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MAGNETIC MICROSPHERULES ASSOCIATED WITH THE K/T AND UPPER EOCENE EXTINCTION EVENTS Stanley M. Cisowski, University of California, Santa Barbara, CA, 93106.

Magnetic microspherules have been identified in over 20 K/T boundary sites, and in numerous DSDP cores from the Caribbean and Pacific, synchronous with the extinction of several radiolarian species near the end of the Eocene. The K/T magnetic spherules are of particular interest as carriers of Ir and other siderophiles generally found in abundance in K/T boundary clay (1). Furthermore the textures and unusual chemistry of their component magnetic phases indicate an origin at high temperature, possibly related to (an) unusual event(s) marking the end of the Cretaceous and Eocene periods (2). Their origin, along with the non-magnetic (sanidine) spheules, has generally been ascribed directly to megaimpact events hypothesized to have periodically disrupted life on Earth (3).

A survey of microspherical forms associated with known meteorite and impact derived materials reveals fundamental differences from the extinction related spherules. For instance, tektites and microtektites are holohyaline and Si-rich (resulting in weak magnetization), do not contain abundant Ir and other siderophiles in cosmic proportions (4), and were formed under conditions of low oxygen fugacity (5). The extensive substitution of Mg and Al for Fe in the component ferrite phases of the K/T spheroids, in contrast, indicates a highly oxygenated environment during their formation (6). Other impact-produced spherules are also characterized by Fe in a reduced or partially reduced state. Currently we are extending our magnetic investigations to ablation spherules, Muong type Indochinites, Irghizites, Zhamanshin glass, and Libyan desert glass, in order to magnetically characterize a wider variety of impact related materials for comparative purposes.

Low temperature magnetic experiments on the K/T and Upper Eocene spheroids indicate that, unlike tektites, extremely small superparamagnetic carriers are not present in abundance. The gradual loss of magnetization with temperature for the K/T spheroids reflects the variable substitution of Mg, Al, and other cations, for Fe+2, as indicated by microprobe analyses of their component spinel phases (2). DC demagnetization curves for the K/T spheroids are most similar to those reported for modern fly ash generated in coal-burning industrial facilities (7). This suggests that the magnetic spheroids, at least for the K/T case, may have resulted from widespread combustion of fossil fuel, perhaps initiated by an impact event, and not directly from the proposed impact itself. Carbon isotope ratio values associated with K/T boundary soot particles are consistent with either derivation from burned forest, or with a small number of coal or marine sediment (i.e. oil shale) combustion sites (8).

The extensive subaerial exposure of Cretaceous combustible black shale during sea level regression in the latest Cretaceous represents a potential source for the magnetic spheroids found in certain K/T boundary clays. Such bituminous rocks are susceptible to natural burning, either through spontaneous combustion initiated by the exothermic oxidation of pyrite, or by external causes, such as lightning strikes, brush fires, or even volcanic activity (9). The abundances of chalcophile elements lost to the atmosphere during combustion of bituminous shales closely matches the abundance patterns of K/T boundary clays, and along with the presence of soot particles (8), fusinite, and cenospheres (10), suggest that widespread fossil fuel combustion, perhaps enhanced by significantly higher atmospheric oxygen content (11), characterized the latest Cretaceous.

The recent discovery of high Ir abundances distributed above and below the K/T boundary within shallow water sediments in Israel (12), which also contain the most extensive known zones of combustion metamorphism, the so called "Mottled Zone" (9), adds a further dramatic footnote to the proposed association between the magnetic spheroids and combustion of organic shales. Interestingly, the "Mottled Zone" also contains the rare mineral magnesioferrite (13), which has been identified both within the K/T magnetic spheroids (2) and as discrete crystals in boundary clay from marine and continental sites (14, 15).

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