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Geochemical and REE Mineral Composition of the Rairakhol Alkaline Complex, Odisha, India

Alkaline igneous-associated rare earth element (REE) deposits represent a significant global economic source of REE. One such example is the nepheline syenite rocks in the Rairakhol area, the largest alkaline complex in western Odisha, which occurs in the northern part of the Eastern Ghats Mobile Belt (EGMB). The nepheline syenite rocks from the Rairakhol alkaline complex in western Odisha have been studied for their mineralogy, petrography, and geochemical properties using XRD, XRF, optical microscopy, ICP-OES, SEM, and EPMA techniques. This study shows that the rocks are composed of hornblende, microcline, albite, orthoclase, biotite, and nepheline as major mineral phases along with calcite, zircon, sphene, apatite, pyrrhotite, magnetite, and ilmenite as the accessory mineral phases. The nepheline syenites have a composition of low SiO₂, high MgO, Fe₂O₃, and CaO, with moderate to low Al₂O₃, Na₂O, and K₂O. These rocks are metaluminous to peraluminous, exhibiting a miaskitic nature. The total REE content is 630 ppm, with an average LREE/HREE ratio of 6.2 and REE-bearing mineral phases identified include apatite, zircon, sphene, allanite, britholite which are rich in Ce, Nd, La, and Pr. Mineral chemistry data shows that the nepheline syenite rocks exhibit high concentrations of Sr (160–1200 ppm) and Ba (640–5000 ppm), with notable anomalies in these elements, alongside significant depletion in P, Zr, and Ti, as well as mild depletion in Th. In contrast, the rocks show elevated Rb, Sr, and Ba abundances, suggesting enriched concentrations relative to typical nepheline syenites. These mineralogical characteristics indicate that the rocks were formed by complex geochemical processes.

Keywords: Nepheline syenite, Rare Earth Elements, Alkaline igneous rocks, REE-bearing minerals

Biography

I am Nikita Ram, born on 13th November 1996 in India. I am currently a Senior Research Fellow at CSIR-IMMT Bhubaneswar, one of the AcSIR labs in India, and a joint PhD candidate at RMIT University Melbourne Australia. I was enrolled PhD in 2021. The topic of research work is the potential of rare earth elements in India. I have completed the primary characterization of nepheline syenite rocks which is the source rock for REE. Currently, I am working on the geochemical characterization of nepheline syenite rocks and the dating of zircon grains at RMIT University.