Crystal Habits of the Magnesium Hydroxide Mineral Brucite Within Coral Skeletons

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ABSTRACT

The use of Magnesium/Calcium (Mg/Ca) ratios in coral skeletons as proxies of sea-surface temperature (SST) and the overall fine-scale fluctuations in coral skeleton Mg/Ca data have been subjects of interest among coral scientists. More information is needed to define biomineralization and other processes taking place within the entire skeleton and within microenvironments of coral skeletons. Understanding how and where Mg is either incorporated into the skeleton or precipitated within voids of the skeleton is essential to answering the above questions and includes identifying individual influencing factors. Previously, we discovered and described physical locations and geochemical signatures of high-Magnesium brucite crystals throughout specific structures in skeletal coral *Montastraea faveolata*. Brucite was found to be concentrated within green bands that occur in some coral skeletons. These green bands are thought to be associated with a high-pH environment created by endolithic algae. Brucite has been identified in the skeletons of several genera of coral, and its existence provides information toward understanding the processes that take place within microenvironments of the carbonate skeleton, beneath the living surface of the coral. To follow up on previous studies, we compared the crystal habits of brucite found within the coral *M. faveolata* to brucite precipitated artificially in seawater using a cathode-array system. Samples were evaluated using a scanning electron microscope equipped with an energy dispersive spectrometer (EDS). As identified with photomicrographs, there are similar crystal habits between the two sample environments, including sphere-like clusters of rosettes, crystals forming a cylinder, loose rosettes. There are also different habits unique to each sample; however, the overall individual crystal form creating the rosette groupings is consistent. Semi-quantitative EDS spectra of both sample types show consistent high-Mg peaks. XRD analysis showed the artificially precipitated crystals to be brucite. Results from the coral skeleton crystals have proven difficult to obtain using XRD, but the crystals were determined to be brucite by infrared spectrometry. This study shows the similarity of brucite crystal habits between environments, and new XRD data from the electrically induced precipitates of brucite, reconfirming the existence of brucite within coral skeletons and contributing information about crystal habits of brucite previously not reported.

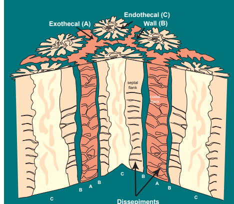
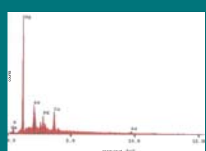
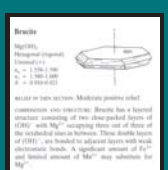


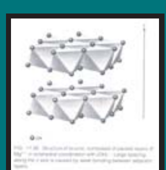
Illustration of basic coral structure in *Montastraea faveolata*. Individual polyps (endothecal areas including septal flanks - light orange) and colonial tissue (exothecal areas including costal flanks - dark orange) are separated by corallite walls (green). Dissepiments act as a "floor" for the tissues as the coral skeleton grows upward.



EDS spectrum of high-Mg crystals (brucite) found within coral skeletons. The graph also shows a low peak of Ca, which is probably the result of beam scatter and includes some of the surrounding aragonite. The sample was coated with Au/Pd.

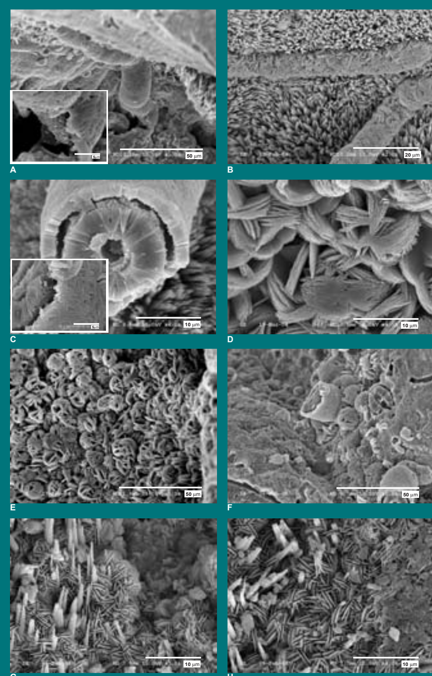


WD Nesse, 1991. Introduction to Optical Mineralogy, 2nd Edition. Oxford University Press, New York, New York, 335 pages (p. 134)



C Klein and CS Hurlbut, Jr., 1993. Manual of Mineralogy, 21st edition. John Wiley and Sons, Inc., New York, New York, 681 pages (p. 392)

Brucite in Corals



SEM photomicrographs of brucite crystals found within skeletons of *Montastraea faveolata*

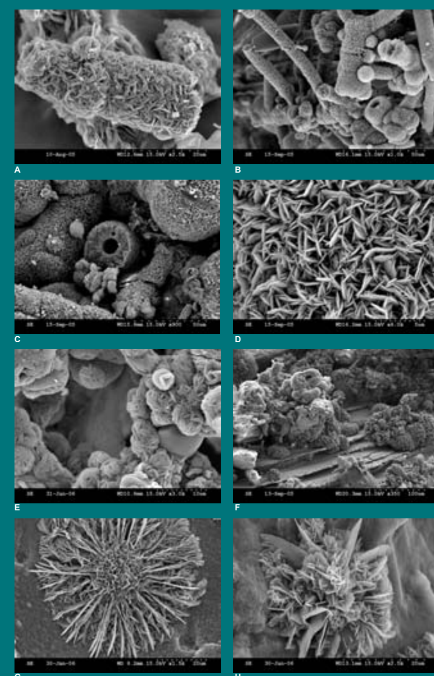
A,B and C: brucite found encompassing endolithic algal remnants

D and E: clusters of brucite crystals within green band

F: both endolithic remnants and brucite crystal clusters

G and H: brucite rosettes intermingled with aragonite needles

Brucite - Electrochemically precipitated



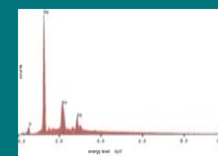
SEM photomicrographs of electrochemically precipitated brucite crystals

A,B and C: brucite found encompassing endolithic algal remnants

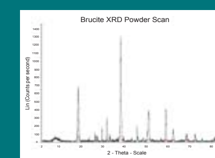
D and E: clusters of brucite crystals

F: brucite crystal clusters and aragonite crystals atop large brucite layered crystals

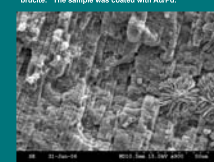
G and H: brucite rosettes centered on dendritic brucite crystals



EDS spectrum of electrochemically precipitated brucite. The sample was coated with Au/Pd.

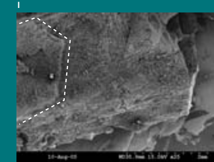


X-ray diffraction pattern of electrochemically precipitated brucite (black lines) compared against a library XRD pattern for brucite (red lines). The XRD is a D4 Endeavor with divergent and antiscatter slits and the sample was scanned from 2 to 85 degrees 2 theta.



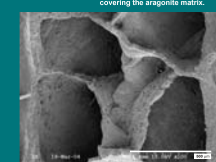
I

(I) Background of image shows noticeable "sheeting" properties of the mineral brucite - also seen are dendritic crystals (J) Hexagonal brucite crystal ontop of larger brucite crystal



J

SEM photomicrograph of an exothecal portion of *M. faveolata*. This image was taken within a green band and shows brucite crystals covering the aragonite matrix.



Well-formed hexagonal brucite crystals with color zoning in manganite vein with unidentified colorless prismatic microxls. Field 2.7mm. Collection and photo R. Bracco.

Locality: N'Chwaning II mine, N'Chwaning mines, Kalahari manganese fields, Northern Cape Province, South Africa. Photo obtained from www.mindat.org

SEM comparison of the crystals between the two environments and XRD quantification of the electrochemically precipitated brucite lend more information toward understanding high Mg precipitates within coral skeletons.

Brucite precipitation in both the coral skeleton and electrochemical precipitation environment is associated with induced high pH situations within the marine/carbonate realm. In both enviroments, coral - aragonite precipitation is predominant. The relationship between the two minerals and concentrations of Magnesium will be researched further.

All coral samples were obtained from Harold Hudson (NOAA- FKNMS). Electrochemically precipitated samples provided by Tom Goreau and Wolf Hilbertz. All SEM images were taken by Noreen Buster at the USGS/Univ. of South Florida Electron Microscope Laboratory. XRD analysis performed by Kate Ceimbronowitz at the USGS St. Petersburg, FL