OH/F substitution in topaz: relationships between structural features, surface reactivity and chemical environments

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Topaz, $Al_2SiO_4(OH,F)_2$, is one of the principal fluorine-bearing silicates that occurs as accessory mineral in fluorine rich-rhyolites and granites, late- and post-magmatic rocks associated with pneumatolytic/hydrothermal events and in ultrahigh-pressure rocks [1]. Fluorine (F) is partitioned in the aqueous fluids at the end of magma crystallization (high T) and carried by post magmatic (low T) circulating. In relation to the efficiency of the mineral/fluid partitioning process (F /OH exchange reactions at various redox conditions) the environmental systems may be constrained [2]. In this work, a selection of gem quality topazes from various localities (Zacatecas-Mexico, Baoshan-PRC and Padre Paraiso-Brazil) are here analysed in terms of major and trace element compositions, to explore the relationships between structural feature (i.e: OH/F substitution), surface reactivity and environmental conditions. Major elements composition is almost constant in terms of Si and Al, whereas F varies in topaz of various localities. LA-ICP-MS revealed sectoral and intrasectoral zoning of trace elements as a function of growth-surface structure. The smooth time-resolved LAM-ICP-MS signals suggest that trace elements are incorporated in the mineral lattice. Preliminary results show that topazes from Zacatecas are richer in Li (+1) and B (+3) (up to 90 ppm) and U-Th (+6;+4). In turn Baoshan topaz contain anomalously high contents of pentavalent Nb (18 ppm), Ta (2 ppm) and W (up to 5 ppm). XRD differences in lattice are registered, showing larger distortions for samples hosting larger atoms. On the basis of chemical and structural data, we propose a model to explain the accommodation of these elements in the crystal structure as function of the geological environment, thus possibly to determine the gem identity.

[1] Zhang, Liou & Shu, (2002) American Mineralogist, 87, 445-453. [2] Alberico et al. (2003) European Journal of Mineralogy, 15, 875-881.