Integrated Time Lapse Seismic Inversion for Heavy Oil Applications

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Abstract

Time Lapse seismic monitoring has become an accepted tool for monitoring heavy oil thermal recovery projects. This success is mainly due to its' ability to track the progress of the production process in the interwell areas of the field. Unfortunately, the interpretation of monitoring data is often complicated because it is difficult to relate the seismic changes to changes in reservoir properties.

Seismic inversion offers the potential of simplifying time-lapse seismic analysis by converting the amplitude changes between surveys to acoustic impedance changes, which are more directly related to rock property variations. Unfortunately, this benefit frequently isn't realized due to changes in event times between surveys that are caused by velocity changes within the reservoir interval. These time changes cause a misalignment of geologic events below the reservoir that result in artifacts when the acoustic impedance results for each survey are subtracted. This problem is compounded when the velocity changes in the reservoir contain frequency components that are below the effective seismic bandwidth, and this often occurs in SAGD production processes. Fortunately, the low frequency velocity change information can be inferred through a careful analysis of the changes in event timing between base and monitor surveys. When this low frequency information is included in the seismic inversion, the results improve significantly over conventional inversions. The effectiveness of this technique has been demonstrated through application to synthetic models and to actaul time lapse datasets. The final inversions contain impedance differences that are more accurate and free of artefacts than those produced with conventional techniques.