Diagenesis of Aragonitic Sponges from Permian Patch Reefs of Southern Tunisia

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1 Introduction and Geological Setting

Djebel Tebaga in southern Tunisia is the only known outcrop of marine Upper Permian on the African continent (Fig. 1). Throughout the Djebel Tebaga a variety of patch reefs, metres to tens of metres in size, are embedded in crinoidal and fusulinid limestones and marls (Fig. 2). Beds directly underlying the reefs are commonly reduced in thickness resulting from early compaction. Besides coralline algae, the important frame-builders are calcareous sponges represented especially by Inocoa, Sclerospongia, Disjectoporida, and less common Sphinctozoa. Close to extinction at the Permo-Triassic time boundary, rugose corals are rare and do not contribute to the reef framework.

During the latest Permian-earliest Triassic regression, these patch reefs were subjected to an arid to semi-arid coastal climate, as indicated by onlapping Triassic beach and dune sands showing occasional dinosaur footprints. The Triassic to Jurassic sequence consists mainly of red sandstones, shales and marls, representing coastal desert environments with occasional shallow marine incursions (Busson 1967, Assereto and Benelli 1971). The Upper Triassic Azizia Limestone described from Libya (Assereto and Benelli 1971) was not encountered in the area and is laterally replaced by sandstone (Busson 1967). The Permian to possibly Middle Jurassic sediments are locally unconformably overlain by coastal/marine Lower Cretaceous clastics and carbonates which, following a Late Cretaceous to Tertiary regression and uplift, were eroded down to the Permian in the centre of Djebel Tebaga.

A previous study has shown that the Permian sponge skeletons are still partly preserved as aragonite (Wendt 1977). The calcareous sponges of Djebel Tebaga therefore offer a unique opportunity to analyze the early diageneric, subsequent burial and weathering products and the overall paragenetic sequence.

2 Methods

In addition to petrographical studies supported by point counting, staining techniques, UV-light and cathodoluminescence microscopy, trace elements and stable oxygen and carbon isotopes were analyzed. The particular type of trace element has been selected, firstly, to deduce the environment in which biominer-
alization took place and, secondly, to interpret the conditions during diagenesis: sodium, strontium, and magnesium were used following suggestions by Land and Hoops (1973), Usdowski (1973), Siegel (1960), and Kinsman (1969). Ferrous iron was also selected because it is a good indicator of reducing conditions and, by negative evidence, of oxidizing conditions, if iron is available in the system.

Spot analyses were carried out on thin sections by energy dispersive X-ray analysis (EDAX). Since the contents are often too low to be effectively measured by EDAX, and elements such as sodium and, to a certain extent, also magnesium, have a very low radiation energy, the separating window between sample and detector was removed. Atomic absorption analyses were performed on total samples using a Perkin Elmer Model 460 because of higher resolution to precise the information obtained from point measurements.

Carbonate phases in total samples were determined by X-ray diffraction using Cu K alpha radiation. Quantitative compositions were calculated from comparison of the integrated main peak areas of the samples with those of known mixtures of aragonite and calcite of Holocene and Pleistocene corals and with Triassic dolomitic reef material from the Alps. From repetitive runs a standard deviation of 5% was obtained. For stable isotope analysis crushed samples were