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Reservoir Top Forecast Enhancements and Rock Volume Estimation by Integrating Well Data into Seismic Velocity Model: Mapping Uncertainties in the Búzios Field, Santos Basin

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Introduction

The construction of velocity models using tomographic inversion or Full-Wave Inversion techniques (FWI) aims to generate the best possible seismic image. However, it does not ensure the true depths of the target reflectors in areas with no drilled wells. To overcome this issue, it is common to update models with well data, especially check-shots, which provide a relation for domain conversion. Updating methodologies, supported by geostatistical methods, have been used for long time, but few topics are discussed about the quantitative impact of these corrections or the scenarios in which they are most beneficial. This paper reviews the process of updating seismic velocities with well data through geostatistics (Kriging with External Drift – KED), quantifying the impact on the definition of uncertainty scenarios regarding depth positioning and gross-rock volume estimation. To illustrate it, we present a case study in the Buzios field, Santos Basin, where it is necessary to update the seismic velocity model with well data to improve forecasts and reduce uncertainties about the top of the reservoir.

Method and Dataset

The input data include volumes of seismic amplitudes and velocities, average velocities of 98 wells, interpreted horizons, well logs as sonic, density, lithology, and geological markers, all loaded into the modeling platform. Initially, the average velocity of the well ties is reviewed, correlating them with the seismic velocity to avoid spurious values. The correspondence of the seismic velocities with the imported horizons is verified. KED is used to interpolate well velocities, using seismic velocities as a trend. After geostatistical interpolation, quality control of the velocities is carried out, considering the differences in the depth positioning between the converted horizon and the geological marker. This method can be applied to any number of wells, with the range of adjustment defined by the variogram. The KED workflow followed by quality control can be applied recursively, since it works as quality control of the seismic-to-well tie.

Results and Conclusions

The workflow has generated an updated velocity model and a reservoir top version that, compared to the reservoir top before this update, has misfit differences up to 60 meters. The rock volume calculation had an increase of around 2,5% for the whole field. During the quality control, morphological differences were found between the salt section delineated in the seismic velocity model and the base of salt horizon mapped in the amplitude volume around a specific well. This inconsistency causes a discrepancy of 60 meters. After updating the velocity model, the difference was reduced to 2 m. Updates to models with this type of problem increase reliability in well planning. In a scenario of intense field exploitation, where building a new velocity model can be time-consuming, a geostatistical updating with well data becomes a necessity to reduce uncertainties.