

# Aquatic Calcification as a Source of Carbon Dioxide

Michel Frankignoulle, Michel Pichon<sup>1</sup> and Jean-Pierre Gattuso<sup>2</sup>

Université de Liège,  
Laboratoire d'Océanologie,  
Institut de Chimie B6  
B4000 Sart Tilman, Belgium.

## Abstract

When calcification occurs in the aquatic environment, carbon dioxide is released into the surrounding water. Due to chemical equilibria of the inorganic carbon system, the release of CO<sub>2</sub> is not stoichiometric but depends on the buffering capacity of the water: the ratio *released CO<sub>2</sub> / precipitated CaCO<sub>3</sub>* ( $\Psi$ ) is nearly 1 in freshwater and about 0.6 in seawater for present-day conditions. Calcification therefore favours the escape of CO<sub>2</sub> to the atmosphere and cannot be considered as a potential carbon dioxide sink in the *Global Change* context. On the other hand, marine calcification will present a positive feedback to the man-induced increase of atmospheric CO<sub>2</sub> and  $\Psi$ (seawater) would increase by about 20% for a doubling of the preindustrial atmospheric CO<sub>2</sub> level.

## Introduction

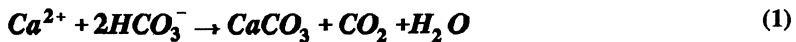
Calcification is a major oceanic process through which carbon is stored in the open ocean (*eg* coccoliths), in shallow water (*eg* coral reefs) and in sediments. The total oceanic carbonate production is estimated to be 1000 Mt C yr<sup>-1</sup> (Morse and Mackenzie, 1990). The response of calcification to increasing atmospheric CO<sub>2</sub> level is sometimes

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1. Australian Institute of Marine Science, PMB 3, Townsville, 4810, Australia
  2. Observatoire Océanologique Européen, Centre Scientifique de Monaco, Avenue Saint-Martin, MC 98000 Monaco, Principality of Monaco.

misunderstood and several scenarios can be found in the literature. While calcification was suggested as a potential mechanism of CO<sub>2</sub> sequestration which could counteract anthropogenic CO<sub>2</sub> release to the atmosphere (Karube *et al*, 1992), it was also proposed as a mechanism explaining the increase of atmospheric CO<sub>2</sub> level during glacial-interglacial cycles (Berger, 1982, Opdyke and Walker, 1992). The purpose of this paper is to investigate the role of calcification on atmospheric CO<sub>2</sub> using chemical thermodynamics. We will demonstrate that this process is a source of CO<sub>2</sub> to the atmosphere.

## Discussion

Calcification can be described by the following equation:



which clearly shows that, for each mole of carbonate precipitated, one mole of dissolved CO<sub>2</sub> is released to the surrounding water. Of course this released CO<sub>2</sub> will further react with bases present in the system (in seawater, mainly carbonate and borate) to reach the equilibrium conditions imposed by associated chemical constants (Wollast *et al*, 1980, Frankignoulle and Gattuso, 1993). The final situation is determined by the following physico-chemical conditions which specify the aquatic system:

- if the system is closed (i.e. no exchange of carbon dioxide with the atmosphere), the partial pressure of CO<sub>2</sub> will increase and its final value will depend on the buffering capacity of the water (Riley and Skirrow, 1975).
- if the system is open to the atmosphere, the partial pressure of CO<sub>2</sub> in the water has to be kept constant and equal to the atmospheric pCO<sub>2</sub> value. This will induce a release of CO<sub>2</sub> to the atmosphere, the magnitude of which again depends on the buffering capacity of the water. Calcification then induces a new distribution of the inorganic carbon species between the phases involved with a net loss for the water and a gain in both the solid (calcite and/or aragonite) and the gas (atmosphere) phases.