Demystifying Presalt Carbonates (Offshore Brazil): Multi Scale Analysis of Heterogeneous Reservoirs

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Abstract

Pre-salt carbonate reservoirs in the offshore Campos and Santos basins have played a crucial role over the last years with giant discoveries being made every year. The overall pre-salt discoveries account for 28.8 BBls RR with a current production of 648,000 b/d. The pre-salt carbonate reservoirs present a heterogeneous variation that can range from thick packages of microbial carbonate sections, interbedded sequences of carbonates and volcanics or complete absence of reservoir facies. Moreover, diagenetic processes have significantly obliterated the initial rock matrix. Described as a world class reservoir, the pre-salt microbial reservoir presents average porosities of 11%, net to gross of 55%, water saturation of 20%, and net reservoir thicknesses of 125 m. This work describes the results of an integrated approach, using rock, log and test data, aiming to identify the main carbonate reservoir facies in pre-salt fields, as well as to predict facies groups/families using petrophysical evaluation. Carbonate facies were classified based on sidewall core macroscopic and microscopic photos and descriptions. Facies code took in consideration the main characteristic of the carbonates and because diagenesis plays an important role in the heterogeneity this was also included as a secondary attribute. Five main facies were identified: shrubs, spherulitic, reworked carbonates, laminated, and coquina facies. Shrubs and spherulitic facies are the most common within the data analyzed. All of them are somehow affected by diagenesis, with dolomitization being the predominant post-sedimentary diagenetic process; in some cases dolomitization occurs together with silicification as the secondary diagenetic process. Porosity and permeability relationship within each of the aforementioned facies, shows a poor or inexistent correlation between the two properties. Test and production data from seven wells were compared with rock and log data allowing a match between the best flow units and reservoir facies. Preliminary data shows that shrub facies present higher values of absolute open flow rates and permeability. Also, the calculated permeability from log data is several orders of magnitude different from those acquired in test data. Besides the issue of scale of measurement, it is striking the fact that reservoir deliverability can be usually underestimated. Overall, a multi-scale integrated evaluation allows a better understanding and derisking of presalt reservoirs.