Nodes and Streamer geometries comparison for the Brazilian Pre-salt imaging

De Souza Junior, Adriano*[1]; Costa, Felipe[1]; Capuzzo, Felipe[1]; da Silva, Sérgio[1]; Karsou, Ammir Ayman[1]; Moreira Roger[1] and Cetale, Marco[1]
[1]GISIS/UFF - Seismic Inversion and Imaging Group/Federal Fluminense University

Summary

Imaging offshore reservoirs in complex media remains a new challenge in the oil industry, especially when there are large salt bodies present which is the case for some of the most profitable basins from Brazil. In this particular case, to produce a well-balanced reliable image of geologic subsalt structures still is a difficult task, since salt acts as a lens, scattering seismic energy and the reservoir is located at very large depths. To overcome these problems, several acquisition geometries are continuously tested, in combination with cutting edge imaging technologies in order to improve the migration result and generate the best image possible. Considering this scenario, this work aims to compare two different acquisition geometries that are used in Brazilian Basins, conventional towed streamer and Ocean Bottom Nodes (OBN), showing advantages and disadvantages of both, as well as a comparison of upgoing and downgoing wavefield images for the OBN geometry.

Results and Conclusions

For this study, a velocity model representative of the Campos Basin was used to generate synthetic datasets for both streamer and OBN geometries using the acoustic wave equation. The acoustic numerical modeling was performed by employing a 3D finite differences scheme, in which a regular grid was considered in the conventional towed streamer case, and a staggered grid was used in the OBN acquisition to record both pressure and vertical particle velocity fields to perform the PZ summation and use the multiples in the migration.

The generated synthetic data was then migrated using a reverse time migration (RTM) algorithm using a smoothed version of the velocity model employed in the forward modeling. Furthermore, a mirror RTM was applied for the OBN acquisition data records. In this way, three images were generated: one from the streamer acquisition, and the last two ones from the OBN geometry, from the upgoing and downgoing wavefields.

With these three images we are able to compare the resolution between them and analyze which geometry provides the best results for the layers under the salt, since there is no energy loss due to attenuation and the velocity model is the same in every case

Analyzing the results, it is possible to notice that the downgoing wavefield of the OBN geometry produces the best image of all three. The streamer image loses quality under the salt; since it has only a few azimuths due to the boat's trajectory and the salt velocities varies strongly in all directions, in some areas there is lack of information and the image does not have a satisfactory resolution.

The upgoing wavefield, besides being almost full azimuth, has the nodes strong footprint in the sea bottom and rapidly loses energy towards the model borders. The downgoing wavefield image, having also full azimuth but using the multiples instead of primary signal to migrate, does not leave footprints on the sea bottom and has better lateral resolution.

Despite the better image results, the OBN acquisition takes longer to perform due to nodes positioning and needs extra steps on time processing, being because of this more expensive and difficult to handle. Studies must be done in each case to evaluate if the intended image improvement justifies these drawbacks.