

Green energy transition: Rare earth elements mineralization in the carbonatites of Pakistan

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Green technologies are a key part of meeting the world's goal of decarbonization. Rare Earth elements (REEs), a component of green technologies, are very important for a fossil fuel-free society and are essential components in electronics, vehicles, homes and in energy supplying infrastructure. Given the strategic importance of REEs, there is a need to explore them using the latest technologies, essential, for the green energy transition. In Pakistan, REEs and other strategic element bearing minerals are found in peralkaline rocks and pegmatites. Peralkaline rocks occur in the Khyber Pakhtunkhwa province, with carbonatites being the main types. The carbonatite bodies in this region are explored as a case study. Geochemical and isotopic studies confirm rift-related and post-collisional partial melting settings for the Koga and Sallai Patti carbonatites respectively. The Sallai Patti carbonatite hosts REEs mineralization but is not economically significant due to the early crystallization of apatite, which reduces the REEs content in the melt. Therefore, carbonatites rich in apatite are not conducive to economic REEs mineralization. Based on this study, it is recommended to apply the same approach to other carbonatite bodies in the province to assess the promising prospects of REEs.