

North Head geology and landscape.

Summary points from a talk by Dr Peter Mitchell 3 December 2022.

If you dive into the web and search; 'geology + North Head' you will find four questionable facts:

1. North Head is all 200 million year old Hawkesbury Sandstone.
2. It is covered by sand dunes 140,000 years old.
3. It is linked to Manly as a tombolo that formed during the last Ice age.
4. It has a hanging swamp which is somehow special.

These stories can be traced to popular books of the 1950s written by Griffith Taylor and Charles Laseron who presented models that were largely untested. Their stories are popular lore and although no longer credible, they are certainly persistent.

The headland appears to be dominated by Hawkesbury Sandstone, which Taylor thought was 160 million years old. Today 200 million years is often cited, but 245 million is more accurate. Beneath the Hawkesbury Sandstone the ocean cliffs expose other sandstones, shales and laminites of the Upper Newport Formation which were deposited in a delta by streams that flowed from New England. These rocks contain plant fossils and invertebrate burrows and are underlain by the Bald Hill Claystones 80m below sea level - the same strata that outcrops at Long Reef. Strangely the Upper Newport rocks were not recognised by geologists until the 1980s even though they were found in early sewer tunnels and waste rock is scattered over much of the surface where it was used for construction. The Upper Newport rocks dip gently west and are not exposed on the Harbour side of the headland.

The Hawkesbury Sandstone was deposited on a vast braid plain by rivers with headwaters in Antarctica. We recognize; sheet bedded quartz sandstone deposited as dune features under low flow conditions, massive bedded quartz sandstone sometimes with a thin bed of quartz pebble conglomerate at their base deposited by major floods, and shale beds deposited as mud on floodplains and in billabongs. Shale at Beacon Hill produced a wealth of fossil fish and insects.

There are at least three igneous dykes, and one or perhaps two, major fault zones running across the Headland. The dykes are basalt but fresh rock is rare as they are deeply altered to a smooth white kaolin clay that was probably prized by Aboriginal people for use as body paint.

The youngest geological unit on North Head is the 'cliff-top sand dunes' which support much of the Eastern Suburbs Banksia Scrub. A better term would be 'bedrock mantling dunes'. The sand is extremely infertile yet it supports a very high diversity of native plants partly because many species have evolved mechanisms, that are capable of stripping thin coatings of yellow iron oxides off individual sand grains and accessing tiny amounts of phosphorous attached to the iron. These processes create a podzol soil profile with characteristic bleached horizons and complex iron/organic pans (coffee rock) that move deeper into the profile over time.

Soil profile development suggests the dunes are perhaps 5,000 years old, the web claims 20,000 and 140,000 years, but dates elsewhere on the coast range from 5,000 to 34,000. No dates have been determined on North Head and there is no accurate map of the sand or a detailed description of the soil. Early work suggested that the sand blew up the coastal cliffs from offshore at times of lower sea level. That is possible, but the sand could also have come from the Botany Sands in the eastern suburbs and/or the floor of the harbour.

The sand acts as a huge sponge and stores most of the rain falling on it, then releases water slowly at the contact with underlying rock. This groundwater system drives permanent stream flow and was tapped by the Quarantine Station. Air photos of 1929 reveal the limits of the sand body and the extensive network of wetlands around it before the landscape was disturbed by construction, drainage, and fire control.

Tourism blurb draws attention to the Hanging Swamp as a special environment but it is only a tiny remnant of the wetlands that existed a century ago and was constructed when the military built an embankment across a shallow valley in the 1960s. The swamp doesn't 'hang', and isn't even on a steep slope, it is better called a 'coastal upland swamp'. The other 1929 wetlands are still there, but their vegetation structure and probably composition have been substantially changed.

To understand any part of the coast we need to consider the effects of changing sea level and the possibility of geomorphic events several times bigger than any we have yet witnessed.

The last global ice age peaked 18-20,000 years ago with sea level 100-120m below present, temperature depressed by 6°C, and exposed a coastal plain ~10km wide. The climate got warmer, sea level rose at 1m/century, sweeping sand before it to form today's beaches. In the last 450,000 years the coast went through five cycles of this magnitude and there must have been extraordinary changes in coastal landscapes and vegetation patterns. Is this important? Well yes, because the sea is presently rising at that rate and in only a couple of generations, we can expect similar changes.

Manly's tombolo? The word literally means a 'tied island' which is a superficial description as there is 68m of sand under the Corso and it is difficult to envisage a time when North Head was ever actually isolated. The more interesting question is why is there such a deep valley there? As for extreme events, Charles Hedley identified three marine terraces at Blue Fish Point in 1924 and thought they were all due to 'coastal warping' rather than sea level change or variable rock structure. In 2001 Ted Bryant claimed that three large tsunamis had hit the NSW coast in the last 3,000 years. Sydney Coastal Councils were concerned enough to engage consultants to model possible tsunamis and their worst case put two metres of sea water through Manly Corso. Bryant's evidence has mostly been rejected but we cannot ignore the possibility of very large storms and tsunamis in the future.

In short; North Head isn't quite what the web pages suggest and certainly 'ain't what it used to be' thanks to our 'management'.