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Innovative Petrophysical Evaluation Workflow Enhances Production: A Case Study From Barmer Basin, Nw India

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ABSTRACT

The Vijaya and Vandana (V&V) fields, located in the central part of Barmer basin, were discovered in 2005 by Cairn. The oil bearing Barmer Hill Formation consists of two types of reservoir packages– sandstones/heteroliths deposited as lacustrine hyperpicnites and porcellanites deposited as alternations of diatomite and mudstone layers. Sandstone lithofacies is the main reservoir rock, but with permeability vastly impaired by cementation. The porosity of sandstone ranges from 10-20% and shows permeability variation of 0.01-200mD. Numerous pay zones of 5-10 meters are dispersed over gross rock thickness of about 500m. Conventional testing of individual pay zones in initial wells produced oil at sub-commercial rates.

The challenge was to characterize the rock in terms permeability variation and identification of zones requiring stimulation treatment. Core analysis data sets including sedimentological descriptions, RCA, thin sections, XRD and MICP were integrated to understand the factors controlling the reservoir properties. Rock classification posed challenges in terms of wide variation in permeability within a narrow porosity range due to dominant post depositional alterations, pore-filling cements such as siderite, dolomite and dispersed clays. Microscopic imaging along with MICP pore size distribution suggested a strong influence of degree of cementation and subsequent dissolution on the present day pore geometry in sands, which influences the measured permeability.

The petro physical workflow consisted of integration of conventional core data with NMR log data to provide pore size classification. Based on pore throat size, three distinct sand sub classes have been identified viz., tight sandstone with permeability ~0.01-0.1mD, moderately tight sandstone (~0.1-10mD) and sandstone with cement dissolution (~10-200mD). Binning of NMR T2 spectra resulted in a rock quality index which was used to identify these sandstone classes in wells. This workflow has resulted in a fit-for-purpose rock type assessment and quantifiable porosity to permeability transform for each rock class. Further, log derived absolute permeability is tied to effective permeability obtained from PTA analysis like PBU, mini-DST and DFIT. Identification of good permeable zones and accurate prediction of K*H (permeability*net pay) against reservoirs pay sands is found to be critical in estimating full production potential of wells.

The result of this study was instrumental in identification of zone for hydraulic stimulation. Hydraulic fracturing stimulation carried out based on this petrophysical workflow in a recent well resulted in 10 fold increase of fluid rate by connecting multiple pay zones. The work flow customized for V&V has resulted into an evolving story for production enhancement, and will be further tested in the upcoming early development through existing and new wells through total connected K*H.