COMPOSITIONAL VARIATIONS IN COSMIC DUST-SIZED PIECES OF MURCHISON MATRIX:
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Introduction. A suite of sixteen samples of the matrix of Murchison weighing from 1.4 to 96 nanograms were analyzed by high precision instrumental neutron activation analysis (INAA). The purposes of the exercise were to compare observed compositional variations with those in interplanetary dust particles (IDPs) of similar size, as well as to serve as practice samples for developing our analytical techniques [1]. Here we report analyses for Fe, Sc, Cr, Co, and Ni, among the most accurately determined elements by INAA.

Analytical. Samples were removed from matrix regions of a thin section of the meteorite and were analyzed for major elements by scanning electron microscope/energy dispersive X-ray (SEM/EDX) techniques. INAA procedures used were similar to those of [1]. These samples were irradiated in the Missouri University Research Reactor for 154 hours at a nominal flux of 4×10^{14} $cm^{-2}sec^{-1}$. Gamma-ray counting continued for about seven weeks after irradiation, each sample being counted several times, at least once for a full day. Masses of the samples were estimated by using the INAA values for absolute Fe abundances (obtained by comparison with standard glasses weighing tens of micrograms) and the Fe values from SEM-EDX analyses. After completing the INAA, we will submit some matrix grains to ultramicrotomy and mineralogical characterization by HRTEM. This examination should also reveal any mineralogical changes produced during the high-flux irradiation. These samples could also serve well as inter-laboratory comparison standards.

Results. Analyses are given in the table, listed in order of increasing iron content. Iron abundances are those from the EDX analyses, while the uncertainties are those associated with INAA analyses for Fe. The figure shows the same data normalized to CI chondrites [2], with the numbers on the x-axis being the normalized Fe concentrations.

Discussion. The mineralogy of Murchison matrix is dominated by serpentine with varying Fe content. Other minerals present are pyrrhotite, pentlandite, tochilinite, olivine, chromite, kamacite, calcite and magnetite. Variation among Murchison matrix samples is due primarily to the relative amounts of Fe-poor (fine-grained) vs. Fe-rich (coarse-grained) serpentine [4]. Given this fact, the iron content of any particular Murchison matrix sample is mainly an indicator of the average composition of serpentine in that particle. Therefore, the analyzed samples listed in order of increasing Fe content are also listed in order of increasing Fe content of the serpentine and grain size. Bulk analyses of these particles by EDX support this view, in that the sample highest in Fe has the lowest Mg and Si abundances, and the sample lowest in Fe has the highest Mg and Si abundances. Compositional effects due to varying accessory mineralogies are superimposed upon this major trend. Individual matrix grains with relative enrichments in Ni probably include larger amounts of pentlandite, tochilinite, or kamacite (which has approximately 5 wt.% Ni here). Cr content is probably most directly tied to the modal content of chromite. The dominant carrier of Sc in this material is not known, yet sizable variations in Sc content are observed.

A few features in the data are worth noting here. 1) Samples with relatively high Fe content have Ni/Co ratios that are essentially constant at the chondritic value, while those having lower Fe tend to have Co enriched relative to Ni. 2) The chromite-rich sample M1 is also enriched in Sc, suggesting a correlation of those two elements, yet the sample lowest in Sc is not low in Cr. 3) The total range of variation is smaller for Fe (highest is 1.6x the lowest) than for the other elements (Sc=15x, Cr=7x, Co=5x, Ni=6x). EDX analyses for well-determined major elements span similar ranges (Si=1.8x, Mg=4x, S=3x, Ca=3x).

These Murchison matrix results suggest that one would expect to observe similar compositional heterogeneity in similarly fine-grained hydrated IDPs. A full understanding of these compositional heterogeneities will require detailed mineralogical analysis, which we are now undertaking.

References: [1] Lindstrom et al. (1989) Lunar Planet Sci. Conf. XX, 574-575. [2] Anders and Grevesse (1989) Geochim. Cosmochim Acta 53, 197-214. [3] Lindstrom et al., this volume. [4] Zolensky et al., this volume.

COMPOSITIONAL VARIATIONS IN MURCHISON: Lindstrom D. J. et al.

		Fe	Sc	Cr	Co	Ni
M13	6.1 ng.	22.5 ± 0.5	7.6 ± 0.3	1910 ± 50	235 ± 7	4100 ± 400
M15	54. ng.	22.9 ± 0.3	5.39 ± 0.15	3260 ± 50	1329 ± 16	22900 ± 400
M21	82. ng.	24.6 ± 0.3	6.16 ± 0.11	3990 ± 50	860 ± 10	14230 ± 250
M16	96. ng.	24.6 ± 0.3	5.28 ± 0.10	2840 ± 40	756 ± 9	14030 ± 250
M19	12. ng.	25.3 ± 0.5	4.09 ± 0.22	2470 ± 60	876 ± 13	14500 ± 600
M17	76. ng.	25.7 ± 0.3	4.42 ± 0.11	2490 ± 40	827 ± 10	14270 ± 290
M9	6.5 ng.	27.4 ± 0.5	1.03 ± 0.22	2730 ± 80	290 ± 7	6100 ± 500
M18	5.2 ng.	27.9 ± 0.6	4.5 ± 0.3	2720 ± 80	711 ± 13	11600 ± 700
M30	23. ng.	30.2 ± 0.4	7.10 ± 0.20	3970 ± 60	928 ± 12	17900 ± 400
M37	9.0 ng.	30.6 ± 0.5	5.86 ± 0.29	2830 ± 70	918 ± 13	19200 ± 700
M32	88. ng.	32.9 ± 0.4	5.37 ± 0.11	2600 ± 40	836 ± 10	17360 ± 300
M34	22. ng.	33.1 ± 0.5	4.64 ± 0.18	3030 ± 50	662 ± 9	13700 ± 400
M36	84. ng.	33.2 ± 0.4	6.12 ± 0.13	2800 ± 40	965 ± 11	19700 ± 300
M12	3.0 ng.	33.3 ± 0.9	15.0 ± 0.7.	13210 ± 250	842 ± 18	17600 ± 1100
M38	42. ng.	35.8 ± 0.5	6.79 ± 0.16	3910 ± 60	963 ± 11	20100 ± 400
M1	1.4 ng.	36.2 ± 1.2	6.8 ± 0.9	4460 ± 240	757 ± 24	17000 ± 1600