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^{222}Rn and ^{220}Rn emanations as a function of the absorbed α-doses from select metamict minerals†

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Abstract

Metamict minerals contain uranium and thorium, which contribute to physical degradation or metamictization of their crystal structures over geologic time. The damage occurs primarily through progressive overlapping recoil nuclei collision cascades from α-decay of ^{238}U, ^{232}Th, ^{235}U, and their daughter products. We measured ^{222}Rn and ^{220}Rn emanations from metamict samples of nine oxides (brannerite, davidite, fergusonites, pyrochlores, samarskites, and uraninite), two phosphates (monazites), and eight silicates (cerite, gadolinites, perrierite, rinkite, thorite, turkestanite, and vesuvianite). The total absorbed α-doses ranged from 1.4×10^{15} to 6.1×10^{18} α-decay mg^{-1} for cerite and uraninite, respectively. The ^{222}Rn emanation coefficients varied from 5×10^{-5}% (uraninite) to 2.5% (turkestanite). The ^{220}Rn emanation coefficients varied from 7×10^{-3}% (gadolinite Ytterby) to 6.2% (gadolinite Marysin). The lowest ^{222}Rn emanation coefficients occurred among metamict minerals containing the highest concentrations of ^{238}U (i.e., uraninite, samarskites, and brannerite). Overall, the ^{222}Rn and ^{220}Rn emanation coefficients observed in this study fall significantly below previously reported values.

Keywords: Metamict minerals, radon and thoron, emanation coefficients, emission rates, alfa doses