SELF-ORGANISATION IN THE EVOLUTION OF THE CARBONATE MATRIX OF THE CORAL REEFS

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The carbonate matrix of coral reefs is subjected to the circulation of fluids from several origins. Both fresh water and water from the lower layer of the ocean present a pH lower than the surface sea water pH, these fluids are not in chemical equilibrium with the rocks and dissolve the calcite. It is observed that the topographic driven flow of fresh water induces the formation karsts, in the upper part of the reef. Deeper in the reef, and at the interface between the volcano and the reef, vugs are observed (1). Similarly to what is observed in surface, part of these vugs may be formed by circulation of the sea water from the lower layer of the ocean. The original permeability of the reef matrix exceeding 10 Darcy allows a vigorous convective circulation (Rayleigh number more than 10 times the critical value) of deep sea water through the basalt to the top of the reef. This is the model of endo-upwelling described in (2).

The purpose of our study is to describe and quantify the feed back between the fluid flow and the transformation of the porosity and permeability of the carbonate matrix. As the system is far from equilibrium and the alteration process can dramatically change transport properties, the alteration front can lead naturally to wormholing and karstification through a reaction/transport feedback. A local heterogeneity of the permeability focuses the fluid which through reaction enhances the porosity and permeability of the matrix; this is the beginning of the formation of a dissolved zone which will resolve in fingered or branching-tree structure (3). We present a parametric study of the destabilization of the dissolution front in the carbonate, as a function of the velocity of the fluid and the chemistry of the system. Large velocities of the fluid favor the splitting of the finger of dissolution. This theoretical modeling study, based on Brinkman (Darcy / Navier-Stocks) flow and mineral dissolution, is a step toward a quantification of the circulation of the fluid coupled to the evolution of the geometry of the carbonate matrix.

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3 abstracts inclus.

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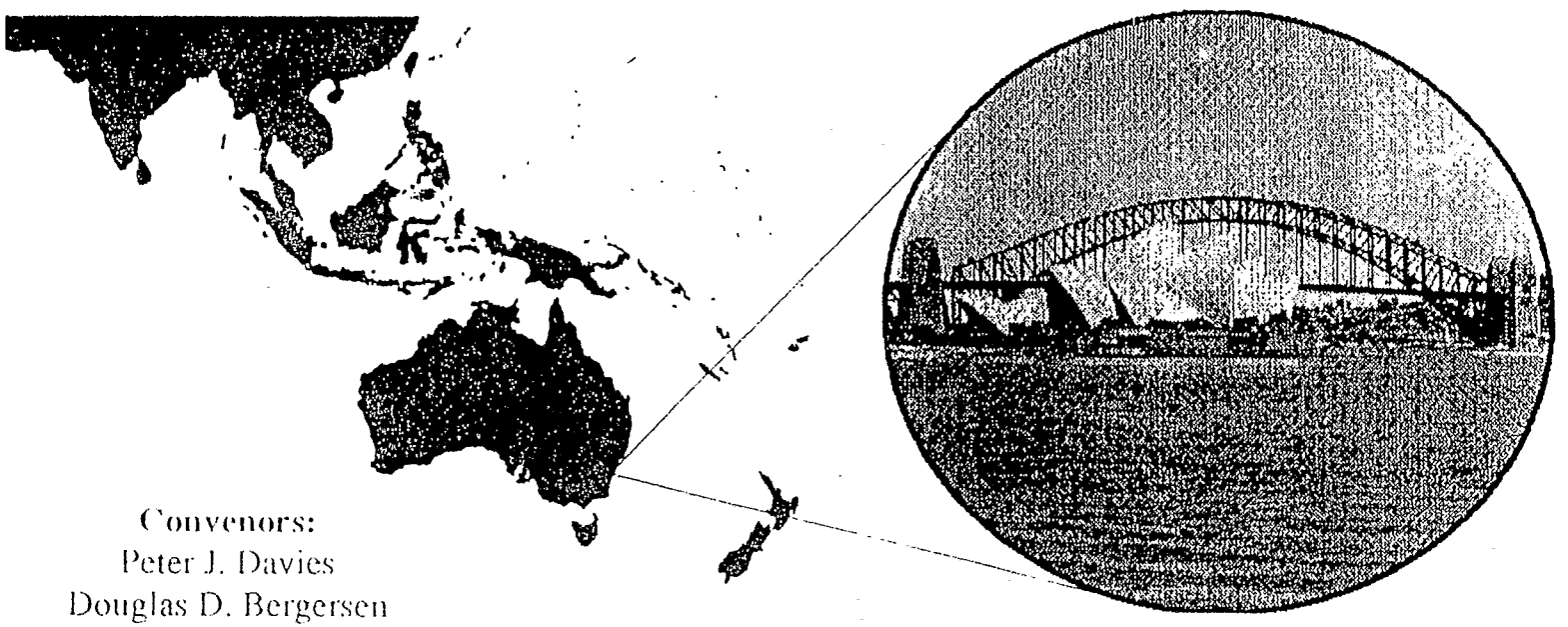

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