SIZE AND DISTRIBUTION OF SHOCKED MINERAL GRAINS IN THE PIERRE SHALE (LATE CRETACEOUS) OF SOUTH DAKOTA RELATED TO THE MANSON, IOWA, IMPACT EVENT

G.A. Izett and W.A. Cobban, U.S. Geological Survey, Denver Federal Center, Denver, CO 80225

Recent $^{40}Ar/^{39}Ar$ dating [1] of sanidine masses in the high-temperature melt-matrix breccia of the Manson, Iowa, impact structure (MIS) indicates that it formed 73.8 ± 0.3 Ma and that it is not coincident with the Cretaceous-Tertiary (K-T) boundary dated at 64.6 ± 0.1 Ma [2] (both ages relative to MMhb-1 513.9 Ma). The MIS sanidine is 9 m.y. older than $^{40}Ar/^{39}Ar$ age spectra of MIS shock-metamorphosed microcline and melt-matrix breccia interpreted by Kunk and colleagues [3, 4] to be 64-65 Ma. The new $^{40}Ar/^{39}Ar$ age of 73.8 ± 0.3 Ma indicates that the extraterrestrial object that formed the Manson structure struck an area probably covered by shallow waters of the Western Interior Cretaceous seaway. Our prediction [1] that a physical record of the Manson impact, including tsunami deposits and shocked mineral grains, might be found in the Pierre Shale in eastern South Dakota at a stratigraphic horizon commensurate with our proposed age for the Manson impact structure was confirmed by Izett and colleagues [1]. Large grains (0.4-2.3 mm) of shocked quartz, quartzite, and feldspar are present in Late Campanian age rocks of the Pierre Shale at eight sites in southeastern South Dakota.

In most of southeastern South Dakota, the lower part of the Pierre Shale consists typically of 55 m of marine shale. The reason for the abrupt appearance of a thin marl 2-3 m thick and underlying basal sandy unit 15-20 cm thick (Crow Creek Member) within the shale-dominated Pierre has intrigued geologists for more than 40 years. The basal sandy unit is pervasively crossbedded siltstone and contains rip-up Cretaceous shale clasts (Sharon Springs Member) as large as 4.5 cm. At a locality southwest of Chamberlain, the remains of a large palm frond were found in the basal crossbedded siltstone. These features suggest that the basal sandy unit may be a reworked tsunami deposit that formed in the Western Cretaceous seaway following the Manson impact event.

Mineralogic evidence diagnostic of an impact was found in the basal Crow Creek Member at eight places in southeastern South Dakota (fig. 1): (1) in Black Dog Township, Lyman County; (2) several sites near Chamberlain; (3) near the Gregory Pumped Storage core hole , Gregory County; (4) near DeGrey in Hughes County, Mount Vernon in Davison County, and along Crow Creek in Buffalo County; and (5) two sites in Yankton County (Yankton limestone quarry and House of Mary Shrine). The acid-insoluble residue of samples from the basal Crow Creek from these sites consists chiefly of quartz and minor feldspar and mica. A few percent of the

MAXIMUM SIZE OF SHOCKED MINERALS IN PIERRE SHALE: G.A. Izett and W.A. Cobban

quartz and feldspar (microcline and plagioclase) grains contain multiple intersecting sets of planar lamellae identical to those in shocked mineral grains from rocks at known impact structures. Some of the shocked quartz grains lack strictly planar lamellae but instead contain irregular, widely spaced fractures indicative of low-level shock.

A map showing the sizes of the largest shocked grains recovered from samples at the eight sites is shown on figure 1. The largest shocked grains are at the two Yankton County sites (2.3 mm and 1.7 mm) and at the site near Mount Vernon (2.2 mm). These sites are about 250 km from the Manson structure in Iowa. In contrast, the largest shocked mineral grains from the basal sandstone of the Crow Creek in Lyman County, at DeGrey in Hughes County, and near Chamberlain are only 0.4-0.7 mm. The large size of the shocked mineral grains in Yankton County and near Mount Vernon implies that they came from a nearby source, such as the Manson impact structure.

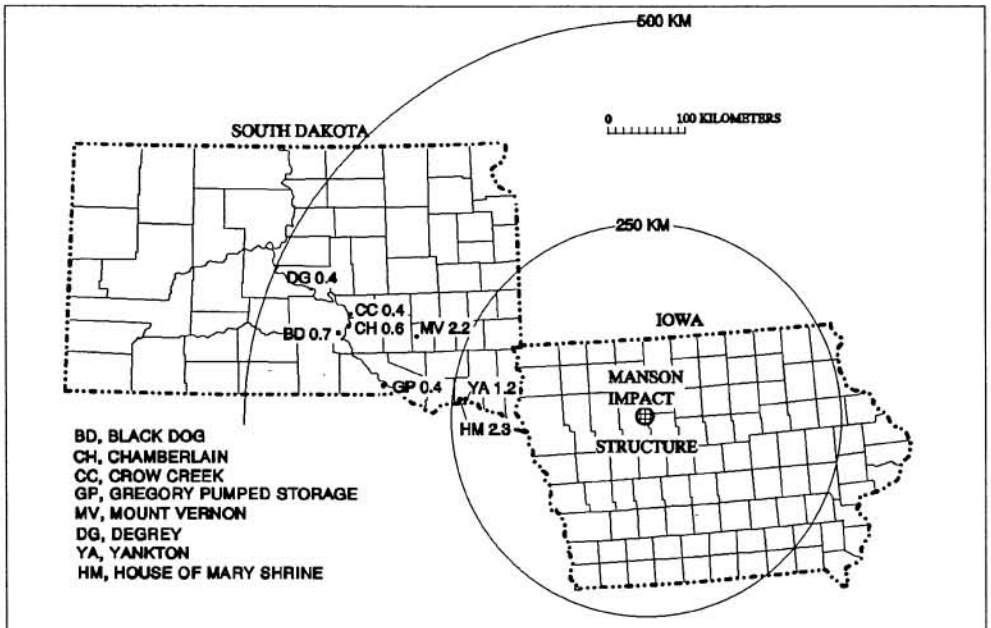

FIG. 1 MAXIMUM SIZE (MM) OF SHOCKED MINERAL GRAINS IN CROW CREEK MEMBER OF PIERRE SHALE

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