American Mineralogist, Volume 87, pages 142–153, 2002

Correlations of octahedral cations with OH^-, O^{2-}, Cl^-, and F^- in biotite from volcanic rocks and xenoliths

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ABSTRACT

To understand compositional variation in igneous biotite, full analyses of a suite of biotites of variable composition from volcanic and xenolith parageneses have been completed. Major and minor elements were determined by electron microprobe analysis, water was determined by manometry and SIMS analysis, and Fe^{3+}/Fe^{2+} was determined by microXANES and Mössbauer spectroscopy. Our new data, together with previous biotite analyses (total of 52 analyses), reveal correlations between O^{2-} (2-F-Cl-OH) and the sum of the octahedral cations Al + Ti + Fe^{3+} + Cr. This correlation allows estimation of either OH^- or Fe^{3+}/Fe^{2+} as long as one or the other has been determined. The hydroxyl site in most mantle micas contains at least 1.0 O^{2-} atoms per formula unit (apfu), indicating that the oxy-component cannot be ignored. The large oxy-component in melt inclusion micas from the martian meteorite Chassigny does not necessarily indicate oxidized or hydrous magmatic conditions because dehydrogenation may have occurred and/or because the oxy-component may be stable at low oxygen fugacity. The large variation in Ti, Al, and Fe^{3+} in natural igneous micas is most likely dependent upon bulk compositional differences in each specific system such as variation of a_{TiO_2} and $a_{Al_2O_3}$ in silicate melts.