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Taking CO2 sequestration projects from the concept stage through to the permitting stage

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Summary

Taking a CO2 sequestration project from the concept stage through to the permitting stage requires an understanding of certain critical features of the subsurface geology of a chosen site to evaluate whether the site has the characteristics needed to make CO2 injection and sequestration a viable option. The project process also requires a successful navigation of the regulatory guidelines and requirements of the jurisdiction that the site is in. The requirements at each stage of the project can generally be divided into two categories: things that the project owner needs to know in order to move forward, and things that the regulator needs to know in order to allow the project to move forward. In this paper we summarize recent CO2 project permitting experiences and in so doing, attempt to describe the relevant questions that must be answered at each stage of the project development and the data and methods that are required to answer these questions. We do this by focusing on the aspects that directly pertain to the subsurface technical team, using examples from specific CO2 sequestration sites in North America.

Project Feasibility Stage

At the pre-feasibility or feasibility stage of the project the owner of a potential CO2 sequestration site needs to know whether supercritical CO2 (SCO2) can be injected in sufficient volumes, at sufficient rates and for sufficient duration to make the project economic. At this stage the focus of the project is identifying potential sequestration zones and using a screening criteria to rank their suitability. The primary factors in a screening criteria are depth, pore volume, permeability, pore pressure, and rock and pore fluid chemistry. These primary factors are also inter-related. For example, available pore space for injection is dependent primarily on porosity and zone thickness (enough volume for storage) and permeability (enough access to the storage volume). We demonstrate this using two examples from the XXXXX. (Figure 1)
During SCO2 injection in a water-filled reservoir, pore fluids are mechanically displaced away from the wellbore and out into the reservoir by and growing plume of SCO2 (Figure 2). Two important factors to understand at this stage are the size of the expected CO2 plume and the change in pressure that it creates as it pushes pore fluids out into the reservoir. Both factors will have a bearing on the longterm injectivity of the sequestration zone as well as on the risks to containment of the plume or leakage potential along offset wellbores or geological structures. Thus these factors strongly impact the suitability of a given zone for sequestration potential and comprise an important element of the screening criteria. In Figure 3 we show a comparison between potential sequestration zones in the XXXXX and the predicted plume size and associated pressure change around the advancing plume. The implications of this prediction are clearly dependent on the specific site in question and its geological characteristics.

Project Permitting Stage

In addition to a higher level of supporting geological, geophysical and reservoir engineering detail, certain risks to CO2 containment and leakage must be addressed at this stage if they have not already been addressed during the feasibility evaluation. Two common risks that need to be addressed are CO2 leakage along or reactivation of faults (Figure 4), and integrity/sealing potential of the primary seal for the sequestration interval. In Figure 4 we show the concept of fault reactivation potential due to a local pore pressure increase around an advancing CO2 plume. Monitoring is a critical aspect of a successful CO2 storage project from both operations and getting through permitting. A comprehensive monitoring and emergency action plan is essential. Monitoring isn't always straightforward, and the amount and associated costs can be a sliding scale. Often it is a balance of cost, specific site risks, regulatory requirements, and stakeholder risk tolerance.

Novel/Additive Information

Pending release of confidential information we will show specific examples from CO2 sequestration sites to demonstrate relevant concepts.

Acknowledgements

Pending release of confidential information.

References

ISO 27914:2017(E). Carbon dioxide capture, transportation and geological storage – Geological Storage.
US EPA Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO2) Geologic Sequestration (GS) Wells Final Rule.