Practical Application of Adaptive Least-Squares Reverse Time Migration (LSRTM) to Advance Field Development and Uncover New Reserves in the Subsalt Provinces

Chong Zeng, Shuqian Dong, Zhaohong Wu, Jean Ji, Darrell Armentrout, and Bin Wang

TGS, 10451 Clay Rd., Houston, Texas 77041

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ABSTRACT

We proposed an adaptive approach to address the practical issues in least-squares reverse time migration (LSRTM) with a focus on subsalt imaging. The problems included imperfect migration velocity, slow convergence in subsalt area, and extra migration artifacts introduced in gradient computation. The adaptive solution involved strategies to enhance data consistency in time domain and control the migration aperture to precondition the LSRTM gradient for fast convergence. We used constrained dynamic warping to correct the misalignments between synthetic and input waveforms due to short-wavelength velocity errors. The waveform amplitude differences were mitigated by a locally windowed gain using input data as reference. During the LSRTM iterations, we gradually opened the migration aperture to control the weighting for updating structures with different dips. The extra artifacts introduced during gradient computation by the two-way migration operator were suppressed via a structure-oriented smoothing process. We demonstrate here the effectiveness of the proposed adaptive strategies via a 3D synthetic model derived from the true geology of the Gulf of Mexico. Lastly, we examined the results of the adaptive LSRTM approach on our multi-client wide-azimuth data acquired in the Freedom area of the Gulf of Mexico. The images of shadow zone and subsalt area were significantly improved after a few iterations regardless of the practical limitations such as velocity error and weak illumination near and below the salt body.

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