INTEGRATING DIGITAL GRAIN AND PORE MORPHOLOGIES INTO ROCK TYPING FOR A POORLY CEMENTED POST-SALT HEAVY OIL RESERVOIR OFFSHORE BRAZIL

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ABSTRACT: Mechanical and transport rock properties play a significant role in characterizing oil and gas reservoirs. Traditionally, these properties are obtained by conventional well logging, seismic methods, and laboratory testing of reservoir rocks, including whole cores, sidewall cores, plugs, and rock cuttings. However, for poorly cemented rocks containing heavy oil, coring techniques and laboratory tests can be difficult to perform because of rock damage caused by gas expansion and stress relief during drilling and core recovery operations. Additionally, there are challenges associated with plugging, cleaning, and conditioning such rock samples for traditional physical laboratory testing. One of the primary goals of core analysis is to define specific rock types along the well trajectory that are used to build geological and engineering reservoir models. This paper focuses on integrating grain and pore morphologies of heavy oil poorly cemented rocks into the rock typing process.Grain and pore morphologies are derived from fit-for-purpose 3D X-ray computed tomography (CT) digital images of the various rock types. The resolution of the images varies according to the sizes of the grains, pores, and throats necessary to define the character of the rock type. A workflow was developed to condition the digital rock samples when significant rock damage is present. This workflow results in a digital rock that is closer to its status in the reservoir before extraction. Digitally or physically, it is currently difficult, if not impossible, to return the rock to its original reservoir state. The 3D segmented images provide the basis for computing grain and pore morphologies. The significant grain population is described by parameters, such as grain size mean, grain size mode, elongation, roundness, and sphericity. There are several ways to define the pores and throats that define parameters, including pore size distribution, throat size distribution, pore-to-throat size ratios, elongation, and connectivity. Integrating spider diagrams of these parameters with other rock properties, such as permeability and other log attributes, improves the quality and consistency of rock type definitions. The grouping derived from grain and pore morphologies correlate well with geological and hydraulic groupings that initially defined the rock types. They provide insight and consistency to the definition of the rock types. After these morphologies are defined, the 3D digital rocks are used to determine routine and special core analysis properties. Most importantly, this workflow creates a true cross-disciplinary approach to defining rock properties that enables teams to share work results and move from measuring small samples to upscaling the reservoir at the seismic scale as needed. The geoscience team has a quantitative database to share with the other team members in a consistent manner.

KEYWORDS: HEAVY OIL RESERVOIR CHARACTERIZATION, POORLY CONSOLIDATED RESERVOIR, DIGITAL ROCK ANALYSIS.