PETROGRAPHY AND PRELIMINARY INTERPRETATIONS OF THE CRYSTALLINE BRECCIAS FROM THE MANSON M-1 CORE. M.S. **Bell,** M.K. **Reagan,** R.R. **Anderson,** and C.T. **Foster** Jr., Department of Geology, University of Iowa, Iowa City, IA 52242

The M-1 core was drilled on the eastern edge of the central uplift within the Manson Impact Structure in Iowa. The lower 107.9 m (106.4 to 214.3 m below ground surface) of the core consists of crystalline breccias. Twelve intervals of thin sections from this core have been studied for preliminary discussion. The breccias are divided into three units by matrix size and abundance. Unit 1 is characterized by a high volume fraction of matrix (ave. 0.54), and a decreasing proportion of matrix with depth. This matrix (106.4 to 147 m) is nearly isotropic and consists of grains < 0.005 to < 0.02 mm in length. The matrix between 112 and 146 meters depth consists of a crystalline intergrowth of felsic and opaque minerals with or without chlorite. This was the hottest section of the core after impact, and may have undergone high temperature metamorphic recrystallization. Unit 2 is transitional between units 1 and 3 (147 - 161 m), and is delineated by a rapid increase in grain size to .01-.04 mm and a decrease in matrix abundance to 10 %. Unit 3 (161 to 214.3) has a coarse, often porous matrix, whose abundance changes from about 10 % at the top to about 2 % at the base. Grain sizes range from 0.01-0.1 mm over this interval and coarsen with depth. Changes in the character of the matrix as well as the changes in clast lithology and abundance outlined below suggest that unit 3 is in-situ brecciated basement with injected melt and shale fragments; unit 1 is a crater veneer deposit consisting of transported basement materials and unit 2 is a mixed zone between units 1 and 3.

The top of unit 1 consists of intermixed sedimentary (3%) and crystalline basement (5%) clasts. The sedimentary clasts are predominantly Proterozoic siltstones. The abundance of the sedimentary clasts decrease to less than 1% within about 1 m, although they are scattered throughout the rest of the core. The basement clasts are mostly granophyric granite and biotite gneiss. Mineral grains in these clasts sometimes exhibit shock effects, and some clasts appear to have been melted by the impact. Polycrystalline quartz clasts less than 0.8 mm in length are abundant (~20%). Most have irregular shapes, but some have a lens-shaped cross-section and smooth boundaries. Mineral clasts include quartz, K-feldspar, biotite, and zircon. Grain shapes range from angular to subrounded. Some grains have no internal deformation, whereas others have a variety of deformation features related to shock metamorphism. Quartz grains have single shock lamellae (type A of [1]), multiple and decorated shock lamellae (types B-D of [1]), or multiple lamellae and a pale brown color from the presence of numerous minuscule inclusions not associated with specific shock lamellae. Some quartz grains are choked with inclusions and lack obvious shock-lamellae, whereas others have been converted to diaplectic and thetomorphic glass. Shock deformation features are scarce in mineral grains at 111.8 m and most of the core appears recrystallized. Deeper within the hot section of unit 1, shock-features regain prominence. Shocked quartz grains in this section often have annealed borders and fractures. All quartz grains have halos of small epidote and phlogopite crystals. Some granophyre clasts are relatively intact whereas others consist of quartz and feldspar melts that are recrystallized to polycrystalline quartz and Na-rich K-feldspar.

The thermal effects seen in the hot section of unit 1 disappear in unit 2. Mineral clast sizes increase with depth in unit 2, as does mineral angularity and degree of shock metamorphism in

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basement clasts. Clasts associated with unit 3 make their first appearance. Polycrystalline quartz grains decrease in abundance downward through unit 2 and are absent in unit 3.

Granophyric granite and biotite gneiss remain abundant in unit 3. Amphibolite also becomes abundant, especially towards the bottom of the core gabbroic rocks and diabases are relatively common, and volcanic rock fragments are rare. Melt fragments that are often altered, recrystallized, and sometimes vesicular are scattered down through the core. Mineral clasts are larger, more abundant, and more angular in unit 3 than in overlying units, and their size and abundance increases downward through the upper part of unit 3. Mineral clasts include blue-green to brown hornblende, K-feldspar, plagioclase, quartz, biotite, magnetite, clinopyroxene, and allanite (?). With the exception of shale clasts, all clasts within unit 3 exhibit shock metamorphic features.

These preliminary data suggest that there are major lithologic differences between units 1 and 3. Unit 3 has abundant amphibolite clasts, coarse mineral and matrix grains, and ubiquitous shock deformational features. There is no evidence of high temperatures within this unit except for the rare melt fragments. Unit 1 is dominated by granophyric granite, biotite gneiss, and associated minerals. Shock metamorphic features are common, but not ubiquitous. The matrix in the upper portion of the unit is exceedingly fine grained and nearly isotropic. The lower portion of the unit was hot enough to generate a finely crystalline groundmass and reaction rims on quartz. The transitional nature of unit 2 suggests that it is a mixture of units 1 and 3, with unit 1 traits increasing upward, and unit 3 downwards. Our preliminary interpretation is that unit 1 represents in-situ basement that was brecciated, mixed, and shock metamorphosed by impact. The rare shale and glass fragments present in unit 3 were likely injected into the jumble during impact. Unit 1 consists of diverse basement lithologies that were transported to the site during or shortly after impact. It may be a fallback breccia, but the high temperatures toward the base, and the mixed zone underneath suggest it was emplaced by flow. Our preferred interpretation is that it is a crater lining deposit generated during impact. Polycrystalline and monocrystalline quartz grains within unit 1 are identical in morphology and degree of shock to those seen in the upper layer of the K-T boundary horizons in the western U.S. [2], suggesting that unit 1 may be the local equivalent of this layer. Additional petrographic analyses and electron microprobe studies are planned to test these hypotheses.

[1] Robertson, P.B., Dence, M.R., and Vos, M.A. (1966) in French, B.M. and Short, N.M., Shock metamorphism of natural materials, Mono Book Corp., p. 433-452

[2] Izett, G.A. (1990) Geol. Soc. Am. Spec. Pap. 249, 100 p.