

SIMS matrix effects in the analysis of light elements in silicate minerals: Comparison with SREF and EMPA data

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ABSTRACT

Matrix effects in secondary-ion mass spectrometric (SIMS) analysis of light elements (H, Li, Be, B, and F) have been investigated in phenacite, kornerupine, danburite, axinite, spodumene, tourmaline, hambergite, and mica, all of which were epoxy-mounted in a known crystallographic orientation relative to the primary-ion beam. As reference chemical information, we used data from electron microprobe analysis (EMPA) and from single-crystal structure-refinement (SREF) on the same crystals used for SIMS. Quantification of secondary-ion intensities into concentrations was done using Si as the reference matrix element. The results indicate that matrix effects due to crystallographic orientation are <10% relative, or below analytical uncertainty for most analyzed elements. In dioctahedral mica, there is a difference in H/Si ion yield (IY) of ~25% relative when the crystal is analyzed parallel and orthogonal to the main cleavage (which is perpendicular to the *c* axis). The magnitude of this effect is significant and higher than our SIMS accuracy for H in micas: $\pm 10\%$ relative.

Among the analyzed elements, Be is affected least by matrix effects, even when present as a major element. The most significant chemical effects on SIMS analysis of H, Li, F, and B in silicates seem to be related to the Fe (+Mn) content of the matrix: the light-element IY decreases as the Fe (+Mn) content increases, as previously seen in tourmaline, axinite, and kornerupine. Silicon and Al seem to have complementary and opposite effects on IY with respect to Fe and Mn. The agreement between SIMS and SREF is close for most light elements when they are present as major constituents. The results of our study also show that analytical problems are still present for B by EMPA, and this technique may not be adequate to measure B accurately in some minerals.