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Carbonate factory prediction through space and time: A spatial model based on environmental parameters

Marie Laugié (2,1), Alexandre Pohl (1), Jean Borgomano (1), Julien Michel (1), Cyprien Lanteaume (2,1), Christopher R. Scotese (3), Camille Frau (4), Emmanuelle Poli (5), and Yannick Donnadieu (1)

(1) Aix Marseille Univ, CNRS, IRD, Coll France, INRA, CEREGE, Aix-en-Provence, France, (2) MODIS Pau, 4 Rue Jules Ferry, Pau, France, (3) Department of Earth & Planetary Sciences, Northwestern University, Evanston, IL, USA, (4) Groupement d'Intérêt Paléontologique, Science et Exposition, 60 bd Georges Richard, 83000 Toulon, France, (5) Total CSTJF, Avenue Larribeau, 64000 Pau, France

Platform carbonates are a major component of the Earth System but their spatial extent through geological time is difficult to reconstruct, due to the incompleteness of the geological record, sampling heterogeneity and their intrinsic complexity. Ecological niche modeling coupled with deep-time general circulation models have been used to design a predictive tool of carbonate factory distribution at a global scale. The model was tested in Modern and Aptian (Lower Cretaceous∼120 Ma) times.
Niche modeling uses the fuzzy logic to define carbonate factory functions that predict carbonate occurrences as a function of sea-surface temperature, sea-surface salinity, open-ocean primary productivity and water depth. In the Modern, environmental parameters come from remote-sensing data. Model predictions are validated against a global map of carbonate factory distribution. For the Aptian, paleoceanographic parameters derive from global paleoclimatic simulations using a coupled ocean-atmosphere general circulation model. Paleobathymetry is obtained from paleogeographical reconstructions. Model predictions are validated with the abundant, well-documented geological data from the Aptian.
Four new carbonate factories are used in the Modern that are a photozoan, heterozoan, marine biochemical and photo-C-factory. These carbonate factories show exclusive relationships with specific environmental parameter values. Carbonate factory functions predict carbonate factory distribution with a 82% fit to the global map of carbonate factories distribution, half of the anomalies being linked to uncertainties on terrigenous deposits. For the Aptian, the photozoan factory function was adapted to account for the presence of rudists and their adaptation to high oceanic temperatures. Two scenarios were tested, (1) a preference of rudists for low marine productivity and (2) a preference for high marine productivity. The niche model accurately predicts the paleogeographic distribution of Aptian carbonate platforms with a 80 % fit to data if a preference of the carbonate factory for low marine productivity values is assumed.