DETERMINATION OF BULK-CARBON CONTENTS IN SEVEN IIIAB IRON METEORITES; Anders Meibom[1], Kaare L. Rasmussen[1], Ole S. Hansen[2], Poul Hornshøj[2] and Niels Rud[2]. [1] Department of Physics, University of Odense, Campusvej 55, 5230 Odense M, Denmark. [2] IFA, University of Aarhus, 8000 Aarhus C, Denmark.

Introduction Previous determinations of the carbon content in iron meteorites relied either on the method of combustion and subsequent determination of the amount of CO_2 produced (Moore et al. 1969, Lewis and Moore 1971) or estimates based on microscopy studies of the abundance of minerals rich in carbon (graphite nodules, cohenite and haxonite). Recently, accelerator techniques have been applied to measure carbon by detecting protons from nuclear reactions (Makjanic et al. 1988 and 1993). Meibom et al.(1992) used X-rays from the nuclear reaction $^{12}C(^{16}O,\alpha)^{24}Mg$ to detect carbon. Now we use detection of X-rays produced by the nuclear reaction $^{12}C(d,p)^{13}C$ with a 1.65 MeV deuteron beam to non-destructively measure the carbon content of iron meteorites. The carbon content might be of importance to the phase diagram as well as to the diffusion coefficients of several elements during the kamacite growth in the slowly cooling parent body. This will possibly have influence on metallographic cooling rate determinations. In this study we have determined the carbon content of seven IIIAB iron meteorites, and we find a weak negative correlation with bulk meteorite Ni ($k_C = 1.2$).

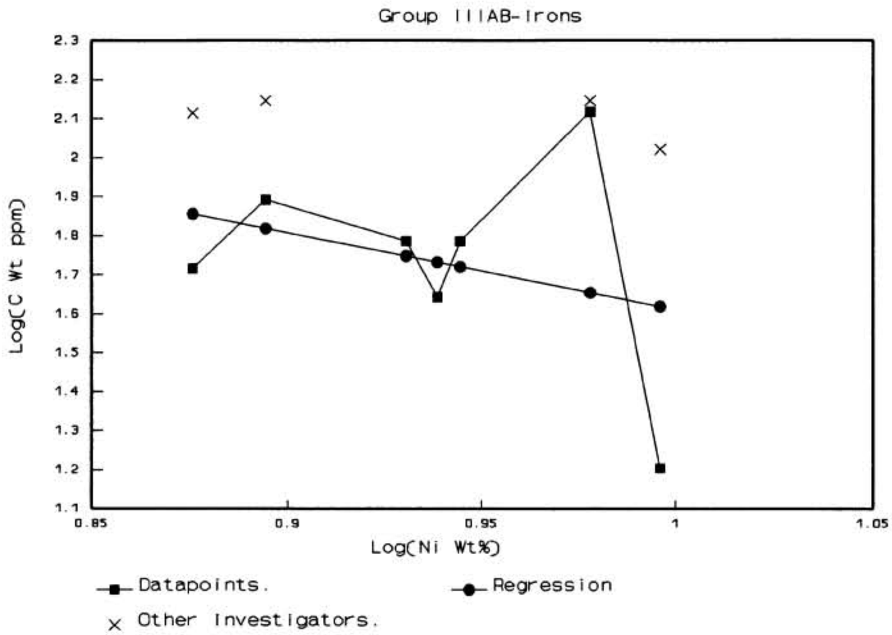
Experimental The tandemaccelerator at Aarhus University, Denmark, was used for bulk measurements of the carbon content of seven iron meteorites. Carbon was detected from the X-ray spectrum of the $^{12}C(d,p)^{13}C$-nuclear reaction. A carbon peak at 3090 keV and a very low background in this part of the spectrum set the detection limit to ca. 1 ppm (by weight). Absolute values of the carbon content were obtained by comparing with standards (e.g. a 0.5 wt% C).

After polishing with 1 μm diamonds and ultra sound cleaning, each meteorite was sputtered numerous times in the measurement chamber to minimize the effect of carbon surface contamination. Successive sputtering and measuring of each meteorite, showed a fast decrease in the carbon signal until a constant level was reached where practically all surface contamination had been removed. The chamber pressure during measurements was ca. 10^{-7} mbar, low enough to ensure that no significant carbon was build-up during measurements.

The size of the beam was 1-2 mm and the meteorites were scanned in one direction to record possible inhomogeneities. Such inhomogeneities have been reported (Makjanic et al. 1988), but our beam is too large to resolve these structures, indicating that our carbon values can be interpreted as the bulk meteorite carbon contents.

Results The seven IIIAB iron meteorites that have been analyzed are in order of increasing Ni-content: Henbury (7.51% Ni), Cape York (7.84% Ni), Tamarugal (8.52% Ni), El Capitan (8.68% Ni), Turtle River (8.80% Ni), Treysa (9,51% Ni) and Bella Roca (9.91% Ni). Compared to previous determinations (combustion and mineral abundance) of the carbon content, our values are systematically lower (up to 85%; Bella Roca) relative to the combustion method. This difference might be explained by our samples being less contaminated. Our beam is large enough to average out the inhomogeneities due to the different carbon solubilities in α- and γ-phase of the Widmanstätten structure, but not large enough to average out the local variations in the distribution of minerals rich in carbon, such as graphite, haxonite or cohenite. This could explain the difference between our measurements and the method of mineral mapping.

As can be seen in the figure below, the carbon contents show a tendency to decrease with increasing Ni-content.



Log(Ni)-Log(C) plot of 7 IIIAB irons. Carbon correlates negatively with Ni. Slope of regression: -1.95. k_C=1.2 (k_{Ni}=0.88).

If we assume that this trend was produced by fractional crystallization described by the Rayleigh equation, a linear relationship in a log(Ni) vs log(C)-diagram can be anticipated if the distribution coefficient for carbon, k_C, is constant. The Ni-contents of the meteorites included in this study range from 7.5-9.9 wt% which spans most of group IIIAB. According to Willis and Goldstein (1982) k_{Ni} increases with increasing concentration of C, S and Ni. As a first estimate we have only taken into account the Ni-dependence using the lowest Ni-value of group IIIAB: 7 Wt%. Equations given by Willis and Goldstein (1982) then give k_{Ni}=0.88. The linear regression on the figure has a slope of -1.95. We then get k_C=1.2. Willis and Goldstein (1982) reported k_C = 0.49 based on the Fe-C phase diagram. This drastic difference might be due to the presence of Ni, S and P, but it could also indicate that processes other than fractional crystallization have been involved in the distribution of C in the core, e.g. diffusion.

Acknowledgements: This work was supported by the Carlsberg Foundation and the Danish Natural Research Council.

Moore C.B., Lewis C.F. and Nava D. (1969) in Meteorite Research (ed. P. Millman). Reidel Publishing.
Lewis C.F. and Moore C.B. (1971) Meteoritics, **6**, 195-205.
Makjanic J., Heyman D., Van der Stap C.C.A.H., Vis R.D. and Verheul H. (1988) Nuclear Instruments and Methods in Physics Research B30 466-469.
Makjanic J., Vis R.D., Hovenier J.W. and Heyman D. (1993) Meteoritics **28**, **1**, 63-70.
Meibom A., Rasmussen K.L., Hornshøj P., Rud N. and Heinemeier J. (1992) Meteoritics **27**, 3, 260.
Willis J., **Goldstein J. I.** (1982) Proc. Lunar Planet. Sci. Conf. 13th **87**, A435-A445.