notches. The Giant's Rock sits in a pool 5 m in diameter and 1 m deeper than the surrounding platform, itself some 3 m below the higher palaeo-abrasion notches in the cliffs behind. Bird (1998) also noted that the current platform is 2-3 m below the raised beaches in this area. Much of the vertical degradation of the intertidal platform appears to have preceded the cart tracks worn into the platform in this area. These are considered by Smith-Grogan (1998) to date from the 16th century. Towards the east, the shore platform rises and is also being deeply (1-2 m) dissected by multiple potholed grooves, running out to sea, as figured by Bird (1998).

Behind the current shore platform and above the outcrops of the raised beaches previously described, there are vestiges of a former higher-level shore platform. This is best exposed adjacent to and west of the Pargodonnal Rocks access steps. This platform, well above HWM, is separated from the lower shore platform by a ramp and/or steeper stepped slope. Freshly exposed joint faces, readily recognisable amongst otherwise honeycombed surfaces, suggest relatively recent wave quarrying as the cause of the steeper slopes. Two small outcrops of raised beach deposits occur on this former platform. One, with manganese-cemented sands and gravels, occurs at the point, where the access steps join the terrace. The presence of rounded cobbles above the eastern gully in this area at the same elevation suggests this deposit may be more extensive, but is now hidden by landslipped debris. The second outcrop comprises iron-cemented coarse-grained sands plastered on the face of the cliff. Significantly, two of the oval-shaped hollows, previously described, occur 3 m below. In the eastern part of the Pargodonnal Rocks area the cliffs behind the shore platform are characterised by steep upper and basal slopes interrupted by a more gently inclined slope (Figure 2a), possibly indicating the former presence of the higher shore platform in this area. The upper parts of the cliffs are extensively weathered and deeply honeycombed, suggesting that they are relatively old features.

Tregear Point northwards

A short coastal section characterised by vertical cliffs and a low shore platform separates the Tregear Point section from Pargodonnal Rocks, indicating the effect of current coastal erosion. At Tregear Point the shore platform rises to 10 m O.D. At the base of the cliffs 20 m east of the access steps, there is a small exposure of raised beach deposits, ranging in grain size from granules to medium size pebbles in a local cliff line re-entrant which passes seaward into a pronounced gully. The presence of a wave-moulded surface some 10 m to the west suggests the former (and greater) extent of these deposits.

The coastal section northwards to Parc Trammel cove is characterised by vertical cliffs, which are fronted by a shore platform, flooded at high water and currently being degraded by extensive potholing and marine erosion along fault zones. At the northern end the platform becomes even more dissected with prominent gullies incising fault zones, which terminate locally in caves at the base of the cliffs. In this area above the present beach and at the same elevation as the upper surface of the shore platform, there is an abandoned cave/gully filled with a 2-3 m thick cobble-rich raised beach deposit. Farther north the cliff line is indented by a series of U and V-shaped coves floored by modern beach sediments.

MOST SOUTHERLY POINT

Geomorphological/geological setting

The Most Southerly Point (MSP) coastal section extends from Bumble Rock in the east to Lizard Point in the west and is ~ 1.5 km long. The shore platform ranges in width from 50 m to more than 500 m off the MSP itself (Figure 3). This extension of the platform is bounded to the west by NE-SW and to the east by NW-SE trending deep (5-10 m) channels which extend landwards to Polpeor and Polbreem coves which are noticeably lower than the adjacent shore platforms. The outer edge of the shore platform is fringed by offshore islands and reefs, which are formed by the crystalline Man of War Gneiss. The shore platform and cliffs landwards comprise mica schists of the Old Lizard Head Series and the Lower Landewednack (hornblende) Schists, which have been thrust over the Man of War Gneiss and have themselves been cut by other thrusts (Jones, 1994, 1997). The Variscan structures have been cut by numerous closely spaced normal faults, which have controlled local indentations of the coastline and the development of sea caves and the pronounced gullies in the area. Head deposits are poorly developed except in a wide shallow truncated valley in the Pistil Ogo area where they are 4 m thick.

Previous knowledge of the Quaternary deposits in the area is confined to the descriptions of Flett and Hill (1912, 1946) who reported a pocket of raised beach deposits 7.6 m above sea level near Bumble Rock, and a gravely raised beach deposit near Lizard Point. Little trace of the latter now exists. Roberts (1985) drew attention to the loessic nature of the head in the area.

Bumble Rock to Polbreem Cove

The cliffs in this sub-section are formed of near horizontally foliated hornblende schists cut by later vertical joints and faults, giving the coastline a characteristic blocky castellated appearance, emphasised by the development of sea stacks, arches, and deep narrow inlets of the coastline, known locally in West Cornwall as *zawns* or more universally as *geos* (Allaby and Allaby, 1999). The small pocket of raised beach deposits, reported by Flett and Hill (1912, 1946) was first brought to their attention by the petrologist Teall, a fact acknowledged by Flett and Hill (1912). It occurs on the north side of a pronounced E-W trending deeply incised geo immediately landward of the Bumble Rock sea stack. On re-examination these deposits (~1 m thick) were found to occur in a 3-4 m wide and at least 4.5 m long hollow (Figure 2c) at right angles to the geo. Both the sides and base show evidence of abrasion. This hollow closely resembles those previously described

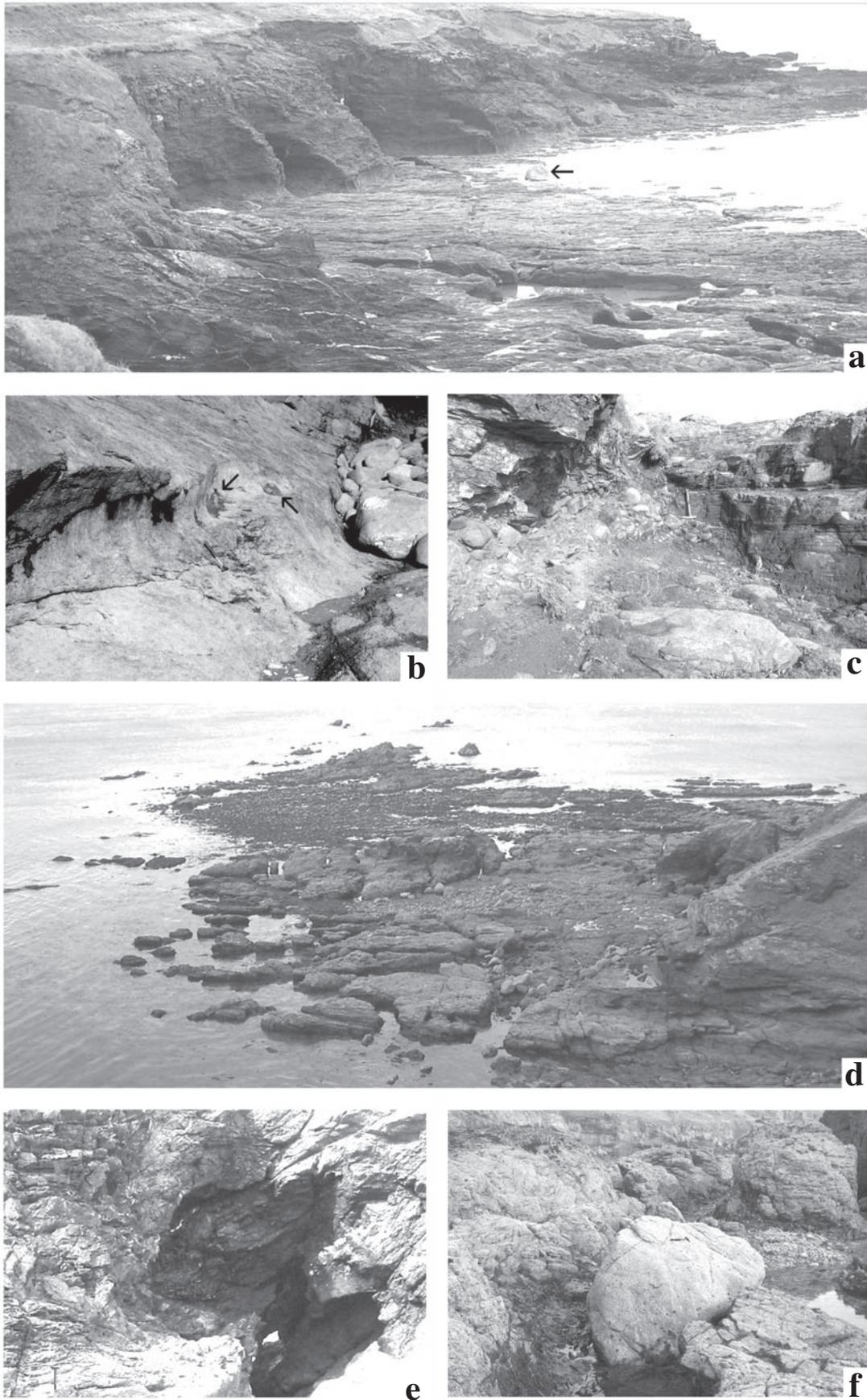


Figure 2. Shore platforms at Portleven and the Most Southerly Point. (a) Pargodonnal Rocks with Giant's Rock erratic (arrow), modern cliff base notch on spur between two former caves and higher older platform in foreground. (b) Former abrasion notch with scraps (arrows) of raised beach sediment cut by modern abrasion notch. The boulders in the background are up to 1 m in size. (c) 'Teall's beach'. (d) Most Southerly Point shore platform, with 2 m boulders visible in middle ground. (e) Abrasion notch lining former cave, now undercut by modern cave. (f) 'Giant' Man of War Gneiss boulder lying in deep gully below HWM.

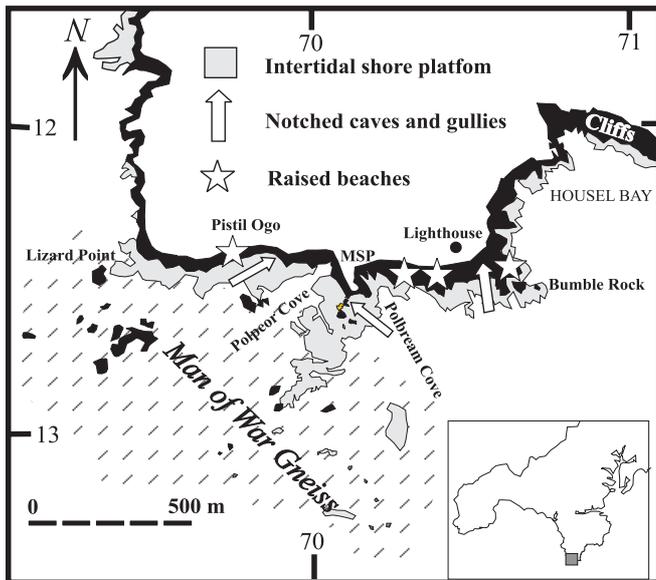


Figure 3. Most Southerly Point location map. The area underlain by the Man of War Gneiss is shown with dashed cross-hatching. Polpeor Island is located at the tip of the middle arrow.

at Pargodonnell Rocks. The sediments comprise rounded locally derived pebbles and cobbles in a sandy matrix and occur at an elevation of 8.5 m O.D.

A search for other raised beach deposits revealed two small exposures in difficult to access eroded fault clefts between Polbrean Cove and the Lighthouse. Significantly these raised beach deposits contain Man of War Gneiss cobbles (up to 25 cm across) set in a pebbly matrix. The eastern exposure was levelled to 9.5 m O.D. In addition a number of geomorphological features (abrasion notches, an abraded gully and an abandoned cave) occur within 100 m of, and at similar elevations to, Teall's discovery. Immediately east of Polbrean Cove, wave moulded surfaces extend intermittently over a distance of 200 m, indicating the existence of a former shore platform in this area. This platform is lower (5–7 m O.D.) and separated by a cliff parallel abrasion notch from the higher raised beach immediately eastwards, possibly indicating the presence of two former high sea level stands.

Most Southerly Point (MSP)

The shore platform in this area is the widest in the whole section under consideration and can be sub-divided into an outer zone, only accessible at lowest spring tides, and an inner more accessible zone immediately south of MSP. This zone is underlain entirely by mica schist and marked by considerable relief. Its western side is topographically highest, with the grass covered Polpeor Island passing seawards onto a platform close to HWM and rising southwards to an islet 4–5 m above HWM (Figure 2d). Abrasion notches (Figure 2e) and caves above HWM, i.e. around 2 m O.D., have been identified in at least 4 different locations around Polpeor Island and in the landward cliff, indicating the existence of a former sea level at this elevation. The platform to the east towards Polbrean Cove is noticeably lower (-0.5 to + 1 m O.D.) and has been excavated into seaward striking near vertical schists. Various trending normal faults have been incised to different depths to form gullies throughout the entire inner platform.

A noteworthy feature of the shore platform immediately below the MSP itself is the presence of large (>2 m) sub-angular Man of War Gneiss boulders, approaching the size and presumably weight (50 tonnes) of the Giant's Rock at Porthleven. Travelling out to the outer reefs and islets indicate numerous Man of War Gneiss boulders, but always of smaller dimensions. The 'giant' boulders always occur in the deeper parts of the inner platform, often in the lee of higher ground and frequently

trapped in gullies (Figure 2f), which are up to 5 m deep below HWM. Their present position and preservation are interpreted to be the result of excavation of fault zones during current sea level and subsequent lowering of the boulders into protected niches. The presence of Man of War Gneiss cobbles in the 8–10 m O.D. raised beach deposits 200 m south-west suggests that gneissic material was already present near the coast at the time of their deposition. This raises the possibility that the widespread Man of War Gneiss boulders on the shore platform may be relict features.

The platform north of Polpeor Island towards Polpeor Cove is even lower (-1.5 to -2 m O.D.) and only slightly higher than the modern beach deposits at Polpeor Cove. It exhibits stacks of the higher +2 m O.D. platform developed to the south and numerous contemporary abrasion notches at the base of these stacks and the cliffs behind it. Small boulders, cobbles and pebbles, are currently abrading the floor of the platform. It is therefore interpreted as a contemporary feature.

Pistil Ogo

The Pistil Ogo section, extending from Polpeor Cove to Lizard Point is characterised by a shore platform, which rises from current sea level to elevations of 8–9 m O.D. The platform is extensively dissected by deep sub-parallel gullies at right angles to each other, exploiting post-Variscan extensional faults. 100 m west of the Pistil Ogo access steps, at the junction of the shore platform with the cliff, is a small exposure of sandy raised beach (< 1 m thick) with rounded igneous (? Man of War Gneiss) cobbles overlain by head. Similar rounded cobbles at the base of the head can be followed eastwards over a distance of 30 m at the same elevation to a horizontal ledge which appears to be part of the former shore platform. Evidence for a lower sea level is confined to former caves, which are currently being undercut and abrasion notches on walls of the gullies, just above the current HWM. The most obvious example occurs immediately below the access path to Pistil Ogo where clear abrasion notches on both sides of a wide NE-SW trending gully can be seen at an elevation of 2.6 m O.D.

DISCUSSION

Flett and Hill (1946) regarded 'Teall's beach' as the oldest and highest raised beach deposit on the Lizard and discussed it in the light of the 20 m raised beach occurrence at Penlee farther west near Newlyn. The latter is currently assigned to Oxygen Isotope (OI) Stage 9 or older (Campbell *et al.*, 1999). However, an 8 m O.D. platform with overlying raised beach deposits is widespread in West Cornwall and occurs at Caerhillian and Gunwalloe Fishing coves (James, 1975, 1995) which lie between Porthleven and the Most Southerly Point. This 8 m level is clearly lower than the Penlee Formation (Campbell *et al.*, 1999) occurrences and is therefore considered to be younger than OI Stage 9 and is correlated with the former Godrevy Formation of Scourse (1996). The raised beaches of this formation are regarded on the basis of amino acid racemisation and thermo-luminescence studies to be of two different ages, OI Stage 5 and 7 (Campbell *et al.*, 1998; Scourse, 1996, 1999). Because the higher platform at Pargodonnell Rocks and Pistil Ogo at the Most Southerly Point is undercut by the caves and gullies associated with the lower platform, it is tentatively ascribed to OI Stage 7 and the lower platform to OI Stage 5.

The two localities investigated form local headlands, indicating that their underlying geology is more resistant to coastal erosion. The better known Quaternary sections, dominated by a single platform and raised beach unit, occur in less resistant slates. A similar situation occurs in South Devon between Bolt Head and Dartmouth. Raised beaches and multiple shore platforms are better preserved on the hornblende and mica-schists between Bolt Head and Start Point area than on the slates of Start Bay to the north (Orme, 1960; Mottershead, 1997).

CONCLUSIONS

The Quaternary sites examined, some 15 km apart, reveal evidence of two former sea levels at 8-10 m and 2-4 m O.D, tentatively attributed respectively to OI stages 7 and 5. This unusual occurrence is attributed to the lack of extensive blanketing head, the resistant nature of the underlying geology and to the fact that the raised beach deposits and other geomorphological evidence occur in protected niches such as caves, gullies and geos, resulting from the erosion of fault zones. There is clear evidence that shore platforms in the two localities have resulted from the successive undercutting of previously formed platforms during an overall falling of Mid-Late Pleistocene sea levels. The lowermost of these former platforms is being reduced and laterally trimmed by current sea level processes to form the intertidal platforms immediately seaward. It is in this situation of progressive step-wise down cutting of the shore platform that large boulders such as the Giant's Rock erratic at Porthleven and comparably sized boulders south of the Most Southerly Point are located. Field observations indicate that their current location is a result of erosion of the platform on which they now rest during the present sea level. In the case of the Man of War Gneiss boulders, there is some evidence that this process of down cutting may have occurred also during the Mid-Late Pleistocene as cobbles of the same formation are found in the high level raised beaches.

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