

The Atypical Igneous-Sedimentary Petroleum Systems of the Parnaíba Basin: Seismic, Well-Logs and Analogues.

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Abstract

The Paleozoic Parnaíba Basin, located in the northeast Brazil, has proven to be one of the most successful onshore gas basins in the country. Since 2010 eight conventional gas fields have been declared as commercial. The current production of 4.8 MM m³/d of gas and minor condensate comes from the Carboniferous Poti sandstones in the Gaviao Real Field. The stacked geometry of the extensive Triassic dolerite sills and dykes complex is responsible to create several four-way closure structures and to compartmentalize both source rock and reservoirs. Intrusion related forced-folds also occurs and are considered a secondary target. The dolerite sills intrude the organic rich intervals of the Devonian Pimenteiras Shale triggering maturation and hydrocarbon generation. Conventional gas accumulations also occur in the sandstones of the Devonian Cabeças Formation and in the Upper Carboniferous Piauí Formation, both with production expected in the near future. Seismic imaging is challenging in many aspects. Major concerns are the complexity to image sub-sill plays, the large areal extent of the basin, strong vertical and lateral velocity heterogeneities, and the difficulty to image vertical sealing structures critical to prospect success. Significant progress has been done in the Pre-stack depth migration processing workflow but even so the addressed challenges are still to be overcome. The pyrite-rich hot-sands of the Poti Formation corresponds to the current main gas reservoir unit and provides its own challenge to the formation evaluation. Good porosity and permeability occurs along the unit that is capable to achieve AOF rates up to 6 MM m³/d of gas. Hornfels aureoles were also identified in the well logs and sidewall core samples, whereas formation testing has proven that these zones are also capable of gas production, probably associated to higher open-fractures density. Wireline logs from the drilled wells tied to the seismic data were key to properly correlate the dolerite sills and allow the first insights about magma emplacement and trapping. The recognition of similar stacked dolerite sill complexes in sedimentary basins worldwide provides insights for the exploration at the Parnaíba Basin.