INSIDE ANCIENT RIVERS - CAVES BEACH

Sea cave formed along sedimentary bedding.

CAVES IN COASTAL CLIFFS

Storm waves bursting with energy have carved amazing sea caves into solid rock of the cliffs at the southern headland of Caves Beach. Some caves are large enough to walk through, and some are interconnected. The caves taper back into the cliffs, and reach up to 24 metres in length. The cave floors are at sea level and normally covered in sand. Their roofs can reach up to about 4 metres above sea level.

The rocks that the caves are carved into are ancient river deposits. They comprise lenticular layers of sedimentary rock: sandstone and conglomerate, originating as sand and gravel dumped here by fast flowing rivers about 250 million years ago, during the Permian Period. Subsequent burial by a thickness of over 2 km of sediment compacted and cemented the river sediments into solid rock. Uplift and erosion have exposed the rocks back at the Earth's surface.

As you explore the cliffs and caves, you can look inside these ancient river channels. They contain pretty coloured river pebbles, fossil tree trunks and branches, ferns and river bed structures.

How did ocean waves create such large holes in strong, solid rock?

Sea caves formed along joints.

ORIGIN OF THE SEA CAVES

The caves probably began forming about 6,500 years ago, after the last glacial period when the rising sea stabilized at its present level.

During the last glacial period, which reached its coldest 18,000 years ago, huge ice sheets grew outwards from the poles by sucking up water from the oceans. This caused sea level to fall globally to 120 metres below its present level. The coastline lay about 20 km farther east than it does today. Rivers had to cut down deeply into the Permian bedrock to reach the sea. Erosion moulded the landscape into a series of rounded hills and valleys.

As the Earth's temperature slowly rose again the huge ice sheets began to melt, causing sea level to rise. The rising sea flooded up into river valleys to eventually form estuaries, bays and beaches. Ocean waves battered the drowned hillsides, cutting into their gentle slopes to produce the headlands and steep sea cliffs we see today.

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Storm waves attacked the new sea cliffs, picking out zones of weakness in the rock faces and cutting into them.

The rocks have horizontal and vertical zones of weakness: horizontal bedding (sedimentary layering) and softer layers, and vertical jointing (cracks). So the surf reached into these weaker zones, creating horizontal and vertical fissures that widened and deepened with continued pounding within a confined space.

Surging waves also compressed air into the fissures. As the waves retreated, the trapped air was released with explosive force. After many impacts the explosions burst the cracks even wider. Swirling waves containing suspended sand, gravel and rock fragments abraded and smoothed the inside surfaces of the fissures, helping to enlarge them.

So the combined action of pounding waves, exploding compressed air and abrasion eventually widened the fissures into caves.

The dominant joints trend southeast, pointing straight into the prevailing southeasterly swell. As a result, many caves have formed along southeast trending joints. On the rock platform in front of the caves, waves have eroded deep gutters along these joints.

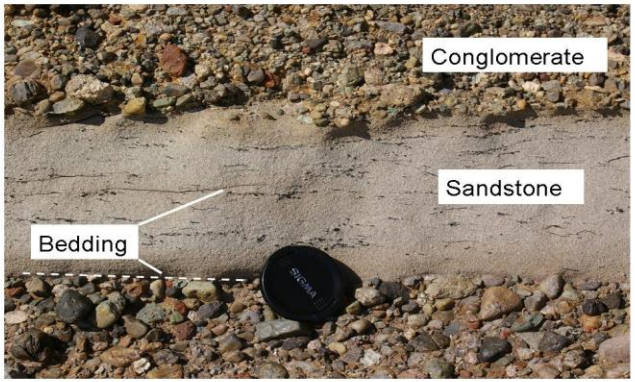
Gutter eroded by waves along a southeasterly trending vertical joint.

Storm waves battering the caves and cliffs, Caves Beach southern headland.
Retreating wave exposes many rocks on the cave floor (left). Wave surges into the cave (right).

LOOKING INSIDE THE CAVES

At high tide and during storms the surf surges into the caves. So it is only safe to walk and crawl through the caves at low tide. Always keep an eye on the waves!

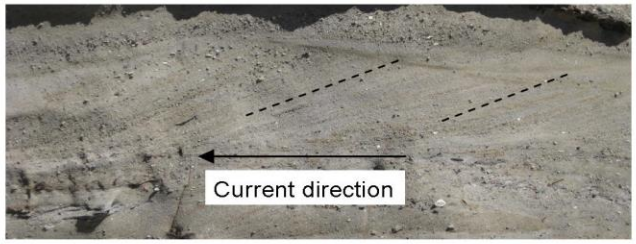
After a long period of calm weather, beach sand accumulates on the cave floors, providing a smooth even surface. But storms wash sand out of the caves, leaving an uneven rocky/sandy floor. Rocks exposed are either more resistant parts of the rock floor beneath, or blocks that have fallen from the roof above. Blocks break off along weak layers, bedding planes and joints.



Black coaly fragments streaked along bedding in sandstone were sticks, leaves and bits of bark.

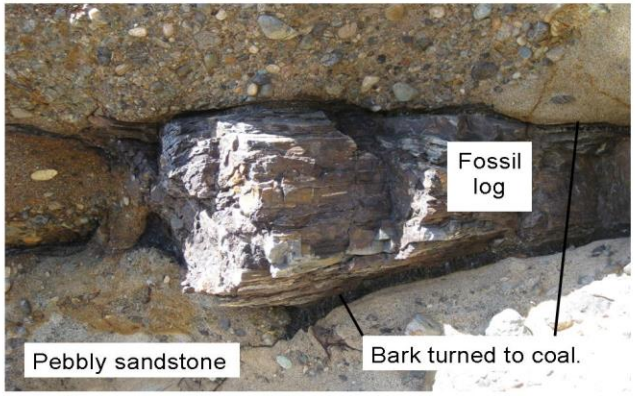
FEATURES OF ANCIENT RIVER DEPOSITS

The walls and roofs of the caves, as well as the cliff faces outside, reveal many secrets about the rivers that flowed here 250 million years ago. Conglomerate, composed mostly of pebbles, indicates that the rivers that deposited the gravel must have flowed very swiftly to carry the pebbles here. Sandstone layers suggest slightly slower river currents. Sandy river channel deposits typically display cross bedding: internal inclined layers. Cross bedding forms on the river bed where small underwater sand dunes migrate downstream. The layers dip downstream. By measuring the dip direction of many exposures of cross bedding in the caves area, it has been estimated that the ancient rivers flowed from mountains lying to the north-northeast.



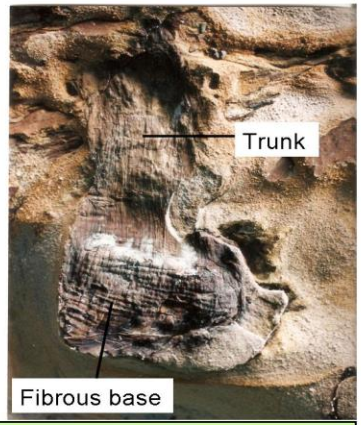
Cross section through a river bed sand dune, now preserved as cross bedding in sandstone.

Conglomerate: compacted and cemented river gravel. Rounded coloured river pebbles are bound together by sand grains and mineral coatings.



Log buried in river sediment. Wood is replaced by limonite (rust, hydrated iron oxide) and grey chalcedony. Growth rings and bark are preserved.

Fossil of possible tree fern trunk preserved in sandstone, exposed in a cave roof. Stem replaced by limonite.



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