

ID: W2346546110

TITLE: The synergistic effects of ocean acidification and organic metabolism on calcium carbonate (CaCO₃) dissolution in coral reef sediments

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ABSTRACT:

Ocean acidification (OA) is expected to reduce the net ecosystem calcification (NEC) rates and overall accretion of coral reef ecosystems. However, despite the fact that sediments are the most abundant form of calcium carbonate (CaCO₃) in coral reef ecosystems and their dissolution may be more sensitive to OA than biogenic calcification, the impacts of OA induced sediment dissolution on coral reef NEC rates and CaCO₃ accretion are poorly constrained. Carbon dioxide addition and light attenuation experiments were performed at Heron Island, Australia in an attempt to tease apart the influence of OA and organic metabolism (e.g. respiratory CO₂ production) on CaCO₃ dissolution. Overall, CaCO₃ dissolution rates were an order of magnitude more sensitive to elevated CO₂ and decreasing seawater aragonite saturation state (ΔAr ; 300–420% increase in dissolution per unit decrease in ΔAr) than published reductions in biologically mediated calcification due to OA. Light attenuation experiments led to a 70% reduction in net primary production (NPP), which subsequently induced an increase in daytime (~ 115%) and net diel (~ 375%) CaCO₃ dissolution rates. High CO₂ and low light acted in synergy to drive a ~ 575% increase in net diel dissolution rates. Importantly, disruptions to the balance of photosynthesis and respiration (P/R) had a significant effect on daytime CaCO₃ dissolution, while average water column ΔAr was the main driver of nighttime dissolution rates. A simple model of platform-integrated dissolution rates was developed demonstrating that seasonal changes in photosynthetically active radiation (PAR) can have an important effect on platform integrated CaCO₃ sediment dissolution rates. The considerable response of CaCO₃ sediment dissolution to elevated CO₂ means that much of the response of coral reef communities and ecosystems to OA could be due to increases in CaCO₃ sediment and framework dissolution, and not decreases in biogenic calcification.

SOURCE: Marine chemistry

PDF URL: None

CITED BY COUNT: 39

PUBLICATION YEAR: 2016

TYPE: article

CONCEPTS: ['Ocean acidification', 'Dissolution', 'Aragonite', 'Coral reef', 'Calcium carbonate', 'Environmental chemistry', 'Oceanography', 'Photosynthetically active radiation', 'Environmental science', 'Carbon dioxide', 'Carbonate', 'Sediment', 'Chemistry', 'Calcite', 'Seawater', 'Geology', 'Photosynthesis', 'Mineralogy', 'Organic chemistry', 'Physical chemistry', 'Paleontology', 'Biochemistry']