FIRST COSMIC DUST TRACE ELEMENT ANALYSES WITH THE SYNCHROTRON XRF MICROPROBE

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The chondritic class of cosmic dust particles collected in the stratosphere generally exhibits major and trace element concentrations similar to the CI meteorites [1]. However, two intriguing differences have previously been reported, (1) a depletion in the refractory Ca relative to CI [1], and (2) enrichments in the volatiles Zn [2] and Br [3] relative to CI. In order to further characterize this class of particles, we have measured trace element abundances in three chondritic cosmic dust particles (U2022G1, W7029K1, and U2015G1) using the synchrotron x-ray fluorescence (SXRF) microprobe at the National Synchrotron Light Source (beamline X26C), Brookhaven National Laboratory (NY).

Two of these particles (U2022G1 and W7029K1) exhibited typical chondritic EDX spectra in the JSC characterization, showing major peaks due to Mg, Si, S, Ca, Fe and Ni as well as detectable Al peaks. The third particle (U2015G1) had a lower S abundance and exhibited EDX detectable amounts of K and Zn in the JSC characterization. Each particle was excited with a 40 micrometer diameter beam of white "continuum" synchrotron radiation. X-ray spectra were taken in air with an Si(Li) detector. A 85 micrometer aluminum detector filter was used to suppress the strong Fe lines and thereby eliminate pileup effects. Live acquisition times ranged from 900 to 10^4 seconds.

To avoid contamination from handling, no effort was made to clean the particles prior to analysis. Instead, each particle was transfered directly from its JSC glass slide shipping container to an individual 8 micrometer thick Kapton foil upon which the samples were studied. Thus, the synchrotron beam excited Kapton and residual silicon oil during analyses. Zn was the only significant interference from the Kapton. The spectrum for a large drop of the oil (roughly 100 micrometers in diameter) on the Kapton was indistinguishable from the Kapton spectrum.

In our largest particle (U2022G1, about 25 micrometers in diameter) instrument sensitivity allowed us to measure abundances of most elements from Cr to Br with a 3 hour data accumulation (figure 1). The two smaller particles had shorter accumulation times, resulting in detection limits below CI concentrations for some elements. A 5 micrometer diameter fragment of U2015G1 broke off from the main mass during shipping and was mounted separately for a 15 minute analysis (U2015G1 frag 2).

Elemental abundances were obtained using the *NRLXRF* analysis package which corrects for absorption by filters and specimens. Particles were assumed to be 0.001 g/cm^2 thick (a sufficiently accurate value for the present work). Concentrations were estimated using Fe as an internal reference element. For this preliminary work, the Fe content was assumed to be 18% for U2022G1 and W7029K1 based on the observation that their EDX spectra have Fe/Si comparable to that in the JSC carbonaceous chondrite standard spectrum. An Fe content of 9% was used for U2015G1 since its JSC spectrum shows Fe/Si about a factor of two lower.

Table 1 gives the results of these analyses. In general, the concentrations are within a factor of 2 of the CI values. However, all three particles exhibited an enrichment in Br ranging from 3 to 37 times the CI abundance. Zn was consistent with the CI value in two of the particles but greatly enriched in the third.

COSMIC DUST TRACE ELEMENTS
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Acknowledgments: NASA NAG9-32 (M. Prinz); NAG9-106 (J. V. Smith); NSF, EAR-8313682 (J. V. Smith); D. O. E., DE-ACO2-76CH00016) (B. N. L., K. Jones; J. V. Smith).

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Table 1: Elemental Concentrations (ppm) and Abundances Relative to CI in 3 Cosmic Dust Particles

Particle	Cr	Mn	Ni	Cu	Zn	Ga	Ge	Se	Br
U2022G1	2060	990	1.09%	180	310	7	40	26	130
/CI	0.92	0.58	0.96	1.6	0.97	0.69	1.3	1.4	37
W7029K1	2000	810	0.65%	240	210	23	28	63	10
/CI	0.88	0.47	0.59	2.1	0.67	2.3	0.88	3.5	2.8
U2015G1	730	150	5000	nd	1.2%	nd	nd	nd	100
/CI	0.33	0.09	0.45		38				28
U2015G1(frag 2)	nd	nd	0.15	nd	1300	nd	nd	nd	130
/CI			0.15		4.3				37

nd = not detected

Figure 1: Particle U2022–G1