Augite and enstatite standards for SIMS oxygen isotope analysis and their application to Merapi volcano, Sunda arc, Indonesia

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Measurement of oxygen isotope ratios in common silicate minerals such as olivine, pyroxene, feldspar, garnet, and quartz is increasingly being performed by Secondary Ion Mass Spectrometry (SIMS). Many mineral groups exhibit solid solution, however, which leads to compositional uncertainty such as in calcic clino-pyroxenes [(Ca, Mg, Fe^{2+}, Fe^{3+}, Al)$_2$(Si,Al)$_2$O$_6$] and magnesium-iron ortho-pyroxene [(Mg,Fe)$_2$Si$_2$O$_6$]. Variations in mineral chemistry can lead to instrumental mass fractionation (IMF) during SIMS analysis, which must be corrected using repeated analysis of compositionally similar standards to ensure accurate results. Here we report on new augite and enstatite pyroxene standards sourced from Stromboli, Italy and Webster, North Carolina, USA (Swedish Museum of Natural History mineral collection) in order to widen the current applicability of SIMS to mineral compositions in common igneous rocks. Aliquots of the crystals were analysed independently by laser fluorination (LF) to establish their true δ^{18}O values. Repeated SIMS measurements on randomly oriented fragments of the pyroxene crystals yielded a range in δ^{18}O less than $\pm$0.32‰ (1σ). The homogeneity tests also verified that the proposed standards do not show any crystallographic orientation bias and that they are sufficiently isotopically homogeneous on the 20 μm scale to be used as routine mineral standards. We tested the utility of our new standards by analysing pyroxene in well-characterised basaltic-andesite samples from Merapi volcano, Indonesia. SIMS data for Merapi augite overlap and exceed the published range of δ^{18}O values for Merapi bulk pyroxene separates, thus demonstrating that 20 μm scale resolution δ^{18}O analysis can reveal a level of isotopic detail that may be masked by bulk crystal or whole rock studies. This advance opens the possibility for rapid but detailed oxygen isotope crystal isotope stratigraphy on common igneous pyroxenes by SIMS.