Understanding the Undercliff

The Undercliff is a narrow tract of land which extends for about 12km along the southern coast of the Isle of Wight, from the village of Bonchurch in the east, to Blackgang in the west. It is the largest urban landslide complex in north-western Europe.

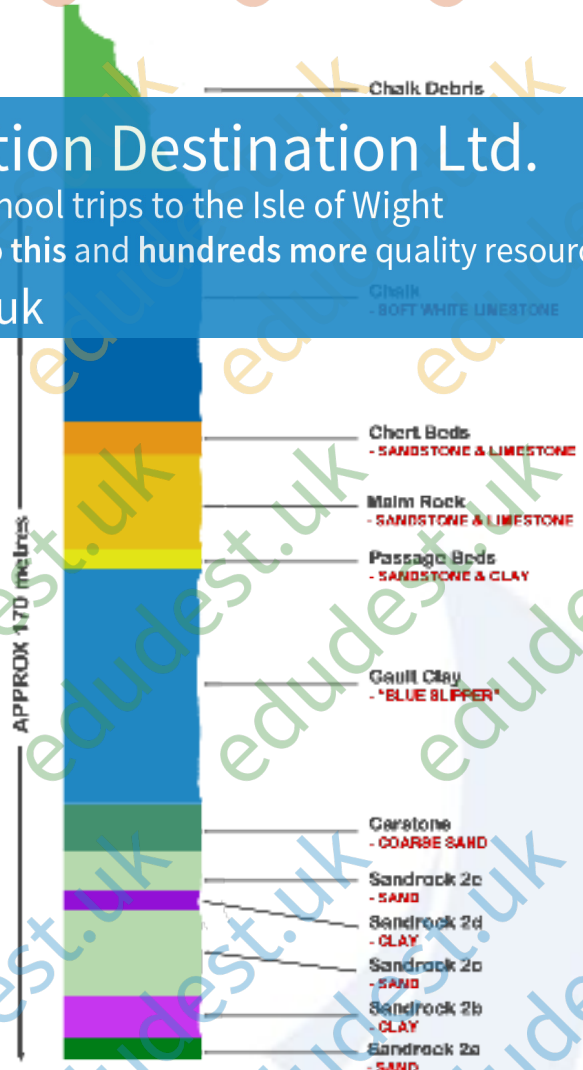
In this study you will learn about:

- ✓ The geology of the Undercliff
- ✓ Types of, and causes of, mass movements on the Undercliff
- ✓ The impact of mass movements on the Undercliff.

An Introduction to the Undercliff

The Undercliff lies below the chalk escarpment which runs the 'spine' of the island, from the Needles stacks in the west, to Culver Down in the East. It is a 0.25-0.5 mile-wide tract of 'slipped land' and an ancient landslide complex.

It formed thousands of years ago when climatic conditions were very different to what they are today. Studies have shown that two main phases of landsliding occurred during the last Ice Age, between 8,000 and 4,500 years BP, and another between 2,500 and 1,800 years BP. At these times, major changes in climatic conditions and sea level rise led to increased erosion and extensive land sliding in this area.



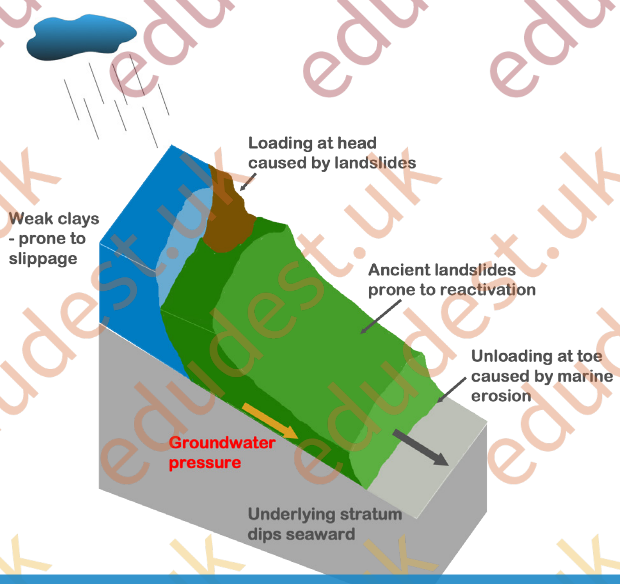
This left a legacy of highly unstable ground, prone to reactivation.

The instability of the Undercliff area is controlled by its underlying geology. In this southern part of the Island, sedimentary rocks, formed between 120 and 80million years ago (the Cretaceous Period), make up the underlying geology.

It is mostly composed of alternating layers of sandstones, clays and chalk (see diagram).

The thin clay layers between the 'sandrock' (more commonly known as Lower Greensand) and the 40m thick layer of Gault Clay are the key factors affecting the instability of the area.

These layers represent significant weaknesses in the local geology; differences in the permeability of the clay (impermeable) versus the sandstones and chalk (permeable) lead to variations in the water pressure within the ground, resulting in landslides, especially following heavy or persistent periods of rainfall which lead to increased pressure, basal instability and increased risks of sliding (water acts as a lubricant and increased water at the base of the Gault Clay leads to increased risk of slope failure).



Also, the strata here dip gently seawards which further aids the sliding of weakened material by gravity towards the sea, and marine processes acting at the 'toe' of the Undercliff in unprotected areas cause undermining and further increase instability.

The diagram (left) summarises the key causes of slope instability at the Undercliff.

Mass movement

Mass movement is the term used to describe the down-slope movement of material under the influence of gravity. All slopes are subject to the forces of gravity and, therefore, are susceptible to mass movement. The risk of mass movement occurring depends on the relationship between the **sheer strength** of the slope material and the **sheer stress** placed upon it by the weight of the slope material under the force of gravity [illegible] the slope to being moved. It is affected by its underlying geology, the angle of the slope, the dip of the strata, vegetation cover, water content and other variable factors such as rainfall input and human interference, e.g. deforestation or development.

Activity 1: Several human and physical factors have decreased the sheer strength of the Undercliff and/or increased the sheer stress upon it, and have made it highly vulnerable to mass movement. Sort the following into human and physical factors by using a colour or code system. One has been left blank – can you think of any other human or physical contributing factor?

Clay is particularly prone to mass movement as it is poorly consolidated and becomes highly unstable when wet	*The rock strata dip towards the sea*	*Alterations to slope angle to construct the A3055 coastal road leading to a less stable configuration in places*
'Cut and fill' operations to establish plots for houses	*A long fetch and exposure to south-west prevailing winds leads to high energy waves and erosion at the toe of the cliff*	*Leakage from storm drains, sewers, water mains and service pipes alters groundwater dynamics*
The difference in height between the chalk escarpment	*Development of roads, foundations for houses, driveways etc. leads to increased impermeable surfaces and affects the slope's response to rainfall*	*Artificial recharge of groundwater by soakaways*
Development of the undercliff has led to a certain amount of vegetation loss	*This is an ancient landslide complex and a legacy of easily reactivated slope failures has been left*	*?*

Activity 2

Some of the reasons for the instability of the Undercliff can be regarded as 'Preparatory Factors' and others can be seen to be 'Triggering Factors'. Look at the definitions for these terms and then, considering what you have read above, ***complete the table to summarise the factors*** leading to slope instability at the Undercliff.

Preparatory Factors: Factors which make it susceptible to failure (landslides) without actually initializing it

Triggering factors: Factors which initiate slope movement / landslides

Preparatory Factors	Triggering Factors

Types of mass movement seen at the Undercliff

Multiple rotation slides involving a series of slipped masses of debris backed by a curved slide plane have occurred mainly at the back of the Undercliff.

Compound slides have also occurred in some places, notably in Upper Ventnor, where a mass of rock has been displaced and left a ridge behind and a depression (Graben) immediately upslope.

Mudslides have occurred in the Gault Clay, originating in a steep 'supply' area and tracking downslope to an 'accumulation lobe' at their base.

Rockfalls also occur along much of the coastline, especially where coastal protection is absent (rockfalls at eastern end of Monk's Bay, Bonchurch shown in photo).

Activity 3

Working with a partner, ***identify the human activities*** on the Undercliff (use your own observations as well as the map extract on page 5 and photos below). For each you should then ***describe the likely impacts*** of land movements on that activity.

Castlehaven Caravan Park and Cafe

St Catherine's lighthouse, St Catherine's Point

Human Activities	Likely Impacts