Submission code: 9N8WQLD80X

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FWI imaging as a tool for improving merge of legacy seismic data

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Introduction

PETROBRAS operates an exploration concession in Santos Basin where, up to now, all available seismic data are two different surveys acquired more than 20 years ago, with streamer cables. They have a very small superposition, each one covering approximately half of the block. Besides that, they were acquired in orthogonal azimuths. In such an inadequate context, one shouldn't expect optimal imaging and, indeed, in a recent reprocessing of these data, migrated seismic volumes (from Kirchhoff and RTM) had their seismic quality limited by this fact.

Method and/or Theory

As part of the reprocessing project, a new velocity model was built taking advantage of acoustic full waveform inversion (FWI). Along this work, it was possible to extend maximum frequency up to 22 Hz, a value significantly higher than initially planned, what was a good surprise coming from data recorded with streamer technology. This value was determined by inversion; in other words, velocity model building was considered concluded when FWI didn't converge anymore. Although the higher frequencies didn't deliver meaningful improvements for migrated images, when compared to an intermediate model where maximum frequency is around 10 Hz, it allowed the achievement of an FWI image where resolution is similar to migrated volumes at the target level, a deep carbonate sedimentary section below thick evaporite walls.

It´s important to mention that least squares reverse time migration (LSRTM) was also done in this project.

Results and Conclusions

Compared to Kirchhoff and LSRTM images, the directional derivative of final velocity model, i.e., the FWI image, happened to be the better image. Thus, obtaining this unforeseen image, we reached a seismic quality level that is better than our initial expectations in the reprocessing project.