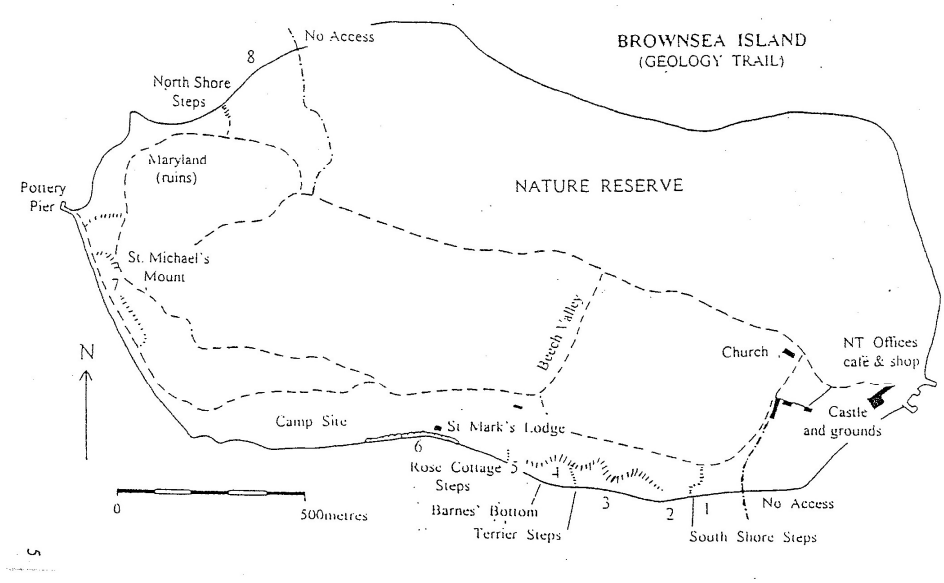
The Geology of Brownsea.
Incorporating a guide to the geology trail.
Prepared by Dorset's Important Geological Sites Group.
1997

GEOLOGY OF BROWNSEA



Brownsea Island is composed of sediments, most of which are unconsolidated (see picture 1, cliffs west of Harry Point), which means they have not been cemented into hard rocks such as sandstone or mudstone.

Branksome Sand west of Harry Point

Brownsea's sediments are *detrital,* that is they are derived by erosion of pre-existing landscapes, the detritus (debris) being carried along by streams and rivers until such time as the water flow slows to allow the debris (suspended particles) to drop out. The coarser material, such as pebbles, deposit first and as the flow decreases when the rivers reach lower and flatter land near the sea, sand grains drop out to be followed by silt, and eventually by clay particles when the flow has virtually stopped (the river has reached the sea). These clay particles are very small flaky minerals such as illite and kaolinite and their composition reflects their source (eg kaolinite from what is now Cornwall and Dartmoor), though there could be some chemical modification by interaction with sea water.

Other sediments are *non-detrital* and are formed chemically or by biological agencies. Typical examples are limestones (including Chalk), salt and coal. None of these occur on Brownsea.
Brownsea's sediments comprise a lower layer of clay (Parkstone Clay –see picture 2- Parkstone Clay) overlain by a sand-rich higher layer (Branksome Sands – see picture 1).

Parkstone Clay near the Scout Camp

These sediments were laid down some 40 million years ago near the mouth of a large river system. The climate was sub-tropical and there were variations in sea level such that the clays were deposited when the sea level was high, forming lagoons, and the sands were deposited when the sea level was low and the river system was dominant. These rivers cut channels into the underlying soft clays resulting in an irregular surface between the clays and sands (see geological section) This section also indicates how the sand/clay interface dips shallowly to the east so that the thick sequence of clay in the west of the island eventually disappears below sea level just east of South Shore Steps. Within the sands, cross-bedding is common where sets of curved sediment laminations cut across older sets of laminations beneath. Such structures are characteristic of sands deposited in shallow river systems (see picture 3 cross bedding in the Branksome Sands).

Cross bedding in the Branksome Sands

Because there were short-lived changes in sea level at any time, the clays contain minor sandy levels and the sands contain minor clay levels. These included layers are often lens-shaped (see geological section).

The gravels which cap the high ground (see picture 4 – Pleistocene river gravels) are the remnants of terraces associated with an ancient Solent River.

Pleistocene river gravels west of Harry Point

These were deposited during a warm period of the Ice Age and are only a few hundred thousand years old. At the end of the Ice Age (some ten thousand years ago) when sea levels rose considerably, the lower levels of the Solent River valley flooded to form Southampton Water, Spithead, The Solent and Poole Harbour. The Chalk ridge that once linked the Needles (Isle of Wight) and Old Harry Rocks was breached and the middle section of the valley lost its southern flank of Chalk hills.

There was a very long time span of many millions of years between the deposition of the clays and sands and the formation of the capping gravels.

THE GEOLOGY TRAIL

On the South Shore of Brownsea Island it is possible to see the changing character of the sands and clays. A white clay can be seen high in the cliff, and a dark grey clay at shore level. These are both within the Parkstone Clay and have been used in two very different industries, the white for terracotta pottery, and the grey for copperas production. (See Historical Use of Minerals). Clay was dug from several cliffs on the southern and western shore, and was mined on the northern side of the island. The mines penetrated 20 metres down to another dark clay level – the Broadstone Clay. Being below sea level the mines were often flooded.

A very careful look at the cliffs on the South Shore will give the visitor an impression of the deposits left by the great Eocene river. At each place the details are slightly different, as would be expected from place to place in a river valley, but some features can be followed for several hundred metres.

The trail should only be undertaken on a falling tide, starting at South Shore Steps, and following the red numbered markers. Please check the tide before leaving the National Trust reception desk. If the tide turns, do not continue to North Shore. The clay outcrops below St. Marks Lodge and north of Pottery Pier can be treacherous.

Detailed geology for each site – see map.

1. South Shore Steps.

The bed with white lumps was formed when a storm-flood broke up a bed of clay, broke branches from small trees, mixed them together and then dropped them here. This narrow band of small pieces of lignite and clay (conglomerate) can be seen within a cross-bedded yellow-brown sandstone, on top of a bed of fine grained sand with very thin clay layers (laminae). This lower horizon is best seen a few metres to the west, above a thick bed of fine grained buff sand. The base of the laminated sands cuts across (truncates) the bedding planes within the buff sand. These beds are part of the Branksome Sands. You will see this bed again, but of different thickness. The buff sands were formed as beach dunes as at Studland today.

The cliff east of South Shore steps is not open to the public for safety reasons. If the tide is well down it can be viewed from a safe distance.

2. West of South Shore Steps.

The dark clay here is lower in the pile of sands and clays than the sand at stop 1. It was formed at a time when sea level was higher and Brownsea was part of a stagnant swampy tidal area or lagoon. Minute sea creatures known as dinoflagellates have been found by looking at the clay through a powerful microscope. As the clay minerals accumulated to form a bed of mud, oxygen became excluded and only partial decay of plants and animals was possible together with the reduction of sulphate ions (from entrapped sea water) to sulphides. Hence the clay is dark in colour – containing organic matter and finely disseminated grains of pyrites (iron sulphide) (see Historical Use of Minerals). The brown-grey clays at the base of the cliff have a greenish-yellow oxidation product (see picture 5 - Jarosite) coating a weathered surface.

At the top of the clay there is a distinctive bed of fossilised wood fragments (see picture 6 - lignite).

Moving westwards, at the base of the cliff is a buff coloured well bedded sand with thin clay layers. Between the clay and the sand in places is a harder iron oxide-cemented sandstone (see picture 7 well cemented sandstones), which you will see more clearly at the next stop.

3. 35m east of Terrier Steps.

On the shore there is a prominent outcrop of ferruginous (iron oxide-cemented) sandstone and pebble conglomerate. Ferruginous rocks result from percolating groundwaters depositing iron oxides which cement the sands and gravels filling a channel in the underlying clays. This would have taken place over a long period of time, after the original formation of the sand and clay beds. This material could have been used as an extra source of iron in the manufacture of copperas. Sandstone formed in this way was used for building in the area around Poole Harbour, particularly in medieval times.

4. Barnes Bottom.

The space above the shore line, with a cliff behind, was cut out when the clay was used for pottery and brickmaking (see picture 8 – source of clay for brick making).

The cliff has been weathered since by rain and wind, and sand has been washed out in a fan. Above the fan can be seen dark brown clay, laminated with very fine grained sand layers, the laminae becoming thinner towards the top. The junction with an overlying coarse sand can be clearly seen. These sands are very coarse (up to 3 mm) at the base, becoming finer upwards and are capped by a thin bed of silty clay at the top of the section. All this is known as the Parkstone Clay of the Poole Formation. At the top of the cliff is Branksome Sand. The clays and sands dug from this area were used for brickmaking. The poor state of the wall by the Castle garden shows the poor quality of the bricks made during the 19th century.

5. East of Rose Cottage steps.

Dark brown weathered clay can be seen at the base of the cliff. The shallow cliff to the right of the steps shows a channel fill of cross-bedded sands cutting down into the clays. The sand unit is brown to ochrous with lenses of clay-lignite conglomerate. This section is a miniature representation of the sedimentation history of Brownsea.

6 Below St. Marks Lodge.

The high cliff on the shore below St. Marks Lodge often slumps because the groundwater runs through the 1.5m of yellow/orange (ochrous) sand, and issues as springs above the 3.5m of dark grey clays. Water seepage beneath the sand is staining the clays red-brown with iron oxide (see picture 9 seeping water).

7 St. Michael's Mount. 200m south of Pottery Pier.

The base of the cliff shows brown silty clays, often with lenses of fine grained sand. The clays become finely laminated towards the top, where the junction with the overlying sands is marked by a colour change to yellow-brown. The sands (Branksome Sand) are coarse at the base and form a distinct vertical cliff. White pebbles from the Ice Age river gravels on top of the cliff spill over the lower beds. Clay was dug from the cliffs to the south to be used initially in the copperas industry and later in the manufacture of bricks and pipes (see picture 10 – broken pipe debris on the beach).

Broken pipe debris on the beach

8 North Shore. 100m east of steps.

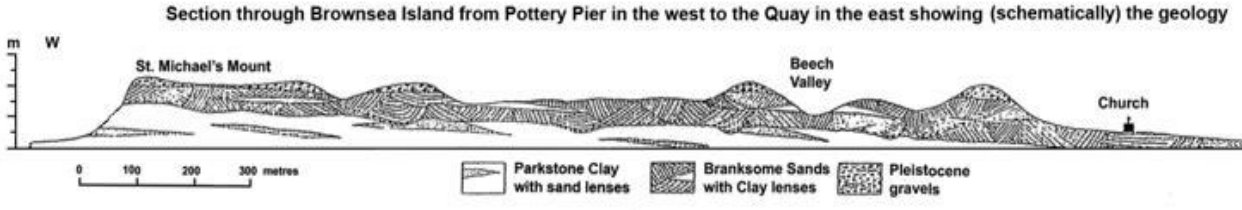
The clay and sand of the Parkstone Clay can be seen in great detail. Sedimentary structures include an undulating surface on top of the clay, and convoluted bedding in the sands. The Branksome Sand can be seen at the top of the cliff.

Beware: This section is not accessible at high tide, and is not safe for parties with young children. See picture 11 – high tide on North Shore.

High tide on North Shore

Return to the main path by ascending the steps.

The top of the island is covered by terrace gravel, mostly of flint weathered from Upper Chalk hills to the west by the Solent River during warm periods of the Ice Age a few hundred thousand years ago.



THE HISTORICAL USE OF BROWNSEA'S MINERAL RESOURCES

The clay-rich formations of the island were used for the production of copperas in the 16th and 17th centuries and for the production of ceramic (bricks and pottery) in the 18th and 19th centuries.

Copperas is the old name for hydrated ferrous (iron) sulphate – a green compound, the colour of which probably explains the name "copperas" by the association of a green colour with the weathering products of copper (verdigris). It was used as a mordant (colour fixer) in the dyeing industry, for tanning and in the manufacture of ink and the pigment Prussian Blue. There are records of Brownsea copperas being shipped from Poole to London by the barque "Bountiful Gift" in 1589.

The clays and sands were deposited in aerated waters, but soon after burial by later sediments and isolation from the water's oxidising conditions the entrapped sulphate ions were reduced to sulphide, expressed now in its most common form – iron sulphide, the mineral pyrites. Pyrites occurs finely disseminated throughout the sediment (giving it a dark colour) or sometimes more concentrated as distinct nodules.

When these pyrite-rich sediments are exposed to the atmosphere at the present time they are oxidised, the iron to yellow-brown hydrated oxides and the sulphur to sulphate ions, which when freely associated with hydrogen ions in water make a dilute solution of sulphuric acid. Concentration of this mixture will produce iron sulphate. The boiling process described in the copperas works on Brownsea (Celia Fiennes 1698-99) was clearly designed to bring about this concentration. The description refers to "stones being gathered and placed on raised beds exposed to the rain, the solution being channelled into the house where liquor is boiled and scrap iron added." The stones were probably nodular pyrite, now worked out and the scrap iron was added to use up excess sulphate ions to produce more copperas. The works were in the south of the island in the vicinity of the camp site.

Copperas was also produced from the Alum Chine and Boscombe Chine areas, while at Parkstone there were "mines" from which copperas and alum were produced. Alum, a naturally occurring sulphate of potassium and aluminium was extensively produced from these areas. It too is used in the dyeing industry.

The whole copperas and alum industry was active from the mid 16th century. It appears to have died out in the early 18th century.

Ceramic products are made from clay, often with significant proportions of quartz sand and sometimes with local impurities such as limestone, ironstone or even sulphides. The mixture is plasticised with water, shaped or moulded, dried and then fired. Firing causes dehydration and some chemical reactions producing new minerals and some fusion to produce glass. The temperature needs careful control to produce the desired ceramic. Depending upon this control and the availability of material, a wide range of product can be manufactured from hand-moulded bricks to the finest porcelain.

It is believed that bricks have been made on the island at various periods since the 18th century using clays from the south of the island. However, in 1882, the island was purchased by Colonel Waugh in the belief

that it contained large quantities of pure white clay suitable for the production of fine porcelain and also offered brilliant prospects for alum production. A pottery works was built in the area of the camp site linked by a tramway to clay pits in the north of the island and to a pier for the export of pottery. Maryland Cottages were built for the workers. The clay was not of the finest quality and only terracotta products and coarse pottery, such as drain-pipe stoneware was produced. Bricks were also made at this time, the works being sited along the southern side of the island.

Brownsea bricks are of poor quality (like the pottery). Those seen on the island today show considerable weathering. When broken, the texture indicates poor mixing of the clay and sands. Additionally, as the clays used were probably rich in sulphides, the resulting bricks would be rich in sulphates; often the cause of decay in bricks and also the disintegration of associated mortars and rendering.

Colonel Waugh's enterprise collapsed and the pottery finally closed in 1887. Apart from some small scale peat cutting this was the last industrial activity on the island.

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