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Strategic Metals and Rare Earth Elements Exploration of Lithium Cesium Tantalum Type Pegmatites: A Case Study from Northwest Himalayas

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Abstract : The LCT (Li, Cs and Ta rich)-type pegmatites, genetically related to peraluminous S-type granites, are being mined for strategic metals (SMs) and rare earth elements (REEs) around the world. This study investigates the SMs and REEs potentials of pegmatites that are spatially associated with an S-type granitic suite of the Himalayan sequence, specifically Mansehra Granitic Complex (MGC), northwest Pakistan. Geochemical signatures of the pegmatites and some of their mineral extracts were analyzed using Inductive Coupled Plasma Mass Spectroscopy (ICP-MS) technique to explore and generate potential prospects (if any) for SMs and REEs. In general, the REE patterns of the studied whole-rock pegmatite samples show tetrad effect and possess low total REE abundances, strong positive Europium (Eu) anomalies, weak negative Cesium (Cs) anomalies and relative enrichment in heavy REE. Similar features have been observed on the REE patterns of the feldspar extracts. However, the REE patterns of the muscovite extracts reflect preferential enrichment and possess negative Eu anomalies. The trace element evaluation further suggests that the MGC pegmatites have undergone low levels of fractionation. Various trace elements concentrations (and their ratios) including Ta versus Cs, K/Rb (Potassium/Rubidium) versus Rb and Th/U (Thorium/Uranium) versus K/Cs, were used to analyze the economically viable mineral potential of the studied rocks. On most of the plots, concentrations fall below the dividing line and confer either barren or low-level mineralization potential of the studied rocks for both SMs and REEs. The results demonstrate paucity of the MGC pegmatites with respect to Ta-Nb (Tantalum-Niobium) mineralization, which is in sharp contrast to many Pan-African S-type granites around the world. The MGC pegmatites are classified as muscovite pegmatites based on their K/Rb versus Cs relationship. This classification is consistent with the occurrence of rare accessory minerals like garnet, biotite, tourmaline, and beryl. Furthermore, the classification corroborates with an earlier sorting of the MCG pegmatites into muscovite-bearing, biotite-bearing, and subordinate muscovite-biotite types. These types of pegmatites lack any significant SMs and REEs mineralization potentials. Field relations, such as close spatial association with parent granitic rocks and absence of internal zonation structure, also reflect the barren character and hence lack of any potential prospects of the MGC pegmatites.

Keywords : exploration, fractionation, Himalayas, pegmatites, rare earth elements
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