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High precision in situ Fe- and Mg isotope analyses of olivine and reference glasses by femtosecond laser ablation MC-ICP-MS

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High precision in situ stable isotope analyses of metals provide a powerful means to resolve small-scale isotopic variations of geological materials, such as diffusion-driven isotopic disequilibria between minerals. Femtosecond laser ablation (fs-LA) MC-ICP-MS has been proven to be capable to perform such analyses without laser-induced isotopic fractionation (e.g. for Fe and Si; [1, 2]). Here we show that this technique can be used to perform high precision Fe- and Mg isotope analyses on magmatic olivine and glass standards (from USGS: BCR-2G, BIR-1G, BHVO-2G and MPI-DING: ML3B-G, KL2-G, GOR128-G, GOR132-G).

Mg- and Fe isotope analyses are performed with sample-standard bracketing. Additionally, for the analysis of Fe isotopes we use an external mass bias correction by introducing a natural Ni standard solution (NIST SRM 986) to the plasma with a quartz glass spray chamber simultaneously to laser ablation of the sample. With this technique we achieve an internal precision of $\pm 0.05‰$ (2σ) for both Fe and Mg. The external reproducibility is $\pm 0.10‰$ (2SD) and $\pm 0.12‰$ (2SD) for δ^{56}Fe and δ^{26}Mg, respectively. Within these analytical uncertainties all analyzed glass standards are homogeneous in both δ^{56}Fe and δ^{26}Mg.

We use BHVO-2G or a synthetic MgO crystal as primary standards for Mg- and BCR-2G or IRMM-014 metal for Fe isotope analyses. The respective rock powders of these USGS glasses are well characterized by solution-based MC-ICP-MS, and our laser ablation data are consistent with these previously published data (e.g. [3, 4]). The MPI-DING glasses show δ^{56}Fe values (normalized to IRMM-014) between 0.02‰ (GOR128-G) and 0.13‰ (ML3B-G), in agreement with the range in δ^{56}Fe defined by global basalts and komatiites (e.g. [5]). δ^{26}Mg values (normalized to DSM-3) of the two Hawaiian tholeiitic basalt glasses (ML3B-G and KL2-G) and one komatiitic glass (GOR128-G) agree well with published data for global oceanic island basalts (-0.26±0.08‰ [6]). The other MPI-DING glass of komatiitic composition (GOR132-G) shows a slightly heavier δ^{26}Mg (-0.13±0.06‰).

Additionally, we have successfully applied the in situ Fe-Mg isotope analysis by fs-LA-MC-ICP-MS to investigate isotopic variations (of up to 1‰) in olivine pheno- and xenocrysts that were generated by diffusive Fe-Mg exchange during magma differentiation [7, 8]. Preliminary results revealed for several olivine grains coupled zoning of Fe-Mg isotopes and Mg# (Weyer et al., this conference), which may help to constrain time scales of magmatic evolution.

References:

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