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Unconventional opportunities for carbon dioxide storage in the Athabasca Region

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Summary

Athabasca oil sands mines and in situ bitumen operations will soon reach the 100 Mt/yr emission cap. The potentially significant costs of transportation to conventional supercritical CO2 storage in geological pore space can be overcome by developing unconventional storage mechanisms in shallow formations, specifically as a gas hydrate and or by dissolution in available formation waters.

Theory

CO2 storage in shallow geological pore space is not currently permitted by Alberta regulations. The purpose of this paper is to discuss two unconventional opportunities for shallow storage in the Athabasca region to reduce the overall cost of Athabasca region CCUS by developing shallow storage opportunities near the inferred site of CO2 capture associated with oil sands mines and in situ bitumen operations. The presentation examines both methods, the current state of these CCUS technologies and the likely configuration of potential proof-of-principle experiments and potential risks for the development of these technologies and the pathway for regulatory approval in the Athabasca region.

Results, Observations, Conclusions

CO2 gas hydrates occur naturally, although less commonly than CH4 hydrates. CO2 hydrates have also been studied extensively in the laboratory and their manufacture in geological media is inferred from an Alaskan gas hydrate production experiment. Several studies of Athabasca region shallow gas pools and aquifers indicate the current existence of, or potential to create environments favourable for the formation of CO2 gas hydrates, in a variety of configurations. While the time-line for a proof of principle experiment that informs regulation suggests an aquifer location where permafrost conditions either exist currently or existed relatively recently such experiments will likely require the inhibition of hydrate formation during injection. However, such sites also provide opportunities for the unambiguous monitoring of hydrate formation and stability. In contrast, it may be that depleted gas pools, where such inhibition is not required, may provide the most attractive initial sites for CO2 gas hydrate storage. Still, the largest storage potential occurs in aquifers rather than depleted gas pools.

Dissolution storage at shallow depths provides another opportunity not currently permitted generally by Alberta regulations. A French experiment of dissolution storage, extracts geothermal energy from produced waters and introduces CO2 into them at the surface prior to their reinjection in geological reservoirs. Injection operations at CMC Research Institutes Newell County field research station (FRS) is a current permitted CO2 injection experiment into Upper Cretaceous Belly River Gp. basal shoreface sandstones at 300 m depth. While not the principle intent of FRS activities, it too will inform both industry and the regulator about the practice and risks of direct CO2 injection and storage in shallow geological pore space.

The result of such pilots will inform industry and regulators regarding the costs and efficiencies of shallow Athabasca region CO2 storage, while demonstrating safe storage and creating stakeholder acceptance.

Additive Information

CO2 pipeline can cost >$1 Million/km, which is a key consideration for Athabasca CO2 CCUS. Recent studies have shown that judiciously sited Athabasca gas hydrate storage can remain stable until the onset of the next glacial epoch, even if ground surface temperatures warm as expected. The presence of two different experiments, in France and in Canada, will help to inform industry and regulators about the potential for and evolution of CO2 storage in shallow aquifers where CO2 is either dissolved in formation waters or it will occur in a gas phase.

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