

**Experimental constraints on stable isotope fractionation due to evaporation from silicate melts.** S. Klemme C.J. Renggli<sup>1</sup>, <sup>1</sup>Institut für Mineralogie, Corrensstrasse 24, 48149 Münster, Germany. stephan.klemme@uni-muenster.de

**Introduction:** Loss of volatile and moderately volatile elements due to evaporation from silicate magmas on Earth and other planetary bodies is a common process, which can lead to strong elemental fractionation of volatile elements in volcanic systems. Whilst the loss of volatile elements during degassing of magmas has been studied recently [e.g., 1], only few experimental studies investigated the consequence of evaporation on the isotopic composition of the melt or the evaporating gas [e.g., 2-3].

Here, we report experimental data on the elemental loss and the stable isotope fractionation of Cr and Te during degassing of silicate melts [4-5].

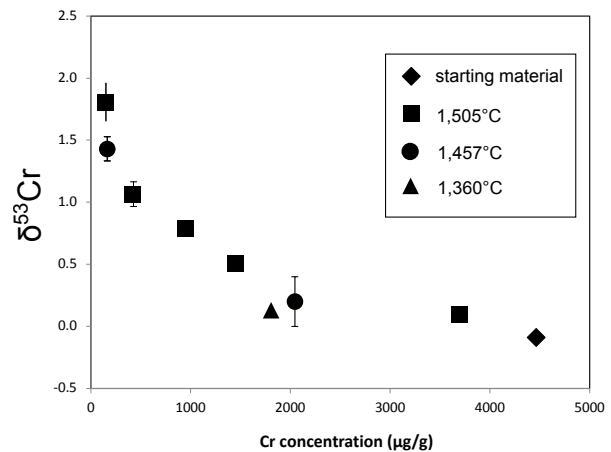
**Experiments:** The experimental starting materials were synthesized using reagent grade oxides (e.g., SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub>, etc). The starting material in the Cr-degassing experiments contained ca. 4500 µg/g Cr, and the starting material of the Te-degassing experiments contained ca. 1 wt.% TeO<sub>2</sub>. Experiments were performed using the Pt-wire loop technique [6]. To prepare the loops, we loaded about 20 mg of starting material (either powder or glass chips [7]) onto a 0.1 mm-thick Pt-wire loop. The samples were then introduced into the hotspot of a vertical alumina tube furnace (Gero GmbH, Germany). Temperature was controlled with a Eurotherm (Schneider Electric, Germany) controller, limiting fluctuations to within 1 °C. The Cr-degassing experiments were run between 1360 and 1505°C, all in air. The Te-degassing experiments were run at temperatures between 868°C and 1459°C, at redox conditions ranging from ΔFMQ -6 to air.

**Analyses:** The major element compositions were analyzed using a JEOL JXA 8530F Electron Microprobe that was calibrated with a variety of pure oxides and minerals of known chemical composition. Trace elements in the experimental run products were measured using laser ablation inductively coupled mass spectrometry (LA-ICPMS) at the University of Münster. Details of the LA-ICPMS method have been reported elsewhere [e.g., 8]. Cr isotopes were analyzed using double spike technique with thermal ionization mass spectrometry (TIMS) at the University of Münster, Germany, and details are reported in [4]. Te isotopes were measured using multi-collector inductively coupled mass spectrometry (MC-ICPMS) also at Münster University. Details are given by [5].

**Results and discussion:** Both Cr and Te are rather volatile in our experiments and consequently Cr and

Te-losses from the residual glasses are substantial. However, Cr and Te losses critically depend on temperature and run duration, with higher elemental losses at higher T and at longer run durations.

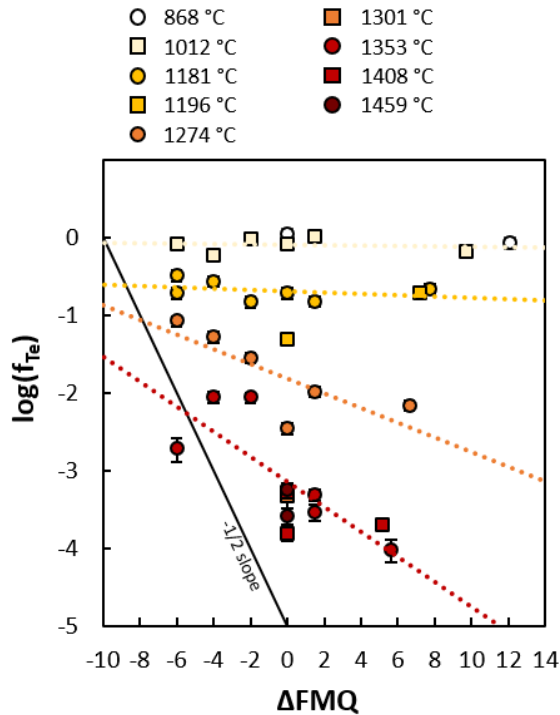
Cr isotopes are strongly fractionated during degassing from melts. As a consequence of degassing, the lighter isotope, <sup>52</sup>Cr, is enriched in the gas phase and hence the residual melt becomes enriched in heavier <sup>53</sup>Cr. However, Fig. 1 shows that about 50% Cr loss is needed to resolve an isotopic fractionation analytically.



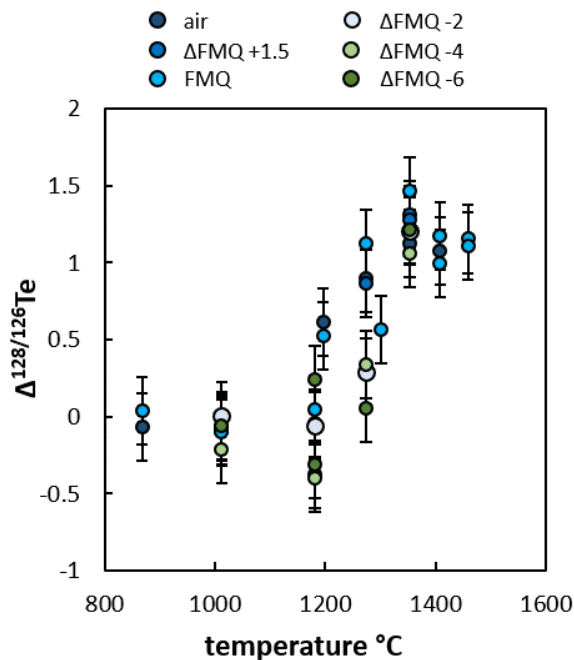
**Figure 1:** Cr isotopic composition of residual glasses ( $\delta^{53}\text{Cr}$ ) plotted against their Cr concentration ( $\mu\text{g/g}$ ). Diamond: starting material composition. Error bars plotted when larger than symbols. Figure modified from [4].

However, the volatility of moderately volatile elements also depends on redox conditions [1]. For example, the volatility of Te decreases with decreasing  $f\text{O}_2$  (Fig. 2).

Moreover, the isotopic fractionation behavior of Te also depends on temperature. At  $T > 1250^\circ\text{C}$ , the heavier isotope, <sup>128</sup>Te, is enriched in the residual melt during degassing. However, at  $T < 1250^\circ\text{C}$ , this behavior is inverted and the lighter isotope is enriched in the residual melt and the heavier isotope preferentially partitions into the gas phase (Fig. 3).



**Figure 1:** Experimental results from Te evaporation experiments from silicate melts. Logarithm of the fraction of undegassed Te to the starting material after 15 min. as a function of  $fO_2$  shown relative to the FMQ buffer. Figure modified from [5].



**Figure 3:** Experimental results from Te evaporation experiments from silicate melts. Stable isotope fractionation of Te as a function of temperature. Figure modified from [5].

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**References:** [1] Sossi P.A. et al. (2019) *GCA* 260, 204-231. [2] Richter F.M. et al. (2009) *Chem. Geol. Lett.* 258, 92-103. [3] Sossi P.A. et al. (2020) *GCA* 288, 316-340. [4] Klemme S. et al. (2022) *Chem. Geol.* 610, 121096. [5] Renggli et al. (2022) *GCA* 339, 35-45. [6] Wijbrans C. et al. (2015) *Contrib. Min. Petrol.* 69, 45-77. [7] Pangritz P. et al. (2013) *ACS Earth Space Chem.* 6, 1108-1111. [8] Beyer C. et al. (2013) *Chem. Geol.* 353, 132-139.