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Sedimentological and Geostatistical Characterization of the Paleozoic Wajid Sandstone Aquifer, Saudi Arabia

Osman Abdullatif (1,,) and Mohamed Makkawi (1,,)

(1) (osmanabd@kfupm.edu.sa) KFUPM, Dhahran, Saudi Arabia, () (makkawi@kfupm.edu.sa) KFUPM, Dhahran, Saudi Arabia

Paleozoic siliciclastic successions form important primary groundwater aquifers in different parts of Saudi Arabia. Determination of aquifer sedimentological heterogeneity is important for realistic aquifer evaluation, development and management. This study aims to establish, from outcrop aquifer analog description, a geological and petrophysical model for the Paleozoic Wajid Sandstone aquifer in southwest Saudi Arabia. This study examined and studied several outcrop analogs for Wajid Sandstone. The methods of study included field and laboratory sedimentological investigations including facies, petrographic, porosity, permeability and statistical and geostatistical analysis techniques. The sedimentological field study revealed that the Wajid Sandstone vary facies, grain size, texture, composition and deposition environments. All these aspects appear to have impacted the porosity and permeability patterns at outcrop scale. The sedimentary facies vary in type, abundances and their vertical and lateral stacking patterns. Depositional environments also vary from fluvial braided stream to shallow marine environments. Grain size of sandstone varies from very fine to very coarse and from moderately sorted to well sorted. Sandstone composition varies from quartz arenite to subarkose. Both depositional and post depositional controls appear to have affected aquifer heterogeneity and porosity and permeability distribution. In general 2D geostatistical porosity and permeability models show agreement at outcrop scale, especially at high values; however, some variability is encountered among Wajid members. The 2D permeability models also reflect depositional factors including depositional environment and sub environment change layering, stratigraphic hierarchy, vertical and lateral facies changes and the superimposition of post depositional changes expresses in matrix and cement content, and cement type and styles.