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Impact of climate on the evolution of carbonate systems during the Middle and Late Jurassic : (Paris Basin, France)

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Reconstructions of the Middle and Late Jurassic Sea Surface Temperatures (SST) of western tethyan ocean display short-term changes (0.5 m.y. to 1 m.y.). Recent shallow-marine carbonate systems are potentially very sensitive to climatic variations, as shown during quaternary period (Deschamps et al., 2012). In contrast, in ancient sedimentary systems, the impact of palaeoclimatic variations on carbonate factories is not easy to identify because of interplay between different controlling factors such as eustasy, tectonic, the variety of carbonate producers, and sediment supply.

The objective of this study is to propose a detailed facies and stratigraphic framework (at the resolution of a million years) for the Middle and Late Jurassic carbonates (about 30My) of the Paris Basin in order to compare the evolution of the carbonate systems with palaeoclimatic variations, recently well documented for the Jurassic of the western European domain (Dera et al., 2011).

The microfacies study display 18 lithofacies that can be merged into seven facies associations along a carbonate ramp. Late Bajocian is marked by the appearance of carbonate facies with scleractinian corals forming lens-shaped bodies and dome-shaped bioherms buildups reaching 10 m thick and 10–20 m lateral extent. Associated to a sea-level fall, an increase of SST seems to favor the development of these corallian buildups. Protected lagoonal environments extend during the Bathonian and are characterized by mioliolid-rich micritic facies. A 2nd order sea-level rise, flooding the Middle Jurassic carbonate ramp system, is followed by a brief drop in SST, suggesting a link between the demise of shallow-marine carbonate factories and the cooling event at the Callovian/Oxfordian transition. The recovery of carbonate production and the location of the carbonate platform during the Oxfordian is controlled by three factors: (1) the geometry of the stratigraphic architecture of thick clay-rich prograding wedges, (2) a 2nd order regressive trend, and (3) a rapid increase of SST during cordatum and transversarium ammonite zones. Protected lagoonal environments developing during the Middle Oxfordian climatic optimum are characterized by an extensive microbial production (Bacinella / Lithocodium, thrombolithic facies). The Late Jurassic begins with another association of (1) sea-level rise, (2) a decrease of SST, and (3) a succession of variable influxes of clastic sediments regularly and increasingly hampering the efficiency of shallow-marine carbonate factories. Finally, the Late Jurassic ends with a drastic change with the appearance of dolomitic facies during a potentially more arid period, coeval with the end of a 1st order regression trend.

Ancient carbonate systems are very sensitive to several controlling factors, and only a strong constraint on the evolution of facies and stratigraphic architectures are necessary to isolate the potential climatic influence.

Dera, G. et al., 2011. Climatic ups and downs in a disturbed Jurassic world. Geology, 39(3): 215-218.
Deschamps, P. et al., 2012. Ice-sheet collapse and sea-level rise at the Bolling warming 14,600 years ago. Nature, 483(7391): 559-564.