THE MANSON, IOWA, IMPACT STRUCTURE AND THE CRETACEOUS-TERTIARY BOUNDARY EVENT; J. B. Hartung American Geophysical Union, 2000 Florida Ave., N.W., Washington, D.C. 20009; G. A. Izett, C. W. Naeser, MS 917, U.S. Geological Survey, Denver, CO 80225; M. J. Kunk, J. F. Sutter, MS 981, U.S. Geological Survey, Reston, VA 22092.

The Manson, Iowa, structure at 35 km in diameter is the largest impact structure recognized in the United States. Recent preliminary $^{40}Ar/^{39}Ar$ age measurements suggest the possibility of a relationship between the Manson impact and the Cretaceous-Tertiary boundary. This paper reviews what is known about Manson and thereby provides background for future work.

The center of the Manson structure is at lat. 42.6° N., long. 92.5° W., about 30 km west of Fort Dodge, Iowa. The structure is poorly understood geologically because, with but one exception, all rocks related to it are covered by more than 30 meters of glacial till. An unusual occurrence of a granitic plug or "central peak" immediately underlying the glacial deposits near the town of Manson was discovered on the basis of rock cuttings from drill holes (1,2). The minimum stratigraphic uplift associated with the central peak is 750 meters. Surrounding the central peak at Manson is a "disturbed" area, about 35 km in diameter, also delineated on the basis of well cuttings. In this area the normal stratigraphic section in Iowa is missing and in its place is "deformed Cretaceous shale" (1,2). Assignment of the "shale" to the Cretaceous Period is based on Inoceramus fragments found in well cuttings and Mesozoic fish scales and poorly preserved cephalopods found at the only known outcrop of the "shale" (3).

A joint U. S. Geological Survey - Iowa Geological Survey project in 1952 obtained drill core from near the center of the disturbed area to a depth of 479 feet (146 m). The upper 93 feet (28 m) of the core consists of glacial till. The remainder of the core is mostly granite and granitic material, fractured and brecciated. A limited amount of core from a drill hole in the surrounding "deformed shale" was also recovered. On the basis of information available at that time, the Manson area was interpreted as a cryptovolcanic structure (4). After the discovery of quartz grains from the central peak containing multiple sets of shock lamellae, the area was reinterpreted as an impact site or astrobleme (5). Descriptions of drill cuttings support the interpretation that the "shale" at Manson is a fall-back breccia similar to suevite from the Ries crater or the Onaping Formation at Sudbury.

Some geophysical data to exist for the Manson structure. Aeromagnetic data for the area were obtained as a part of a larger study of the midcontinent gravity anomaly (6). A gravity survey of the entire disturbed area has been made (7), and a seismic refraction study was done to determine the contours on the top of Cretaceous rocks in the region (8). The gravity and magnetic surveys identified regions within the disturbed area where basement rocks are nearer to the surface than in surrounding regions. The seismic study was accomplished with difficutly because of the low velocity contrast between the glacial till and the underlying "deformed Cretaceous shale". Nevertheless, a rough contour map of the top of Cretaceous rocks was obtained.

Additional interest in the Manson structure was stimulated recently from the suggestion that the Manson impact structure and the Cretaceous-Tertiary boundary could be coeval (9). A fission track age on shocked and

severely microfractured apatite grains separated from Manson core material of 61 ± 18 (2 σ) Ma has been obtained at the USGS lab in Denver, CO. This age represents the time of cooling to a temperature below 100° to 130°C. Grains of microcline, a mineral known to have a low blocking temperature against loss of argon, were separated from granitic material from the Manson core and analyzed using the $^{40}Ar/^{39}Ar$ method in the USGS lab in Reston, VA. The shock and associated heating are indicated by the presence of multiple sets of shock lamellae in coexisting quartz grains. The resulting $^{40}Ar/^{39}Ar$ age spectrum, shown below, can be interpreted most easily in terms of a Precambrian crystallization age for the granite of the central peak, based on ages for basement granites measured elsewhere, followed by a reheating event less than, but not much less than, 70 Ma ago. Measurements of other rocks in the same laboratory, where the same standard was used, place the Cretaceous-Tertiary boundary at >66 Ma (10). Although contemporaneity cannot be demonstrated on the basis of these preliminary radiometric age data, the age inferred for the Manson impact is so near the age for the Cretaceous-Tertiary boundary that additional work on Manson material would be rewarding.

The hypothesis that the Manson structure and the Cretaceous-Tertiary boundary event are related has survived initial tests. More severe tests must be undertaken and probably will require a drilling program to acquire adequate samples.

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