MANSON IMPACT STRUCTURE ROCKS: EVIDENCE FOR IMPACT MELTING

J. B. Hartung and R. R. Anderson, Iowa Dept. of Natural Resources, Geological Survey Bureau, 123 N. Capitol St., Iowa City, IA 52242.

The formation of the Manson Impact Structure (1) occurred 65.7 ± 1 Ma ago, an age indistinguishable from that of the Cretaceous-Tertiary boundary (2). Therefore, the Manson impact may be related to events at the boundary.

Recently, we initiated a restudy of Manson rocks and report here preliminary results of an effort to identify material which had experienced melting during the Manson impact. Because the entire structure is covered by 30 to 60 meters of glacial deposits, the samples studied were obtained from cuttings collected during drilling of water wells. Three cores which penetrate a total of 285 meters of rock within the impact structure have not yielded any evidence of impact melting.

Cuttings from 15 wells (Figure 1) have been studied. Wells selected are near the center of the structure and are among those which penetrated igneous and metamorphic rocks of the central uplift or associated totally disrupted stratigraphic sections. Depth intervals were selected for further study based on our own binocular microscope study of cuttings and the presence in earlier well logs of terms such as glass, tuff, volcanic, basalt, rhyolite, and phonolite. Selected single fragments and populations of fragments present at selected depth intervals were studied in thin section. Fragments recovered from 7 wells contained material judged to be the product of impact melting. This material displayed at least one of the following characteristics: 1) flow structures, 2) absence of birefringence, 3) microlites or devitrification or alteration textures indicated by small areas of spherulitic or radial extinction, and 4) color ranging from nearly colorless to honey-colored to dark brown.

Impact melt rock characteristics differed between wells and in at least one case differed within the same depth interval of one well. Three types of melt rock were identified by the study of thin sections of fragments from 57.9 to 59.4 m deep in the John Weideman well (W-11744). Type I (Figure 2) was light green and displayed easily recognized flow structures. The other two types of melt rock from this interval were dark brown; one displayed flow structures (Type II); the other did not (Type III). All fragments contained inclusions and microlites separated by areas lacking birefringence. Semi-quantitative chemical compositions of these fragments were obtained using an energy-dispersive x-ray microanalysis system. Results are shown in Table I. The clear areas of all three fragments have similar chemical compositions which correspond to a high aluminium iron-magnesium silicate, possibly a mineral of the chlorite group, but more likely one or more clay minerals; suggesting a fine-grained siliciclastic sediment or sedimentary rock was the protolith. The high titanium measured in the dark flow lines suggests the former presence of an ilmenite grain which was heated beyond its melting point and severely deformed in response to impact stresses.

Melt rock characteristics and associated polymictic microbreccia (Figure 3) that we observed in Manson samples are similar to those reported from other impact structures. Although judgements based on study of cuttings alone are difficult, we conclude that suevite-like fall-back deposits exist within the Manson structure, thus enhancing the possibility of obtaining information relating to the impacting object and the Cretaceous-Tertiary boundary. A worthy target for future core drilling would be the recovery of such a fall-back deposit.

References

1. Hartung, J.B. and Anderson, R.R. (1988) LPI Tech. Rept. 88-08, 32 pp. Lunar and Planetary Inst., Houston.
2. Kunk, M.J. et al. (1989) Science, 244, 1565-1568.

MANSON IMPACT STRUCTURE ROCKS: Hartung J. B. and Anderson R. R.

Table I. Chemical Compositions of Manson Impact Melt Rocks. (Atom %)

Melt Rock Type / Element	I (Clear Area)	I (Dark Flow Line)	II (Clear Area)	III (Clear Area)
Mg	17-18*	---	13-15*	12-14*
Al	23-24	16	21	22
Si	33-36	31	39	40
K	---	---	2-3	2
Ca	---	13	1-2	2
Ti	---	22	0-2	0-1
Fe	23-24	18	20-21	20-22
TOTAL	96-102	100	96-104	98-103

* Range for three measurements at different locations

Figure 1

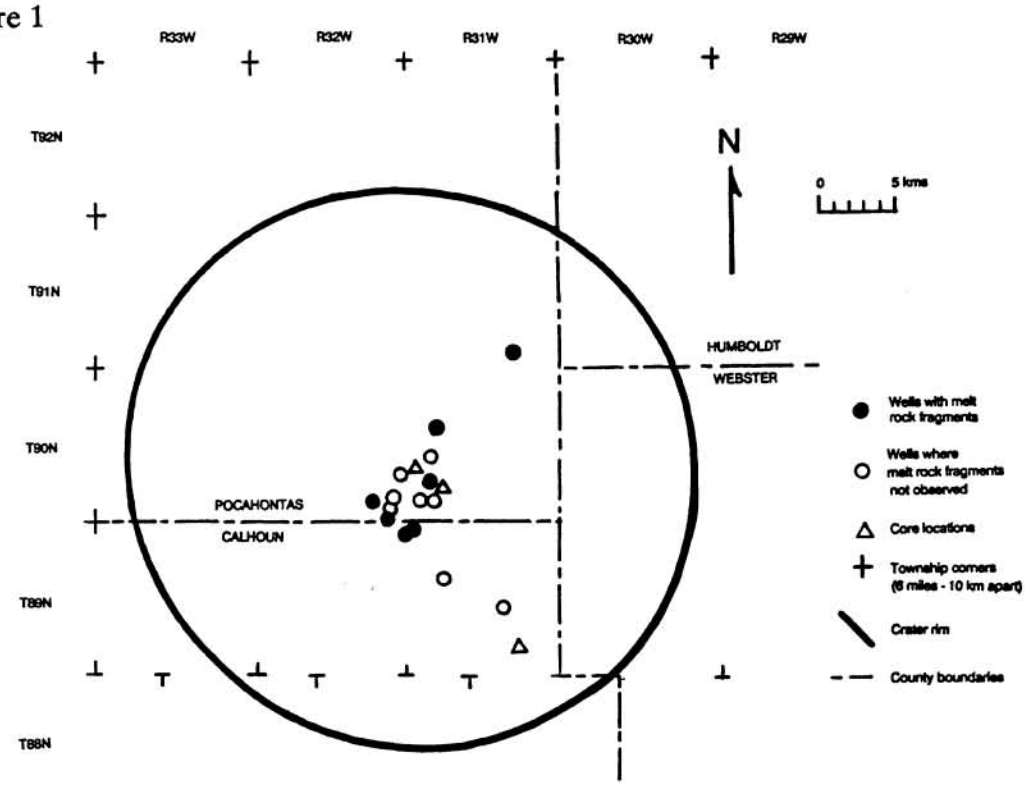

Figure 2

0 0.5 mm

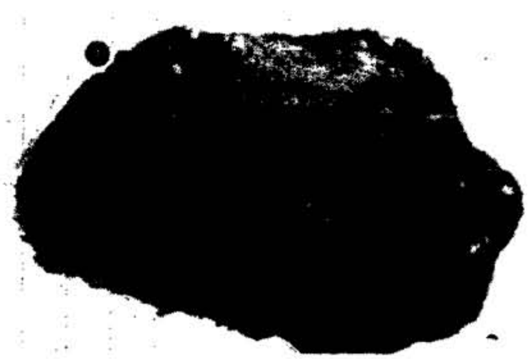

Figure 3

0 0.5 mm