FIRST RESULTS FROM THE MANSON IMPACT STRUCTURE CORE-DRILLING PROJECT: PRELIMINARY OBSERVATIONS AND INTERPRETATIONS FROM THE M-1 CORE

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The U.S. Geological Survey- and Iowa D.N.R. Geological Survey-sponsored Manson Impact Structure Core Drilling-Project began in the summer of 1991 with the drilling of the Manson M-1 core on the northeast edge of the central peak (Figure 1) of the K-T boundary impact site. The core reached a depth of 703 feet (211 m) and penetrated three primary lithologies (Figure 2), a shale-dominated sedimentary clast breccia (SCB), a crystalline rock breccia with a glassy matrix (CBG), and a crystalline rock breccia with a sandy matrix (CBS).

The SCB, 204-311 feet (61-93 m), is dominated by centimeter- to meters-sized clasts of Cretaceous shale, siltstone, and sandstone, with minor Paleozoic carbonate, sandstone, and shale, and some clasts of Proterozoic Red Clastics shale, siltstone, and sandstone. Very rare clasts of crystalline rocks and glassy fragments are observed. The clasts are supported by a gray matrix composed of sand-, silt-, and clay-sized particles with approximately the same composition as the clasts. Only extremely rare clasts display impact shock effects. Weak hydrothermal alteration affected all of the units, but did not obscure the primary lithologies discussed here.

The CBG, 311-~485 feet (93-~146 m) includes centimeter- to meter-size clasts of felsic igneous and metamorphic rocks with very rare amphibolite clasts and devitrified, flow-banded glass fragments. The clasts are supported by a finely granular, nearly isotropic matrix composed largely of devitrified glass with some areas displaying flow banding and regions of replacement of the glass by chalcedony and other forms of quartz and zeolites. Individual grains and small aggregates of quartz and feldspar are common in the matrix, and many display shock lamellae, kink-bands, and disrupted extinction patterns.

The CBS, ~ 485-703 feet (~146-211 m), contains abundant clasts of amphibolite and felsic igneous and metamorphic clasts, as well as rare gabbroic and mafic volcanic fragments and glassy grains. CBS clasts are generally larger and more abundant than clasts in the CBG. The CBS matrix is composed of sand-to silt-sized grains of crystalline rocks or minerals derived from these rocks. Nearly all grains that comprise the CBS show shock-metamorphic effects.

The contact between SCB and CBG is sharp but irregular. Clasts of glassy material from CBG are included up to 17 m in the SCB above the contact, and shale clasts up to 9 m in the CBG below it. Angular fragments of flow-banded glass and rounded glassy fragments with irregular boundaries are included in the SCB, suggesting that both solid and liquid phases of glass were included. Shale fragments below the contact are completely surrounded by glassy material, suggesting that it was a liquid when the shale was incorporated.

The contact between CBG and CBS is gradational, with glassy matrix steadily replaced by matrix grains. The size and abundance of crystalline rock clasts and grains in the matrix increase downward through the two units, as does the number and apparent intensity of shock-deformation features.

The preliminary interpretation is that CBG and CBS represent shock-brecciated crystalline rocks of various lithologies from the crater floor that were partially melted from the top down by impact energy. Some movement and minor mixing of these units is indicated by the glassy grains in the CBS, probably occurring during crater formation or during uplift of the central peak. The SCB probably represents a debris flow of Bunte Breccia-type material, ejecta, and pre-impact strata from the crater rim that occurred shortly after crater formation. Evidence indicates that the CBG had partially cooled, with a thin, glassy crust that was ripped up and incorporated, along with some still-molten material, into the shaley debris. At the same time shale fragments were thrust down into

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the molten CBG. Subsequent alteration modified some grains and matrix.

A second core drilled in 1991, the Manson M-2, penetrated 823 feet (247 m) in the center of the crater moat area (Figure 1). The M-2 core encountered a sedimentary clast breccia, similar to SCB in the M-1 core, from 195-320 feet (59-96 m), a layered sequence of poorly consolidated siltstone, shale, and sandstone from 320-656 feet (96-197 m), and another sequence of sedimentary clast breccia from 656-804 feet (197-241 m). The M-2 core has not yet been studied in detail. Additional cores will be drilled in 1992 as a part of the Manson Impact Structure Core-Drilling Project.

Figure 1. East-west cross-section of the Manson Impact Structure showing the location of the Manson M-1 and M-2 cores.

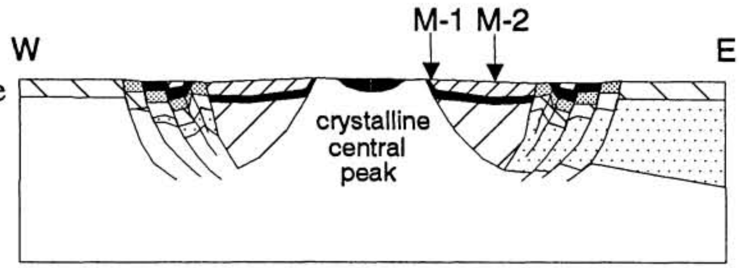

Figure 2. Generalized lithologic logs of the Manson M-1 and M-2 cores