Determining the intrinsic reactive surface area of minerals and the implications for near-wellbore geochemical reservoir stimulations

SYED ANAS ALI[1], JAY R. BLACK[1] & RALF R. HAESE[1]

[1]Peter Cook Centre for CCS Research, The University of Melbourne, Australia; alis1@student.unimelb.edu.au

Reactive-transport modelling of fluid-rock interactions in a geological reservoir requires site specific surface areas of the rock forming minerals to predict the extent of mineral dissolution and subsequent changes in porosity and permeability. The reactive surface area of minerals is often one of the least well-constrained variables in porous rocks, and therefore introduces a large uncertainty in reactive-transport modelling results. Weathering reaction rates in natural systems have been shown to be orders of magnitude lower than predicted using models involving assumptions in regards to mineral surface area-to-mass ratios [1-2]. The discrepancy has been explained by several reasons including mineral overgrowth, poor pore-to-pore connectivity and a heterogeneous flow fields.

In this project, we conduct core-flooding experiments in order to estimate the intrinsic reactive surface area of quartz, kaolinite and K-bearing mica in a consolidated sandstone core collected from a prospective CO_2 storage site. Our approach is based on the classic reactive-transport equation, far from equilibrium standard mineral dissolution rates as well as the experiment specific fluid residence time and the cation concentrations in the outflow solution. Measurable dissolution of siliciclastic minerals was achieved using injection solutions with pH 2 and pH 11 at 60°C and fluid residence times of up to 10 hours. Our results prove to be reproducible and show a one order of magnitude lower (intrinsic) reactive mineral surface area for quartz, while kaolinite and mica are within the lower range of published surface areas [1-2]. The results will be applied in reactive-transport simulations near the well-bore of a prospective CO_2 storage reservoir to determine whether CO_2 injectivity can be improved through geochemical reservoir stimulation.

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