Distribution and origin of naturally occurring radioactive materials (NORMs) in mylonitic rocks of north Abu Rusheid, Eastern Desert, Egypt

Sara Sakr[1,2,*], Kazumasa Inoue[1], Sarata Kumar Sahoo[1,2]

[1]Tokyo Metropolitan University, 7 - 2- 10 Higashiogu, Arakawa-Ku, Tokyo 116 - 8551, Japan

[2]National Institutes for Quantum Sciences and Technology (QST), 4 - 9- 1 Anagawa, Inage-Ku, Chiba 263 - 8555, Japan

[*]Email: 22997706@ed.tmu.ac.jp

Abstract

Mylonitic rocks in north Abu Rusheid, Eastern Desert of Egypt, are rich with naturally occurring radioactive materials (NORMs). Uranium (U) and thorium (Th) decay series are widely considered as NORMs, with more abundance in the Earth's crust. NORMs may become concentrated through industrial processes such as niobium (Nb) and tantalum (Ta) extraction, zircon and zirconia, metal production, and mining of uranium ore. This study investigated the distribution and mineralogical hosts of NORMs in mylonitic rocks from North Abu Rusheid, located in Egypt's mineral-rich Arabian-Nubian Shield. Thirty samples were collected from three trenches (TA, TB, and TC) to measure trace element concentrations using inductively coupled plasma mass spectrometry (ICP-MS). Mineralogical studies were conducted using heavy liquid separation and environmental scanning electron microscopy (ESEM) with EDX to identify minerals. Results indicated significantly elevated concentrations of refractory elements such as Nb (up to 1322 μg g^{-1}), Ta (up to 252 μg g^{-1}), Zr (up to 1901 μg g^{-1}), U (up to 171 μg g^{-1}), and Th (up to 454 μg g^{-1}) were higher than upper continental crust values. Metal concentrations such as Sn were (up to 136 μg g^{-1}), Zn (up to 574 μg g^{-1}), and Pb (up to 771 μg g^{-1}). The minerals identified in this study include columbite (host to Nb, Ta, and U), zircon (Zr-rich), cassiterite (Sn-rich), and uranothorite (a radioactive mineral containing both U and Th). The spatial distribution and mineralogical associations suggest a common origin for U and Th, with notable implications for radiological protection in potential mining activities. This research highlights the need for risk assessment and management strategies for radiation exposure in future resource exploitation in the North Abu Rusheid area. These findings will support safe practices in mineral extraction industries.