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MANSON IMPACT STRUCTURE, IOWA: FIRST GEOCHEMICAL RESULTS FOR DRILL CORE M-1.

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The Manson Impact Structure is a large complex impact crater centered ca. 5 km north of the town of Manson, Iowa [1,2]. It is the largest intact impact structure recognized in the United States (35 km in diameter). Its $^{40}Ar/^{39}Ar$ age is indistinguishable from that of the Cretaceous-Tertiary (K-T) boundary [3]. The Manson structure may be one element of the events at the K-T boundary. The crater is completely covered by Quaternary glacial sedimentary deposits that are normally underlain by Cretaceous clastic sediments and flat-lying carbonate sediments of Phanerozoic age, as well as Proterozoic red clastic, metamorphic, volcanic, and plutonic rock sequences (e.g., [1,2,4]. The study of a reflection seismic profile, provided by Amoco, was critical in interpreting the structure [4]. In the 35 km diameter zone that marks the extension of the crater the normal rock sequence is disturbed due to the impact, and at the center of the structure granitic basement rocks are present that have been uplifted from about 4 km depth.

In 1953, two drill holes yielded core samples at locations on the central uplift (Fig. 1). The lithologies encountered in these cores are described by [1]. Recently, 12 new holes (M-2 and M-2A at the same location) were drilled (for locations see Fig. 1). A total of 4019 feet of core was obtained. The goal of the drilling was to understand the structure of the crater (in comparison to geophysical data), to find clues regarding the nature of the projectile, obtain more precise age data, and to determine the properties and distribution of the lithologies present at the crater. Our studies consist of detailed petrological and geochemical characterization of all cores, with emphasis on a detailed description of all rock types found in the core samples and their relationship to target rocks. In addition we try to study possible connections between the Manson crater and events at the K-T boundary. After completion of the geochemical analyses, we will calculate which mixtures of known target rocks provide a good match for the composition of impact melts and impact derived breccias at the crater. Some earlier work was based on samples obtained from well cuttings and provided some first estimates of the breccia and melt rock compositions [5,6].

Here we present first geochemical data on samples from the Manson M-1 core (Pierson). The drilling for this core was completed on May 8, 1991, at a depth of 703 feet. The interval from 186-703 feet was cored. The drill hole was placed on the flanks of the central uplift (Fig. 2). The major lithologies encountered in this drill hole are, in order of increasing depth, glacial till, followed by thick sequences of sedimentary clast breccia, and igneous clast breccia (with "glassy" and sandy matrices; see Fig. 2). For the geochemical and petrological studies we have obtained samples from 42 different depths, representing all major lithologies. The sedimentary clast breccia contains numerous shale clasts which may be of Cretaceous age and could be part of the pre-impact target lithology. The samples were powdered and analyzed by XRF. The results given in Table 1 show the relatively wide variations present in the shale composition as compared to more restricted compositions of the matrices of both the sedimentary and the crystalline rock breccia. Figs. 3a-c show the variation of some major elements with depth for the three main lithologies. It is obvious that the matrix compositions show only a limited variation, with the exception of one sample (660.6 ft) which contains a partly altered mafic rock clast.

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MANSON IMPACT STRUCTURE

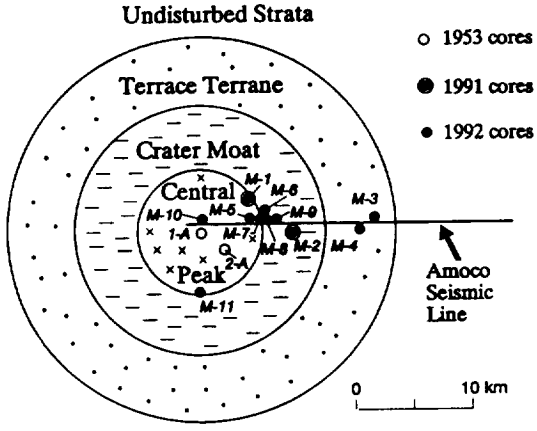


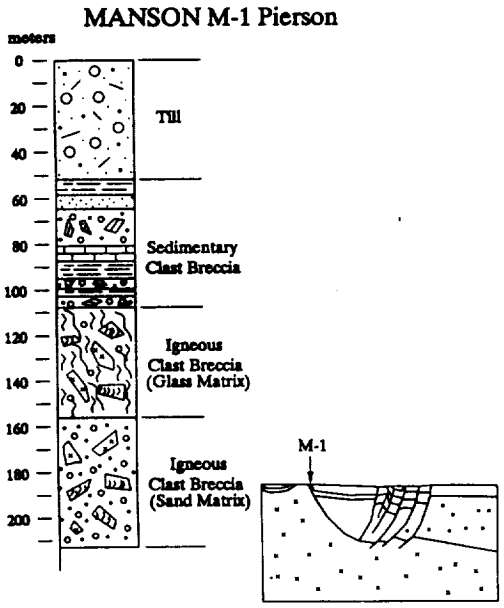
Fig. 1: Location of Manson drill holes. →

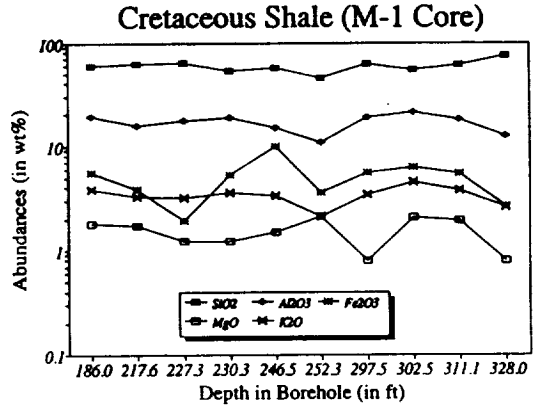
MANSON CRATER DRILL CORE M-1: FIRST GEOCHEMICAL DATA: Koeberl C. et al.

Table 1: Major element compositions (average and range) for selected rock types encountered in Manson Core M-1 (in wt%)

	M-1 Avg Sh/C	M-1 Min Sh/C	M-1 Max Sh/C	M-1 Avg SCB-M	M-1 Min SCB-M	M-1 Max SCB-M	M-1 Avg CRB-GM	M-1 Min CRB-GM	M-1 Max CRB-GM	M-1 Avg CRB-SM	M-1 Min CRB-SM	M-1 Max CRB-SM
SiO2	59.55	45.63	74.41	63.71	59.88	68.32	63.75	59.73	65.26	60.15	51.53	62.10
TiO2	1.00	0.63	1.25	0.58	0.53	0.65	0.96	0.84	1.40	0.86	0.74	1.03
Al2O3	16.84	10.75	21.08	8.77	7.82	10.73	13.96	13.18	14.86	14.94	10.15	15.80
Fe2O3	5.04	1.92	9.97	4.13	3.37	4.77	5.51	4.62	7.60	7.04	6.13	11.13
MnO	0.03	0.01	0.08	0.06	0.04	0.07	0.09	0.07	0.11	0.11	0.07	0.23
MgO	1.52	0.78	2.14	4.39	3.18	6.00	2.90	2.11	3.73	4.14	3.11	11.94
CaO	2.22	0.24	16.56	6.80	3.17	10.27	2.35	1.81	3.04	4.73	3.16	9.12
Na2O	0.40	0.11	0.70	1.07	0.07	2.43	3.78	3.41	4.44	4.74	2.22	5.50
K2O	3.38	2.13	4.50	1.09	0.65	1.72	3.41	3.02	3.87	2.13	1.19	2.66
P2O5	0.11	0.03	0.19	0.18	0.12	0.31	0.20	0.18	0.26	0.19	0.08	0.22
LOI	9.21	3.55	17.17	8.39	5.78	11.88	2.40	1.58	3.62	1.20	0.69	2.20
Total	99.30			99.18			99.30			100.22		

Note: Sh/C + (Creteaceous?) Shale; SCB-M = Sedimentary Clast Breccia (Matrix); CRB-GM = Glassy Matrix, Crystalline Rock Breccia CRB-SM = Crystalline Rock Breccia, Sandy Matrix





← Fig. 2: General M-1 core stratigraphy.

↕ Fig. 3a-c: Major element variation with depth in individual samples of three major rock types from the Manson M-1 core.