ELEMENT ABUNDANCE PATTERNS IN CARBONATE GLOBULES AND RIMS FROM AH84001: G. J. Flynn[1], S. R. Sutton[2], and L. P. Keller[3] 1) Dept. of Physics, SUNY-Plattsburgh, Plattsburgh, NY 12901, 2) Dept. of Geophysical Sciences, The University of Chicago, Chicago, IL 60637, 3) MVA Inc, 5500-200 Oakbrook Parkway, Norcross, GA 30093.

McKay et al. [1] reported possible evidence for ancient biological activity in carbonate globules and the rims on the carbonate globules from the AH84001 meteorite. Both the formation temperature and the origin of these carbonate globules and rims is controversial. McKay et al. [1] suggest the carbonates formed at low temperatures, while Harvey and McSween [2] indicate they formed at significantly higher temperatures. While McKay et al. [1] suggest that these carbonates contain a number of indicators suggesting they may have been derived from ancient biological activity, Bradley et al. [3] propose that some of the features formed from vapors at high temperatures, possibly in the hot gases from volcanic vents. Since element abundance patterns have previously proven useful in constraining the formation temperatures and formation mechanisms of planetary materials and meteorites, we have begun a study of the element abundances in carbonate globules and rims from AH84001 using the X-Ray Microprobe (XRF Microprobe) on Beamline X26A of the National Synchrotron Light Source at Brookhaven National Laboratory. This instrument, which has previously been employed in the chemical analysis of interplanetary dust particles, has been described in Flynn and Sutton [4].

The carbonates described by McKay et al. [1] consist of transparent, orangish carbonate globules ~50 to 100 microns in size coated with opaque rims about 10 microns thick. Samples were prepared by extracting fragments of a carbonate globule and of rim material from fresh fracture surfaces of AH84001. A transparent orangish sample was extracted. This sample, estimated to be ~60x50x10 microns in size, will be called "carbonate globule." A second, opaque sample was extracted. This sample, estimated to be ~30x20x5 microns in size, will be called "rim." We examined each sample under a binocular microscope and saw no evidence for transparent material adhering to the rim sample or vica versa, however, we cannot conclusively exclude the possibility that small amounts of rim material are present on the "carbonate globule" sample or that small amounts of carbonate globule are present on the "rim' sample.

The two samples were analyzed for major and trace elements (S, Cl, Ca, Ti, Cr, Mn, Fe, Ni, Cu, Zn, Ga, Ge, Se, Br, Rb. Sr, Y, and Zr) using the an ~6 micron analysis beamspot on the XRF Microprobe. Element abundance ratios relative to Fe were obtained. Determination of the Fe abundances in each sample is in progress.

Since the beamspot was significantly smaller than each sample, multiple analyses were conducted at different spots on each sample. Several elements are inhomogeneously distributed, with S, Cl, Ga, and Br showing variations at or near the order-of-magnitude level at different spots on the rim sample and Cl, Ti and Cr showing order-of-magnitude variations at different spots on the carbonate globule. These large variations indicate that S, Cl, Ga, and Br are inhomogeneously distributed in the rim sample on the scale of the ~6 micron beam spot, and that Cl, Ti, and Cr are inhomogeneously distributed in the carbonate globule.

Although large variations in the abundances are seen in the spot analyses, the averages of the element/Fe ratios for the 3 to 6 spot analyses show remarkable similarity between the rim and the carbonate globule. The average element/Fe values for all elements measured except Cr and Ga are within a factor of two in the rim sample and the carbonate globule sample. Chromium is a factor of 4 higher in the carbonate globule than the rim, and Ga, which is very near the instrument detection limit, is a factor of 3 higher in the rim than in the globule. The results are consistent with this rim having formed by in-situ alteration of the carbonate globule.

The siderophile elements Ni and Ge are present at extremely low abundances in both the rim and the carbonate globule, with a Ni/Fe ratio about $2x10^{-3}$xCI and a Ge/Fe averages ~$8x10^{-2}$ xCI. These values are roughly consistent with the Ni and Ge concentrations tabulated by Treiman et al. [5] for bulk analyses of the meteorite Shergotty (Ni = $8x10^{-3}$xCI and Ge = $2x10^{-2}$xCI).

The volatile elements Cu, Zn, Ge, and Se are all present in element/Fe ratios <CI. The chlorine abundance was highly variable, varying by an order-of-magnitude among the spots analyzed, but all 3 spots on the carbonate globule and all 5 spots on the rim showed chlorine/Fe >3xCI. Bromine/Fe was <CI in all carbonate globule spots analyzed and averaged ~CI for the 5 rim samples. The chlorine/bromine ratios in these samples are ~10^4, almost two orders-of-magnitude higher than the value measured in Antarctic ice [6], suggesting these samples have not been contaminated by halogens carried by the ice.

Both the rim and the carbonate globule have high concentrations of the refractory elements Ca and Sr (compared to the CI ratios). However the Ti/Fe and Zr/Fe ratios are lower than CI in bot the rim and the carbonate globule.

These preliminary results suggest:

1) on average, this rim and this globule have very similar element/Fe, suggesting the rim may have formed by a in-situ alteration of the carbonate globule,
2) the chemical compositions of the rim and globule are somewhat variable from spot to spot, indicating inhomogeneous distributions of many elements on the ~6 micron scale,
3) both the rim and the globule have extremely low Ni concentrations, ~$2x10^{-3}$xCI, and
4) both the rim and the globule contain low concentrations of the volatile elements, except for chlorine, (compared to CI) suggesting they formed from a starting material of low volatile content or that they formed at an elevated temperature.

Further experiments, in which the element abundances will be measured on flat sections of rim and carbonate globule documented by optical and Transmission Electron microscopy, are in progress.

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