Efficient Broadband LS-WEM

A new methodology is much less compute-intense.

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Least squares migration (LSM) solutions have historically been limited to computationally expensive adaptations of reverse time migration and by necessity run on small data volumes. PGS will present a new LSM at EAGE 2017 that uses a visco-acoustic anisotropic one-way wave-equation operator that can be efficiently applied to large datasets. Substantial improvements in seismic image resolution and interpretability are demonstrated on 3-D data volumes from the North Sea and the Gulf of Mexico (GoM).

Why consider LSM?

Conventional depth migration produces a blurred representation of the earth reflectivity, with biased illumination and limited wavenumber content. The image resolution at a given depth is controlled by the migration operators, the acquisition parameters (source signature, frequency bandwidth, acquisition geometry), and the earth properties at the reflector depth and the overburden (velocity, attenuation). Some of these conditions can be mitigated during acquisition and processing by employing technologies such as dual-sensor data, full-azimuth acquisition geometries and attenuation compensation and using high-resolution earth models during depth migration (i.e., models derived from full-waveform inversion). However, when heterogeneities are present in the earth and the acquisition geometry leads to insufficient source and receiver coverage on the surface, both the illumination and wavenumber content of the depth-migrated images can be significantly restricted.

The resolution of the depth images can be improved by posing the imaging problem in terms of least squares inversion. LSM solutions are designed to produce images of the subsurface corrected for wavefield distortions caused by acquisition and propagation effects. They implicitly solve for earth reflectivity by means of data residual reduction in an iterative fashion, which usually demands intensive computation.

An efficient visco-acoustic anisotropic LS-WEM

PGS has implemented a new LSM using an accurate visco-acoustic anisotropic one-way wave-equation operator.

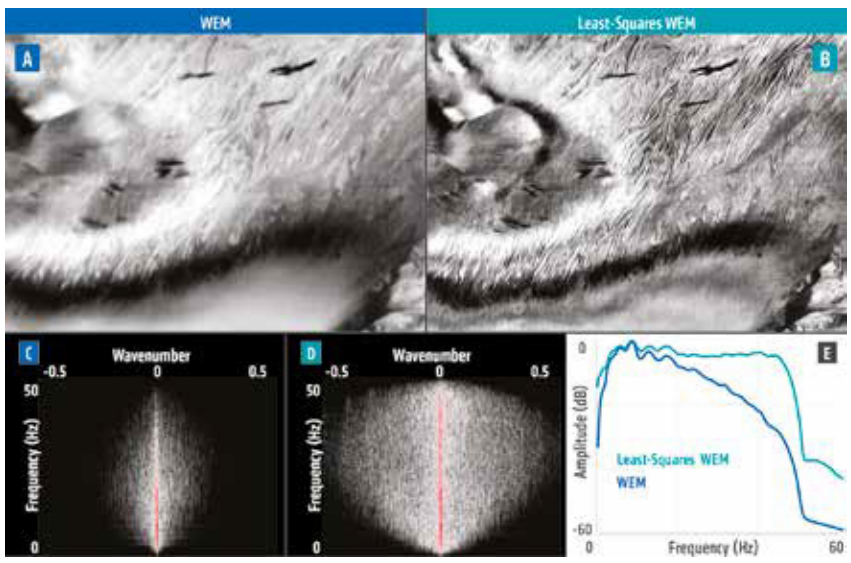

Figure 1. This GoM 3-D WAZ field data example shows (A) a depth slice at 1,150 m (3,773 ft) from WEM, (B) a depth slice at 1,150m from LS-WEM, (C) the WEM F-K spectrum, (D) the LS-WEM F-K spectrum and (E) the frequency spectra comparison of WEM and LS-WEM. (Image courtesy of PGS)

A one-way operator is integrated with a fast linear inversion solver in an efficient migration/demigration workflow, namely, an implicit LSM one-way wave-equation migration (LS-WEM). The PGS LS-WEM simulates data by wave-equation Born modeling and iteratively updates the reflectivity by migration of the misfits between the observed and simulated data. Each iteration comprises one Born modeling and one migration.

The computational cost of the iterative LSM relies on the efficiency of the wavefield propagation algorithm. The implementation of the inversion uses a one-way wave-equation operator that has the advantages of both accuracy and efficiency. Furthermore, the implementation combines the one-way extrapolator with fast linear inversion solvers into an efficient migration-inversion system.

Figure 1 shows the results of applying the PGS LS-WEM to a wide azimuth (WAZ) dataset from the GoM. The results also demonstrate that the PGS LS-WEM can deliver superior images compared to conventional depth migration. The image improvements include reduction of the acquisition footprint, better vertical and horizontal resolution, and improved wavenumber content (Figures 1C, 1D and 1E]. The PGS LS-WEM also balances the overall imaging amplitudes and especially augments the deeper reflection targets. More importantly, better images of the fault structures are obtained because of the improved wavenumber content.

For more information, this topic will be presented at 11:20 a.m. in Room A1 (Seismic Imaging-Migration Theory I) Tuesday, June 13. ■

Cote d'Ivoire to present at EAGE

The recently appointed Minister for Oil and Energy of Cote d'Ivoire, M. Thierry Tanoh, will attend the 79th EAGE to present exploration investment opportunities in the republic. Tanoh will be joined by a delegation from the ministry; the state oil company Petroci; PGS; and an existing operator, Total to promote the availability of 27 concessions. PGS will host two "road show" events at its conference suite in the meeting room area Tuesday from 14:30 to 16:00 and Wednesday from 9:30 to 11:30. For more information, visit Cote d'Ivoire at the International Pavilion (1151). ■