

FURTHER STUDIES OF THE HYDROUS ALTERATION AND OXYGEN ISOTOPIC FRACTIONATION OF REFRACTORY CONDENSATES; R. N. Nelson (Georgia Southern College), S. K. Bhattacharya, M. H. Thiemens (UCSD) and J. A. Nuth (GSFC)

Samples of FeO_x , SiO_x and TiO_x were prepared in the flow condensation apparatus¹ at GSFC from gas mixtures of $\text{Fe}(\text{CO})_5\text{-O}_2\text{-H}_2$, $\text{SiH}_4\text{-O}_2\text{-H}_2$ and $\text{TiCl}_4\text{-O}_2\text{-H}_2$, respectively at temperatures of 750 K and 1000 K. These samples were first sent to UCSD for oxygen isotopic analysis and then to Georgia Southern College for studies of hydrous alteration at 350 K. In addition, additional studies of the hydrous alteration of previously prepared samples of Fe-Al-Si oxide smokes were carried out at Georgia Southern College. Results from both the isotopic fractionation and the hydrous alteration experiments will be presented. Preliminary results from the isotopic fractionation experiments are described below.

Oxygen was extracted from the condensates by pumping on the samples for at least 10 hours at 400°C. An aliquot of BrF_5 was then admitted to the nickel reaction tubes at room temperature for 3 hours in order to etch away any adsorbed oxygen bound on the surface which had not been thermally released. Oxygen was ultimately removed from the etched samples by overnight reaction with BrF_5 at 800°C.

The stoichiometry of all samples is less than that expected for TiO , SiO or FeO . While it is possible, albeit unlikely, that some oxygen was removed during the etching at room temperature, that process would not result in isotopic fractionation of the condensates. Similar etching of isotopically known standards does not result in either fractionation of the material or the evolved gas. Although it is not yet certain, the oxygen deficiency appears to be a result of the grain formation process, rather than a result of the analytical procedure.

The isotopic fractionations observed are clearly non-equilibrium (see Table 1). For example, the different SiO_x samples yield the same isotopic ratios, even though the experiments were performed at two significantly different temperatures (750 K and 1000 K). In addition, the SiO_x and FeO_x experiments likewise produce similar results (within 1 per mil), though at equilibrium the $\delta^{18}\text{O}$ of SiO should be approximately 8 per mil lighter than that of FeO . TiO should similarly be 12 per mil heavier than SiO whereas it is only enriched by 5 per mil. The observation that the condensates are depleted in ^{18}O relative to the composition of the gas phase, is consistent with a kinetically dominated process in that an equilibrium process should enrich the condensate in ^{18}O rather than deplete it as we observe.

Finally the observed variability for duplicate analyses (Table 1) is probably due to sample heterogeneity, and significant isotopic differences exist between, e.g., TiO and SiO-FeO , although the cause of the difference is not understood at present.

TABLE 1

Sample Designation	wt. (milligrams)	O ₂ Yield (micromoles)	$\delta^{18}\text{O}$ (per mil)	$\delta^{17}\text{O}$ (per mil)
SiO _x -818(750)	2.77	22.1	- 12.5	- 6.1
SiO _x -819(1000)	4.40	6.0	- 12.6	- 6.2
SiO _x -819(1000)	7.97	13.6	- 13.8	- 6.7
FeO _x -826	7.97	64.6	- 11.4	- 5.8
FeO _x -826	8.90	74.8	- 12.1	- 6.2
TiO _x -814	8.96	60.4	- 7.3	- 3.7
TiO _x -814	8.23	76.5	- 9.0	- 4.6

Isotopic composition is with respect to the composition of the O₂ in the reaction mixture.

Reference

1. Nuth, J. A., Nelson, R. N., Thiemens, M. H., and Donn, B. D., 1987, Abstract submitted to the XVIIIth LPSC, pps. 726-727.