PRAA SANDS - A REALISTIC APPROACH TO GEOLOGICAL CONSERVATION OF A CORNISH QUATERNARY COASTAL SECTION

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The mile long coastal section at Praa (formerly Prah) Sands is one of the most complete Quaternary sequences in West Cornwall. Subject to severe coastal erosion and beach sand mobility, the quality and extent of exposures continually vary. Approved in 1995 as a Cornwall Regionally Important Geological / Geomorphological Site (RIGS), a long-term monitoring exercise was initiated with the aim of providing a permanent three-dimensional record of the stratigraphical relationships among the various units, including possible multiple raised beaches, a complex head sequence, Holocene peat and coastal dunes.

The results to date suggest that in the westernmost section the raised beach deposits contain at least two distinct stratigraphic beach units, one of which appears on the basis of ESR dating to be the oldest yet recognised in Cornwall. The well known palaeosol, Reid's Palaeolithic Floor, was observed in 1995/96 to be associated with a marked erosion surface, sub-dividing the Praa Sands Clay Member of Scourse (1996) into two lithostratigraphic units, comprising an upper complex soil association and an underlying low-lying basinal deposit. The head farther east is derived from two different sources, clearly expressed in the topography. The overlying Holocene radiocarbon dated peat is underlain by thin hitherto unrecognised and presumably undated deposits. The peat itself thickens in the area of the main stream of the Praa Sands embayment, suggesting the presence of an older Holocene abandoned channel.

The approach of the Cornwall RIGS Volunteer Group to Quaternary sites could be considered by other conservation bodies as an instructive model.

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INTRODUCTION

Large sectors of the Cornish coast are fringed by Quaternary sediments, which are subject to severe (up to 70 m per 100 years) coastal erosion. Whether this erosion is allowed to progress or is prevented by sea defence works, the result is the same — loss of important geological data, relating to the Quaternary Period and the evolution of the Cornish coastline. Already many important sites (Penlee, Perranuthnoe, Gunwalloe Fishing Cove, Coverack, *etc.)* have been partially or totally lost. Unlike the hard Variscan rocks/granites, the soft Quaternary deposits of Cornwall are difficult to conserve. Containing a record of climate and sea-level changes in the relatively recent geological past, their fullest possible documentation, whilst exposures last, is of regional importance.

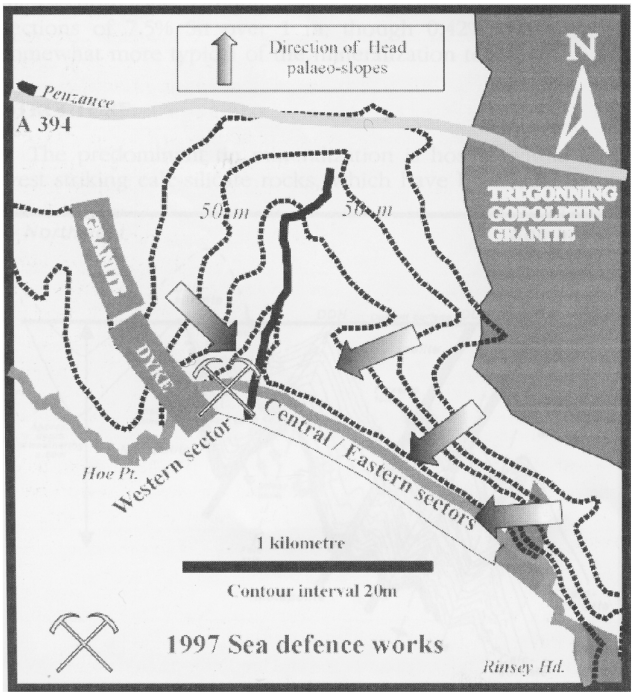

Figure 1: *Geological / Geomorphological setting of Praa Sands Quaternary section.*

The mile long coastal section at Praa (formerly Prah) Sands contains possibly the most complete Quaternary sequence in West Cornwall (Scourse, 1996). The effects of Quaternary sedimentation are clearly reflected in the landscape, making Praa Sands equally important as a geomorphological site. The site was approved in early 1995 as a Cornwall Regionally Important Geological/Geomorphological Site (R1GS), and notified to the appropriate local government planning authorities.

Recognising the importance of the site, the continuous coastal erosion, probability of imminent coastal defence works, and need for up to date documentation, a realistic approach to conservation was adopted by the RIGS Group, involving a long-term monitoring exercise. This was initiated in 1995 with the following objectives:

- Establishment of a continuous and permanent documented three-dimensional record of the stratigraphical relationships among the various depositional units to serve as a research database and to facilitate consultation exercises with local planning authorities.
- Public awareness enhancement of the geological importance of the site.

At this time the most modern account of this coastal sector was that of French (1983). Previous sections had been published by Ussher (1879) and Reid and Reid (1904). The latter was amended by Robson (1944) in the light of the exposures at the time. The locality was not included as an SSSI in the recent GCR review

(Campbell *et al.,* 1998), almost certainly because at the time of the SSSI selection it was not as well documented as at present.

Subsequently Scourse (1996) published a section, based on fieldwork in 1982/3. This section is the most comprehensive in terms of coverage of the entire Praa Sands exposure since that of Ussher (1879). Van Vliet-Lanoë *et al.* (1997) have reported two ESR dates for the raised beach deposits in the westernmost part of the section. Scourse and Kemp (1999) have recently discussed the preliminary results of a pedological analysis of samples from the head section in the same general area.

The RIGS monitoring project was accelerated in the first half of 1997, when Kerrier District Council undertook sea defence works over a 140 m section immediately west of the principal stream in the area.

SETTING

The Praa Sands coastal cliff section is aligned west-north-west - east-south-east (Figure 1). The landward geomorphology comprises a north-south trending embayment, occupied by an underfit stream. The western edge of the embayment is marked by relatively steep valley slopes. To the east of the embayment north-west - south-east trending coastal slopes / palaeo-cliffs dominate. The topography of the embayment is strongly suggestive of a fluvial origin, presumably dating back to the Tertiary, flanked by coastal slopes in the eastern half of Praa Sands Bay.

Much of the Praa Sands embayment is underlain by metamorphosed Devonian Mylor Slate. To the east it is flanked by the Godolphin/Tregonning Granite which comes to the coast at the extreme easternmost part of the Praa Sands section near Rinsey Head. In the westernmost part at Folly Rocks an 18 m wide granite-porphyry dyke (Floyd *et al*., 1993) trends north-west -south-east inland from the shore platform.

To facilitate discussion the cliff section has been divided into three sectors:

- Western sector, known locally as Sydney Cove. This section is the most complete stratigraphically, *i.e.* in the vertical sense and therefore historically has received most geological attention. Paradoxically the lateral continuity is the most difficult to decipher, being obscured by major and minor landslides.
- Central sector, backed by the main dune development and topographically the lowest area.
- Eastern sector, marked by increasing height which rises to a culmination before decreasing slightly and merging with the granite dominated slopes to the east.

RAISED BEACH DEPOSITS

Raised beach deposits have only been observed in the Western sector.

West of the Folly Rocks granite-porphyry dyke massive cobbly raised beach deposits (- 1.20 m thick) rest on a rock platform (4m OD) followed by a 70 cm thick layer of tabular Mylor Slate blocks which in turn is overlain by several metres of clay-dominated head. The raised beach comprises large (metre scale) boulders of Mylor Slate lithology and is remarkable for the paucity of Folly Rocks type granite-porphyry. The matrix is sandy and has been dated by ESR techniques as 302 ka BP (Van-Vliet-Lanoë *et al.,* 1997). The raised platform can be followed eastwards with poorly exposed bouldery deposits, resulting from vegetation overgrowth, until it abruptly ends and is separated from the modern beach by a 1.25 m high vertical face. At the base of this vertical face iron- and manganese-cemented raised beach deposits with large Mylor Slate boulders are observed beneath the toe of the major landslide in the area at a lower elevation than the main raised beach to the west. These lower raised beach deposits have a maximum observed thickness of one metre above the current beach and do not appear to differ significantly in composition from the raised beach deposits to the west. The relationship of this lower unit, hitherto unreported, to the main beach to the west is unclear as yet.

East of the Folly Rocks granite-porphyry dyke between the two major landslides in the area occurs another raised beach section. Here, two lithologically distinct deposits are exposed:

1. A basal, bright orange iron-cemented sand with local granule layers, resting on the Mylor Slate shore platform.
2. An overlying bouldery deposit with large sub-rounded clasts of granite-porphyry, quartz and Mylor Slate. The matrix is muddy.

On the eastern side of the section, the two deposits overlie each other directly (Figure 2). Towards the west the upper bouldery deposit passes laterally into head in the basal part of which can be seen small rounded clasts. More importantly in this western part of the section a 60 cm thick laminated clay with occasional large angular clasts can be seen separating this basal head layer from the underlying iron-cemented sands. This clay appears to wedge out eastwards due to local infill or as a result of erosion prior to or associated with the deposition of the overlying head. The lower iron-cemented sands have been dated by Van Vliet-Lanoë *et al.* (1997) as 340 ka BP. The overlying bouldery bed resembles similar types of deposit exposed in Brittany and is interpreted as a shore ice rafted deposit (Van Vliet-Lanoë: pers. comm.). However it is equally possible and probable that it represents the reworked edge of the head deposits immediately to the west.

During the sea defence construction phase 200 m farther east raised beach deposits were again observed throughout the construction works in this sector, comprising a single bed, 30-60 cm thick, with manganese-cemented coarse sands and granules with occasional granite-porphyry boulders. The shore platform junction with the overlying raised beach was found to be approximately 2.5 m OD throughout this eastern area. Towards the slipway the Mylor Slate basement appeared to rise with concomitant decrease in thickness of the raised beach deposits. The slate basement in this construction area was extremely fissile and easily excavated.

HEAD

Western sector

The head section in this sector is one of the most significant in Cornwall as it was here that Reid and Reid (1904) described the first Quaternary palaeosol in Britain (Scourse, 1996).

The overall head section decreases in thickness from 20 m to 3 m in a west to east direction. This decrease in thickness results principally from the declining elevation of the upper surface of the head. The variation in the height of the underlying raised beach complex is relatively minor. The thickest westernmost section is badly affected by major landslides and vegetational overgrowth. The head in this area is characterised by large blocks of Mylor Slate, quartz and granite-porphyry in a clay matrix.

There is a marked change in character of the head 30 m east of the Folly Rocks granite-porphyry dyke, where the lower section becomes clay-rich. Scourse (1996) recognising the rareness of basal clay-rich intervals in head sections of West Cornwall formalised this unit as an independent member of his Godrevy Formation - the Praa Sands Clay Member. Between 1995 and 1996 in the course of our monitoring exercise it was found as a result of particularly favourable exposure conditions that the Praa Sands Clay Member was clearly divisible into two mappable units (Figure 3), separated by an undulatory surface that appeared to rise toward the west until obscured by the first major landslide. The relief on this surface was measured, using an Electronic Distance Measurer (EDM) and was found to be in the order of a metre. Exposures of this surface, which occurred in the lower parts of the cliffs, have been covered to a great extent since by two subsequent landslides and emplacement of a rock armour toe. For purposes of further discussion the two mappable units are referred to as the Upper and Lower Praa Sands Clay. These two units almost certainly correspond to the two distinct loamy deposits, recognised by Reid and Reid (1904) beneath the main head in this part of the section. These were observed by the Reids to be separated by a 15cm thick black clay, now known as Reid's (Palaeolithic) Floor.

The Lower Praa Sands Clay, greenish/grey in colour, is a bedded sequence with local large blocks of granite porphyry and quartz. Small discontinuous iron-cemented vertical tubes, interpreted by Reid and Reid (1904) and subsequent workers as plant rhizomes, are ubiquitous. In one locality now unfortunately hidden by rock armour metre scale sedimentary bedforms (? cut and fill) were observed. Angular quartz clasts are frequently found in the clay matrix and as gravel lenses. In the course of the excavations for rock armour emplacement this clay unit was found to continue eastwards with decreasing thickness to the slipway where it abutted a gently rising Mylor Slate basement. West of the first major rotational landslide the Lower Praa Sands Clay wedges out relatively rapidly into the main blocky head section in a complex interdigitating relationship.

The Upper Praa Sands Clay unit, comprising a red brown clay with small angular quartz clasts, overlies the undulatory surface below. It appears to wedge out to the east as it was not seen in the area of sea defences. Its westward extension is hidden by landslides. This upper unit was seen to infill the irregular surface on top of Reid's floor and the Lower Praa Sands Clay unit and to have a thickness, ranging from 1.25 - 3.5 m above the level of the irregularities. The infill appeared to result from a combination of drape and bottom-up sedimentation. Flame-like and small jagged erosion structures were also occasionally observed at the contact of the two Praa Sand Clay units, suggesting local brittle, ? when frozen, fragmentation. The contact of the Upper Praa Sands Clay with the overlying more typical head, which contains frequent granite-porphyry, quartz, and Mylor Slate clasts, was observed (Figure 3) to be a relative planar surface dipping downslope (*i.e.* eastwards). Reid and Reid (1904) regarded the Upper Praa Sands Clay, which they termed 'quartzose loam', as a soil deposit. Recent preliminary work by Scourse and Kemp (1999) confirms their interpretation, with which our observed sedimentary draping is also consistent.

The uppermost metre or so of the overlying head in some conditions during the year appears paler. In 1997 as result of temporary storage against the cliffs of material, excavated farther east, it was possible to examine the normally inaccessible upper part of the cliffs. Here the upper section was found to comprise silt, interpreted here on the basis of its field characteristics, as loess. This loess unit, previously unreported in this sector, was not seen beneath the peat farther east in the area of the sea defence works.

Central sector

The toe of the new slipway is founded on Mylor Slate. East of this the basement was found to deepen during the sea-defence construction phase and was not again observed in the rock armour trenches. The head reappears farther eastwards beyond the built-up area where only the upper 1-2 m is exposed beneath the overlying peat and dunes in the eastern half of the sector. It is composed of grey clay with quartz and slate clasts. In this sector obvious loessic components are apparently absent.

Eastern sector

This part of the section has received relatively little detailed attention (French, 1983; Scourse, 1996). However if further sea defences are undertaken, this area with a number of residential properties will probably be the potential site.

The head rises eastward from the Central sector to a maximum of 10-15 m above the beach before descending slightly eastwards. The lower part comprises predominantly platy slate clasts with some angular quartz fragments in a clayey matrix. The clast content and size noticeably increase gradually eastwards, here interpreted as reflecting the increasing proximity of the coastal slope. The gradual nature of the facies change within the head in this sector is to be contrasted with the more abrupt facies change between the head and the Lower Praa Sands Clay in the Western sector. A few tens of metres west of the fallen pill box on the beach, sand beds occur towards the base of the section.

The upper part of the section throughout the sector becomes finer grained and more loessic in character. In places distinct lenses / channels of silty / sandy material occur. In the western part of the sector frost wedges (? polygonal in plan) are associated with the lower head / loessic head transition (French, 1983)

East of the fallen pill box, the slaty head passes relatively rapidly into an increasingly granite fragment dominated head in a more granular matrix, indicating the influence of the eastern granite-dominated slopes.

PEAT

A layer of peat occurs between the head and overlying coastal dunes in the lower lying parts of the Praa Sands coastal section.

The peat is most continuously exposed in the Central Sector, where currently it forms a low platform above HWM. It can be seen dipping westwards. It is to this section that palynological (French, 1983) and radiocarbon dating measurements, ranging from - 1300 - 1900 years BP (French, 1983; Scourse, 1996), refer. The peat wedges out to the west and east. The western margin is now obscured by the 1997 sea defences, although traces of it can be seen just above the slipway immediately west of the Welloe Rock Inn. This part of the section was figured by Scourse (1996). He reported the contact between the head and peat to be gradational with a marked decrease in clasts upwards in the head section beneath. However there is field evidence that there may be a separate clay-rich unit between the head and the peat horizon in this section (personal communication: D. Pirrie). A clay unit in a similar stratigraphic position has been observed recently in the western part of the Central sector.

During the sea defence construction works, attention was focussed on following the peat eastwards from the exposed section to the west, now protected by a regraded slope with a grass matting covering, into the rarely exposed built up area. Here, peat or the former evidence of its existence (rootmarks) in the underlying head was traced eastwards past the Welloe Rock Inn foundations. Between this point and the stream the peat was observed to thicken (3+ m) abruptly where its base was found to be 0.5m OD. During excavation of the rock armour trench immediately west of the newly constructed steps, two large oak logs, one with roots, were recovered. Slices of the logs were cut and sent to Sheffield University for dendrochronological analysis. In November, 1998, this peat deposit was exposed on the beach stretching 15- 20 m seaward of the rock armour toe. A sizeable (40 cm diameter) tree stump was observed *in situ* growth position.

CONCLUSIONS

The method adopted by the Cornwall RIGS Group of continuous monitoring, taking advantage of times when exposure is optimal at individual outcrops, and gradually establishing an overall picture, has shown positive preliminary results. Wherever possible, exposures, often temporary in nature, were photographed.

Field observations suggest the presence of two stratigraphically separated raised beach units in the western section of Praa Sands. It is speculated that the intervening clay unit is an older Lower Praa Sands Clay type deposit. Published ESR dates (Van Vliet-Lanoë *et al*., 1997) suggest that some parts of the Godrevy Formation in this section may contain the oldest (-300 ka BP) raised beach deposits in west Cornwall. Scourse and Kemp (1999), however, have added a *caveat* to these ESR dates, highlighting the lack of supporting technical information accompanying the results.

The well known palaeosol, Reid's (Palaeolithic) Floor, within the Praa Sands Clay Member has been observed to be associated with a marked topographically expressed unconformity, indicating a significant stratigraphic break in the western Praa Sands section, involving erosion and subsequent palaeosol development. Although the underlying Lower Praa Sands Clay exhibits some characteristics of a solifluction deposit (Scourse, 1996), the repid facies change to

FIGURE 2. *Basal iron-cemented raised beach sands, ovelain by boulder-rich bed. The Praa Sands Clay occurs above and is capped by head.*

FIGURE 3. *Head section, showing erosion surface within the Praa Sands Clay Member. The surface is now largely covered by subsequent landslides and rock armour.*

more typical coarse head to the west and the horizontally layered nature of the unit may equally well indicate the presence of a low-lying marsh or swamp environment of deposition, immediately downdip of steep active periglacial slopes. If this interpretation is correct, it implies that there were at least two major pulses of head deposition which prograded increasingly south-eastwards with time into the Praa Sands embayment (Figure 1). The uppermost head unit, overlying the Praa Sands Clay Member, passes upwards into a loess-dominated unit. Loess has been dated elsewhere in West Cornwall as Upper Devensian (Wintle, 1981). The youngest progradation of head at least is therefore regarded as Devensian in age.

The topographic expression and nature of the head between the Western and Eastern / Central sectors differ, clearly reflecting different palaeo-settings (valley slope / drowned valley embayment *versus* coastal slopes). The currently exposed sections in the Central and Eastern sectors appear to correlate with the probable Devensian head sequence above the unconformity in the Western sector.

The Holocene section at Praa Sands is more complex than previously recognised. There appears to be a thin clay interval, observed in both the Western and Central sectors, separating the underlying head from the well-known and radiocarbon-dated peat horizon. The discovery of a major peat-filled channel close to the present stream and presumably the palaeo-drainage axis implies considerable discharge variations during the Holocene which have yet to be investigated. The seaward continuation of this channel is still exposed on the foreshore on occasions.

Clearly the Praa Sands section is an important Quaternary site in terms of needs for ongoing research. In view of the popularity of the Praa Sands beach, the unstable nature of the cliffs and attendant residential concern, it is not surprising that recent unforewarned trenching of the cliff sections by geoscientists has led to altercations (Scourse and Kemp,1999). Liaison with the Cornwall RIGS Group could minimise future such occurrences.

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