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# Isothermal recrystallization of fully metamict gadolinite ($REEFe^{2+}Be_2Si_2O_{10}$) in argon studied using $^{57}$Fe Mössbauer spectroscopy

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This study used $^{57}$Fe Mössbauer spectroscopy to track the annealing process for isothermal recrystallization of fully metamict gadolinite ($REEFe^{2+}Be_2Si_2O_{10}$) dated at 1795 Ma in argon at 973 and 1373 K. Ternary solid solutions of gadolinite ($REEFe^{2+}Be_2Si_2O_{10}$), calciogadolinite ($CaREE_2Fe^{3+}Be_2Si_2O_{10}$) and hingganite ($REE_2H_2Be_2Si_2O_{10}$), where REE means rare earth elements and yttrium, are collectively named gadolinites [1]. Radioactive elements in metamict minerals damage crystal structure primarily due to recoil nuclei from a-decay of $^{238}$U, $^{232}$Th, $^{235}$U, and their daughter products. Metamict minerals are widely used in geochronology and can serve as natural analogues for the study of radiation effects in high-level nuclear waste (HLW). Changes in the $^{57}$Fe Mössbauer parameters vs. annealing temperature are sensitive indicators of the thermal recrystallization and can be used to determine activation energy for recrystallization [2]. The activation energy $E_A$ å 2 eV for recrystallization was determined based on the model of radiation damage in solid state nuclear track detectors (SSNTD) [3]. The measurements show that for isothermal annealing at 973 K, recrystallization occurs after 384 h, while for heating at 1373 K, complete recrystallization occurs after three minutes.

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[2] Malczewski et al. (2020) *J. Geosci*, **65**, 37-44.

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