Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.17306

Structural Control of Lithium-Pegmatite Mineralization from Kalba-Narym Belt, East Kazakhstan

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Eastern Kazakhstan is a natural laboratory of pegmatite occurrence associated with the Early Permian Kalba-Narym batholith. Part of the Central Asian Orogenic Belt (CAOB), the Kalba-Narym Belt is formed due to the continental collision between Kazakhstan and Siberian plates in the Late Paleozoic, known as Great Altai Hercynide system (extending for >2500 km to Chinese Altai, Russian Altai, and Mongolia). There are several plutonic bodies in the Kalba-Narym Belt, including Early Kalba granodiorite-granite, Late Kalba granite-leucogranite, and Monastyr leucogranite complexes, which comprise the post-orogenic batholith. The syntectonic granites are sheared and mylonitized due to continuous shear deformation subsequent to the granitic magma emplacement. The pegmatites in the Central-Kalba ore district are related to Phase 1 granites of the Kalba complex, yielding 291 and 286 Ma ($^{40}Ar/^{39}Ar$ dating of muscovite and lepidolite; Khromykh et al., 2020). The pegmatite mineralization occurring at the top of the granitic bodies likely originated from highly fractionated granitic melts. These pegmatites can be classified as LCT-type pegmatite such as Yubileynoye and Krasny Kordon deposits (sub-economic). The mineralogical zonation differentiates barren pegmatite of quartz-microcline and quartz-microcline-albite assemblages from mineralized pegmatite of lepidolite-cleavelandite-spodumene/petalite assemblage (Li-Cs-Ta-Nb-Be-Sn). Pegmatite formation occurs at the intersections of W-E deep faults, namely Gremyachy-Kina fault (Ognevka – Bakennoe ore zone in the north), Asubulak fault (Asubulak ore zone in the center), and Pervomaysk-Belogorsk fault (Belaya Gora – Baymurza ore zone in the south). Differentiation of granite magma provides the source of fluids containing rare metals and volatiles such as F and B based on the occurrence of various types of tourmaline within the magma-fluid system. These fluids are more likely percolated via late brittle regime (observed faults in the mineralized regions), which are probably connected to early brittle stage, i.e., fault planes and tectonic breccia in the Kalba-Narym batholith, forming the pegmatites in the roof of the batholith. It is likely that the Kalba pegmatite district is associated with orogenic collapse, intense shearing and pull-apart strike-slip deformation of continental lithosphere in a tectonic strain-stress regime that evolves from transtensional to extensional, enabling decompression to trigger fluid release and mobilization of substantial volumes of melts.