

1-D and 2-D Modelling of the Parnaíba Basin: A Case Study of a Prolific Atypical Petroleum System

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Abstract

Atypical Petroleum Systems were defined by Magoon and Dow (1994) and is described as those systems where source rock maturity is triggered by igneous intrusion superimposing the effect of normal overburden maturation. In the last decade there has been an increase in research related to this topic due to the exploratory success in basins where igneous intrusions are the main mechanism for hydrocarbon accumulation and exploratory targets (Jackson, 2013; Miranda, 2013; Senger et al., 2017). Successful examples are the Parnaiba Basin and Solimões Basin in Brazil (Miranda et al., 2018; Eiras et al., 2003) and the Neuquén Basin in Argentina (Rodriguez Monreal, 2009). Although well recognized in and documented in the Karoo and Vøring basins (Aarnes, 2011; Iyer, 2017) this mechanism hydrocarbon generation has not yet been developed for commercial accumulations here. Since 2010 the Parnaiba Basin, located in the northeast Brazil, went through an large exploratory campaign that resulted in the discovery of 1 Tcf (28 Bcm) of gas in place (Miranda et al., 2018; Cunha et al., 2014) in 18 distinct accumulations. The atypical petroleum system in the basin was described by Rodrigues, 1995, but the first commercial discovery was only established in 2010. During the last decade of exploratory effort nearly 12.400 mi (20.000 km) of 2D seismic lines were acquired and 150 wells have been drilled (exploratory and production wells). The scope of this presentation is to integrate the acquired data using 1D and 2D modelling for source rock maturation, hydrocarbon generation and migration pathways to reduce exploratory uncertainty. Petroleum system modelling also corroborates the production data from eight gas field that

points to a dry gas zone in the central part of the basin moving towards wet gas to the north. The existence of commercial oil accumulations has not yet been proven in the basin but based on this work it is believed that oil discoveries can occur in the near future. With an areal extent of more than 230.000 mi² (6000.000 km²), the Parnaíba Basin is still considered one of the exploration frontiers in the onshore Brazil. The challenges to work in such large areas, allied to the complex geology of intricate network of dykes and sills are still to be overcome. Hopefully the success of the gas discoveries in the central part of the Parnaíba Basin can be expanded to other areas and perhaps even replicated in other basins in Brazil and around the world.