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From Turbidites to Carbonates: Breaking Paradigms in Deep Waters

M. Carminatti, J. L. Dias and B. Wolff/Petrobras

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Abstract

In the beginning of exploration of the Brazilian Continental Shelf, Petrobras focused its exploratory efforts on deltaic sequences and a discovery was done in the offshore extension of the Sergipe-Alagoas Basin. The important discoveries in turbidites in Campos Basin in the middle 1970's, pointed out these siliciclastic reservoirs as the main exploratory targets in the Brazilian continental margin.

Applying well defined geological models, along with true seismic amplitude and in-house wavelet processing, Petrobras advanced into Campos Basin deep waters in the middle 1980's. Production in such scenery of deep waters and heavy oil was the great challenge to overcome at that time.

In the 1990's, the deep water petroleum province in Campos Basin consolidated the Petrobras expertise in Exploration and Production in turbidite reservoirs in the deep and ultra-deep realms. The development of technologies integrating oil and reservoir characterization, drilling systems, artificial lifting and flow technologies were carried out to overcome the challenge of producing from turbidites in deep waters.

New geodynamic and geotectonic concepts of rifting have defined new strategies for deep and ultra-deep water areas in Brazilian offshore basins. In Santos basin, these concepts together with seven years of work where the exploratory process was followed according to innovative procedures and adjusted to the geological challenges of the area, Petrobras obtained a tremendous exploratory success and a world-class petroleum province was found.

This province is located in the central portion of Santos basin, in ultra deepwater, ranging from 2,000 to less than 3,000 meters water depth and situated about 200 km from the Brazilian coast line. It represents a prominent regional feature covered by a continuous evaporitic sequence, thicker than 2,000 meters. The pre-salt targets comprise a thick carbonate section in depths ranging from 5,000 to 6,500 meters.

With the results a paradigm was broken, pointing for the great potential of carbonate rocks in the deep/ultra-deep waters in the Brazilian Continental Margin. New exploratory models and production technologies will be necessary to overcome the challenges that Petrobras will face in near future.

Introduction

Brazilian petroleum exploration commenced onshore in the Reconcavo Basin in 1948. By the mid 1950s, several small fields had been discovered in the Neocomian/Barremian rift section and by the beginning of the 1960s, exploration of the same rift section led to the discovery of the first onshore Brazilian giant oil field, in the Sergipe Basin. By the mid 1970s, several medium-size fields were found on the continental shelf area of this basin.

As an outcome of first oil crisis the exploration of the Brazilian continental margin basins accelerated and by the end of the 1970s, several offshore fields were discovered in the continental shelf of Campos Basin. Intense exploration had then started in Brazil. Petrobras, a government controlled company, rapidly gained experience and developed sedimentological and stratigraphic models for the Brazilian passive continental margin, and its exploration activities moved toward deep water regions. The 1980s were punctuated by the discovery of giant deep water fields in the continental slope region of the Campos Basin (e.g., the Marlim, Albacora, and Caratinga Fields). Very innovative technology was developed to produce from marine siliciclastic reservoirs in this region. The oil-bearing reservoirs are turbidite systems of hyperpicinal origin, deposited in prodelta and deep marine settings. Production from these fields, together with the other Brazilian continental margin fields placed Petrobras as the 9th largest energy company in the world.

In recent years, exploration activities began to focus on the Sao Paulo Plateau (Figure 1), a prominent topographic feature in water depths ranging from 2,000 to 3,000 meters. A continuous Aptian evaporitic sequence, thicker than two thousand meters, exists in this region, contrasting with the very thin marine section above. The explored reservoirs are carbonates that occur