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Source tests of some configurations and possibility of relaxed parametrization

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Introduction

Source tests were conducted during an ocean-bottom node (OBN) seismic acquisition campaign. These tests encompassed various configurations that resulted in different total source volumes. Among them were configurations analogous to the production project source, which employed a triple-source setup with a total volume of 3736 in³. The volume reduction tests were performed using three configurations, collectively referred to as REDVOL, with respective total volumes of 2296 in³, 1576 in³, and 1078 in³. Source elements were selectively removed to minimize the anisotropic radiation effects in the impulse response. One of the anticipated advantages of reduced-volume sources is the potential for operational optimization during seismic acquisition. Additionally, two further configurations, designated as QUAD and HEXA source, were tested. These configurations also utilized varying source volumes; however, their primary objective was to evaluate data quality under conditions of shot overlap. In the QUAD configuration, shots were closely spaced in time relative to key geological events, while in the HEXA configuration, full temporal overlap was implemented. In both cases, the deblending process was critical to ensure that the pre-processed data achieved quality levels comparable to those obtained with the triple-source configuration, thereby enabling reliable comparisons. The tests were executed using a set of ocean-bottom receiver lines and two shot lines oriented at azimuths of 120° and 300° for each source configuration. The objective was to perform 4D analyses on the acquired data, aiming to quantify the potential increase in 4D noise levels associated with each configuration.

Method and/or Theory

The acquired data underwent a comprehensive preprocessing workflow, largely aligned with the procedures adopted in the production project. However, specific adaptations were necessary due to the inherent limitations of the test configuration, particularly the use of only two shot lines. Certain preprocessing stages benefited from the availability of production project data, such as the corrections related to each OBN, which include repositioning (X, Y, Z) and geophone component reorientation, were directly informed by previously established parameters. Conversely, the water velocity correction had to be recalculated, as this property is time-dependent and subject to variations in environmental conditions such as salinity, temperature, and tidal effects. Comparative analyses and data evaluations were conducted following the application of reverse time migration (RTM). In the image domain, it was possible to compare 3D seismic sections, amplitude spectra, and seismic attributes. An important analysis is whether the different configurations have a consistent Amplitude Versus Angle (AVA) behavior, which contributed to a more reliable elastic seismic inversion.

Results and Conclusions

The qualitative and quantitative comparison of the source test configurations aims to support informed decision-making for future seismic acquisition projects, particularly in terms of operational efficiency and cost-effectiveness. Additionally, certain configurations, such as those involving reduced source volumes, may serve as technical references in future consultations with environmental regulatory agencies, potentially facilitating the approval of acquisition campaigns in areas located in relatively sensitive or restricted regions.