MICROPROBE OBSERVATIONS ON THE SANTA CATHARINA METEORITE

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Since its discovery about a century ago the Santa Catharina meteorite has attracted considerable interest, due to its high Ni content (35%) and its unusual structure (1).

Thermomagnetic measurements by Lovering and Parry (2) have shown that the meteorite is constituted by at least two phases, one with 50-55% Ni and the other with 28% Ni. The electron microprobe analysis of these phases (3) revealed that the sample investigated contained a high percentage of 0 in the Ni rich phase (45% Ni and 46% Fe).

From Mössbauer and X-ray studies (4,5) the presence of an ordered Ni:Fe superstructure L-10 in the Santa Catharina has been established. This could to be the Ni- and 0-rich phase of Lovering and Anderson (3).

We studied polished sections of an almost uncorroded sample of this meteorite with a Microscan 5 (Cambridge Scientific Instruments) microanalyser. It was the scope of our study to verify specially the composition of the Ni-rich phase.

The result confirm that two different Fe-Ni phases are the main constituents of the Santa Catharina. Modal estimates gave 35-42% by vol. for the darker coloured (less reflective) Ni-rich phase, and 63-56% by vol. for the Fe-richer, bridhter coloured phase. Schreibersite, Troilite and fracture fillings are minor constituents. The two Fe-Ni phases form domains of oriented intergrowth, (100) and (111) being predominant.

Microchemically both Fe-Ni phases proved to be inhomogeneous. The Ni-poorer phase showed variations of 26-31% Ni and 74-69% Fe (by weight) and contains Co $\lesssim$ 1%. We cannot exclude even a larger range of compositional variations, since our data are based on some 25 analyses only. In spite of these chemical variations no distinct internal differences in light- or electron-reflectivity could be observed.

The Ni-rich phase has an average composition of 50.1% Ni and 47.5% Fe by weight (based on 50 analyses). Maximum values are: Ni - 51.3% and Fe - 48.9% (by weight).

S was detected as a "new" minor constituent besides the previously known ones, O and Co (3). O and S are the most important minor constituents, Co being < 0.5%. Special attention was paid to the internal zoning of the Ni-rich phase. This zoning is evidenced by light- and electron-optics, forming darker rims along the borders, as well as darker zones and/or domains within the individuals. Quantitative measurements of the variations of the main constituents proved not to be repeatable due to resolution limits. The semiquantitative study of the zoning as exhibited by the minor elements (O and S) was done by mechanical line profiles under fully focusing conditions. The results show that the darker zones/domains are richer in O and S than the lighter coloured regions of the same individuals.

Moreover, the mechanical line profiles showed the existence of a "secondary" type of O. This O is a product of enrichment initiated along cracks and fractures crosscutting the Ni-rich individuals. In these parts the O contents are considerably higher than in the "primary" zones and as a further characteristic feature the O is enriched, while S contents are lowered. In the "primary" zones O and S show synchronous variations.

Concluding it may be stated that the Santa Catharina meteorite contains an ordered Ni-Fe superstructure near 50:50% by weight (respectively 1:1 atomic ratio), as previously suggested (4,5). However, this superstructure is neither pure nor homogeneous.

Impurities of the minor elements O, S and Co are present totalling up to 2.5% by weight. They may be important for the stabilisation of this rare but important Ni-Fe phase, as well as a guide to the better understanding of its structure. S and the "primary" O show synchronous variations in zones/domains of individuals of this phase and are believed to belong to the early cosmic history of the meteorite.

"Secondary" O is present and enriched along cracks and veins cutting the Ni-rich phase. By this process S-contents are lowered. This "secondary" O and the lowering of S-contents are thought to be postcosmic and can be attributed to the "sensu strictu" geologic history of the meteorite. This secondary oxidation may explain the high O values (8% by weight) reported (3).

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(2) J.F. Lovering and L.G. Parry, Geochem. Cosmochim. Acta 26, 361 (1962).

(3) J.F. Lovering and C.A. Anderson, Science 147, 734 (1965).

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