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Large-Scale Hypogenic Karst Creating Siliciclastic Reservoirs: The Case of the Cretaceous Wasia Group

Martin Keller[1], Roman Koch[3], and Daniel Bohnsack[2]

[1]Ministry of Environment, Water and Agriculture, Riyadh, Saudi Arabia.
[2]Munich School of Engineering, Garching, Germany.
[3]GeoZentrum Nordbayern, Friedrich-Alexander University Erlangen, Erlangen, Germany.

ABSTRACT

On the Arabian Plate, the Cretaceous sedimentary succession hosts a multitude of reservoir rocks, both for hydrocarbons and for water. Some reservoirs are among the largest in the world. Reservoirs are present in siliciclastic as well as in carbonate rocks. The Wasia Group is one of the most important groundwater reservoirs in Saudi Arabia and represents a porous sandstone aquifer. Many of the sandstones have porosities between 30% and 40%; permeabilities vary between 1 and 9 D. Neither matrix is visible in thin-section nor clay coatings or cements. Remnants of kaolinitic and carbonatic cement are locally preserved; ghost structures of carbonate cement, however, are very abundant. Strong corrosion is visible on the quartz-grain surfaces and heavy minerals. Leaching caused structural disintegrity of feldspar clasts in samples obtained 100s of km away from the source area. We interpret these data and observations presented here to be the effect of large-scale dissolution processes. Large-scale dissolution of carbonate cement (karstification) and of feldspars affected the sediments during diagenesis. It is hardly conceivable that this was an early diagenetic process because the resulting lose fabric should have been compacted with increasing sedimentary overburden and with concomitant pressure solution between quartz grains. In addition, karstification affected rocks, which during a (Cretaceous) sea-level fall were well below the depth of surface (epigenic) karst. Hypogenic karstification is increasingly recognized as a major process in subsurface terrains. One variety of this process is sulfuric hypogenic karstification, in which sulfur released from various sources enhances the effects of dissolution through formation of sulfuric acid. Hydrocarbon source rocks are abundant in the pre-Wasia strata of the Arabian Shelf. Degassing of these source rocks is a likely source for sulfur, which in turn in contact with groundwater formed sulfuric acid. In many areas, groundwater in the Wasia aquifer is warm to hot, what additionally might have increased dissolution of carbonate (and other) cements in the sandstones. Ultimately, we believe that (sulfuric) hypogenic karst may also be responsible for the deep-seated karst in the overlying Aruma and Umm Er Radhuma formations.