BUNTE BRECCIA-LIKE DEPOSITS WITHIN THE MANSON IMPACT STRUCTURE (IOWA); EVIDENCE FOR IMPACT INTO A SHALLOW MARINE ENVIRONMENT?

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Ongoing study of 12 research cores recovered from the Manson Impact Structure (MIS) in north-central Iowa has advanced our understanding of the largest intact impact structure in the U.S. and one of the best preserved complex craters in the world. Of the impact rocks encountered in the cores, one of the most enigmatic is the **Phanerozoic Clast Breccia (PCB)**, a poorly consolidated polymict breccia that is preserved as the upper impact unit in all areas of the MIS. The **PCB** is a matrix-supported breccia with clasts ranging in size from mm to in excess of 100 m. Clasts are dominated by Cretaceous marine rocks, with subordinate Paleozoic carbonate-dominated sedimentary rock clasts, minor clasts of Proterozoic Red Clastics, and very rare clasts of Proterozoic crystalline rocks and impact meltrock. The abundance of each clast lithology is inversely related to its pre-impact depth of burial. Parallel deformation features and other indicators of a hypervelocity impact are very rare in these clasts. The matrix is a light gray, calcareous, sandy, silty shale that contains scattered to common Cretaceous Foraminifera in some samples. **PCB** clast composition varies within the MIS, especially near its base, reflecting lithologies in underlying breccia units. The **PCB** is compositionally similar to the Bunte Breccia described from the Ries Crater (Germany) [1, 2]. Ries Bunte Breccia is a polymict breccia composed of clastic material derived from all stratigraphic horizons of the target, however "the frequency of (clasts from) a given target horizon is inversely proportional to its pre-impact position in the Ries target" [1, p. 42]. It is interpreted as a mixture of proximal impact ejecta and material excavated by secondary cratering processes, mobilized and emplaced by turbulent debris surge. At the Ries Crater, Bunte Breccia is found only in the area immediately outside the crater rim. At Manson all impact materials not structurally preserved within the crater have been removed by post-impact erosion. However, unlike Ries Bunte Breccia, the **PCB** is found inside the crater, recovered in cores from the Terrace Terrane, the Crater Moat, and even in the Central Peak Pit. In fact, petrographic examination of all drill cores and most available cutting samples collected during the drilling of water wells within the MIS show the **PCB** to be preserved as the uppermost impact-related unit in most areas of the crater (Figure 1). Manson **PCB** appears to be Bunte Breccia that was originally deposited outside the MIS, but subsequently remobilized and transported into the crater as debris flows. The **PCB** was transported back into the Manson crater with sufficient energy to carry it for at least 17 km, across the Terrace Terrane, to the floor of the Crater Moat (about 2 km below the crater rim), and up at least 2 km to the top of the Central Peak, where it is preserved in the Central Peak depression.

Another clastic unit similar to the **PCB** was reported in the Chesapeake Bay Impact Crater [3]. The Chesapeake Bay Crater is thought to have been formed by an impact into a thick sequence of unconsolidated sediment overlain by about 200-500 m of sea water. The **PCB**-like unit, informally called the *Exmore boulder bed* or *Exmore breccia,* was interpreted as a Bunte Breccia-like material that was originally deposited outside the crater, but was swept back into the crater by the return of water displaced by the impact (Powars, 1994, pers. comm.). Like the *Exmore breccia,* a likely mechanism for driving the **PCB** debris flows into the Manson Crater is water, surging back into the crater following an impact into a shallow-marine environment. Stratigraphic investigations and paleogeographic reconstructions suggest that the Late Cretaceous Pierre Seaway had regressed out of Iowa and its eastern margin lay in central South Dakota at about 73 Ma, the age recently suggested for the Manson Impact and its proposed ejecta blanket in the Crow Creek Mbr of the Pierre Shale Fm [4]. The probable departure of the seas from the Iowa area at that time (demonstrated by the subaerial unconformity separating the Claggett and Bearpaw marine cycles) and the evidence suggesting that the Manson Crater was formed in a marine environment, raise questions concerning the 73 Ma age for the Manson impact.

Evidence for marine conditions at the time of the Manson impact does not necessarily preclude a K-T boundary age. Although most previous Late Cretaceous paleogeographic reconstructions suggest that the sea had regressed from the Midcontinent prior to the K-T boundary, the eastward erosional truncation of upper-most Cretaceous strata across North and South Dakota has removed direct evidence of eastern sedimentation. However, two lines of evidence are suggestive that a seaway remained along the eastern margin of the Western Interior at K-T time:

1) Nonmarine strata of the Hell Creek-Ludlow Fms progressively thin eastward between Maastrichtian-Paleocene units (the thinning trend extrapolates a K-T shoreline position in the eastern Dakotas).
2) Marine-related fish occurrences in upper-most Maastrichtian channels of the Hell Creek Fm provide indirect evidence that a seaway persisted across parts of the Dakotas at K-T time (see [5]).

It appears likely that the western-derived clastic wedge (Hell Creek Fm) had not advanced into the eastern Dakotas or western Iowa at K-T time, leaving open the possibility that a K-T impact in the Manson area would have occurred in a shallow marine setting. Biostratigraphic and depositional studies of Cretaceous rocks in the Manson Structure are needed to determine the timing and environmental setting of the impact, and to independently evaluate significant discrepencies between published radiometric dates from Manson (65 vs 73 Ma).

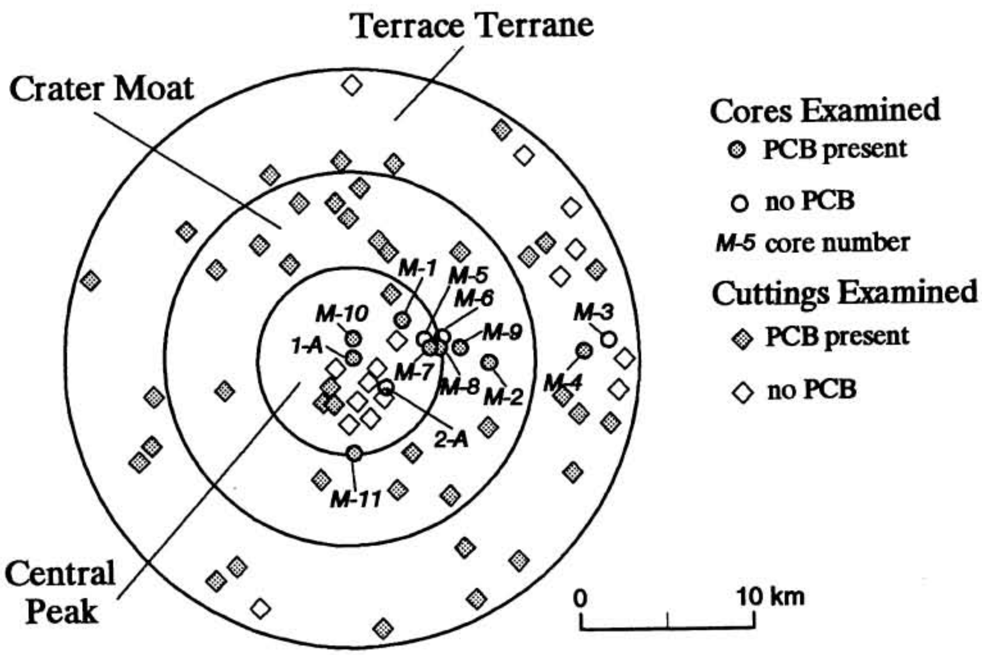

Figure 1. Location of Phanerozoic Clast Breccia (PCB) as identified by petrographic analysis

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