CRYSTAL ORIENTATION EFFECTS FOR OXYGEN-ISOTOPE MEASUREMENTS OF MAGNETITE AND CHROMITE .

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Introduction: Chromite ($FeCr_2O_4$) is a potential tracer of the populations of meteorites that have come to Earth over its geologic history [1]. However, in order to use oxygen isotopes to sort out this record, it is necessary to understand potential instrumental artifacts that could affect SIMS analyses. Huberty et al. [2] report a crystal-orientation fractionation effect for magnetite. Because chromite has the same crystal structure as magnetite, one might expect it to show a similar fractionation, but none has been reported [e.g., 3]. We carried out a set of measurements to examine whether crystal orientation influences the oxygen isotopic ratios obtained by SIMS for chromite and magnetite.

Experimental: We studied a magnetite sample from the El Laco volcano in the Andean Cordillera of northern Chile and a cumulate chromite sample from the Stillwater complex in the Beartooth Mountains of Montana. Electron backscatter diffraction (EBSD) analyses of carefully prepared one-inch round polished sections confirm the grains are randomly oriented in both samples. Oxygen isotopes (^{16}O and ^{18}O) were measured using the Cameca ims 1280 SIMS at the University of Hawai'i.

Results and Discussion: Eighteen magnetite crystals and sixteen chromite crystals with a wide range of orientations were selected for SIMS analysis. Three to six individual measurements were made on each grain. The SIMS spots were examined by SEM after analysis. After eliminating spots that hit cracks (which tended to give lower $\delta^{18}O$ values), most grains showed good reproducibility within individual grains. The total range of $\delta^{18}O$ values exhibited by magnetites was ~3‰ and by chromites was ~0.6‰. We were unable to connect the isotopic variations in either magnetite or chromite grains to crystallographic orientation [cf. 4]. A possible explanation for some of the variation in $\delta^{18}O$ for magnetite might be the structure that developed in the craters during sputtering. Chromite almost always showed smooth crater floors, but magnetite showed extensive pitting and differential sputtering. In some cases, the pitting appeared to be controlled by the crystal structure. The degree of roughness on the crater floor might affect $\delta^{18}O$ values. Our observations clearly showed that cracks crossing through the ion probe pit were excavated and widened by the ion beam, and these grains gave lower $\delta^{18}O$ values. However, pitting does not explain all of the $\delta^{18}O$ variation.

Conclusions: We prepared and carefully documented samples of volcanic magnetite and cumulate chromite and measured $\delta^{18}O$ in crystals with a wide range of orientations. While we found large variation in $\delta^{18}O$ in magnetite compared to those in chromite, we are so far unable to attribute the variation to crystal orientation in the ion probe.

References: [1] Schmitz B. 2013. *Chem. der Erde* **73**:117-145. [2] Huberty J. et al. 2010. *Chem. Geol.* **276**:269-283. [3] Valley J. W. and Kita N. T. 2009. *MAC short course: secondary ion mass spectrometry in the earth sciences*, **41**:19-63. [4] Caplan C. E. et al. 2015. Abstract #2794. 46th LPSC. Supported by NASA grant NNX14Al19G to GRH.