8ICEG Invited Lecture

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Invited Lecture Title

Modeling Geological Storage of Carbon Dioxide with a Focus on Leakage

【08:30 - 09:00 , Tuesday 30th Oct. 2018】

Biography

Professor Michael Celia is the Theodora Shelton Pitney Professor of Environmental Studies at Princeton University, where he serves as Director of the Princeton Environmental Institute. He is also a Professor in the Department of Civil and Environmental Engineering. His areas of research include ground-water hydrology, multi-phase flow in porous media, numerical modeling, and subsurface energy systems with a focus on geological sequestration of carbon dioxide and shale-gas systems. The carbon sequestration work is part of a large industry-funded multi-disciplinary effort at Princeton known as the Carbon Mitigation Initiative. Professor Celia served for 10 years as editor of the journal *Advances in Water Resources*. He is a Fellow of the American Geophysical Union (AGU) and the American Association for the Advancement of Science (AAAS) and the recipient of the 2005 AGU Hydrologic Science. He was the 2008 Darcy Lecturer for the National Ground Water Association, and received the 2014 Honorary Lifetime Membership Award from the International Society for Porous Media (Interpore). In 2016 Professor Celia was elected to the U.S. National Academy of Engineering. He has also received several teaching awards, the most recent being the Distinguished Teaching Award from the School of Engineering and Applied Science at Princeton, awarded June 2017.

Abstract

Carbon Capture and Storage, or CCS, is a technology that involves capture of CO_2 from large point sources and subsequent injection of the captured CO_2 into deep geological formations. In order for CCS to be effective, the injected CO_2 must remain in the injection formation for centuries to millennia. One of the most important environmental concerns associated with large-scale CCS is the possible leakage of fluids from the deep injection formation into shallow fresh-water aquifers, which serve as sources of drinking water. Potential leakage pathways include natural or induced fractures and faults, and old abandoned wells drilled for the purpose of oil and gas

exploration and production. Fluid migration along old wells is usually considered to be the highest leakage risk, especially in places like North America where millions of old oil and gas wells are co-located with the best locations for CO_2 injection.

The system involves multi-phase fluid flow in complex rock systems, described by a set of coupled, nonlinear partial differential equations. In this lecture, I will present an overview of the governing equations, and then focus on models we have developed to analyze leakage risks associated CO_2 injection with a specific focus on possible leakage of both CO_2 and displaced brine along old wells. These models use a set of simplifying assumptions, which are appropriate for the underlying physics associated with many injection scenarios. I will also describe several measurement programs that have yielded new data and information about effective hydraulic properties of old wells. Finally, I will combine the modeling and data to provide a quantitative estimate of leakage risks for a specific field site in the Province of Alberta in western Canada. The talk will conclude with brief comments on the future prospects for large-scale CCS and its possible role in a carbon-constrained world.