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Front Cover: View to the SSE on White Cay in Grahams Harbour off the north coast of San Salvador, Bahamas. At this spectacularly scenic site one can see that marine erosion has removed the entire windward portion of these early Holocene eolianites (North Point Member, with an alochem age of ~5000 radiocarbon years B.P.) that were deposited when sea level was at least 2 meters below its present position.

Back Cover: Stephen Jay Gould, keynote speaker for this symposium, holds a *Cerion rodregoi* at the Chicago Herald Tribune's 1891 monument to the landfall of Christopher Colombus, which is located on the windward coast of Crab Cay on the eastern side of San Salvador Island, Bahamas. The monument consists of an obelisk constructed from local limestone which houses a carved rock sphere depicting the globe with the continents. The inscription carved in a marble slab, reads: "On this spot, Christopher Columbus first set foot upon the soil of the New World."

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SIGNIFICANCE OF BACTERIAL ACTIVITY IN CARBONATE DIAGENESIS

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ABSTRACT

Previous work indicates that dry fossil phreatic caves in the Bahamas have formed in a time scale too rapid to be explained by the exclusive application of inorganic diagenetic processes. Water and rock samples from the mixing zone of blue holes (submerged caves) in the Bahamas contain significant bacterial populations. Bacterial activity within the water column was measured using radioactive isotopes ^{14}C acetate and bicarbonate, ^{35} S-sulphate, and [methyl ^{-3}H] thymidine. Results indicate that bacterial populations (number attained using the Acridine Orange Direct Count method, AODC) within the water column are active and viable. Bacterial numbers range from 3.80 x $10^6/cm^3$ at the top of the mixing zone to 1.05 x $10^6/cm^3$ at the bottom of the mixing zone. Rock cores that penetrate up to 8 cm into the cave walls also reveal considerable populations (7.38 x $10^5/cm^3$) within the carbonate rock, and the numbers decrease only slowly with greater penetration. The data indicate that the cave systems are biogeochemically active.

INTRODUCTION

Within the Bahamian platforms an interesting underwater landscape exists which has been created by dissolution processes originally thought to have been exclusively abiotic. Current research is now revealing information to the contrary. Data which has been collected during the last three years, from three different cave systems (Lucayan Caverns and Owl's Hole, Grand Bahama Island; Stargate, South Andros Island), demonstrate that biotic activity within these cave systems is driving dissolution and, together with the geochemistry of the water column, is making and enlarging caves.

Blue holes, which is a colloquial term used to describe the entrances to those underwater environments, became a focus of this study following work examining fossil phreatic caves (Schwabe et al., 1993) referred to as flank margin caves (Mylroie and Carew, 1990; Whitaker and Smart, 1996). Those currently dry caves formed during the late Pleistocene, when sea level was up to 6 m higher than today (substage 5e, ~125,000 ka), and it supported small fresh-water lenses within eolianite ridges. Those large voids (up to 14,000 m^3) formed during a short geological time (< 15,000 years, Carew and Mylroie, 1990). Based on the very small island sizes during times of elevated sea level, when only the upper parts of the eolian ridges and a few beach and shoal deposits stood above sea level, fresh-water lens volumes were severely limited. Considering the size of those micro-lenses, water budget constraints, and the limitations of the geochemical dissolution model for calcite (Mylroie et al., 1991), it should not be possible to produce such large dissolution voids in small islands in such a short time.

THIS STUDY

To try to resolve the problem of how the fossil phreatic caves formed so quickly, given the constraints mentioned above, study of blue holes within the Bahamian platform (which are the modern analogue to the fossil phreatic caves) offers the opportunity for direct observations of active cave development. These cave systems are unique because they are relatively easily accessible to cave divers, and they therefore provide access to the mixing zone so that it can be sampled, and the active chemical processes can be studied *in situ*. An investigation into the nature and function of bacterial communities in modern mixing zones within submerged caves is currently in progress (Schwabe, 1997)

The fresh-water and saline zones of the water column within these cave systems have been characterized utilizing salinity, temperature, and geochemical profiling. Vertical profiles though the water column of three different lens-based cave systems have identified the location and thickness of the mixing zones. Significant bacterial populations were observed, using AODC methods, in all water samples collected from the water columns. Most importantly however, it was demonstrated that the bacteria are not only present in large numbers, but also the the populations are viable. Results from turnover ratesacquired from radiotracer experiments using ^{14}C acetate and bicarbonate, demonstrate that heterotrophic bacteria are utilizing this material and are reproducing. Also, ^{35}S-sulphate reduction rates demonstrated the presence of sulphate reducing bacteria, and thymidine incorporation demonstrated that DNA synthesis was occurring. These results are important because they demonstrate the potential for bacterial metabolic activity to alter the chemistry of the water column and wall rock environments; such information could not be conclusivey demonstrated from bacterial counts alone.

A vital piece of information, which adds further support to the hypothesis that bacterial activity is an important component of dissolution and cave development, is the discovery of large bacterial populations ($7.38 \times 10^5/cm^3$) within rock cores taken from the cave walls. This information, together with SEM photomicrographs showing dissolution pits or pores lined with bacteria, demonstrates that bacteria appear to thrive within the wall rock. It is still to be proven whether the pores in which the bacteria reside were preexisting and due exclusively to inorganic geochemical processes, or whether the porosity has been developed or enhanced by bacteria-generated CO_2 and H_2 which led to dissolution of the wall rock . However, a simple experiment in which rock core sections are soaked with Brom-thymol blue showed that localized acidification does occur.

CONCLUSIONS

The preliminary results reported here have answered some significant questions concerning bacteria in these cave systems. We now know unequivocally that bacterial populations are present in significant numbers in these cave systems within the Bahamian carbonate platforms. We also know from the radiotracer experiments that these bacteria are viable, and are actively altering the water-column chemistry and the wall rock environment. From this collective data, it can be said that cave development in the Bahamian carbonate platforms is not purely an abiotic process, and a possible explanation is at hand to explain the accelerated cave development demonstrated by the fossil phreatic caves (flank margin caves) of the Bahamas.

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