CO_2 sequestration – geophysicists are needed!

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Summary

The geological sequestration of CO_2 is generally known under the umbrella term of Carbon Capture and Storage (CCS) and is a CO_2 emissions reduction strategy that is an integral part of climate change action plans of governments and industry. The business case for CCS is developing rapidly as more companies are embracing the concept of 'Net zero carbon by 2050'. Enhanced oil recovery (EOR) using anthropogenic CO_2 is also an emissions reduction vector that does generate revenue in the absence of policy or a carbon price. Geophysicists bring critically needed expertise to the implementation of CCS, including the full value chain from site selection through operational monitoring, project closure, and de-risking CCS technology in general. New geophysical businesses and technologies are needed not only to meet regulatory compliance (storage verification) but also for leak detection and mitigation, source identification and crucial performance validation to drive the improvement of processes and to alleviate any public concerns about this technology. Full deployment of CCS and CO_2-EOR could result in expenditures and a workforce that are comparable in size to the upstream natural gas sector.

Background

The Global CCS Institute recently reported on the increasing uptake of CCS, with 10 large-scale projects recently added to its database, bringing the total number of CCS facilities globally to 51 with a combined storage capacity of 96 million tonnes of CO_2 per year (https://www.globalccsinstitute.com/resources/global-status-report/).Key areas that geophysicists can contribute to CO_2 sequestration are in site selection and characterization and in geophysical monitoring of the injected CO_2 plume. Characterization of the storage complex is important for storage capacity estimation, understanding rock properties to predict injectivity, understanding probable fluid flow scenarios in the storage reservoir and integrity of the cap rock.

Of paramount importance to CCS operations is the ability to track and quantify the injected CO_2 plume in the storage formation and to detect any migration through the overlying cap rock into shallower aquifers, or release into the atmosphere. Cap rock assessment procedures need development as cap rock facies may vary laterally and fluid migration pathways (e.g. faults and connected fracture systems) may intersect cap rock sequences. Monitoring and verification of containment and injected CO_2 conformance are vital not only for public acceptance of CCS but also for the ultimate transfer of environmental liability from the operator to the government. Surveillance of the overburden from the ground surface to the reservoir is needed to verify containment and comprehensive monitoring technologies and protocols thus need to be established, using a wide range of existing and next-generation technologies.

Methods

Figure 1 illustrates typical opportunities for CO_2 sequestration and CO_2 – EOR in Alberta. Large scale storage is mostly likely to take place in deep saline aquifers and 2 projects in Western Canada are already in progress (Quest project by Shell and partners in Alberta, and Boundary

Dam by SaskPower in Saskatchewan). Enhanced oil recovery with CO_2 has been very successful at Weyburn, also in Saskatchewan and the Alberta Carbon Trunk Line with CO_2-EOR by Enhance Energy is close to start-up. CMC Research Institutes and the University of Calgary operate a Field Research Station in Newell County, Alberta for advancing CCS monitoring technologies.

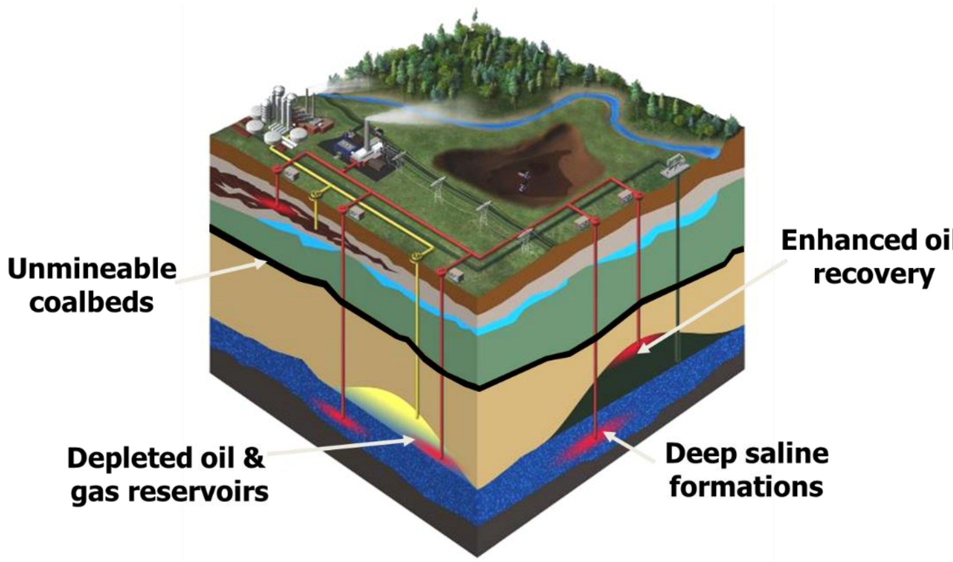

FIG 1. Example CO_2 sequestration and CO_2 enhanced oil recovery reservoirs in Alberta

Comprehensive site characterization and operations monitoring require a broad array of geophysical and other technologies, including time-lapse seismic, electromagnetic, electrical, gravity methods as well as geodetic and geochemical surveys to provide verification of containment and conformance. Implementing these surveys at scale will require many geoscience and data science professionals.

Discussion

In order to meet Alberta's CO_2 emissions reduction targets, many more projects need to be undertaken. A study by Sharp and Melton (2013) found that scale up of CCS technology requiring new tools, business lines and services could result in the creation of 9,000 to 27,500 new, additional, full-time, HQP positions by 2030 across all sectors. The anticipated jobs indicate a massive investment in the Western Canadian Economy exceeding $1 billion, as three to four person-years of HQP demand accompany each $1 million that industry invests in carbon management infrastructure, while each $1 million of carbon management operations and maintenance spending would result in a 5.9 to 6.6 person-years demand for HQP. About 90-100% of the investment phase and 100% of operations spending on labour would be in Canada, with most occurring in Western Canada.

References

Sharp, J and Melton, Noe, 2013, Estimating HQP demand associated with industrial carbon investments, Navius Research, Final Report.