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PRELIMINARY $^{40}Ar/^{39}Ar$ AGE SPECTRUM AND LASER PROBE DATING OF THE M1 CORE OF THE MANSON IMPACT STRUCTURE, IOWA: A K-T BOUNDARY CRATER CANDIDATE: Kunk, M.J.,USGS, Reston, VA 22092, Snee, L.W., USGS, Denver, Co 80225, French, B.M., NASA HQ, Washington DC 20546, Harlan, S.S., USGS, Denver, CO 80225, and McGee, J.J., USGS, Reston, VA 22092

Preliminary $^{40}Ar/^{39}Ar$ age spectrum and laser probe dating results from new drill core from the 35-km-diameter Manson Impact Structure (MIS), Iowa indicates a reasonable possibility that the MIS is a Cretaceous-Tertiary (K-T) boundary impact event. Several different types of samples from a melt-matrix breccia, a unit of apparent crater fill intersected by the M1 core, have been analyzed. $^{40}Ar/^{39}Ar$ results from these samples indicate a maximum age for the MIS of about 65.4 ± 0.4(2σ) Ma. Petrographic analyses of the samples indicate a high probability that all the dated samples from the melt-matrix breccia contain relict grains that were not entirely melted or degassed at the time of impact, suggesting that the actual age of the MIS could be somewhat younger than our preliminary results indicate. The results are consistent with a previously published age estimate of shocked microcline from the MIS central uplift of 65.7 ± 1.0 Ma[1].

The possibility of multiple impacts at the K-T boundary has been suggested by the boundary layer in the Western Interior of North America which consists of a two-part layer that may record two or more bolide impacts[2]. The lower thicker member of this layer is a claystone composed mostly of kaolinite, but it contains spherules that may be the alteration product of impact-produced tektites. This lower layer may be ejecta from the Chixulub crater in Mexico, which has an age indistinguishable from that of the K-T boundary[3,4]. The top surface of the lower claystone layer appears to have supported some plant growth for a period of time before the deposition of the upper member. This upper member, the so-called "magic layer", contains the iridium anomaly and shocked mineral grains that characterize the K-T boundary layer worldwide[5,6], and allowed the recognition of a bolide impact(s) at the K-T boundary. The "magic layer" records an event that is clearly distinct from that of the lower member of the doublet.

If multiple impacts occurred at the K-T boundary, the MIS located in northcentral Iowa is a K-T boundary crater candidate[7] because of its previously published age of 65.7 ± 1.0 Ma[1], and its proximity to K-T boundary sites that have the highest concentrations and largest sizes of shocked mineral grains[6].

The recently drilled M1 core from the MIS apparently penetrates ejecta deposits ("crater fill") that include a unit of probable melt-matrix breccia that contains clasts of apparent basement lithologies that have been intensely shocked. Some clasts have been partially melted. Although petrographic analysis of some of these clasts suggests the growth of new potassium feldspar from a melt, all of the samples studied to date also appear to contain relict potassium feldspar that was not melted by the impact and that may record older pre-impact ages. The matrix of this breccia is cryptocrystalline and also represents material that was incompletely melted because it contains mineral grains (xenocrysts?) with obvious shock features.

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Samples selected for preliminary $^{40}Ar/^{39}Ar$ dating include feldspar grains from clasts in the melt-matrix breccia that were melted and recrystallized to varying degrees, and the matrix itself from the melt-matrix breccia. Sanidine from the Fish Canyon Tuff (27.79 Ma) and MMhb-I (519.4 Ma) were used as fluence monitors. Tektite glass from the K-T boundary layer in Haiti was irradiated at the same time and was dated at 65.0 ± 0.4 Ma. The results from the Haitian tektites are indistinguishable from previously published results[3].

$^{40}Ar/^{39}Ar$ age spectrum results on feldspar from variably melted and recrystallized clasts from the melt matrix breccia do not develop age plateaux. The overall pattern of these age spectra suggests the presence of incompletely degassed protolith feldspar or the presence of some extraneous argon in the samples. Ages of individual steps increase with temperature of extraction and range from about 68 Ma to 123 Ma. These age spectra are interpreted to represent a maximum age for the MIS of ~68 Ma.

$^{40}Ar/^{39}Ar$ laser probe results from a bulk potassium feldspar sample from the 420.5 foot level of the M1 core are consistent with conventional age spectrum total gas results from the same sample at ~74 Ma. $^{40}Ar/^{39}Ar$ laser probe results of multiple one and two grain aliquots from the same sample range in age from 65.4 ± 0.4 to 97.5 ± 2.6 Ma. Although the 65.4 ± 0.4 Ma result agrees with previously published results from the MIS, it may still represent an overestimate of its age because of the possibility that some portion of the individual grains may be protolith material that has been incompletely degassed. The older ages of some of these analyses are almost certainly due to included incompletely degassed protolith material.

$^{40}Ar/^{39}Ar$ age spectra of melt matrix samples are more complex than those of the feldspars and are interpreted to represent the effects of some combination of the presence of excess ^{40}Ar in the samples, ^{39}Ar recoil during irradiation, and the inclusion of incompletely degassed protolith material. These age spectra suggest that the time of impact is less than ~73 Ma.

Our preliminary $^{40}Ar/^{39}Ar$ results on samples from the MIS M1 core indicate a maximum age for the MIS of 65.4 ± 0.4 Ma. This age taken together with our age results from the Haitian tektite sample of 65.0 ± 0.4 Ma indicates a reasonable probability that the MIS was formed during K-T boundary times. Additional $^{40}Ar/^{39}Ar$ work is required to test for the possibility of yet younger ages, to more precisely date the MIS, and to more tightly compare the age of the MIS with that of the K-T boundary.

[1] Kunk et al.(1989) Science, 244, 1565-1568. [2] Shoemaker and Izett (1992) Lunar and Planerary Science, XXIII, 1293-1294. [3] Swisher et al. (1992) Science, 257, 954-958. [4] Sharpton et al. (1992) Nature, 359, 819-821. [5] Alvarez et al. (1980) Science, 208, 1095-1108. [6] Izett (1987) Geological Society of America Bulletin, 99, 78-86. [7] French (1984) Science, 336, 53. [8] Izett et al (1991) Science, 252, 1539-1542