Recent Trends in Offshore Exploration: More Data, Less Model

Guillaume Cambois[1] and Mazin Farouki[2]
[1]*PGS, Singapore*
[2]*PGS, Kuala Lumpur*

New marine acquisition techniques – such as wide- and multi-azimuth, over-under and dual-sensor – provide additional data that complement conventional narrow-azimuth towed streamer data. These new data help reduce uncertainties in velocity model building and ultimately lead to a more accurate image of the subsurface.

It is a well known aspect of the general inverse theory that ill-posed problems need additional constraints to be resolved. These constraints often take the form of an *a priori* model from which the solution is required not to differ too much. This model represents an initial guess that must obviously be close to the exact solution if we want the correct answer. An alternative approach is to collect more independent data to reduce the under-determination of the system.

Imaging in complex geology where pre-stack depth migration is required to correctly reveal the subsurface structure is such an ill-posed problem. Common exploration targets include sub-salt, sub-basalt, and beneath gas plumes. The complex structures and the high velocity contrasts in these regimes combine to diffract seismic waves in all directions. The little energy that gets recorded by the relatively small streamer spread does not contain enough information to fully reconstruct the complex structures. In addition, noises (such as multiple reflections) further distort the already weak signals. Consequently, imaging in these complex geology regimes leaves a lot to interpretation.

To reduce under-determination more independent data must be collected. The industry started to gradually increase the streamer spread, reaching typically 9km in length and up to 1.3km in width. This comparatively small width was first addressed by acquiring surveys in multiple directions (see for example La Bella et al., 1998). Later techniques extended the width using additional source vessels (see for example Michell et al., 2006). An alternative approach is to acquire ocean-bottom seismic, which provides wide-azimuth as well as potentially multi-component data, but at a significantly higher cost.

It was also observed that due to attenuation and other high-frequency losses, target reflections often contain mostly low-frequency energy. Hence, enhancing the low-frequency content of seismic data provides higher signal-to-noise ratio. This can be readily achieved by towing sources and streamers deeper to benefit from the low-frequency boost of the ghost. However, the deep tow eliminates high-frequencies and a compromise has to be found to preserve resolution in the overburden.

Recent developments, such as dual-sensor streamer (Tenghamn et al., 2007) and 3D over-under (Kragh et al., 2009), gather more independent data and offer a no-compromise bandwidth extension on the receiver side. On the source side, over-under (Moldoveanu, 2000) and multi-level arrays (Cambois et al., 2009) also increase low-frequencies without loss of high-frequencies.

The methods listed above will be further developed and illustrated with various examples from around the world.

AAPG Search and Discovery Article #90118©2011 GEO India 2011, 2nd South Asian Geoscience Conference, Greater Noida, New Delhi, India, 12-14 January 2011