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Enigmatic Coral Rock Pillars – Another Look into Reef Dynamics

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Abstract. Stone capped calcareous pillars, rising 10-70 cm above the surrounding reef surface are to be found at Aqaba (Jordan) and on several other fringing reefs of the Northern Red Sea from intertidal down to 3 m depth. Terrigenous (non-calcareous) cobbles and boulders are fixed on top of coral limestone. At Aqaba it is assumed that the stones were once introduced by fishermen and came to rest in depressions of the reef. Afterwards the surrounding reef limestone was eroded so that only the substrate underlying the granite stones has been left as singular towers. ^{14}C-dating of a column sample provided an age of 345-560 years. Several interpretations are possible: the respective reef part did not grow since then, or younger layers were removed by bioerosion. Some suggestions are provided based on erosion data of sea urchins (*Diadema setosum*) and fish, gathered at that site. Two more examples of partial reef decline are presented from a reefflat at the Sinai coast north of Dahab indicating uplift along the margin of the Gulf of Aqaba and from the bay Marsa Bareika at the southern tip of Sinai where big boulders are interpreted as ballast stones discharged in an antique harbour.

Key words: Long-term reef shaping, bioerosion, Gulf of Aqaba (Red Sea)

Introduction

Some reefs at Aqaba (Jordan, Northern Red Sea) are under observation since 1972 (Mergner and Schuhmacher, 1974). They exhibit contrasting aspects from thriving coral communities with up to 60% living cover to barren limestone rock. The latter one is cleared by grazing fish and sea-urchins, especially *Diadema setosum*. Stone capped limestone pillars which rise 10-70 cm above the surrounding reef surface caused us to take a closer look at these structures and their history.

Similar structures found in other parts of the Red Sea are also shown.

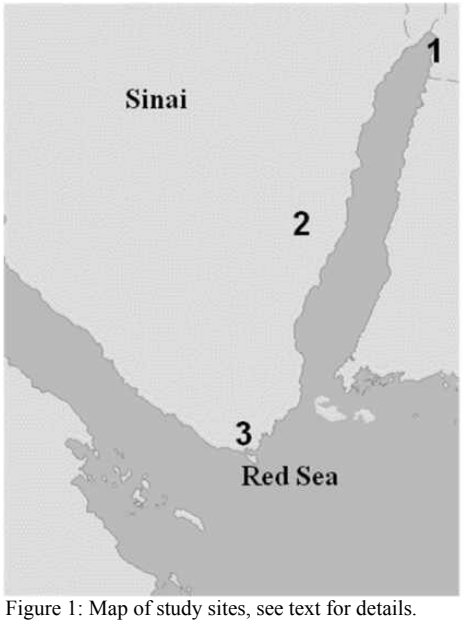

Figure 1: Map of study sites, see text for details.

Results and discussion

Findings from three sites of the Northern Red Sea are presented (Fig. 1):

1. Aqaba (northern end of the Gulf of Aqaba),
2. East coast of Sinai Peninsula between Dahab and Abu Galum,
3. Marsa Bareika, Ras Mohamed National Park, southern tip of Sinai.

In each case terrigenous cobbles and boulders are fixed on top of columnar elevations carved out from coral limestone.

Case study Aqaba:

Fig. 2 shows the top of a forereef mound at approx. 10 m depth off the Marine Science Station Aqaba. The arrow points to one of the cobblestones. The underlying pillar was identified as remnant of a *Porites* colony (Fig. 3). Its ^{14}C-dating revealed an age of 453 +/- 107 years. A neighbouring column made of a faviid skeleton was dated as to a maximum of 50 years.

It is assumed that the stones were once introduced by fishermen and came to rest in depressions of the reef. Afterwards, the surrounding reef limestone was eroded so that only the substrate underlying the granitic stones was left as singular towers. It is unknown when the stones were introduced, therefore several interpretations are possible: The respective reef part did not grow since decades/ages, or younger layers were removed by bioerosion, before the stone fell down. There is considerable bioerosion at that site: The density of *Diadema setosum* is 1.2 ind m^{-2}; the removal of carbonate substrate was calculated from gut contents and faeces analyses (considering

reworked material) as 1.023 kg m-²yr^{-1} (Kroll 1995, Reinicke and Schuhmacher 2008). Grazing fish, especially the acanthurid *Ctenochaetus striatus*, removed 1-3 mm yr^{-1} from *Favia* skeleton tiles which were exposed as colonization plates (v.Treeck et al. 1996 - regarding the impact of *C.striatus* see also Schuhmacher et al., session 10, this volume).

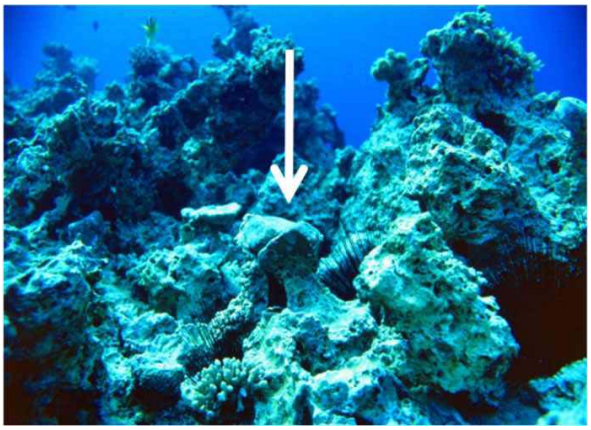

Figure 2: Granite stone on top of a forereef mound, Aqaba.

Figure 3: Stone capped *Porites* column; scale bar 7.5 cm.

Example case Sinai coast:

The mountains between Dahab and Ras Abu Galum steeply slope into the Gulf allowing development of only a narrow fringing reef. The reef flat continuously receives rubble tumbling down from the adjacent mountains. Fig. 4 shows the reef flat at low tide. At high tide the boulders are immersed except those on the tallest sockets. From the height of the calcareous columns it can be concluded that a 30-50cm thick layer was removed from the reef flat. The fact that the recent reef surface reaches to low tide level indicates a still considerable uplift of the western margin of the Gulf of Aqaba graben. Specific agents of bioerosion and time scales were not investigated.

Figure 4: Reef flat at low tide with terrigenous debris.

Example case Marsa Bareika:

Marsa Bareika is a large bay at the southern end of Sinai. A slightly inclined sandy wadi (river bed) enters the inner bay from the north. A poorly developed reef is interrupted by sandy areas. Several limestone outcrops, crowned by heavy boulders represent hardbottom islets that are sparsely colonized by corals (Fig. 5-6). The present topography does not provide an indication how the big boulders got to the site; anthropogenic transport, however, is likely. The bay is a natural harbour (today small vessels of the Ras Mohamed National Park are moored here). It is assumed that in ancient times (perhaps 2-4000 years ago) ships anchored at this site and dropped ballast stones – probably in exchange for copper or other minerals which were mined on Sinai and shipped to Egypt and further south. For a hypothetical bottom profile of that time see Fig.6. Archaeological studies have yet to be conducted. It would be intriguing to investigate ecological conditions and time periods, when this reef body formed and faded.

Figure 5: Boulder on top of a 70 cm high socket of reef rock.

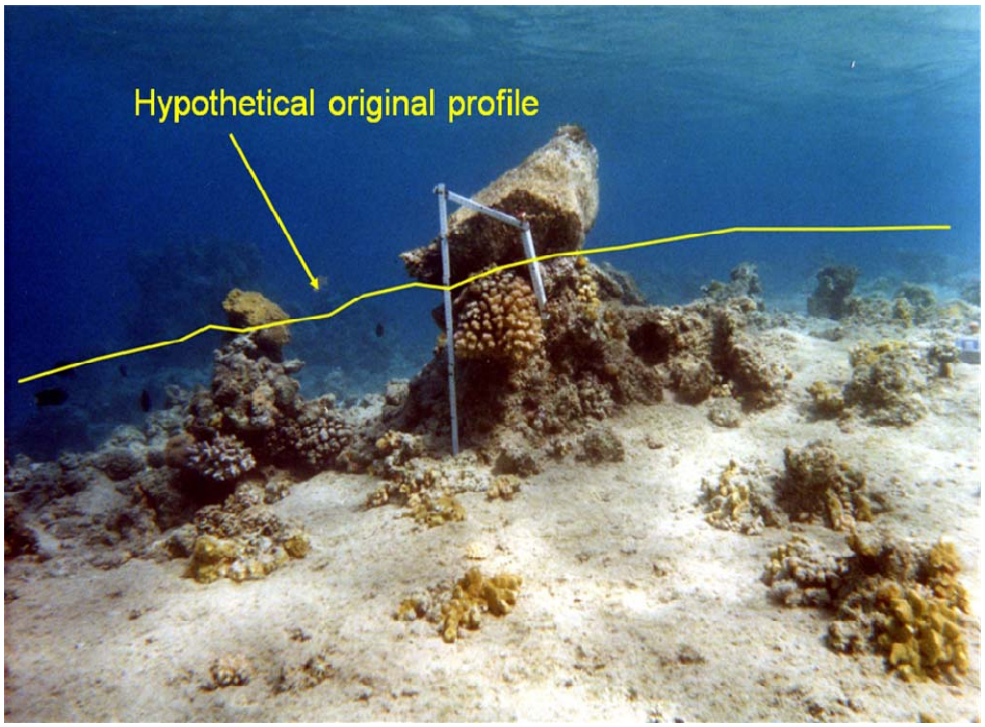

Figure 6: Boulder capped remnants of a former reef.

Conclusion

All three examples show reef areas, where the reef framework is eroding. The stone capped towers are remnants wittnessing of former reef developments. Anthropogenic reasons for the decline of these reef parts can be excluded. This presentation is thought to sensitize for this phenomenon at other places and to generate discussion about circumstances and modes of bioerosional reef shaping.

Acknowledgement

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