DESCRIPTIONS AND PRELIMINARY INTERPRETATIONS OF CORES RECOVERED FROM THE MANSON IMPACT STRUCTURE (IOWA)

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A core drilling program initiated by the Iowa Geological Survey Bureau and U.S. Geological Survey in 1991 and 1992 collected 12 cores totaling over 1200 m from the Manson Impact Structure, a probable K-T boundary structure [1,2] located in north-central Iowa. Cores were recovered from each of the major structural terranes, with 2 cores (**M-3** and **M-4**) from the Terrace Terrane, 4 cores (**M-2, M-2A, M-6,** and **M-9**) from the Crater Moat, and 6 cores (**M-1, M-5, M-7, M-8, M-10,** and **M-11**) from the Central Peak (Figure 1). These supplemented 2 central peak cores (**1-A** and **2-A**) drilled in 1953. The cores penetrated five major impact lithologies including (**1**) **Sedimentary Clast Breccia (SCB),** a polymictic breccia interpreted as a post-impact debris flow, dominated by clasts of Cretaceous marine shale, lesser numbers of Paleozoic carbonate, sandstone, and shale clasts, minor Proterozoic Red Clastics clasts, and rare clasts of igneous and metamorphic rocks and impact melt rock. These clasts are in a medium gray, calcareous, sandy, silty, shale matrix, (**2**) **Impact Ejecta,** an inverted sequence of Proterozoic Red Clastics and Paleozoic carbonates apparently emplaced as an overturned ejecta flap, (**3**) **Central Peak Crystalline Rocks (CPC),** Proterozoic gneisses and granites up-lifted from the crystalline basement to form the Central Peak, (**4**) **Crystalline Clast Breccia with a Sandy Matrix (CCB-S),** a polymictic breccia composed of clasts of Proterozoic gneisses and granites displaying abundant planar deformation features (PDFs) and other impact deformation features in a matrix of sand- to silt-sized crystalline rock fragments and mineral grains from disaggregated crystalline rocks, and (**5**) **Crystalline Clast Breccia with a Melt Matrix (CCB-M),** a rock composed of clasts similar to the sandy matrix breccia in a dominantly isotropic matrix that displays regions of flow-banding, interpreted as originally melt in some areas, subsequently crystallized to varying degrees. This unit is the impact melt layer.

Sedimentary Clast Breccia was encountered mantling portions of all 3 major structureal terranes in cores **2-A, M-1, M-2, M-4, M-6, M-8, M-9, M-10,** and **M-11** (Figure 1). Where it overlies the **CCB-M** on the Central Peak (especially in **M-1**) the **SCB** incorporates both angular melt rock clasts (solid when fractured and entrained in the **SCB**) and irregular "blobs" of melt rock (apparently molten or plastic when entrained). This indicates emplacement of the **SCB** debris flow very shortly after crater formation, when only a thin crust had formed on melt rock that capped the central peak. The composition of the **SCB,** dominated by the shallowest pre-impact lithologies, is similar to the anticipated composition of the latest, proximal ejecta, which is assumed to be a major source of this debris flow. Maximum **SCB** in thicknesses penetrated in the Manson Impact Structure include 137 m (**M-4**) in the Terrace Terrane, 191 m (**M-2**) in the Crater Moat, and 77 m (**M-10**) on the Central Peak. The magnitude of these debris flows and their presence in all terranes of the structure, including at the center of the Central Peak (**1-A**), poses many questions about mechanisms of their transportation, mixing, and emplacement. **SCB** flows would presumably have traveled across the Terrace Terrane, down to the crater floor in the Moat area, and up and over the Central Peak. Although most previous interpretations of latest Cretaceous paleogeography concluded that epicontinental seas had completely regressed from the North American continental interior (including the Manson site), alternative stratigraphic interpretations suggest that the seaway may in fact still have been present in the area at the close of the Cretaceous. Water displaced by the impact and flooding back into the crater could have been a factor in transport of the massive **SCB** debris flow.

Crystalline Clast Breccias were encountered on the Central Peak. **CCB-S** was penetrated in cores **2-A, M-1,** and **M-11, CCB-M** in cores **M-1, M-7, M-8,** and **M-10**. While clast in these breccias are almost exclusively crystalline, rare shale and siltstone clasts and rare melt rock clasts are present throughout

DESCRIPTIONS AND INTERPRETATION OF MANSON CORES Anderson, R.R. et al.

these units. Additionally, some crystalline clasts are mantled with glassy layers, reminiscent of accretionary lapilli. These clasts and the polymictic character of the breccias suggest some amount of clast movement and mixing. These breccias probably represent impact-brecciated transient crater floor, the **CCB-M** from a position nearer inside of the transient crater where temmperatures were highest. The thickest sequence of **CCB-S**, 65 m, was penetrated in the **M-11** core, and the thickest **CCB-M**, 80 m, in the **M-7** core.

The **Central Peak Crystalline Rock** was encountered in the **2-A, M-5, M-7, M-8,** and **M-10** cores. The **CPC** is dominated by biotite oligoclase quartz gneiss, but includes other gneisses, granitic intrusives, and minor mafic lithologies. In the **M-7, M-8,** and **M-10** cores the **CPC** is present as large blocks separated by thin intervals of **CCB-S**, apparently intruded between the blocks. Also present in **CPC** blocks are thin pseudotachylite-like bands of melt rock which frequently cut across gneiss foliation.

The overturned flap of **Impact Ejecta** material penetrated in the **M-4** core includes Proterozoic Red Clastic strata overlying Paleozoic Cambrian, Ordovician, and Devonian strata. Although all Paleozoic units present at the time of impact are preserved (in inverted order) in the **M-4** core, they are only about 18% of their pre-impact thicknesses.

Samples from these cores are currently being investigated by over a dozen scientists. As their research advances, so will our understanding of the Manson Impact Structure and its relationship to events at the K-T boundary. Samples from these cores are available as research materials from both the U.S. Geological Survey and the Iowa DNR Geological Survey Bureau. Interested scientists are encouraged to contact the authors.

References: [1] Anderson, R.R. and Hartung, J.B., Proc. Lunar Planet. Sci. 22, 101-110, 1992.
[2] Kunk, M.J., Izett, G.A., Haugerund, R.A., and Sutter, J.F., *Science* 244, 1565-1568, 1989.

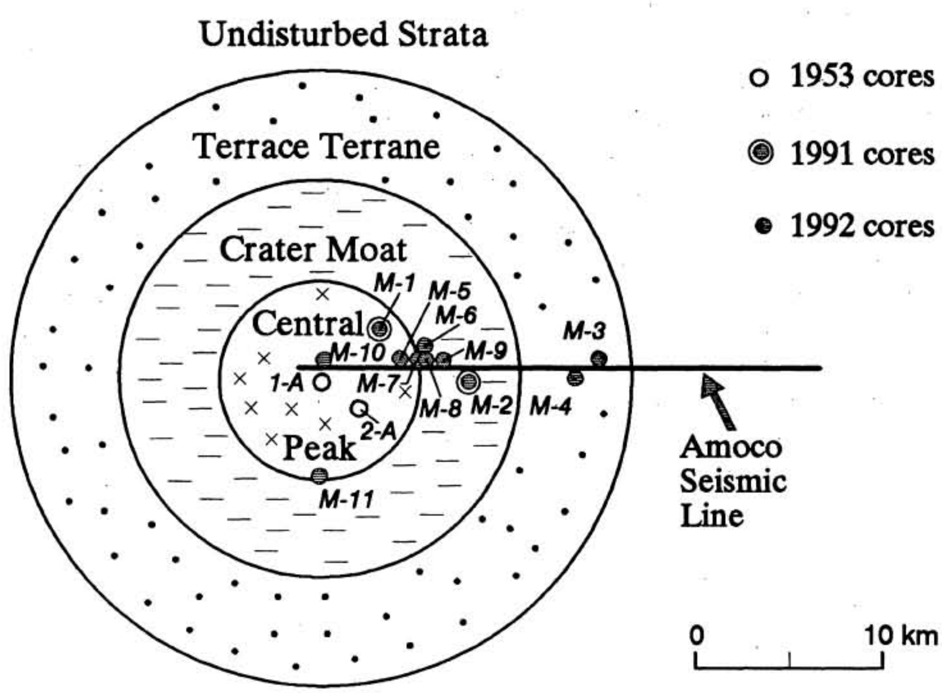

Figure 1. Location of the Manson Impact Structure cores and principal crater terranes.