Time-Lapse PP-PS Joint Inversion Over an Active SAGD Project

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Summary

The goal of this seismic reservoir characterization project is to map the extent of the SAGD steam chamber, determine future potential, and to serve as guide for planning production strategies and performance.

The Jackfish-1 steam-assisted gravity drainage (SAGD) project has been in production since 2008. The data used for this study include 2003 (Baseline) and 2014 (Monitor) multi-component seismic surveys. In addition, more than 70 vertial wells, including 12 observation wells and one concurrent-steam dipole well, were used.

The workflow includes 4D seismic surveys calibration, PS-PP registration, PP-PS joint inversion, time to depth conversion, cross-plotting analysis, and geobody extraction.

As a result of this study, we conclude that:

- PP-PS joint inversion on both baseline and monitor surveys provide detailed Vp, Vs and density estimations, and associated difference volumes. Those volumes allow the quantitative evaluation of the steam chamber in three-dimensions.
- The decrease in P-impedance or density can be used to identify the developed steam chamber.
- As expected, changes in the S-impedance was not as significant as in P-impedance in the developed steam chamber zones because shear is less sensitive to fluid and temperature changes.
- There are relatively large anomalies in S-impedance and Vp/Vs ratio surrounding developed chamber areas indicating the direction of steam chamber growth.
- Increases in Vp/Vs ratio indicate the heated chamber. Decreases in Vp/Vs ratio suggest water in the reservoir has changed from liquid to steam.
- Geobodies extracted from cross-plotting between lambda-rho and density differences volumes match the cumulative production and injected steam volumes. They also show a good correlation with the steam tops from observation wells.
- There still a large productive potential for this project.