AAPG/SEG/SPE HEDBERG CONFERENCE
"Geological Carbon Sequestration: Prediction and Verification"
August 16-19, 2009 – Vancouver, BC Canada

U.S. Geological Survey Probabilistic Assessment Methodology for the Evaluation of Carbon Dioxide Storage

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The U.S. Geological Survey (USGS) has developed a probabilistic assessment methodology for evaluation of the technically accessible resource potential for storage of CO_2 in subsurface geologic formations of the United States. This methodology for assessing CO_2 storage is based on USGS assessment methodology of oil and gas resources, which has been created and refined over the last 30 years. In the case of CO_2 storage, the resource that is evaluated is the technically accessible pore space in the subsurface in the depth range of 3,000 to 13,000 ft, within a geologically defined storage assessment unit consisting of a storage formation and an enclosing seal formation. The storage capacity assessment methodology is primarily a volumetric calculation of pore space coupled with an estimate of 'storage efficiency', the percentage of pore space that would be occupied by free-phase CO_2. Storage assessment units are divided into portions that are physical traps (PTs), which in most cases are producing or depleted oil and gas reservoirs, and the surrounding saline formation (SF) that constitutes the remainder of the storage formation. The distribution of the size of potential storage resource is determined separately for the PT and SF settings by Monte Carlo simulation methods. To estimate the aggregate storage resource distribution of PTs, a second Monte Carlo simulation step is used to sample the distributions of the size and number of PTs.

Aspects of the USGS capacity assessment methodology which make it distinct from other proposed methods include utilization of various distribution functions of the available data as input values. The data available for PTs allow for several types of storage capacity values to be determined, such as: (1) the amount of CO_2 stored via enhanced oil recovery (EOR); (2) the amount of CO_2 that can be stored relative to the net volume of fluid produced from the trap; and (3) the volumetric estimation of available pore space using distribution of the areal extents, thicknesses, and porosities of known traps and storage efficiency values. The ultimate goal of the storage capacity assessment methodology is to determine the total trap volume beyond the petroleum-bearing volume, i.e. the "fill-to-spill" storage capacity. The SF methodology is a volumetric estimation that uses Monte Carlo simulations to sample distributions based on the uncertainties of the average values for thickness, porosity, and storage efficiency. The storage distributions assessed in both PTs and the SF are reported as unconditional and conditional capacity. The unconditional capacity estimates, in contrast to the conditional estimates, take into account the probability of successful storage for individual PTs or the entire SF, as defined by the likelihood that the CO_2 stored will be greater than a prescribed minimum. Therefore, the unconditional storage values represent estimates with the greatest degree of geologic certainty based on current knowledge and available data.