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

A Formal Method for Ranking and Selecting Suitable Sites for Carbon Dioxide Geological Sequestration

C. Vivalda[1], S. Saunier[2], Q. Liu[3], B. Jing[3]

[1]Schlumberger - Carbon Services, France
[2]Schlumberger - Carbon Services, UK
[3]Schlumberger – BGS, China

The work presented in this paper addresses a method for pre-assessing potential sites for carbon dioxide geological sequestration and its implementation in a software tool. Indeed, one of the main challenges for a carbon capture and geological sequestration project deployment is to find adequate sites able to meet a set of criteria designed to qualify the site for operation (CO2 injection), closure, post-closure and long term survey.

Well established processes to be followed for site selection, together with the type of criteria to be chosen, and their individual specifications to assess the suitability of the site are not fully developed today and the regulatory framework in most countries around the world is not mature enough to provide full guidance. Only a few approaches coming from academia and industry are publicly available. The statement above applies to the different alternatives currently suggested for carbon dioxide sequestration, such as depleted oil and gas reservoirs, deep saline formations and coal beds. Depleted oil and gas reservoirs are the better characterized and a large amount of reliable data is normally available for their assessment. Deep saline formations represent the largest capacity among the three but the data available for these reservoirs are generally very scarce. In all cases, but in particular in the latter, the method presented in the paper contributes to minimize the time and the costs related to a thorough characterization of a potential storage site, by providing a preliminary qualitative or semi-quantitative analysis for selecting and ranking potential sites for further investigations.

The method aims at pre-assessing potential storage sites and founds its strength in its ability to handle the numerous and non-homogeneous criteria that should be used to make objective decisions.

The approach is based on a few main elements, namely:
- a comprehensive set of criteria able to capture the main characteristics of the site;
- a method to handle criteria that are different in nature and relevance with respect to some objectives the site has to fulfill;
- a decision making support system that helps decide on the base of the assessed criteria, whether the site can be considered suitable for further explorations or not.

These elements are combined to build a robust tool that uses the Analytical Hierarchy Process (AHP) theory to organize criteria with respect to the relevant objectives the site has to fulfill, such as carbon dioxide long term containment with negligible impact on Health & Safety and the environment, costs optimization, geographic location peculiarities preservation and impact, permitting, policy and regulations impact and public acceptance. The sets of criteria are grouped in classes, e.g. environmental, geo-mechanical, -physical, -chemical, regulatory, etc. and are structured into a hierarchy.

The site selection hierarchy is structured in a way to include all the criteria encompassing different kind of sites, locations, regulatory frameworks, etc.

The hierarchy structure is used to pair compare candidate sites with respect to each individual criterion, by elicitation of expert judgment or by preliminary quantitative evaluations. The expert judgment elicitation can be made in group, and a consensus or a vote by compromise reached, or individually by each expert. The AHP method uses geometric mean to aggregate the individual judgments and assess their dispersion.

Once the process is completed, the method permits to rank the candidate sites and those that do not satisfy pre-established acceptability rules are disqualified. The last step consists in performing sensitivity analyses to isolate the most sensible criteria and support the definition of a roadmap for further characterization work.

A software tool supporting the user in the process for site selection is being developed.

A pre-compiled generic hierarchy of criteria relevant for selecting and ranking sites is submitted to the user. The hierarchy is deployed according to a risk-avoidance principle. The current hierarchy of criteria has been built by relying on the expertise of people with solid background in the relevant sciences and knowledgeable in the carbon capture and storage community, and on the public information available. The structure of the hierarchy is expected to evolve as feedback from field applications, benchmark with other approaches and new knowledge is brought in.

Initial applications carried out on real cases have proven to be quite promising.