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Geologic Control on Noble Gas Migration

An important component of monitoring underground nuclear explosions is a realistic understanding of the non-prompt post-detonation processes and changes in the environment that produce observable physical and radio-chemical signatures. As such, the material and fracture properties that are brought to bear on noble gas migration within various lithologies is essential. Here we present an empirical methodology to measure noble gas breakthrough on tuffs and rhyolitic lavas. Gas concentration curves are compared with microfracture networks analyzed by microscopy and computed tomography (CT). After release upstream from the sample, a quadrupole mass spectrometer is used to measure nitrogen, argon, xenon, and sulfur-hexafluoride downstream of the sample in real time, allowing the time-series arrival curves for each gas to be determined for each sample. Along with comprehensive material and fracture property analyses, the parameters derived from noble gas experiments will provide invaluable insight into the three-dimensional structure of damage zones, the production of temporally variable signatures and the methods to best detect underground nuclear explosion signatures. Finally, this work provides critical information for predictive modeling capabilities.

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