

**IRON OXIDATION STATE AND MOLECULAR  
STRUCTURE OF MID-OCEAN RIDGE BASALT  
GLASSES: A RAMAN SPECTROSCOPY STUDY**

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The oxidation state of iron in natural glasses relates to the oxidation state of the magmatic source, and affects the molecular structure and physico-chemical properties of magmas. Insights into the redox conditions at depth, prior to fractional crystallisation and degassing, can be gained through the analysis of melt inclusions. The use of bulk techniques to measure iron redox, such as wet chemistry, is not possible for these sub-mm sized inclusions. Instead, micrometric techniques such as Fe K-edge X-ray Absorption Near the Edge Structure (XANES) spectroscopy are required. The latter has been successfully used to determine the redox state of, for example, komatiitic and Mid-Ocean Ridge magmas, yielding critical insights on the oxidation state of the mantle throughout Earth history. However, this technique requires double-polishing the inclusions as well as access to synchrotron light sources.

Raman spectroscopy offers an alternative way to determine the redox state of iron-bearing glasses. It is an easy-to-use and non-destructive technique, has micrometre spatial resolution, and requires minimal sample preparation. However, while these factors make Raman spectroscopy well suitable for the study of melt inclusions, the technique samples inelastic Raman-active vibrations from all the species in the glass, most of which do not include iron. As a result, the Raman signal from glasses is often difficult to interpret, such that it is difficult to use Raman as a quantitative tool.

A series of MORB glasses with  $Fe^{3+}/Fe_{TOT}$  ratios ranging from 0.0 to 1.0, determined by Mössbauer and Fe K-edge XANES spectroscopy, were used to develop simple Raman calibrations based on the intensity of specific peaks, or on more complex machine-learning linear and non-linear algorithms. The limitation of the Raman technique is that, currently, the calibrations are specific for a given composition. When correctly calibrated, however, Raman spectroscopy can determine  $Fe^{3+}/Fe_{TOT}$  to within  $\pm 0.05$ . Raman spectroscopy further allows one to investigate the changes in the molecular structure of MORB glasses that result from changes in the iron redox state.