Trace element partitioning between olivine and melt in lunar basalts

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Supplementary Materials

This file of research data and supplementary materials include the following:
(1) Calibration curves for measurement of trace element concentrations in olivine in lunar samples by LA-ICP-MS with various laser spot sizes, 65, 85 and 110 μm, respectively (Figs. S1-S3).
(2) Comparison of trace element concentrations in standards in this work by LA-ICP-MS with reference values (Table S1 in the data file, Fig. S4). The reference values are from GeoRem (Jochum et al. 2005, 2006, 2011).
(3) Calibration curves for measurement of trace element concentrations in olivine-hosted melt inclusions in lunar sample 12009 (Fig. S5).
(4) Comparison of trace element concentrations in standards in this work by SIMS with reference values (Table S2 in the data file, Fig. S6). The reference values are from GeoRem (Jochum et al. 2005, 2006, 2011).
(5) Trace element composition in San Carlos olivine (Table S3 in the data file) measured to assess LA-ICP-MS data quality. The measurement was on the same grain that has been measured by Spandler et al. (2010), and comparison was shown. Note that Spandler et al. (2010) used NIST standards 610 and 612, which contain trace element concentrations of ~500 ppm and ~50 ppm, whereas we used many more standards, especially including those with trace element concentrations as low as 0.02 ppm (NIST 616). In addition, to improve the analysis of Al in olivine, we specifically used a standard (SRM 1830 glass, containing 635 ppm Al) that contains fairly low Al concentration because Al concentration in olivine is low (other standards in our list contain ≥1.9 wt% Al_2O_3). Therefore, our data are expected to be more accurate for Al, as well as elements with < 5 ppm concentration in olivine, such as Ti, V, Y, and Zr. The comparison is excellent except for lower Al concentration by a factor of about 2 in our work.

In addition, all data behind the figures, plus raw SIMS data are in the data file in spreadsheet format.

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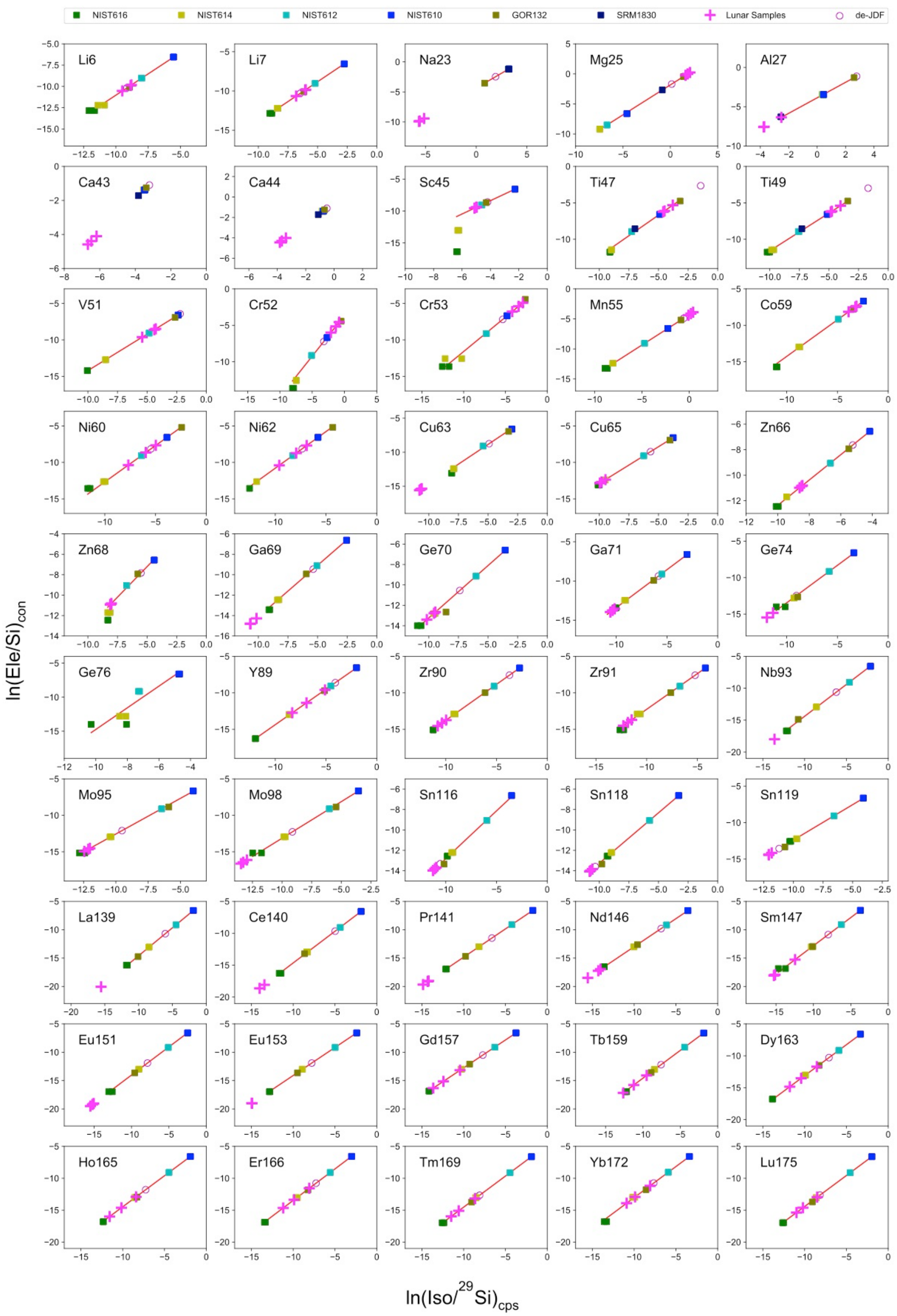

Fig. S1. Calibration curves for LA-ICP-MS analyses with 65-µm spot size. Lunar samples measured in this batch include: 74235-4, 12040-36, and 12040-41. All the standards in the plot are used for calibration.

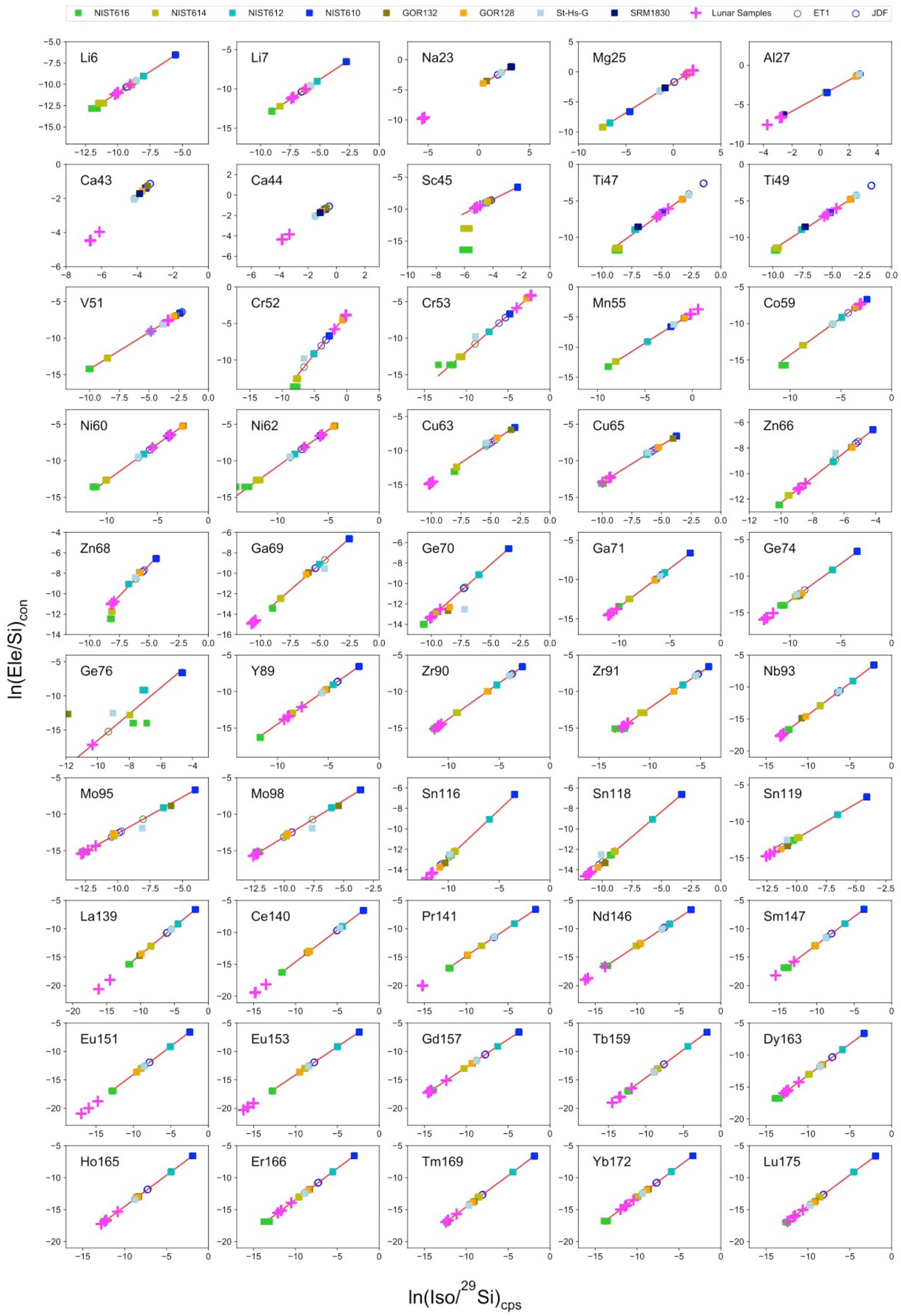

Fig. S2. Calibration curves for LA-ICP-MS analyses with 85-µm spot size. Lunar samples measured in this batch include: 12009-6, 12009-11, 15647-6, 15016-10. All the calibrations are shown here, however, the data reported are from ^{7}Li, ^{27}Al, ^{45}Sc, ^{49}Ti, ^{51}V, ^{53}Cr, ^{55}Mn, ^{59}Co, ^{60}Ni, ^{66}Zn, ^{89}Y, ^{90}Zr, ^{118}Sn, ^{157}Gd, ^{159}Tb, ^{163}Dy, ^{165}Ho, ^{166}Er, ^{169}Tm, ^{172}Yb, ^{175}Lu. For 15647-6, a very short time integration was used due to the bad spectrum shape.

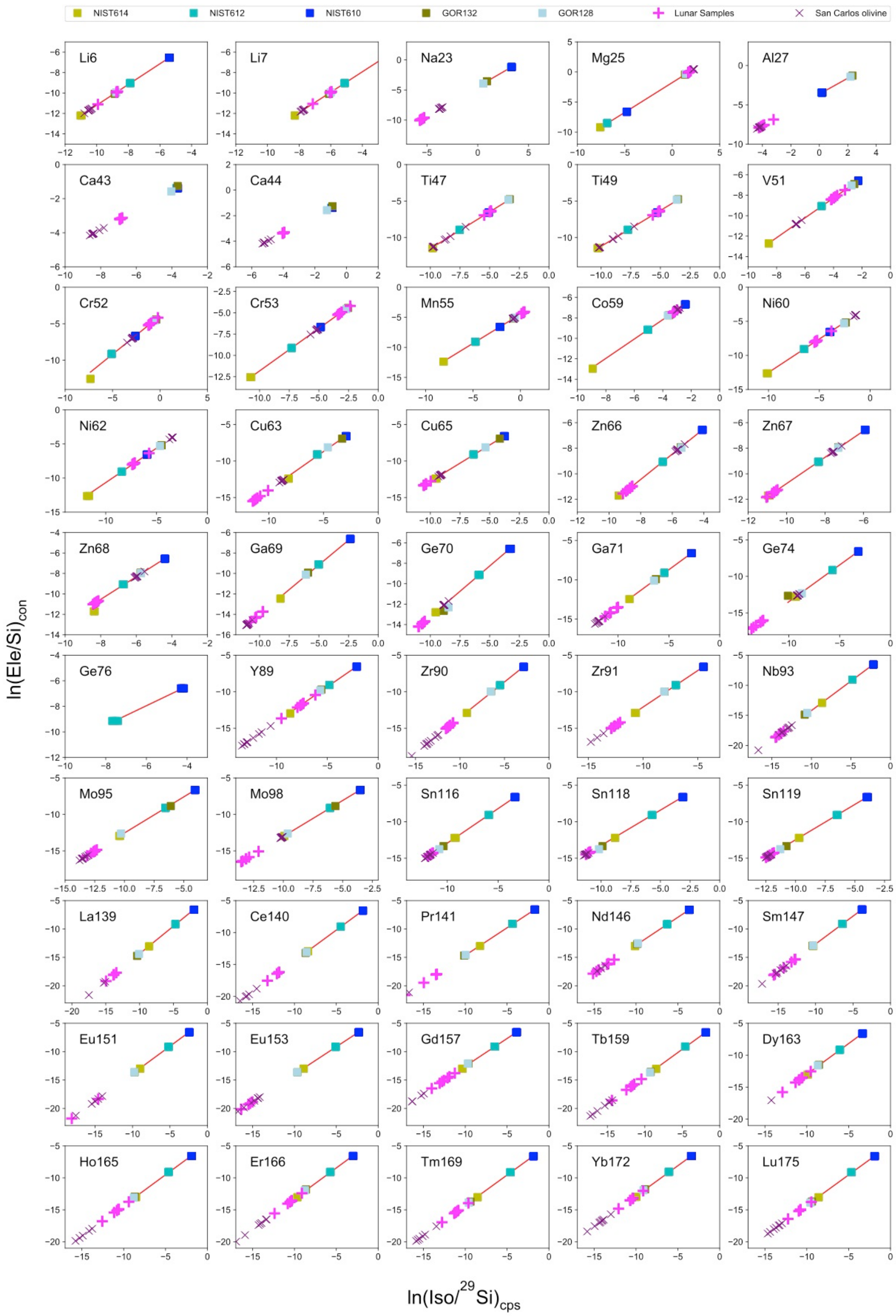

Fig. S3. Calibration curves for LA-ICP-MS analyses of San Carlos olivine with spot size of 110 μm. San Carlos olivine was measured in a different batch from the samples reported in this study. Therefore, a separate calibration was shown here.

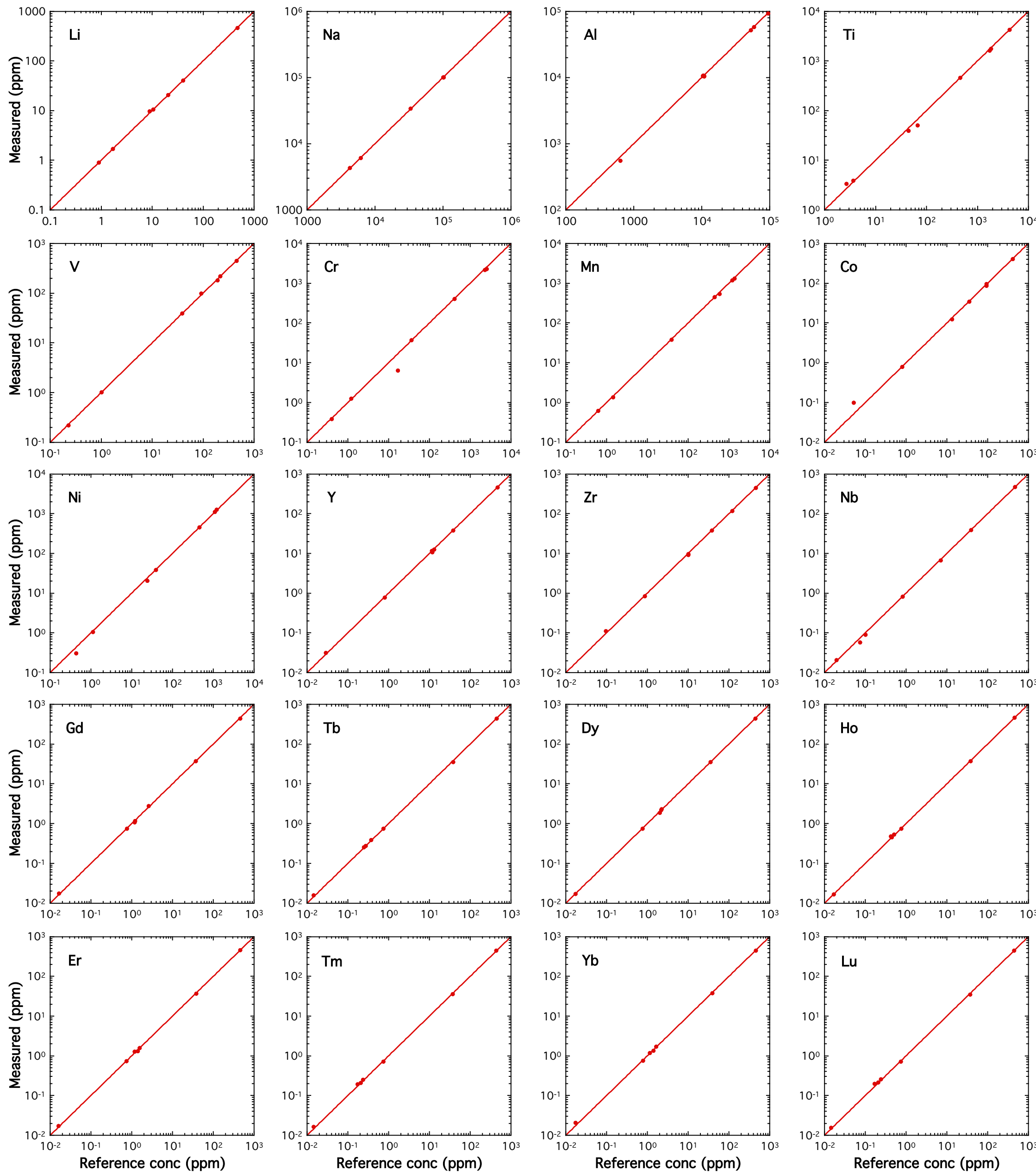

Fig. S4. Comparison of measured concentrations in 8 reference materials (five NIST standards NIST610, NIST612, NIST614, NIST616, and SRM1830; and three MPI-DING standards GOR-132G, GOR-128G, and St-Hs-G) for measurement of elements in olivine by LA-ICP-MS with reference values (GeoRem website, Jochum et al. 2005, 2006, 2011) or certified values. SRM 1830 is used for the calibration of low Al concentration in olivine, and only a few certified values are known. The error bars are about the size of or smaller than the symbols. The line in each panel is 1:1 line.

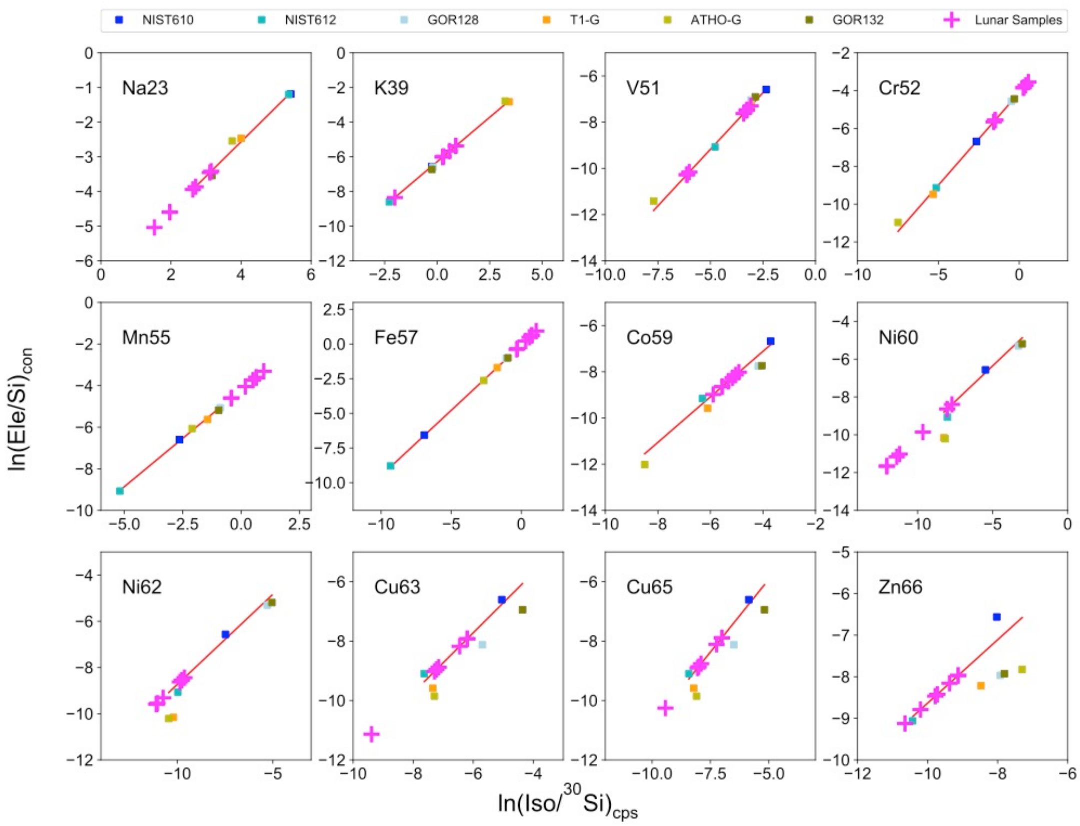

Fig. S5. SIMS calibration for transition elements for sample 12009-6 and 12009-11. Data reported are from ^{51}V, ^{52}Cr, ^{55}Mn, ^{59}Co, and ^{60}Ni. Data for Ni, Cu and Zn are not used because the calibration curves are deemed unsatisfactory.

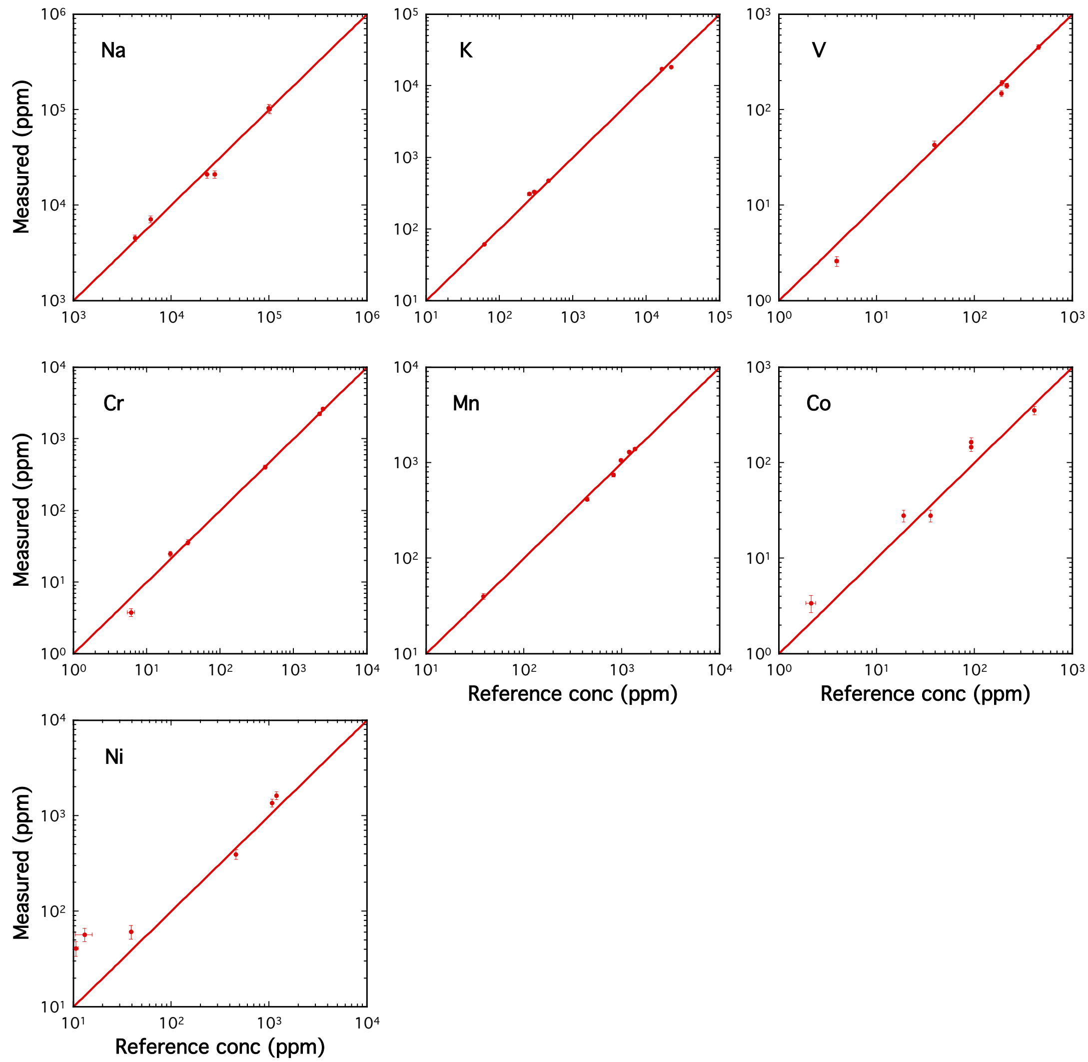

Fig. S6. Comparison of measured concentration in 6 reference materials (NIST standards NIST610, NIST612, and three MPI-DING standards GOR-132G, GOR-128G, T1-G and ATHO-G) for measurement of concentrations in melt inclusions in 12009-6 and 12009-11 by SIMS with reference values (GeoRem website, Jochum et al. 2005, 2006, 2011).