Mineralogy and petrography of Fe-Mn phosphates from the Varuträsk pegmatite, Sweden

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Iron-manganese phosphates are common accessory minerals that occur in rare-element pegmatites belonging to the LCT (Lithium-Caesium-Tantalum) petrogenetic family [1]. The Varuträsk pegmatite (Sweden) is a well-zoned and extremely differentiated pegmatite of the petalite subtype [1]. Due to the historical importance of that pegmatite, in which early phosphate transformation sequences were determined [2-3], phosphate samples stored in the Swedish Museum for Natural History, as well as new samples collected on the field, have been re-investigated.

Triphylite is the main primary Fe-Mn phosphate in Varuträsk. Chemical compositions obtained from electron-microprobe analyses show that triphylite contains significant amount of manganese, varying from 0.35 to 0.45 atoms per formula unit (Fe/(Fe + Mn) ≈ 0.56), while the magnesium content is generally very low. Triphylite is then frequently replaced by *ferrisicklerite* and heterosite during high-temperature hydrothermal alteration processes. During this replacement, the Fe/Mn ratio of primary triphylite is generally preserved. However, some *ferrisicklerite-sicklerite* show higher manganese contents reaching 0.72 atoms per formula unit, suggesting that lithiophilite also occurs as a primary phase in Varuträsk.

Some rims of montebrasite are observed around *ferrisicklerite* grains at the interface with muscovite. Alluaudite-group minerals are frequently formed by alteration of triphylite during Na-metasomatism. In Varuträsk, secondary alluaudite-type phosphates have been observed in various assemblages and under a wide range of compositions: assemblage (I) is composed of green to yellow varulite; assemblage (II) contain green hagendorfite forming unusual graphic textures with silicates (albite, quartz and tourmaline); assemblage (III) shows dark green alluaudite *sensu stricto* replacing primary triphylite ; assemblage (IV) is formed by yellow to orange fractures filled by alluaudite *sensu stricto* and cross-cutting *ferrisicklerite*.

Apatite is frequently found as a secondary phase. Some well-zoned fractures show a significant decrease of the fluorine content from the border to the core, highlighting changes in fluid composition during pegmatite evolution. Hydroxylation processes took place during the low-temperature hydrothermal transformations, and *ferrisicklerite* is then principally replaced by jahnsite-group minerals. Finally, during meteoric alteration, triphylite is locally replaced by vivianite, sometimes associated with colourless fairfieldite. LA-ICP-MS analyses were carried out on primary and secondary phosphates in order to determine the crystal-chemical and geochemical constraints governing trace-element distribution.

References:

[1] Černý P and Ercit T S (2005) Can Mineral 43: 2005-2026
[2] Quensel P (1937) GFF 59: 77-96
[3] Mason B (1941) GFF 63: 117-174