EXTRATERRESTRIALLY-DERIVED MAGNESIOFERRITE AT THE K-T BOUNDARY, CARAVACA, SPAIN; B. F. Bohor, E. E. Foord, and P. J. Modreski, U.S. Geological Survey, DFC, Box 25046, Denver, CO 80225

The K-T boundary layer clay at the Barranco del Gredero section, Caravaca, Spain, is approximately 10 cm thick (1), but the basal, Fe-rich portion of the layer, containing K-feldspar microspherules (2) and most of the iridium, is <3 mm in thickness (3). This basal layer was examined for heavy oxide and/or metallic phases by first washing out the clay and then magnetically separating the ferromagnetic material. SEM photographs of the magnetic fraction thus obtained show skeletal grains and octahedra (Fig. 1). Energy dispersive X-ray spectrometry (EDS) of these grains shows peaks for the elemental association Fe-Cr-Ni, as well as for Si, Al, and Mg. EDS spectra of this material closely resemble those of metallic alloys found injected into rocks beneath the Ries (4) and Rochechouart (5) impact craters. Electron-microprobe analyses of these magnetic grains from Caravaca confirm the initial EDS analyses; their average composition, in wt. %, is Fe_2O_3 = 76.47, Cr_2O_3 = 1.16, NiO = 3.95, SiO_2 = 0.25, Al_2O_3 = 6.78, TiO_2 = 0.79, and MgO = 10.01; total 99.41. These values are similar to three of the four analyses obtained by Smit and Kyte (6) on ´magnetite´ (magnesioferrite) from the K-T boundary layer in Umbria, Italy. A calculated structural formula on the basis of 3 total cations is

$$(Mg_{.55}Fe^{+2}_{.36}Ni_{.12})_{1.03}(Fe^{+3}_{1.77}Al_{.15}Cr_{.02}Ti_{.02}Si_{.01})_{1.97}O_4.$$

X-ray diffraction analysis of the Caravaca grains also indicated them to be magnesioferrite with a_o = 8.370 Å.

Smit and Kyte (6) found at two locations in Italy that the magnesioferrite and magnetite were contained in polymineralic spheroids. Montanari et al. (7) also found ´magnetite-bearing´ spherules in K-T boundary clays in northern Italy, but they reported that the spheroids from Caravaca were composed almost entirely of pure sanidine. We concur with this observation that the majority of the Caravaca spheroids are white to buff and are composed of sanidine, although we did observe a few green flattened spheroids of glauconite. No black or brown spheroids, such as reported from the K-T boundary clay at Petriccio by Montanari et al. (7), were seen in the Caravaca clay. However, magnetic separation of Caravaca material revealed that whereas some of the sanidine spheroids are completely nonmagnetic, others show some weak magnetic susceptibility indicating a possible ´magnetite´ (magnesioferrite) component.

The morphology and general composition of the magnesioferrite at Caravaca indicates rapid crystallization at high temperature, perhaps directly from a vapor phase, in an environment of moderate oxygen fugacity. Elemental similarity with the metallic alloy injected into rocks beneath two known impact craters suggests direct derivation as meteoritic material from a vaporized chondritic bolide, and not an authigenic origin in a marine environment as proposed by Montanari et al. (7).

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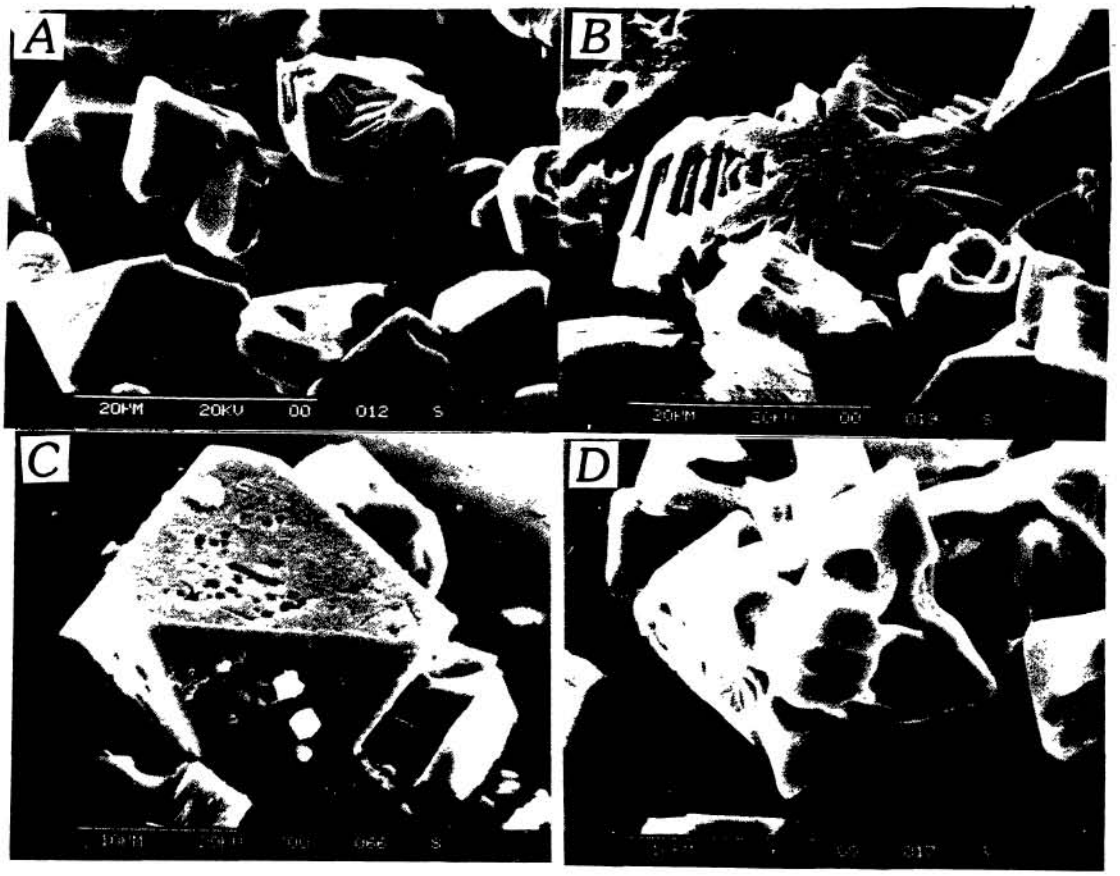

Figure 1 - SEM photographs of magnesioferrite crystals from the K-T boundary clay at Caravaca, Spain. A) Note.--predominant octahedral {111} form, skeletal growth crystal in upper right, and 3-fold symmetry of crystal face at center of photo (scale bar = 20 micrometers); B) flattened skeletal growth crystal with 3-fold symmetry (scale bar = 20 micrometers); C) octahedron showing growth or solution cavities (scale bar = 10 micrometers); D) 6-pointed, euhedral crystal (scale bar = 10 micrometers).

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