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Aberrant features of the Messinian coral reefs, Spain*

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RESUMEN

Se describen someramente los principales arrecifes del Messiniense en España, haciendo hincapié en el conjunto de "anomalías" que presentan los arrecifes del Neógeno inferior en comparación con las asociaciones arrecifales actuales. Se discute la importancia y significado de *Porites* sp. como coral claramente dominante, y a menudo exclusivo, en la construcción de edificios arrecifales.

During the Messinian event, coral reefs existed scattered along the Mediterranean coast. We should be able to obtain accurate information on Messinian environments by studying its reefs. Although some of these reefs are recognized in the literature, we are not aware of detailed studies on them; one exception in Spain is the work of DABRIO (1974,1975) in the area of Purchena. The purpose oh this paper is to present a preliminary report of our work on the Messinian reefs in Spain, pointing out a constant set of "anomalies" in the community composition of these reefs in relation to earlier Neogene and to modern reef communities. Although the precise age of most of these outcrops is not well tnown, we believe that they are roughly contemporaneous, mainly because (1) these anomalies in the communities are a response to very specific and exceptional environmental conditions, clearly related to the Messinian crisis, (2) it appears that analogous aberrant communities existed in other Mediterranean localities in analogous stratigraphic position. We do not have as yet a completely satisfactory explanation for all of these aberrant features; but a tentative interpretation is here outlined as a working hypothesis.

GENERAL DESCRIPTION

Spanish Messinian reefs vary considerably in size, morphology, substrate and diagenetic processes. Fig. 1 shows the main known localities in Spain and their relationship to regional structural features. MONTENAT (1973, 1975) provides an excellent geologic framework for most of these reefs. The thickest reef-wall occurs in Santa Pola and Mallorca (20-70 ?m); in Purchena they are much thinner (2-6 m). In the area of Níjar, at least three prograding reef stages can be seen, each one building up on the slope of the previous one. Níjar and Lucainena de las Torres are the most laterally continuous barrier and fringing reef outcrops (about 15 km), and they can be traced for a similar distance, or more, in the subsurface at Mallorca. Entire reef slopes are exposed in Carboneras and Níjar, with :ontinuous exposure between flat reef-top and the horizontal toe of the slope. We can infer minimum water depths of near 150 m in Carboneras, and probably similar features in the subsurface at Mallorca. In Níjar, the minimum water depth could be at about 70 m. In general, SE facing slopes are better developed (or preserved) than the NW ones.

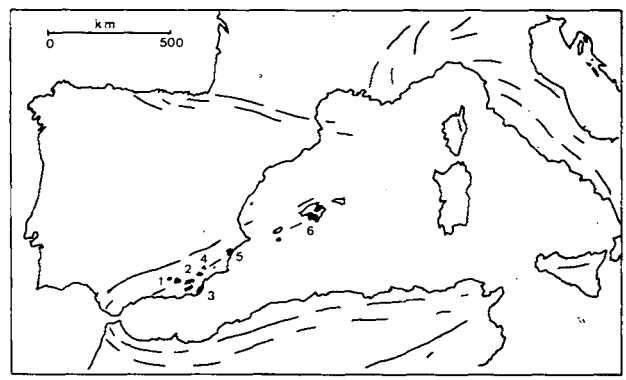

Fig. 1: Known Messinian reefs in Spain. 1: Purchena, 2: Níjar and Lucainena, 3: Carboneras, 4: Lorca, 5: Santa Pola, 6: Mallorca.

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Reef substrata are siliciclastic fan deposits in Purchena and Lucainena, volcanics in Carboneras (probably with atoll-like morphologies), and older Miocene sediments in Mallorca. Preservation of wide reef-wall buttresses is particularly good in Santa Pola and Níjar, and to a lesser degree in Carboneras. Evidence of extensive submarine cementation is found in Mallorca and decreases toward the west. In Purchena there is practically no cementation. The inferred water turbulence was very high in the area of Mallorca, and in general also seems to be diminishing toward the west. Gravitational displacement of reef blocks and sediment is quite common during the Messinian and Lower Pliocene. A characteristic vertical fracture system parallel to the reef-front seems to have contributed to slope instability.

All these variations are suggestive of a complex paleogeography; in general, the open sea should be toward the east and, apparently, there is not much evidence of good communication with the Atlantic.

REEF COMMUNITIES

In view of the variability in the Spanish Messinian reefs, the rather constant coral composition is here considered to be quite significant. The reef builder in the Spanish Messinian is *Porites* sp. This coral is clearly dominant, and often exclusive, in the reef-wall framework. The typical *Porites* morphology is longn vertical, bifurcating or trifurcating sticks, 2-10 cm thick and up to 4 m high, in bush-like and organlike configurations. In more exposed areas *Porites* appears in successive flat colonies connected by vertical columns. In more protected areas hemispherical star coral heads of *Sidereastrea* sp and *Montastrea* sp may occur. Although these coral heads may be up to 50 cm in diameter they are not conspicuous as reef builders. In some places star corals adapt a columnar colonial morphology similar to *Porites*. Brain corals are less comon except at some points Puchena, the area with the highest coral diversity in the Spanish Messinian. That high diversity occurs in the less expected locality, with the thinner reefs, poor cementation, and probably less wave action away from the inferred open seas to the east. Significantly, in this locality *Porites* is smaller than farther east, but still is very abundant and has the same morphology.

In the area of Santa Pola, and probably in Carboneras and Mallorca, *Porites* is intergrown or closely associated with blue-green (?) algal stromatolite bioherms, one to tens of meters high, in the reef-front. This stromatolite-*Porites* association is also well developed in oolitebar sequences in more shelfward positions. The apparent absence of tidalite sequences, fenestral frabrics or indications of emergence, together with the stromatolite morphology (units up to 15 m thick of perfect hemispheroidal heads up to 10 m in diameter), may suggest a rather deep submarine environment.

Production of *Halimeda* sp is usually very high. This codiacean alga occurs in thick (2-5 m) packstone beds in the fore-reef slope. Red alga nodules and branches, vermetid gastropods, bryzoans and serpulid worms are present in some locations, but do not play a significant role as binders in the reef-wall framework. Organic boring (sponge, mollusc, worm, alga, fungi) of the reef is abundant in some places, specially in Mallorca.

ABERRANT FEATURES

In the community composition of the Spanish Messinian reefs that we have briefly summarized, we find a significant set of anomalous or aberrant features: (1) A drastic reduction of diversity of reef-building species, in comparison with earlier Miocene, or older, reefs in the area (CHEVALIER, 1961, PERMANYER and ESTEBAN 1973); (2) The exclusivity to the Messinian of the large size and shape of *Porites*. This group appeared in the Middle Cretaceous and is well represented in reefs since the begining of the Cenozoic, showing colonial morphologies similar to the ones of modern species. Only during the Messinian do they develop exceptionally large columns and flat-and-column structures, or appear in exclusive *Porites*-reef; (3) The presence and abundance of stromatolites in a reef front or in areas associated with corals, *Halimeda* and bryozoans, all these supposedly sensitive indicators of normal marine conditions.

INTERPRETATION

These anomalous or aberrant features produce a special archaic aspect in the Messinian reefs in relation to other reef communities in the area. These features reflect conditions of growth that differ considerably from "normal" marine. *Porites* and *Sidereastrea* are known in modern seas as the corals more resistant to salinity and temperature variations or to waters high in suspended sediment. However, in these physically stressed modern environments they occur as small and isolated colonies, in contrast with the ones in optimal marine conditions. This suggests that another kind of ecological control had to favor the huge Messinian *Porites* colonies, perhaps growth in absence of ecologic competition.

WORKING HYPOTHESIS

Our hypothetical interpretation implies two stages. First, a Messinian crisis (salinity -) would eliminate most of the normal marine biota, only preserving some of the more resistant species (particularly, *Porites* and *Sidereastrea*) and favoring the development of stromatolites. Second, a rapid re-establishment of normal or near-normal marine conditions would provide these communities with the opportunity for growth in a non-competitive situation. The problematic part of this hy-

pothesis is to explain the absence of coral and stromatolite competitors and, at the same time, the presence of *Halimeda*, bryozoans, etc. What kept browsers, grazers and scrapers on algal mats and corals from reestablishing themselves in the reef environment?

Several considerations may help explain this problem. During the Tortonian, coral reefs disappear on the Atlantic side of France and yet they were flourishing on the Mediterranean side (CHEVALIER 1961), suggesting that the Mediterranean was a "refuge" during the Late Miocene. In the periods of reestablishment of marine conditions during the Messinian, there were no corals or coral competitors on the Atlantic side that could emigrate to the Mediterranean. To explain other absences we can also consider that during the Messinian, periods of normal marine conditions were so short or so rapidily established that there was no time for invasion of diversified Atlantic communities. Other possible considerations may involve the nature of the communication with the Atlantic or the amount of organic matter or suspended sediment in the water.

Much more information and field data are needed in order to delineate a basic paleogeography and paleoecology of the Messinian reefs. The ideas here expressed only attempt to stimulate further work on this exciting and poorly understood subject.

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