Surface Tufa Deposits of the Leeuwin-Naturaliste Ridge

Jane Scott

The Leeuwin-Naturaliste Ridge in the far south-west of Western Australia is made up of very young, wind-blown (aeolian) limestone less than 2 million years old, which rests unconformably on a basement of hard, resistant, Precambrian granite-gneiss and other metamorphic rocks. While the processes of solution and deposition occurring here are essentially the same as in any limestone rock, the region features some unique karst which results from the young age and aeolian nature of the limestone, combined with the topography of the Ridge.

As the limestone was deposited in the form of huge sand-dunes which gradually consolidated, the pre-existing east-west drainage was generally maintained, and streams continued to flow through to the coast. However, the flow of water was impeded in many places, backing up into swamps from which water gradually seeped westwards through the base of the limestone. This water was (and still is) aggressive due to its high content of carbon dioxide from the air and from soil acids, and it has carved out many cave systems en route to the ocean.

Tufa is the common name given to calcium carbonate which is re-deposited from solution in water saturated with carbon dioxide. As water, containing dissolved carbon dioxide from the air, and from plant respiration and decay in the soil, travels through limestone strata, calcium carbonate is dissolved and held in solution as calcium bicarbonate. When this water emerges again into the open air, either in caves or as surface springs, changes in environmental conditions can cause the carbonate to be re-deposited.

As cavers, we are familiar with stalactites, stalagmites and other calcium carbonate deposits in caves, but are maybe not so aware of the tufa deposits that occur at surface springs. These springs and seepages emerge along the Capes coast at the junction of limestone and the impervious granite-gneiss rock beneath. The tufa deposits which form around them vary from a thin veneer, to massive cliff features, such as those at Quarry Bay and Meekadarabee.

Thin sheets of tufa coat the granite in many places, and form cement around water-worn boulders, for instance on the boulder beach north of Gracetown. Tufa covers the sloping granite rocks at the southern end of Foul Bay, and at Cosy Corner. Some of it is still active in winter, while a large area has not been replenished for a long time. At a larger spring near Kilcarnup, a long, thick raft of tufa has built up over the sand where the water trickles down to the sea. Adjacent deposits, which are now dry, show how the stream has changed course over the years.

The most spectacular tufa outcrops occur where the spring water falls over a vertical drop. At Quarry Bay, near Augusta, and at Meekadarabee Falls, near Ellensbrook, substantial deposits have built up from spring water trickling over a cliff face, allowing carbonate to accumulate gradually. At Meekadarabee, the whole of the cave has developed in a huge tufa deposit, formed over thousands of years from the spring which emerges from the north side of the valley.

The incorporation of vegetative material helps provide a framework on which the mineral can be laid down. The part played by mosses, twigs, roots and leaves can clearly be seen if you look closely at the cliff sites, where complex, overhanging, bell-like shapes have slowly built up as water trickles over the vegetation. Various types of algae are found growing in the lime-rich spring water where tufa forms over beaches and rocks, and these also become incorporated into the deposits. Photosynthesis by aquatic plants, which extracts carbon dioxide from the water, may accelerate the deposition of calcium carbonate.

The role of microorganisms in the formation of carbonate deposits is complex. In several localities, eg. north of Quarry Bay, south of Conto's Beach and below the spring north of Canal Rocks, superb rimstone pools have formed. These pools become very special minature eco-systems, which contain a host of algal and bacterial species, unique because of the high carbonate content of their environment, and high salinity due to their proximity to the sea. A fascinating feature of these pools, is the growth in them of tiny stromatolites. These rock-like structures are built up by a combination of

the growth of cyanobacteria (formerly known as blue-green algae), and the precipitation of calcium carbonate from the water. They appear as small nodular concretions in the pools.

Stromatolites belong to a group of organisms known as microbialites, and are among the oldest lifeforms on our planet. They are complicated beasties, despite their formation by simple organisms, and they grow in a variety of ways. Those found at Lake Clifton, which are known as thrombolites, for instance, have quite different structures to the stromatolites found at Shark Bay. Those found along the Capes coast are particularly significant, because their intricate, finely-layered structure is similar to that of fossil forms, which grew millions of years ago in the Precambrian period, when stromatolites were the dominant life-form on earth. This type is apparently very rare amongst living stromatolites today.

I hope that this short introduction will generate interest in the unique tufa deposits that occur along the coastline of the Leeuwin-Naturaliste Ridge. If we become more aware of these fascinating and unusual formations, and learn more about them, we will hopefully look after them, and treat them with the respect they deserve.

REFERENCES

MOORE, L. S., PENTECOST, A. and BURNE, R. V. (1997). The Tufas of Augusta, Western Australia (Draft paper).

BURNE, R.V. and MOORE, L. S. (1987). Microbialites: Organosedimentary Deposits of Benthic Microbial Communities. *Palaios* 2: 241-254.

MCNAMARA, K. (1992). *Stromatolites*. WA Museum. 28.

ACKNOWLEDGEMENT

Many thanks to Linda Moore for her comments and corrections to this paper, which was originally printed in *Inside CLINC*, the journal of Cavers Leeuwin Inc., Vol. 3, 1999.

Contact details

C/o Post Office Witchcliffe WA 6286.