Forward Seismic Modeling for DAS: Learn by Doing

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Abstract

DAS (Distributed Acoustic Sensing) type systems are increasingly used in various segments of the oil and gas industry, with emphasis on VSP (Vertical Seismic Profile) surveys. Given, however, the relatively small number of works related to deep water, a seismic modeling project was undertaken seeking to emulate this context, trying to understand the perspective of detection and positioning in depth of microseismic events. The seismic modeling was developed from volumes of velocity and density calculated from geomechanical models already established for the area and the results obtained are initially related to the complete pressure field, so that there is no phase change in the registered events. Next, seeking to include the unidirectional character of the optical fiber, the vertical components (Vz) of elastic modeling undertaken for the sources at the top of the reservoir are also presented separately. In this way, it is possible to verify the polarity inversion in the primary wavefront, as can be observed in cases available in the literature. Considering the indications obtained from the researched papers and the characteristics of the available algorithms, it was decided to analyze different signal/noise ratios for the modeled data, allowing the understanding of which situations may be favorable, or unfavorable, to the detection of microseismic events. Five noise values were used: 50%, 100%, 200%, 300% and 400%. Each of these values corresponds to the percentage ratio between the maximum amplitude of the noise and the maximum amplitude of the data. Thus, the value of 50% indicates that the added noise may have a maximum amplitude equivalent to 50% of the largest amplitude of the original modeled seismic data. For the positioning of sources, the approximate offsets of 50, 250 and 500 meters were defined in relation to the well, in addition to three depths: at the top of the reservoir, in the central portion of the reservoir and finally, below it. The seismograms presented show that the different offsets (in relation to the well) give rise to hyperboloids with different features, resulting from the opening of the wavefront. The result of this dynamic is that for events simulated at greater distances, energy recording occurs in different sensors simultaneously. The results thus obtained indicate that the system with fiber optic sensors installed in a well can contribute significantly within the noise limits indicated in the experiments, generically standing at a signal/noise ratio equal to 0.5 (200% noise), adding It is known that the actual conditions depend on parameters not available at the moment, such as the magnitude of the events and, mainly, the environmental noise in the area. The uncertainty analysis carried out from the modeled data is also relevant for the contextualization of the problem, since it was possible to indicate that while events close to the well can have their depths satisfactorily estimated, for more further events, there is a significant ambiguity in the records.