Petrophysical Rock Types of the Khuff C, Eastern Saudi Arabia

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Petrophysical rock types (PRTs) can be defined as objects in the three dimensional space defined by Thomeer pore system parameters. Classifications in the Thomeer parameter space must also be accompanied by relationships to convenient well bore measurements (commonly well logs) and geologic parameters to create economic value in the petroleum business. Recent and detailed core-and-log-based high-frequency, sequence-stratigraphic characterization of the Khuff-C by Eid, Dukhayyil and Tawil are now complete and this work builds on that important geological foundation. Hence, any effort to define petrophysical rock types must include and utilize a host of multidisciplinary data.

We acquired additional core plug data for petrophysical rock typing of the Khuff-C using detailed petrophysical core description and Archie rock type description at the centimeter level. These plugs were selected to explore and sample various aspects of the pore systems after extensive and detailed core-log integration. Detailed petrographic data was generated at King Fahd University of Petroleum and Minerals to aid in petrophysical rock typing, with mercury injection capillary pressure (MICP) data (Thomeer analyzed) and with Qemscan mineralogical images. Samples displayed a wide variety of textures and mineralogies. Wide variation in pore types was observed from intercrystalline (limestone and dolomite) to interparticle, intraparticle and moldic pore types. Despite this, the MICP data was strongly (86%) monomodal. The prevalence of MICP monomodality and multiple pore body types implies that the pore throats (doorways) and not the pore bodies (rooms) control the flow of fluids in these rocks.

Six PRT trends are determined, named by their dominant mineralogy and dominant pore type (Dolomite_Moldic_Intraparticle_Intrasketal, Dolomite_Interparticle, Dolomite_Intercrystalline, Calcite_Moldic_Intraparticle_Intrasketal, Aerial, Mix) in which the maximum pore throat diameter is directly related to the sample porosity and within which the Thomeer Pore Geometrical Factor, G , is relatively constant. These six PRTs are then demonstrated to be in excellent accord with the Eid-Dukhayyil-Tawil depofacies (Exposure/Paleosol, Supratidal, Salina, Tidal Flat Complex, Burrowed Shallow Subtidal, Zoophycos Subtidal, Restricted Lagoon, Shoal Flanks, High Energy Shoal and High Energy Shoal with Clasts).

These results and the agreement with depofacies is a key result, which enables improved and geological net pay and permeability calculations and Thomeer-based saturation-height models. The results also demonstrate that certain stratal architectures result in lateral stratigraphic traps. The optimum implementation of these petrophysical rock types is possible in wells where full geochemical well log data has been acquired.