# Primary Information from Secondary Signals: Tracking Early and Late Diagenetic Dynamics from Authigenic Minerals

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Organic carbon remineralization and associated diagenetic processes are coupled to oceanographic and atmospheric conditions. As a consequence, changes in environmental conditions often trigger vertical shifts of benthic redox fronts. Authigenic minerals are formidable recorders of these spatial-temporal dynamics. Their nature and distribution not only reflects the diagenetic history of sediments and sedimentary rocks, but also allows for the reconstruction of past environmental conditions. Yet, the precipitation of authigenic minerals may result from a combination of different diagenetic processes and, thus, environmental conditions. In addition, authigenic minerals are sensitive to diagenetic alterations. Therefore, the interpretation of this record is not straightforward.

Reaction-transport modeling (RTM) represents an ideal tool for decoding the diagenetic history recorded in authigenic mineral distributions. Here, we combine observations of authigenic minerals with RTM to explore the diagenetic dynamics in both shallow and deep subsurface environments. 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. Furthermore, a combination of observed authigenic barite depth profiles and RTM is used to backtrack the longterm ($10^5$-$10^6$ yrs) dynamics of a deep sulfate-methane transition zone associated with distinct Cretaceous black shale layers (subsurface “hot spots”) resulting from an increased organic carbon productivity and/or burial. 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. Therefore, the combination of RTM and authigenic mineral observations also yields important quantitative interpretations concerning the nature of the paleoenvironment and emphasizes the importance of diagenesis in the interpretation of the geological record.