

Mineralogy and Geochemistry of Mud Volcano Deposits across Java Island, Indonesia: A New Potential Source of Lithium?

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Global demand for critical elements has increased sharply in recent years, particularly for lithium, which is a key component of electric vehicle batteries. In Indonesia, the potential for lithium remains largely underexplored, although previous studies have suggested enrichment in geothermal brines and mud volcano deposits. However, detailed characterization of lithium enrichment has only been reported geothermal brines. This study presents the mineralogical and geochemical characterization of the Ciuyah mud volcano and compares it with other mud volcanoes across Java Island, Indonesia. Mineralogically, the mud samples are predominantly composed of clay minerals, including kaolinite, illite, smectite, and vermiculite, with minor amounts of quartz, calcite, aragonite and pyrite. Geochemically, most mud volcano deposits are enriched in Al_2O_3 , whereas samples from Ciuyah and Sangiran show greater enrichment in CaO. Lithium concentrations in the Ciuyah mud deposits ranges from 54.5 to 102.9 ppm, which is comparable to other deposits in the region. The geochemical data further suggest two provenance end-members for mud volcanoes across Java: (i) sedimentary-dominated and (ii) volcanic-dominated sources; however, this distinction does not appear to control the lithium concentration. On PAAS-normalized spider diagrams, mud volcano deposits across Java exhibit relatively flat REE patterns with positive Eu anomalies, reflecting the influence of hydrothermal fluids. Additionally, the Ciuyah mud samples display distinctive positive Nd and negative Ho anomalies relative to other locations. Given the abundance of clay minerals as the main component of the mud samples, we hypothesize that lithium-bearing phases are associated with the clay fraction. Further studies are required to confirm this relationship and to assess the potential for lithium recovery from this type of deposit.