Uranium minerals from the Picoto uranium mine area, central Portugal

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The Picoto uranium mine area is located close to Vilar Seco village, central Portugal. The mineralization occurs mainly in quartz veins, which intersect a Variscan medium- to coarse-grained porphyritic two-mica granite. The quartz veins fill N37°-45° E and N50°-70°E faults and are locally brecciated. The quartz veins contain torbernite, metatorbernite and uranophane, and also some U-bearing minerals, such as chlorite and Fe- and Mn-hydroxides. Pyrite is also present. The torbernite, meta-torbernite, Fe- and Mnhydroxides are also disseminated along weathering zones, filling microfractures and spaces between grain boundaries in the granite, but anatase may also occur in granite samples affected by episyenitization. In general, torbernite and metatorbernite from quartz veins and adjacent granite occur as aggregates of green thin tabular crystals, in the range of 5 μm □ 10 μm to 1.5 mm □ 2 mm. Uranophane has a massive habit and is composed by aggregates of yellow acicular crystals that fill spaces between quartz grains. These masses can be homogeneous or show a banded pattern, characterized by the alternation with torbernite/meta-torbernite + quartz. U-bearing muscovite occurs in fine-grained aggregates of quartz + muscovite within the brecciated quartz veins. Zircon was only identified in the granite, and is generally enclosed in biotite. Representative chemical compositions of torbernite and meta-torbernite in quartz veins and adjacent granite are $(Cu_{0.94}Pb_{0.01})_{\square 0.95}(UO_2)_{1.98}(PO_4)_{2.00}\cdot 9H_2O$ and $(Cu_{0.85}Ca_{0.01}Pb_{0.01})_{\square 0.87}(UO_2)_{1.90}[(PO_4)_{1.98}(AsO_4)_{0.01}(SiO_4)_{0.01}]_{\square 2.00}\cdot 8H_2O$, respectively. The uranophane composition is $(Ca_{0.97}Pb_{0.01})_{\square 0.98}(UO_2)_{1.78}[(SiO_3OH)_{1.94}(PO_4)_{0.06}]_{\square 2.00}\cdot 5H_2O$. Zircon cores have on average 0.43 wt. % UO_2. Chlorite occurs as thin, sparse, anhedral flakes associated with torbernite + quartz, and has on average 0.59 wt. % UO_2. Fe-hydroxides often show zoned textures and have on average 0.32 wt. % UO_2, whereas in Mnhydroxides the mean UO_2 content is 0.61 wt. %. U-bearing muscovite has a greenish-yellow colour and the composition $(Na_{0.02}K_{0.85})_{\square 0.87}(Al_{1.79}Ti_{0.01}Fe^{2+}_{0.15}Mg_{0.09}Li_{0.01})_{\square 2.05}[(Si_{3.18}Al_{0.82})_{\square 4.00}O_{10}](OH, F)_{2.00}$, showing sorption of 1.52 wt. %UO_2.