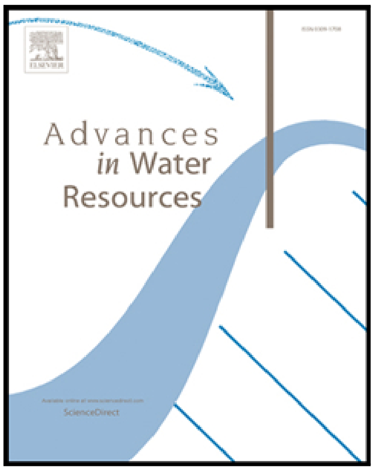
Accepted Manuscript



Multimodal imaging and stochastic percolation simulation for improved quantification of effective porosity and surface area in vesicular basalt

Christopher Zahasky, Dana Thomas, Juerg Matter, Kate Maher, Sally M. Benson

PII: S0309-1708(18)30555-4
DOI: https://doi.org/10.1016/j.advwatres.2018.08.009
Reference: ADWR 3182

To appear in: *Advances in Water Resources*

Received date: 27 June 2018
Revised date: 14 August 2018
Accepted date: 14 August 2018

Please cite this article as: Christopher Zahasky, Dana Thomas, Juerg Matter, Kate Maher, Sally M. Benson, Multimodal imaging and stochastic percolation simulation for improved quantification of effective porosity and surface area in vesicular basalt, *Advances in Water Resources* (2018), doi: https://doi.org/10.1016/j.advwatres.2018.08.009

Multimodal imaging and stochastic percolation simulation for improved quantification of effective porosity and surface area in vesicular basalt

Christopher Zahasky[a,*], Dana Thomas[b,c], Juerg Matter[d,e], Kate Maher[f], Sally M. Benson[a]

[a]Department of Energy Resources Engineering, Stanford University, Stanford, CA
[b]Department of Geological Sciences, Stanford University, Stanford, CA
[c]now at the Jackson School of Geosciences, University of Texas at Austin, Austin, TX
[d]Department of Ocean and Earth Science, University of Southampton, Southampton, UK
[e]Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY
[f]Department of Earth System Science, Stanford University, Stanford, CA

Abstract

Improved methods for predicting fluid transport and vesicle connectivity in heterogeneous basalts are critical for determining the long-term reaction and trapping behavior of sequestered carbon dioxide and maximizing the efficiency of geothermal energy production. In this study we measured vesicle geometry, pore connectivity, and vesicle surface area of three basalt cores from the CarbFix carbon storage project in Iceland using a combination of micro-computed tomography, clinical computed tomography, and micro-positron emission tomography. A vesicle percolation simulator was then constructed to quantify vesicle connectivity across a complete range of porosities, pore size distributions, and microporosity conditions. Percolation simulations that incorporate important geologic features such as microporosity are able to describe the trend of experimental measurements made in this study and in previous work, without relying on statistical or empirical techniques. Simulation results highlight and quantify the trade-off between storage capacity and reactive surface area in high porosity basalts. Experiment and simulation results also indicate that there is very limited connected pore space below total porosity values of 15%, guiding improved site selection for large scale CO_2 storage projects. Use of this stochastic percolation simulation method for basalt storage reservoir evaluation will enable more accurate storage capacity and mineral trapping estimates.

Keywords: carbon capture and storage; geothermal energy; positron emission tomography; effective porosity; micro-CT; percolation simulation

*Corresponding author: zahasky@stanford.edu