

## **Fluorophlogopite from Piano delle Concazze (Mt. Etna, Italy): Crystal chemistry and implications for the crystallization conditions**

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### **ABSTRACT**

Fluorine is an important proxy for magmatic differentiation processes in the shallow parts of volcanic plumbing systems. Fluorophlogopite is one of the more important fluorine carriers in magmatic rocks. In the present study, a full crystal chemical investigation of fluorophlogopite 1M from Piano delle Concazze, Mt. Etna volcano, Italy, is carried out. The fluorophlogopite occurs in a benmoreitic lava from prehistoric volcanic activity at Mt. Etna (post-caldera forming phase of the “Ellittico” eruptive center; ~15 ka BP). It is primarily associated with fluorapatite covered with amorphous SiO<sub>2</sub> and crystallized during syn/post-eruption pneumatolytic stages. The mica sample studied here is among the most Fe- and Ti-rich fluorophlogopite found in nature. EPMA data yielded the following mean chemical formula for this mineral



Structure refinements on four fluorophlogopite crystals, performed in space group *C2/m*, converged at  $R = 0.03\text{--}0.04$ , with cell parameters in the ranges  $a = 5.323\text{--}5.324$ ,  $b = 9.219\text{--}9.222$ ,  $c = 10.116\text{--}10.119$  Å,  $\beta = 100.1\text{--}100.3^\circ$ . Major substitutions are  $\text{OH}^- \leftrightarrow \text{F}^-$ ,  $\text{M}^{3+}\text{-oxy} \leftrightarrow \text{M}^{2+}\text{-oxy}$  ( ${}^{\text{VI}}\text{M}^{2+} + \text{OH}^- \leftrightarrow {}^{\text{VI}}\text{M}^{3+} + \text{O}^{2-}$ ) and Ti-oxy substitution:  ${}^{\text{VI}}\text{Ti}^{2+} + 2(\text{OH})^- \leftrightarrow {}^{\text{VI}}\text{Ti}^{4+} + 2\text{O}^{2-}$ . The fluorophlogopite from Piano delle Concazze exhibits the shortest *c*-parameter with respect to other fluorophlogopites found in nature. The short *c* parameter is essentially due to the absence of the hydroxyl group in favor of F<sup>-</sup> and especially of O<sup>2-</sup> and to the thus increased attractive interaction between the interlayer cation and the anion content (F<sup>-</sup>, O<sup>2-</sup>) located at the O4 site. A comparison with other natural fluorophlogopites (namely from Biancavilla, Etna and Presidente Olegario, Brazil) show intermediate crystal-chemical features for the Piano delle Concazze fluorophlogopite. Particularly at Etna, differences in the chemical composition of the crystallized fluorophlogopites could be related to the various extent of enrichments by transfer of a gas phase achieved in specific parts of the volcanic plumbing system.

**Keywords:** Fluorophlogopite, crystal chemistry, substitution mechanisms, IR spectroscopy, volatile transfer