Analysis of Ethiopian Li and rare metal ores by ToF-ERDA and PIXE

J. Dobrovodský[1], G. G. Berhe[2], P. Noga[1]

[1] Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, Advanced Technologies Research Institute, Trnava, Slovakia
[2]Mekelle University, Mekelle, Ethiopia

The development of renewable and new generation nuclear energy sources and the special high-strength materials increases the demand for the availability of some rare elements. Methods such as AAS, XRF, ICP-OES, ICP-MS, but also PIXE, etc. are usually used for the chemical analysis of the relevant ores. In the project "Assessment of extraction and refining of Li, Nb, Ta and U from Ethiopian Kenticha Spodumene Ore" we focused on the quantification of the elements present in the samples of powder ores using a combination of the methods Time-of-Flight Elastic Recoil Detection Analysis (ToF-ERDA) and Proton Induced X-ray Emission (PIXE) [1,2].
ToF-ERDA provides analysis of all elements from hydrogen to uranium with the sensitivity of the order of 0.02 at. %. For the ToF-ERDA analysis, a 45 MeV Au8+ analyzing beam and POTKU [3] evaluation program were used. Since most of the ore material consisted of elements lighter than Si, which PIXE “does not see”, matrix data of samples from ToF-ERDA measurements were used for the correct quantification of heavy elements from PIXE measurements. As ToF-ERDA is considered as absolute method, no reference calibration samples are required. For PIXE analysis a 3.5 MeV H+ ion beam and normal incident were used to optimize the sensitivity of PIXE analysis and the GUPIXWIN analysis program [4] for evaluation.
The presented results of elemental analysis of selected ore samples allow us to assess the achieved sensitivity of our ToF-ERDA and PIXE setups.

References:
[1] Dobrovodský J; Beňo M; Vaňa D; Bezák P; Noga P 2019 Nucl. Instr. Meth. Phys. Res. B 450 168.
[2] Jozef Dobrovodský; Dušan Vaňa; Filip Ferenčík; Zoltán Száraz, AIP Conf. Proc. 3251, 080008 (2024), https://doi.org/10.1063/5.0235389.
[3] K. Arstila, J. Julin, M. Laitinen, J. Aalto, T. Konu, S. Kärkkäinen, S. Rahkonen, M. Raunio, J. Itkonen, J. P. Santanen, T. Tuovinen, T. Sajavaara, Nucl. Instr. Methods Phys. Res. B 331, 34-41, (2014).
[4] Campbell J L, Cureatz D J T, Flannigan E L, Heirwegh C M, Maxwell J A, Russell J L, Taylor S M 2021 Nucl. Instr. Methods Phys. Res. B 499 77-88.