Natural Area: M14. Studland Cliffs to Portland Bill	Geological Significance: Outstanding (provisional)

General geological/geomorphological character: The area is one of the most famous in the world for Upper Jurassic geology, with many sites of international importance. The Studland Cliffs to Portland Bill Maritime Natural Area demonstrates clearly how wave action and variations in lithology produce differential rates of cliff erosion, forming deeply incised bay, stacks etc. Geologically and geomorphologically these are valuable teaching grounds. Littoral processes include a low and intermittent eastward drift.

Geological history: The earliest deposits are exposed east of Weymouth where the junction between the Oxfordian Stage and underlying Callovian Stage is visible (approximately 157 Ma) in tropical marine clays (the Oxford Clay), this junction also marks the base of the Upper Jurassic. This Oxford Clay represents the first major deepening of water since the Lias. The overlying complex sand, limestone and clay sequence, which contains a rich molluscan fauna, belongs to the Corallian Group which was largely deposited in shallow water with some affinity to the modern Bahamas. At the top of the Corallian Group the boundary with the overlying Kimmeridge Clay marks the Oxfordian-Kimmeridgian boundary (approximately 155 Ma). Both the Oxfordian lower and upper boundaries are internationally important. The Kimmeridge Clay is one of the thickest clay units in the local Jurassic representing a relatively deep water deposit. It is rich in fossils including vertebrate remains such as giant marine reptiles and has a high organic content, a local source of oil. In the Upper Kimmeridgian there is a progressive shallowing of environment culminating in the shallow marine Portland sandstones and limestones (the famous Portland Stone used for building worldwide) which again contain a rich molluscan fauna with occasional vertebrates. The Portland Group includes sections through the historical base for Portlandian Stage (now part of the Tithonian Stage). The limestones and shales of the overlying Purbeck Group represent the onset of non-marine conditions with lagoonal and brackish water deposits (with fossil stunted tress) indicating a hot arid climate. The Jurassic-Cretaceous boundary (approximately 146 Ma) lies within the Purbeck Group and the area is internationally important for the study of this boundary which is still the subject of debate. The Purbeck group yields important vertebrate faunas including fish, reptiles, dinosaurs and early mammals. The overlying river or lake deposited clays of the Fluvial environments dominated the overlying Lower Cretaceous Wealden Group depositing a sequence of sandstones, grits and clays (best seen in Warbarrow Bay). The Wealden Group is overlain by a marine sequence deposited by a tropical sea flooding back into the area, part of a global rise in sea level. - this sequence includes fossiliferous Lower and Upper Greensands (125-97 Ma) and intervening Gault Clay. The overlying Upper Cretaceous Chalk sequence (97-74 Ma) represents the deposit of a widespread shallow sea. The sequence, in particular the chalk, is folded and faulted showing evidence of the northern-most effects of the Tertiary Alpine Orogeny (approximately 15 Ma). Though the area was not glaciated during the Pleistocene it has been affected by changes in glacial and interglacial climate, notably one of the most important raised beach sequences on the south coast.

Geomorphological evolution and processes: Portland beach runs northwestwards from Portland Castle as far as Small Mouth and is quite distinct from Chesil. It is about one and a half miles long and at the Portland end, encloses the Mere. It is built mainly of Portland and Purbeck rocks brought by wind driven waves, deflected from their normal course by the Isle and running eastwards on this part of the shore. Pebbles of Portland and Chesil beaches do not mingle and the little valley between them is a sharp, geological boundary. Between Weymouth and Lodmoor a beach runs for about two miles, it is higher and narrower toward Lodmoor which typifies a true storm beach, of large pebbles. The Portland breakwater has influenced these beaches considerably by reducing sediment fed into their systems. While Weymouth is relatively stable Lodmoor beach is threatened by inundation. The cliffs on the easterly face of the Isle of Portland are greatly affected by landslips, but are most famous for the raised beach at Portland Bill [15-6m OD]. The wave cut platform in Purbeck and Portland beds, on which the beach rests, slopes downwards away from the cliff face.

From approximately White Nothe to Studland Bay the coast is known as the Isle of Purbeck. Purbeck represents some of the best and most interesting and varied cliff scenery in England and Wales. An important feature is the reversed fault seen in Ballard Point which reappears behind Arish Mell, Lulworth and Durdle Door. The chalk headlands of White Nothe reach 500ft and the bedding plains indicate a syncline eastwards. Between Dungy Head and Lulworth Cove the sea has already cut through the Portland stone in three places; it is now eating into the broken Purbeck Beds, and once they are demolished erosion in the soft Wealden Beds will be rapid. Stair Hole shows this extremely well. Between St. Albans Head and Durlston Head the Portland stone provides much resistance to erosion so that the cliffs are vertical, and erosion is mainly limited to joint plains. Durlston Bay is the best section of Purbeck rocks seen in this country; nearly the whole succession is repeated by two strike faults. Ballards Down forms a distinct promontory at the eastern end of the Isle of Purbeck where differential erosion of sands and clays to the north and south of the chalk cuesta has produced Studland Bay and Swanage Bay respectively. Swanage Bay is cut in the soft Wealden beds and lies between the resistant Purbeck strata of Peveril Point and the chalk of Ballard Point, illustrating the effects of differential erosion. Towards Handfast Point are the Pinnacles, detached columns of chalk, then a large cave called Parsons Barn and finally the famous Chalk stacks of 'Old Harry', and what remains of 'Old Harry's wife'.

Key geological/geomorphological features:

- Internationally important stratigraphic sites, including Callovian-Oxfordian, Oxfordian-Kimmeridgian, Kimmeridgian-Portlandian and Jurassic-Cretaceous boundaries.
- World famous fossil localities.
- Displays all stages in the formation of caves, arches and stacks.
- Portland Bill, a raised beach (15-6m OD), on the Isle of Portland

Number of GCR sites:

Portlandian: 9 Jurassic-Cretaceous Reptilia: 6 Aptian Albian: 3 Kimmeridgian: 3 Oxfordian: 2 Cenomanian-Maastrichtian: 2 Alpine Structures of England: 2 Coastal Geomorphology of England: 2 Wealden: 2 Pleistocene/Quaternary of southern England: 2 Palaeoentomology: 1 Palaeogene: 1 Tertiary-Mesozoic Fish/Amphibia: 1

Geological/geomorphological (P)SSSI coverage: There are 5 coastal (P)SSSIs in the MNA containing 36 GCR SILs representing 13 different GCR networks. The outstanding geological importance of the area is without doubt. The South Dorset Coast SSSI contains twenty four separate geological interests including the type area for the Kimmeridgian, key Portlandian sections, Lower Cretaceous Wealden sections (Wessex Formation) and sections through Lower to Upper Cretaceous Gault, Upper Greensand and Chalk. The fossil fauna is equally important the SSSI having yielded many type specimens. These include reptiles from the Kimmeridge Clay and the Portlandian of Durlston Bay (turtles, crocodiles, pterosaurs, plesiosaurs, ichthyosaurs and dinosaurs). Durlston Bay is also the most important mammal locality of its age in the world and has yielded one of Britain's richest insect faunas. The Isle of Portland is the type area for the Portlandian Stage (also known as the Tithonian Stage), West Cliff being particularly important. It is also worth noting that the Isle of Portland exposes the South Coast's most important raised beach which documents at least two marine episodes. More recent landslips are also important with some of the best examples of joint and fissure controlled slab failure being present on the Isle.

Key geological management issues:

- Maintain dynamic nature of the coastline and associated landforms such as Lulworth Cove, by maintaining the natural marine erosional processes around the islands
- Ensure responsible Fossil collecting from sensitive or vulnerable coastal sites.
- Monitor and regulate the Tourism industry regarding such issues as (i) expansion and associated development and (ii) visitor pressure on coastal sites.

Key geological objectives:

1. **Prevent damaging coastal works** by a) ensuring all coastal defence proposals are part of an agreed Shoreline Management Plan.

2. **Manage palaeontological resource** by a) controlling where possible (through adoption of responsible collecting policies), damaging fossil collecting.

3. **Provide interpretation** to increase awareness of the area's importance.

Useful guides/references:

ARKELL, W.J. 1947: The Geology of Weymouth, Swanage, Corfe and Lulworth. Memoir of the Geological Survey of Great Britain.

BRUNSDEN, D. & GOUDIE, A. 1981: Classic Coastal Landforms of Dorset, Geographical Association.

COPE, J.C.W. *et al.*, 1980: A correlation of Jurassic rocks in the British Isles, 2. Middle and Upper Jurassic. Geological Society of London Special Report, **15**

HOUSE, M.R. 1992: The Dorset Coast, Geologists Association Guide.

MELVILLE, R.V. & FRESHNEY, E.C. 1982: British Regional Geology: The Hampshire Basin and adjoining areas. British Geological Survey, HMSO.

Earth science coastal (P)SSSIs in the Maritime Natural Area:

- South Dorset Coast
- Isle of Portland
- Portland Harbour Shore
- Purbeck Ridge (East)
- Studland Cliffs

Natural Area: M15. Start Point to Portland Bill (Lyme Bay)	**Geological Significance:** Outstanding **(provisional)**

General geological/geomorphological character: The Start Point to Portland Bill Maritime Natural Area encompasses the large arcuate coastal embayment known as Lyme Bay. The onshore area comprises rocks of Devonian age (410 to 355 Ma) in the west which young eastwards to Permo-Triassic 'red beds' (210-290 Ma) around Budleigh Salterton/Sidmouth and softer Jurassic strata (205 to 135 Ma) between Lyme Regis and Portland Bill. Both Triassic and Jurassic rocks are unconformably overlain by Cretaceous sediments (110 to 80 Ma) which form the 'cappings' to the coastal topographic highs such as Stonebarrow Hill and Golden Cap. All the strata are superbly exposed along the coastal sections and the area contains many key localities of international geological significance for stratigraphy and palaeontology. The more resistant Devonian rocks in the west of the bay produce a rocky cliff line to the Natural Area, the softer Jurassic clays and shales to the east of Lyme Bay give rise to a distinctive smooth arcuate coastline which rapidly erodes and is dominated by coastal landslips and mass movements.

Onshore geology: The Devonian rocks exposed between Start Point and Brixham are represented mainly by metamorphic schists formed during the Variscan Orogeny (a mountain-building period 375 to 300 Ma). From Brixham northwards to Torquay the Devonian strata are primarily of mid Devonian age and represent a carbonate reef facies. Certain beds contain typical and abundant reef fossils including corals, bryozoans and stromatoporoids. Between Babbacombe Bay and east of Sidmouth the cliffs comprise mainly Permo-Triassic sandstones and interbedded conglomerates (the 'red beds'); these represent terrestrial/fluvial sediments which were deposited in an arid environment. Red sandstones near Sidmouth occasionally yield fossil remains of terrestrial reptiles.

The Jurassic sediments are admirably exposed between Pinhay Bay (west of Lyme Regis) and Portland Bill - virtually the whole of the Jurassic Period is represented. The sequence exposes classic and standard sections, perhaps the best in Europe, which have been studied and the fossil fauna collected since the eighteenth century. The Jurassic strata consist mainly of fossil-rich clays and shales (interbedded with limestones in parts). The area is internationally renowned for its fossils which include vertebrates (marine lizards, pterosaurs, dinosaurs, fish) and abundant invertebrates (including ammonites, belemnites, bivalves, corals, and insects). The Cretaceous sediments represent mainly marine deposits which are also rich in fossil material. The area around Beer Head and Seaton comprises condensed mid Cretaceous limestones overlain by a sequence of fossiliferous Chalk. Eastwards the Cretaceous strata are typically represented by clays, greensands and chalks which unconformably overlie the Jurassic sediments and form the capping to higher ground. Lyme Bay is also famous for its coastal geomorphology with numerous classic landforms such as shingle beaches and spits. The constantly crumbling soft cliffs and rates of erosion have resulted in a number of spectacular and large scale landslips.

Offshore geology: The offshore geology in the bay largely mirrors the sequence onshore. To the west of the bay Permo-Triassic sediments dominate (Devonian strata have a very limited extent offshore being confined exclusively to relatively narrow areas in Start Bay). Offshore strata young progressively eastwards and comprise near horizontal lower, middle and upper Jurassic sediments - Cretaceous sediments do not crop out offshore within Lyme Bay until a point approximately 35 nautical miles south of Lyme Regis. These strata are overlain by a sequence of Quaternary sea bed sediments which vary in clast size from mud to gravel grade. Near-shore sea bed sediments between Bridport and Budleigh Salterton comprise gravelly sands, coarser sandy gravels occur adjacent to Chesil Beach. Further offshore, and to the west of the bay, the sea bed sediments are dominated by sandys and muddy sands. Most of these sediments were deposited within a marine transgression phase during temperate Flandrian (Holocene) times - the sediments lie outside of the main palaeovalley deposits which appear to represent a complex river system much modified by marine processes. This Flandrian transgression saw the initiation of mobile sediments (sandbanks) and eventually the covering of the sea bed with lag sediments as the transgressive phase was completed.

Key geological/geomorphological features:

- Coastal exposures of Devonian, Jurassic and Cretaceous strata, many key localities of international importance represented
- Fossil localities including type localities for vertebrate remains (marine reptiles, dinosaurs, pterosaurs and fish) and invertebrates (especially ammonoid cephalopods)
- Coastal geomorphological features
- Coastal landslips

Number of GCR sites:

Portlandian-Berriasian: 13 Coastal Geomorphology of England: 9
Jurassic-Cretaceous Reptilia: 7 Marine Devonian: 5 Permian-Triassic: 5 Kimmeridgian: 4
Mesozoic-Triassic Fish/Amphibia: 4 Oxfordian: 3 Toarcian: 3 Mass Movement: 3
Aptian-Albian: 3 Wealden: 3 Rhaetian: 2 Hettangian-Pliensbachian: 2 Cenomanian-Maastrichtian: 2 Palaeoentomology: 2 Bathonian: 2 Aalenian-Bajocian: 2 Mesozoic Mammalia: 2
Callovian: 2 Permian-Triassic Reptilia: 1 Mesozoic Palaeobotany: 1
Alpine Structures of SW England: 1 Mineralogy of SW England: 1 Pleistocene/Quaternary of SW England: 1 Pleistocene/Quaternary of S. Central England: 1

Geological/geomorphological SSSI coverage: There are 17 coastal (P)SSSIs in the MNA covering 83 seperate GCR SILs and 27 different GCR networks. This indicates the very high diversity of the area's geological heritage. The largest of these sites are those which expose Jurassic strata, such as Axmouth to Lyme Regis SSSI, West Dorset Coast SSSI and South Dorset Coast SSSI. These sites contain many of the notable fossil localities although Devonian limestones in Torbay (eg. Daddy Hole SSSI and Hopes Nose to Walls Hill SSSI) are also fossiliferous in places although the beds here are typically more massive and fossils are difficult to extract.

The landslips at Axmouth to Lyme Regis SSSI form one of the largest landslide areas in England and are internationally renowned. Sites such as Chesil Beach and the Fleet SSSI and Dawlish Warren SSSI are important for their coastal geomorphology, showing features such as tombolos, longshore drift and shingle beach structures.

Key geological management issues:

- Threats to coastal geological exposures, coastal geomorphological features and mass movement landforms from coastal engineering and coastal defence projects
- Overuse and misuse of sensitive fossil localities
- Dredging of sea bed sediments and resulting effects on geomorphological processes

Key geological objectives:

1. Maintain the operation of natural coastal processes within Lyme Bay, including the present cliff erosion, sediment transport and deposition patterns.

2. Maintain the integrity of coastal exposures and coastal landslips

3. Encourage responsible fossil collecting in sensitive localities

Useful guides/references:

MELVILLE, R.V. & FRESHNEY, E.C. 1982: The Hampshire Basin and adjoining areas. British Regional Geology handbook, Institute of Geological Sciences, NERC

HAMBLIN, R. J. O. *et al.* 1992: The geology of the English Channel. United Kingdom Offshore Regional Report, British Geological Survey

HOUSE, M. R. 1989: Geology of the Dorset Coast. Geologists Association Guide.

Earth science coastal (P)SSSIs in the Maritime Natural Area:

- Axmouth to Lyme Regis
- Sidmouth to Beer Coast
- West Dorset Coast
- Ledram Bay to Sidmouth
- Budleigh Salterton Cliffs
- Dawlish Cliffs
- Dawlish Warren
- Hopes Nose to Walls Hill
- Babbacombe Cliffs
- Daddy Hole
- Hall Sands
- Saltern Cove
- Slapton Ley
- Burton Bradstock
- Chesil Beach and the Fleet
- South Dorset Coast
- Isle of Portland

Natural Area: M16. Start Point to Lands End	Geological Significance: Outstanding (provisional)

General geological/geomorphological character: The Start Point to Land's End Maritime Natural Area has the highest number (36) of coastal SSSIs with a GCR interest. The coastline is generally rocky in character, with coves and headlands, and a number of flooded estuaries (*rias*) cutting into the rolling inland plain. The solid rocks of the area are almost wholly of Upper Palaeozoic age (400 to 230 million years old). These are mainly folded and faulted Devonian and Carboniferous slates and sandstones, with some igneous rocks. Younger Permian sandstones and mudstones crop out several kilometres offshore in the shallow continental shelf (mostly less than 60m deep) of the Western Approaches.

Onshore Geology: The rocky coastline provides sections through deformed Palaeozoic slates and sandstones. These were once sands and muds at the bottom of a marine gulf in Devonian and Carboniferous times. Throughout this period, the gulf narrowed as the old continental area forming the south side of the sea drifted north towards a landmass covering central and north Britain. During the closure (known as the Variscan Orogeny), volcanoes became active within the gulf, intruding small igneous bodies into the sediments. Eventually, the sea closed entirely and the bottom sediments and rocks were squeezed and crumpled up to form a land area, folding and faulting them in complex ways. Part of the deep oceanic crust and underlying mantle was also caught up in the closure, and is now seen as the Lizard's serpentinites. The collision caused large volumes of molten rock to rise up through the deformed rocks, some of which reached the surface as lava. Rock which solidified below surface formed the granite in the southwest of the MNA. The hot granites heated up groundwaters, which leached out minerals from the granite and sedimentary rocks, concentrating them into mineral-bearing fluids. These percolated through faults and breaks in the rocks and precipitated out tin, copper and lead minerals on cooling. The area underlain by the granites has been a land area of considerable relief since the Variscan orogeny. The area was not glaciated during the last ice ages, but was a periglacial tundra zone above sea level. Deposits of 'head', solifluctory gravels formed= by freeze-thaw action were created widely during glacial periods. The coastline has changed during Holocene eustatic sea-level changes. Raised beaches mark previous inter-glacial periods when the sea-level was higher, and submerged coastlines and drowned mature valleys formed during glacial periods of lower sea level.

Offshore Geology / Geomorphology: Variscan rocks underlie most of Plymouth Bay for 5 to 10 km offshore. The seabed in the outer part of the MNA is underlain by younger Permian and Triassic red mudstones and sandstones which form a thin cover on top of the Variscan rocks, recording a time when the area was part of a continental desert. The Eddystone Reef is of particular interest because it is composed of ancient gneisses and schists which are similar to those in Brittany and the Channel Islands and were part of the southern continent. Apart from rocky areas around the Lizard, the S. Devon coast and Eddystone Reef, most of the seabed has a covering of Quaternary sediment, primarily sand and gravel, quite rich in bioclastic debris. Muddier sediments are found off the Fal Estuary and Plymouth Sound. Most of the bedforms are are modern, with sand patches and sandwaves dominant, and some areas of rippled sand sheets south of Plymouth Sound and around the Lizard.

Geomorphological Evolution and Processes: Start Point to the Lizard is predominantly a rugged, largely undeveloped cliffed coastline, intersected by drowned river valleys, which effectively separate the frontage into independant units. Sandy beaches in the east of the MNA and pebble/sandy beaches west of Rame Head extend to the Lizard and are backed predominantly by slate cliffs that extend seawards as rock reefs. The transport rate in this part of the MNA is insignificant, with virtually no nett drift along the coast between Start Point and Lizard Point. Wave action is an im portant process which produces local cliff erosion and helps to produce extensive sand beaches in estuary mouths, promontories etc. (e.g. Rivers Avon and Erme).

Erosion of the boulder clay overburden at the west end of Whitesand Bay, caused by swell penetrating to the eastern end of this frontage, has produced extensive sand beaches in the bay. Tidal currents may help distribute china clay waste within St. Austell Bay, but otherwise currrents play no significant role in coastal processes.

The rocky cliffed peninsulas of resistant schists and igneous intrusions of the Lizard and granite cliffs of Penwith, shelter the lower lying land in Mount's Bay. Slate cliffs covered by boulder clay in Mount's Bay, back wide sand flats in the west. Pocket sand or shingle beaches are found along the cliffed frontage with a shingle beach at Loe bar. Loe bar encloses a lagoon (Loe Pool), occupying part of a former ria and forms an integral part of a beach system extending from Porthleven to Gunwalloe. The beach is about 4km long and 250 metres wide. The beach is formed of flint shingle and coarse sand for which there is no local source. Present day inputs of sediment from the adjacent cliffs are small and overall the beach is in deficit. The bar itself is a sediment sink as far as the overall beach budget is concerned. The bar is likely to survive as long as shingle remains within the main beach that feeds it. It has been suggested that the origin for loe Bar and similar landforms (eg. Slapton sands) is their development as offshorer bars which were gradually moved onshore as Holocene Sea level rose. Loe bar forms part of a wider suite of flint beaches along the southern coast of England. (eg. SW coast of the Isle of Wight). The bay between Landsend and Lizard Point forms a natural coastal cell. There is very low eastward drift in Mount's Bay and seasonal alongshore movements along Loe bar but no apparent nett drift. Wave action is the dominant process, causing significant onshore/offshore beach movemnts but little net alongshore movement in this section of the MNA. Landsend is famous for being the most westerly point of the country.

Key geological/geomorphological features:

- Igneous rocks, particularly 'ophiolitic'(mantle) rocks around the Lizard, and others at Start Point.
- Devonian sediments deformed by the Variscan orogeny.
- Minerals sites, particularly related to the granites.
- Sea-level change sites: raised beaches and rias eg. Loe Bar.

Number of GCR sites:

Igneous Rocks of Southwest England: 16 Marine Devonian: 15 Variscan Structures Of Southwest England: 5 Mineralogy of southwest England: 5 Coastal Geomorphology: 2 Pleistocene/Quaternary of southwest England: 1

Geological/geomorphological SSSI coverage: There are 38 coastal (P)SSSIs in the MNA containing 44 GCR SILs which represent 6 different GCR networks. These are predominantly related to the solid geology and the story of the ancient marine gulf which closed during the Variscan Orogeny, and related evidence of that mountain building episode. An example of the marine sediments laid down in the Devonian is at Rosemullion SSSI. The igneous rocks of the basin are exemplified by Coverack Cove and Dolor Point SSSI. Bovisand and Jennycliff Bays SSSI is an example of the deformation of the sediments. The granites of the Cornubian batholith are shown for example at Folly Rocks, whilst the related mineralisation can be seen at Tremearne Par. The periglacial environment during the glacial stages of the Ice Ages are represented for example by the Pendower GCR site. Loe bar SSSI is an excellent example of a shingle bar with additional interest in that the bar blocks a ria and the sediments in the adjacent cliffs suggest that the beach occupies an interglacial embayment. Whitesand Bay PSSSI, is one of a suite of major south-west facing beaches on the English Channel coast (the others being South-west IoW and Seven Sisters). It is backed by a cliffline having a slope-over-wall form which is little affected by retreat. The slope-over-wall cliff reaches a hieght of 80metres towards the eastern part of the bay and established residences on part of the slope indicate the stability of this part of the cliff.

Key geological management issues:

- Maintain natural processes: use of integrated Shoreline Management Plans to support the conservation of continued natural processes and protect the rock cliffs from coastal protection works.
- Use of coastal quarries to provide armour stone for coastal protection, and related pollution issues.
- Offshore exploitation of mineral resources, including tin placers, gravel and maërl (fertiliser).
- Mineral collecting, and resultant damage to, and pollution of the marine environment.

Key geological objectives:

1. **Maintain and where possible enhance** the existing geological and geomorphological features and natural processes, including use of estuarine and shoreline management plans for the coastal zone.

2. **Encourage initiatives** aimed at the joint management and promotion of the NA's geological and biological resources e.g. in offshore areas such as the Eddystone Reef.

3. **Any operation which significantly reduces or stops natural processes** from acting upon the coastline should be opposed.

4. **Maintain integrity of Loe Pool and bar through** a) avoiding disturbance to natural processes and b) avoid using important sources of shingle for gabion cage filling and c) any coastal defence scheme must be considered within an agreed Shoreline Management Plan.

Useful guides/references:

EVANS, C.D.R. 1990: The geology of the western English Channel and its western approaches. BGS UK Offshore Regional Report.

FLOYD, P.A., EXLEY, C.S. & STYLES, M.T. 1993: Igneous Rocks of Southwest England JNCC GCR Series Volume 5; Chapman & Hall, London.

STEERS, J.A. 1964: The Coastline of England and Wales (2nd Edition) Cambridge University Press.

Earth science coastal (P)SSSIs in the Maritime Natural Area:

- Baulk Head to Gunwalloe Church
- Bull Cove
- Caerthillian to Kennack
- Coverack Cove and Dolor Point
- Coverack to Porthousestock
- Cuckoo Rock to Nar Point
- Cudden Point to Prussia Cove
- East Portholland to Cadythew Rock
- Folly Rocks
- Gerrans Bay to Camels Cove
- Kennack to Coverack
- Kingsand to Sandway Point
- Kynance Cove
- Loe Pool
- Meneage Coastal Section
- Mullion Cliff to Predannack Cliff
- Penlee Point
- Cuckoo Rock to Nar Point
- Poldhu Cove to Pollurian Cove
- Porthgwarra to Pordenack Point
- Porthleven Cliffs
- Porthleven Cliffs East
- Rosemullion
- St. Michael's Mount
- Tater Du
- Tremearne Par
- Whitsand Bay
- Wheal Penrose
- Bovisand and Jennycliff Bays
- Faraday Road
- Mount Wise
- Prawle Point and Start Point
- Salcombe to Kingsbridge Estuary
- Wallsend Industrial Estate
- Western King
- Wheal Emily

Maritime Natural Area: M17. Isles of Scilly	**Geological Significance:** Considerable **(provisional)**

General geological /geomorphological character: The Isles of Scilly lie some 40 km WSW of Lands End and consists of an archipelago of over 200 islands and islets. The vast majority of these are devoid of vegetation and soil; only five are permanently inhabited.

Geological History: The solid geology of the islands is granite (around 290 million years before present). The granite is part of a huge subterranean batholith stretching from Dartmoor to the Scillies, but exposed only in places where the overlying cover rocks have been stripped from the domes by weathering and erosion. Slow cooling of the batholith during formation has given the granites a distinctive crystalline and coarse grained texture: this is reflected in the poorly formed and acidic soils of the area.

Quaternary History: The maximum glacial limit during the Quaternary reached as far south as the north coast of the Scillies, eroding the rocks over which it passed and depositing glacial tills (sand, gravel and clay) across this area of the island. Periodic periglacial weathering of the granite during the Quaternary (the last 2 million years) created granite tors on much of the Scillies and a weathering mantle (regolith) around their bases. Solifluction deposits (head) also developed at this time as these regoliths were mobilised and flowed down slope across permafrost. The result of granite weathering and erosion of low cliffs and platforms takes two forms, an angular head and the production of much sand which is often blown up into small ridges and dunes. In places such as Porthloo head deposits may reach a thickness of several metres and are found in association with organic horizons which allow dating and correlation between sites.

Geomorphological evolution and processes: During interglacial periods when climate was warmer, raised beaches formed around the islands as a result of the relatively high sea levels. There are clear traces of raised beaches or platforms at 3 - 8 m above the present sea level. These show up best in areas of weathered granite and less clearly where the rock is sound and well jointed. Submarine contours around the archipelago show clearly that the whole group is a result of the erosion and submergence of the once continuous granite batholith stretching from Dartmoor, on the mainland, to the submarine outcrop of Haig Fras, some 100 km to the WNW of the Isles of Scilly. Evidence suggests that the archipelago is still sinking. The Isles of Scilly archipelago is encircled by a 50m depth contour which comes to within a few hundred metres of the shore along much of the north, east and south coasts, suggesting a steep slope from the shore into deep water at many locations. The Western Rocks, Annet, St.Agnes and rocks and islands west of Bryher are separated from the rest of the archipelago by depths in excess of 10m, whilst St.Marys is separated from Bryher, Samson, Tresco and St.Martins by depths of less than 1m. These latter 4 islands are joined by extensive tidal flats at extreme low tides. Prevailing winds and swell in the region of the Isles of Scilly are from the south-west and, particularly in view of the presence of deep water close to the shore, south- and west-facing coasts on the outer rocks and islands are clearly extremely exposed. A high proportion of winds also come from the north. East-facing coasts, amongst the islands and in Bays very sheltered conditions occur. The amount of blown sand has increased considerably and in places like Hugh town the likelihood of inundation has reduced. Blown sand is most conspicuous on Tresco forming a ridge in the SE shore of the island reaching a hieght of 11m in some parts, which forms quite an effective barrier to the sea. A noteworthy characteristic of the islands is the number of sand bars and tombolos which now join former islands.. It appears the overall land area of the Scillies has not decreased in recent times, despite earlier submergence of the Archipelago, predominantly due to the constant washing up of fine sand from the shallow sea floor around the islands.

Key geological/geomorphological features:

- Granite weathering landforms including coastal tors
- Coastal cliff sections showing glacial deposits in the nothern Scillies and head deposits in the south
- Coastal geomorphological features such as beaches, sand bars, and tombolos which join the islands
- Raised beaches or platforms at 3 - 8 m above present sea-level

Number of GCR sites:
Pleistocene/Quaternary of SW England: 11 Coastal Geomorphology of England: 2

Geological/geomorphological SSSI coverage: There are 11 coastalk (P)SSS's in this Maritime Natural Area containing 13 GCR SILs representing 2 different GCR networks. Peninnis Head SSSI forms a prominent cliffed headland on the south side of St. Marys and is significant for Quaternary Geomorphology. It demonstrates spectacular granite cliff topography and is a particularly good example of the granite tors of the islands, weathering landforms and associated head deposits. Porthloo SSSI is a site noted as the type site for the Porthloo Breccia (a periglacial head deposit). Tean SSSI is composed of a series of granite tors, separated by lower land overlain with glacial till, erratics and outwash gravels. The site is important because it marks the approximate southern limit of the glaciation in this area, as shown by soliflucted glacial outwash gravels.

Key geological management issues:

- Maintain levels of exposure and integrity of all GCR sites including coastal sections.
- Maintain natural marine erosional and littoral processes around the islands
- Sea-level rise is likely to increase the rate of coastal erosion. This is likely to lead to increased demands for coastal defence. Although not large in scale, if carried out in an unco-ordinated manner they may damage sensitive geomorphic environments and increase further demands for protection works.

Key geological objectives:

1. **Discourage cliff-top development which may require future defence works:** Sites such as Watermill Cove, Porth Seal and Bread and Cheese Cove are under a greater threat from damaging operations, as they represent individual examples of exposed organic horizons not found elsewhere around the islands. ie; management priority.

2. **Maintain natural marine and littoral processes** by ensuring a) coastal defence proposals are part of an agreed shoreline management plan and b) restricting or avoiding development schemes such as cliff drainage or alteration which may alter natural coastal processes such as sediment transport or directly obscure cliff exposures.

3. **Maintain and Enhance Geological Resource** through a) development of a Shoreline Management Plan and b) through interpretation and education promoting the resource and safe guarding its future.

Useful guides/references:

STEERS, J.A. 1981: Coastal Geomorphological features of England and Wales, The Oleander Press.

HISTOCK, K. 1983: Sublittoral survey of the Isles of Scilly, Field Studies Council.

Earth science coastal (P)SSSIs in the Maritime Natural Area:

- Gugh
- Peninnis Head (St. Mary's)
- Higher Moors and Porth Hellick Pool (St. Mary's)
- Eastern Isles (Including Great and Little Gamilly and Great and Little Arthur)
- Chapel Down (St. Martins)
- White Island (off St. Martins)
- Porth Seal (St. Martins)
- Tean
- Castle Down (Tresco)
- Watermill Cove
- Porthloo