

The composition of the spodumene of Asian pegmatite fields

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The composition of the rock forming spodumene from rare metal pegmatite of the Enisei ridge, the Sangilen Plateau, the Southern Tian-Shan, the Pamir, and the Gindukush was studied using a X-ray microprobe analysis. The age of them ranges from Pre-Cambrian to Palaeogene inclusively. The spodumene demonstrates two types of bodies: classic albite-spodumene veins with profile lithium specific, and spodumene-microcline-albite complex ones (Li, Rb, Cs, Ta, Nb, Be) from zoning pegmatite fields. It is found that the main components defining a mineral composition, except of kind-forming (Li, Al, and Si), are Fe, Mn, Na, K, Ti, and partly Ca and Mg. In addition, the spodumenes of linear separate lithium vein series of albite-spodumene type are always significantly more enriched in Fe, Mn, Ti, Ca, Mg despite their age, whereas the complex-type spodumenes of spodumene-microcline-albite veins from zoning fields are constantly enriched in Na and K. The same tendency was found while sampling the spodumenes with different generations of all vein types. An early spodumene is always more contaminant than a later one, especially with Fe, Mn, and Ti. Generally, late spodumenes are less contaminant, but have more Na and K. The discovered tendency correlates with changing the color of a mineral from greenish-grey to white and pinkish-white, and with growth of excretion size (from sm to dm). Ca and Mg as contaminants are not very typical for a spodumene and always seen in minerals of lithium pegmatites from the Sangilen (Central Asia). That is probably related to localization of province veins in the carbonate suite, which is responsible for modification of initial melts that enriches these veins in Ca and Mg. Sampling demonstrates direct correlation between Al and Si. At the same time, significant Al-abundance is often seen while calculating the crystal chemical formulas. This all indicates that the isomorphic replacement of silicon by the element takes place in tetrahedrons of mineral structure.

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Combined accessory mineral micro-analysis: The strength of a multi-phase approach

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Accessory mineral micro-analysis provides a diverse and versatile toolbox for deciphering the timing and conditions of petrological processes. We explore the use of multi-mineral U-(Th)-Pb geochronology and trace-element analysis using LA-‘split-stream’-ICP-MS in a study of rare near-UHP crustal xenoliths in the Pamir (peak conditions 2.5-2.8 GPa, 1000-1100 °C, eruption ~11 Ma [1]). These direct samples of the deep crust recovered from under an active collisional orogen provide a unique opportunity to assess how orogenic roots form and evolve.

We analyzed zircon, monazite, and rutile from a variety of rocks (eclogites to grt-ky-qtz granulites) in thin section using an excimer laser coupled to a Nu Plasma HR and a Nu AttoM. This set-up provides REE-HFSE concentrations and U-Th-Pb isotope ratios—hence, petrogenetic, thermometric and age data—for small amounts of ablated analyte. Our analysis yielded 1) U-Pb ages, Ti concentrations and REE in zircon, 2) U-Pb and Th-Pb ages and REE in monazite, and 3) U-Pb ages and HFSE concentrations (incl. Zr) in rutile.

Zircon and monazite defined 6 age populations between 55-11 Ma, each typically having uncertainties of 1 Ma or better. The Ti-in-zircon and zircon U-Pb ages imply a three-stage P-T-t history, involving Barrovian metamorphism (55-20 Ma), deep burial leading to near-UHP conditions at ~12 Ma, and rapid magmatic heating shortly before the 11-Ma eruption. Monazite data complement this history. Rutile yielded ~11-Ma U-Pb dates exclusively, demonstrating the reliability of this thermochronometer.

The data show that different accessory mineral techniques are largely complementary and that their combined use is very powerful in refining and redefining geodynamic models. In addition, we demonstrate that, through ongoing development in LASS-ICP-MS technology, we are able to identify and resolve a wide range of petrological processes on a Myr time scale for Cenozoic rocks.

[1] Hacker *et al.* (2005) *J. Petrol.* **46**, 1661-1687.