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Microbialite development in Quaternary reefs : the nature of the problem

Camoin, G.[1]

[1] CNRS-CEREGE, Aix-en-Provence, France

The microbialite contribution to the volume and rigidity of carbonate buildups and reefs have often equalled, or exceeded, the contribution of skeletal metazoans throughout the geological column. Since their first descriptions in the Late Pleistocene to Holocene reefs from Tahiti [1, 2], microbialites have been then reported in various Quaternary reef frameworks from a number of areas, as well as from the walls of the deeper forereef slopes and in shallow-water caves [3, 4]. This implies that microbialites may have played a significant role in the development of Quaternary reefs, as well as in related sedimentary and diagenetic processes. In particular, it has been demonstrated that they may have significantly affected reef development, by strengthening the frameworks and limit the susceptibility of reefs to biological and physical erosion. However, two major related issues are barely addressed : 1) the relative timing of coral framework development and microbialite encrustation, and 2) the environmental significance of microbialite development in reef frameworks.

The accurate reconstruction of development patterns and the quantification of microbialite growth rates in carbonate buildups and reefs clearly rely on the ability to obtain a reliable chronological frame. The sedimentological and paleoecological criteria (e.g. the relationships between builders, environmental significance of the various reef dwelling communities etc.) provide a relative chronology which, generally, does not allow to fully address those issues ; major controversies regarding reef growth patterns and relationships between actual builders and microbial fabrics have appeared in the past and are still under debate. Quaternary reefs may provide the unique opportunity to address those issues through the potential dating of the various components of the reef frameworks coupled with a proper study of the framework architecture. An accurate chronology can been obtained through the ^{14}C dating of numerous triplets of contiguous corals, coralline algal crusts and microbialites to better constrain the chronology of the framework development and to reconstruct the involved accretion processes [5].

The occurrence and development of microbialites in Quaternary reefs has been interpreted as reflecting an ecosystem response to environmental change, including an increase in alkalinity and nutrient content in interstitial waters bathing the subsurface of the living reef framework in relation to terrestrial groundwater seepage and periodic runoffs, or to upwelling processes [3,4]. Direct relationships between nutrient increase and the widespread development of microbial features have been established in modern reef environments [6, 7]. During post-glacial sea-level rise, these effects may have declined as sea level stabilized in the mid Holocene, thus explaining the overall decline of microbialite abundance 6,000 years ago [3, 4]. Changes in atmospheric CO_2 and their impact on seawater carbonate saturation have been considered to explain the variability in microbialite abundance during glacial cycles [8].

References:

[1] Montaggioni and Camoin (1993) Geology 21 : 149-152

[2] Camoin and Montaggioni (1994) Sedimentology 41 : 655-676

[3] Camoin et al. (1999) Sedimentary Geology 126 : 271-304

[4] Camoin et al. (2006) Sedimentary Geology 185 : 277-295

[5] Seard et al. (2011) Marine Geology 279, 63-86

[6] Sprachta et al. (2001) Palaeogeography Palaeoclimatology Palaeoecology 175 : 103-124

[7] Gautret et al. (2004) Journal of Sedimentary Research 74 : 462–478

[8] Riding et al. (2014) Geobiology, DOI: 10.1111/gbi.12097