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Pre-Salt Santos Basin—Well Construction Learning Curve Acceleration

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Abstract

Drilling and completing either exploratory or development wells in Pre-Salt prospects present several challenges. The wells are located in very deep waters, beyond 2,000 m WD and they are also deep wells, with more than 5,000 m TVD. Pressure and temperature is normal, but contaminants such as H₂S and CO₂ represent an additional difficulty.

Most of all, drilling through salt layers as thick as 2,000 m presents the most challenging aspect of these wells. Directional, extended reach (ERW), horizontal and multilateral wells will be evaluated for production development, but the reservoir is a carbonate horizon just below the salt, meaning that high angle navigation and multilateral joints will be located inside the salt layers. These wells measured depths will reach 8,000 m or more.

The salt geo-mechanical loads on the casing and cementing will require high strength materials and high capacity rig equipment. The competency of the salt formations and, most of all, of the carbonate reservoir, totaling more than 3,000 m to be drilled, will require special BHA and bit design to increase penetration rates, thus reducing rig time. Carbonate reservoir will require production liner, perforations/slots and stimulation treatments designed to maximize production.

Although these challenges could be overcome today, with existing technology, due to the current high costs scenario, well construction time and risks must be minimized. Some technology development is already underway to address these issues, but most of the gains can be materialized without new technology, by proper engineering design, risk management and learning curve acceleration.

After 8 wells drilled in Pre-Salt prospects, Petrobras has already gained important know-how in these projects, but there is still a long way ahead. In the following years, well construction campaign for an Extended Well Testing (EWT) and a Pilot Production System in the Tupi Pre-Salt area, plus additional exploration wells, will provide field test opportunities for development and optimization of well engineering techniques and equipment. This paper will present the highlights of Petrobras E&P program to make the best use of these opportunities to leverage the well construction learning curve.

Introduction

In recent years, exploration activities in Brazil began to focus on the São Paulo Plateau, a prominent regional topographic feature in water depths ranging from 2,000 to 3,000 m. A continuous Aptian evaporitic sequence, in some points thicker than 2,000 m (**Fig.1**), exists in this region, contrasting with the very thin marine section above. The reservoir section occurs just below the evaporitics and is composed by microbialite carbonates. In such a Pre-Salt section, with variable thickness, a few exploratory wells were drilled. Petrobras is now facing a challenge similar to that one encountered during the discoveries of deep-water turbiditic reservoirs in Campos Basin.

Salts belong to a group of sedimentary rocks called evaporites, resulting from sea water evaporation. Submitted to a sustained constant stress, evaporites can suffer considerable deformation, in a behavior denominated "salt creeping". Due to this characteristic, salt intrusions and domes can be found in many sedimentary basins, associated with either high pore pressure zones, or fractured zones ("rubble zones").