Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35269

Determination of the $Fe^{2+}/\sum Fe$ ratio in Natural and Experimental Glasses with the EPMA flank method

PHILIP SIMON WIEGEL, RENAT R. ALMEEV, FELIX MARXER AND FRANCOIS HOLTZ

Leibniz University Hannover

Oxygen fugacity (fO_2) plays a key role in controlling the physicochemical evolution of magmatic systems e.g., compressibility, viscosity, volatile solubility, crystallization sequences. Constraining fO_2, therefore, provides insight into magmatic processes. fO_2 prevailing in magma reservoirs is commonly reconstructed from the $Fe^{2+}/\sum Fe$ ratio in glasses from volcanic rocks, determined using techniques such as XANES or Mössbauer spectroscopy. Although these methods provide data with high accuracy and precision, routine application is often limited by costs and instrument availability. The electron probe microanalysis (EPMA) based flank method offers a practical alternative, enabling routine, high spatial resolution measurements at lower costs. However, its application to glasses is limited by the scarcity of reliable calibration standards and by beam-induced redox changes affecting the FeLβ/FeLα ratio used to quantify Fe^{2+}.

In this contribution, we constrained the precision that can be reached for $Fe^{2+}/\sum Fe$ determination in glasses with EPMA. We acquired Time Dependent Intensity (TDI) data for the EPMA flank method with a JEOL JXA-iHP200F using a suite of synthesized dry and H_2O-bearing basaltic to andesitic glass standards spanning $Fe^{2+}/\sum Fe$ ratios from ~0.3 to 1. Furthermore, we investigated both natural and additional experimental glasses to assess beam damage and reliability of the flank method for different compositions.

Our results show that most samples exhibit a linear decay of the FeLβ/FeLα ratio with time when applying the following analytical conditions: 15 kV, 120 nA, 20 µm beam size, for an analysis duration of 120 seconds. Dry and hydrous (up to 1 wt%) basaltic glasses (e.g., typical mid-ocean ridge basalts) yield an analytical precision of $Fe^{2+}/\sum Fe \approx \pm 0.05$, which results in a precision of $\approx \pm$ 0.8 log fO_2 units near QFM. More hydrous glasses, show lower precision ($Fe^{2+}/\sum Fe \approx \pm 0.1$) due to their drastic decay and require exponential TDI corrections models. Precision also decreases with lower Fe content and higher alkali concentrations. The $Fe^{2+}/\sum Fe$ ratios obtained using our approach are in good agreement with independent reference values, highlighting the potential of the flank method as an accessible and reliable approach for redox state determination in a wide range of natural glass compositions with total FeO > 5 wt%.