Automated mineral analysis of mineral concentrates from a carbonatite REE mineral resource, Fen Complex, Norway

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The Fen Complex in Southern Norway is a c. 580 Ma igneous complex consisting of ultramafic lamprophyres, highly alkaline silicate rocks, and carbonatites. It is world famous for being the type locality for a variety of rare and rather exotic rock types (e.g., Sövite, Damtjernite, Fennite). Some of the carbonatites contain high concentrations of Rare Earth Elements (REE) and are therefore the focus of a recent exploration campaign. However, whole rock concentrations of Th are high, which provides an environmental obstacle for exploitation at present. The first metallurgical tests on grab samples produced a rougher flotation concentrate of a complex mineral assemblage. We have used advanced electron microscopy techniques to characterize these mineral concentrates in terms of modal composition, mineral associations and REE-mineral liberation, in order to optimize the recovery and grade of the REE in the mineral concentrate. In total 5 samples of rougher flotation concentrate were studied in detail with a FEG Scanning Electron Microscope with a fast SDD EDS detector using the Oxford Instrument programs Aztec and INCA Feature. We have found that careful mineralogical and textural SEM analysis of large polyphase particles provide a clear picture of the textures and associations of REE-minerals in the host rock, and allow to distinguish multiple phases of formation of (REE, Th)-fluorcarbonates and (REE, Th)-bearing monazite, as well as discrete Th-rich minerals. The INCA automated mineralogy system was used in order to determine grain size distribution and liberation of >20,000 REE-minerals, REE-bearing minerals and non-REE minerals in the rougher flotation concentrate. This information can be used in the future to improve the beneficiation processes of REE, and for mitigation of the environmental impact of Th-rich phases in the Fen Complex REE-ores. This study also provides a compelling case for the use of quantitative automated mineral analysis in mineral exploration and mineral processing.