MANSON IMPACT STRUCTURE ROCKS: GEOCHEMISTRY OF IMPACTITES.

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INTRODUCTION. The Manson Impact Structure is the largest recognized in the United States, 35 km in diameter, and has a radiometric age indistinguishable from that of the Cretaceous-Tertiary (K-T) boundary **[1]**. For these reasons the Manson structure may be considered at least one element of the events which led to the catastrophic loss of life and extinction of many species at that time. Our knowledge of the structure is sparse, mainly because it is buried beneath 30 to 60 meters of Pleistocene glacial deposits. Essentially, the only samples available for study are cuttings derived from the drilling of water wells.

SAMPLES AND ANALYSES. We have undertaken a basic geochemical study of samples carefully chosen to offer the best possibility of revealing a relationship, if any exists, between the K-T boundary and the Manson impact. Furthermore, a major objective of this study was to investigate the chemical relationship between target rocks penetrated by the Manson impact and impact-derived rocks and glasses. Using a binocular microscope we hand-picked fragments of water-well cuttings judged to be glassy or to consist of mixed breccia, or both. The levels in wells from which the samples were obtained are known, based on previous studies **[2]**, to contain such material. Nevertheless, considerable uncertainty exists in establishing the lithologic character of samples based only on binocular microscope inspection of mm-sized fragments. The 15 samples chosen for INAA analysis were divided into three classes: 1) Glassy - flow structures and isotropic phases, 2) Microbreccia - angular unsorted clasts, usually polymict, no flow structure or layering, 3) Light-matrix Microbreccia - same as microbreccia, but with distinctly lighter matrix. Following the final INAA measurements and after an appropriate cooling time, thin sections were prepared from the samples for optical and electron microscopy.

RESULTS AND DISCUSSION. Chemical concentrations of 33 trace and minor elements plus Na, K, and Fe were obtained for 15 samples, six considered glassy and nine microbreccias. The range of concentrations of all elements for all microbreccias almost never exceeded a factor of two and never was less than a factor of 1.5. No systematic differences or trends with respect to a particular element, well, or color were observed. The data are consistent with the view that microbreccias are mixtures of fairly locally derived rocks and contain no exotic component.

For the six glass samples element concentrations are shown in figure 1. Units are ppm except for Na, K, and Fe, which are weight %, and Ir and Au, which are in ppb. The letters in the sample names are abbreviations of the water well names. Ranges of concentrations of all elements measured equalled or exceeded a factor of 3, except for Sr and Sc, the concentrations of which ranged from 140 to 240 ppm and 14 to 33 ppm, respectively. For the E(manuel) Z(ehr) well sample the concentrations of As, Br, and Au exceeded the average values for the remainder of the wells by factors of 10, 17, and 24; absolute concentrations were 21, 19, and 36 ppm, respectively. This sample displays lesser enrichments of the elements, Sb and Cs, and the highest K and the lowest Fe and Mn concentrations of all glasses analyzed. Apparently some glasses are derived from material which has experienced less mixing than have the microbreccias. They may represent melting of single mineral grains or, at most, single rock types.

Rare-earth element concentrations for the 6 glasses, normalized with respect to C1 chondrites, are shown in figure 2. Eu anomalies are not significant in most samples. Fig. 2 shows that - with one exception - the glass samples have only very minor negative Eu anomalies. This is also true for part of the microbreccia samples. Other microbreccias have pronounced negative Eu anomalies (similar to the ZE sample in Fig. 2), and patterns that are indistinguishable from typical granites (which are found in well cuttings near the center of the structure). The M(anson) C(ity) well sample is different in having considerably higher REE abundances than all other samples (including microbreccias), maybe indicating a high apatite content. It is also high in Sc, Hf, and Ta, but low in K (0.66 wt.%; K/U=1580). The source rock of this glass has yet to be identified, but it might be derived from some of the granites that were uplifted during the central peak formation.

The lithologic character of the rocks penetrated by the Manson impactor is well-established **[3]**. At the time and place of the Manson impact the Cretaceous sea had withdrawn to the west leaving over 100 meters of clastic sediments, mostly very fine-grained, at the surface. Underlying Pennsylvanian rocks consist of coal-bearing shale, roughly 100 meters thick. The remainder of the Phanerozoic section is dominated by carbonates, with interbedded shale and sandstone, about 700 meters thick, which in turn is underlain by Precambrian red clastic sedimentary roughly 4 km thick. Underlying basement rocks consist mainly of granitic-to-syenitic composition igneous and metamorphic rocks with some amphibolite bands. The presence of more mafic intrusive rocks is also possible. The entire section was penetrated by the impactor, so melts and breccias may have been derived from any of these rock types. Analyses of these target rocks are still in progress at this time. We also plan mixing model calculations to determine if glasses and microbreccias are simple mixtures of host rocks.

References
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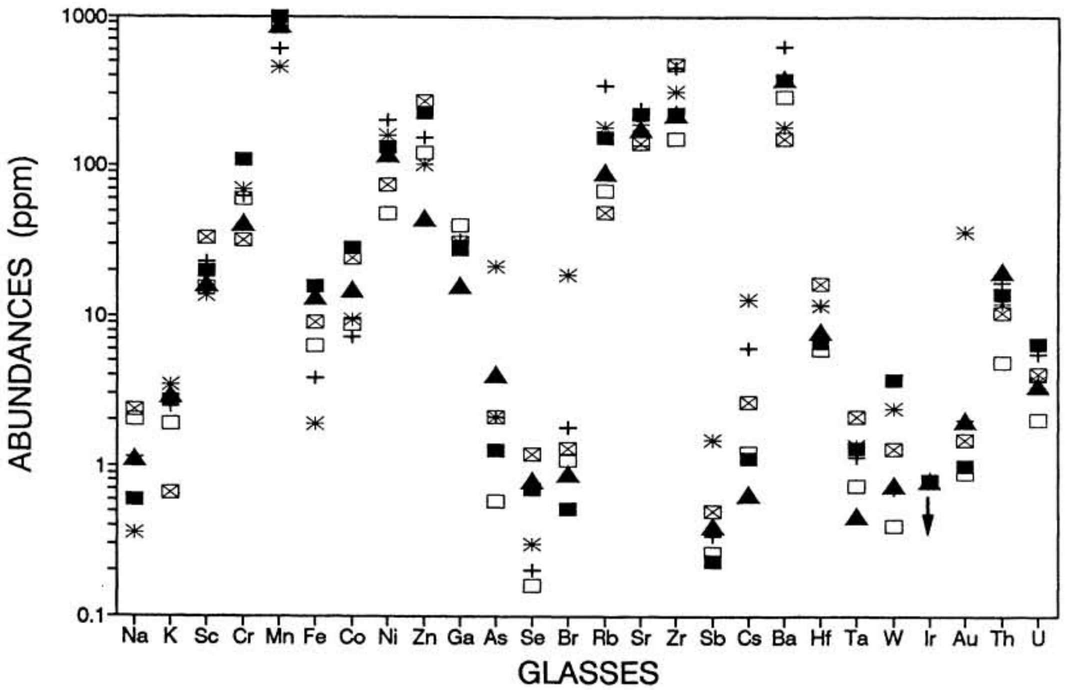

Figure 1. *Abundances of 26 elements in glass samples from different wells at the Manson impact structure. Data in ppm, except Na, K, and Fe in wt.% and Ir and Au in ppb. JW, LS, and ZE are black glass samples.*
Figure 2. *Chondrite-normalized REE patterns in the Manson glass samples (legend for Figs. 1 and 2).*