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Quantification of the impact of acidified brine on fracture-matrix transport in a naturally fractured shale using in situ imaging and modeling

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Understanding flow, transport, chemical reactions, and hydro-mechanical processes in fractured geologic materials is key for optimizing a range of subsurface processes including carbon dioxide and hydrogen storage, unconventional energy resource extraction, and geothermal energy recovery. Flow and transport processes in naturally fractured shale rocks have been challenging to characterize due to experimental complexity and the multiscale nature of quantifying exchange between micrometer-scale fractures and nanometer-scale pores. In this study, we use positron emission tomography (PET) to image the transport of a conservative tracer in a naturally fractured Wolfcamp shale core before and after exposure of the core to low pH brine conditions. Image-based experimental observations are interpreted by fitting an analytical transport model to every fracture-containing voxel in the core. Results of this analysis indicate subtle increases in matrix diffusivity and a strong reduction in fracture dispersivity following exposure to low pH conditions. These observations are supported by a multi-component reactive transport model that indicates the capacity for a 10% increase in porosity at the fracture-matrix interface over the duration of the low pH brine injection experiment. This porosity enhancement is the result of exposure of carbonate minerals in the shale matrix to low pH conditions. This workflow represents a new direct approach for quantifying fracture-matrix transport processes and provides a foundation for future work to better understand the role of coupled transport, reaction, and mechanical processes in naturally fractured rocks.

Participation

In-Person

References

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