Diabase Sill Intrusions in the Parnaiba Basin: Imaging Challenges, Velocity Modeling and Seismic Interpretation

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Abstract

The growing demand of energy in Brazil boosted the interest on exploration in frontier basins, especially for gas. As an example, after a few years of an exploratory campaign done in the Parnaiba basin, eight commercial gas fields have already been declared. Since the main petroleum system is related to the sub-sill structures, one of the challenges is to have the best seismic imaging as possible as well as accuracy in the depth conversion maps. This work will discuss the difficulties of interpretation and depth conversion of the interpretations of the reservoirs related to this atypical petroleum system in Parnaiba Basin. The main issues are: (1) the imaging bellow the intrusions, up to 200m thick, (2) the influence of the horizontal velocity variation of the host rocks, and (3) the low reflection velocity layers deposited during the Cretaceous.

The workflow used to achieve the results was: reflectors interpreted in the time domain seismic data; synthetic seismograms calibration from drilled wells; construction of the geological model divided by the interpreted reflectors; layers' slicing the model due to the stratigraphy; input of the velocities from the logs of the drilled wells; input the velocities points from the processing; RMS velocity distribution and equalizing between wells' logs and seismic processing; consolidation of the final velocity model calibrated by all the data; and time to depth conversion of the maps using the consolidated model.

The sills crossing the stratigraphy and velocities' anisotropy are the biggest challenge to the accuracy of the depth conversion. This workflow allows calibrated depth maps generation, which gives support for positions of new well locations. The presented interpretation and depth conversion uncertainties are a great incentive to the development of new research and hopefully future solutions. One of them is the Pre-Stack Depth Migration processing which has been proving itself accuracy considering the processing flows improvement.

In addition, another possible solution has been the high resolution PSTM processing, where the goal is to define the sills top and base, allowing a properly calibrated seismic-well correlation, hence proving a better prediction of the thicknesses variation. Nowadays, the predicted versus drilled wells have shown a marginal error of the top of the reservoir, however, this error will hopefully be reduced.