# Crystallization behavior of iron- and boron-containing nepheline based glasses: Implications for the performance of high level nuclear waste glasses

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**Abstract**

The present study focuses on understanding the compositional and environmental dependence of iron redox in nepheline-based simplified, inactive high-level nuclear waste glasses designed in the quinary Na2O–Al2O3–B2O3–Fe2O3–SiO2 system. The impact of composition and different heating environments (air, inert and reducing) on the crystallization behavior and iron redox chemistry of glasses have been investigated using X-ray diffraction, electron microscopy, Mössbauer spectroscopy and vibrating sample magnetometry. The results indicate that while iron coordination changed as a function of glass chemistry, the heating atmosphere exhibited a minimal effect on the redox behavior in the glass-ceramics, thus leading to a minimal impact on the crystalline phase assemblage. However, the heating atmosphere had a significant impact on the microstructural evolution of these glasses as the formation of an iron-rich layer of crystals on the surface of the glass-ceramics was observed when heated in air or inert atmospheres. Details of these results, along with an explanation on the basis of diffusion kinetics of oxygen and network modifiers in glasses, and the plausible implications on the chemical durability of high-level nuclear waste glasses will be discussed in the presentation.

**Keywords:** nepheline, nuclear waste glass, crystallization, iron

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