Chemical Characteristics of Zircons from the Rare Metal Deposit in the Khaldzan Burgedei Peralkaline Complex, Western Mongolia

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The Khaldzan Burgedei peralkaline complex hosts a potential rare metal (Zr-Nb-REE) deposit in Mongolia. We investigated the mineralogy and geochemistry of rare-metal bearing minerals, and enrichment mechanism of the HFSE and REE mineralization, based on samples that were collected from drill holes in the complex, by using SEM-EDS, CL image, EPMA, and LA-ICP-MS. The studied area of the Khaldzan Burgedei complex consists of two main units of quartz syenite and granite. The HFSE and REE minerals occur in the highly hydrothermally altered quartz syenite and fractionated granite. Zircon is the most common accessory mineral in the drill hole. Based on textural and chemical composition characteristics, zircon is classified into three types. Type I zircon is observed in the quartz syenite and granite. This zircon exhibits euhedral to subhedral shape, is 25-100 mm in size, and coexists with feldspar, amphibole, and quartz. It locally shows banded zoning textures with quartz. The Type 1 zircon also contains significant Y_2O_3 (~1.68%), $SREE_2O_3$ (0.45-2.05%) and Nb_2O_5 (0.14-0.41%) as identified by EPMA data. Results of Laser Raman analysis show molecular water vibration peaks (3,390 and 3,600 cm^{-1}). In CL images, zircons shows grey, darkish grey background, and quartz shows dark background. Type II zircon occurs in the hydrothermally altered quartz syenite and fractionated granite. It occurs as subhedral to euhedral grains, 20-150 mm in diameter. Zircon in the altered quartz syenite coexists with quartz, fluorite, and chlorite. These zircons show chemical zoning, and the narrow rims of these zircons are characterized by high birefringence and oscillatory zoning. The results of the EPMA analysis show enrichment of Y_2O_3 (1.2-7.25 wt %) $SREE_2O_3$ (0.24-4.75%), and Nb_2O_5 (~ 4.54%) in the rims. The zircon has high ThO_2 (~7.84%) and FeO (~6.14%) contents. Zircon in the granite shows a porous core and weak chemical zoning texture. The zircon contains 1.34-5.7 wt % Y_2O_3 , 0.64-2.70% $SREE_2O_3$, and ~4.39% Nb_2O_5. Results of the Laser Raman analysis for Type 2 zircon show a broad peak (3250-3700 cm^{-1}) for molecular water. The CL images show a dark background where there is an increased trace element content, and a grey background where there is a decreased trace element content. Type III zircon is observed in the quartz syenite. Zircon of this type is anhedral, fine-grained, 10-30 μm in size, and occurs in unidentified mineral pseudomorphs with quartz and fluorite. Zircon contains ~0.9% Y_2O_3. Some anhedral zircons have an envelope of REE carbonates [synchysite-Ca(Ce, La)$(CO_3)_2$F]. Results of Laser Raman analysis show no detected molecular water vibration peaks. The CL images show dark to bright grey background. The three zircon types are recognized in these units: magmatic (type-1), magmatic-hydrothermal (type-2), and late hydrothermal (type-3) zircons. Type 2 zircon is most enriched in REE, Nb, Fe, and Th, particularly where increased Th and Fe content zircon shows a halo on CL images. Both magmatic and hydrothermal processes contributed to the concentration of Zr, Nb, and REE.