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Depositional environment control on the geochemical signal of ancient shallow-water carbonates (Upper Jurassic, French Jura)

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Chemostratigraphy has become a key tool to study shallow-water carbonate systems and propose insightful time correlations where biostratigraphic markers are limited. However, the bulk geochemical signal of shallow-water carbonate deposits commonly results from the superposition of local and global trends. Additionally, the shallow-water carbonate deposits frequently undergo intense diagenetic alteration obliterating the original seawater signature.

Based on three well-constrained Upper Jurassic sections of the French Jura, this study aims at discussing the control of the original depositional environment on the bulk geochemical signature of ancient shallow-water carbonates. Using isotope ratios ($\delta^{13}\text{C}$, $\delta^{18}\text{O}$, $^{87}\text{Sr}/^{86}\text{Sr}$), elemental concentrations (Ca, Mg, Fe, Mn, Sr, Al, U) and statistical methods, this paper shows that two main processes, closely linked to the depositional environments and associated conditions, control the overall signature of bulk samples of the studied deposits: the detrital input and the diagenetic effects. The detrital input, identified by increase in Fe, Al, Mn and U concentrations, is the highest in very proximal areas (supra- and intertidal domains) affected by terrestrial organic matter and pedogenetic material influx, and in distal realms (open sea) characterized by fine terrigenous fraction deriving from continental landmass erosion. The diagenetic effects can be subdivided into two processes: the dolomitization and the diagenetic imprint. The dolomitization, associated to increase in Mg and $\delta^{18}\text{O}$, mostly concerns supra- and intertidal deposits affected by refluxing evaporitic-derived brines. The diagenetic imprint, mainly associated to decrease of $\delta^{13}\text{C}$, $\delta^{18}\text{O}$ and increase in $^{87}\text{Sr}/^{86}\text{Sr}$, is the most important in platform margin deposits associated to high porosities enhancing fluid-rock interactions during burial and/or meteoric diagenesis. Because of these processes, time correlations are overall very difficult to establish between the studied sections.

The combined analyses of depositional environments and geochemical signal finally led to the conclusion that the concept of “geochemical facies” might represent an interesting tool to discuss depositional conditions and diagenetic effects along specific depositional models. This integrated study provides (1) relevant results to step back on challenging chemostratigraphic interpretations in shallow-water carbonate settings and (2) new insights into the complex sedimentological, diagenetic and geochemical interactions in shallow-water carbonate depositional systems.

