The geology of the Naze cliffs Walton-on-the-Naze

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Geological Field Guide

The Naze is one of the finest geological sites in Britain. The cliffs provide a glimpse into several periods of the distant past: from a time when Essex was a subtropical sea to one of the coldest periods of the Ice Age.

The cliffs to the north of Walton-on-the-Naze consist of London Clay, a rock formed at the bottom of a sea in Eocene times (about 50 million years ago) when Britain had a subtropical climate. Above the London Clay are sands called the Red Crag, part of a remarkable sequence of sediments of late Pliocene age (about 3 million years old) which have yielded information on the climate at the beginning of the Ice Age.

The London Clay *– a time of crocodiles and palm trees*

At the beginning of the Eocene Period about 50 million years ago southern England had a subtropical climate and the area that was to become Essex was submerged beneath a warm sea, up to 100 metres (300 ft) deep. The shoreline supported a subtropical rain forest with plant species related to the mangroves. Similar coastal areas are now found in present day Indonesia and Malaysia. Rivers flowed into this sea bringing mud and silt which settled and became compacted, eventually to form a thickness of up to 170 metres (500 feet) of stiff blue-grey clay called the **London Clay**, which is well exposed in the lower half of the cliffs.

The London Clay Sea was home to crocodiles, turtles, gastropods, bivalves, brachiopods, nautiloids and many species of fish including sharks, and some of these fossils, such as sharks' teeth, can be found on the beach, having been washed out of the cliffs by the waves. The London Clay is also famed for the fruits and seeds of subtropical plants, which had been carried by rivers into the sea. Pieces of fossilized wood preserved in the mineral pyrite (fools' gold) are common on the beach but these are unfortunately subject to chemical decomposition once collected. Rivers flowing into the London Clay Sea also carried the bones of mammals that lived in the rainforest, such as an early horse, which was no larger than a small dog. These fossils give us a glimpse of the rapid evolution of mammals following the extinction of the dinosaurs. Also found on the beach are the tiny bones of birds that lived during this period. Although these are rare, the London Clay here has produced some of the best-preserved bird fossils of this age in the world.

Sharks' teeth from the London Clay.
Photo: © G.Lucy

The clay exposed at Walton is at the base of the London Clay sequence (Division A). During the Eocene period the European continental plate was just starting to split away from North America and this was accompanied by intense volcanic activity in western Scotland. Evidence of this is present here as pale bands in the London Clay cliffs which contain volcanic ash from these eruptions.

The Red Crag *– a sea teeming with shellfish*

About 3 million years ago, at the very end of the Pliocene period, probably all of Essex was covered by a sea between 15 and 25 metres (50 to 80 feet) deep and the climate was cool. As the sea advanced across Essex a sand containing an abundance of marine shells was laid down as dunes on the sea bed, fairly close to the shoreline. These shell banks now form a deposit called the **Red Crag** which underlies parts of North-east Essex and Suffolk.

At Walton, shelly Red Crag can be seen resting on the London Clay. The rust-red colour of the sand and its fossils is due to the former presence of iron pyrite which was washed from the London Clay into the basal Red Crag and there oxidised. The final product of this chemical reaction is a red

deposit of iron oxide, which has stained the shells. Rain water seeping through the sands runs out on meeting the impervious clay, with the result that slumped masses of shelly sand are continually sliding down to be removed rapidly by waves lapping against the foot of the cliff.

The most common fossils are bivalves and gastropods such as the dog-cockle *Glycymeris glycymeris.* The fossils show that the sea had an extraordinarily rich diversity of shellfish - nearly 300 species have been recorded from the Naze. The shells are fragile, and look like modern shells, but they are real fossils. They include *Neptunia contraria* - the 'left handed whelk', which spirals in the opposite direction to almost all other species of gastropod.

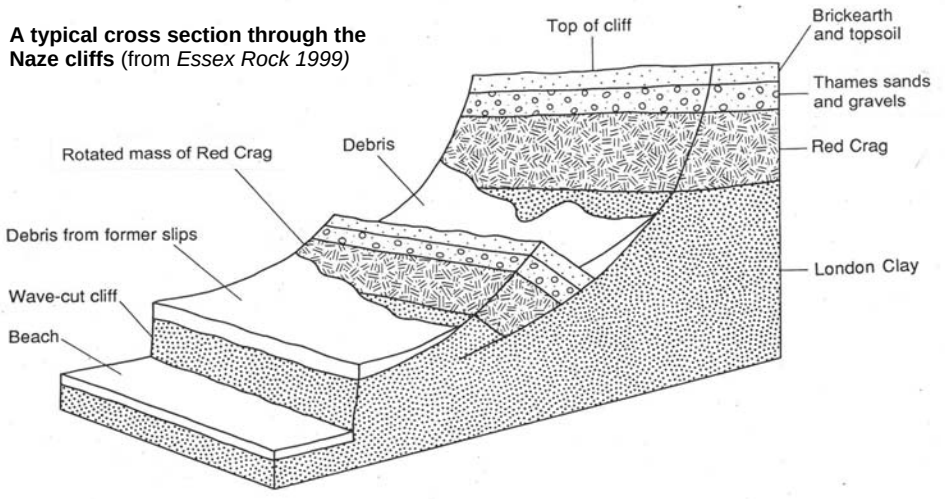
Neptunia contraria from the Red Crag. *Photo: © G.Lucy*

The junction between the London Clay and the Red Crag represents a time interval of about 47 million years. At this junction there is a thin, impersistent layer of phosphatic nodules, fossils derived from the London Clay and well rounded lumps of sandstone called 'boxstones' believed to be of Miocene age (about 10 million years old). Boxstones are the only examples of Miocene rocks in Britain. The Nodule Bed also yields very rolled but highly polished bones of whale and large terrestrial mammals such as deer and elephant. These were washed into the Red Crag Sea from Miocene deposits removed by marine erosion long ago, and possibly recycled several times before being incorporated in the Red Crag. The high polish shown by the fossil bones from the Red Crag is still a mystery. Shark teeth can also be found in the nodule bed, most of them derived from the London Clay but some are from Miocene and Red Crag sharks.

Perhaps the most sought-after fossil tooth is that of the giant shark *Carcharodon megalodon,* which can exceed 10 centimetres (4 inches) in height. This shark was one of the largest ever to have lived and may have been as much as 12 metres (40 feet) long and weighing up to 65 tons. Teeth of this creature are extremely rare but they have been found on the beach.

After the Red Crag Sea had retreated the sand was exposed to the air and it was probably at this time that the iron was oxidised to produce the distinctive colour.

A typical cross section through the Naze cliffs (from *Essex Rock 1999)*



Contorted sediments at the top of the cliff. *Photo: © G.Lucy*

Evidence of an extremely cold climate

At the top of the cliff are layers of brickearth, sand and gravel probably laid down by an early River Thames which flowed across central Essex about 600,000 years ago, to become a tributary of the Rhine. In places the gravel and sand is noticeably contorted and folded. This must have occurred during the most recent glacial period between 20,000 and 15,000 years ago - one of the coldest periods of the Ice Age. The ground was then frozen to a considerable depth (permafrost). When the ground eventually thawed, it was saturated and became deformed as heavier beds sank down into lighter beds below.

Handout produced for GeoEssex by Gerald Lucy (revised May 2011)