Characterization of a Massive Dolomitization System Near Carbonate Platform Margins: Insights from Integrated 3-D Geological and Diagenetic Modeling

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Abstract

Recent regional mapping has shown that massive, stratigraphically discordant dolomite occurs within the Upper Jurassic to Lower Cretaceous intervals in the Northeastern Pangea continental margin. Petrographic and geochemical analyses indicate multi-phase dolomitization with a wide range of associated diagenetic processes that include silicification, dedolomitization, precipitation of calcite, fluorite, and kaolinite, and emplacement of pyrobitumen. Both matrix and pore-filling dolomite have been identified. For matrix dolomite, either porosity generation or redistribution is the dominant process, whereas porosity decreases sharply with the increase of dolomite volume fraction for the pore-filling dolomite. In this study, we developed an integrated workflow of geological and diagenetic modeling. The results from the geological modeling were used as the model domain and inputs for the diagenetic modelling. With the calibration and enhancement using the constraints from the geological modelling, the diagenetic modelling results can be utilized to support the prediction of reservoir quality. The high-resolution 3-D geological model indicates that the massive dolomite is heterogeneously developed and distributed mainly in the northeastern part of the study area, with a southward decrease trend in dolomite content. Two episodes of dolomitization are likely to occur, supported by multiple lines of evidence. A hybrid mechanism of two dolomitization processes has thus been proposed, which has been tested and validated by diagenetic modeling. The first process is driven by the

tectonic compression and developed adjacent to a shelf-interior salt basin. The second process is related to late hydrothermal dolomitization overprinting the early dolomite. The integrated modeling approach of this study helps to enhance the understanding of the hybrid dolomitization mechanism and associated diagenetic processes, providing new insights on reservoir quality prediction over the extensively dolomitized carbonate platforms.