Reservoir depth prediction and GRV uncertainty analyses when building alternative seismic velocity scenarios: a case applied in the pre-salt reservoir of the Santos Basin.

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The discovery of the O&G pre-salt reservoirs province of Santos Basin is among the major and successful world´s exploratory events in recent years. In general, these accumulations are located far from the coast circa 300 km, ranging the water depths between 1-2 km, and reaching the reservoir in subsurface depths varying from 4-6 km. To develop the discovery fields, dozens of seismic surveys were acquired, and were drilled over than 350 wells. Currently, the pre-salt province produces approximately 2,3 million barrels per day, accounting for near to 75% of the Brazilian production. After acquiring the mentioned seismic data, significant efforts were put during the seismic data processing, particularly facing the construction of velocity models requirements for the proper seismic migration due to the geological area complexity. As result, the seismic images exhibit good quality and had small discrepancies in depth predictions when compared to the subsequently drilled wells. The accurate depth forecasting from the seismic data, might lead us to the wrong conclusion that the associated uncertainties with the forecasted top of reservoirs depth positioning may be negligible. However, most of the wells are drilled in elevated structural areas, searching for better reservoir quality, and avoiding reaching the fluid contacts, biasing the sensitivity analysis regarding depth prediction in undrilled portions, such as the low-structural regions that present insufficient data availability. Considering the presented challenges, we propose a study intending to capture possible velocity uncertainties associated with the post-salt siliciclastic and carbonate rocks, as well as the salt layer, over the pre-salt reservoirs depth estimating and the related sensibility regarding the gross rock volume (GRV). The applied methodology involves building distinct velocity scenarios based on well information, velocity models, and seismic data. The study contemplates two sections analyses: post-salt and salt. As premises, the reservoir section kept the original (unchanged) velocity model. In the post-salt section, the initial model was modified based on statistical values obtained from wells, resulting in optimistic and pessimistic velocity volumes in terms of reservoir horizon positioning. For the salt section, we performed an acoustic inversion, and we converted the impedance volume into velocities using two fit regressions: optimistic and pessimistic cases, respectively, also associated with reservoir horizon positioning. The scenarios were calibrated with the available wells adopting simple kriging algorithm. Then we demigrated the reservoir top horizon with the original velocity and remigrated it using each of the delivered velocity models. In the sequence, we evaluate differences in depth positioning between the models, lateral displacements, possible reservoir structure opening/closing, and quantified the respective GRV´s differences having the original seismic scenario as reference. We believe the methodology was capable in capturing mandatory and greater uncertainties regarding the reservoir structure by providing the most suitable optimistic and pessimistic models based on the available seismic and well data. The geological model for the study area, was adapted to the new optimistic and pessimistic scenarios, resulting in GRV´s variations of +11% and -13% respectively, along with new oil distribution maps, which may affect the development of production strategies.