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An innovative workflow to deal with velocity models of distinct seismic acquisitions to build bigger than basin-scale seismic images

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Abstract

An accurate seismic velocity model is a key aspect for confident seismic imaging generation. Special attention traditionally remains on building feasible geological features to represent the subsurface environment. Besides, these geological events' lateral and vertical positioning are important, not even being the main target for seismic imaging. Therefore, after the seismic migration effort, it is necessary to perform the well-tie calibration in the delivered models, ensuring the confident events depth positioning and, if possible, laterally allocation the events that may not be migrated appropriately. With these conditions in mind, a vast research area is still running regarding seismic velocity modeling and the inherent calibration needs when dealing with seismic information. For instance, regarding exploration targets, areas bigger than basin-scale studies are crucial, and building large velocity models to sample this large scale is not a common task because of the difficulties in acquiring a vast amount of data at once. Normally, a single seismic acquisition does not cover the entire area, depending on the basin size. Thus, it is reasonable to combine distinct seismic acquisitions to reproduce these "bigger than basin-scale" seismic images, and this combination does not necessarily provide enhanced imaging, great resolution, and depth forecast. This work presents an innovative workflow for building bigger than basin-scale seismic velocity models and its applications for different portions of Brazil, intending to answer for the aspects of imaging, resolution, and lateral and vertical positioning. To exemplify this approach, we show a case study in the Southeastern Brazilian basins, covering the junction of the different seismic acquisition data from the Santos, Campos, and Espirito Santo basins. It was necessary to use geostatistical approaches to distribute sonic velocity log-data, acquired in the existing drilled wells, conditioned by the interpreted regional seismic horizons, using the compressional velocities delivered for previous 2D and 3D seismic velocity surveys, previously modeled also using this seismic horizon as trend. Summarizing, six seismic time surfaces and data from more than 400 wells were used to constrain the velocities. Another important aspect was the imposition of the salt layer with a constant compressional velocity of 4,500 m/s, very close to halite velocity. This mineral represents circa 80% of the entire salt section. We will show our findings while building a velocity model covering an area of about 600,000 km². The velocity model and the maps obtained in-depth do not present non-geological artifacts as seen after conventional projects using the standard velocity model approach, designed for single acquisition of small areas in bigger than basin-scale areas. This modeling workflow is capable to deliver regional and consistent velocity models, reproducing the existing geology. These models are useful when reprocessing the combination of distinct seismic acquisitions, delivering reliable seismic images for big areas.