Reducing Uncertainty in Time-Lapse Seismic Interpretation for Thermal Applications

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Abstract
Time Lapse seismic techniques have been applied to monitor heavy oil steam flood recovery processes for many years. Unfortunately, the interpretation of these 4D surveys is often complicated due to the wide range of pressure, saturation and temperature effects that occur in the reservoir rocks. Several combinations of these reservoir properties can cause the same seismic response and this makes it very difficult to arrive at a unique interpretation. An extra constraint can be added to the interpretation process by calculating the volume of reservoir that corresponds to specific time lapse anomalies. When reservoir volumes are taken into account, the range of possible interpretations is restricted.

This approach to interpretation has been applied to interpret a 4D survey that was recorded over a steam flood pilot in NE Alberta. First, modeling was performed to determine the types of seismic changes that should occur as the production process affected changes in temperature, saturation and pressure in the reservoir. Next, the time lapse surveys were compared to locate the areas of the field that were affected by production. Initially, it was impossible to make a unique interpretation of reservoir properties due to the interplay between pressure, saturation and pressure effects. Finally, the reservoir volume of the 4D anomalies was estimated and compared to the production and injection data for the field. Through this process, it was possible to make definite statements about the distribution of pressure and temperature changes observed over the pilot area.