

CLIMATE CHANGE AND ANTHROPOGENIC EFFECTS ON SHALLOW-WATER
CARBONATE BIOGEOCHEMISTRY

A THESIS SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY
OF HAWAI'I IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF

MASTER OF SCIENCE

IN

OCEANOGRAPHY

DECEMBER 2003

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ABSTRACT

As a consequence of anthropogenic activities, future projections suggest that the saturation state of surface ocean waters with respect to carbonate minerals will decline during the twenty-first century owing to increasing atmospheric CO₂. As a result calcareous organisms could have difficulty calcifying, leading to production of weaker skeletons and their greater vulnerability to erosion, and ultimately leading to dissolution of calcareous sediments. At the same time, sea surface temperature could be significantly higher and the amount of organic matter deposited within the coastal zone could also increase owing to human activities. Increased deposition of organic matter and subsequent remineralization within the sediments of the coastal region could have implications with respect to the carbonate geochemistry of the pore water-sediment system, affecting rates of carbonate dissolution and precipitation. Increasing dissolution of metastable carbonate minerals, such as high magnesian calcite has been suggested as a mechanism to restore changes in saturation state and pH owing to increasing atmospheric CO₂, acting as a buffer, and could counteract any negative effects on calcareous organisms and communities. In order to investigate the effects of climate change and anthropogenic activities on the carbonate biogeochemistry of the shallow water ocean environment, a global physical-biogeochemical box model referred to as *SOCM* (Shallow-water Ocean Carbonate Model) was developed. Numerical simulations demonstrated that biogenic calcification could decrease by 7-44% throughout the 21st century owing to a decrease in carbonate saturation state. Dissolution of metastable carbonate minerals could increase owing to increased deposition and remineralization of

organic matter, but will not result in the production of sufficient alkalinity to buffer the carbon chemistry of the surface ocean water. However, a buffer effect was observed within the pore water system. Sensitivity analysis indicated that the extent of dissolution was mainly controlled by remineralization of organic matter rather than reaction kinetics. In the current standard simulation, the metastable equilibrium of the pore water changed from 21 mol% magnesian calcite to 14 mol% magnesian calcite. Future changes in pore water carbonate saturation state could affect the average composition and rates of precipitation of carbonate cements in contemporary shallow-water sediments.