Investigating the Meteoritic Component of Cretaceous-Paleogene Impact Spherules in South Carolina

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Introduction: The Cretaceous-Paleogene boundary in the Southeastern Atlantic Coastal Plain nearly has been obliterated by the incision of middle to late Eocene estuarine valleys. An isolated exposure of white kaolinitic sands of the Maastrichtian Sawdust Landing Formation with overlying coarse, orange sands, typical of the Danian Clayton Formation, occurs near Columbia, South Carolina. The contact is defined by a conspicuous decimeter-thick clay layer composed of upper and lower strata of purplish-gray kaolinite/dioctahedral smectite sandwiching a dark band rich in lepidocrocite, trioctahedral smectite, and leaf fragments. Iridium concentrations in the clay, determined by quadrupole ICP-MS (and checked against blanks, iridium stock solutions, and well-characterized K-Pg impact boundary sediments) exceed 20 ppb. We have interpreted this sequence to be correlative with the Chixculub ejecta horizon in other parts of North America [1,2].

The clay sequence is capped by a seven-centimeter layer of indurated millimeter-scale goyazite spherules. Although the spherules have been diagenetically altered, and algal overgrowths are common toward the base of the layer, the spherules contain shocked quartz and glass fragments and exhibit other textures indicative of accretionary growth in a plume. Furthermore, ferropseudobrookite inclusions in the spherules not only suggest a high temperature environment, the development of graphite in these grains suggests a reaction between Fe-Ti oxide and hot carbonate. Consequently, we interpret these spherules as altered impact lapilli from the Chicxulub impact.

Meteoritic Component? The spherules contain native Fe and Ni, usually in contact with or embedded in quartz grains. And although ferropseudobrookite may be explained by high temperature alteration of Fe-Ti oxides from either the target or the bolide, the former does not adequately explain the observation of Ni-rich zones in these oxides. Nickel/vanadium-rich silicates (garnets?) are also observed along with niobium and chromium-rich rutile. In the absence of any obvious source of mantle volcanism, and given the stratigraphic placement at the K-Pg boundary, it is necessary to investigate the hypothesis that these grains originated within the asteroid.

Implications: In addition to providing clues to nature of the Chixculub impactor and information about the environment within the expanding impact plume, the enrichment of this deposit with meteoritic debris suggests the possibility that the location is on an ejecta ray. This would be consistent with very high iridium concentrations in the boundary clay. A northeast trending ray also would support the prior conclusions of Schultz and D'Hondt [3] that the Chixculub impact occurred at an oblique angle from the south.

References: [1] Harris R. S. et al. (2014) *Geological Society of America Abstracts with Program* 46:707. [2] Harris R. S. (2016) *LPS XLVII* Abstract #2840. [3] Schultz P. H. and D'Hondt S. (1996) *Geology* 24: 963-976.

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