Carbonate dissolution in coral reefs

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Carbonate dissolution has recently been reported in some coral reefs, especially at night, even though saturation state of calcium carbonate is well over one with respect to aragonite (omega-aragonite), which is one of the most abundant mineral phases of carbonate in reef environments. Magnesium calcite, which is also the abundant mineral phase of carbonate in reefs, is said to be responsible for this dissolution, but the relative contribution of aragonite/Mg calcite to the dissolution and the site of the dissolution have not been revealed clearly. This study performed laboratory and field measurements of dissolution rates of carbonates in coral reefs in order to explain the dissolution rates encountered in the field from both measurements.

We measured dissolution rates of bulk sediments, corals (aragonite), foraminifera and coralline algae (Mg calcite) separately under various omega-aragonite conditions (1˜3.5). The experimental data suggested that the bulk sediment started to dissolve when omega-aragonite was 3 and the dissolution rate increased with decreasing omega-aragonite. Mg-calcite (both foraminifera and coralline algae) also dissolved when omega aragonite became lower than 3, whereas aragonite (coral) did not dissolve until omega-aragonite became lower than 1.5. We could well explain the bulk dissolution rates from the relative composition of these biogenic carbonates and their dissolution rates.

Field measurement demonstrated that the net dissolution of carbonates was observed at nighttime at the mean rate of 1.2 mmol/m2/hr even though the omega-aragonite was about 3 and 2 in the water column and in the pore water, respectively. From the laboratory and field measurements, Mg calcite and not aragonite is thought to be responsible for the dissolution of carbonates in present-day reefs. We can explain the dissolution rates measured in the field by assuming the dissolution of a top few centimeters of the sediments calculated from the combination of the pore water profile of omega-aragonite and the dissolution rate measured in laboratory.