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Ciprianiite and mottanaite-(Ce), two new minerals of the hellandite group from Latium (Italy)

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ABSTRACT

Two new minerals of the hellandite group were found within alkali-syenitic ejecta enclosed in pyroclastic formations of the Roman Comagmatic Province (Latium, Italy). Mottanaite-(Ce) [ideally $^{X}Ca_4^{Y}(CeCa)^{Z}Al^{T}Be_2(Si_4B_4O_{22})^{W}O_2$] and ciprianiite [ideally $^{X}Ca_4^{Y}[(Th,U)(REE)]^{Z}Al^{T}\square_2(Si_4B_4O_{22})^{W}(OH, F)_2$] occur as transparent, brown-colored, tabular euhedral crystals in miarolitic cavities and voids of the ejecta, which consist mainly of sanidine and plagioclase (An ranging from 20 to 80%), with minor amounts of feldspathoid, clinopyroxene and/or clinoamphibole, magnetite, titanite, and zircon. Locally, accessory minerals include britholite-(Ce), baddeleyite, phosphate to silico-phosphate phases close in composition to the brabantite-cheralite series, thorite, fluorite, danburite, and vonsenite. The genesis of the new hellandite end-members can be related to late-stage post magmatic hydrothermal fluids enriched in Zr, Ti, REEs, and actinide elements.

Both mottanaite-(Ce) and ciprianiite have a vitreous luster and are non-fluorescent. Cleavage is absent in mottanaite-(Ce), fair to good in ciprianiite, {100}. Twinning is frequently observed in ciprianiite. Due to the strong intra-crystalline chemical zoning and twinning, physical properties could be measured only for mottanaite-(Ce). D_{meas} is 3.61(4) g/cm^3, D_{calc} is 3.88 g/cm^3. Mottanaite-(Ce) is biaxial negative, with $\alpha = 1.680(5)$, $\beta = 1.694(2)$, $\gamma = 1.708(5)$; $2V_{meas}$ ~90°.

Both minerals are monoclinic, space group $P2/a$, $Z = 2$. Unit-cell parameters for the crystals studied are: $a = 19.032(9)$ Å, $b = 4.746(3)$ Å, $c = 10.248(5)$ Å, $\beta = 110.97(5)°$, $V = 864.3(8)$ Å^3 for mottanaite-(Ce), and $a = 19.059(5)$ Å, $b = 4.729(1)$ Å, $c = 10.291(4)$ Å, $\beta = 111.33(2)°$, $V = 864.0(5)$ Å^3 for ciprianiite. Single-crystal structure refinement confirmed the presence of a further distorted tetrahedral site which was first detected in a hellandite-(Ce) sample from Latium (Oberti et al. 1999). This site is occupied by Be (±Li) in stoichiometric mottanaite-(REE), whereas it mainly hosts hydrogen (bonded to the O5 oxygen atom) in ciprianiite and hellandite-(REE); solid solution between the end-members is possible, as shown by the studied samples. The chemical composition of the refined crystals was obtained by combining EMPA (for medium-Z elements) and SIMS analyses (for low- and high-Z elements); their results are in excellent agreement with the chemical information obtained from the structure refinements. The crystal-chemical formulae of the crystals studied, recalculated on the basis of 24 anions, are $^{M3,4}Ca_4^{M2}[REE_{1.45}Ca_{0.37}(Th,U)^{4+}_{0.17}Y_{0.01}]_{\Sigma=2}{}^{M1}(Al_{0.50}Fe^{3+}_{0.38}Mg_{0.03}Ti^{4+}_{0.07})_{\Sigma=0.99}{}^{T}(Be_{1.18}Li_{0.02}\square_{0.37})B_{3.99}Si_{3.98}O_{22}{}^{O5}(O^{2-}_{1.04}F_{0.53}OH_{0.43})_{\Sigma=2}$ for mottanaite-(Ce); and $^{M3,4}Ca_4{}^{M2}[REE^{3+}_{0.72}(Th,U)^{4+}_{0.66}Ca_{0.60}Y_{0.02}]_{\Sigma=2}{}^{M1}(Al_{0.48}Fe^{3+}_{0.38}Ti^{4+}_{0.10}Mg_{0.05}Mn^{3+}_{0.02})_{\Sigma=1.03}{}^{T}(Be_{0.82}\square_{0.60}Li_{0.04})B_{4.00}Si_{4.00}O_{22}{}^{O5}(O^{2-}_{0.97}OH_{0.54}F_{0.49})_{\Sigma=2}$ for ciprianiite.