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REE-Enriched Migmatites and Gneisses of the Son Valley Crystalline Area Sonbhadra, Uttar Pradesh: Can it be a Potential REE Deposit in India?

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Rare earth elements (REEs) are critical for many contemporary technologies, including electronics, renewable energy, and defense application. However, the supply chain for REEs is frequently intricate and influenced by geopolitical and commercial issues. In the present study, we investigated the migmatite and gneisses of different parts of the Son Valley Crystalline (SVC) area for its REE potential. The study area is part of the Chhotanagpur Granite Gneissic Complex (CGGC), which is exposed along Son Valley in the Sonbhadra district of Uttar Pradesh, India. The area is highly deformed and metamorphosed. Petrography of migmatite and gneiss from the Kudri, Jarha, Barwatola, and Jaurahi areas was carried out. It shows a higher concentration of REE-bearing phases viz. zircon, apatite, titanite, monazite, and at times xenotime, and garnet. The REE-bearing phases, particularly zircon, monazite, and xenotime were found as inclusions within biotite, whereas apatite and titanite were found exclusively as inclusions within feldspar. To quantify rare earth oxide (REO) concentration, we did an electron probe microanalysis of REE-bearing phases such as apatite, titanite, monazite, and xenotime. The mineral chemistry of these phases reveals a higher concentration of total rare earth oxides (TREO; 0.84-1.91%, av. 1.37%) and monazite with TREO (44.54-68.51%, av. 58.98%). This study highlights the potential of REE mineralization in the SVC area, which warrants a detailed exploration. The chemical age of monazite from Kudri migmatite is 799 to 1056 Ma, av. 928 Ma (n=10), and Jarha gneiss is 837 to 1339 Ma, av. 1088 Ma (n=13). These chemical ages of monazite show its origin from Mesoproterozoic to Neoproterozoic age, which is a quite lot of variation in the formation age. Considering the total REE contents and abundance of REE-bearing minerals, SVC has huge potential to host REE reserves. However, rigorous geological and exploration studies are warranted.