

High Resolution Seismic Monitoring of a Heavy Oil Reservoir

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Steam is injected to many reservoirs to lower the viscosity of the heavy oils to allow them to flow and be produced. Such enhanced oil recover processes require substantial capital investments; bypassed sections of the reservoir or lost steam can compromise the economics of a project. As such, it is important to develop tools to monitor the injection of steam to the reservoir.

It has been known for some time that the introduction of steam to the reservoir will produce a detectable seismic response. More precisely, the elevated temperatures pore pressures and stresses that accompany steam injection result in relatively large changes in the material's seismic velocity. For example, in laboratory measurements the velocity of heavy oil saturated sands can drop by as much as 15% or more. Such reservoirs serve as ideal testing grounds for the development of technologies for time-lapse, or 4D, seismic reservoir monitoring.

The University of Alberta Field Geophysical acquisition system has now been used to repeat a series of 5 2D seismic profiles over a Lloydminster sand near Senlac, Saskatchewan from November 1999 to October 2001. These profiles were acquired with a high trace sampling (1.5 m) with a seismic vibrator taking exceptional care with repeated geophone and source positioning. A seismic processing stream, developed to optimize visualization of the temporal changes in seismic reflectivity encountered at the reservoir level, suggests little change in the reservoir conditions to May 2001 but a distinct change in character is observed post July 2001. Inversion of the seismic reflectivity suggests the changes are due to decreased velocity in the reservoir possibly resulting from exsolved methane.