The Jadar Li(B) Deposit (Serbia): Insights Into a Giant Volcano-Sedimentary-Hosted Li-B System

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Volcano-sedimentary systems (VSS) show enormous potential for economic concentrations of critical metals such as lithium. Lithium VSS are located in block-faulted basins developed within felsic volcanic provinces of crustal affinity. In most conventional VSS (e.g., McDermitt Caldera, US), the alteration of Li-fertile volcanic rocks leads to the formation of an “Li-smectite trap,” where hectorite and other related clays represent the main ore repository. The Jadar deposit (Serbia) is the largest lithium deposit in Europe, holding JORC indicated and inferred resources of 143.5 Mt Li at 0.838% Li, and is considered part or the VSS family. However, contrary to conventional VSS, the ore assemblage in Jadar is dominated by the presence of the unique Li-mineral jadarite ($LiNaSiB_3O_7(OH)$), an Na- and Li-borosilicate. In this study, we provide the first geological account on the “jadarite-type” VSS by presenting a combination of petrographic, lithogeochemical, and isotopic data. The mineralization in Jadar is hosted in lacustrine-deposited volcanogenic rocks (i.e., mica-dominated air falls end epiclastic rocks), which experienced post-depositional processes including zeolitization, K-(auto)metasomatism (i.e., K-feldspar alteration), and clay alteration. These processes mirror the closed hydrologic system diagenesis (CHSD) observed in Li clay-type VSS, yet the Jadar deposit shows the following peculiarities: (1) extensive carbonate alteration, leading to the breakdown of early-formed Mg(Li)-smectites and the formation of primary dolomite; (2) a lack of primary quartz and secondary silica; and (3) Li fixation in borosilicates, coeval to zeolitization. These features highlight that the diagenesis at Jadar occurred at higher pH if compared to clay-type VSS. Our data indicate that the hyperalkaline diagenetic conditions at Jadar led to the stripping of silica from Li(B)-fertile volcanogenic material, which was remobilized to form a gel-like material, which was precursor to formation of a jadarite–zeolite assemblage.