

## Elbrusite-(Zr)—A new uranian garnet from the Upper Chegem caldera, Kabardino-Balkaria, Northern Caucasus, Russia

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### ABSTRACT

Elbrusite-(Zr)  $\text{Ca}_3(\text{U}^{6+}\text{Zr})(\text{Fe}_2^{3+}\text{Fe}^{2+})\text{O}_{12}$ , a new uranian garnet ( $Ia\bar{3}d$ ,  $a \approx 12.55 \text{ \AA}$ ,  $V \approx 1977 \text{ \AA}^3$ ,  $Z = 8$ ), within the complex solid solution elbrusite-kimzeyite-toturite  $\text{Ca}_3(\text{U}, \text{Zr}, \text{Sn}, \text{Ti}, \text{Sb}, \text{Sc}, \text{Nb} \dots)_2(\text{Fe}, \text{Al}, \text{Si}, \text{Ti})_3\text{O}_{12}$  was discovered in spurrite zones in skarn xenoliths of the Upper Chegem caldera. The empirical formula of holotype elbrusite-(Zr) with 25.14 wt%  $\text{UO}_3$  is  $(\text{Ca}_{3.040}\text{Th}_{0.018}\text{Y}_{0.001})_{\Sigma 3.059}(\text{U}_{0.658}\text{Zr}_{1.040}\text{Sn}_{0.230}\text{Hf}_{0.009}\text{Mg}_{0.004})_{\Sigma 1.941}(\text{Fe}_{1.575}^{3+}\text{Fe}_{0.559}^{2+}\text{Al}_{0.539}\text{Ti}_{0.199}^{4+}\text{Si}_{0.099}\text{Sn}_{0.025}\text{V}_{0.004}^{5+})_{\Sigma 3}\text{O}_{12}$ . Associated minerals are spurrite, rondorfite, wadalite, kimzeyite, perovskite, lakargiite, ellestadite-(OH), hillebrandite, afwillite, hydrocalumite, ettringite group minerals, and hydrogrossular. Elbrusite-(Zr) forms grains up to 10–15  $\mu\text{m}$  in size with dominant  $\{110\}$  and minor  $\{211\}$  forms. It often occurs as zones and spots within  $\text{Fe}^{3+}$ -dominant kimzeyite crystals up to 20–30  $\mu\text{m}$  in size. The mineral is dark-brown to black with a brown streak. The density calculated on the basis of the empirical formula is 4.801  $\text{g}/\text{cm}^3$ . The following broad bands are observed in the Raman spectra of elbrusite-(Zr): 730, 478, 273, 222, and 135  $\text{cm}^{-1}$ . Elbrusite-(Zr) is radioactive and nearly completely metamict. The calculated cumulative dose ( $\alpha$ -decay events/mg) of the studied garnets varies from  $2.50 \times 10^{14}$  [is equivalent to 0.04 displacement per atom (dpa)] for uranian kimzeyite (3.36 wt%  $\text{UO}_3$ ), up to  $2.05 \times 10^{15}$  (0.40 dpa) for elbrusite-(Zr) with 27.09 wt%  $\text{UO}_3$ .

**Keywords:** Elbrusite-(Zr), new garnet, uranium, solid solution, metamictization, Raman spectroscopy, EBSD, Upper Chegem caldera