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The petrogenesis of the Be- and HFSE- multi element mineralization of Høgtuva (Norway)

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The Høgtuva tectonic window forms part of the regional structure of the Transscandinavian Igneous Belt (TIB) and is situated in the county of Nordland in Northern Norway. As such, Høgtuva is a granitic body that was emplaced about 1.7 Ga ago and subsequently metamorphosed under amphibolite-facies conditions during the Caledonian orogeny at approximately 420 Ma. In the south eastern part of this window structure, phenakite is the volumetrically most important of several beryllium minerals that are found in such quantities that the respective parts of Høgtuva can be considered a major European Beryllium deposit that hosts 350000 tons @ 0.18 wt% Be.
Parts of the Be ore zone display anomalously high concentrations of Zr, Nb, Th, U, REE, Li, Zn and Sn. Fieldwork and detailed petrographic investigations revealed that fine-grained late-stage (presumably hydrothermal) zircon and other HFSE-incorporating minerals are not cogenetic with the beryllium minerals even though they locally occur in close spatial association. In this respect, pseudomorphic replacement textures of late-stage zircon after e.g. a beryllian rhönite-group mineral represent striking evidence that the late-stage zircon postdates at least some beryllium minerals. Besides the occurrence of late-stage zircon, hydrothermal activity in the mineralized areas is indicated by compositional data of major rock-forming minerals: albitic feldspar and magnetite are of pure end member composition, biotite displays elevated Zn-contents while rare clinopyroxene is nearly pure aegirine in composition although whole rock data prove the mineralized gneisses to be metaluminous. In contrast, feldspar and magnetite form higher degrees of solid-solution series, Zn contents are significantly lower in biotite and clinopyroxene is absent in the non-mineralized gneisses outside the south eastern part of the window.
In order to further decipher the temporal and genetic relationships of the beryllium minerals and the late-stage HFSE phases, we present results on the in-situ U-Pb age dating of the late-stage zircon and selected beryllium minerals in petrographic thick sections. Absolute age determinations allow for identifying cogenetic minerals and establishing a mineral succession. Based on this, mineral equilibria are formulated and those intrinsic parameters identified that control the stabilities of the respective minerals found in the mineralized gneisses. The overall interpretation of textures, mineral composition, age determination of selected minerals and the identification of the parameters controlling mineral stabilities point to the adjacent Precambrian and Caledonian metasedimentary nappe sequences as sources for beryllium, the HFSE and the other elements enriched in the mineralized area. Accordingly, these elements are interpreted to have been mobilized and subsequently introduced into the Høgtuva gneisses where they gave rise to the mineralization.