

Alkaline Magmatism in the Adang Volcanic Complex, Mamuju District (Western Sulawesi, Indonesia): A Preliminary Study on Rare Earth Elements Enrichment

Fadlin Fadlin¹, Renaldi Suhendral², Godang Shaban³, Muhammad Rayyan¹, FX Anjar Laksono⁴

¹Geological Engineering Department, Jenderal Soedirman University, Purwokerto, Indonesia,

²Research Center for Geological Resources, National Research and Innovation Agency, Bandung, Indonesia, ³Independent Geochemist, Geochemistry Tectonic Modelling and REE Researcher, Jakarta, Indonesia, ⁴Doctoral School of Earth Sciences, University of Pécs, Pecs, Hungary

Alkaline igneous rocks are one of the major sources of rare earth elements (REEs). The largest REE deposits are primarily discovered in alkaline rocks and carbonatites (e.g., Bayan Obo, China; Mountpass, California; Mountweld, Australia), which typically form in post-collisional and continental rift-related tectonic environments. The Adang Volcanics is one of the uncommon volcanic systems that resulted from continental extensional settings, composed of mafic alkaline rocks, which have alkalinity ranging from ultrapotassic to sodic and have not been explored for their relationship to the enrichment of REEs. This study investigates the processes behind the formation of the Adang volcanic rocks and their role in REE concentration. Multiple analytical methods were used in this study, including Petrography, XRD, SEM-EDS, XRF, and ICP-MS. The results of petrographic observation show that the samples are mostly composed of leucite-bearing minerals characterized by textures such as trapezohedral and skeletal forms. The whole-rock geochemistry data indicate that the Adang Volcanic developed in within-plate continental extension, which magmatism is derived from decompression of the enriched SCLM [characterized by $\text{TiO}_2 > (-1.1610 + 0.1935 \times \text{Al}_2\text{O}_3)$] and in certain zones appears to have involved the post-collisional environment. The metasomatism processes have substituted the leucite (KAlSi_2O_6) with analcime ($(\text{NaAlSi}_2\text{O}_6\text{H}_2\text{O})$), resulting in a reduction of potassium and other mobile elements, including REEs. The magmatism resulted from the enriched SCLM, which has auto-generated the higher Th/Nb, Th/La, and Th/Ce ratios. The alkaline rocks of Adang Volcanic have a high REE content, with total REE (TRE+Y) ranging from 1069.2 to 1454.7 ppm, compared to the concentration of the REEs in the Earth's crust, which ranges from around 130 to 240 ppm. The enrichment of REEs in this formation is driven by metasomatism processes and secondary upgrading through hydrothermal alterations, which are embedded in REEs-bearing minerals (e.g., Florencite (La-Ce-Th), Loparite (La-Ce-Th), and Johnsenite (Ce-Th)).