Determination of Iron Oxidation State in Biotite Using Electron Probe Microanalysis

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The oxidation state of iron in minerals and silicate glasses is an influential indicator of redox conditions during magma generation and crystallisation. This results from oxygen fugacity, temperature, pressure, and melt composition. The Fe^{3+}/Fe^{2+} ratio, in particular, affects the local structure of silicate melts, thus influencing their physical and chemical properties, including viscosity, degree of polymerisation, heat capacity, density, and phase equilibrium. Several techniques have been proposed to accurately determine the iron oxidation state in minerals. In this study, a JXA-iHP200F electron probe microanalysis instrument was calibrated using garnet samples including almandine (Fe^{2+}-rich) and andradite (Fe^{3+}-rich), under conditions of 20nA beam current, 15 Kv accelerating voltage, 10 µm bean size, TAP as crystal, and 30 ms dwell time on peaks. The flank method was applied which encompasses searching for maximum and minimum positions of difference spectra between almandine and andradite and calculating the ratio of Lβ/Lα at those positions. Lβ/Lα values are sensitive to iron oxidation state, and thus to the Fe^{2+} contribution in specimen. A regression line between Lβ/Lα and Fe^{2+} has been successfully established for biotite samples collected from various global locations. This calibration may be applied in geological investigations.