GeoConvention
Calgary • Canada • March 7-11 2016
OPTIMIZING RESOURCES

Time-Field Refraction Statics Analysis in 3D

Kamal Abo Jnah and Igor B. Morozov
University of Saskatchewan, kaa265@mail.usask.ca, igor.morozov@usask.ca

Summary

Picking of first arrivals, their quality control, and inversion for refraction statics are among the most important and time-consuming parts of reflection seismic data processing. These operations can be significantly improved by using the concept of travel-time fields (TTFs). In a 3-D survey, the first-arrival TTFs are 2-D surfaces in a five-dimensional space of shot and receiver coordinates. Several key operations related to the evaluation of statics are performed by simple manipulations with the TTFs. For example, by using reciprocal travel times in the common-source and common-receiver TTFs, individual-shot statics (uphole times) and short-wavelength receiver statics can be calculated. Reciprocity relations help guiding consistent automatic travel-time picking and quality control of the travel times. Errors in experiment geometry can also be detected and corrected by using the statistics or reciprocal travel times. By using common-midpoint TTFs, “vertical” travel-times can be measured and transformed into a fairly accurate near-surface velocity model by using the Herlglotz-Wiechert transform. In an improvement of this method, a 3-D diving-wave model of the subsurface is obtained by applying multiple travel-time reductions (linear-moveout removals) to the source- and receiver-order TTFs. For a given ray parameter p, the positions of turning points at the refractor with velocity $V_{ref} = 1/p$ are determined by building an envelope of the reduced TTFs. These subsurface velocity-determination procedures require no control points and use no tomographic inversion, and therefore they can readily be automated for applying to very large datasets. The above approaches are illustrated on a real dataset from the Teapot Dome project in Wyoming, U.S.A.

Acknowledgements

The research by K. Abo Jnah was supported by Suncor through the Institute of International Education.

References

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