DEVON RIGS GROUP

REPORT ON THE ASSESSMENT
OF
COUNTY GEOLOGICAL SITES
IN THE NORTH DEVON AREAS OF OUTSTANDING NATURAL BEAUTY

Phase 1 Area from Hartland to south side of the River Taw

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Phase 1 Area from Hartland to south side of the River Taw

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Prepared by: **Devon RIGS Group** 15th July 2004

For: **Northern Devon Coast and Countryside Service**

CONTENTS

FIGURES

TABLES

PLATES (All in Appendix 1)

Plate 7 The slump bed at Gallant Rock with contorted masses of sandstone in a thick bed of massive silty mudstone.

Plate 8 The Skittering Rock Shale (*Gastrioceras cancellatum* horizon

Plate 9. View of Colpit Quarry showing Embury Shale

Plate 10. View of part of Portledge to Peppercombe section with geological overlay

Plate 11. Purplish red conglomerate form near western end of site

Plate 12. Conglomerate and sandstone from south-western end of section

Plate 13 Permo-Triassic unconformable over Bude Formation at [SS 383 244]

Plate 14. Permo-Triassic unconformable over Bude Formation at [SS 381 243]

Plate 15. Meandering channel incised in tidal flats with Egret for scale

Plate 16. Point bar and meander

Plate 17. Point bar sedimentation showing interlamination of sandy mud and sand with an example at the bottom right of a cross-bedded sandstone from the Carboniferous Mermaid's Pool Sandstone near Mermaid's Pool, Westward Ho!.

Plate 18. Bank collapse and soft sediment deformation. Insets photos annotated in blue are from Carboniferous beds near Seafield House, Westward Ho!

Plate 19. Modern worm burrows. Inset photo annotated in blue from Carboniferous near Mermaid's Pool, Westward Ho!

Plate 20. Mud surface with worm burrows forming pimples on surface

Plate 21. Ripple marked surface on tidal flat Inset photos annotated in blue are from the Carboniferous near Seafield House, Westward Ho!

Plate 22. Worm burrows and tracks on the top surface of the Mermaid's Pool Sandstone

Introduction

The RIGS Initiative in Devon: County Geological Sites

The Regionally Important Geological/Geomorphological Sites (RIGS) Initiative was set up by the Nature Conservancy Council, now English Nature, as part of its Earth Science conservation Strategy. The purpose being to register sites showing valuable geological or geomorphological features on a county-wide basis, in a similar fashion to sites showing other natural and environmental features. An essential concept of the initiative is to promote the educational and research use, as well as the conservation of such sites.

The RIGS Group for Devon was set up in 1991 from among people interested in geological conservation and education, including members from Exeter University, The University of Plymouth, Exeter and Plymouth city museums, and from school staff and interested amateurs. It proceeded to contact other similarly interested people in the county, asking them to submit proposals for sites in their local area which they considered suitable to be nominated as RIGS. This procedure produced an initial list of 120 sites for the county, which were compiled into a computer based list. One such site lies in the present area being described, that of Colpit Quarry (SS 22SE/00). For this survey it is included with an updated description. Other original County Geological Sites are Marsland Mouth to Clovelly and Rowden Gut to Mermaid's Pool (also an SSSI). Three more detailed sites are now designated within the original Marsland Mouth to Clovelly site

For the purpose of registration and promotion of sites identified through the RIGS Initiative in Devon, the term County Geological Site (CGS) has been adopted, as their status parallels that of County Wildlife Sites, which are also being registered for conservation purposes.

County Geological Site Numbers

Site registration numbers used in this report, and on the accompanying registration sheets and maps, are made up from the number of the Ordnance Survey 1: 10,000 quarter-sheet e.g. SX55SW, together with an additional number allocated to each site located within the quarter sheet e.g. SX55SW 1. This system provides a unique number for each site and allows the provision of site numbers for further sites in each quarter-sheet area. The system also gives an immediate approximate site location within five a five kilometre square. If, as occasionally happens, a site lies across the boundary between two quarter sheets, the site is referred to the sheet which contains the larger part of the site.

Access to County Geological Sites

Many of the sites proposed as County Geological sites in the AONB are accessible from cliff paths or are on the foreshore and do not present problems of access. Where sites are on

privately owned land there is no implied right of access and it is the responsibility of persons wishing to visit the site to contact the land owner and abtain permission to visit

Site Sensitivity.

Some indication of the sensitivity of certain sites to damage has been given. There is a need in all cases for adherence to the Country Code and A Code for Geological Field Work (issued by the Geologists' Association) when visiting sites. An arrangement whereby copies of these codes are given to those applying for details of the sites, would assist with the conservation of the sites.

Conservation

Only one site, that of Colpit Quarry, require conservation works. The first is a sporadically worked clay pit in which the sections deteriorate markedly between the short periods of extraction. The operator over the years moves the extraction area and backfills the previously exposed area. They could perhaps be induced to leave an area with exposure and perhaps spend a short time cleaning it up with a digger whenever they visit the pit to extract more clay. In the case of Colpit Quarry degradation of the rock faces is less likely to happen.

Sites of Special Scientific Interest (SSSIs).

The SSSIs in the AONB have been either selected because of their nationally important geological features or for their nature/environmental features but which also have an important geological component. As such sites have statutory protection and regulation, they are therefore not discussed in this report but listed in Table 1.

SSSIs

Locality	Grid Reference	Type of site	GCRs within site
Marsland Mouth to Clovelly	212 175 to 315 254	Botanical and geological with an emphasis on structure. Geomorphology	4 GCR sites, Hartland Quay, Hartland Point, Welcombe Mouth and Blackchurch Rock to Clovelly
Hobby to Peppercombe	320 242 to 383 242	Mainly botanical with mention of Carboniferous	None
Mermaid's Pool to Rowden Gut	403 266	Stratigraphy,sedimentology and structure in Bideford Formation	None
Westward Ho! Cliffs	420 291 to 434 296	Quaternary deposits and Geomorphology	One GCR, Westward Ho!
Fremington Quay Cliffs	517 340 to 512 332	Fossiliferous Devonian to Carboniferous sequence	3 GCRs (Devonian, Dinantian and Quaternary)
Braunton Burrows	430 350	Mainly biological but some geomorphology	None
Brannam's Claypit	530 316	Pleistocene till and sediments (This site now backfilled)	None

GCRs

Locality	Grid Reference	Geolological speciality	Comments
Welcombe Mouth	212 179	Anomalous folding	
Hartland Quay	224 250	Geomorphological (River valleys truncated by cliffs)	
Hartland Point	224 264 to 237 277	Structure (Folding)	No stratigraphy or sedimentology
Clovelly to Mouth Mill	317 251 to 295 265	Structure (Folding)	No stratigraphy, biostratigraphy or sedimentology
Westward Ho! Cobble ridge	440 310	Geomorphology (Cobble spit)	
Fremington Quay Cliffs	517 340	Fossiliferous marine Devonian	
Fremington Quay Cliffs	517 337	Uninterrupted fossiliferous sequence from Devonian to Carboniferous	
Fremington Quay Cliffs (South)	511 331	Quaternary (Raised beaches ?glacial deposits)	

Westward Ho!	422 291 to 434 296	Quaternary (Shore platforms, raised beach and Head)	

Table 1. Geological and geomorphological SSSIs and GCR sites

JNCC has confirmed proposals submitted by English Nature for additional GCR sites to be established in the Clovelly to Marsden Mouth area, for features of importance for Upper Carboniferous stratigraphy and sedimentology. As these sites have not been formally included in the current SSSI notification and it is uncertain when this is likely to happen, RIGS sites are here proposed for key sections of this coast for similar features – although not necessarily in the identical locations to the GCR sites

The present Survey

Northern Devon Coast and Countryside Service asked for a survey to be made of geological and geomorphological sites in the North Devon Areas of Outstanding Natural Beauty additional to those already protected by SSSI status. New and modifications of existing County Geological Sites are here proposed for the southern part of the North Devon AONB and listed in Table 2 below. Their descriptions along with maps and photographs are to be found in Appendix 1

CGS Site No.	Locality	Grid Reference	Geolological speciality
SS 21NW/1	Embury Beacon	SS 216 195	Namurian to Westphalian stratigraphy and biostratigraphy
SS 22SW/1	Hartland Quay	SS 225 248	Westphalian sediments and structure
SS 32NW/1	Blackchurch Rock to Clovelly	SS300 266 – 318 251	Namurian stratigraphy and biostratigraphy)
SS 22NE/1	Colpit Quarry	SS 279 250	Embury Shale with *Gastrioceras subcrenatum* marking the junction of the Namurian and Westphalian

SS 32SE/1	Portledge to Peppercombe	SS 379 243 – 387 248	Permian stratigraphy, sedimentology and faulting
SS 43SE/1	Appledore tidal flats	SS 452 305	Modern tidal flats demonstrating sedimentary features of tidal sediments for comparison with ancient sediments such as those in the Carboniferous section at Westward Ho!

Table 2. Proposed County Geological Sites

Summary of the geology of the North Devon AONB and its immediate surroundings

The AONB and its surroundings is mainly underlain by sandstones , shales and subordinate cherts belonging to the Carboniferous period. Outcrops of the underlying Devonian rocks, mainly shales, occur along the northern margin on the southern side of the River Taw (Figs 1 and 2). A small area of 'red beds' of Permo-Triassic age unconformably overlies the Carboniferous on the cliffs of Bideford Bay. There is then a gap in the sedimentary record there being no Jurassic, Cretaceous or Tertiary in the area. There is strong evidence that sediments of this part of the sequence were present at one time and have been eroded away. Jurassic, Cretaceous and Tertiary rocks underlie extensive areas under the Bristol Channel and indeed Tertiary beds are found close by on land at Petrockstowe and at Buckland Brewer. Much later in the geological history of the area during the Ice Age the ice came as far south as the Taw

Estuary and clays and gravels associated with this are found at Fremington. The last beds are the raised beaches and river deposits which were deposited since the Ice Age and are still being deposited today.

Devonian

The youngest rocks of Devonian age occurring south of the River Taw belong to the Lower Pilton Beds, and these consist mainly of dark grey mudstones with some thin limestones and sandstones. There are abundant fossils of brachiopods and trilobites comparable to similar ones found in the topmost Devonian of the Ardennes. The fossils indicate deposition in nearshore shallow water conditions in well aerated water. These beds are best seen in the SSSI designated at Fremington Cliffs (Table 1).

Carboniferous

Lower Carboniferous (Dinantian)

The Devonian Lower Pilton Beds pass up into the dark mudstones of the Upper Pilton Beds and and in contrast to the Devonian mudstones below these contain only goniatites and conodonts of a basal Carboniferous age. The goniatites are free swimming organisms and the absence of bottom dweller such as brachiopods and trilobites indicates that the conditions on the sea floor was poorly oxygenated and that the sea was much deeper than in the Devonian. The succeeding Fremington Chert, made up of thin chert bands with black mudstone and dark muddy limestones, also only contains free-swimming animals such as goniatites and bivalves, thus again suggesting deep water and poorly oxygenated bottom waters. Chert deposition indicates the abundant availability of silica dissolved in the sea water which may have come from subsea hot springs associated underwater volcanic activity common during the Lower Carboniferous in many parts of Devon**.**

Upper Carboniferous (Namurian and Westphalian)

The beginning of the Upper Carboniferous marks a change in the type of sediments entering the basin and the nature of the sedimentary basin. Large quantities of sand silt and mud transported by rivers from a landmass to the north entered the area via a delta or deltas. The sediments spilled out of the delta distributaries on to the basinal slopes where it built up until triggered into mass movement by disturbances such as storms or earth tremors. Turbid flows of muddy sand (turbidity currents) the flowed at high speed down into the deeper parts of the basin. As these flows lost speed the sand came out of suspension and sedimented as beds of sand on the sea floor. In between these sporadic more violent sedimentary events, quieter deposition of dark muds went on. The scouring and erosional effects of these turbidity currents and any coarser debris they were carrying, cut grooves and linear depressions in the mud floor

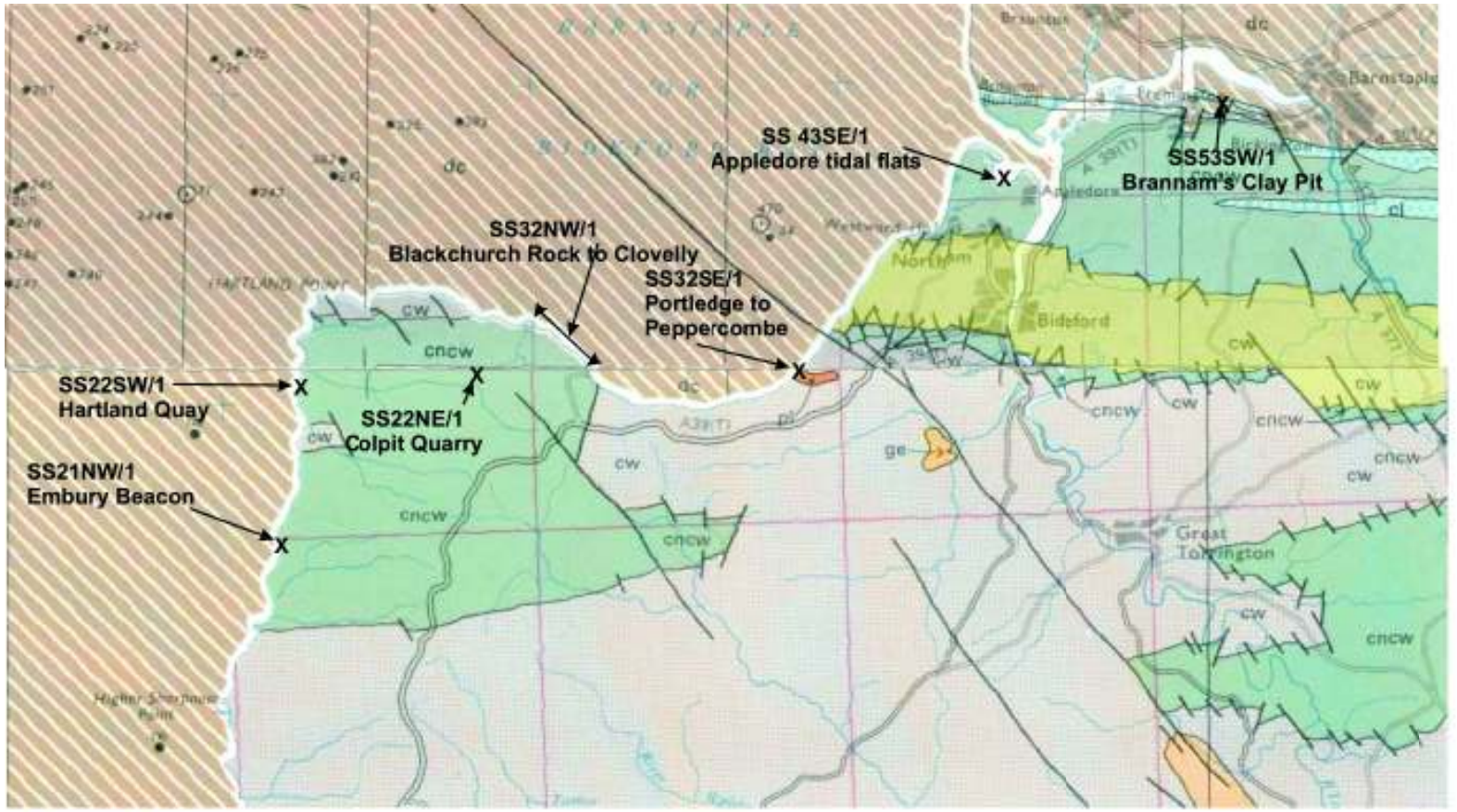


Figure 1. Geological map of the area around North Devon AONB with sites annotated

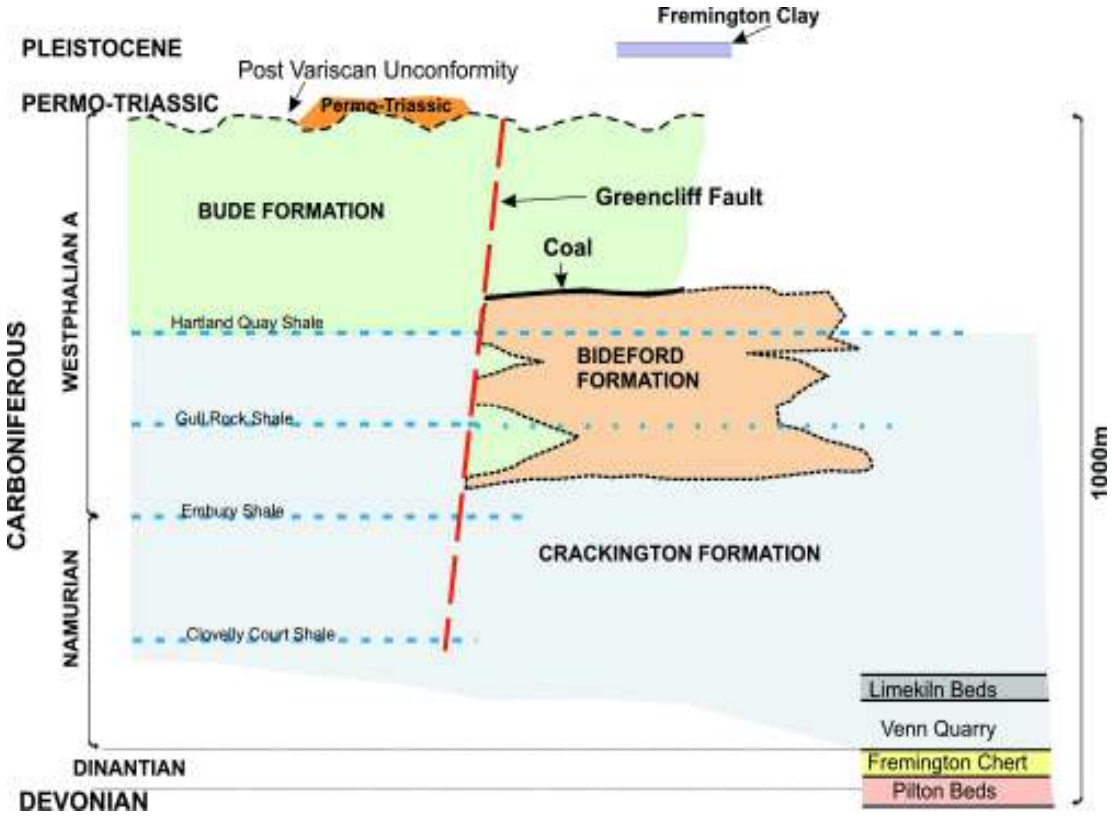


Figure 2 Stratigraphy of the North Devon AONB

and these were then filled in as casts by the succeeding sand. We see these cast marks now on the bases of many of the sandstones. The basin in which this sedimentation took place was not fully marine but possibly brackish. Its connection with the worlds oceans must have been restricted in some way. However at certain times the regional sea level rose and incursions of fully marine water of normal salinity flooded into the basin. This brought with it a fauna of goniatites and free- swimming bivalves. These events are marked in the sequence by bands of black rather sulphurous shale often with layers of sideritic goniatite bearing nodules. These shales form good markers in the sequence and are usually named eg Embury Shale and Gull Rock Shale (Fig. 00). They correlate with similar bands in the Millstone Grit and Coal Measures of S.Wales and the rest of Britain. Some of them are even recognised in Europe from southern Spain and Portugal to Germany.

The Upper Carboniferous formations defined in Devon reflect differences in time of deposition as well as their depositional position within the basin, which could have been within the delta, on the slopes immediately below the delta and in the deeper parts of the basin. **The Bideford Formation** (Fig. 2) contains sediments from a variety of situations within a delta. It includes massive cross-bedded sandstones, up to 20m thick from the distributary channels, laminated burrowed sandstones siltstones and mudstones from such areas as the interdistributary bays, seatearths from areas which rose above sea level and had

vegetation growing, and a few thin coal seams. In some areas it can be seen passing into and being overlain by rocks of the **Bude Formation** which also contains massive but rather structureless sandstones, which can be up to 20m thick, as well as silty sandstones, slumped beds and mudstones. These sandstones are described as proximal turbidites since they were deposited up slope and closer to the basin margins. Some of the beds within the Bude Formation show signs of having been deposited in relatively shallow water. The **Crackington Formation** in general underlies the Bude Formation but is in part equivalent to the lower part of the Bideford Formation. It was deposited in deeper water and consists of thinner sandstones (in the order 10cm to 0.5m) than those of the Bude and Bideford formations. These sandstones, which are referred to as distal turbidites, are interspersed with black to dark grey mudstones. In some bits of the Crackington Formation succession the rocks consist dominantly of dark mudstone with only subordinate thin sandstones. Very muddy sequences like this occur in the Wanson Beds between the Embury Shale and Gull Rock shales, and in the Limekiln Beds at Fremington [SS 514 333] (Fig.2). Marine bands with goniatites are more common in the Crackington Formation suggesting that access to full marine conditions was less restricted. Well developed marine bands with goniatites in the Crackington Formation are best seen in the Blackchurch Rock to Clovelly section [SS300 266 – 318 251] although they are also present at Colpit Quarry [SS 279 250], in the Limekiln Beds at Fremington. Outside the area goniatites have been collected at Venn Quarry [SS 580 306].
The southern margin of the deltaic Bideford Formation is rather abrupt and is coincident with a major E-W fault, the Greencliff Fault. To the north of the fault the Hartland Quay Shale is within the Bideford Formation while to the south of it
is within deeper water sediments at or near the junction of the Bude and Crackington formations. This suggests that this fault was moving at the same time as sedimentation was going on.

The highest beds of the Upper Carboniferous of SW England are not seen in the Bideford area. They crop out in a synclinorial belt stretching east from the north Cornish coast at Duckpool [SS 200 110] inland towards an area just south of Tiverton. Here the Upper Carboniferous has an additional 1200m of succession and reaches as high as the base of Westphalian C. There is some evidence to suggest that even more Carboniferous strata were once present above this, but it was subsequently eroded.

The Variscan Orogeny

While the deposition of the Devonian and Carboniferous rocks in the Bideford area was still going on, rocks of the same age were already being folded and faulted farther south in Cornwall and south Devon. This deformation was the result of the closure of a short lived

ocean to the south and the collision of a continental plate to the south with the one hosting SW England. This caused the sediments to be squeezed out of their depositional basins and thrust up into a mountain chain. This deformation progressed northward through time so that by the time deposition had ceased in the Bideford area (some time in the late Wesphalian) the Upper Carboniferous rocks of this area were folded and faulted and became part of the mountain chain. This rather prolonged deformation event is known as the Variscan Orogeny and its effects are seen in fold belts throughout Europe. In our area the event is mainly manifested in folding in the Carboniferous rocks such as that to be seen at Hartland Quay and along the coast to the west of Clovelly. Faulting along E-W and NW-SE lines is common and these faults have been often reactivated several times during the post Variscan history of the area. One such fault is the important NW-SE trending wrench fault, the Sticklepath Fault, crosses the coast at Babbacombe Mouth [SS 395 260]. It traverses the SW England peninsula from Torquay to Bideford Bay and on towards Pembrokeshire. It affected the development of both the Bovey and Petrockstowe basins thus showing that it continued moving at least until Tertiary times.

Permo-Triassic

The mountain belt thrown up by the Variscan Orogeny was no sooner built when it was attacked by intense weathering either during the very late Carboniferous or during the Permian. The climate had become arid by this time, but with sporadic periods of heavy rainfall which rapidly dismembered the poorly vegetated mountains and brought down floods of debris charged water to form alluvial fans and temporary rivers which spilled out eventually into temporary playa lakes. The rocks produced by this type of sedimentation are conglomerates and breccias, some containing large boulders, sandstone and silty mudstone all usually deeply red-stained. The main areas of outcrop of these rocks stretches from the Torbay area to Exmouth and Sidmouth and northwards towards Taunton with a fault bounded salient heading west through Crediton to Hatherleigh. We have however a small outcrop on the coast between Portledge and Peppercombe where red conglomerates and sandstones rest unconformably on the Upper Carboniferous on one side and faulted against on the other. Since this outcrop is so remote from the main area of ‘red beds’ in the east, it is difficult to decide whether it belongs to the Permian or to the younger Triassic.

There is now a large gap in the sedimentary record in this area, although evidence from surrounding areas such as the Bristol Channel suggests that both the Jurassic and Cretaceous seas covered the area and that a considerable thickness, perhaps as much as 4Km of Mesozoic and Tertiary sediments may have covered the Bideford area. We know that over 670m of

Tertiary sediments occur at Petrockstowe just south of the area, but since these are fluviatile deposits and are probably limited to a river flowing through a fault bounded trough, it is unlikely that they covered the whole north Devon area at this thickness. It is probable that the great thickness of Mesozoic strata was all removed by erosion by late Tertiary.

Pleistocene (The Ice Age)

The next strata in the sedimentary record after the Permo-Triassic to crop out in the Bideford area are gravels, tills and ? lacustrine clays of the Ice Age. It is thought that ice of the Wolstonian Stage reached the north Devon and Cornish coast and pushed up the Taw Estuary. The last glaciation of the Ice Age, the Devensian ice did not reach farther south than south Wales. The Wolstonian ice transported erratic blocks including gneiss, porphyry, dolerite and epidiorite into the area and these are now found on old shore platforms and within till. These erratic probably came in the ice from western Scotland. The most studied deposit is at Fremington near Barnstaple where deposits of stony till (boulder clay) are found. This clay is a ground up rock powder with erratic pebbles carried by the ice and left when it finally melted away. Another less stony clay is found also within the deposit and it is possible that this clay was deposited in a shallow lake trapped in front of the ice. When the Wolstonian ice retreated northwards there followed a relatively warm period and a farther glaciation, the Devensian during which the Bideford area was gripped in permafrost which created many periglacial features such as ice wedge casts and frost cracks in the soils and weathered rock.

The last part of the geological history of the area is the establishment in the late Pleistocene and Flandrian of a river and estuary system with attendant river terrace gravels and loams as well as estuarine muds. This system bore some resemblance to the present river system, but curious anomalies in the present Taw and Torridge layout suggests that river captures have occurred since Pleistocene times. One suggested site at Appledore displays some of the features of modern estuarine deposits and compares them with similar fossil features in the Carboniferous.

Other Flandrian features in the area are the submerged forest deposits at Westward Ho! and Saunton which are dated at around 5000 to 6500 BP and imply a rise in sea level since then of perhaps 1 to 2m

Appendix 1
Site descriptions

Site reference no SS21NW/1 **Name:** Embury Beacon

District: Torridge **Parish:** Hartland

National grid ref: SS 216 196 **OS sheets: 1:50k** 190 **1:25k** 126 **1:10k** SS 21NW **GS 1:50k** 308

Locality description (address): Cliff section below Embury Beacon

Nature of site: View of cliff section seen from just off the coastal path at [SS 2168 1990]

Geological / geomorphological features: Cliff section showing the top part of the Crackington Formation from the *Gastrioceras subcrenatum* horizon (Embury Shale) at the base up to above the level of the *Gastrioceras listeri* horizon (Gull Rock Shale). In the bottom half of the cliff (Plate 00) much dark grey to black shales with subordinate thin (<30cm) sandstones can be seen. The sandstones commonly show small groove casts and prod casts on their bases. These beds look identical to the Wanson Beds seen at the southern crop of the synclinorium south of Bude. Above this sandstones predominate and individually they are thicker particularly at the top of the cliff above the Gull Rock Shale. A massive slump bed occurs below the Gull Rock Shale. These are more commonly found within the Bude Formation which is just above the top of the section. The presence of massive sandstones above the Gull Rock Shale and the slump bed below it suggests that the Bude Formation type of sedimentation is starting earlier in this area instead of the more normal level around the Hartland Quay Shale.
The section occurs on the southern limb of a large anticline the axis of which trends E-W to the north of the cliff section and across Broadbench on the foreshore below. The southern limb dips at c.20° southwards while the northern limb dips northward at nearer 65°.

Reasons for registration as a Regionally Important Geological / Geomorphological Site: A spectacular display of the upper part of the Crackington Formation with examples of two of the main marine shales as well as a slump bed.

Site sensitivity: None

Safety: The viewpoint is at the top of a cliff, but landslipping means that it is a confused slope rater than a vertical cliff at this point. A descent from around the viewpoint to beach level is possible in order to examine the rocks more closely, but it means traversing a very rough active landslip, and depending on the groundwater conditions, mudflows. There is also a risk from falling debris of sandstone blocks from the cliff to the south. It certainly would be unwise to take any party down.

Interest groups:. **University.** Undergraduate - Research
Professional geologists - Amateur geologists.

Access and Parking: Parking at side of unclassified road at [SS 2200 2021]. Access to coastal path about 100m to the south of this

Date of assessment (V = visited) : February 2004 E C Freshney

Site owner :
Other comments:

References:
Freshney, E.C. , Edmonds, E.A., Taylor, R.T. and Williams, B.J. 1979. Geology of the country around Bude and Bradworthy. *Mem. Geol. Surv. G.B.*

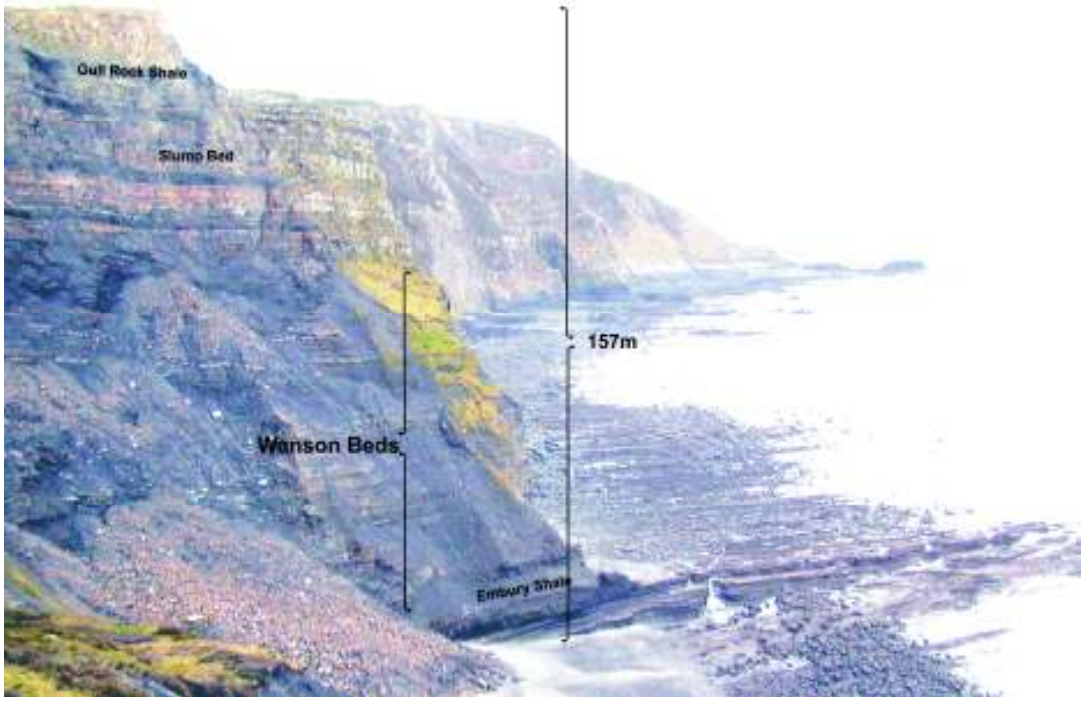
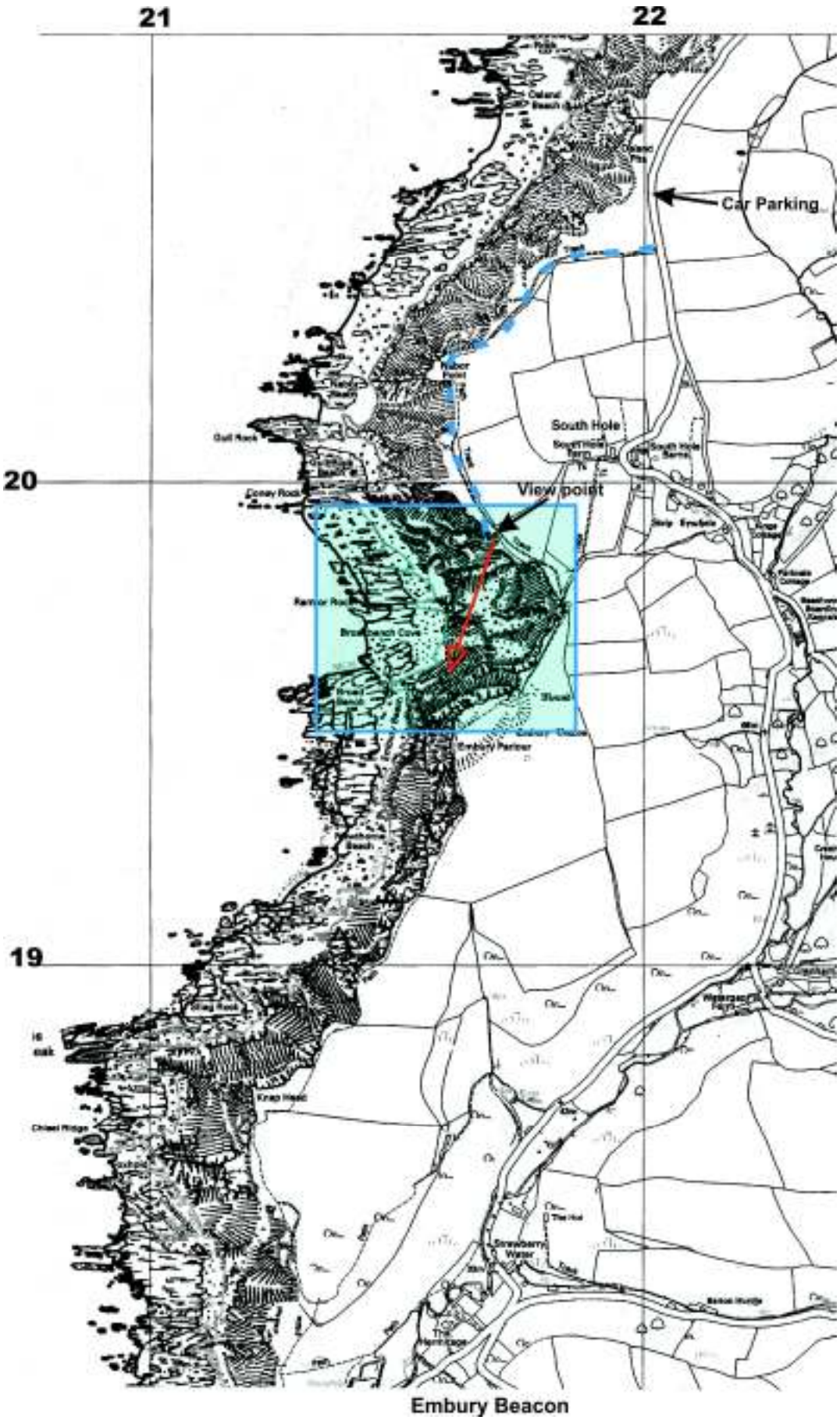


Plate 1 Cliff showing Namurian succession between Gull Rock Shale at top to Embury Shale at base


21
22
20
19
Car Parking
South Hole
View point
Embury Beacon

Site reference no. SS22SW/1 **Name:** Hartland Quay

District: Torridge **Parish:** Hartland

National grid ref: SS 223 248 **OS sheets: 1:50k** 190 **1:25k** 126 **1:10k** SS22SW **GS 1:50k** 292

Locality description (address): Hartland Quay, Hartland, nr Bideford

Nature of site: Cliff exposures

Geological / geomorphological features: Folded Crackington Formation turbiditic sandstones and mudstones with two marine shale beds, the Hartland Quay Shale and the Longpeak Shale. The Hartland Quay normally contains the goniatite *Gastrioceras amaliae*, although it has not been found at this locality. The Hartland Quay Shale, possibly correlatable with the Margam Marine Band of the Welsh Coalfield nominally marks the top of the Crackington Formation. However, the first upward occurrence of massive Bude type sandstones is used in practice to mark this boundary. The shale can be examined at a small natural arch [SS 2242 2484] (Plate 2a), where it is 1.47m thick, and at the base of the cliff [SS 2252 2487]. At these localities torpedo shaped fish coprolites can be seen and occasionally crushed anthracoceratid goniatites. The higher shale, the Longpeak Shale does not come down to beach level until 300-400m to the north of Hartland Quay. Both shales are visible in the series of spectacular upright to slightly overturned folds displayed in the cliffs (Plate 2).

A view south from the car park reveals the hanging valley and abandoned alluvial tract of the Milford Water which is listed as an SSSI.

Reasons for registration as a Regionally Important Geological / Geomorphological Site: An easily accessible site where top Crackington Formation and marine shales may be examined along with spectacular examples of folding.

Site sensitivity: None known

Safety: Care must be taken in approaching cliffs where some areas could be unstable with debris falls. Hard hats should be worn. Rock surfaces in the intertidal zone are often slippery. Access from the concrete ramp to the north of the hotel to the foreshore is cut off at high tide. Examination of the sections north of the quay are probably best done on a falling tide.

Interest groups: **Schools.** Years 17-18. **University.** Undergraduate - Research Professional geologists - Amateur geologists - General public.

Access and Parking: There is a limited amount of parking at the end of the road near the hotel particularly in the holiday season. There are overflow car parks higher up the cliff. Access to the beach to the north is down a concrete ramp to the north past the hotel

Date of assessment (V = visited) : **V** Feb 2004 E.C Freshney

Site owner : Foreshore

Other comments:

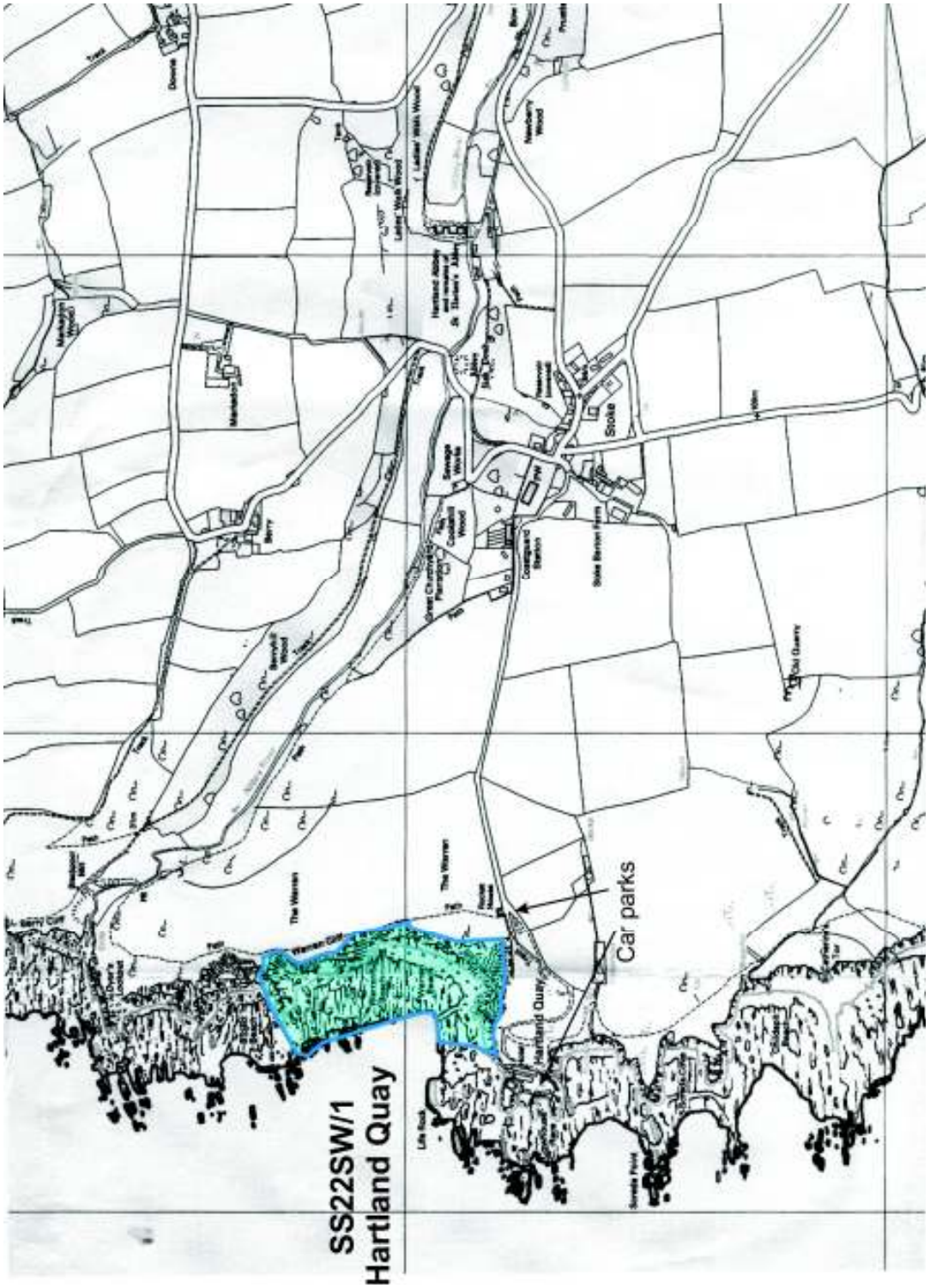
References:

Edmonds, E.A., Williams, B.J. and Taylor, R.T. 1979. Geology of Bideford and Lundy Island. *Mem Geol. Surv. G.B.,* sheets 292, with 275, 276, 291 and part of 308.

Freshney, E.C. and Taylor, R.T. 1972. The Upper Carboniferous stratigraphy of north Cornwall and west Devon. *Proc. Ussher Soc.,* Vol.2,pp. 464-471.

Plate 2. Folded Crackington Formation sandstones and mudstones, with two marine shales, the Longpeak and Hartland Quay shales

Plate 2a. Hartland Quay Shale (*Gastrioceras amaliae* horizon).
Contains rod shaped coprolite pellets.


SS22SW/1
Hartland Quay
Car parks

Site reference no. SS32NW/1 GCR2934 **Name:** Clovelly Coast

District: Torridge **Parish:** Hartland

National grid ref: 298266 3182509 **OS sheets: 1:50k** 190 **1:25k** 114 **1:10k** SS32SW **GS 1:50k** 292

Locality description (address): Coast from Mouthmill to Clovelly

Nature of site: Coastal cliffs

Geological / geomorphological features: This section of coastal shows a continuous geological section through some 520 m of sandstones siltstones and shales in a major anticlinal structure with some repetitions of the sequence by minor folds and a major fault. The geological sketch map and section of the coast illustrates the structure and stratigraphy.

At Blackchurch Rock, Mouthmill (Plate 3) the Hartland Quay shale is exposed it has yielded the goniatite *Gastrioceras amaliae.* 300m and 400 m SE the nodular Gull Rock Shale with *Gastrioceras listeri* is exposed in two anticlines (Plates 4 and 5). This shale is repeated by a syncline SE of Gallantry Bower above a near vertical sequence in which shale predominates. Below these shales The Embury Shale contains nodules with *Gastrioceras subcrenatum.* The sequence continues predominantly in sandstones with another nodular shale the Deer Park Shale has yielded goniatites fragments and is probably the Gastrioceras cumbriense horizon. About 20 m below this shale a massive slump bed produced by collapse and submarine movement of sediments occurs. About 18m below the slump bed another nodular shale with goniatites the Skittering Rock Shale occurs. A repetition of this shale at Skittering Rock (Plate 8.) near Clovelly has yielded *Gastrioceras* cf. *cancellatum.* The Clovelly Court Shale, a thin black shale with *Gastrioceras ?sigma* lies in the core of the main anticline 250 m WNW of Wood Rock and is the lowest part of the succession. The anticlinal fold core is shown in Plate 6.

South of Wood Rock a major strike fault repeats part of the succession including the major slump bed at Gallant rock (plate 7.) and the Skittering rock Shale at Skittering Rock (plate 6)

Reasons for registration as a Regionally Important Geological / Geomorphological Site: The unique geological section in the Devon (Culm) facies of the Upper Carboniferous through the Namurian Westphalian boundary with fossiliferous horizons containing goniatites which enable correlation with the coalfield areas of the rest of Britain and parts of Europe.

Site sensitivity: None

Safety: This section must be visited on a falling tide. Access at Mouthmill becomes possible about one hour after high water. A minimum of 3.5 hours should be allowed for the traverse of the section allowing reasonable time for geological examination. On a rising tide the western end becomes inaccessible first and a return along the beach should not be attempted. Because of the slippery and unstable nature of the cobble and boulder beaches strong and supportive footwear is necessary. Visitors should be reasonably agile. The cliffs appear to be generally stable.

Interest groups: Schools. Years 17-18. **University.** Undergraduate - Research Professional geologists - Amateur geologists

Access and Parking: Parking is available in the main car park above Clovelly village. It is recommended that the section be approached from the west at Mouthmill. This entails walking from the car park along the coastal footpath through the Clovelly Estate to Mouthmill a distance of about 1½ miles 2¼ km. The return along the coastal section is of similar length.

Date of assessment (V = visited) : **V** March 2004 R T Taylor

Site owner: Open access

Reference: Edmonds, E. A. *et al.,* 1979. Geology of Bideford and Lundy Island. Memoir of the Geological Survey of Great Britain. London: HMSO.

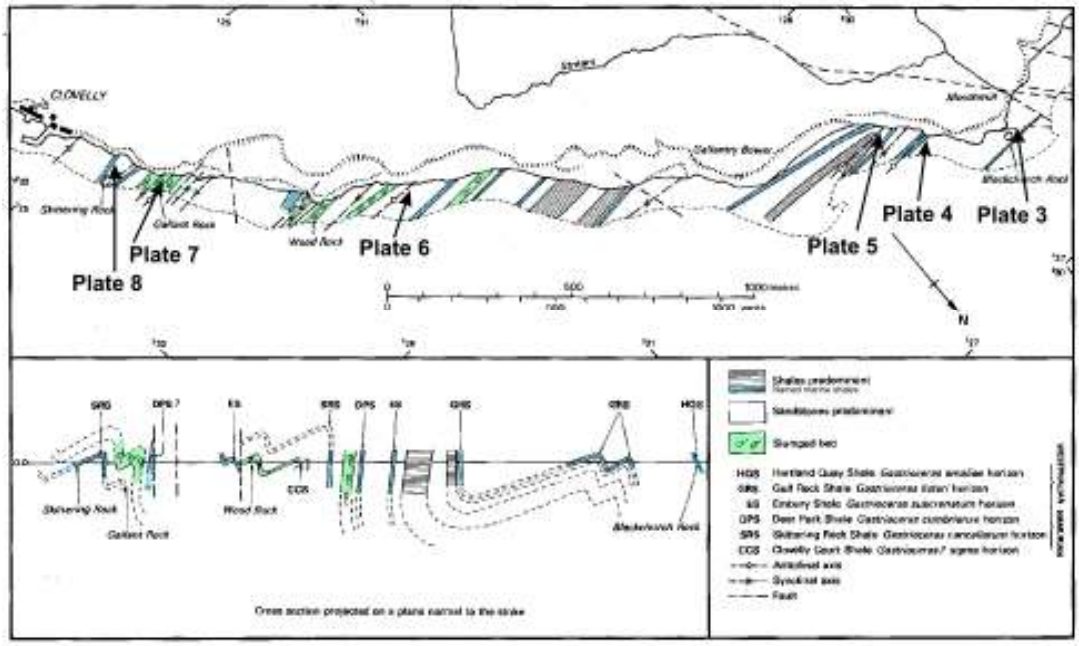


Figure 3 Geological map of foreshore between Blackchurch Rock and Clovelly and cross section of the geology (from Edmonds et al 1979)

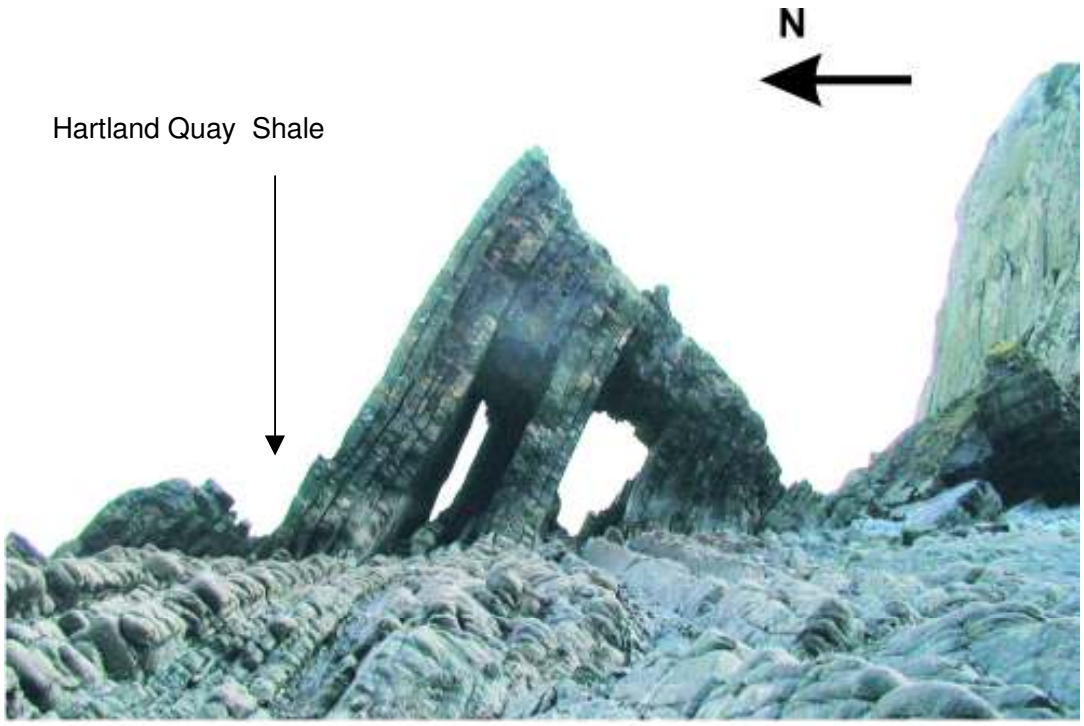


Plate 3. Blackchurch Rock, the Hartland Quay Shale (*Gastrioceras amaliae* horizon), lies 2m to the north of the main face of the rock

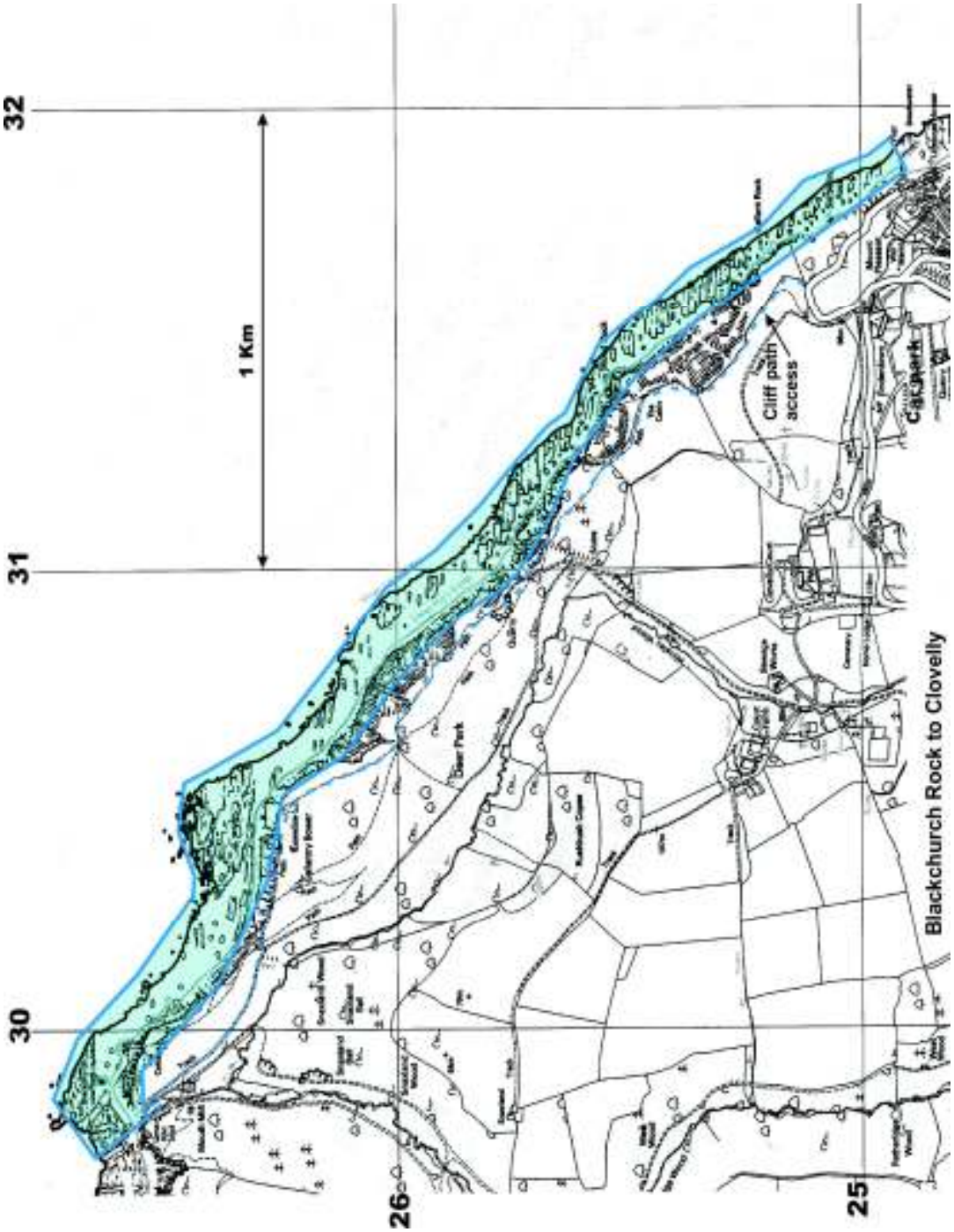
Plate 4 The Gull Rock Shale. (*Gastrioceras listeri horizon)*

Plate 5. Nodules with goniatite fossils in a fallen block from the Gull Rock Shale

Plate 6. An overturned and faulted fold in sandstone beds NW of Wood Rock

Plate 7. The slump bed at Gallant Rock with contorted masses of sandstone in a thick bed of massive silty mudstone

Plate 8. The Skittering Rock Shale, *Gastrioceras cancellatum* horizon


32
31
30
26
25
1 Km
Cliff path access
Car park
Blackchurch Rock to Clovelly

Site reference no. SS22SE 1 **Name:** Colpit Quarry

District: Torridge **Parish:** Hartland

National grid ref: 2792 2492 **OS sheets: 1:50k** 190 **1:25k** 1253 **1:10k** SS22 SE
GS 1:50k 307/308

Locality description(address): 300m ENE of Rosedown Mill, along gated trackway off Colpit Lane, Hartland.

Nature of site: Quarry (intermittent use), small. Stream gully down the west side of the site.

Geological / geomorphological features: Crackington Formation, Upper Carboniferous. Sandstone and thin shale beds with the fossiliferous Embury Shale with *Gastrioceras subcrenatum* exposed between two major faults This horizon marks the boundary between the Namurian and Wesphalian stages of the Carboniferous. Three dimensional goniatite fossils are present in decalcified nodules in the shale. Impressions of fragments occur on the surface of a thin sandstone in the shale. Groove and prod casts occur on the bases of thin sandstones immediately above the Embury Shale and siltstones contain plant fragments. The Embury shale is also exposed in the stream gully forming the west side of the site. Pleistocene Head deposits with convolutions, overlie the shale on the east side of the site.

Reasons for registration as a Regionally Important Geological / Geomorphological Site: A unique inland exposure of the fossiliferous Embury shale with ***Gastrioceras subcrenatum*** Other new species of Gastrioceras are likely to be present. The site also demonstrates good examples of faults, sedimentary structures Pleistocene Head deposits and has excellent educational value. The site is very accessible compared with the coastal out crops of this horizon.

Site sensitivity: Collecting should be restricted to scientific and educational users.

Safety: Generally safe for active persons. An important safety aspect is associated with the use of part of the quarry as a range by the Two Rivers Rifle Club. Geological visitors to this site need to ascertain that the range will not be in use, before their visit, to ensure safe access.

Interest groups: **Schools.** Primary - Secondary **-** 6th Form **.** **University.** Undergraduate - Research Professional geologists - Amateur geologists - General public.

Access and Parking: Along trackway. Limited parking for cars and minibuses on Colpit Lane. It is possible to drive up to the quarry

Date of assessment (V = visited) : **V** 17th December 1994 Revisited 2003 R T Taylor

Site owner :

Other comments: Extension of the quarry since the publication of the Geological survey memoir has crossed the fault separating the sandstone, originally worked, from the shale. The Embury Shale should remain exposed in the remaining quarry faces at the limit of the working and every effort should be made to ensure that they are preserved.

Since the first assessment there has been little further quarrying and the eastern part of the quarry has become overgrown. Landslip has affected the northern face of the quarry but the Embury Shale with goniatites bearing nodules is still accessible.

References: Edmonds, E. A. *et al*., 1979. Geology of Bideford and Lundy Island. Memoir of the Geological Survey of Great Britain. London: HMSO.

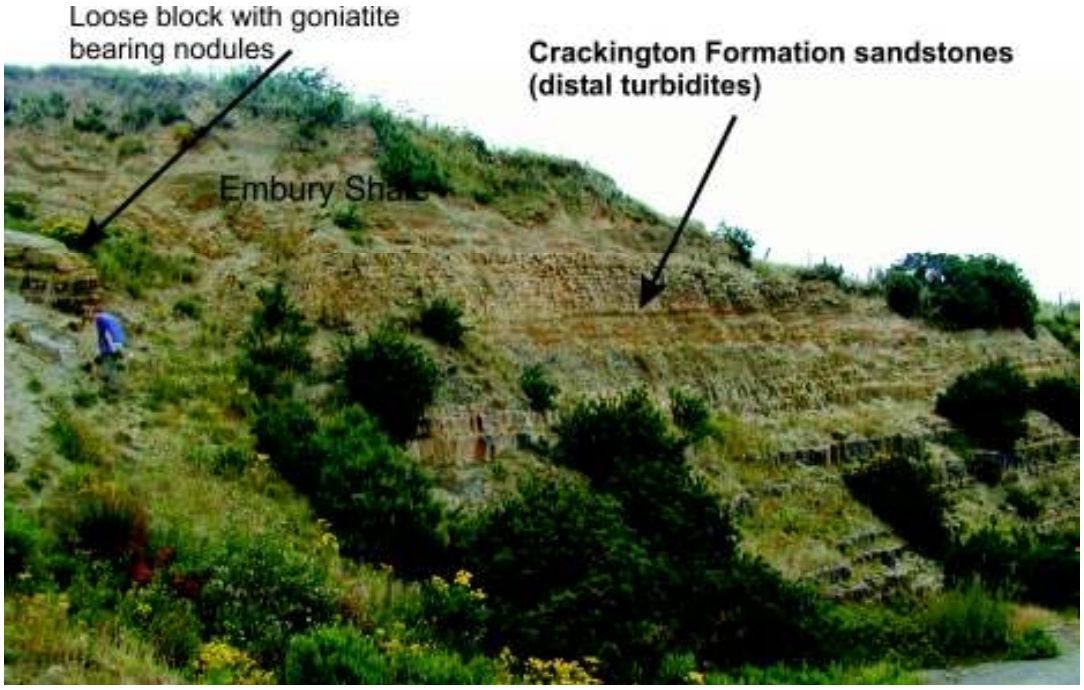
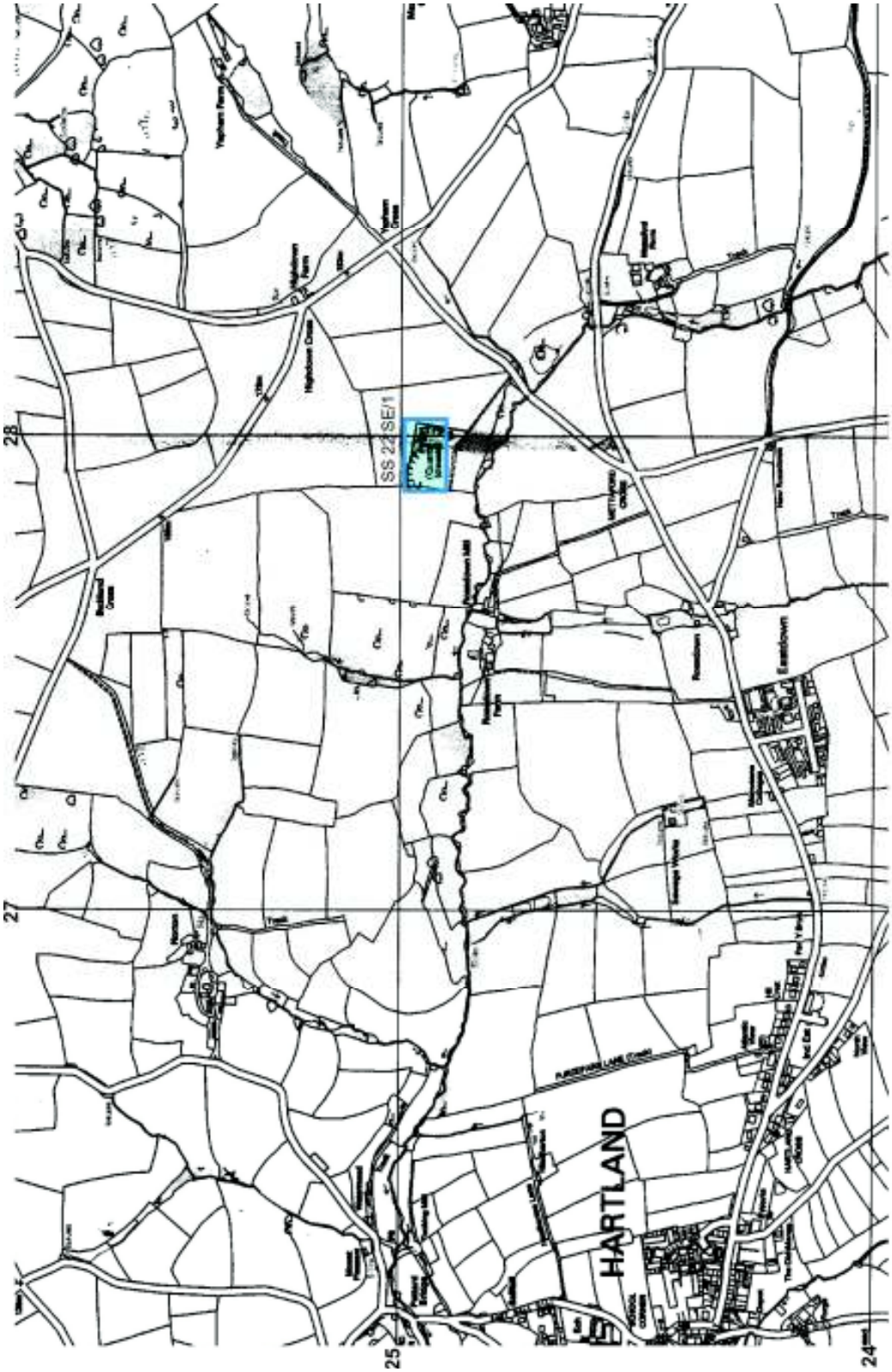


Plate 9. View of Colpit Quarry showing Embury Shale


SS 22 SE/1
HARTLAND
Colpit Quarry

Site reference no. SS32SE/1 **Name:** Portledge Peppercombe Permian Outlier

District: Torridge **Parish:** Alvington and Parkham

National grid ref: SS 379 243 **OS sheets: 1:50k** 190 **1:25k** 126 **1:10k** SS 32SE

GS 1:50k 292

Locality description (address): Coastal exposure, Portledge- Peppercombe, Horn's Cross, nr Bideford

Nature of site: Cliffs and foreshore.

Geological / geomorphological features: Permo-Triassic 'red beds' unconformably overlying folded Bude Formation. The Permo-Triassic consists of conglomerates, sandstones and silty sandstones with associated calcrete nodules. Some of these rock types are arranged in fining-upward cycles indicative of alluvial sedimentation. These sediments were deposited in alluvial fans or as infill to wadis and in temporary sand filled channels. The finer silty sandstones with calcrete were deposited in temporary playa lakes, the calcrete forming in the ancient soil in a situation of highly variable water table level. The climate would have been arid with widely spaced intervals of heavy rainfall.

The deposits are preserved in a half graben with an east-west fault defining its north eastern margin. The south western edge of the graben is repeated by the NW-SE trending Peppercombe Fault which is parallel to the larger Sticklepath to the north-east.

Reasons for registration as a Regionally Important Geological / Geomorphological Site: Good exposures of Permo-Triassic rocks and the only ones in this part of Devon. This type of flash flood alluvial sedimentaion can be well demonstrated here.

Site sensitivity: None known

Safety: The cliffs are not high but there is a risk of falling debris: clasts from the conglomerates and larger sandstone blocks from the Bude Formation. A hard hat is therefore advised. There is a need to be aware of tide conditions, but as there is c200m between MHW and MLW there should be a low risk of being trapped. Access paths and steps can be slippery if wet.

Interest groups: **Schools.** Years 17-18. **University.** Undergraduate - Research Professional geologists - Amateur geologists.

Access and Parking: On foot approximately 1.5Km from parking in lay-by on A39 just east of Horns Cross

Date of assessment (V = visited) : **V** Jan 2004 D.J. Cox

Site owner : Exposures are on foreshore. Access is on National Trust footpaths.

Other comments:

References:

Burley, R.A. and Cornford, C. 1998. Carbonate cements constrain the burial history of the Portledge- Peppercombe Outlier, North Devon. Proc. Ussher Society. Vol. 9, pp. 188-203.

Gayer, R.A. and Cornford, C. 1992. The Portledge-Peppercombe Permian outlier. Proc. Ussher Society. Vol.8 pp.15-19

Edmonds, E.A., Williams, B.J. and Taylor, R.T. 1979. Geology of Bideford and Lundy Island. *Mem Geol. Surv. G.B.,* sheets 292, with 275, 276, 291 and part of 308.

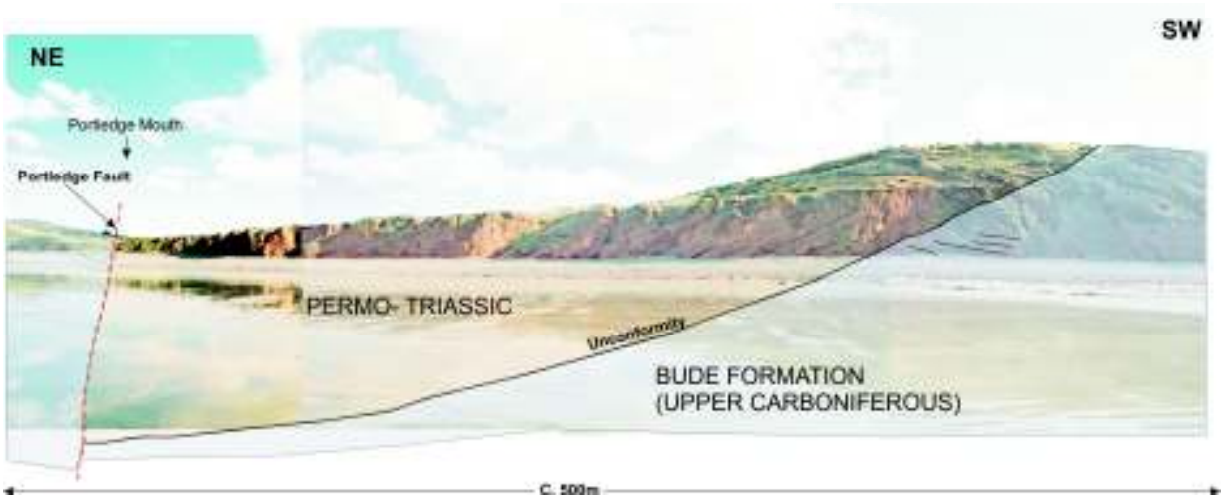


Plate 10. View of part of Portledge to Peppercombe section with geological overlay

Plate 11. Purplish red conglomerate from near western end of site

Plate 12. Conglomerate and sandstone from south-western end of section

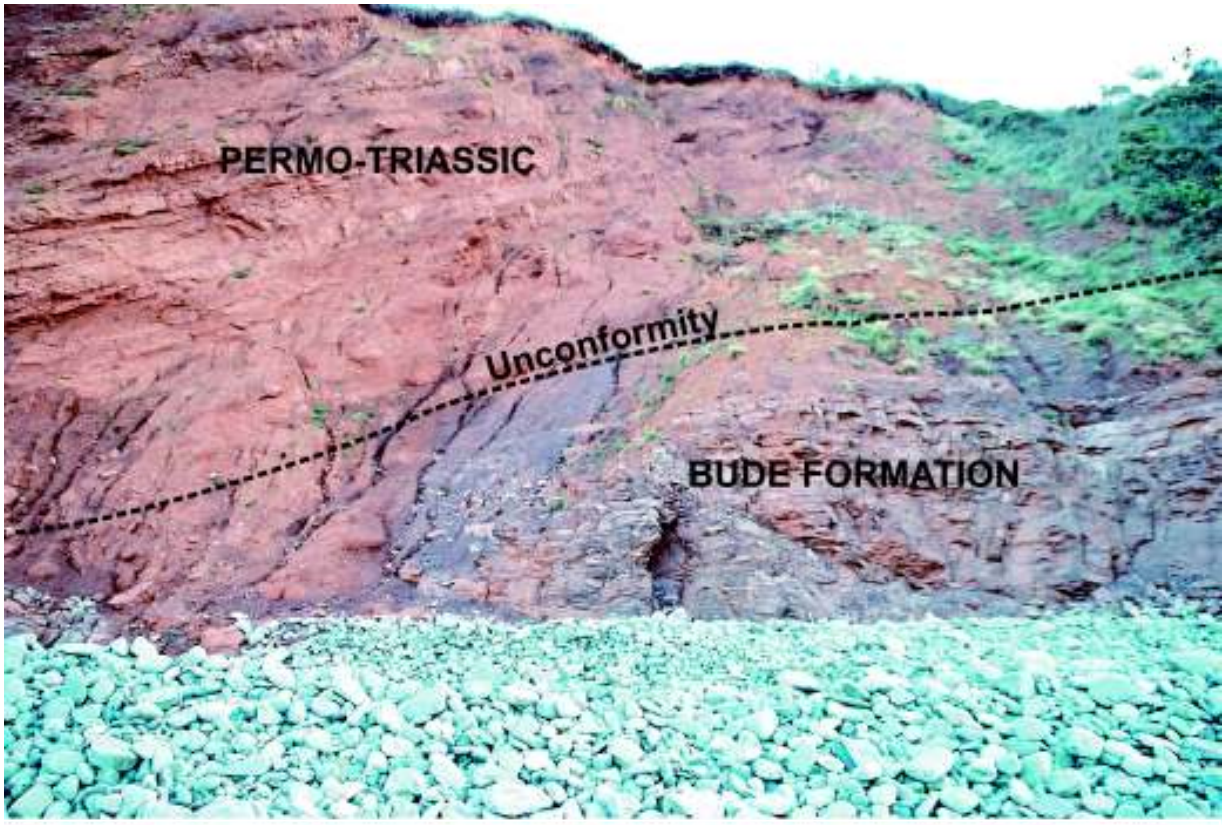


Plate 13 Permo-Triassic unconformable over Bude Formation at [SS 383 244]

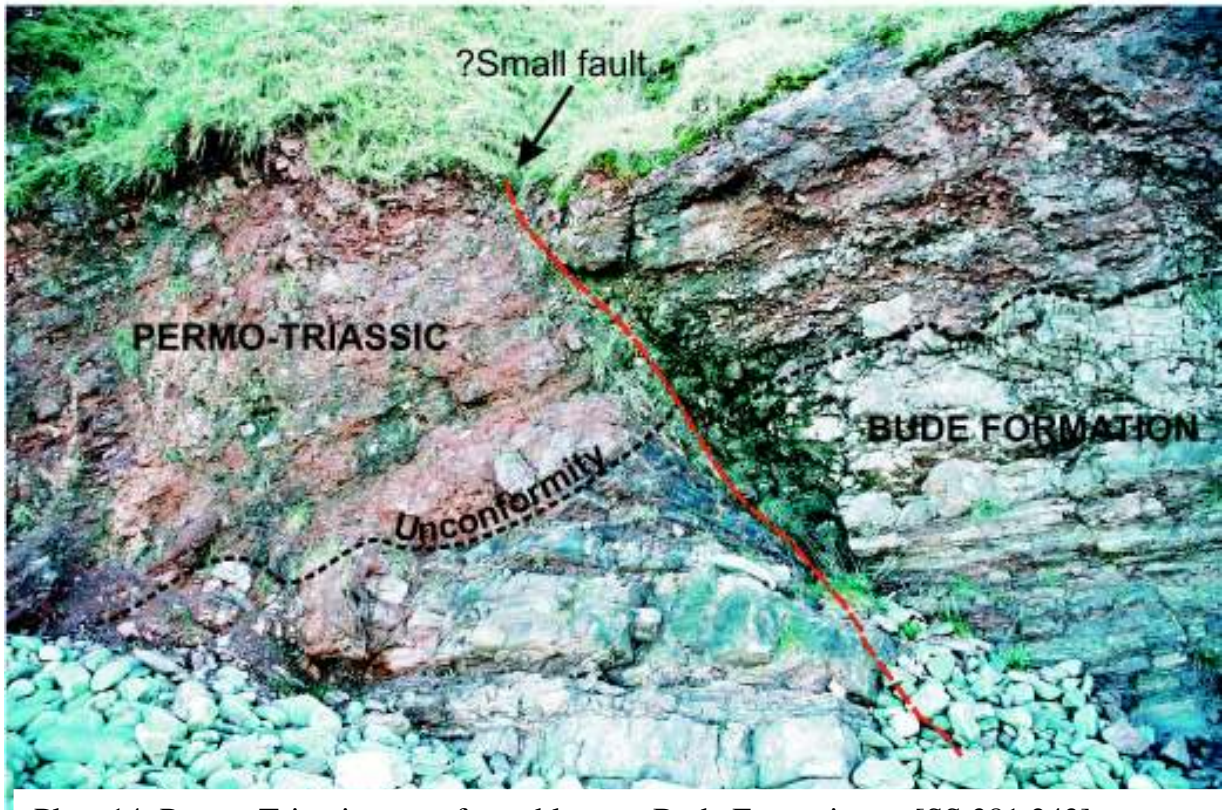
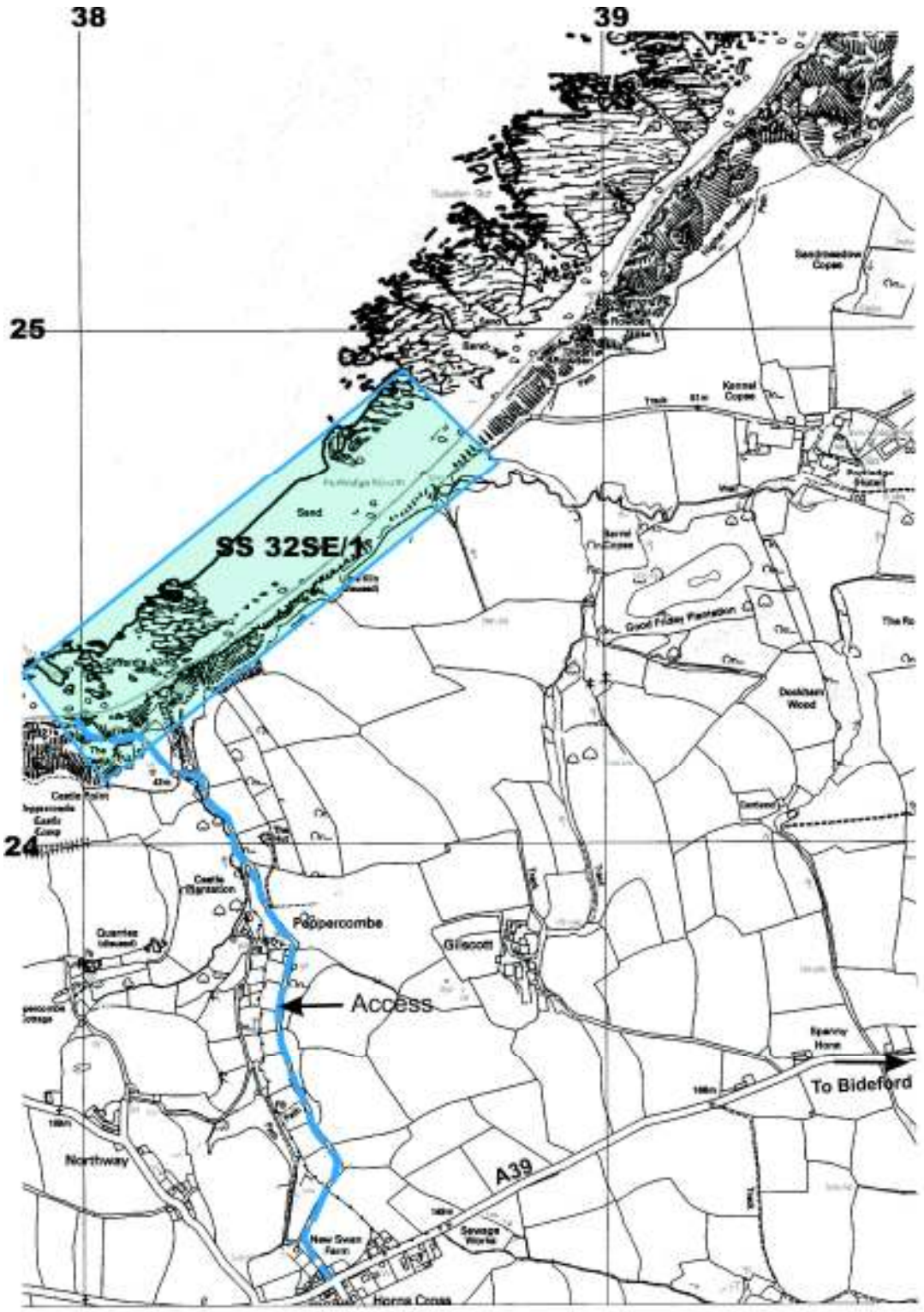


Plate 14. Permo-Triassic unconformable over Bude Formation at [SS 381 243]



Portledge to Peppercombe

Site reference no. SS43SE/1 **Name:** The Skern

District: Torridge **Parish:** Northam

National grid ref: SS 452 305 **OS sheets: 1:50k** 180 **1:25k** 139 **1:10k** SS43SE

GS 1:50k 292

Locality description (address): The Skern, Appledore

Nature of site: Embayment off the Taw/ Torridge estuary occupied by tidal flats and shifting river channel

Geological / geomorphological features: Tidal flat mud and sand deposits crossed by a shifting meandering channel (Plate 15). The channel displays point bars and sections through point bars as well as bank collapses with the consequent debris forming intraformational breccias(Plates 16-19). Bioturbation mainly in the form of worm burrows is common (Plate 20). Ripple marks are often present on the top surfaces of the flats (Plate 21).

Reasons for registration as a Regionally Important Geological / Geomorphological Site: A good place to examine modern sedimentological processes and the resulting sedimentary structures in an estuarine or tidal environment. These features can be compared with fossil sedimentary structures in the upper part of the Westward Ho! Formation (Crackington Formation on BGS map and memoir) which outcrops on the foreshore in an SSSI between Seafield House [SS 423 291] and Mermaid's Pool [SS 419 290] (Walker, 1970 and Xu Li, 1990. Some of the features to be seen here, running from east to west are as follows:-

a) dominant silty mudstone

b) asymmetric ripples which are often reworked thin sands

c) thin (mm) graded fine sand beds

d) slumped beds (contorted and folded soft sediment deformation)

questionably associated with channelling

e) channel sands (metre scale lensoid sand bodies), with ...

f) basal sand lag

g) channel fill with intraformational conglomerate (bank collapse)

h) destroyed bedding in 0.5m mudstone below Mermaid's Pool Sandstone

i) sharp base of cross bedded Mermaid's Pool Sandstone which shallows up into emergent burrowed horizons.

Site sensitivity:

Safety: Wellington boots are advisable as the intertidal zone is soft and muddy. It is also necessary to be aware of the tides. It is probably better to be starting the examination on a falling tide

Interest groups: **Schools.** Years 12-16: Years 17-18. **University.** Undergraduate – Research Professional geologists - Amateur geologists - General public.

Access and Parking: See map for access road and parking

Date of assessment (V = visited) : March 2004 C. Cornford

Site owner :

Other comments:

References:

Edmonds, E.A., Williams, B.J. and Taylor, R.T. 1979. Geology of Bideford and Lundy Island. *Mem Geol. Surv. G.B.,* sheets 292, with 275, 276, 291 and part of 308.

Walker, R.G. 1970. Deposition of turbidites and agitated-water siltstones: a study of the Upper Carboniferous Westward Ho! Formation, North Devon. *Proceedings of the Geologists' Association*, 18, 43-67.

Xu Li 1990. Changes in the Deltaic Sedimentation in the Upper Carboniferous Westward Ho! Formation and Bideford Group of SW- England. *Proceedings of the Ussher Society*, 7, 232-236.

Plate 15. Meandering channel incised in tidal flats with Egret for scale

Plate 16. Point bar and meander

Plate 17. Detail of section through point bar showing interlamination of sandy mud and sand.

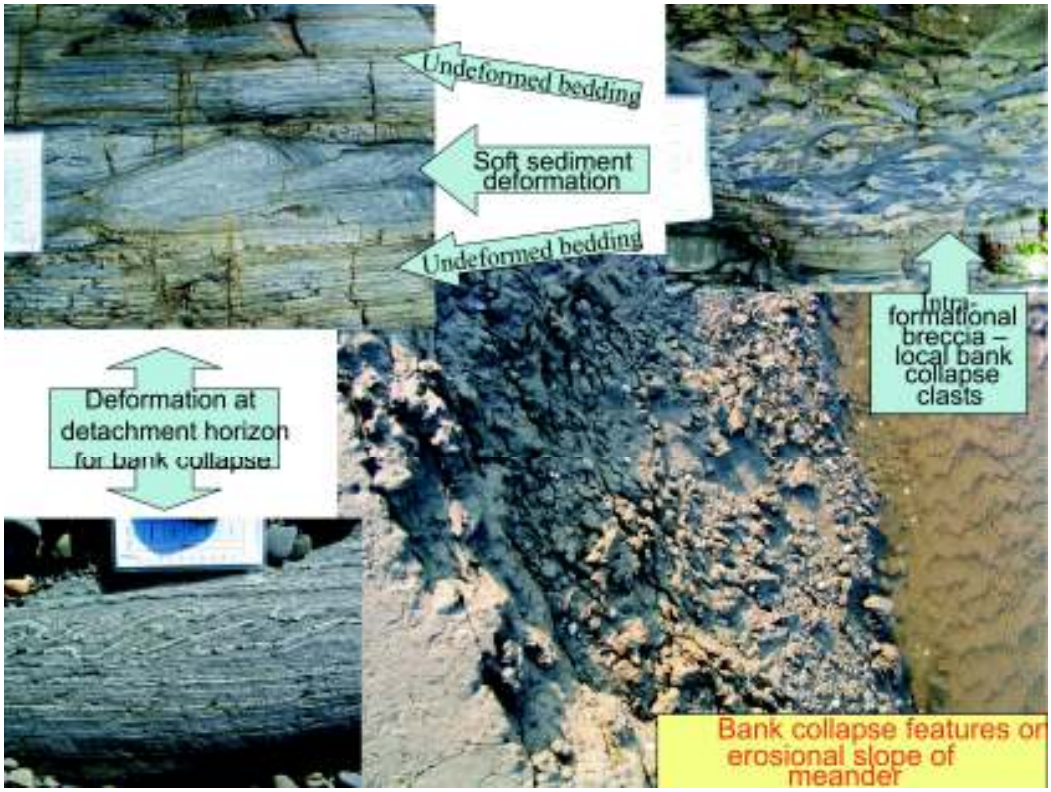


Plate 18. Bank collapse and soft sediment deformation. Insets photos annotated in blue are from Carboniferous beds near Seafield House, Westward Ho!


Plate 19. Intraformational mud clasts forming channel lag deposits

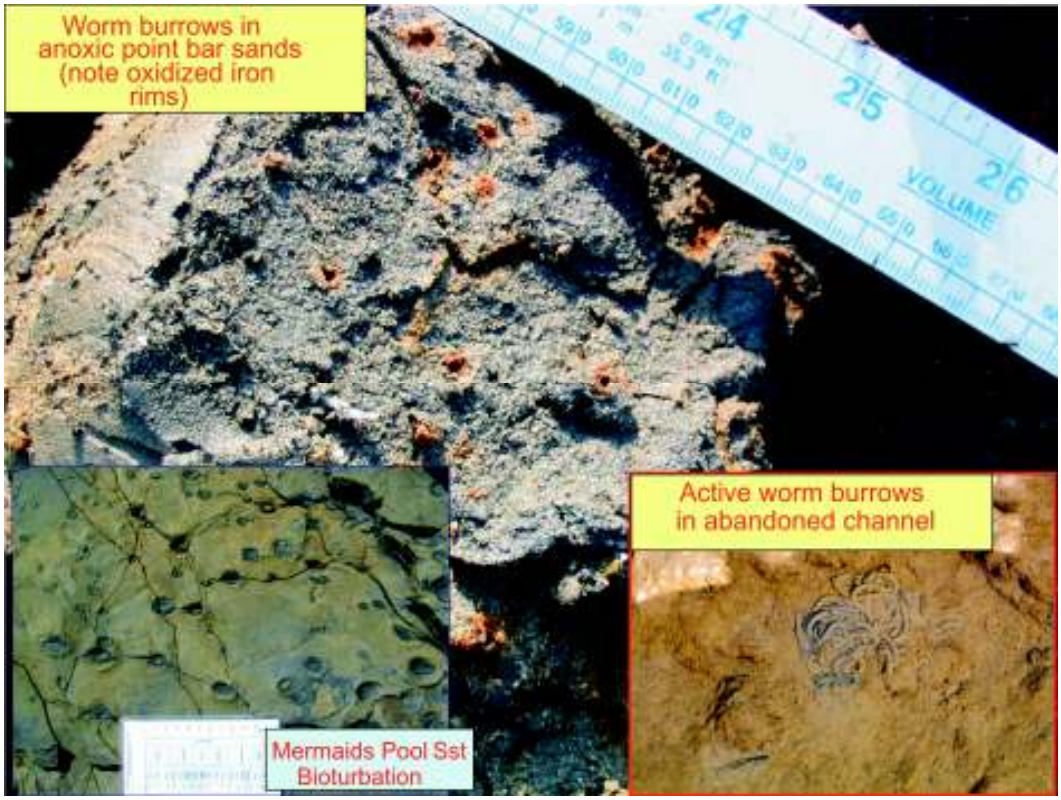
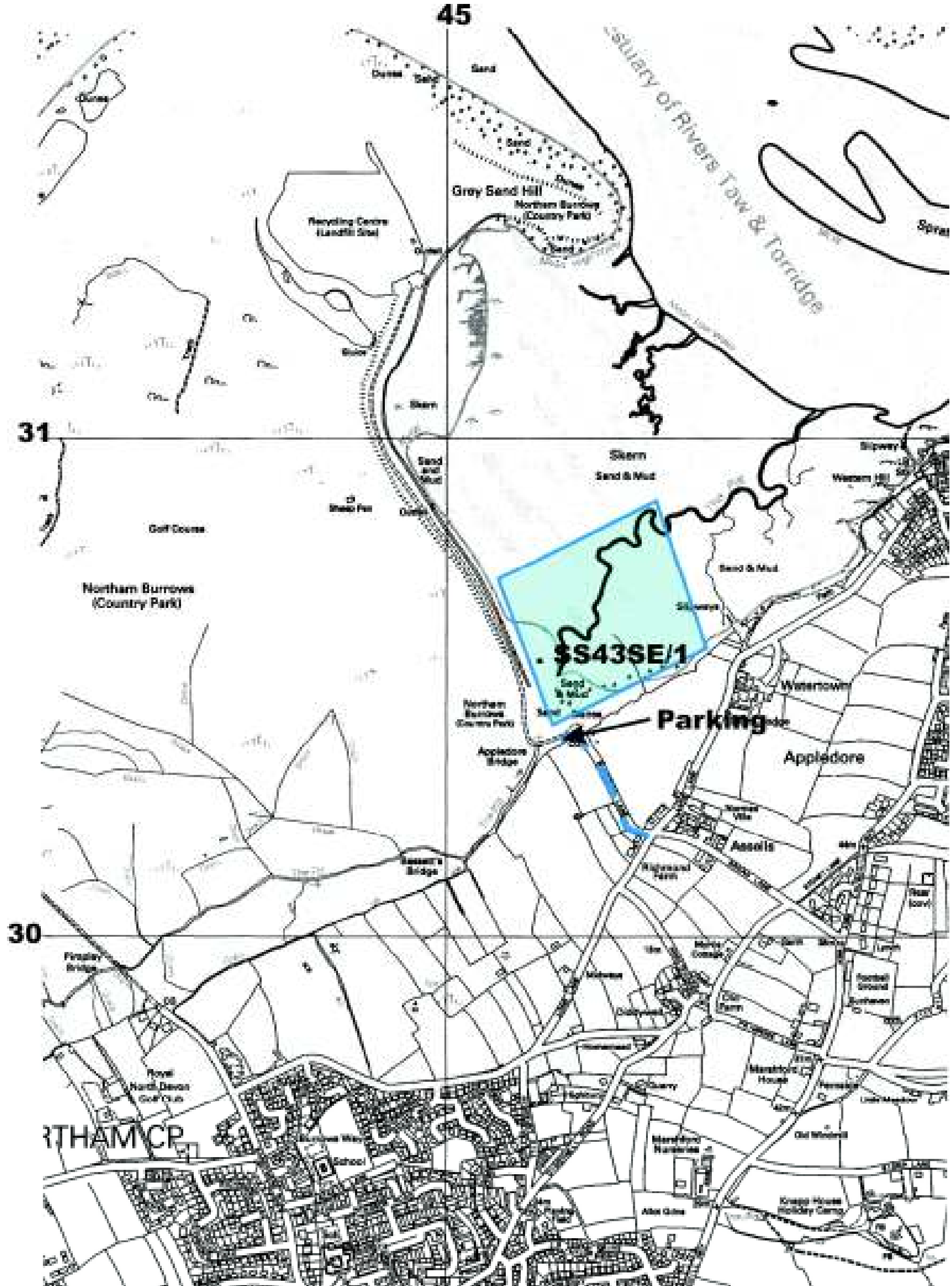


Plate 20. Modern worm burrows. Inset photo annotated in blue from Carboniferous near Mermaid's Pool, Westward Ho!

Plate 21. Ripple marked surface on tidal flat Inset photos annotated in blue are from the Carboniferous near Seafield House, Westward Ho!


45
31
30
Estuary of Rivers Taw & Torridge
Grey Sand Hill
Northam Burrows (Country Park)
Recycling Centre (Landfill Site)
Golf Course
Skern
Sand & Mud
. SS43SE/1
Parking
Watertown
Appledore
Appledore Bridge
Assels
Royal North Devon Golf Club
THAM CP
Appledore

Appendix 2 Glossary and abbreviations

Alluvial fan	A fan-shaped deposit of gravel, sand and mud deposited where a fast flowing steep stream flattens out commonly at the foot of hills or mountains.
Bivalve	Marine or freshwater molluscs having a soft body with platelike gills enclosed within two shells hinged together
Brachiopod	Sessile, two-shelled, marine animals that somewhat resemble bivalves(i.e. "clams") externally but are quite different internally.
Breccia	A rock formed from angular fragments instead of rounded. See conglomerate
CGS	County Geological Site. A RIG site of countywide importance
Chert	A fine-grained sedimentary rock composed of crypto-crystalline silica
Conglomerate	A rock formed from rounded fragments or pebbles
Conodont	Distinctive multi-bladed teeth made made of calcium phosphate which belonged to a worm like creature possibly ancestral to vertebrates
Distributary	Minor rivers that branch off from a major river before it reaches the sea, particularly in a delta
Distal turbidite	A sedimentary deposit formed by a bottom hugging current bearing a poorly sorted load of sand, mud and silt. The 'distal' refers to it being deposited far out in the basin or on the lower slopes
GCR	Geological Conservation Review. The GCR was designed to identify those sites, usually already SSSIs, of national and international importance needed to show all the key scientific elements of the Earth heritage of Britain.
Goniatite	One of an extinct genus of fossil cephalopods, allied to the later ammonites
Interdistributary bay	The areas of deposition on a delta between the mouths of the distributaries
Lag deposits	Coarser sediments, such as cobble gravel which are transported only during perio
Playa lake	A temporary t-floored center of undrained desert basin
Point bar	The deposits laid down in the convex side of a river meander

Proximal turbidite	See distal turbidite. Proximal turbidites are deposited farther up the marine slope nearer the coastal margin
'Red beds'	Sediments, usually conglomerates, sandstones and mudstones stained red by an oxidation commonly found in a desert environment
Seatearth	A fossilised soil profile commonly with fossil roots or rootlets
Sideritic	A rock containing iron carbonate
Slumped bed	A sediment formed of the transported and disrupted debris of pre existing sediments. This disruption takes place on a marine slope and may be triggered by an earth tremor
Synclinorial	A complex but generally major synclinal fold
Till	Accumulations of unsorted, unstratified mixtures of clay, silt, sand, gravel, and boulders deposited by a glacier
Trilobite	Marine arthropods, a phylum of hard-shelled creatures with multiple body segments and jointed legs
Turbidity current	A bottom hugging current bearing a poorly sorted load of sand, mud and silt
Unconformably	A situation where a geological surface separates older from younger rocks and represents a gap in the geologic record
Westphalian C	A part of the Coal Measures named from Westphalia in Germany
Wrench fault	A fault which moves in a lateral direction rather than up and down as is the case of a normal or reverse fault