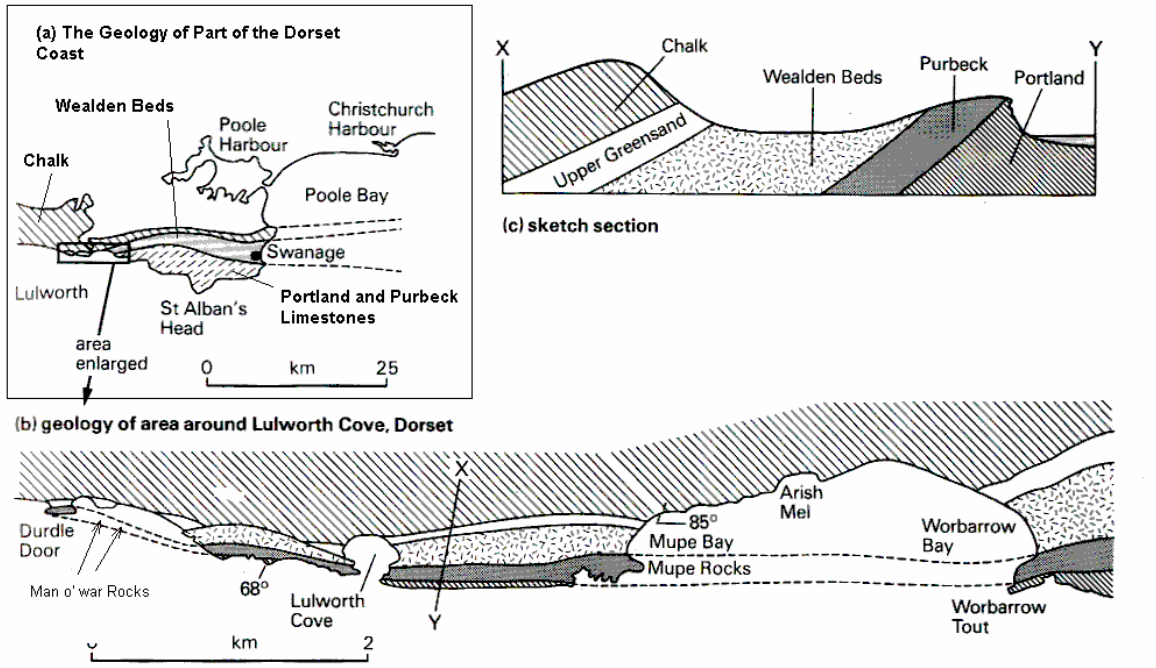
AS Geography 1.3 Coastal Environments *Student Notes*

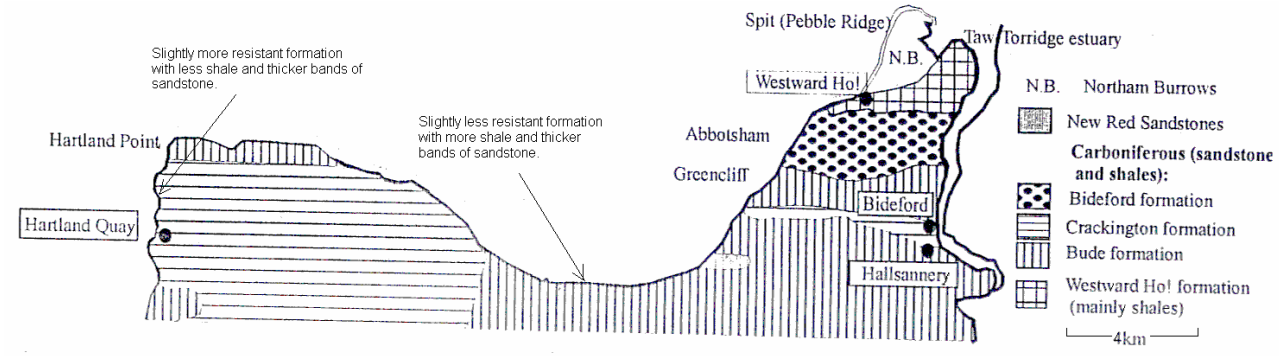
The geological factors influencing the rate and location of coastal processes.

You need to appreciate the spatial and temporal variations in the influences of a range of factors. (Some of these factors will be examined in more detail later, in relation to specific landforms).

- **Rock lithology.** Some rock types resist erosion more than others. In Dorset, the weaker rocks are the clays and soft sands of the Wealden Beds, whereas the relatively harder Portland Limestones and chalk resist erosion more effectively.



- In Bideford Bay, North Devon, the rocks are composed of alternating narrow bands of Carboniferous shales and coarse sandstone called greywacke. The sandstone is much more resistant to erosion and headland form where the proportion of sandstone to shale is higher.



At the smallest scale, differences in the resistance of rocks can lead to **differential erosion** where the various processes of erosion pick our the weaker bands leading to a ribbed effect. This is very apparent in the rocks at Hartland Quay where the sandstone bands stand out like ribs between the eroded bands of shale.

- **Rock dip and geological structures**

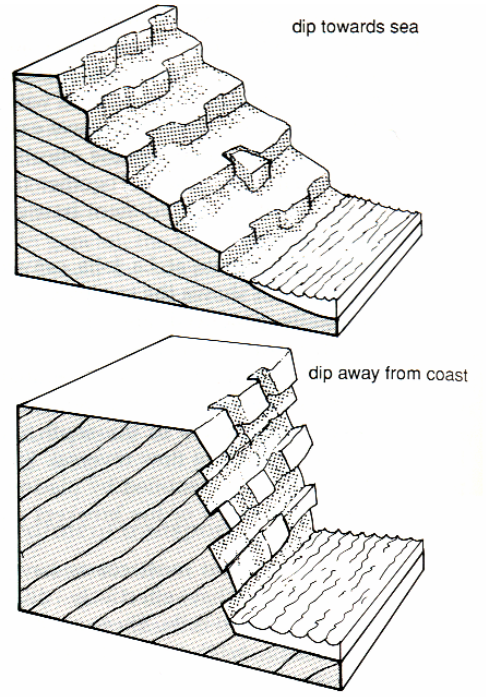
Most rocks have internal structures. These include **bedding planes** (found in most sedimentary rocks), **cracks** or **joints**, **folds** and **faults**. These structures provide weaknesses in the rocks that can be exploited by processes such as hydraulic action and abrasion. Very often, tectonic processes in the past will have compressed or distorted the rocks, causing the structures.

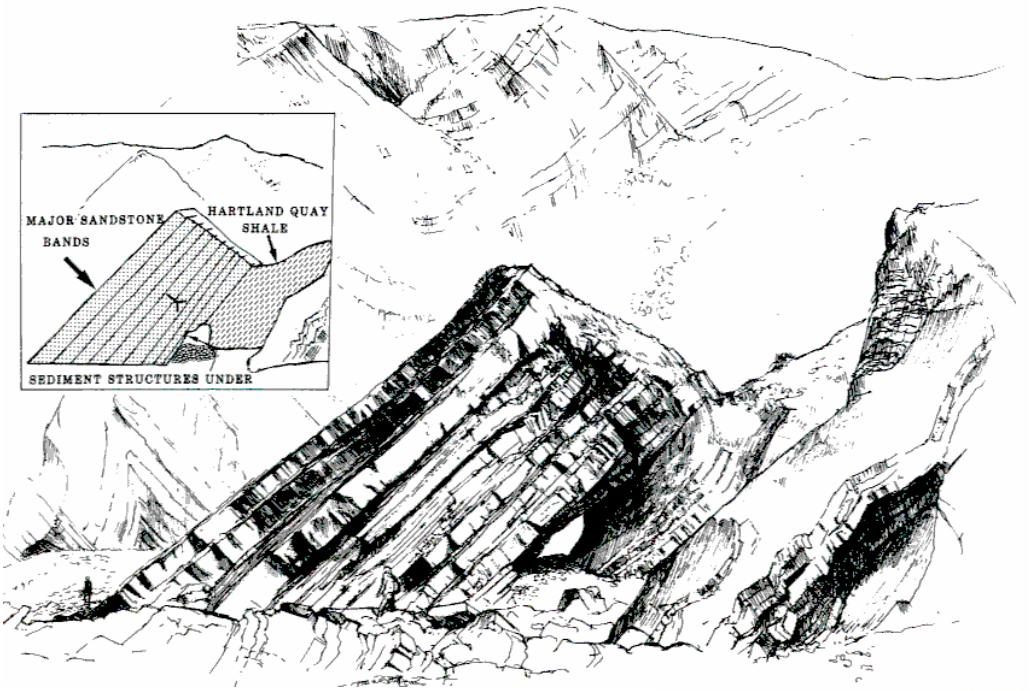
This can tilt the rocks changing their angle of **dip**. The impact can be seen in the rocks as Stair Hole in Dorset and on the stack formation at Hartland Quay such as Bear Rock, Life Rock and Tunnel Slab.

If the strata (layers of rock) dip towards the sea (as on the back of Tunnel Slab in Warren Bay at Hartland Quay, fragments of weakened rock may slip down the bedding planes, aided by subaerial and marine processes, leading to a more gentle slope.

If the bedding planes dip away from the sea, the angle of rest of the cliff becomes much steeper as it is more stable. In the vicinity of Lulworth Cove and stair Hole in Dorset, the Purbeck Limestone dips away from the sea on the exposed coast leading to a much steeper cliff face.

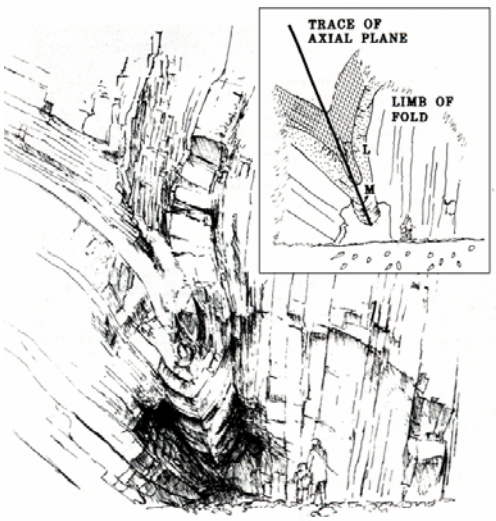
Mark the direction of the dip on the two diagrams.





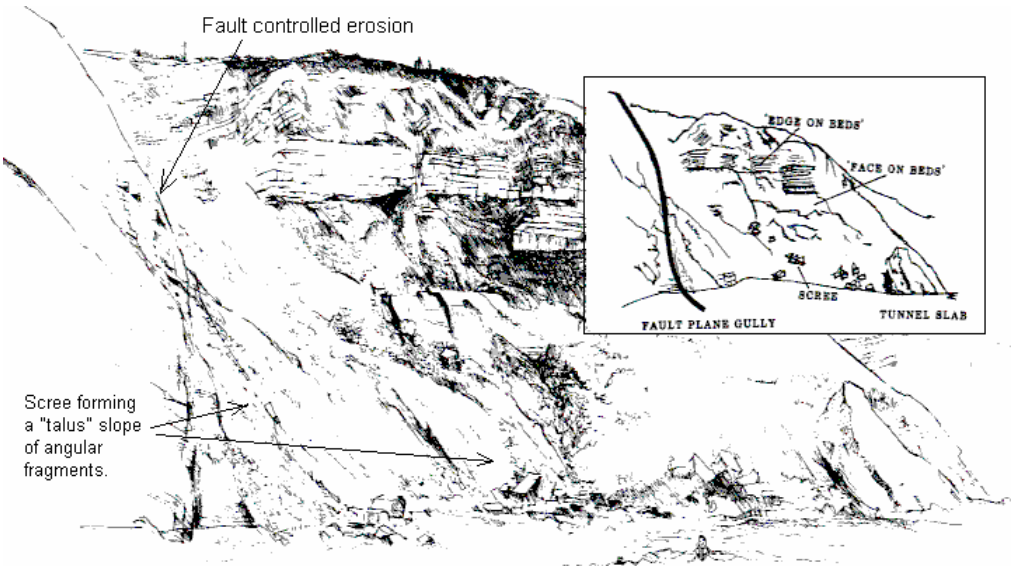
The rocks at Hartland Quay also demonstrate the impact of other geological structures on the shape of a cliff face. At tunnel slab, the erosion of a thicker band of Shale (the Hartland Quay Shale) has produced an arch-like like formation. Notice the differential erosion in the rocks along **bedding planes** and **joints**.

The impact of tight chevron folding at Warren Bay is to weaken the rocks along the axis of the fold. Whether the fold is a **syncline** of an **anticline**, the weakening of the rock has enabled the processes of erosion to deepen the wave-cut-notch into a sea cave.



The diagram here shows a tightly folded syncline and a cave forming in its axis.
Here an open anticline provides a point of weakness for marine erosion along the line of its axis.

Geological faults in Warren Bay also provide a line of weakness as the rock will have been crushed and fragmented at the time of faulting. Notice the fallen rock “scree” at the base of the cliff called a “talus” slope.

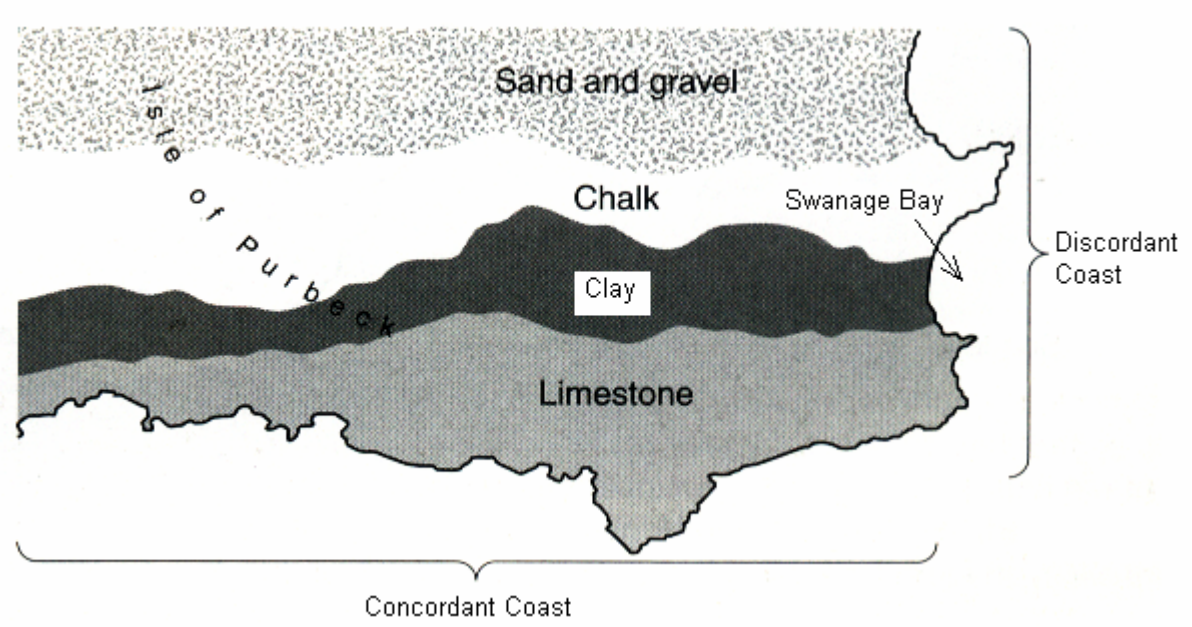


Coastal Orientation (Concordant or Discordant)

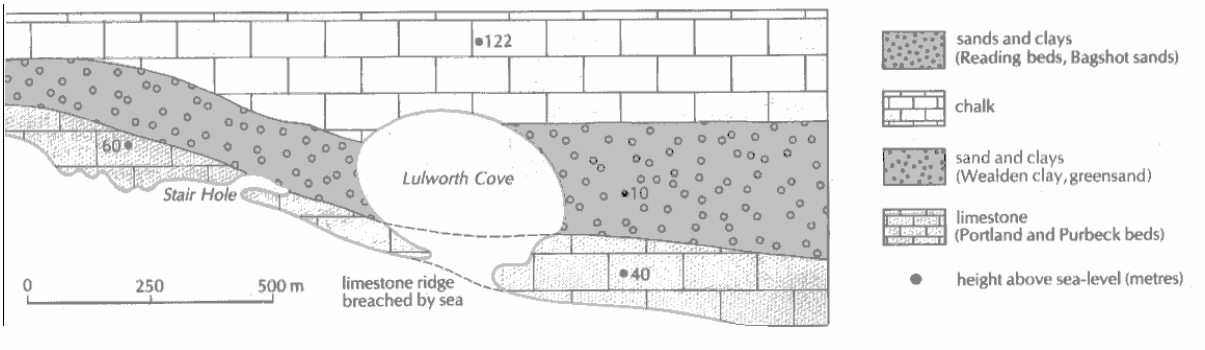
In both North Devon and Dorset it is possible to see the impact of the orientation of the coast in relation to the geological strata. Where the rocks run parallel to the coast, it is said to be **concordant** and when the strata intersect the coast they are said to be **discordant**.

With both types of coast waves will try to exploit and attack the weaker rocks. These may be weak because they are physically soft, or if they have structures such as faults and folds which can be exploited by hydraulic action, abrasion and other marine processes.

On the Dorset coast, the impact of the **discordant coastline** in the Swanage area of the Isle of Purbuck is clear. **Headlands** form where the harder chalk and limestone and **bays** form where the rocks resist erosion less. These sheltered bays will also be the sites of sediment deposition in sheltered water where waves are refracted.



Rocks running parallel to the coastline typify the concordant coast of south Dorset.



The erosion of the coastline can be traced as a sequence of events that is reflected in current coastal landforms that are various stages of development.

1. The Portland Limestone (and to a lesser extent, the weaker Purbeck limestone) acts as a barrier to erosion. It is folded, faulted and fractured in places, having been subject to tectonic pressures in the past.

2. The processes of marine erosion exploit weaknesses in the limestone, forming wave cut notches, and in places caves. In places such as Stair Hole, these caves have reached the much softer Wealden Clays and sandstones. This material, when undercut by marine erosion, is very easily removed. It is washed by rainwater and winter mudflows towards the sea where it is removed by marine processes. This can be clearly seen in Stair Hole.

3. Some of the caves in the limestone will collapse, allowing more waves to enter the developing enclosed inlet behind the limestone wall. The erosion of the clay and soft sandstone will continue until the chalk is reached.

4. This has already happened at Lulworth Cove and the gap in the limestone has also been enlarged. Waves entering the Cove refract so they have dispersed energy by the time they reach the chalk wall. The chalk erodes slowly through gentle wave-trimming and occasional rockfalls and cliff face collapses. Meanwhile, mudflows, streams and rainwater help to remove the soft clay and sand into the Cove, which is removed by the tides.

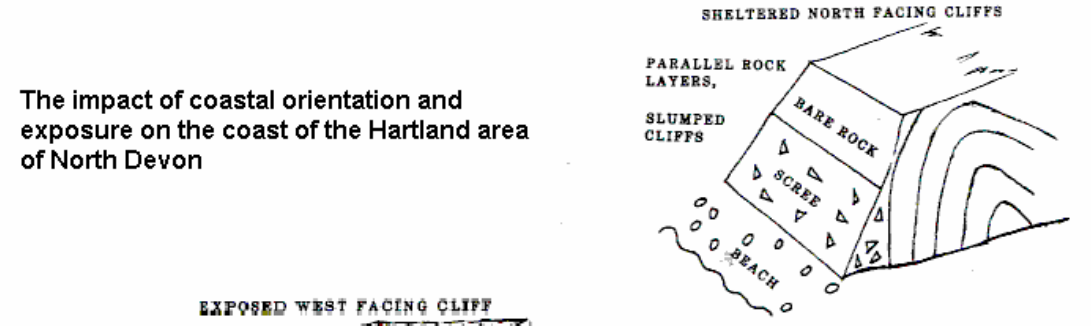
5. Further along the coast in St. Oswald's Bay, close to Durdle Door, the clay and sand have been completely removed and the chalk cliff now marks the main line of the coast. However

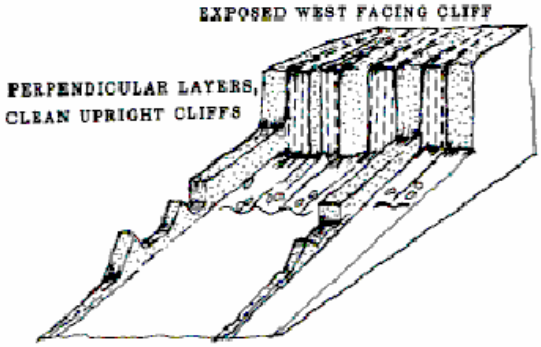
remnant of resistant limestone still exist for example the Man-o'-War rocks (stacks and stumps) in St.Oswald's Bay. Further east, Mupe Rocks in Mupe bay follow the same pattern.

6. Some more resistant bands of limestone still remain. The Arch at Durdle door is in one of them. The arch is a remnant of a former cave that probably started life in a similar way to the new caves back at Stair Hole.

In North Devon, the impact of structure is more important that the rock type as the shales and sandstones form relatively thin bands. On the west facing rocks at Hartland Quay, the beds and folds face straight out to sea and this encourages the formation of upright cliffs. On the northern coast of the Hartland Headland, the rock structures (or strike) run parallel to the coast. Where the beds dip seawards, this encourages the cliffs to slump (landslides) creating a more gently sloping but untidy cliff face. This difference is exaggerated by the relative exposure of each coast to destructive waves. The west facing Hartland Quay coast is much more exposed and therefore there is more **wave-trimming** at the base of the cliff.

The impact of coastal orientation and exposure on the coast of the Hartland area of North Devon





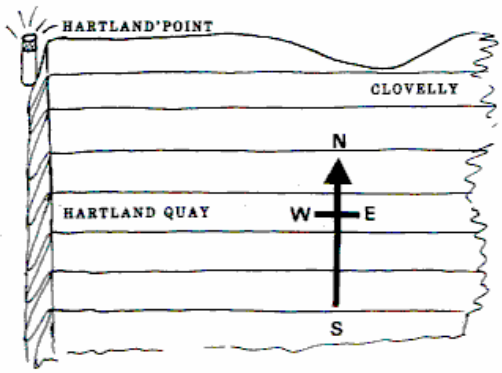


Plate Tectonics, Earthquake and Volcanic activity. In the long term, plate tectonic movements in the earth's crust are responsible for most of the folding and faulting that can be found on he coastline. It is also responsible for the long term shaping of the coastlines of whole continents. In the short term, volcanic and earthquake activity have local influence. Volcanic eruptions on Hawaii regularly extend the coast outwards creating new land. The 1964 Alaskan Earthquake caused major changes to the coastline; some areas experienced a fall in sea level while others experienced a rise as the crust readjusted to the reduction in pressure between tectonic plates (see later notes on sea level changes).