AAPG Datapages/Search and Discovery Article #90254 ©2016, GEO-2016, 12th Middle East Geosciences Conference & Exhibition, Manama, Bahrain, March 7-10, 2016

Chemostratigraphy and dolomitization mapping of Middle to Upper Jurassic formations, Northeastern Saudi Arabia

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ABSTRACT

The Jurassic sediments in northeastern Saudi Arabia contain some of the richest oil reservoir and source rocks on the Arabian plate. On the basis of geochemical correlation using carbon isotopes and biomarkers, these sediments are believed to have sourced most of the oil in the Jurassic and Early Cretaceous reservoirs of Saudi Arabia, Qatar and the United Arab Emirates. The integration of seismic data and the Jurassic sequence stratigraphic model, which provides better biostratigraphic resolution, has resulted in the development of a high-resolution stratigraphic model within these sediments. In northeastern Saudi Arabia, dolomitization has negatively impacted this biostratigraphic scheme, and consequently, chemostratigraphic techniques have been utilized.

This chemostratigraphy study includes 872 core and cuttings samples, taken from Middle to Upper Jurassic sediments in seven (7) wells in northeastern Saudi Arabia. The sections studied comprised limestones with subordinate calcareous mudrocks and dolostones. Although inductively coupled plasma-optical emission spectrometry (ICP-OES) and inductively coupled plasma-mass spectrometry (ICP-MS) were used to acquire data for 50 elements, the scheme was based on changes in the following “key” immobile elemental ratios: Nb/Y, Nb/Yb, Zr/Ta, Ti/P, Y/Th, Zr/Hf and Th/Zr. The scheme comprised a hierarchical order of three zones, thirteen subzones and four divisions. In addition to proposing a chemostratigraphic scheme, the study also modeled the extent and distribution of dolomite utilizing Mg/Ca ratio.

Variations in the aforementioned key elemental ratios were largely dependent on changes in source/provenance, reflecting increases or decreases in the abundances of a particular detrital heavy mineral. The chemostratigraphic zones were correlative between the study wells except for localized absence of some subzones due to erosion or non- deposition. One significant conclusion from this study is that there is little, if any, association between the occurrence of dolomite and the placement of chemozones. The dolomitization process may actually have a negative impact on the reservoir quality, particularly in sectors close to the fluid entry points (usually faults), interpreted by chemostratigraphic correlation, where the risk of overdolomitiza-tion is higher. The extent of dolomitization increases in the northern wells, due to the higher Mg/Ca ratio, indicating a higher proportion of dolomite.