Nb, Ta, Ti, REE(Y), Zr, Sn, Th, U OXIDES FROM GRADISTEA DE MUNTE RARE ELEMENT MINERALS OCCURRENCE, SEBES MTS., ROMANIA

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The Gradistea de Munte (GM) rare element minerals occurrence is situated in the north of the Sebes Mts., Southern Carpathians, in the upper course of the Orastie River. Geologically-structurally the GM area consists of the amphibolite facies rocks of the Upper Proterozoic Sebes-Lotru Series of the Getic Crystalline. The most important host rock of the mineralization is a quartz-microcline-albite gneiss/"granite". Sometimes the rocks being formed only from microcline, albite, some phlogopite/biotite and accessory rare minerals, quartz is missing. Cyrtolite/zircon and magnetite are always present as ore/mineral components of the rock. The rare earth element mineralization is represented by carbonates, oxides, silicates and phosphates, in veinletes and nests of mm to cm size grains. The REE oxides in GM belong to 7 groups: **pyrochlore, fergusonite, columbite, "ilmeno-struverite", baddeleyite**, **cassiterite** and **thorianite-uraninite**. **1. Pyrochlore group** has 3 subgroups**. A. Pyrochlore subgroup** with the major B-site cations (Nb + Ta) > Ti and Nb > Ta, comprises **pyrochlore, yttropyrochlore-(Y), uranpyrochlore, plumbopyrochlore** and **thoriopyrochlore**, defined by the cations residing in A-site. The GM **pyrochlore** has (Ca,Fe,U,Th) > 20% in A-site, $Nb_2O_5 \approx 50\%$ and $Ta_2O_5 \approx 2$–10%. **Yttropyrochlore-(Y)** contains beside dominant Y (≈ 15–20 wt% Y_2O_3) in A site some oxides of Ce, Nd, Dy, Gd, Yb≈(10 wt%). The Nb_2O_5 content varies between 40–50 and Ta_2O_5 between 1–2 wt%. It always contains some UO_2 and ThO_2, thus metamictisation being very common. In addition, yttropyrochlore-(Y) has some SiO_2 content, common in metamictic and late stage hydrated pyrochlores. Yttropyrochlore-(Y) is the best widespread term of pyrochlore. **Plumbopyrochlore** has (Pb,Ca,U) > 20% in A site, $Nb_2O_5 = 46.5$ and $Ta_2O_5 = 18.5$ wt%. **Uranpyroclore** has UO_2 dominance in A site (= 13–25%) with some $Ln_2O_3 \approx 4$, Ca + Ba ≈ 10, $Y_2O_3 = 1.5$–6 and $ThO_2 = 2$ wt%. Its Nb_2O_5 content varies between 30–50 and Ta_2O_5 between 10–15 wt%. It is omnipresent as few mm to cm size grains in all types of rocks/ores from GM. In transmitted light it is light red, yellow orange, red. It contains some ZrO_2 (≈ 2 wt%), being associated with cyrtolite. Like yttropyrochlore, it has high SiO_2 content (7–10 wt%). The GM **thoriopyrochlore** is Th dominant with some Y, and Fe in A site. The ThO_2 content is very high, around 40 %wt. It contains OH and clorine≈(0.6 wt%) in *Y* site. It is associated with thorite and thorogummite. **B**. **Microlite subgroup** ($Ta_B \geq Nb_B$, Nb + Ta > 2Ti) comprise the **uranmicrolite,** with $Nb_2O_5 \approx 30$, $Ta_2O_5 \approx 48.5$, $UO_2 \approx 14.6$ wt%, **thormicrolite** with $Nb_2O_5 \approx 19$, $Ta_2O_5 \approx 25$, $ThO_2 \approx 48$ wt%, and **yttromicrolite** with $Nb_2O_5 \approx 22$, $Ta_2O_3 \approx 25$ wt%, having U, Th, respectively Y in A site > 20%. **C**. **Betafite subgroup,** $B = 2Ti_B \geq (Nb + Ta)_B$, in GM is represented by the occurrence of **betafite** (U > 20% in A site) and **yttrobetafite-(Y)** (Y > 20% in A site). The last one occurs as big grains of up to 1 cm. The chemical composition of yttrobetafite-(Y) varies: $TiO_2 = 27$–30, $Y_2O_3 = 15$–22, $Nb_2O_5 = 22$–27, $Ta_2O_5 = 7$–19, $ThO_2 = 5$–10, $UO_2 = 4$–6 wt%. Some yttrobetafite-(Y) grains have a very Ta-rich composition: $Ta_2O_5 = 31.2$, $Y_2O_3 = 28.8$, $TiO_2 = 36.0$ wt% and they do not contain Nb_2O_5. Compositional zoning was visible from yttrobetafite-(Y) inside to **Ta-yttrobetafite-(Y)** outside in a grain. **2**. The **fergusonite group** contains the **fergusonite-(Y)** with $Nb_2O_5 = 45$–58, $Y_2O_3 = 25$–35, $Yb_2O_3 + Gd_2O_3 + Dy_2O_3 \approx 4.5$ wt% and very little Ta_2O_5, with maximum 5 wt% UO_2 and ThO_2 content. The grains of fergusonite-(Y) are zoned with **formanite-(Y),** which has $Y_2O_3 = 34.6$, $Ta_2O_5 = 48.2$ wt% and little CaO, FeO and ThO_2. Another grain has $Y_2O_3 = 36.15$, $Ta_2O_3 = 45.72$, $Ce_2O_3 = 5.17$ and CaO = 4.43 wt% composition. The same grain could be built up from many phases, corresponding to yttropyrochlore-(Y), yttromicrolite-(Y), formanite-(Y) showing the Ta increase. **3. Ferrocolumbite** has: FeO = 16.2, MnO = 3.03, $Nb_2O_5 = 72.8$, $Ta_2O_5 = 4.2$, $TiO_2 = 3.5$ wt% and **manganocolumbite** has $Nb_2O_5 = 76.28$, MnO = 10.93, FeO = 0.44, $TiO_2 = 0.8$ wt%. Some grains have high UO_2 content of up to 8.4 wt%. The composition of some grains are (Y_2O_3 + FeO + MnO) > 20 wt%, high Nb_2O_5 (> 65 wt%) some Ta_2O_5 and no TiO_2 which could belong to **yttrocolumbite. 4**. **"Ilmenorutile"** has: $TiO_2 = 49.5$–52.5, $Nb_2O_5 = 21.8$–26.5, $Ta_2O_5 = 7.7$–13.31, FeO = 9.4–12.03 wt%, showing a solid solution with **"struverite"**. **5**. **Baddeleyite** appears to be one of the oldest minerals, older than cyrtolite and its presence indicates that the first mineralized solutions were subsaturated in silica. Its composition shows only ZrO_2 with some ThO_2 and very little HfO_2. **6. Cassiterite** appears as big cm grains in hydrothermal veinlets and has little U, Th and Fe in its composition. **7**. **Uraninite** and **thorianite,** usually form solid solutions with the composition $UO_2 = 49.1$, $ThO_2 = 48.0$ wt%. Separately, uraninite has composition: $UO_2 \approx 96.6$ wt% with little ThO_2, Y_2O_3, PbO, FeO, and thorianite has $ThO_2 = 96.3$, PbO = 3.27, FeO = 0.23, $SiO_2 = 0.16$ wt%. Generally, the content of Nb + Ta in all rare minerals is higher than that of Y + REE, and the Y content is much higher than Ce. Also, the Th content is much higher than U. The zirconium has the highest content.