UNIT 2 COASTAL ENVIRONMENTS

Recommended Prior Knowledge As is the case for all the Advanced Geography Options, completion of the core modules is expected. The coastal environments option builds on knowledge and understanding gained in the compulsory core units of *Rocks and Weathering.*

Context The focus here is on the link between **process and form** and the ways in which human activity is impacting upon coastlines. Examples may be taken from any part of the world but knowledge of coral reefs is mandatory.

Outline Knowledge and understanding of coastal processes should precede study of the landforms produced by these processes along cliffed and constructive coasts. 2.1 and 2.2 will be inter-linked in this option, as teaching of the relevant process ideally should precede introduction of the landforms. Hence erosional processes precede cliffed coastlines and transportation and deposition precedes constructive coastlines. Detailed knowledge of coral reefs is required, as is appreciation of the role of human activity in the coastal environment. To exemplify the problems of sustainable management, one or more stretches of coastline may be chosen.

2.1	**Wave and Marine Processes**	**Waves** **Definition of a wave** Waves are oscillation of the water surface. Make the point that the water does not move forward. **Wave terminology** Wave height, length, frequency, crest, trough. This can be done by means of a diagram. **Formation and size of a wave:** 1. Wind velocity, 2. Depth of water 3. Fetch. ie. The distance that the wind has travelled across the water surface influences the nature of the wave. Waves possess energy therefore have the ability to carry out processes **Breaking Waves:** Waves break when the water depth is too shallow to support the whole oscillation. **Swash**: Forward movement of water up the beach, **Backwash:** movement of water down the beach. Relative strength of the two influences the nature of the wave. **Constructive Waves/Swell waves:** swash is greater than	www.geography@btinternet.co.uk is the best web site for links. Highly recommended for all aspects of coasts www.s-cool.co.uk also has links. The other best sources are Geofile Online from Nelson Thornes. Reference will be made to specific articles where relevant.	**Waugh** p.141-2 **Nagle** p.106 **Guinness and Nagle** p.293 **Bishop and Prosser** (**B and P)** p.59-has an excellent diagram **B and P** p.60 **B and P** p.60 **Waugh** p.144-5 **Nagle** p.107

		backwash – large fetch, long wave length, low height, found on low gradient beaches, low energy waves which **deposit** material **Destructive waves/storm waves:** backwash greater than swash – short fetch, short wave length, high waves and frequency, found on steeply sloping beaches, high energy waves which **erode.** **June 2002 Q3(a)** **Wave Refraction**-link to headlands and bays. Variations in water depth-deeper water around headlands, concentration of erosion whereas deposition in bays **Relationship between wave type and beach profile.** See Fig. Candidates should understand the relationship between the two profiles. Explain how beaches may be in a state of dynamic equilibrium because the steeper profile produced by swell waves will cause destructive waves which comb material down the beach and may deposit if offshore. This will reduce the gradient to return to constructive waves. Will introduce ideas of erosion, transportation and deposition of material. Beach profiles may show significant variation between stormy seasons and less stormy seasons, due to variations in wave energy and dominant wave type, linked to wind direction. **November 2002 Q4 (a)** Has a diagram which is an excellent teaching source. See Fig.1 One approach to the study of processes is via the **Sediment Cell**. A unit of study which considers a section of coastline in terms of an 'open' system and dynamic equilibrium between erosion and deposition, sources/inputs and sinks/outputs of sediment. See Fig2.for a teaching aid. **Sources:** weathered cliffs, beach material, offshore bars, river sediment, in-drift of material from adjacent littoral cell, beach nourishment, **Sinks**: offshore bar, beaches(could be in the form of a spit),sand dunes, out-drift to next sediment		**Guinness and Nagle** p.294 **B and P** p.61 **Nagle** p. 107-excellent diagrams **B and P** p.89 has a well annotated diagram Fig.1 **B and P** p.67 Christchurch Bay Hants as an example. **Nagle** p.113 good diagram of a sediment cell. **Digby (CE)**p.113-well linked to human activities 2.4 Fig 2.

		cell. Transport along the cell (LSD) current and tidal action within the cell. Cells are ideal units for study of coastal management-link to 2.4 and the landforms in 2.2 **June 2002Q4(a**) has an excellent teaching resource in the form of a flow diagram. **Nov 2003. Q3(a)** The sediment cell could usefully be used as a framework for the answer. **Marine Processes** Waves as agents of: **Erosion: hydraulic action or impact ie.** The sheer force of the waves exerts a pressure which can be up to 30000kg/sq.m in storms**, wave quarrying (cavitation)** is the compression of air in openings in the rocks at the coast as the wave hits. Decompression takes place as the wave recedes. This process weakens the structure and increases surface area for other forms of erosion. Therefore large blocks can be 'quarried'(removed from the cliff face). **corrasion/abrasion.** The load carried by the breaking waves acts as a tool rather like sandpaper it smooths the rock. Important in producing the notch at the cliff base and in shaping wave cut platforms. **Attrition-**reduction in calibre of the load carried by waves as abrasion occurs between the particles. **Solution-**active in calcareous rocks like chalk and limestone where carbonation-solution creates soluble material which is carried away by the waves. **November 2002 Q3 (a)** **June 2003 Q3(b)**		**Cook, Hordern et al, (CHE)** 459, 468 - 473 **B and P** p.64 has a good explanation of quarrying. **Waugh p.149-150** **Nagle** p.109 (good diagram) **Guinness and Nagle** p.297(excellent whole page diagram
2.2	Landforms produced due to coastal erosion. **Cliffed coastlines**	**Erosion:** Evolution of a typical cliff profile: Cliff, notch, abrasion/wave cut platform, beach. **Nov 2002 Q3(a)** **Cliffs:** Should be studied in **profile(cross section) and plan** **(i) Form** **Factors influencing cliff form:** i. Sub-aerial processes of weathering and mass movement		**B and P** p.79-80 Example p.81-3 **Waugh** p.151 **Clowes and Comfort** p.260 –good diagrams **CHE 473 - 475**

		ii. Lithology and structure of the rocks iii. Human activity iv. isostatic and eustatic changes **Simple form** **Vertical cliffs** in massive resistant rock, eg chalk, limestone, granite. **Complex/Composite form**: **Mixed lithology**, which have undergone rotational slip. **Slope over-wall cliffs**- actively eroded cliff base and a contrasting upper slope of 'dead'/degraded cliff between 5 and 50° which represents past periglacial processes when sea level was lower. Rise in SL has produced new vertical cliff face. **November 2003 Q4(a) Diagram E** **Influence of dip of strata**-horizontal vertical seaward and landward dipping. **Active and inactive cliffs**-the latter are dominated by sub-aerial processes. **Shore platforms** – raised beaches and degraded clifflines, linked to sea level change. Development of spits may also lead to degraded clifflines as wave attack is prevented. Annotation of photographs can be a useful exercise here. See Fig.3 and 4. Human activities may be introduced here eg building on cliff tops-contributory factor in cliff collapse/rotational slip. **June 2003 Q3(b); November 2003 Q4(a).** **Headlands and bays**: relationship to lithology along a section of coast. Plan and headland profile: Evolution of landforms produced due to erosion on the headland (deep water, wave refraction, concentration of erosion on the headland: caves, arches, stacks. Deposition: Having considered headlands and focused on erosion the logical progression is into bays, and deposition, shallow water and breaking waves.	Geo Factsheet 129 the impact of structure and lithology on coastal landforms	**B and P** p.70-79 V good diagrams p.74-75 **B and P** p.75 C**B and P** p.74 **B and P** p.74 **Clowes and Comfort** (C and C) p.261 excellent photograph Figs 3 and 4 Photographs to sketch and annotate. **Waugh** p.151-2 **Waugh** p.153 **Waugh** p.143 **Nagle** p.116 (good diagrams) **Guinness and Nagle** p.300-1 **B and P** p.86 **C and C** p.278-9

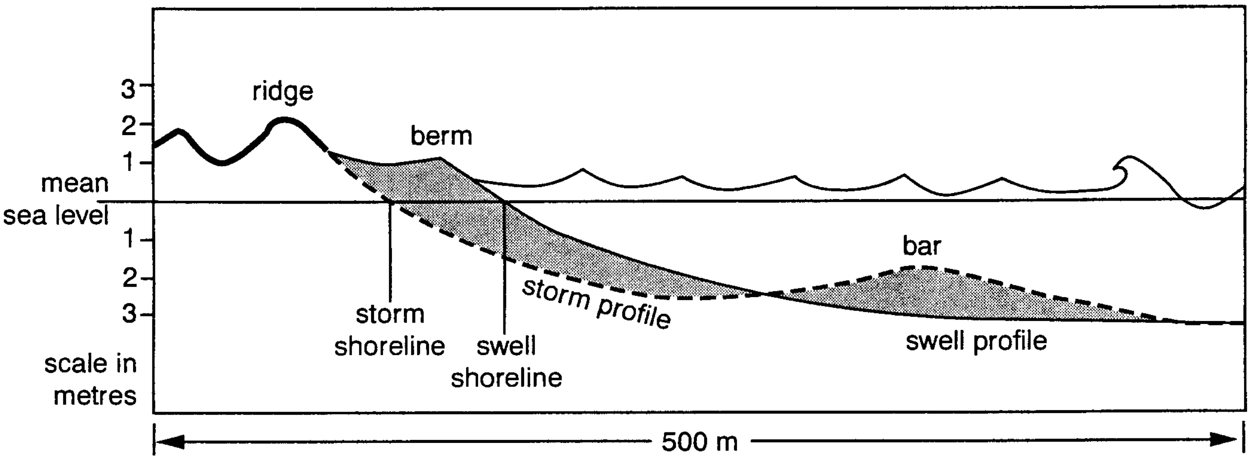
2.2	Landforms produced due to transportation and deposition **Constructive Coastlines**	**Marine Processes** **Transportation**: direction of movement is related to direction of the prevailing wind and direction faced by the coast. Material may be carried up and down the beach if prevailing wind at right angles to the coast or **along beach** if the wind approaches at an oblique angle. **Longshore Drift.** **Longshore currents** may be important in bays where wave refraction is significant **Deposition**: if swash is greater than backwash-beaches are constructed/built up and if longshore drift is taking place then beaches are built along the shore. **Beaches:** Should be studied in **profile(cross section) and plan,** Gradient, Variation in calibre of material from cliff to low tide, storm beach, berm, offshore bar. Relate back to wave type-constructive/destructive and swell and storm profiles 1.1. **Micro-features:** ripples, cusps, runnels -formation of these features-understanding of processes operative to produce these small features. Beaches that develop due to Longshore Drift: **Spits** **Simple spits** a fairly long narrow straight ridge of sand shingle with one attached to the mainland and one end in open water **Compound spits** which have laterals/recurved laterals. Evolution of spits. **June 2002 Q3(b)** **Bars**-both ends attached to the mainland. Usually has a lagoon behind it.eg. Slapton Sands and Slapton Ley(lagoon behind the bar) **Offshore bars** and relationship to spits and longshore drift.	Geofactsheet Number 145 April 2003 www.curriculumpress.co.uk	**Waugh** p.154 **Nagle** p114-5 **Guinness and Nagle** p.301 **C and C** p.274. **B and P** p.89-92 **Band P** p.92 **B and P** p.94 **Case Study of Start Bay including Slapton** p 95-8 **B and P** p.94 **Guinness and Nagle** p.304 **Waugh** p.156 Case Study of E seaboard of the USA **Guinness and Nagle** p117-8 **C and C** p.282-6 **Waugh** p.157 **Nagle** p.118 **Guinness and Nagle** p.304-5

2.3		Eg Chesil beach in which offshore material deposited during the Pleistocene has moved inland as a result of the Flandrian transgression(post glacial rise of sea level). **June 2003 Q4 (a) Good illustration of a spit to use as a teaching aid.** **Tombolos.** **Barrier islands** relationship to offshore bars. **November 2003 Q3 (b)** **Coastal sand dunes**: formation, form and plant succession in relation to stabilisation of the sand. **Salt marshes**-may be considered in relation to spits and tidal sedimentation in estuaries. Plant succession in so far as the vegetation stabilises the sediment. **June 2002 Q3(b)** Throughout links can be made to 2.4. Human activity is relevant and important in influencing the stability and long term nature of these landforms. Depositional landforms in particular are unstable and fragile environments. **June 2003 Q4(b)**		**Guinness and Nagle** p.307 **Case Study of Scolt Head Island Norfolk** **B and P** p.100-1 **W.Wales Case Study of sand dunes and salt marsh** **Waugh** p.158 **Nagle** p.119 There are plenty of case studies which focus on depositional landforms and their sustainability link to 2.4 **Nagle** p.117 **B and P** p.98-100

2.4	**Coral Reefs**	**Formation and Development** Understanding of a coral polyp- a single organism living in a symbiotic relationship with zooxanthellae/algae. Ability of coral to build reefs by production of calcium carbonate. Reef form related to algal variety. This is necessary basic understanding although questions are likely to focus on form and theories of formation **Conditions for growth: Temperature:**23-25˚C; **Water Depth:**less than 25m but not exposed to air; **Light:**for photosynthesis; **Salinity** required;**clean,clear water** sediment free, **well oxygenated water** produced by strong wave action; **Global distribution:**Tropical seas between Tropics of Cancer and Capricorn. Offshore, on eastern and western continental and island margins. **Forms of reefs**: Fringing; Barrier; Atolls demonstrate links between the three forms. June 2003 Q3(a) November 2002 Q3(b) includes theories of formation. **Theories of formation-**Darwin, Daly and Murray. Darwin is the best documented and demonstrates the evolution from fringing through barrier to atoll. Limited spatial application. Will include causes and effects of sea level change on reefs-may link directly to human activity. Coral reefs would be an excellent example to use for sustainable management of a section of coastline.(2.4) However alone a reef cannot exemplify all the aspects of human impact which require study so it needs ot be used in addition to another/other case studies. **One stretch of coastline**- manageable length ie not the south coast of the UK. A littoral cell is a useful unit for study. Ideally it could include both cliffs and depositional features as the result of longshore drift. Consideration of		There is a wealth of information on Coral reefs. ***The Blue Planet*** Richard Attenborough BBC publications Book and Video. Excellent section on the formation and forms of reefs. p.108-9 **Flintoff and Cohen** p.32 **Digby (CE)** p.109 **Warn** p.6-7 **Witherick and McNaught** p.73-4 ***The Blue Planet*** p.105 **Warn** p.4 **Gillett** p.68-70 **Warn** p.5 ***Blue Planet*** p.103-4 **Warn** p.5

	Sustainable Management of Coasts	balance between natural processes and human influences. Management strategies: **Coastal protection measures**: hard and soft engineering, integrated planning ie. SMP'S(Shoreline Management Plans), government policy, managed retreat, 'do nothing'. Conflicts and local issues which may arise. Cost-benefit analysis of alternative protection measures. Sustainable management may involve more than coastal protection, i.e. zoning of human activities, marine reserves, limits on fishing, **A range of case studies may be considered more appropriate which illustrate particular threatened landforms.** Eg. Coral reefs, spits, salt marshes (see below) However ideally candidates should appreciate the balance of processes along a section of coastline and be able to evaluate the advantages and disadvantages of the possible solutions which may involve both physical protection and human utilisation of a stretch of coastline. A coral reef coastline may not offer sufficient coverage of all aspects of this unit so that whilst it exemplifies a coastal area under threat, the range of landforms is somewhat restricted and it is advisable to consider examples of other stretches of coastline too. **November 2002 Q4(b); June 2002 Q4 (b); June 2003 Q4(b)** (protection of salt marshes); **November 2003 Q4(b)**	Geofactsheet Number 141 Holderness Coast A study of coastal management www.curriculumpress.co.uk	Chapter 6 **B and P** is devoted to Management of Britain's Coasts-excellent information on protection measures/strategies. Illustrated by Fairlight Cove (also covered in detail in **Waugh** p.171-175) and Barton on Sea cliffs in Hampshire.Also in **Witherick** p.61 **Witherick** p.60 has an excellent diagram of forms of human intervention along the coast. **Nagle** p123 Coastal protection at Portland Dorset **Guinness and Nagle** Managing Dawlish Warren a spit-p 302-4 **Digby (CE)** is geared towards the human impact on coastal systems Chapter 7 and 8 Focus on the Northumberland coastline International coastline Chapter 9 West Africa p.118-121 Chapter 10 Managing Coral reefs p135-143Focus on Thailand. **CHE 482 – 492** covers useful material on coastal engineering

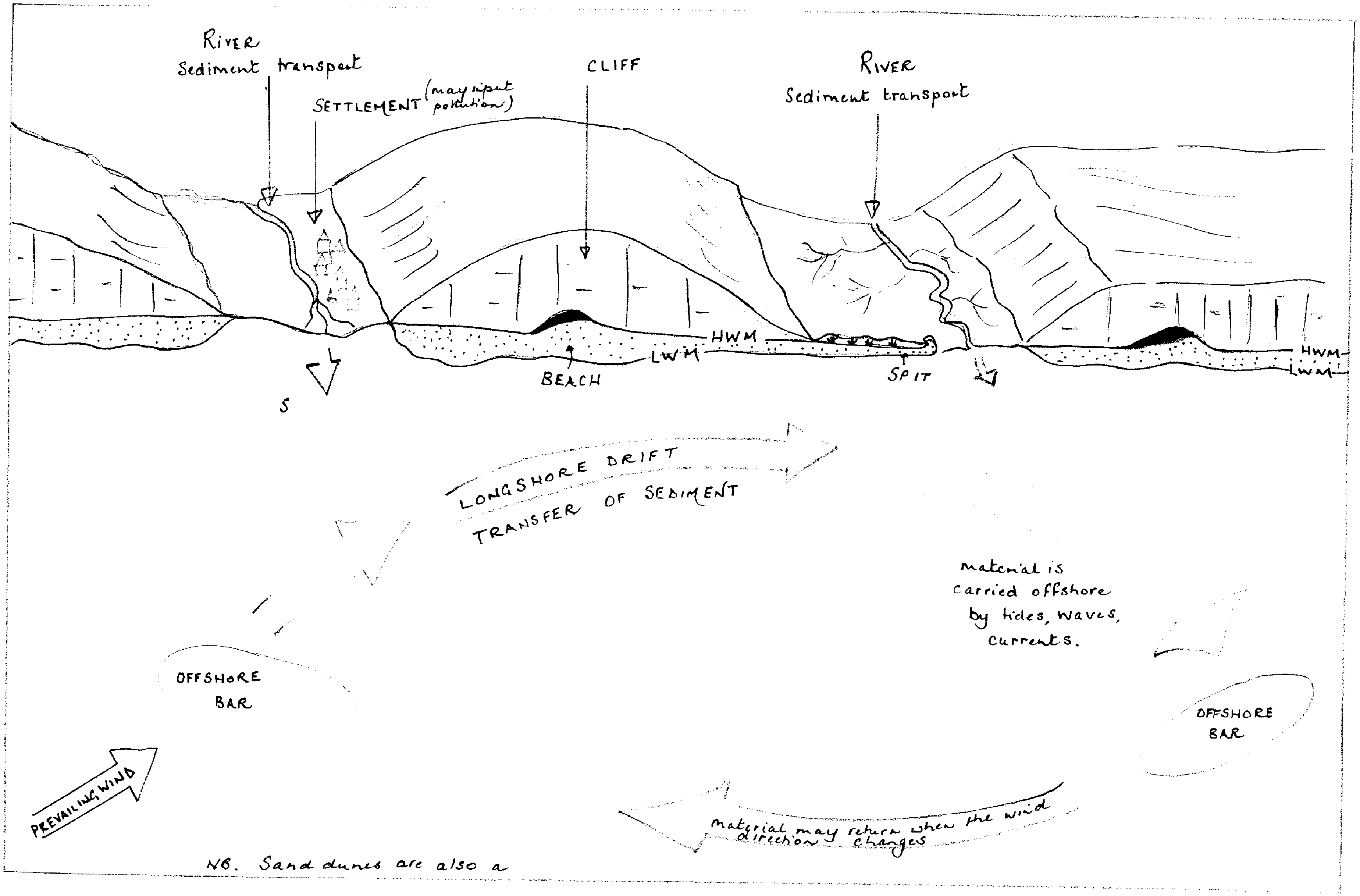
Fig.1 A changing shore profile



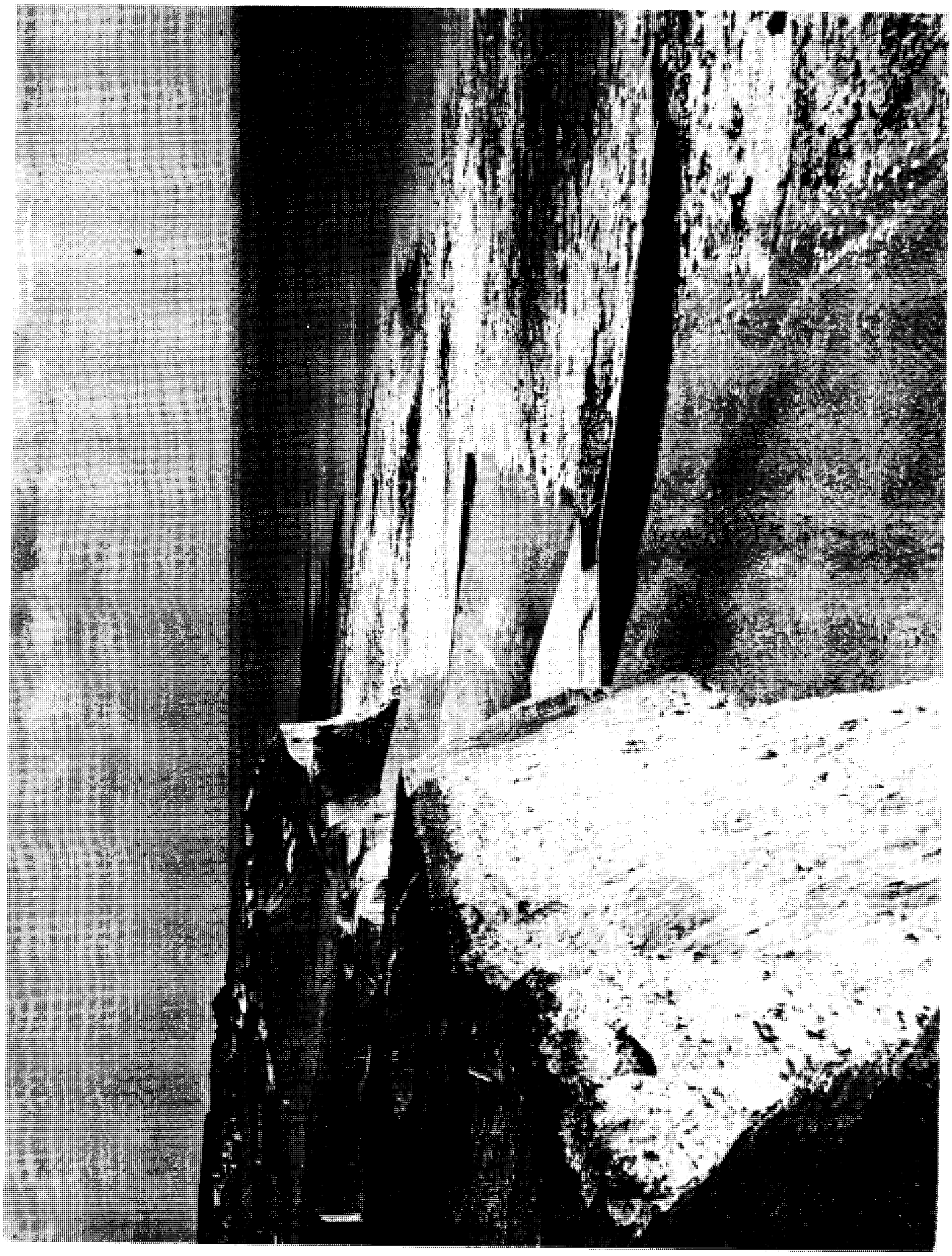
[Turn over

Fig. 2.

Fig. 2 A sediment cell



PHOTOGRAPH A FOR QUESTION **3**



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