INTERSTELLAR GRAPHITE IN TIESCHITZ; X. Gao, C. Alexander, P. Swan and R. Walker, McDonnell Center for the Space Sciences and Department of Physics, Washington University, One Brookings Drive, St. Louis, MO 63130-4899.

In previous work on the CM meteorite Murchison, chemical and physical techniques were used to produce separates rich in spherical graphite particles [1]. Most grains exhibit highly anomalous $^{12}C/^{13}C$ ratios as well as anomalies in other, minor elements indicative of a circumstellar origin for the grains [2]. In this work, we report the first observation of similar interstellar carbon-rich spherules in separates from an ordinary chondrite. New separation and mapping procedures used to assess the concentration of these and other interstellar grain components are also described.

A 4.5 gm starting sample of Tieschitz was treated using a modification of the original methods developed by the Chicago group [3]. The modified methods were developed to produce samples enriched in the known interstellar phases (diamonds, SiC, graphite, corundum) more rapidly, and with smaller starting amounts of material, than previously done. The resulting interstellar grain-rich separates are smaller and less pure than those of the Murchison K series, but as we demonstrate here and in a companion abstract dealing with interstellar oxide grains [4], they contain enough interstellar material to measure in a variety of ways. A key element in the new method is the use of x-ray mapping [5] to locate interesting species at various stages in the separation procedure. Concentrations of different species are determined directly by a combination of weighing and mapping. The interstellar origins of various components are further assessed by ion probe isotopic measurements. This approach for determining the concentrations of interstellar dust species is thus fundamentally different than indirect methods used to infer the concentrations of various interstellar phases (based, for example, on noble gas measurements [6]).

After toluene-methanol extraction, the remaining Tieschitz sample was reacted with HF-HCl in a pressure bomb to dissolve silicates, and subsequently treated with $Na_2Cr_2O_7$ to remove reactive kerogens. A diamond-rich fraction was prepared by colloidal separation. The remaining material was separated by density and grain size into sub-samples enriched in various phases. SEM mapping of a density separate of 1.9-2.4 g/cm^3 and nominal size > 0.2 μm showed that this fraction contains many carbon-rich spherulitic particles with morphologies similar to those previously shown to be interstellar graphite grains [2,7].

Thirty-eight of these grains, chosen on the basis of their external morphologies and high carbon x-ray count rates, were subsequently analyzed in the ion microprobe for their carbon and nitrogen isotopic compositions. As shown in Fig. 1, two of the spherules studied have highly anomalous $^{12}C/^{13}C$ ratios that fall within the (large) range previously measured in graphite grains from Murchison [2] and are similarly identified as interstellar material, probably graphite. One grain with normal C composition appears to be enriched in ^{15}N.

In contrast to the relative paucity of isotopically anomalous carbon-rich spherules found here (3/38), 50% to 95% of similar spherules from different density fractions of Murchison residues, encompassing about the same range as the Tieschitz separate studied here, are anomalous. The origin of these carbon-rich spherulites with isotopically normal carbon is unclear. Some such grains exhibit N and/or Mg anomalies and thus do not appear to have formed in the solar system. Whatever their origin, their abundance relative to that of the demonstrably interstellar graphite grains appears to be much higher in Tieschitz than in Murchison. However it must be noted that isotopic patterns are known to be associated with external morphologies [8] and we cannot rule out the possibility that the apparent difference results from selection biases used by different investigators in choosing which grains to measure in the ion probe. As we show in Fig. 2, grains of both normal and anomalous isotopic compositions can have similar "graphitic" appearances.

One of the primary purposes in developing the modified etching procedures described here was to survey, by direct measurement, the concentration of different interstellar phases in various meteorites. Based on the weight fractions of various residues and the proportion of isotopically anomalous grains, we estimate that the bulk concentration of demonstrably interstellar graphite in Tieschitz is almost 100x less than that in Murchison. Considering that the interstellar material probably resides exclusively in the fine-grained matrix, there still appears to be an order of magnitude lower concentration in Tieschitz than in Murchison.

References: [1] Amari S. *et al.* (1990) *Nature* **345**, 238-240. [2] Amari S. *et al.* (1993) *Nature* **365**, 806-809. [3] Amari S. *et al.* (1993) *Geochim. Cosmochim. Acta* (in press). [4] Nittler L. *et al.* (1994) *LPSC* XXV, submitted. [5] Swan P. *et al.* (1989) *LPSC* XX, 1093-1094. [6] Huss G. (1990) *Nature* **347**, 159-162. [7] Bernatowicz T. *et al.* (1991) *Ap. J.* **373**, L73-L76. [8] Amari S. *et al.* (1993) *Meteoritics* **28**, 316-317.

Figure 1. Isotopic composition of Tieschitz graphite and comparison with that of Murchison graphite.

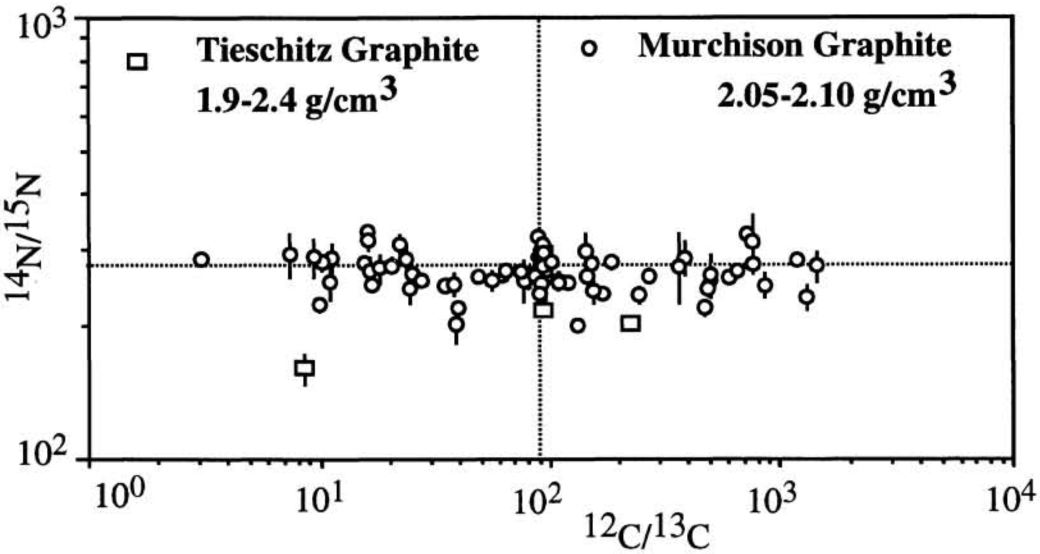

Figure 2. Two carbon-rich spherules from Tieschitz. 2a is isotopically anomalous with $^{12}C/^{13}C = 8.8$, 2b has normal isotopic composition.