Phases relationships in the actinide waste forms with a garnet structure

T.S. LIVSHITS AND S.V. YUDINTSEV

Institute of Geology of Ore Deposits, Moscow, Russia (lita_239@yahoo.com)

Complex oxides with a garnet-type structure (sp. gr. *Ia3d*) are suggested for long-lived actinide waste immobilization (Yudintsev *et al*, 2007). Three cationic sites in the structure provide for simultaneous incorporation of actinides and other elements into lattice. The highest actinide content (30 wt.%) was found in the ferrate garnet, where the “B” and “X” sites are filled in Fe^{3+}. General formulae of the phases corresponds to $^{VIII}A_3{}^{VI}B_2{}^{IV}X_3O_{12}$, where “A” = Ca^{2+}, $REE^{3+/4+}$, $An^{3+/4+}$; “B” = An^{4+}, Zr^{4+}, Fe^{3+}; “X” = Fe^{3+}. We have summarized data on the phases relations and compositions in ceramics of the garnet stoichiometry doped with typical impurities of actinide waste (Na, Al, Cr, Mn, Ni, Si, Zr). 50 samples were produced by cold pressing and sintering method at 1300–1500 ^{o}C and examined with XRD and SEM/EDS. Temperature in this range has a little effect on the phases composition. Addition of Al and especially Si reduced actinides solubility in the garnet structure resulting in appearance of actinide oxide (Fig.1). Na and Si in precursor leads to decreasing of melting point and formation of glass. High corrosion products (Cr, Ni) content in the initial mixture resulted in appearance of spinel. This work was supported by the Russian Foundation for Basic Research (project 05-05-64005) and the U.S. DOE.

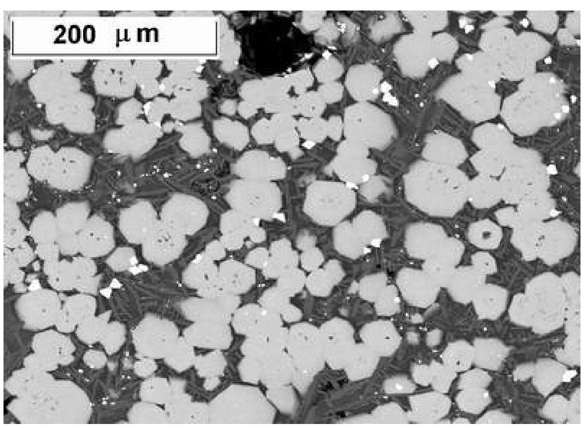

Figure 1: Formation of ThO_2 (white) in garnet-based (gray) sample as result of addition of silica into the initial batch.

Reference

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LAM ICP study of cloudy diamonds: Implications for diamond formation

A.M. LOGVINOVA, I.V. ASHCHEPKOV AND S.V. PALESSKY

IGM SB RAS, Novosibirsk, Russia (logv@uiggm.nsc.ru)

Cloudy centers of octahedral diamonds from the Internationalnaya and Yubileynaya Mines (Yakutia) have been studied by LAM ICP. They are abundant in nanometic melt-inclusions, consist of multi-phase assemblages (silicates, oxides, carbonates, sulfides, brine and fluid bubbles) (Logvinova *et al*., 2006). The centers (dark zone) of the cloudy area show the increase of TRE content of two orders of magnitude comparing to the clear periphery (Diamond 1). Abundance of TRE and La/Yb_n ratios are close to those of kimberlite melts. Two-folded REE patterns are indicative of multistage melt percolations. The light matter often reveal Y dips common for diamonds. Diamond 2 shows Ta, Nb, Zr, Hf peaks typical of picroilmtnites. Inclined REE for centers may suppose crystallization of protokimberlite melts. Multiplied zonation and polymict inclusions in many diamonds suggest a complex model for diamond growth near protokimberlite magmatic systems at which the evolved ultramafic melts splite to form sulfide, silicate and carbonate liquids during the cooling when they interact with surrounding peridotites and eclogites. The TRE patterns show mixed sulfide (Pb, Cu) and silicate melts signatures differing from spongier (Rege *et al*., 2003) and coated diamonds (Afanasiev *et al*., 2005). The abundance of Ba, U, Pb, high Cu/Ni ratio and Eu anomalies may suggest admixture of subduction components from the wall rock eclogites.

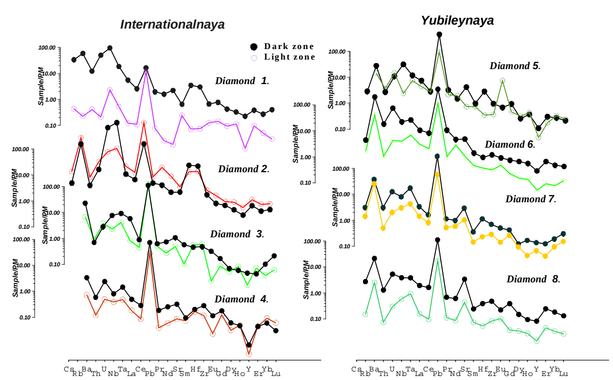

Figure 1. Trace element pattern for dark and light zones from cloudy diamonds.

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