STATISTICAL PROBABILITY ESTIMATIONS FOR GEOCHEMICAL KINETICS MODELING OF CO_2–WATER–ROCK INTERACTIONS

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ABSTRACT

With global interest in geological storage as a means of mitigating the current practice of venting carbon dioxide (CO_2) emissions to the atmosphere, the need to validate sites with regard to a detailed accounting of stored volumes of injectate becomes increasingly important. Specifically, effective measurement, verification, and accounting (MVA) of carbon capture and storage (CCS) projects will depend upon a thorough understanding of what has been injected and the percentages that reside in the gas phase, that are dissolved within formation waters, or that are physically trapped within the rock matrix as new mineral precipitate. Thus a thorough understanding of geochemical interactions is required to advance our understanding of CCS and develop effective MVA protocols.

At present, many uncertainties exist in the numerical modeling of geochemical kinetics, such as the determination of reactive surface area, quantification of CO_2 reacting with water, the dynamic nature of the process, and many others. As such, this work introduces a range of estimated uncertainty in an effort to provide a numerical estimation for possible outcomes of geochemical interactions among CO_2, water, and reservoir rock. In this work, the conceptual approach for a kinetic modeling analysis is reviewed, and a methodology based on the Fokker–Planck statistical equation is proposed. According to these preliminary considerations, critical variables are identified and determined. Results of this modeling provide a range from the least reactivity to the best reactivity for examined minerals and predict the range of uncertainty that exists in the kinetic modeling based on provided data. This work was performed by the Energy & Environmental Research Center through the Plains CO_2 Reduction Partnership, one of the U.S. Department of Energy's National Energy Technology Laboratory Regional Carbon Sequestration Partnerships.