Qualitative Comparisons of Surface Deformation over a SAGD Reservoir in Alberta

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Summary

Surface deformation has been monitored via satellites over the Jackfish oilsands since 2008. In an effort to understand more about the subsurface, the surface deformation data has been compared to time-lapse seismic and production information. Surface deformation is known to be driven by changes in pressure and thermal expansion in the reservoir. As Devon's intent is to keep pressure constant in the reservoir, we do not consider it as a significant contributor to the cumulative surface deformation and assumes it's impact is negligible in the interpretation. This assumption for pressure allows us to make comparisons and correlations between seismic time-delay, an approximation for steam chamber thickness, and surface deformation.

Introduction

Interferometric Synthetic Aperture Radar (InSAR) is becoming a more desirable method to monitor surface deformation, in particular ground heave in the oilsands related to thermal SAGD operations. Devon has licensed data from TRE-Altamira using the RADARSAT-2 satellite,which collects roughly 9 usuable images each year to calculate deformation. Surface deformation has been used to monitor pressure changes in conventional reservoirs and carbon sequestration and is primarily thought as a method to understand and monitor caprock integrity in oilsands production. Previous efforts (Granda et al, 2012) have shown that surface deformation can be correlated with steam injection rates. Others (James et al, 2012) have also shown that surface deformation can be used to map the steam chamber. However, there are discrepencies when surface deformation is used to infer steam chamber thickness. These differences can provide further insight into reservoir production and quality.

Method

For accurate relative comparisons, data must be spatially and temporally coincident. We assume that changes in surface deformation are driven by thermal expansion of the reservoir, that reservoir pressures are constant after start-up, and that time delays are dominated by fluid substitution of the bitumen by the steam. We can identify four areas of investigation: high deformation and high time delay; high deformation and low time delay, low deformation and high time delay; and low deformation and low time delay.

These areas of interest can be identified on a crossplot of the time delays and surface deformation. By focussing on these areas of interest and displaying where they are spatially located on a map these comparisons can be analysed and further interpreted.

Conclusions

Although surface deformation and seismic time delays are both results of thermal SAGD operations, the underlying causes are subtly different. Surface deformation is driven by thermal expansion and seismic time delay by fluid substitution. This qualitative interpretation of these observations can grant us further insight into the quality of the reservoir we are producing, pad conformance and allow us to characterise different styles of low performing reservoirs.

References

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