GEOPHYSICS PAPER 20

BROADBAND MARINE SEISMIC – BREAKING THE LIMITS

Robert Soubaras[1] & Carl Notfors[2]

[1] CGGVeritas, 1 rue Leon Migaux, 91341 Massy Cedex, France
[2] CGGVeritas, 9 Serangoon North, Avenue 5, 554531 Singapore

The importance of recording the full range of frequencies (low as well as high) is widely accepted. High-fidelity, low-frequency data provides better penetration for the clear imaging of deep targets, as well as providing greater stability in seismic inversion. Broader bandwidths produce sharper wavelets and both low and high frequencies are required for high-resolution imaging of important features such as thin beds and stratigraphic traps.

The industry has been facing many issues that have limited the performance of marine seismic surveys with respect to bandwidth. Among them, we find mechanical and acoustic noise, source and receiver ghosts and attenuation with depth. Until recently, conventional de-ghosting was found to be sub-optimal. Thanks to recent advances in technology and also in operational capabilities, we have seen several improvements, in particular with the use of solid streamers, deep towing and notch diversity.

We describe a different technique to achieve broadband marine streamer data. The proposed solution is a new combination of streamer equipment, novel streamer towing techniques, and a new de-ghosting and imaging technology. It uses receiver notch diversity to yield a broadband spectrum and takes full advantage of the low noise and low-frequency response of the new generation of solid streamers. As a result, the method creates an exceptionally sharp and clean wavelet for interpretation. It can be tuned for different water depths, target depths and desired output spectra.

A key element of this towed streamer broadband seismic technique is the streamer itself. The new generation of streamer electronics can record hydrophone signal as low as 2Hz, which adds an additional one or two octaves to the low-frequency end of spectrum. Another key element is the design of solid streamers which can significantly reduce noise (particularly sea-state noise) when compared to fluid-based (including gel) streamers (Dowle, 2006).

This combination of low-frequency hydrophone recording and reduced noise make solid streamers an excellent platform for broadband recording. An additional advantage for this technique is that the solid streamer has a uniform density, stable buoyancy and is robust enough to operate at extreme depths (greater than 60m). This deep-tow capability facilitates streamer depth profiles which have significant ghost-notch diversity and optimal low-frequency recording.

Marine receiver deghosting has received renewed interest recently as a key component of broadband imaging. Different approaches for acquiring broadband marine streamer data such as over-under streamers, dual-sensor streamers or variable-depth streamers require their own deghosting methods which may include 2D propagation assumptions method. We introduce a novel approach (Soubaras, 2010) which leads to a deghosting method adapted to any acquisition method and which is optimal in terms of signal-to-noise ratio because it is not performed as a preprocessing stage. It is true amplitude, being able to extract the true deghosted reflectivity, i.e. the reflectivity that would be obtained should the water surface be non-reflecting. The principle of this method is to perform a standard migration together with a mirror migration, and to perform a joint deconvolution using these two images as inputs. We refer to a mirror migration as one which migrates from receivers that are mirrored above the surface.

We will show field data results of the new technology that demonstrates its ability to retain frequencies of up to 6 octaves (Soubaras and Dowle, 2010) and the difference this makes to the resolution as well as deep penetration of the data.

REFERENCES

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