CARBON AND SULFUR ABUNDANCES IN 74001/74002 DRIVE TUBES FROM SHORTY CRATER, Everett K. Gibson, Jr., SN7/Geochemistry, NASA Johnson Space Center, Houston, TX 77058 and Fikry Andrawes, Lockheed Electronics Co., Inc., Houston, TX 77058.

The material in 74001/74002 consists mainly of droplets of ultramafic composition consisting of homogeneous orange glass or their partially crystallized equivalent, black glass droplets (1). There has been a variety of explanations for the origins of these glasses; hypotheses including volcanic and impact processes and an impact of a meteorite into a lava lake (models summarized in (1)). Gibson and Moore (2) noted the variable carbon contents of the orange soil 74220. Carbon concentrations ranged from 3.6 to 100 μgC/g. In addition to the carbon variations, detailed studies of the surfaces of the glassy particles showed that sulfur was a major phase which had been condensed or sublimated onto the surfaces of the glass droplets (3,4). The surface condensates of sulfur along with other volatile trace elements suggests that 74220 and 74001 may have been drived from a pyroclastic event and the surface coatings represent samples of volcanic volatiles (5).

In this paper we report carbon and sulfur abundances in seven samples from 74001/74002, the orange soil 74220, and the Apollo 15 green glass 15427. Total carbon and sulfur measurements were made using the procedures of (6,7). Portions of all of the samples were heated to 1000°C for 24 hours under vacuum (10^{-6} torr, $P_{O_2} < 10^{-10}$ atms.) in order to remove the surface carbon and sulfur. Analysis of the heat-treated samples provided information on the original carbon and sulfur contents of the ultramafic glasses prior to the encrustations of the volatile phases on the droplet's surfaces (2). The analytical results are given in Table 1.

Total carbon abundances for seven samples of 74001/74002 ranged from 5 to 30 μgC/g with a mean of 16 μgC/g. No direct correlation of total carbon abundances with sample depth or orange to black glass transition zone was noted. The heat-treated samples ranged from 4 to 15 μgC/g and had a mean residual carbon of 9 μgC/g. Heat treatment removed between 20 to 57 percent (mean of 42 percent) of the carbon present. Orange soil 74220 and green glass 15427 contained 80 and 12 μgC/g respectively and upon heating the carbon concentrations were reduced to 50 and 5 μgC/g, respectively.

Total sulfur abundances for the 74001 and 74002 samples ranged from 420 to 750 μgS/g and a mean sulfur value of 549 μgS/g. Lower sulfur abundances were noted for samples from 74001 (with one exception). Heating under vacuum reduced the sulfur abundances around 83% (mean of 7 samples) and the residual sulfur contents ranged from 30 to 150 μgS/g. Orange soil 74220 and the green glass 15427 contained 820 and 330 μgS/g respectively, and upon heating the sulfur concentrations were reduced to 80 and 225 μgS/g respectively.

Sulfur abundances for the samples from 74001/74002 and 74220 glasses are only one-quarter the mean sulfur abundances for the Apollo 17 basalts (mean value of 1880 μgS/g) (8). If the orange and black glasses, which have mafic compositions similar to the Apollo 17 basalts (1), are related to the source regions from which the Apollo 17 basalts were derived, these glasses have been very effectively outgassed of their sulfur or their sources were depleted in sulfur initially. However, the abundances of surface sulfur implies that the sulfur was condensed or sublimated onto the droplet's surfaces at the time of

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System

CARBON AND SULFUR ABUNDANCES IN 74001/74002

Gibson E.K. and Andrawes F.

their formation from a volatile phase rich in sulfur-bearing species (3,4). Heating experiments showed that an average of 83 percent of the surface sulfur was removed by simple heat treatment. Enrichment in surface sulfur implies that the volatile phases associated with the formation of the orange and black droplets found in 74001/74002 were very rich in sulfur (e.g., S_2) in agreement with the observations of (2,3,4).

To check for the presence of any volatile phase (e.g., H_2, CO, CH_4, N_2, O_2, CO_2, Ar) trapped in the orange droplets, samples of the 74220 were crushed and the released volatile phases analyzed under the conditions described by Gibson and Andrawes (1978, this volume). The only volatile phase released upon crushing was nitrogen in the amount of 2.5 ngN/g. No carbon gases were seen at a detection limit of 0.3 ngCH_4, 0.6 ngCO and 3.9 ngCO_2. Any sulfur gases released upon crushing would not have been detected because of the chromatographic columns used for the experiments. The absence of any carbon gases released upon crushing along with the low carbon abundances obtained for 74001/74002 samples implies that the volatile phases associated with the formation of the orange and black droplets was either initially depleted in carbon and no significant carbon species were retained or the subsequent heating within the deposition blanket of 74001/74002 caused the loss of carbon phases which had condensed on the surfaces. However, the later model implies that the temperatures were sufficiently high for carbon loss, but not great enough to produce major sulfur loss from the 74001/74002 materials.

REFERENCES:

1. G. Heiken et al. (1974) Geochim. Cosmochim. Acta 38, 1703-1718.
2. E.K. Gibson and C.B. Moore (1973) Earth Planet. Sci. Lett. 20, 404-408.
3. C. Meyer et al. (1975) Proc. Lunar Sci. Conf. 6th, 1673-1699.
4. P. Butler and C. Meyer (1976) Proc. Lunar Sci. Conf. 7th, 1561-1581.
5. G. Heiken and D. McKay (1977) Proc. Lunar Sci. Conf. 8th, 3243-3255.
6. E.K. Gibson et al. (1976) Proc. Lunar Sci. Conf. 7th, 1491-1505.
7. C.B. Moore et al. (1970) Proc. Apollo 11 Lunar Sci. Conf., 1375-1384.
8. E.K. Gibson (1977) Phys. Chem. Earth 10, 57-62.

TABLE 1. TOTAL CARBON AND SULFUR ABUNDANCES

Sample	Depth, cm	Carbon, μgC/g		Sulfur, μgS/g	
		Initial	Post-Heating	Initial	Post-Heating
74220,20	Surface	80 ± 10	50 ± 8	820 ± 20	80 ± 10
74002,1104,1106,1108	5.5-7.5	9 ± 3	4 ± 2	420 ± 20	120 ± 10
74002,1093,1095,1097	13.5-15.5	30 ± 4	13 ± 3	680 ± 30	110 ± 10
74002,1084,1086,1088	18-20	17 ± 4	9 ± 3	590 ± 30	150 ± 10
74002,1071,1073,1075	26.5-28.5	21 ± 4	15 ± 3	750 ± 40	65 ± 10
74001,1076	37	5 ± 3	4 ± 2	510 ± 40	30 ± 5
74001,1080	44	9 ± 3	5 ± 2	440 ± 20	70 ± 10
74001,1089	57.5	20 ± 4	11 ± 3	450 ± 20	70 ± 10
15427,44	Surface	12 ± 4	5 ± 2	330 ± 20	225 ± 20

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System