

Relationship between chemical and structural features of topaz to unravel formation conditions: A multidisciplinary approach

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Topaz ($\text{Al}_2\text{SiO}_4(\text{OH},\text{F})_2$, *Pbnm* space group) is one of the most important fluorine bearing silicates that occurs as accessory minerals in fluorine rich silicates rocks associated with magmatic or hydrothermal events. The colourless topaz population from the region of Baoshan, Western Yunnan (China) occur in deposit from various origin (i.e. hydrothermal, magmatic and greisen) associated to the Tengchong-Baoshan Sn-polymetallic metallogenic belt. In this work, we propose a geochemical model to link the crystal structure to a possible geological environment, and ultimately to determine the gem identity and provenance. The successful strategy to combine chemical microanalyses with synchrotron X-Ray and neutron powder diffraction in situ measurements (in the 298-1300K temperature range) allowed to accurately determine the mineral structure. The SEM-EDS shows a F content of ~15.4 wt%, while trace elements from LA-ICP-MS it is noteworthy that there is a particular enrichment in Ge (140 ppm), Ca (140 ppm), the presence of Ti (10.4 ppm) and Fe (13 ppm) and a low content of Zn (0.5 ppm), W (0.19 ppm) that crystallise into associated phases such as cassiterite and other oxides. On the basis of micro-X-ray data, the spatial distribution of Al, Si, Ga, Ge, As, as well as those of F and OH on topazes' surface confirms a random arrangements of O and F in octahedra, Al-Ga and Si-Ge substitution and the As absorbance in the cavities between octahedrons. On the basis of neutron diffraction data, F content is estimated to be ~1.59 with OH/F= 0.240 in agreement with the chemical data. The topaz – mullite transformation (for the first time here has been recognised through heating ramp diffraction analyses) has been interpreted as the potential initial crystallization temperature of topaz in a fluid-dominated system. In such a view, we infer that the Baoshan topaz started to form at ~1203-1225 K from a water poor /fluorine rich fluid ($(\text{fH}_2\text{O}/\text{fHF})^{\text{fluid}} \sim 1.2 \log \text{ units}$). Altogether, these data are coherent with topaz formation from a greisen type reaction thus reducing the number of possible topaz source deposits in the large district of Tengchong-Baoshan Sn-polymetallic metallogenic belt.

[1] Precisvalle et al. (2021), *Sci. Rep.* 11, 2666