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Effects of source configuration changes on the 4D repeatability: a Pre-Salt case study

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Introduction

The transition from dual to triple or more sources in seismic acquisitions is necessary to improve the quality and resolution of the acquired seismic data. Triple sources allow for better signal sampling, resulting in a more accurate representation of the underlying geological structures. This is especially important in complex areas where detailed geological characterization is crucial for decision-making in exploration and production. Additionally, the use of triple sources can help reduce acquisition time and improve operational efficiency, as it enables the collection of more comprehensive data in less time. This change can also contribute to long-term cost reduction, as more precise results can lead to better planning and lower risks in development projects. But the transition to triple sources in 4D acquisitions, considering that the baseline acquisitions were performed with dual sources, can have several significant impacts in data consistency: careful processing and calibration of the data are necessary to ensure that the information is compatible and comparable. One can also expect improvements in Temporal and Spatial Resolution: Acquisitions with triple sources can offer enhanced temporal and spatial resolution, allowing for better monitoring of changes in the reservoir over time. This can result in a more accurate understanding of the reservoir's behavior during different production phases. The reduction of costs in acquisition may imply an increase in costs during processing: The transition may require additional investments in technology and training, as well as potentially longer processing times to integrate and analyze the new data. This increase will depend on specific conditions of the fields and reservoirs involved, however, the long-term benefits in terms of efficiency and accuracy may justify these initial costs. In summary, the transition to triple sources in 4D acquisitions, following a baseline of acquisitions with dual sources, may present challenges but also offers opportunities to improve data quality and operational effectiveness in exploration and production. A careful and integrated approach will be essential to maximize the benefits of this transition.

Method and/or Theory

Seismic lines were acquired with OBN-type receivers in a Pre-Salt field of the Santos Basin with a water depth of about 1500 meters, to be compared with Base survey seismic lines, also OBN-type, repeating the positioning of the seafloor sensors in relation to this. The Base survey was acquired with dual sources, and the test lines were acquired with dual sources (to achieve the reference 4D signal, with maximum shot positioning repeatability), with aligned triple sources, staggered triple sources, and aligned quadruple sources. The main objective was, after a conventional 4D seismic processing using Least Squares Kirchhoff and RTM migrations, to analyze the final noise differences in 4D between the reference test and the others, as well as the consistency of the observed 4D signal.

Results and Conclusions

The processing of the acquired data is ongoing, and its first results will be presented during the SBGf Conference Rio'25. In the initial analysis of the data, without applying the pre-processing steps, an average NRMS difference of up to 10% was observed between the reference test and the other tests when compared to the Base survey. The expectation is that this difference will be reduced to minimal values, and the effort required for Seismic Processing to achieve this goal will also be evaluated.