IRON-NICKEL ALLOY SUPERSTRUCTURES IN THE MINERAL JOSEPHINITE*

J. Danon[x], R.B. Scorzelli[x], I.S. Azevedo[x]
J.F. Albertsen[xx], J.M. Knudsen[xx], N.O. Roy-Poulsen[xxx]
Y. Minai[xxxx], H. Wakita[xxxx], T. Tominaga[xxxx]

x Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro, Brazil
xx H.C. Oersted Institute, Copenhagen, Denmark
xxx Niels Bohr Institute, Copenhagen, Denmark
xxxx Faculty of Science, The University of Tokyo, Japan

The presence of the ordered phase Fe-Ni with superstructure L10 has been detected in Josephinite by Mössbauer spectroscopy.

* To be published in Radiochem. Radioanal. Acta.

IRON-NICKEL ALLOY SUPERSTRUCTURES IN THE MINERAL JOSEPHINITE

Detailed studies of the mineral Josephinite has shown the presence of two Fe-Ni phases in this mineral[1]. One is the ordered $FeNi_3$ cubic alloy, and another is a not completely characterized phase containing less proportion of Ni.

Recently Mössbauer spectra of Josephinite were published[2]. The results of these interesting investigations indicate the possible presence of a noncubic Fe-Ni alloy. This evidence comes from the presence of a quadrupole interaction in the magnetically split component of the Mössbauer spectra.

An iron-nickel alloy giving rise to a quadrupole splitting has recently been identified in some iron meteorites[3,4,5,6,7]. This alloy has the approximate composition Fe-Ni(50-50) and the L10 structure, which is fct. The Mössbauer spectra at room temperature of this alloy shows a magnetic hyperfine field of $Hi = 289k0e \pm 2k0e$ and a quadrupole shift of $\Delta E = +0,20 \frac{mm}{sec}$.

Recently it has been observed that mechanical treatment such as filing of the meteorites can induce phase transformations in the Fe-Ni alloys[8]. For this reason we have investigated the nature of these alloys in Josephinite by measuring the M.S. of thin sections instead of powdered samples of the mineral.

We have found that the magnetically split part of the Mössbauer spectrum can be fitted with the spectrum of the ordered phase $FeNi_3$ and that corresponding to the ordered phase FeNi (fig. 1). At room temperature the hyperfine field of the $FeNi_3$ phase is $H_i = 277$ kOe and no quadrupole shift is present whereas the FeNi phase has $H_i = 289$ kOe and $\Delta E = +0.20$ mms^{-1}. The values of the hyperfine fields of both phases increase by 15 kOe on going to liquid nitrogen temperature.

Mössbauer spectroscopy thus indicate the possible presence of the ordered phase of the type FeNi in Josephinite, as previously found in iron meteorites. Preliminary results from X-ray diffraction analysis also indicate the existence of the ordered FeNi-phase in Josephinite. However more investigations are needed to understand in detail the structure of these interesting iron-nickel minerals.

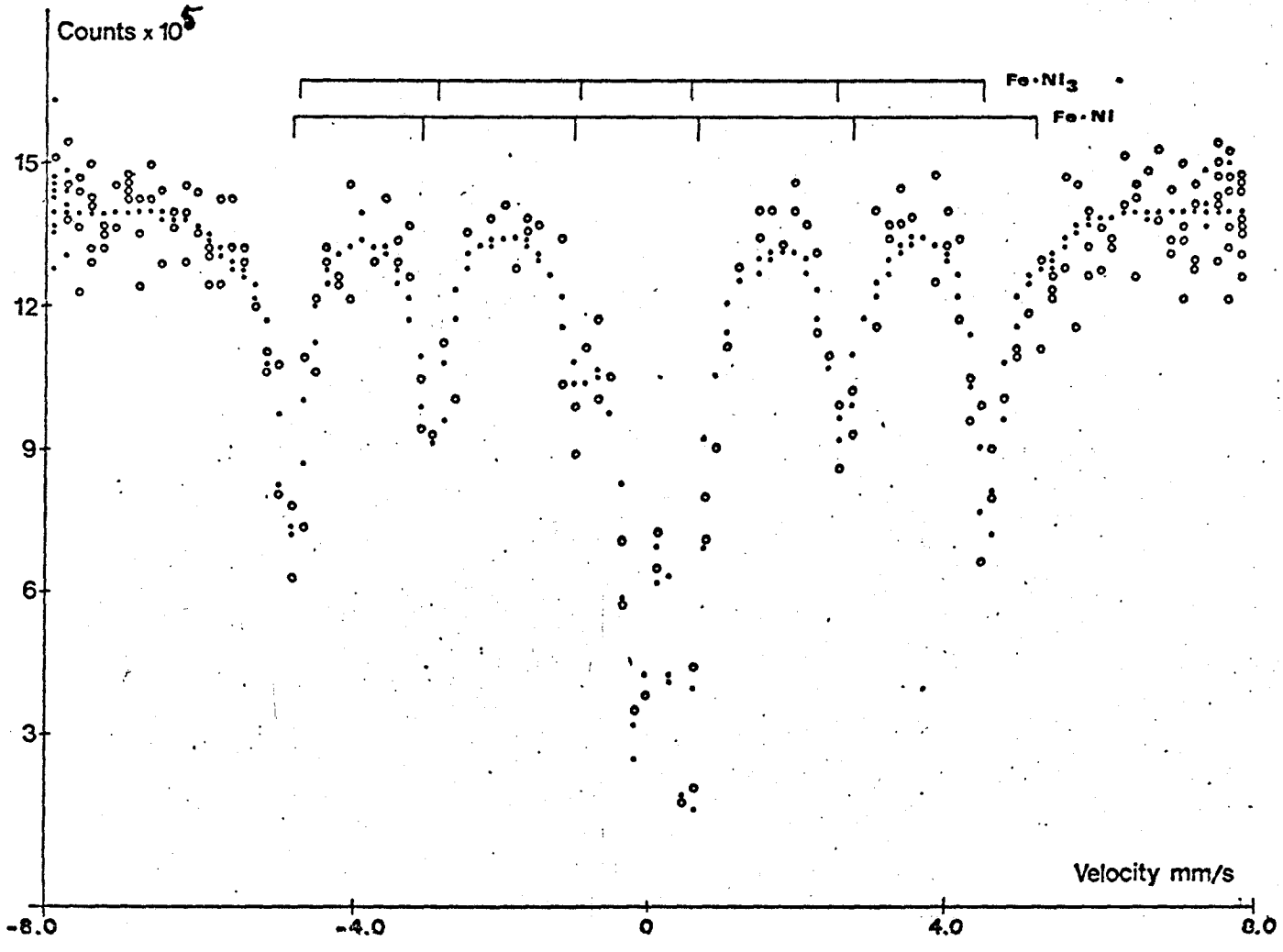

Fig. 1 - Mössbauer Spectra of a thin section of Josephinite (sample ≠ 2, ref. 2) measured at 110K with a 25 mCi ^{57}Co/Rh source .

The presence of the ordered FeNi-phase in iron meteorites is ascribed to the very slow cooling rate (1°C per 10^6 years) of the meteorite, when it resided in the mother planet.

The presence of the ordered FeNi phase in Josephinite may help to elucidate the origin of these unique nickel-irons, which recently has been extensively discussed[9,10,11].

REFERENCES:

1 . F.I. Botto, G.H. Morrison
Am. J. Sci. 276 (1976) 241.

2 - Yoshitaka Minai, Hiroshi
Wakita, Takeshi Tominaga
Radiochem. Radianal. Letters 36 (1978) 193.

3 - J.F. Petersen, M. Aydin and J.M. Knudsen
Phys, Lett. 62A (1977) 192.

4 - J.F. Albertsen, M. Aydin and J.M. Knudsen
Physica Scripta 17 (1978) 467.

5 - J.F. Albertsen, G.B. Jensen and J.M. Knudsen
Nature 273 (1978) 453.

6 - Jacques Danon, Rosa Scorzelli, Izabel Souza Azevedo, Walter Curvello, J.F. Albertsen et Jens M. Knudsen
C.R. Acad. Sc. Paris B, 287 (1978) 199.

7 - J. Danon, R.B. Scorzelli, I. Souza Azevedo, W. Curvello, F. Albertsen and J.M. Knudsen.
Nature (in press).

8 - J. Danon, R. Scorzelli and I. Souza Azevedo
An. Bras. Acad. Ciências (in press).

9 - John M. Bird and Maura S. Weathers
Earth and Planetary Science Letters, 28 (1975) 51.

10 - Henry J.B. Dick and Holmes Gillete
Earth and Planetary Science Letters 31 (1976) 308.

11 - Peter Bochsler, Anton Stettler and John M. Bird, Maura S. Weathers
Earth and Planetary Science Letters 39 (1978) 67.