GCEP

Global Climate & Energy Project

STANFORD UNIVERSITY

Collaborative Research on Carbon Sequestration in Saline Aquifers in China

Investigators

Dongxiao Zhang (Director), Kristian Jessen, University of Southern California;
Qingdong Cai (Co-Director), Bin Gong, Yi Zheng, Peking University
Yilian Li (Co-Director), Yanxin Wang, Jianmei Cheng, China University of Geosciences-Wuhan

Objective

Three international institutions, Peking University (PKU), China University of Geosciences at Wuhan (CUG), and the University of Southern California (USC), have formed a unique collaboration to address fundamental issues associated with large-scale sequestration of CO_2 in saline formations in China. The collaboration is the first project that systematically investigates the fundamental issues associated with carbon sequestration in saline aquifers in China. If successful, the project will generate a long-lasting effect on Chinese research in geological carbon sequestration, increase the knowledge base, and promote public awareness and acceptance of this viable option for mitigating the effects of greenhouse gas emissions.

Background

Recently China has become the largest emitter of CO_2 due in large part to rapid economic development and the accompanying increase in demand for energy. The Chinese energy feedstock is based on fossil fuels, particularly the wide availability of domestic coal. The transportation and manufacturing sectors also contribute to large amounts of CO_2 emissions. The country has undertaken a variety of efforts aimed at reducing and mitigating greenhouse gas emissions. Some of these efforts and technologies have been widely implemented such as energy efficiency measures, while others require more research and development. Geological carbon sequestration in saline aquifers in China is one area with a large carbon-storage potential and where the research is considered in its infancy.

Approach

The research plan integrates geological modeling, reservoir simulation, and laboratory experiments to identify the appropriate scientific approach for quantifying the storage capacity in these highly complex geological settings. The research effort is divided among three main tasks which are discussed below, to provide a better understanding of carbon storage in saline aquifers in China.

Geology and Hydrogeology: This effort involves a comprehensive review of sedimentary basins in China to examine basin characteristics and their proximity to CO_2 point sources. As a starting point, the proposed research will leverage data from many years of oil and gas exploration that has provided a good understanding of the distribution of geological basins in mainland China as well as in offshore territories (see Figure 1). The major relevant factors to CO_2 storage include the lateral extent and quality of caprocks/seals, the geological and hydrogeological properties of the formations including depth, porosity, permeability, temperature, pressure, and geochemical conditions. Based on this survey and data analysis, up to three aquifer systems/basins will be selected for detailed hydrogeologic, experimental, and modeling studies of CO_2 sequestration processes. This information will expand the understanding of the storage potential in China and reduce the uncertainty of the estimated storage capacity in selected basins.

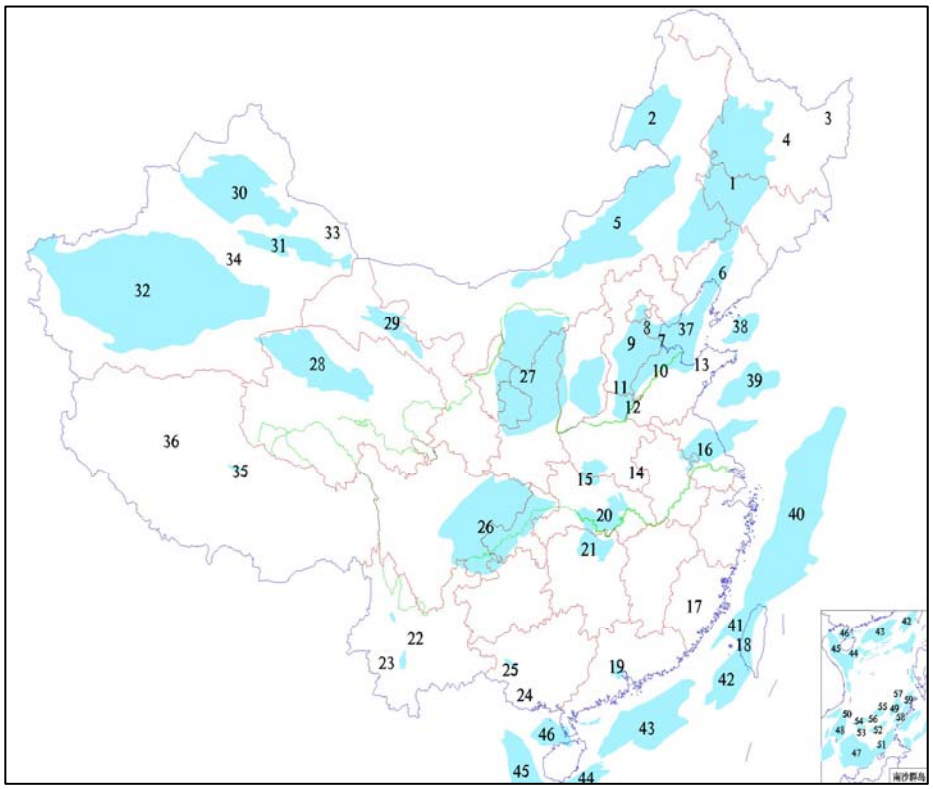

Figure 1: Sedimentary basins in China.

Experimentation: The proposed experiments will identify and measure key parameters affecting the migration and permanent storage of CO_2 in the subsurface. The experiments will be performed on formation or caprock materials from saline aquifers in China. The data will provide direct and region specific inputs for proposed simulation studies. Two types of experimental techniques will be used, flow-through (dynamic) and static (batch). One type of dynamic experiment will form the basis of new models that will describe the transition between the flow during the injection and post-injection periods. Additionally, the impact of CO_2 and brine rock interactions will be investigated in dynamic displacement experiments at aquifer conditions. Finally, static, long-term batch experiments will examine the geochemical reactions in response to CO_2 injection into the aquifer and will quantify the kinetics of mineral dissolution or precipitation in the host environment.

Modeling and Simulation: Models and simulations will incorporate experimental results to develop understanding of the long-term fate of CO_2 in Chinese saline aquifers. The simulations will also identify other important processes that need to be studied with experiments. Microscopic interactions of CO_2, brine, and geological media at the pore-scale will be modeled and simulations at the macroscopic level will be performed to study the behavior of CO_2 and host media when large amounts of CO_2 are stored in the aquifer formations.