Improved in situ Pb isotope analysis of low Pb samples by LA-ICP-MS using a solid-state 193 nm Nd:YAG laser

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We have tested the capabilities of a new solid-state 193 nm Nd:YAG laser ablation system for in-situ $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$ measurements by LA-ICP-MS. Experiments were performed with MPI-DING and USGS reference glasses using the fast electrical scan mode (0.075 s per pass) of a single collector sector-field mass spectrometer. Mass fractionation was corrected by concurrent analysis of NIST SRM 612. We typically obtained an external precision for $^{208}Pb/^{206}Pb$ and $^{207}Pb/^{206}Pb$ of 0.05 - 0.2 % RSD for 50 - 100 µm three-spot analyses of low-Pb (1 – 10 µg/g) MPI-DING glasses. The precision of Pb isotope ratio data of the high-Pb GSE-1G sample (366 µg/g) was < 0.2 % for spot sizes ≥ 10 µm. Even 2 and 5 µm spot size measurements could be performed with GSE-1G. The LA-ICP-MS data of the MPI-DING reference glasses agree within uncertainties (about 0.05%, 0.1% for $^{208}Pb/^{206}Pb$, $^{207}Pb/^{206}Pb$, respectively, and 100 µm spot size analyses) with the reference values obtained from TIMS and solution MC-ICP-MS. A comparison of the 193 nm Nd:YAG laser results with those obtained from a 213 nm Nd:YAG laser system shows that there is almost a factor of two improvement of precision using the new solid-state 193 nm Nd:YAG laser. Because of lower sample consumption of the 193 nm Nd:YAG laser, the Pb detection efficiency (2.5×10^{-3}) of the mass spectrometer is a factor of 2.5 higher than that using the 213 nm laser. Reasons for these improvements are the shorter wavelength (193 nm compared to 213 nm) and the shorter pulse width (2.8 ns compared to 5 ns) of the new laser ablation system. Thus, the mean particle size of the ablated material and localized heating of the sample is reduced leading to a more uniform mass fractionation.

As a result there is a variety of applications in geochemistry, cosmochemistry and environmental research, such as investigation of Pb isotopes in 50 – 200 µm large magmatic melt inclusions, where Pb concentration is in the 0.1 – 2 µg/g range or highly resolved 5 µm spot analyses in heterogeneous manganese crust, where Pb concentration is about 500 – 1000 µg/g.