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# Geochemical reactivity assessment of Serra Geral Group basalts under regionally relevant $CO_2$ injection conditions: an integrated experimental and geochemical modelling approach

JOÃO PEDRO ZIELINSKI[1], **STEPHANIE CARVALHO DA SILVA**[1], RAFAEL BRAGA[1], RODRIGO SEBASTIAN IGLESIAS[2], ERICO A. DOS SANTOS[1], WILLIAM J. FUCKS[1], ANTONIO R. G. OLIVEIRA[1], MELLANYE F. GRAF[1], VICTOR HUGO J. M. DOS SANTOS[1], CASSIANE NUNES[3] AND LEONILDES SOARES DE MELO FILHO[3]

[1]Institute of Petroleum and Natural Resources (IPR)-PUCRS
[2]Escola Politécnica – PUCRS - Pontifícia Universidade Católica do Rio Grande do Sul
[3]Repsol Sinopec Brasil (RSB)

Subsurface $CO_2$ mineralization in mafic volcanic rocks is an important alternative for permanent Carbon Capture and Storage (CCS). In South America, the Serra Geral Group (SGG), within the Paraná–Etendeka Large Igneous Province (PE-LIP), represents a major continental flood basalt province with significant potential for in situ $CO_2$ mineralization. However, uncertainties remain regarding the effective geochemical reactivity of these volcanic rocks under reservoir conditions expected to be found in the region (which is geothermally cold). To address this gap, a series of laboratory batch-reactor experiments coupled with numerical simulations are being conducted on representative SGG samples selected to reflect the mineralogical and textural variability of distinct lava flow lithofacies of the SGG. Experiments were performed under conditions of 40 °C and $pCO_2$ of 50 bar using an alkaline synthetic groundwater representative of deeper reservoir conditions (>900 m), with reaction times of up to 90 days. The experiments revealed rapid early-stage chemical changes followed by progressive stabilization towards quasi–steady-state conditions, providing constraints on dissolution behavior over time. BET-normalized silicon release rates (mol/m$^2$/s) indicated that the reactivity of SGG basalts is of the same order of magnitude as that of the Columbia River Basalt Group and altered Icelandic basalts, reflecting the role that both crystalline (mainly plagioclase and pyroxene) and secondarily formed phases (calcite, zeolites, and clay minerals) might play in this geochemically altered province. Complementary to the experimental study, geochemical modelling of the fluid-rock interaction kinetics (dissolution and precipitation) is currently underway to investigate the temporal evolution of fluid composition using the PHREEQC software and the Kinec_v3_4.dat thermodynamic database. Initial simulation results show trends consistent with the experimentally observed progressive evolution of fluid composition and its stabilization toward quasi–steady-state conditions in the batch-reactor experiments. Variability among simulations indicates that the specific surface area assigned to primary minerals, as well as the nature of the secondary mineral phases involved, exerts a strong control on the model outcomes. Although still under development, this integrated approach provides a valuable framework for evaluating modelling parameters and offers insights into the potential for $CO_2$ mineralization in SGG basalts.