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One Step Further Towards Real-Time Quantitative Seismic Monitoring

For over a decade, Gaz de France has acquired unique expertise in storing gas in brine-filled reservoirs to buffer supply to meet domestic demand. Bubble expansion, field pressure and gas saturation must be monitored as accurately as possible in order to maximize safety and gas recovery, and optimize production.

Gaz de France has therefore developed a comprehensive seismic monitoring system with CGG and IFP based on low-energy stationary seismic sources operating continuously and simultaneously in conjunction with vertical multi-component receiver antennae. The system is fully automated and remotely controlled. Tiny changes in the seismic response (a few microseconds and decibels) can be measured and calibrated to direct reservoir measurements. This high-resolution seismic monitoring has the potential to optimize exploitation scenarios. Reservoir production induces changes in saturation, pore pressure and stresses, which may influence the process of wave propagation in rocks. To obtain quantitative interpretation, geomechanical effects, induced by raising and releasing pore pressure inside and probably outside the reservoir, and gas saturation variations are also taken into account, in particular via extensive rock physics modelling (Hertz-Mindlin model and Gassmann equation). Each reservoir state (production scenario) can be identified in terms of physical properties and associated seismic response, leading to a quantitative assessment.

Oil reservoir production (heavy oil) and recovery operations (steam and CO_2) may also be monitored as long as appropriate acquisition parameters are designed i.e. source energy, number of sources and receivers, receiver depth, etc. This opens the way to a new range of quantitative applications for seismic monitoring. Two demonstration sites have to date been equipped with a number of wells. We propose to show and discuss our more recent results.