



Columbite and fergusonite from rare metal granitoids, Central Eastern Desert of Egypt

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The Central Eastern Desert (CED) of Egypt, as a part of the Arabian Nubian Shield (ANS) belt, hosts more than 14 rare metal granitoid plutons. The garnet bearing muscovite granite (GBMG) from Gabal Abu-Diab and alkali-feldspar granite (AFG) from Gabal El-Ineigi were selected to study their rare metal mineralization. The GBMG and AFG are a metaluminous to weakly peraluminous consists of quartz, K-feldspar, plagioclase and muscovite in both types with subordinate amounts of garnet in GBMG and biotite + fluorite in AFG. Columbite, zircon, thorite, rutile, ilmenite and monazite are the common accessories in both types, while fergusonite are exclusively encountered in AFG. Both granitoids are highly fractionated calc-alkaline characterized by high Rb, Nb, Y, U and many other HFSE contents, and extremely low Sr and Ba. Texturally, the columbite and fergusonite crystals occur as homogeneous disseminated grains between the major minerals phases and as inclusion in protolithonite, zircon and fluorite. In few cases, they have a well-developed normal and oscillatory zoning pattern, suggesting their primary magmatic crystallization. Compositional variation (results of electron microprobe analyses) of columbite and fergusonite from these granitoids is evaluated. Columbites from AFG are mostly represented by Ta rich columbite-(Fe) with average chemical composition of Nb_2O_5 (88 wt. %), Ta_2O_5 (up to 31 wt. %), FeO (17 wt. %) and MnO (5 wt. %). While columbites from GBMG, are classified as Ta poor columbite-(Mn) and are chemically consists of Nb_2O_5 (73 wt. %), Ta_2O_5 (6 wt. %), FeO (9 wt. %) and MnO (12 wt. %). Fergusonite-(Y) occur as homogeneous crystals with an average concentration of Nb_2O_5 (44 wt. %), Y_2O_3 (24 wt. %), Ta_2O_5 (2.3 wt. %), UO_2 (2.1 wt. %) and ThO_2 (1.2 wt. %). The $\Sigma\text{REE}_2\text{O}_3$ dominated by HREE (Yb_2O_3 , Er_2O_3 , Dy_2O_3 , Gd_2O_3 , Lu_2O_3 and Tm_2O_3), ranges from 15.3 to 16.6 wt. % and Ce_2O_3 (up to 3.3 wt. %). The Metamictized fergusonite contain ubiquitous subordinate amounts of U and Th that could be formed due to the hydrothermal effect. During the late magmatic fractionation stage, the progressive decrease in temperature led to gradually ceasing the solubility of rare metal complexes in magma followed by sequentially crystallization of rare metal minerals including columbite and fergusonite.