Geophysical Research Abstracts, Vol. 9, 00701, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-00701

Examination of natural and synthetic minerals as matrices for actinide waste immobilization

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The key issue for economically reliable and ecologically safe solution of the problem of actinide-containing radioactive wastes disposal is immobilization of the most dangerous long-lived transuranic actinides (Np, Pu, Am) in highly durable containment matrices (waste forms). Possibility of this way for actinide waste streams management is confirmed with results on study of their natural analogs – such as radioactive minerals with high contents of Th, U, and REEs – actinides imitators (zirconolite, pyrochlore, britholite). In spite of these minerals were subjected to irradiation due to actinides decay and interaction with underground waters for a very long period of time (millions of years) they have demonstrated a strong retardation of these elements in their structure. Main requirements applied at appropriate actinide waste forms selection include: high isomorphic capacity in respect of radioactive waste components, resistance to radiation damage and corrosion by hot water solution, and possibility for economically efficient industrial-scale fabrication. In this presentation we have discussed structural-chemical properties and the behavior under irradiation and underground water attack for minerals of pyrochlore, zirconolite and britholite groups. These minerals are considered to be the perspective host phases for long-term actinide immobilization. Besides, peculiarities of some synthetic compounds doped with actinides are also characterized. Main attention is paid to the phases with garnet and murataite structure that have no radioactive minerals – analogs in the nature. The data were obtained with different analytical techniques: XRD, SEM/EDS, TEM (HRTEM), XPS. Results of the research show that safe immobilization of actinides may be provided with optimal selection of the containment matrices only. This work was supported by the Russian Foundation for Basic Research (project 05-05-64005) and US Department of Energy (RUC2-20009-MO-04).