

THE PINNACLES: interesting structures in the Tamala Limestone.

The formation of the Tamala Limestone is given in another factsheet. This rock, made largely from shelly sand dunes which have been cemented together by percolating rainwater, sometimes has patches or layers which are much more solid. Some, as previously explained, are due to the concentration of the calcareous cement around roots and so on. Larger layers of solid calcareous material represent a surface deposit called calcrete, which formed below the soil layer at one stage due to rain and chemical weathering. This can form a resistant cap, protecting softer limestone layers below from erosion. In the Pinnacles Desert, many columns have a "hat" of calcrete which has helped to protect it, which can make them look mushroom-shaped.

The solid calcrete layer was cracked, often by plant roots forcing their way down in a search for water, so that when the limestone was leached by more rain, the roots and cracks formed channels for water movement. Parts of the calcareous sand in the unprotected porous limestone dissolved away, but the well-cemented areas and the limestone protected by capping did not dissolve. The solid sheaths around large roots remained even after the roots themselves had rotted away, and in some cases parts of them may be seen as walls to some of the columns. The insoluble quartz sand component of the dunes was left behind, between the columnar shapes of limestone formed by this subsurface weathering.

What happened when there was more erosion? The loose quartz sand between the limestone shapes and pillars was blown away, to reveal the columns. It is likely that, once exhumed, the pillars may have been buried again by other sets of sand dunes, only to be re-exhumed and then reburied. The Tamala Limestone all along the Swan Coastal Plain has suffered this kind of subsurface erosion, and pinnacles can be seen in many places, even along the river near UWA!

You can see the original wind-bedded layers in many of the columns, showing that they represent remnant parts of an original dune system. Occasionally there are fossil soil layers and other features which match outcrops of the Tamala limestone elsewhere. Look out for fossil weevil pupal cases, like the ones in the fossil soils on Rottneest: these look like small elongate eggs, with usually a hole near one end where the beetle *Leptopius* exited. There may even be small chert Aboriginal artefacts which are at least 6000 years old.

How old are the Pinnacles? We know that most of the Tamala limestone probably formed between about 500 000 years ago and the last few thousand years: some would argue that it is still forming today. In this relatively recent geological past, the Northern Hemisphere was gripped in an Ice Age, during which there were warmer periods when much of the ice melted. Water locked up as ice on the land caused a drop in sea level: when it melted there was a corresponding rise in sea level. In addition, conditions in the interglacial period from about 130 000 to 80 000 years ago were good for marine life, so we have a source for the abundant shelly material which made up the vast dunes which became the Tamala limestone, much of which is thought to date from that time. The last great Ice Age in the Northern Hemisphere lasted from 25 000 to 15 000 years ago, and the drop in sea level (and the onset of drier conditions) would have allowed the build-up of the large dunes of shell sand all along the coast of WA.

The process of pinnacle formation may have taken many thousands of years. We know that most pinnacles must have formed before 6000 years ago, since Aboriginal artefacts thought to be of that age have been found in amongst them, and even cemented to the outside of a column. This suggests that the pinnacles may have been reburied after Aborigines visited them, subjected to percolating water which then cemented a little more, and afterwards have been re-exposed.

For a more detailed, illustrated account, see the booklet "Pinnacles" by Ken McNamara, published by the Western Australian Museum (1995 edn.) and for sale in the Museum.