A PETROOGRAPHIC STUDY OF THE DIAGENESIS OF THE SUE POINT FOSSIL REEF SAN SALVADOR, BAHAMAS

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INTRODUCTION

During the months of June and July of 1987 a survey was made of the Sue Point fossil reef on the northwest corner of San Salvador Island, Bahamas. Core samples were taken and petrographic analysis of the samples was completed. The following is a description of the facies defined by outcrop and sample study, and a discussion of the diagenetic sequence and history of the facies. Figure 1 is a schematic representation of the features described for each facies.

FACIES DESCRIPTION AND INTERPRETATION

Beach Rock Facies

This facies consists of well sorted and well rounded, creamy-white, bioclastic limestone with a grain size varying from 1.25mm. to 3.5mm in diameter. The allochems include foramanifera; algal flakes; and fragments of coral, echinoderms, bivalves and other molluscs. This facies also contains peloidal and ooid grains, the latter of which are rimmed with brown, micritic, aragonite cement. There are also intraclasts composed of two or more ooids, peloids, and/or bioclasts, with similar concentric aragonitic rims that coat the entire grain.

Cements are patchily distributed within this facies. Low-Mg calcite cements vary from thin rims on the surfaces of individual grains, to void spaces fully occluded with equant, sparry crystals. The cement within these voids exibits the classic coarsening-inward crystal size pattern.

This facies also contains intergranular micritic cement composed of low Mg-calcite that is long and sinuous in shape. Associated with this micritic cement are patches of whisker calcite. This too is low-Mg calcite, but it displays a much different crystal habit of long hair-like needles radiating from a central core. Both of these cement types form as a result of the biological activity of plants and fungi. These cements form as sheaths around roots and root hairs that upon organic breakdown remain as casts. The whisker calcite is a fast growing calcite polymorph associated with the rapid flux of CO_2 gas within the sediment resulting from the breakdown of the organic root material.

Coralstone

This facies is composed mainly of large in situ coral heads of Monastrea annularis and Acropora cervicornis. Some of the coralites in these heads are partially or completely filled with sediments consisting of ooids, peloidal grains, and bioclasts, as well as micrite and sparry calcite cement. The bioclasts in this sediment include broken coral fragments, bivalve fragments, and foramanifera. The distribution of sediment infill in some cases defines geopetal structures: early micritic cement is found within the sediment and late-stage sparry calcite cement is found above the sediment in some of the voids that were partially sediment-filled. The patchiness of late-stage cementation can be attributed to the irregular nature of vadose diagenesis.

Eolianite

This facies consists of very fine, well sorted and very well rounded, lithified sand (.0625mm. - 1.25mm.). This facies is carmel in color, darker than the beach rock facies. The eolianite is composed of ooids and a minor amount of bioclasts that include bivalve fragments, algal flakes, foramanifera, and coral fragments. This facies is composed of a series of normally graded laminae 0.2mm to 0.5 mm thick. Normal grading is common in eolian deposits and forms during progradation of dunes.

The eolianite facies is generally well cemented. Some whisker calcite is present but the majority of the cement is equant, sparry, low-Mg calcite. There is an inverse relationship between the size of the grains and the degree and style of cementation within the laminae. The laminae composed of large grains exibit more rim cements and less pore-filling cementation than the laminae of smaller grain size which are generally filled with equant crystals. This distribution is a function of the capillary action within the sediments at the time of cementation. Smaller grains

With these studies as background, the Keck Bahamas Geology Research Group conducted four weeks of research investigations on San Salvador during June and early July, 1987. After several days of reconnaissance field trips for familiarization with the carbonates environments and rock record of the San Salvador natural laboratory, two research teams were formed. The "Construction Crew," headed by Professor White and including Doug Cattell (Colorado), Storr Nelson (Whitman), and Molly Stark (Smith), had as its goal the detailed geologic mapping and sampling of a large Pleistocene fossil coral reef at Sue Point. The research objectives were to expand on and supplement knowledge gained from earlier studies of the Cockburn Town fossil coral reef, particularly with regard to the diagenetic history of the various reef facies.

The "Fossils" team, directed by Professors Curran and Thomas and including Cara Davis (Pomona), Lorrin Ferdinand ((F&M), Daisy Hagey (Williams), Lynn Neal (Wooster), and Jennifer Schuster (Carleton) had more diverse goals, with projects ranging from the study of modern hardgrounds to the analysis of Pleistocene bivalve faunas. A central theme for this group of projects was the investigation of taphonomic processes in tropical marine, shallow-water environments, addressing questions of how the borings, shells, and tests of modern organisms might come to be preserved in ancient deposits. The specifics of each student project are described in detail in abstracts in this volume.

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pack more densely, creating more and smaller pore spaces which hold water better than larger spaces. Precipitation of cement tends therefore to be more complete within finer sands, whereas larger grains which are usually covered by thin films of water, tend to be surrounded with rim cements.

Subtidal Calcarenite

This facies consists of poorly sorted, well rounded, calcarenite. The sediment ranges from very fine to medium sand size (.0625mm. to 3.0mm.). The sediment is bioclastic with minor amounts of peloidal and oolitic grains. The bioclasts include algal flakes, mollusc fragments, coral fragments, foraminifera, and echinoderm fragments.

The total volume of cement is minor and there are two general types: intragranular and intergranular. The intragranular cement consists of fibrous and dogtooth aragonite. These cements are found within: (1) pores of algal flakes, (2) the chambers of foramanifera tests, and (3) secondary voids within ooids and other allochems. Small amounts of whisker calcite can also be found in these void spaces.

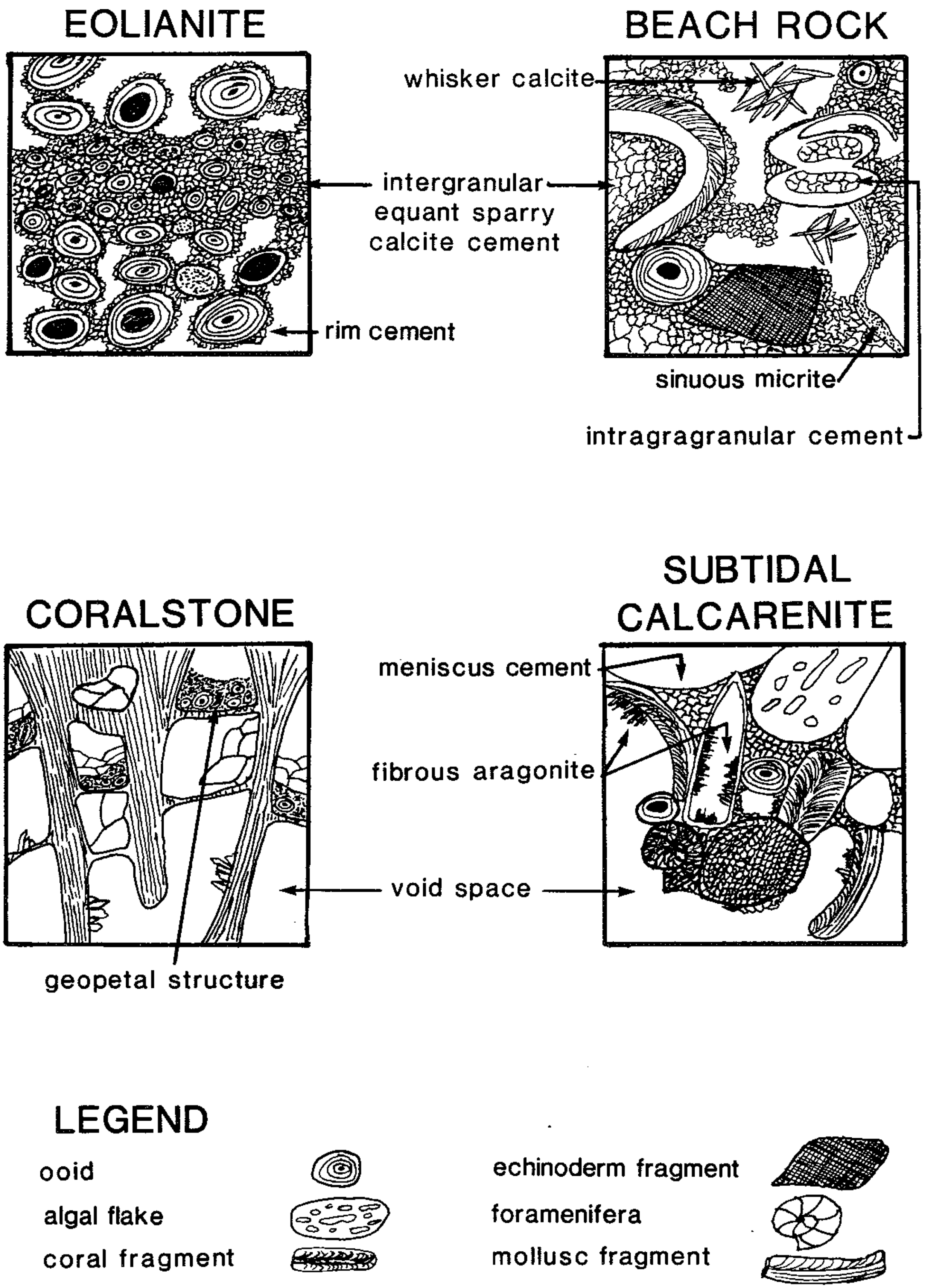
The intergranular cement is found in several forms. Brown, blotchy, marine micrite cement is patchily distributed holding small groups of ooids and bioclasts together. Laminar, orange-brown micritic aragonite cement also rims intraclasts that were most likely derived from beach rock or hardgrounds. These intraclasts exibit two generations of cementation: both the component grains and the intraclasts themselves are rimmed with this laminar micritic marine cement (aragonite or high-Mg calcite). There are also meniscus cements composed of low-Mg calcite, that exibit smooth curviliner crystal faces. The curvilinear nature is apparently caused by precipitation of calcite around bubbles at the water-air interface. Whisker calcite is also present in small amounts within void spaces in the sediment.

DISCUSSION

The above discussion of facies has focussed on the compositional and textural nature of allochems and cements. Based on the relationship between allochems and cements and between various cement types, a sedimentologic and diagenetic history will be outlined below.

The earily stages of deposition involved the formation of well washed bioclastic and oolitic sediment. At this time marine aragonitic cements were precipitated around ooid grains and to a lesser extent between various allochems. Erosion and transport of early-cemented sediment from locally developed hardgrounds and beachrock created intraclasts which were in turn subjected to aragonitic rim cementation during transport. After final deposition the intragranular spaces of some bioclasts were sites of precipitation of fibrous aragonite. This fibrous aragonite formed in the marine phreatic zone and marked the end of the early diagenetic phase of these sediments, at which point there was little intergranular cement. An exception to this is the early micritic cement within the sediment forming the geopetal structures in the void spaces of the coralstone.

The sediments of this study are presently in the meteoric vadose zone, which, considering that the Holocene has been a period of eustatic sea level rise, indicates prolonged exposure of these sediments to meteoric waters. There is, in fact, considerable evidence for a second diagenetic phase of alteration and cementation under meteoric vadose conditions. The dominant intergranular cement consists of equant, sparry low-Mg calcite with various textures diagnostic of vadose conditions (e.g. rim, pendant, meniscus, and whisker calcite cements). The dissolution of ooid cores and the precipitation of low-Mg calcite, blocky cements also occured at this time. The prolonged exposure of these facies to meteoric waters has caused local development of thin, draped caliche layers and the long sinuos low-Mg calcite cement that formedaround roots and root hairs.


EOLIANITE
BEACH ROCK
whisker calcite
intergranular
equant sparry
calcite cement
rim cement
sinuous micrite
intragragranular cement
CORALSTONE
SUBTIDAL
CALCARENITE
meniscus cement
fibrous aragonite
void space
geopetal structure
LEGEND
ooid
algal flake
coral fragment
echinoderm fragment
foramenifera
mollusc fragment