POST-IMPACT ALTERATION OF THE MANSON IMPACT STRUCTURE; L.J. Crossey and P. McCarville, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131

Core materials from the Manson impact site (Manson, Iowa; Fig. 1) are examined in order to evaluate post-impact alteration processes. Diagenetic interpretation of post-impact events is based on petrologic, mineralogic, and geochemical investigation of core materials; including target strata, disturbed and disrupted strata, ejecta, breccias, microbreccias, and impact melt. The diagenetic study utilizes research cores obtained by the continental scientific drilling project (CSDP) at the Manson structure, as well as core and cuttings of related materials (Alvina Luebke core, Manson 1-A, Manson 2-A, Amoco Eisheid #1 Deep Petroleum Test Well). Samples include impactites (breccias, microbreccias, and melt material), crater fill material (sedimentary clast breccias), disturbed and disrupted target rocks, and reference target material (Amoco Eisheid #1 materials). The study of multiple cores will permit development of a regional picture of post-impact thermal history. The specific objectives are: (1) provide a detailed description of authigenic and alteration mineralogy from diverse lithologies encountered in research drill cores at the Manson impact structure, and (2) identify and relate significant post-impact mineral alteration to post-impact thermal regime (extent and duration). Results will provide mineralogical and geochemical constraints on models for post-impact processes (including infilling of the crater depression; cooling and hydrothermal alteration of melt rocks; and subsequent long-term, low-temperature alteration of target rocks, breccias, and melt rocks). Preliminary petrologic and x-ray diffraction examination of fracture linings and void fillings from research core M1 indicate the presence of quartz, chlorite, mixed-layer clays, gypsum/anhydrite, calcite, and minor pyrite.

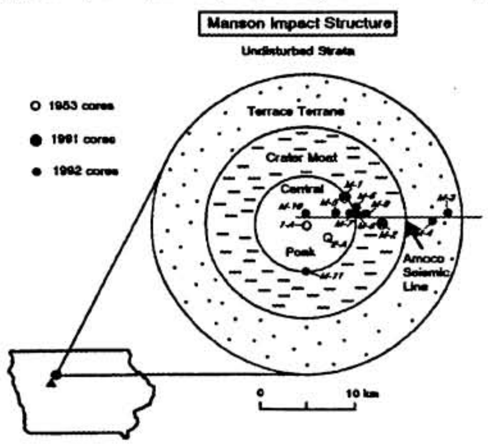

Fig. 1: Location and schematic of Manson impact structure in NW Iowa. Triangle indicates location of Amoco Eisheid #1.

While much emphasis has been given to establishing mineralogical and geochemical affinities among boundary layer clay, ejecta, impactor, and target rocks, little attention has been given to post-impact processes. Re-equilibration processes occurring after the physical and thermal disruption associated with large impacts may include: infilling of the crater depression, cooling of melt rocks, development of a related hydrothermal circulation system, and mineralogical and geochemical alteration of target rocks, ejecta, and melt rocks. The availability of core material from the post-impact crater fill, breccia lens, ejecta blanket, and melt rocks provides the opportunity for detailed investigations of post-impact alteration not possible from cuttings, and less affected by surface weathering phenomena operative at currently exposed (and well-studied) crater sites. Examination of alteration mineralogy and geochemistry will provide constraints on models for the cooling history of the impact site. Of particular focus in this study are (1) secondary minerals filling voids and fractures, (2) alteration mineral paragenesis of the reactive glasses encountered in several of the research drill cores, and (3) degree of thermal alteration of sedimentary clasts encountered in breccia units distributed across the Manson study area.

Analysis will include petrography (quantitative mineralogy and paragenetic sequence of alteration mineralogy), scanning electron microscopy (qualitative analysis of alteration phases and textural interpretation), electron microprobe analysis (quantitative analysis of selected authigenic phases; including zeolites, feldspars, pyrite, chlorite, and illite), and x-ray diffraction analysis (mineralogical analysis of clay-size materials). Preliminary examination of core M1 reveals the presence of mineralized fracture surfaces and vugs. Petrographic analysis indicates the presence of abundant quartz, clay, calcite, minor pyrite, gypsum/anhydrite, and zeolites; x-ray diffraction and scanning electron microscopy indicates that the most abundant authigenic clay phases coating fractures are chlorite and an expandable mixed-layer clay (Figs. 2 and 3). A similar assemblage has been noted in fractures of the Siljan Ring, Sweden [1] and altered materials of the Ries Crater, Germany [2], [3], and [4]. Shocked quartz, feldspar, and biotite are noted in varying degrees of abundance within breccias of the M1 core: remnant grains of recrystallized quartz typically contain a central pore. X-ray diffraction analysis of laminated, pyritic, black shales (interpreted to be displaced Proterozoic Nonesuch Shale) from the M1 core indicates that minimal, if any, graphitization has occurred.

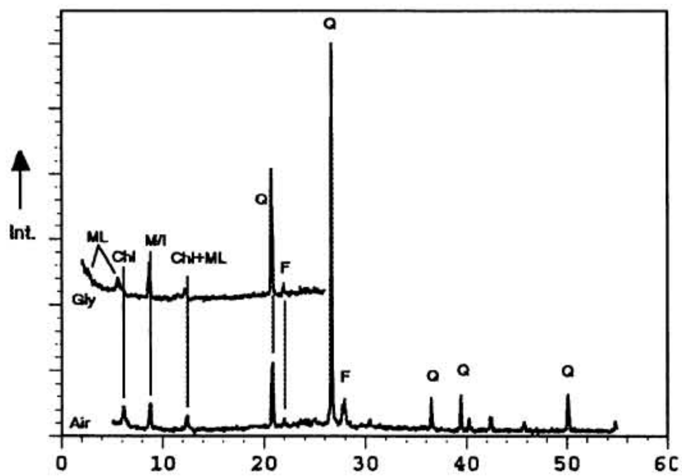

Fig. 2: X-ray diffractogram of fracture surface materials from 128m depth in the M1 core. Chl = chlorite, ML = mixed-layer clay, M/I = muscovite/illite, Q = quartz, and F = feldspar. X-axis is degrees 2-theta. Upper pattern illustrates shift of expandable mixed-layer clay upon solvation with glycol.

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Fig. 3: Scanning electron photomicrograph of authigenic clay from 122m depth in the M1 core. Morphology and energy-dispersive X-ray analysis indicates an Mg- and Fe-rich mixed-layer clay.