

ABSTRACT: Cape Range, Australia, on the northwest coast of the continent at 21° S, 113° E, is a NNE striking anticlinal ridge 315 m high, 100 km long, and 20 km wide extending into the sea, consisting of Miocene carbonate rocks with a series of coastal terraces of Pliocene and Quaternary carbonates and siliciclastic dunes. Inland escarpments, representing former sea cliffs, and deep valleys cutting the limbs of the anticlinal ridge host many cave entrances at a variety of elevations. The lowest unit, the Mandu Formation, a chalky and marly limestone, contains many tafoni (pseudokarst) caves with simple, single chamber plans and widths up to 15 m or more, and height up to 10 m. The higher, purer Miocene limestones, and the younger Pliocene and Pleistocene coastal terrace limestones, host numerous flank margin caves from 300 m elevation in the Miocene rocks to sea level in the Quaternary rocks. These caves have entrances up to 30 m wide and heights of 6 m, with single chamber caves being common but complex chamber caves also present. Some caves are entered by small entrances that lead to large phreatic chambers, which eliminates both sea cave and tafoni as possible explanations. The close association of these caves with sea cliffs and incised valleys argues against a deep hypogene origin, which would leave a cave pattern unrelated to the surface configuration. Miocene uplift tapered off into the Pliocene; the flank margin caves in the paleo sea cliffs represent the outcome of the interplay of tectonic activity and glacioeustasy over a 300 m vertical range, with lowstands causing valley incision; highstands raised the fresh water lens and allowed cave development in the valley walls. Cave development began with the first tectonic-driven subaerial exposure in the Miocene and continued through to the last Pleistocene interglacial.



location of Cape Range. The Miocene Pilgramunna, Trealla, and Tulki Limestones are typical lagoonal limestones. The Mandu is a marly chalk. The sand sheets are primarily siliciclastic, coastal plain deposits primarily carbonates.



Flank Margin Cave Development and Tectonic Uplift, Cape Range, Australia

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Figure 2: The Mobowara Fanglomerate is made up primarily of limestone clasts and carbonate matrix, and exhibits both traditional and unusual dissolutional features (pencil 14 cm long for scale).

Background: Large breached flank margin



Figure 3: Rhizomorphs (fossil roots) exposed by flank margin cave dissolution, which removed host rock preferentially from the more resistant root path.











Figure 4: Tafoni in the Mandu Formation. Differentiating tafoni from breached flank margin caves requires careful inspection (e.g. Waterstrat et al., 2010).

carbonates. Lower right image is Mandu Formation.

Figure 6: Maps of typical flank margin caves in the Miocene lagoonal carbonates.



Terraces fronted by scarps represent former sea-level positions

Figure 7: Tectonic Uplift and gentle folding resulted in subaerial exposure of the Miocene carbonates and their subsequent fluvial incision (left, looking south). The uplift was episodic, creating terraces fronted by scarps (right, arrows, looking across the peninsula west to east).

> Background: Looking south along the axis of Cape Range. Quaternary carbonate coastal plain to the right, uplifted and incised Miocene carbonate terraces center and left.



Figure 8: Flank margin cave in coastal terrace scarp (left), looking west. Terrace and scarp, with flank margin cave entrances (right), looking southwest. Indian Ocean in distance in both images.



Figure 9: Incised valley (left), with currently ephemeral stream channel, flank margin caves on the valley wall, and the Indian Ocean in the distance. Flank margin cave (X) and tafoni (right).

References Cited

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