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An experimental determination of the effect of pressure on the $Fe^{3+}/\Sigma Fe$ ratio of an anhydrous silicate melt to 3.0 GPa

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Abstract

The effect of pressure on the $Fe^{3+}/\Sigma Fe$ ratio of an anhydrous andesitic melt was determined from 0.4 to 3.0 GPa at 1400 °C with oxygen fugacity controlled internally by the Ru + RuO_2 buffer. Values of $Fe^{3+}/\Sigma Fe$ were determined by Mössbauer spectroscopy on quenched glasses with a precision of ±0.01, one standard deviation. This precision was verified independently by XANES spectroscopy of the same samples. The XANES spectra show a systematic increase in energy and decrease in intensity of the 1s → 3d transition with increasing pressure. The results to 2.0 GPa are in good agreement with predictions from density and compressibility measurements fitted to a Murnaghan equation of state, but the datum at 3.0 GPa has higher $Fe^{3+}/\Sigma Fe$ than predicted from the trend established by the lower-pressure data. This might be due to a coordination change in Fe^{3+} at high pressure; although there is no evidence for this in the Mössbauer spectra, such a change could account for the change in intensity of the 1s → 3d transition in the XANES spectra with pressure.

Keywords: redox ratio, silicate melt, XANES, Mössbauer, experimental petrology