The determination of sulfur concentration in silicate glasses and recrystallized silicate melt inclusions by LA-ICP-MS

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Sulfur is one of the most abundant volatile elements in magmas, typically present at 100-2500 ppm concentration level. Despite its relatively low concentration, it plays a critical role in magma-related ore genesis, and S-rich volcanic eruptions can also affect the Earth's climate. Reconstructing the variation of S concentration in silicate melts helps understanding the evolution of upper crustal magma reservoirs and associated ore-forming processes.

Silicate melt inclusions (SMI) in minerals provide a uniqe opportunity to track the variation of S concentration in the silicate melt phase of the magma. However, quantitative S analysis has so far required SMI quenched to a homogeneous glass either naturally or after reheating in the laboratory. Most often, neither of these processes produce bubble-free glassy SMI, and reheatig experiments also carry the risk of volatile loss from the SMI due to cracking of the host mineral induced by internal overpressure. Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) offers a unique opportunity to simultaneously obtain the concentration of S along with major and trace elements even from recrystallized SMI. We optimized analytical conditions for S analysis on a LA-ICP-MS consisting of an NWR-193 UC laser ablation system and an Agilent 7900 quadrupole mass spectrometer. The best results were obtained measuring ^{34}S, which is not significantly affected by O_2 interference. Application of a custom made ablation cell allowed reducing ^{34}S backgrounds to yield S detection limits around 30 ppm when ablating silicate glasses with a 40 μm beam at 10 Hz repetition rate and 7 J/cm^2 energy density. Accuracy and precision of S analysis was tested on a set of experimental glasses with S concentrations ranging from 140 to 16900 ppm as determined by electron probe microanalyzer (EPMA). Most LA-ICP-MS analyses yielded results consistent with the EPMA data within 6 relative%. The precision of the LA-ICP-MS analyses was 20 relative% at 140 ppm S concentration, and <5 relative% above 500 ppm S, comparable to the best achievebale values by EPMA. Analyses of unheated natural silicate melt inclusions yielded S concentrations consistent with EPMA data obtained on naturally glassy or reheated SMI from the same samples.