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Changes in Radioxenon Isotope Activity Ratios During Subsurface Transport

Atmospheric concentrations of radioxenons 135Xe, 133mXe, 133Xe and 131mXe can be used to discriminate between civilian releases and nuclear explosion sources. It is based on the isotopic activity ratio method. It is not clear whether subsurface migration of radioxenons, with eventual release into the atmosphere, can affect the activity ratios due to fractionation. Fractionation can be caused by different diffusivities due to mass differences between radioxenons. Barometric pumping causes an oscillatoric flow in upward trending fractures which, combined with diffusion into the porous matrix, leads to a net transport of gaseous components. Species transport has been widely studied with different numerical codes. However, transport in the post-detonation regime is still neglected in the literature. We use a general purpose reservoir simulator (Complex System Modelling Platform, CSMP++), specifically designed to account for structurally complex geologic situation of fractured, porous media. Parabolic differential equations are solved by a continuous Galerkin finite-element method, hyperbolic differential equations by a complementary finite volume method. The parabolic and hyperbolic problem can be solved separately using the operator-splitting method. This study examines fractionation of 135Xe, 133mXe, 133Xe, 131mXe during barometric pumping-driven subsurface migration, which can affect surface arrival times and isotopic activity ratios.

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