Diagenetic Mechanism Based Dolomite Mapping

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Abstract

Diagenesis poses a strong impact on the quality of reservoirs in carbonate platforms, particularly in the Arabian Shelf. One such dominant process is dolomitization, which can either enhance, preserve or degrade reservoir porosity depending on the type of dolomitization. Thus, an understanding of dolomitization and its pervasiveness across a reservoir is critical for assessing porosity. Several studies have investigated the nature of upper Jurassic dolomite bodies of the Arabian Shelf. The prevailing theory on the underlying regional dolomitization mechanism suggests that fractures/faults could have constrained migration pathways of dolomitizing fluids, thereby controlling dolomite distribution.

To that end, a novel workflow has been established based on the dolomitization mechanism and multiscale fracture characterization to map dolomite distribution in the upper Jurassic succession of the Arabian Shelf. The workflow leverages multiscale fracture characterization as an indicator of dolomite content. The dolomite mapping method involves three consecutive steps: 1) Establish a connection between the individual seismic response of various fracture scales with their respective borehole image logs and core interpretations, (2) utilize multiple seismic attributes to characterize multiscale fractures, and (3) interpret dolomite bodies, based on a final fracture map, and validate lithology using well data.

In addition, the method classifies fractures into macroscale, mesoscale, and microscale fractures recognized through seismic fault interpretation and seismic attributes: edge, curvature, and variance, respectively. The macroscale fractures (faults) are larger than seismic wavelength in size and are discerned from seismic data, whereas mesoscale fractures are equal to seismic wavelength and recognized from curvature. In contrast, microscale fractures refer to sub-seismic scale fractures that are sensitive to variance. The latter is also employed to map the full spectrum of multiscale fracture systems with emphasis on microfractures.

The dolomite predictive workflow was applied between wells in the carbonate platform. Preliminary analysis indicated that dolomite was distributed in a heterogeneous manner, and developed mainly in the southeastern block and along a NW-SE trending belt of the study area, diminishing westward. These results were substantiated by lithology logs and image log interpretations, demonstrating strong agreement between well data and the seismic-derived dolomite fracture map. As a result, three probable dolomite zones were characterized in order of descending dolomite content.

These zones hold potential for lateral diagenetic-stratigraphic traps where porous/tight dolomite interlaces with tight/porous limestone in the area. Overall, our findings indicate that dolomitization is widespread throughout the southeastern part of the platform, and progressively decreases westward. These results suggest that multiscale fracture systems influence massive dolomitization in this geological setting, and thus can be leveraged to delineate intricate dolomitization systems.