Primary Information from Secondary Signals

S. ARNDT[1*], S. E. GREENE[2]

[1] Department of Geosciences, Environment and Society, Université Libre de Bruxelles, Bruxelles 1050, Belgium, Sandra.Arndt@ulb.ac.be

[2] School of Geography, Earth and Environmental Sciences University of Birmingham

Earth history is punctuated by a series of rapid and extreme perturbations of the global carbon cycle and climate. Marine sediments bear the testimony of these events in the form of significant isotopic excursions, spectacular and unusual mineral deposits or organic-rich strata. These so-called proxies, represent measurable descriptors that provide important insights into past environmental conditions and climate. In the past, the quest for the development of viable paleoenvironmental proxies has, understandably, revolved around primary depositional information. However, the use of such primary signals in the reconstruction of paleoenvironmental conditions strongly depends on their degree of preservation. In this context, diagenesis is generally considered an unwelcome agent of disturbance that can significantly modify or overprint the primary signal, rendering its interpretation difficult or even impossible. However, such secondary signals are formidable recorders of the diagenetic history and contain valuable information about past environmental conditions. Yet, the interpretation of this record is not straightforward.

Reaction-transport modeling (RTM) represents an ideal tool for assessing the degree of preservation and decoding the diagenetic history recorded in these secondary signals. Here, we illustrate how RTMs can be used to develop a quantitative framework that allows extracting information from secondary signals. We use RTM to evaluate the potential of different diagenetic processes to promote widespread precipitation of authigenic carbonates in the shallow subsurface as observed during the Triassic-Jurassic transition. Simulation results allow disentangling the interplay of diagenetic processes that controlled the precipitation of the observed authigenic minerals and provide important quantitative information concerning diagenetic process rates. In addition, these results highlight the tight coupling between shifting environmental conditions and diagenetic dyanmics in both shallow and deep subsurface environments. They emphasize the importance of diagenesis in the interpretation of the geological record.

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