SeisMovie™: a Continuous Land Seismic Monitoring System

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Over the previous 15 years, a new seismic monitoring method called 4D has been developed. It consists in repeating regularly 3D seismic measurements over a producing field and interpreting the observed seismic differences in term of reservoir fluid movement. This method has proved its efficiency in offshore reservoirs for which it is now systematically applied in the North Sea and the Gulf of Mexico. In the other hand, results in land reservoirs have been disappointing. It is due to several difficulties of traditional surface 4D land seismic:

- A signal to noise ratio varying from one measure to the next, especially due to the effect of the near surface conditions variations (ground roll) and the surface noise (industrial noises, weather changes, …)
- A signal to noise ratio weaker than in marine leading to 4D effects far more subtle and difficult to interpret
- The need for frequent measurements incompatible with the technico-economic model of the land conventional seismic acquisition (relatively high cost, difficulty to mobilize a crew on demand according to the monitoring needs, environmental issues, ...)

To overcome these difficulties CGG has developed, in conjunction with GDF (Gaz de France) and IFP (Institut Francais du Petrole), a seismic monitoring technology called SeisMovie™ based on low-energy surface or buried sources operating continuously and simultaneously in conjunction with a network of permanent receivers' antennae. The antennae can be vertical when very high sensitivity is needed or horizontal when spatial information is necessary. As the sources and receivers are stationary and cemented, one of the major causes of non-repeatability (positioning and coupling differences) is removed.

Furthermore, during the course of the system's development, it was found that, unlike their surface counterpart, buried sources and buried receivers could be almost insensitive to weather changes and provide a far better repeatability. The seismic source selected is a 1 kW piezoelectric source, which offers excellent reliability. This system is fully automated and remotely controlled. This type of high-resolution seismic monitoring has the potential to optimize exploitation scenarios: tiny changes in the seismic response (a few microseconds and a few percent) can be measured and calibrated to direct reservoir measurements.

A one month continuous experiment on a SAGD pilot site in Canada was recorded end 2005 and shows a high level of repeatability in an industrial context. The steam plant adjacent to the recording area and nearby drilling operations during this period did not prevent the system from being able to detect significant 4D seismic signals.

Transit time variation through the reservoir could be measured at a rate to be chosen relating to the S/N ratio and to the speed of production changes. In this case, we worked on a 3-day sliding window. It showed a good tie with well data and temperature measurements recorded in observation wells. Through continuous recording, it is possible to check the evolution of anomalies over calendar time and validate them.

As the movie obtained for each sensor can be merged into an overall map movie, interpretation of steam movement will be greatly facilitated. This will be especially true if the recording starts at the beginning of steam injection.

SeisMovie™ is a promising monitoring tool for SAGD developments and may thus be considered as a possible alternative to 3D time-lapse seismic.