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Pseudoimpedance’s Improvement in Initial Model for Seismic Inversion

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Introduction

Acoustic seismic inversion is established as one of the main strategies for geophysical characterization of reservoirs, whether in the exploration phase or to detail an area proven to contain oil or gas. An important element for the seismic inversion flow is the initial impedance model, as the combination of this with the seismic data allows for the estimation of the elastic properties of the rocks of interest. The fundamental technique for generating this initial volume is supported by the interpolation of well data, which allows for the calculation of impedances from sonic and density logs. However, a commonly encountered problem is the low spatial representativity of these wells, which can become more critical in areas with few drillings. Among the proposed strategies to mitigate this problem are the use of geological interpretations as well as the use of velocity models. This work proposes a methodology that uses a volume of pseudo-impedances as a weighting element for the impedances estimated from the wells.

Method and/or Theory

The fundamental concept applied in this work is based on the use of a volume of pseudo-impedances as a spatially representative element of the geological characteristics of the study area, thus eliminating the need of horizons and/or faults. The variation of amplitudes in the pseudo-impedance volume works as a weighting factor for the impedances obtained and interpolated from well data. Then, the pseudo-impedance tends to reduce the bias naturally present in those well data, since they not only are few in number, thus representing the geology of a limited region, but also because wells tend to be drilled in favorable locations for reservoirs. In this study, a near offset stack underwent iterative deconvolution, integration, and low-frequency structural filtering for the generation of the pseudo-impedance volume. This volume was combined with the initial impedance model generated from the wells, thus creating an optimized impedance model with greater geological representativity. For comparison purposes, seismic inversions were performed with the enhanced model as well as with the volume generated solely from the wells. The analysis of the results involved selecting seismic traces at the positions of the wells used in the initial volume. For the optimized volume, the initial model did not utilize one of the wells, and thus, it served as a blind test. Considering the difficulty of visually analyzing the profiles, a representative average error was calculated for the entire interval of the wells, aiming to provide a quantitative element for evaluations.

Results and Conclusions

The comparison between the impedance volumes obtained from seismic inversions using different initial models preliminarily indicates a significant correlation between them, suggesting the robustness of the algorithm used. However, it is possible to suggest distinctions of different magnitudes throughout the impedance volume, which can be observed in more detail at the positions of the wells. Highlighting the blind test region, we find that the values of the accumulated errors along the well differ by about 12%, favoring the inversion obtained from the optimized initial model. It is interesting to note that at shallower depths, there is an almost absolute equivalence between the two inversions; however, at greater depths, there is a significant gain for the data from the proposed methodology, which presents impedance values much closer to those used as references, obtained directly from the well itself.