Contribution ID: **80**

Type: **Oral Presentation**

Strategies for overcoming the challenge of gigaton-per-year basalt carbonation

Thursday, 22 May 2025 09:05 (15 minutes)

Basalt carbonation has gained traction as a large-capacity technique to manage atmospheric carbon dioxide (CO_2) concentrations and potentially avoid the most dramatic impacts of climate change. Yet, while several successful injection operations have demonstrated the efficacy of this technique at the scale of thousands of tons of CO_2 injected per year, achieving the necessary impact on atmospheric CO_2 concentrations will require expansion to the gigaton-per-year scale. However, implementing basalt carbonation at this scale will face important geochemical and hydrogeological challenges. At the gigaton-per-year scale, maximizing per-well CO_2 injection rates will likely involve injecting CO_2 in a supercritical, rather than dissolved, state, which will, in turn, lead to less efficient basalt carbonation (Tutolo et al., 2021). To combat this challenge, we are exploring alternative injection strategies, including Water-Alternating-Gas injection (Awolayo et al., 2025), which will enhance in-situ CO_2 dissolution, as well as an acid pretreatment step that will enhance cation extraction from the basalt prior to, or alongside, CO_2 injection (Zhang et al., 2024). Moreover, sub-optimal –in terms of lower reactivity, and non-ideal permeability and porosity –basaltic aquifers will need to be exploited to help us achieve gigaton-scale basalt carbonation. To explore methods for combatting these challenges, we are examining their effects using a combined experimental and reactive transport modeling approach. Our initial laboratory experiments indicate decreased reactivity of altered, lower-reactivity basalts relative to pristine and/or glassy basaltic counterparts. However, our simulations incorporating hydrogeologic heterogeneity indicate that heterogeneous aquifer permeability and porosity tend to increase rates of mineralization relative to simulations incorporating idealized isotropic, homogenous aquifers. Finally, we are exploring the possibility that the acid pretreatment step utilized to enhance cation release may also enhance permeability and pore connectivity in tight aquifers. Ultimately, our results indicate that achieving the substantial promise of basalt carbonation as a climate change solution will require innovative solutions to a wide variety of challenges not generally investigated in existing laboratory and field-scale studies.

Country

Canada

Acceptance of the Terms & Conditions

Click here to agree

Student Awards

Water & Porous Media Focused Abstracts

This abstract is related to Water

References

Primary author: TUTOLO, Benjamin

Co-authors: AWOLAYO, Adedapo (McMaster University); HWANG, Bohyun (University of Calgary); TIAN, Jianwei (McMaster University); BARTELS, Madeline (University of Calgary); EISAMAN, Matthew (Yale University); ZHANG, Qin (TU Delft)

Presenter: TUTOLO, Benjamin

Session Classification: MS25

Track Classification: (MS25) Advances in Carbon Mineralization: Unveiling Multiscale Geo-processes and Coupled Mechanisms