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Nb Ta Sn oxides association from the Malpensata granitic pegmatite, Central Southern Alps (Lecco province, Italy): magmatic differentiation, crystallization mechanism and geochemical inferences

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The Malpensata granitic pegmatite dike, embedded into the high-grade metapelites of the Dervio-Olgiasca Zone (crystalline basement of the Southern Alps), shows a complex mineral assemblage which includes, schorl, garnet, beryl, uraninite and secondary uranium bearing minerals, zircon, apatite several Li-Fe-Mn phosphates, columbite-tantalite group minerals, ferrotapiolite, microlite and cassiterite. The Malpensata dike shows an asymmetrical zoned structure composed of different units: 1) a wall zone which includes layers of fine grained black tourmaline embedded in medium-coarse albite+quartz 2) an intermediate zone composed of medium-coarse white albite and layers of medium grained black tourmaline+garnet+muscovite and subordinate oxides of Nb-Ta 3) a central zone of blocky albite (megacryst plagioclase zone) with quartz+tourmaline+garnet graphic textures and many accessory phases as Li-Fe-Mn phosphate, oxides of Nb-Ta-Sn, zircon, uraninite and many secondary uranium bearing minerals 4) a roof zone composed of coarse white albite+quartz + muscovite and subordinate black tourmaline.

In this study five Nb-Ta-Sn oxide mineral associations, sampled in the blocky albite unit, were investigated with back-scattered SEM images in order to describe textural and paragenetic characters. Quantitative analyses were obtained by means of EDS electron microprobe analyses. Unit cell data were obtained by means of an X-ray

powder diffractometer.

The analyses of oxides of Nb-Ta-Sn showed a chemical zonation moving from the intermediate toward the central blocky zone of the Malpensata granitic pegmatite which may be represented as follows:

ferrocolumbite → Ta-rich ferrocolumbite → ferrotantalite, ferrotapiolite, cassiterite, microlite

Moreover chemical characters of Nb-Ta oxides reveal an important fractionation of Ta during magmatic crystallization with a very low fractionation of Mn. A late hydrothermal stage, which follows, is characterized by a high activity of Na and U, as indicated by the fracture-filling crystallization of Na- and U-rich microlite. Crystal-chemical, textural and paragenetic features allow to discriminate three crystallization stages in the Nb Ta Sn oxides association: i) a higher temperature magmatic crystallization of ordered ferrocolumbite and Ta-rich slight disordered ferrocolumbite, ordered ferrotantalite, ferrotapiolite and cassiterite; ii) a lower temperature magmatic crystallization of primary microlite in undercooled conditions (oscillatory zoning) and partial to total replacement of microlite at the expenses of cassiterite; iii) a late hydrothermal crystallization of Na-, U-rich microlite as fracture filling in primary microlite. The most chemical-evolved association, found in the blocky albite unit, is represented by ferrotantalite-ferrotapiolite pairs, microlite and cassiterite. Moreover the minor element ratio (Ta+Nb vs Fe) in cassiterite indicates that host pegmatite is Li-enriched as confirmed by the presence of Li-bearing phosphates like triphylite and ferrisicklerite. All these characteristics allow to classify the Malpensata dike as a geochemical moderately evolved LCT granitic- pegmatite belonging to the beryl-columbite-phosphate sub-type.