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Reservoir Management of the Giant Pre-Salt Mero field: The Strategic Choice of Fiber Optic Permanent Reservoir Monitoring

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Introduction

Located in the Libra block of Santos Basin, 180 km from the coast of Rio de Janeiro, at a water depth of up to 2,500 m, the giant pre-salt Mero field presents several challenges to reservoir characterization and production management.

From the point of view of the structural framework, the challenges are linked to strong compartmentalization observed in some areas and to the existence of igneous rocks that pass through the pre-salt section, reaching the post-salt section in some regions. From the perspective of sweeping efficiency, besides reservoir segmentation, magmatic intrusions tend to disrupt fluid flow and may also affect communication between zones. In addition, reservoirs present a high gas-oil ratio with a high CO₂ content. To prevent water and gas breakthroughs and optimize oil production, adopting a robust and reliable monitoring strategy combined with proactive production management is essential.

Method

In Mero, a permanent production monitoring strategy has been outlined, consisting of the installation of a fiber optic infrastructure that will allow, on the one hand, monitoring the movement of fluids in the reservoir through 4D seismic, and on the other, detect the arrival, at each zone of the producing wells, of the fluids injected into the reservoir, allowing management through intelligent completion valves.

The starting point was the definition of a strategy based on the use of permanent seismic reservoir monitoring system (PRM) instead of traditional streamers or ocean bottom nodes surveys. This decision considered the very low levels of 4D signal expected for the stiff carbonate reservoirs and the imaging challenges posed by the complex salt overburden and igneous intrusions. The inherent advantages of PRM, including high repeatability, improved data quality and access to real-time data, add up to the possibility of continuous passive monitoring and potential reduction of carbon footprint of seismic acquisitions.

An all-optical system was chosen, consisting of fiber optic 4C seismic receivers, connected to the platform via fiber optic cables, subsea wet-mate connectors and a fiber optic umbilical. The reliability of this type of system has been demonstrated, for example, at the Ekofisk field, which has more than 98% of the seismic receivers operating after 15 years of installation.

Concluding Remarks

More than 200 km² of the seabed will be covered with around 400 km of cables which will incorporate over 4,500 seismic receivers. This massive subsea optical infrastructure offers a unique opportunity for the deployment of innovative technologies, in particular fiber distributed sensing, applied in wells for flow monitoring, flow rate estimation and management through the intelligent completion valves, for the survey of well integrity, for detection of leakage and flow assurance anomalies, as well for seismic acquisitions, as a complementary technique to the traditional seismic methods.