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A Conceptual Mineral Systems Model for the LCT Pegmatites

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The LCT (lithium-caesium-tantalum) pegmatites are of uttermost importance for hosting minerals having the highest concentrations of lithium, a critical metal. Consequently, there is an urgent need to understand the genesis, emplacement, and preservation of these deposits within the framework of mineral system analysis for effective regional-scale exploration targeting. Through an exhaustive review of literature encompassing pegmatite occurrences worldwide, this study conceptualizes the targeting criteria for the formation of lithium-bearing pegmatites: (i) volcanic-arc granites, post-collisional granites, and the granites derived from the anatexis of the metapelites, derived from sediments that have undergone extreme chemical weathering and residual enrichment, making them the fertile sources for Li;(ii) compressional zones and post-collisional extension zones as the prospective geodynamic settings that initiate the mineralization process; (iii) crustal-scale faults in the aforementioned tectonic settings that facilitate the focusing and transportation of these melts; and (iv) the post-emplacement tectonic regime that preserves the deposits. Additionally, this research identifies spatial proxies based on the aforementioned criteria that are accessible from publicly available geoscientific data sets, including geological and topographic maps, airborne geophysical data, geochemical data, and remote sensing data sets. These spatial proxies can be integrated using methods like fuzzy inference model for the targeted modelling of lithium-bearing LCT pegmatites, thereby highlighting the most prospective areas for further detailed exploration.