Title: Petrophysical Considerations for CO2 capture and storage

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**Abstract:** XXXXX

**One-Sentence Summary:** This paper aims to discuss the petrophysical considerations that need to be made for compliance with the CO2 Storage Resources Management System (SRMS), and highlight key differences and similarities between the SRMS and the Petroleum Resources Management System (PRMS)

**Introduction:** Commercial scale carbon capture and storage (CCUS) requires an accurate understanding of the underlying subsurface for successful implementation of field development plans. The suitability of geological formations for CCUS is essentially an integration of multiple scales, and disciplines (Figure 1). In a similar manner to how exploration for oil and gas is conducted, a staged process will ensure that the data at the various length scales that integrated appropriately

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Figure : Schematic illustrating the process of Data Integration

Starting with seismic (Figure 1 (a)), there is a need to perform depth conversion, evaluate the stratigraphy/ facies and interpret the horizons and faults. At the broad scale, one would than high grade potential storage sites (Figure 1 (b)). From here, properties requires for static modelling would need to be populated with evaluations made from petrophysical logs, routine and special core analysis (Figure 1(c) to Figure 1(e)), where the goal would be estimation of porosity, permeability, minerology, relative permeability and capillary pressure. At this scale as well, there should be consideration given to the geomechanical aspects of the potential storage sites, with an attempted to understand the stress regime, seal potential, geometry, and integrity. Consideration must also be given to hydrodynamism and whether faults encountered would act as conduits or seals. Also equally important are the reservoir engineering aspects of any CCUS project, and in particular, pressure and temperature analysis, phase behaviour of injected CO2 fluids and the integration of data related to well tests that would have been performed in analog or offshoot wells. Geochemically, aspects related to mineral composition, rock-fluid-Co2 interactions and microbial activity must be considered (Figure 1(f)).

The integration of all the above results in the development of static and dynamic models where the volumetric evaluation of the potential storage capacity can be determined (theoretical capacity). When building the dynamic model, the efficiency of CO2 injectivity into reservoir facies would be accounted for by an “efficiency factor” (analogous to a recovery factor in oil and gas) to account for transmissibility, pore-scale trapping mechanics and connected volumes, from which an estimate of the actual storage capacity would be determined (effective capacity).

**PRMS vs. SRMS:** The Petroleum Resource Management System (PRMS) [1] provides the model for the development of the SRMS, by which CCUS projects can be voluntarily contrasted against. Both frameworks are similar in that they are project based, independent of implementation and detail how resources can be quantified, categorised and classified. The definitions provided within the SRMS follow standard industrial definitions for most terms and draw parallels from the definitions provided in the PRMS.

Unlike the PRMS however, which ultimately concerns itself with the commercial viability of hydrocarbons (reserves), the SRMS [2] is concerned with the evaluation of accessible pore volumes to store CO2 (storable quantities) geologically, with an expectation of permanence. Shown in Table XX is the contrast between the PRMS and the SRMS in terms of project-based definitions

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| --- | --- | --- | --- |
| SRMS | | PRMS | |
| Total  Storage  Resources (P+C+U) | Definition | In-Place  Resources | Definition |
| Prospective  Storage  Resources (U) | Undiscovered | Prospective  Resources | Estimated volumes associated with undiscovered accumulations |
| Contingent  Storage  Resources (C) | Discovered, sub-commercial until a project has financial commitment to commence injection | Contingent  Resources |  |
| (Commercial)  Storage  Capacity (P) | Discovered, anticipated to be commercially accessible by application of a development project at a given date | Reserves |  |

Each category (P, C or U) within PRMS and SRMS also must consider the probability of potential outcomes om the form of low (P90), best (P50) and high (P10), to capture geological and engineering uncertainties.

Commercial Storage Resources must further satisfy four criteria: The target geologic formation must be discovered and characterized (including containment); it must be possible to inject at the required rates; the development project must be commercial; and the storage resource must remain, as of the evaluation date (i.e., not previously used for storage), on the development project(s) applied. Commercial

The SRMS is intended to be used with saline geologic formations/ acquifers and depleted hydrocarbon fields. SRMS does

Scenario 1: Producing from Field A for injection into Field B: Same operator no issue. Geologically would need to know information on both fields. Commercially would depend on ownership. For example, if Field A (storage) is owned by Company A and Filed B is owned by company B(producer), than there has to be a tariff payment from Company B to Company A for acceptance of the CO2.

**Key Petrophysical Differences between SRMS and PRMS**

Depends on the application. Is this for Storage or Utilisation? Both Storage and Utilisation require that the depleted (oil or gas) zone be well understood. If there is intention to store in the aquifer, than having a proper understanding of salinity is key. Understanding the fracture pressure is very important as well, to prevent over-pressuring the reservoir. For utilisation i.e. enhanced oil or gas recovery, the gas-fluid-rock interaction is key. Also, an understanding of how the CO2 plume is moving in the strata will be important.

**Salinity and Electrical Properties:**

**Fresh Water vs Saline Aquifer**

**Geochemical Alternations with Interaction with CO2**

**Porosity:**

**Effective vs Total**

**Saturation:**

**Less Critical in SRMS**

**Permeability**

**Mobility ratios, miscibility and Liquid Permeability**

**Capillary Pressure & SWIRR Ranges:**

**Phase Diagram?**

**Pc modelling**

**Trapped Residual Phase**

**Trapped Gas Saturation**

***Discussion and Implications:***

**Injection into Aquifer**

**Injection into Depleted Reservoir**

**Risking. Data Collection and Analysis Required**

**Importance of Cased Hole Monitoring**

**Effect of Thermal Cooling and Geomechanics**

**Injection Rates and Flow Pathway**

**Fines Migration and Time Lapse Monitoring**

Table : Blah Blah

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Figure :Moo Moo

# **References**

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