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A Comparison of 3D Azimuth-Angle Domain Common Image Gathers using Poynting Vector and Optical Flow Methods

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ABSTRACT

Angle domain common image gathers (ADCIGs) are frequently used to estimate the accuracy and reliability of background velocity models used in prestack depth migration. Also, ADCIGs can provide information during migration velocity analysis (MVA) and image-domain full waveform inversion by directly providing the depth move-out residuals to be employed for velocity model updates.

There are two approaches, namely, indirect and direct, for obtaining ADCIGs during reverse time migration (RTM). The indirect approach involves the generation of extended image gathers, which are later transformed to angle gathers (e.g., Sava and Fomel, 2006). This formulation requires extremely high computational cost and memory.

Alternatively, the direct approach forms angle gathers during the RTM imaging step by sorting image contributions into different opening angle bins (e.g., Zhang, 2014). This step requires the propagation direction of both source and receiver wavefields. A popular method in direction vector-based estimation is to use the Poynting vector (PV). The PV methodology was traditionally employed for the removal of the low frequency artifacts inherently generated in the process of RTM. Although this method has an advantage in reducing computational costs, wave direction vectors obtained from the PV cannot be calculated correctly in the region of complex geological regimes due to variability of source and receiver wavefields. Therefore, post-processing procedures, such as applying median filtering and/or partial stacking of adjacent angles, are required during the PV methodology.

Optical flow (OF) is a methodology used for resolving the wave motion between successive image wavefields by minimizing the objective function consisting of motion vectors and spatial derivatives of the wavefield. It is proven that RTM ADCIGs obtained by the OF methodology exhibit higher quality when compared to those obtained by the PV method. Since the OF method requires an iterative procedure to minimize the objective function, its computational cost is considerably higher compared to the PV approach.

In this presentation, by employing both synthetic and 3D field data examples (3D WAZ), we will demonstrate the differences in efficiency and quality of the RTM derived azimuth-angle gathers obtained from the two algorithms. The numerical tests were conducted in various complex geological regimes.