

Primary Nb-Ta minerals in the Szklary pegmatite, Poland: New insights into controls of crystal chemistry and crystallization sequences

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ABSTRACT

An assemblage of primary, extremely As- and Sb-rich, Nb-Ta minerals from the Szklary pegmatite includes columbite-(Fe), columbite-(Mn), tantalite-(Mn), stibiocolumbite, stibiotantalite, an as yet unnamed (As,Sb,U)-rich (Ta,Ti)-oxide, $\text{Mn}_3\text{UAs}_2\text{Sb}_2\text{Ta}_2\text{Ti}_2\text{O}_{20}$, and holtite. Anomalous trends of Mn-Fe and Ta-Nb fractionation in the columbite group and crystallization sequences in the primary assemblage can be explained by the contamination of the pegmatite-forming melt by ultramafic and mafic wall-rocks, the competition among these minerals for Ta and Sb and with biotite and tourmaline for Mg, Fe, and Ti, and local variations in melt composition. A hot magmatic fluid, exsolved from the parental melt, reacted with the primary Nb-Ta oxides, inducing two different patterns of alteration. The columbite-group minerals were altered to fersmite, pyrochlore, and bismutopyrochlore locally grading to plumbopyrochlore, whereas stibiocolumbite, stibiotantalite, and the (As,Sb,U)-rich (Ta,Ti)-oxide altered to stibiomicrolite, uranmicrolite grading to betafite, and then to bismutomicrolite or Bi-dominant betafite. In all of the secondary pyrochlore-group minerals, Ta-Nb fractionation is comparable to, or only slightly greater, than that in the primary Nb-Ta oxides, indicating a modest differentiation of the residual melt coexisting with the fluid.

Keywords: Columbite-(Fe), columbite-(Mn), tantalite-(Mn), stibiocolumbite, stibiotantalite, holtite, fersmite, pyrochlore-group minerals, fractionation trends, Szklary pegmatite, Lower Silesia, Poland