Converted-Wave Statics Estimation from a PS-Receiver-Stack Image

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Abstract

Objective
We introduce a novel and practical method to estimate converted-wave (S-wave) statics from a PS-receiver-stack image by aligning a target PS event to a PS-guidance structure provided by users. Our method is robust to low quality field data as the PS-guidance structure works as a physical constraint.

Methods
Before stacking a PS dataset to a PS-receiver-stack image, available source-side P-wave statics and the common-conversion-point normal-moveout (CCP-NMO) correction are applied. The corresponding PP dataset, which is NMO corrected and with both source-side and receiver-side P-wave statics applied, is stacked to a PP-receiver-stack image. We manually pick out a target event on this PP-receiver-stack image and convert it to a PS-guidance structure via a-priori PP-to-PS velocity conversions. As the PS target event, corresponding to this PS-guidance structure, on the PS-receiver-stack image has no S-wave statics applied, there exist time differences between them. Consequently, unknown S-wave statics of this PS dataset can be retrieved by aligning this PS target event to the PS-guidance structure on the PS-receiver-stack image, and our mathematical solver is a two-step method based upon optimizing a semblance-based cost function.

Results
We use a challenging field dataset with a complex near-surface condition to demonstrate the success of the method. Source- and receiver-side P-wave statics have been resolved for its corresponding PP dataset, and the source-side statics are applied to the PS dataset. On the PS-receiver-stack image, deviations are clearly observed between the target PS event and the PS-guidance structure, hand-picked on the PP-receiver-stack image and converted via PP-to-PS conversion velocities. By aligning the PS target event to the PS-guidance structure via our method, the S-wave statics are successfully retrieved and show a good correlation with known surface elevation information. We further apply these S-wave statics to the pre-stack PS data and CCP stack them. Compared to the PS-CCP-stack image without S-wave statics, our S-wave statics correctly fix false structures and better improve the continuity and quality of deep events.

Conclusions
We propose a novel and robust method to estimate S-wave statics from a PS-receiver-stack image. This is a semi-data-driven method, and it uses a user-provided PS-guidance structure as a physical constraint. This method has achieved promising results on multiple field datasets.