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Influence of S and Cl on the evaporation of Cu from silicate melts

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The evaporative loss of elements from silicate melts is a ubiquitous process in volcanic and planetary processes. Besides volcanic degassing on Earth, the possible evaporative loss of (moderately) volatile elements from precursor bodies plays a key role in the early evolution of terrestrial planets. Although degassing of elements is a big research topic within the last years[1-3] the evaporation behavior of most volatile elements like Cu remains poorly constrained. To extend our knowledge on evaporation and possible applications to the formation of Earth and other terrestrial planets, we investigated the degassing behavior of Cu from a silicate melt at 1200-1500 °C, a broad range of oxygen fugacity (δFMQ = -6 to air), and varying compositions including S and Cl as possible speciation-changing ligands in 1-atm gas mixing furnaces.

Volatile bearing glass chips[4] were suspended on Pt-wire and lowered into a vertical gas mixing furnace for 15 minutes. The oxygen fugacity was controlled by mixing CO and CO_2 gas. We measured starting materials and experiments by electron microprobe (EMPA) line profiles from the center to the rim of each grain (25 measurements per experiment) to identify possible diffusion profiles.

Results show that the volatility of Cu increases with increasing temperature and decreasing oxygen fugacity. Although Cu is suspected to evaporate as CuCl or CuS at high temperatures from volcanic magmas[5], and during experiments[6], our experiments show no significant change of the evaporation behavior of Cu as a function of Cl concentration. The addition of sulfur, however, leads to increased Cu evaporation from the silicate melt, especially at reducing conditions. Additionally, the degree of degassing in our experiments does not correlate with the 50% solar nebula condensation temperatures.

References

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