A Workshop on What Makes a Good Seal for Geological Storage Projects?

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On January 12 to 15, 2010, U.S. Geological Survey (USGS) and the Global Climate and Energy Project, Stanford University, held a participatory workshop on “Seals and Caprocks in Geologic Sequestration” at the Asilomar Conference Grounds, Monterey, California, USA. Sixty-five participants in academia, government agencies, and industry from six countries discussed topics that included depositional environments and petrology of caprocks, interfacial tension and capillary pressure in CO₂-H₂O-rock systems, basin-scale characterization, and geomechanics and geochemistry of seals and caprocks. The program had a limited number of oral presentations with discussion sessions following each talk. Twenty-five posters were displayed during both days of the meeting. The program included extended afternoon breaks allowing participants time for in-depth discussions in the informal setting of the Asilomar State Park Grounds on the dramatic Monterey Bay coast. The conference was organized by Sally Benson and Sam Krevor from Stanford and Bob Burruss and Leslie Ruppert from USGS.

The goal of the workshop was to bring together scientists with expertise in petrophysical, geological, hydrological, and geochemical properties of caprocks and seals for water and petroleum retention with scientists studying carbon capture and storage (CCS) for CO₂ storage and retention in geologic strata. In the course of the workshop a number of important opportunities for further research were identified. These topics fall into the four broad categories identified below.

1. Developing Guidelines for Assessing the Suitability of Seals for Geological Storage of CO₂
   - What level of retention is needed below or within a seal?
   - What geological, hydrogeological, geochemical and geomechanical properties are required to assure safe and effective storage of the seal/reservoir system?
   - What operational requirements, such as injection well specifications and depths, pressure buildup and injection well spacing, are needed to ensure that the seal/reservoir system will deliver the needed storage security?
   - Are seals with 3-dimensional closure needed, or is it possible to trap CO₂ beneath flat or dipping structures?
   - To what extent are existing requirements on seal properties for natural gas storage applicable for CO₂ storage? What, if any, are the seal requirements for natural gas storage—and on which basis were they established?
   - What is the best approach to characterize and monitor whether or not abandoned and active wells have the potential to leak?
2. Improving and Increasing Measurements of the Transport Properties of Seals
   - How can we increase the amount of data available about permeability, relative
     permeability and capillary entry pressure of seals?
   - What new methods can be developed to shorten the amount of time needed to
     obtain accurate measurement of the transport properties of seals?
   - In which important ways does the transport properties of seals differ between CO₂
     storage and hydrocarbon accumulations (from which most of our knowledge of
     seals is derived)?

3. Understanding Geochemical Controls on Transport Properties and Performance of
   Seals
   - How does the organic matter content of a seal affect the sealing properties of
     mudrocks?
   - In the case of organic-rich shale, how could organic matter interactions with CO₂
     change the mechanical and transport properties of the shale?
   - What is the role of dissolution, precipitation, and surface reactions on the
     transport properties of seals?
   - How do coupled geomechanical, geochemical, and transport processes affect the
     long term containment properties of seals?
   - What is the role of surface absorption/desorption on caprock sealing?

4. Characterizing the Transport and Geomechanical Properties of Seals Over the Spatial
   Extent of the Area Affected by a Storage Project (hundreds of km²)
   - What tools (properties?) do we need to measure the heterogeneity of seals and
     model them on regional scales?
   - How does depositional heterogeneity affect the transport properties of seals?
   - How do you determine the area over which the prospective seal needs to be
     characterized?
   - What hydrogeological, geochemical and geomechanical techniques are most
     promising for characterizing saline formation seals?
   - How do we optimize field testing to maximize knowledge of caprock properties?
   - How much information is needed to develop accurate models for predicting
     storage performance for large-scale projects?
   - What are the best approaches for reporting and dealing with uncertainty?
   - What can be learned from EOR and natural gas storage to inform characterization
     of seals for geological storage?

The participants concurred that while there are many opportunities for research, *increasing experience with commercial scale projects is urgently needed* for moving forward. A productive research program in seal properties and characterization is best carried out in parallel with these commercial scale projects.
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