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Mineralogic Changes during Growth in the Red Alga, Clathromorphum compactum

Abstract. *The amount of magnesium in the skeletal calcite of the encrusting marine red alga* Clathromorphum compactum *varies seasonally in response to changes in water temperature. X-ray diffraction analyses of serial samples of this alga collected in the Gulf of Maine indicate more than a 40-percent change in composition during a year and demonstrate a more rapid calcification during warmer periods.*

Marine organisms deposit skeletal parts composed of a wide variety of mineral forms. Among the carbonate-secreting groups, the minerals calcite, aragonite, and a variety of magnesium calcites (*1*) are common (*2, 3*). Green algae deposit aragonite exclusively. Red algae deposit both aragonite and magnesium calcites, the latter containing up to 30 mole percent magnesium, calculated as $MgCO_3$, in solid solution in the calcite (*1*). The coccolithophores deposit a calcite very low in magnesium.

Clarke and Wheeler (*4*) and Chave (*2*) have shown that in calcite-secreting groups of marine organisms, the magnesium content of the whole calcitic tests increases almost linearly with water temperature over the range 0° to 30°C. Thus tropical forms of a given taxon have a higher magnesium content than their boreal counterparts. During an attempt to determine the rate of growth and calcification in an individual encrustation of the red alga *Clathromorphum compactum,* we found that seasonal changes in the magnesium content of the skeletal calcite could be detected.

Because of the small radius of the Mg^{++} ion, relative to the Ca^{++} ion, an increase in the number of Mg^{++} ions in solid solution causes a decrease in the lattice spacings which can be quantitatively evaluated by means of x-ray diffraction techniques. The $d(112)$ spacing of the calcite was measured by using the $d(111)$ of fluorite (CaF_2), added as an internal reference standard. The composition of the calcite was determined from Fig. 1 of Goldsmith *et al.* (*5*). The accuracy of the analytical technique is about ± 0.2-percent $MgCO_3$. Contamination by dried salts from the sea or organically bound magnesium is no problem because only magnesium in the calcite lattice is measured by this technique.

Serial samples of a compact encrustation of *C. compactum* were taken from the surface inward, by cutting into the specimen with a fine file. The depth of the cut was measured with a micrometer ocular. The material removed, in 100- to 200-μ units, was collected, mixed with powdered fluorite, and mounted on glass slides for x-ray analysis. The results obtained are shown in Fig. 1. Layers deposited in the fall contain the gametangia, identified by *C* in the figure.

In the Gulf of Maine, where water temperatures range from near 0° to 13°C, *C. compactum* deposits skeletal calcite containing from 9.5 to 14 mole percent magnesium, calculated as $MgCO_3$. The alga deposits approximately 500 μ of carbonate annually, thicker layers being deposited in the summer and thinner layers in the winter. Since we have not yet determined whether growth and calcification occur when the water temperatures are at their lowest for this region, we do not know whether a full temperature record is preserved in the specimen.

In the case of *C. compactum,* seasonal growth increments are easily identified by the morphology of the colony, particularly by localization of gametangia. The technique described could be applied to other algae, in which the morphologic characteristics of growth are not so definitive, so that growth and calcification rates could be determined.

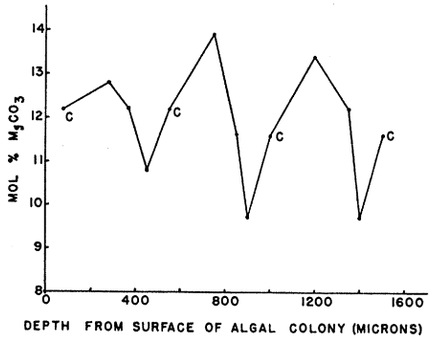

Fig. 1. Magnesium content of successive layers of skeletal calcite in *Clathromorphum compactum.* Fall layers containing gametangia are indicated by *C.*

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Hemoglobin Polymerization in Mice

Abstract. *Polymerization of certain mouse hemoglobins to eight-chain double molecules is completely inhibited by iodoacetamide. Each double molecule appears to consist of two* $\alpha_2\beta_2$*-units linked by way of their* β*-chains with two disulfide bridges.*

Hemoglobins from various strains of mice have been termed either "single" or "diffuse" according to the appearance of electrophoretic patterns of the hemolyzates (*1*). Diffuse mouse hemoglobins have a component sedimenting at approximately 7*S* which increases in quantity during storage (*2*). Discovery that formation of 7*S* components in frog and turtle hemoglobins can be prevented by sulfhydryl (—SH) reagents (*3*) suggested that formation of 7*S* components in mouse hemoglobins might be similarly inhibited. My experiments were designed to test this hypothesis and to determine the number of reactive —SH groups, the number of groups believed to be involved in disulfide (—S—S—) linkages, and distribution of these groups between the α- and β-chains. Initial experiments showed that hemoglobins from each of three strains of mice possess a total of eight cysteine or half-cystine residues per $\alpha_2\beta_2$ unit, of which four freely react with iodoacetamide in a fresh preparation. Hemoglobin from one strain was examined further; the 7*S* component was isolated as described below. It was hypothesized that some of the four reactive —SH groups took part in —S—S— linkage between the two tetramers composing the 7*S* component, and that other —SH groups