A second property of interest is anisotropy of magnetic susceptibility. The anisotropy ellipsoid defines a rock fabric, and uniformity of susceptibility ellipsoid orientation among mutually-oriented subsamples indicates a uniform fabric throughout the meteorite material. Non-uniformly oriented subsample ellipsoids indicates a local fabric associated with each subsample. All the samples possess a generally uniform foliated fabric. The degree of anisotropy (the ratio of maximum to minimum susceptibility) is typically in the range 1.1–1.2.

The randomly directed NRM in Kapoeta, Petersburg and Sioux County shows that in these samples the observed NRM arises from the magnetization acquired by matrix, lithic clasts and mineral fragments before they accumulated into the final meteoritic material. The most likely origin of this magnetization is a thermoremanent magnetization (TRM) acquired in an ambient magnetic field during cooling after heating in the original parent body. The magnetic field could have been an enhanced interplanetary field or one generated within the parent body. The latter source is currently favoured. There is also evidence from the nature of the NRM that there was no heating above ~750 °C, or very severe shock, after final accumulation of the meteorites. This would result in uniform remagnetization or demagnetization of the meteoritic material, according to the presence or absence of an ambient magnetic field. The uniform fabric indicated by the susceptibility anisotropy observations was acquired either during or after the final accumulation of the meteorites. Its probable origin is in the distortion of magnetic particles towards a disc shape by shock compression.

The results so far obtained for the NRM of Le Teilleul are more difficult to interpret. The inhomogeneous NRM in the other meteorites is believed to be the main cause of their anomalous demagnetization behaviour, yet the Le Teilleul subsamples demagnetize conventionally in intensity and direction. A possible explanation is that the NRM is approximately uniform within each of the measured subsamples, but scattered in direction between subsamples. The most likely origin of the primary NRM is again a TRM in an ambient magnetic field on the parent body.

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Isotopic Analysis of Os and Re with negative thermal ion mass spectrometry and application to the age and evolution of iron meteorites. R. A. Creaser, D. A. Papanastassiou and G. J. Wasserburg. Division of Geological and Planetary Sciences, Caltech, Pasadena, California 91125, USA.

The ^{187}Re-^{187}Os isotope system has long been recognized as a method by which the age of iron meteorites can be directly determined (Herr *et al.,* 1961). Pioneering work by Luck and Allègre (1983) established a whole-rock isochron for iron meteorites and the results were used to determine indirectly the half-life of ^{187}Re. We have developed: a) high ionization efficiency mass spectrometry techniques for platinum group elements including both Re and Os separated from iron meteorites (Creaser *et al.,* 1991, 1992); b) low filament loading blanks for both Re and Os (<0.1 picogram, each); c) high yield and low blanks for the chemical separation techniques (yields 70–80%; blanks 1 pg for Os, <10 pg for Re). We have developed a new method for the rapid, clean and efficient separation of Os and Re from 10^{-2} g samples of iron meteorites. This will permit taking advantage of variations of Re/Os on a small scale. The chemical separation scheme involves acid dissolution, preconcentration of Os and Re from Fe-Ni, oxidative solvent extraction of Os and ion exchange chromatography to recover Re. We have established that Os and Re thus chemically separated from iron meteorites show the same ionization efficiency as Os and Re from standard solutions, namely ~20% for each element.

Of primary importance is the degree of isotope exchange and equilibration between sample and spike for Os. By analyzing the isotopic composition of Os at different stages of the chemical separation we are able to demonstrate that isotopic equilibration can be achieved to the level of ±1‰. However this is not yet a routinely resolved issue. We believe, based on experience during the development of this technique, that isotope equilibration for Os prior to chemical separation is a critical issue that needs further attention. The results we have obtained so far from iron meteorites are given in Table 1. We have started analyses of the large magmatic group of IIA irons, which are little shocked and little metamorphosed, in order to attempt to establish a high precision isochron for these objects. For two samples, where we have high precision data for both Os and Re, the slope indicated is 0.077, which yields an age of ~4530 Ma using the best estimate of the ^{187}Re half-life by direct measurement (Lindner *et al.,* 1989). These results are in close agreement with the revised data of Horan *et al.* (1992) but markedly different from published iron meteorite data using the lower precision techniques where slopes of 0.070–0.074 indicate apparent ages of 4150–4350 Ma. We believe that previously reported data, including the data on the half-life of ^{187}Re, require confirmation using the current high precision and high sensitivity techniques, before the reliability and utility of the Re-Os technique can be ascertained.

Table 1. Re-Os isotopic data from iron meteorites.

		Os ppm	Re ppb	$^{187}Os/^{188}Os$	$^{187}Re/^{188}Os$
Bennett County	IIA	59.6 ± 0.1		0.12503 ± 5	
Coahuila	IIA	9.87 ± 0.02		0.14158 ± 7	
Tocopilla	IIA	1.062 ± 0.002	207.9	0.16913 ± 15	0.9451
Negrillos	IIA	69.4 ± 0.1	5022.7	0.12315 ± 2	0.3497
Cape York	IIIA			0.13374 ± 9	
Canyon Diablo	IA			0.13464 ± 11	
Tlacotepec	IVB			0.12068 ± 8	
Osmium standard $(NH_4)_2OsCl_6$				0.14911 ± 3	

Acknowledgement. This work was supported by NASA, Grant NAG 9-43. Contribution No. 779.

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Spinel-rich inclusions in the Mighei C2 chondrite. Andrew M. Davis[1] and Glenn J. MacPherson.[2] [1]Enrico Fermi Institute, University of Chicago, 5640 S. Ellis Ave., Chicago, Illinois 60637, USA. [2]Department of Mineral Sciences, NHB-119, Smithsonian Institution, Washington, DC 20560, USA.

Most studies of refractory inclusions in C2 chondrites have focussed on the presumably more primitive and refractory hibonite-rich inclusions, but the most abundant type of inclusion in Mighei and other C2 chondrites are spinel-rich ones. A preliminary report on Mg isotopes in 6 Mighei inclusions and trace elements in three of them was made by MacPherson and Davis (1991). We have now measured trace element and Mg isotopic compositions in 22 spinel-rich inclusions from three thin sections of Mighei in order to constrain models for their origin.

Mighei spinel-rich inclusions range from nodular, with a compact interior of spinel with subordinate pyroxene and perovskite rimmed by pyroxene, to chainlike, in which several pyroxene-rimmed spinel-rich areas are close to one another but separated by 10–20 μm of meteorite matrix. The spinel-rich inclusions are small, so that 2 to 6 ion microprobe analyses of spinel-rich areas using a 25 μm diameter beam spot sample a significant fraction of each inclusion. Of the 22 inclusions analyzed, seven have REE patterns that are unfractionated or have negative Eu anomalies (group I), seven have volatility-fractionated group II patterns, two chainlike inclusion have both group I and group II patterns in different spinel-rich areas, two have group III patterns with depletions in Eu and Yb, three have irregular patterns that are different from group II but appear to be volatility-fractionated and one (Davis, 1991) has an ultrarefractory REE pattern. The enrichment factors for LREE in all but the latter inclusion range from ~5 to ~100 × C1 chondrites. The dominant carrier of REE and most other refractory