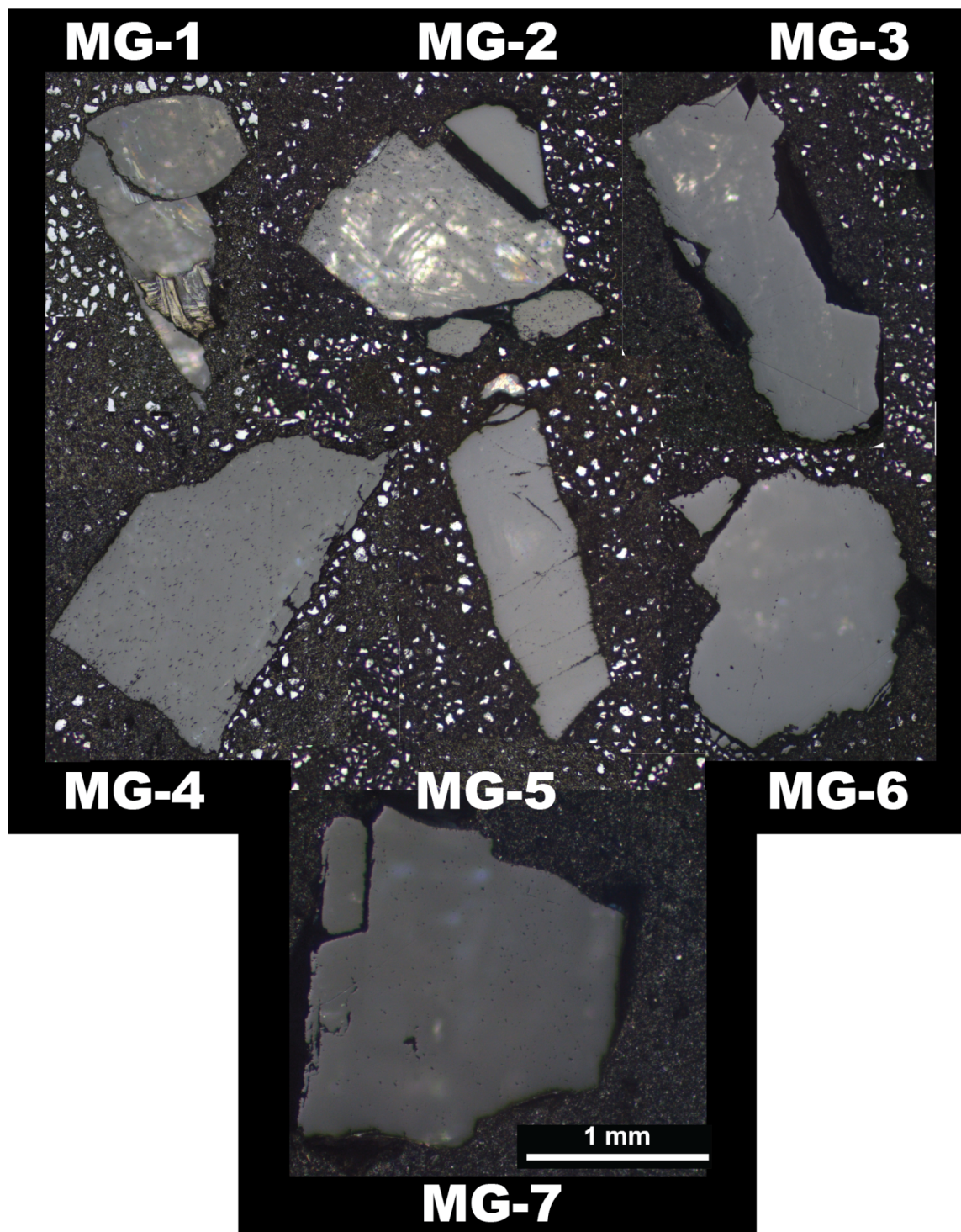
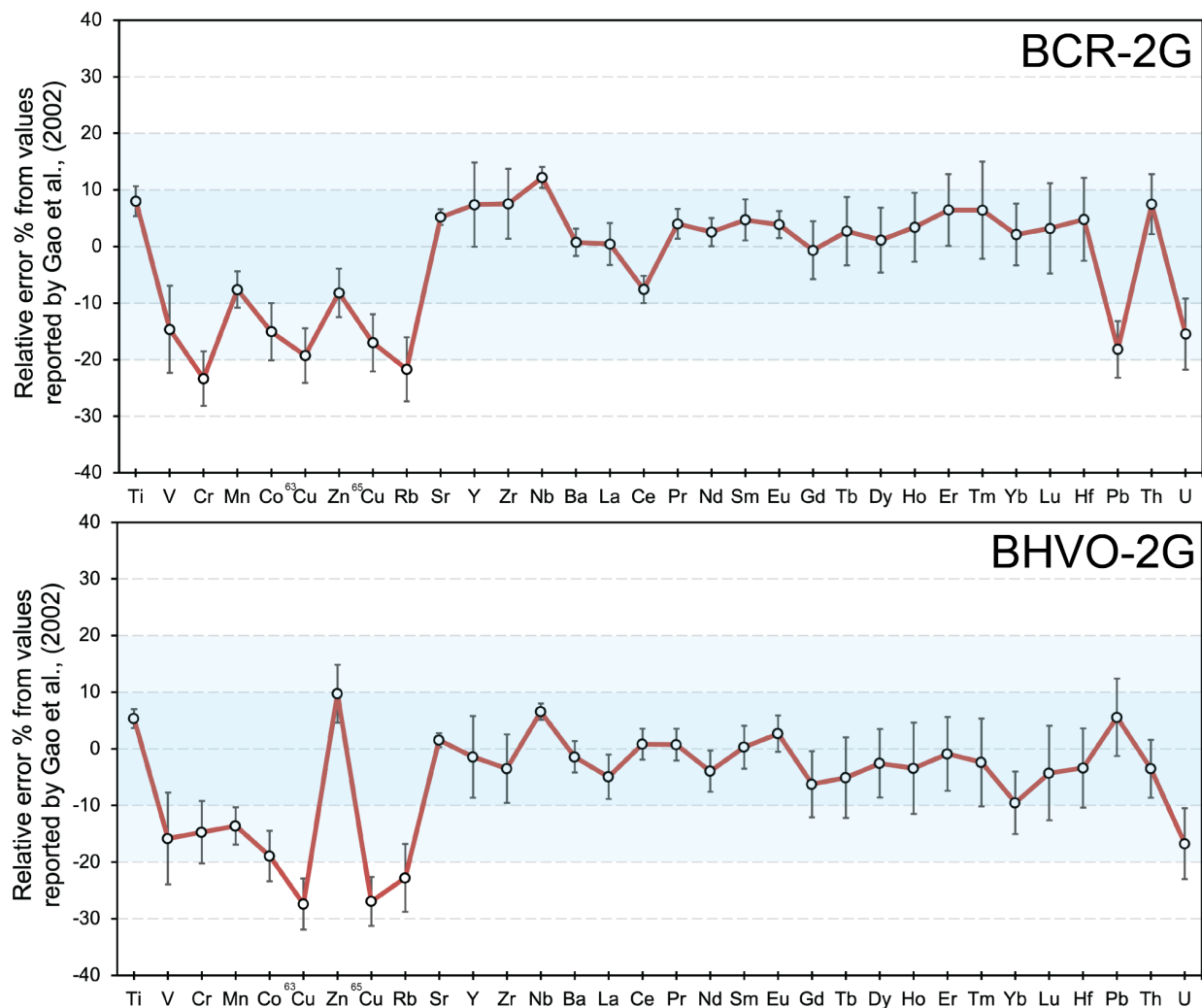


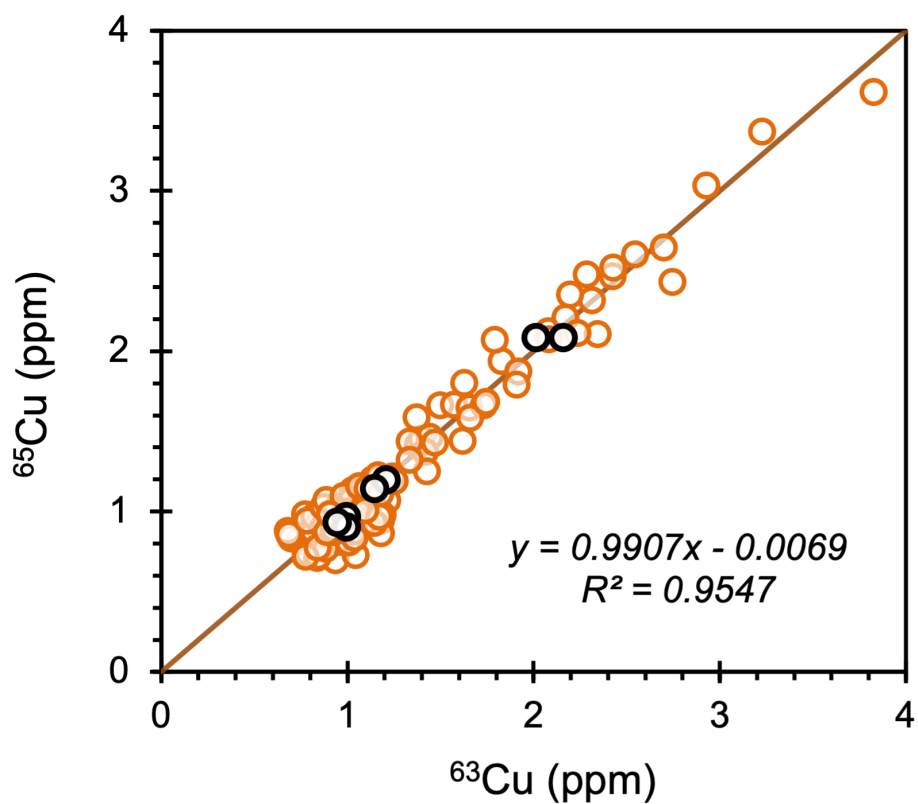
Supplementary Figure S1. Reflected light images of Miyake-jima anorthite crystals (MG-1 — 7) mounted in indium. Some anorthite crystals such as MG-1, MG-2, and MG-3 show strong internal reflection.



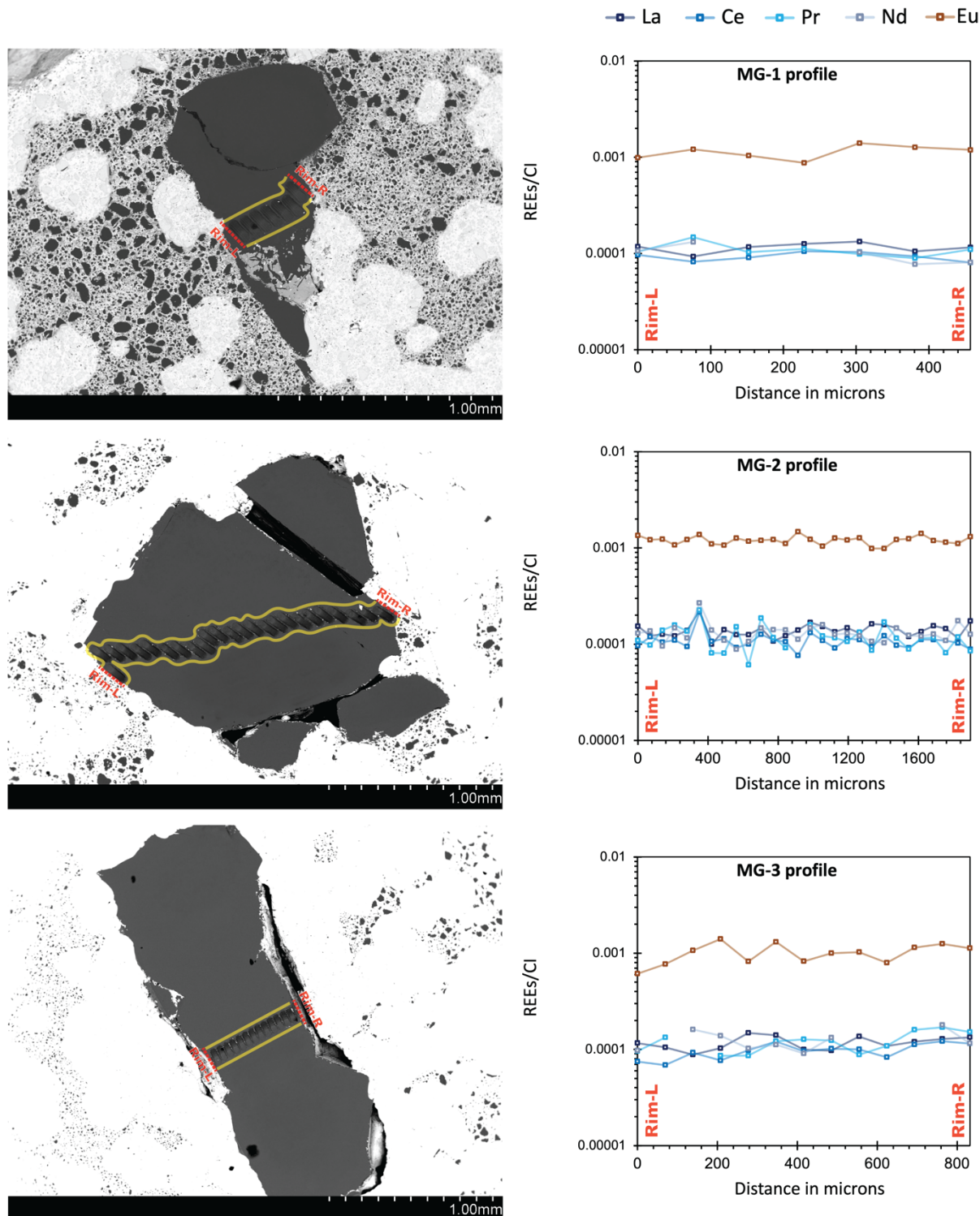
Supplementary Figure S2. Relative error of analyzed external reference material BCR-2G and BHVO-2G with respect to concentrations reported by Gao et al. (2002). Error bars are 1- σ standard deviations of the relative error means. The blue bands show error envelopes for 10% and 20%. Relative error data is based upon 12 BCR-2G and 12 BHVO-2G analyses.



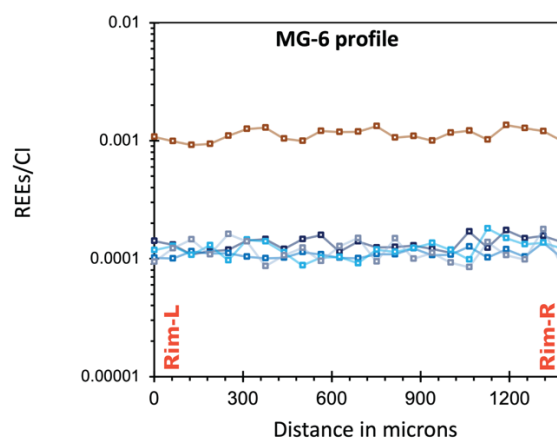
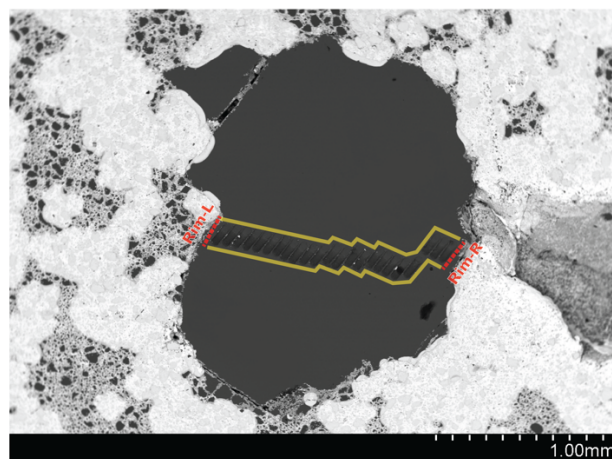
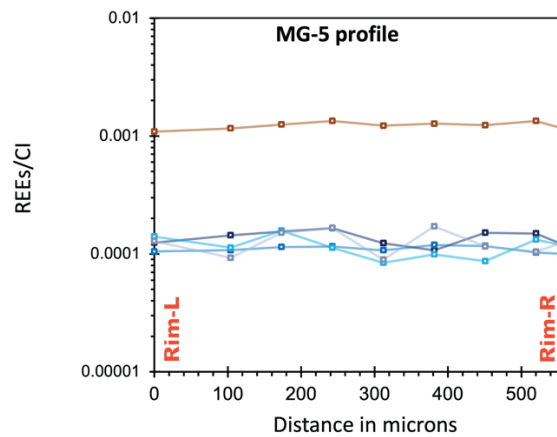
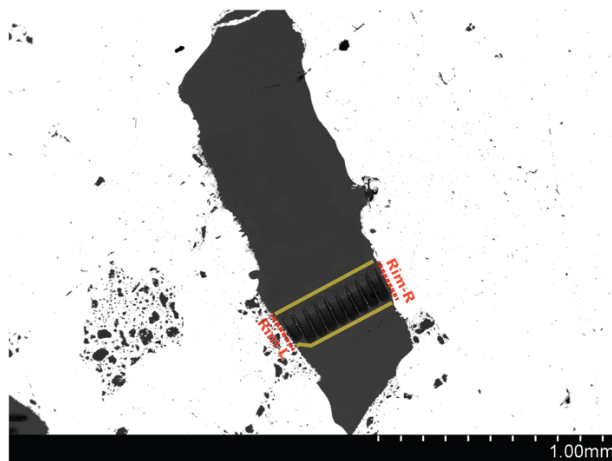
Supplementary Figure S3. Concentration of copper (in ppm) measured using ^{63}Cu and ^{65}Cu isotopes for individual analyses (orange open symbols) and grain core averages (black open symbols). 1:1 line is shown for reference.



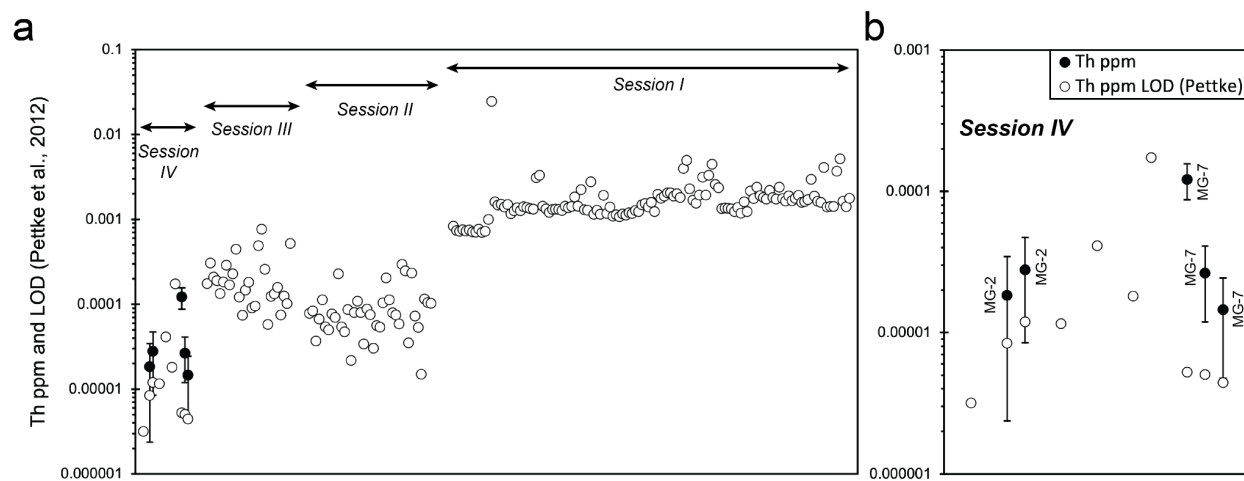
Supplementary Figure S4. Chondrite-normalized (McDonough and Sun 1995) individual LREEs across profiles of crystals MG-1, -2, -3, -5, and -6, where the distance on the x-axes represent scan steps from edge to edge of individual crystals. The corresponding BSE images show the pits formed due to ablation. These raster profiles have been reconstructed using data from ‘Session I’ where laser spot size of 35 μm were used to ablate raster lines of $\sim 75 \mu\text{m}$ length.



Supplementary Figure S4. *Continued.*



Supplementary Figure S5. Measured Th concentrations (with 2-sigma standard errors) and all limits of detection (LOD) for analyses of Miyake-jima crystals in (a) all sessions and (b) session IV.



Supplementary Figure S6. Comparison between analytical techniques for (a) Na (ppm) from SIMS and LA-ICP-MS techniques and (b) Ti (ppm) from SIMS and electron microprobe techniques. The opaque symbols in 2(b) have Ti concentrations derived from SIMS calibrated against only GSE glasses while the transparent symbols are calibrated against both NIST-series and GSE glasses. Gray line shows the 1:1 relationship. Red bars show 1-sigma standard errors of the mean of seven individual SIMS measurements and black bars indicate 1-sigma standard deviations arising from the average of analyses of multiple points with electron microprobe.

