Success Story: Oil and Gas Industry

Using HPC to increase recovery and reduce environmental impacts of oil and gas exploration and production

The need for greater energy independence, a sustainable environment, and reduced conventional production has driven innovation and enterprise in the global oil and gas industry. It stands second only to the biomedical industry in the application of advanced technology. Of late, high-performance computing (HPC) has become an increasingly important tool, especially in the US.

Oil and gas companies are among the world's largest users of HPC, chiefly in the use of geophysical processing of 3D and 4D seismic imaging volumes for exploration and production. They also harness HPC tools, platforms, and approaches for reservoir management (geophysical inversion), development of new compounds and chemicals (molecular dynamics), and planning drilling efforts (advanced visualization). Lawrence Livermore National Laboratory worked in concert with several domestic oil companies for many years.

In fact, the industry's standard geophysical simulators and memory/interconnect platforms were developed in partnership with LLNL during a set of experiments with Society for Exploration Geophysicists in the mid-1990's.

Since then, the Lab has partnered with oil and gas companies to develop tools to improve recovery with low cost and low environmental impact. Central to these efforts is a tool that directly assesses the probability of key reservoir characterization and sub-surface plumes and fluid distributions. Specifically, the techniques integrate independent field data (cores, logs, seismic data), production data (pressures, temperatures, barrels produced), and monitoring data to tightly constrain subsurface fluid distribution and rock properties (porosity, permeability, velocity). Unlike conventional techniques, the technique swiftly generates ALL models of high likelihood, providing operators and field developers with information needed to manage their existing assets.

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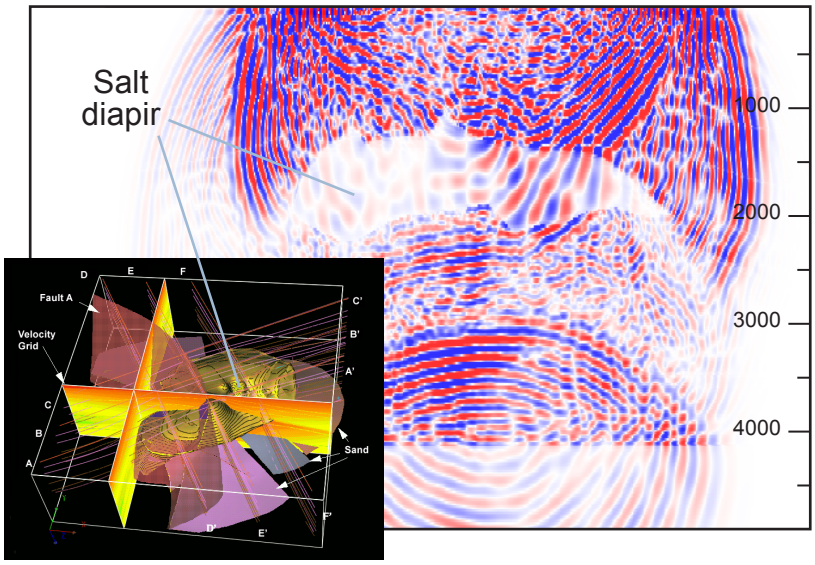
The low-cost, post-processing system reduces the need for observation wells and has demonstrated commercial success in oil and gas recovery, carbon capture and sequestration, and geothermal energy. The system is already in use to track injected carbon dioxide in projects in Wyoming (Anadarko's Salt Creek field) and Saskatchewan (Weyburn). Additionally, Chevron is employing the approach to increase recovery and improve environmental performance at some of its enhanced oil recovery projects.

Through advanced modeling and simulation, private sector participants have improved well recovery, reduced operating costs, and reduced failure risk. These early results only suggest higher promise for HPC in improving domestic energy production with reduced environmental consequence.

The long-electrode ERT tool (left) and the downhole tilt-meter (inset) are used to monitor subsurface production and injection conditions and interpreted using HPC.

(below) Elastic wave model of a salt diapir from the Gulf of Mexico, based on the SEG/EAGL model (inset). The simulation uses the WPP code, which runs 10x faster than traditional wave propagation models.