FLYNN CREEK IMPACT CRATER: PETROGRAPHIC AND SEM ANALYSES OF DRILL CORES FROM THE CENTRAL UPLIFT. T. A. Gaither , J. J. Hagerty, K. A. Villareal, A. L. Gullikson, and H. Leonard, U.S. Geological Survey, Astrogeology Science Center, 2255 N. Gemini Drive, Flagstaff, AZ 86001 email: tgaither@usgs.gov.

Introduction: The Flynn Creek impact crater is a ~3.8 km diameter, >200 m deep, complex, flat-floored impact crater, with a central uplift and terraced crater rim [1 – 4]. The crater formed ~360 Ma in what is now north central Tennessee (36°17' N, 85°40' W) [1-4]. Between 1967 and 1979, USGS scientist Dr. David Roddy conducted a drilling program at Flynn Creek crater, an invaluable terrestrial analog for the study of planetary impact cratering dynamics [5,6]. The drilling program produced more than 3.8 km of nearly continuous core from 18 separate bore holes [7]. These samples, along with an additional three drill cores donated to the USGS, are now contained in over two thousand standard core storage boxes at the USGS in Flagstaff, Arizona. Here we discuss the USGS Flynn Creek Crater Drill Core Collection (FCCDCC) and present initial results of a petrographic and microbeam exploration of samples from the FC79-12 drill core.

The USGS FCCDCC Web-based Portal and Online Database: The 21 drill cores of the FCCDCC are available to the scientific community via a web-based portal and online database. Modeled after the USGS Meteor Crater Sample Collection (http://astrogeology.usgs.gov/facilities/meteor-crater-sample-collection), the USGS FCCDCC web-based portal and online database (https://astrogeology.usgs.gov/facilities/flynn-creek-crater-sample-collection) facilitates the scientific community's access to this unique suite of geologic samples and data. The website features an interactive map of Flynn Creek crater with links to the drill core documentation, drill core photographs for 21 cores, core sample database, and core sample request forms, such that researchers may identify, request, borrow, and utilize samples and data from Flynn Creek crater.

Flynn Creek Crater Geology: Confirmation of an impact origin for the Flynn Creek impact structure came in 1966 with the discovery of shatter cones in exposures of the central uplift [8]. Remnants of the ejecta blanket, which contains crudely inverted stratigraphy, are present within a large graben along the southern rim. The rocks involved in the deformation are Ordovician-aged carbonates (i.e., limestone and dolomite) that overlie crystalline basement [2]. Scientific studies at Flynn Creek crater during the 1960's and 1970's [1-2, 7-15] laid the groundwork for understanding structural deformation during marine target impact crater formation. The potential for an impact-induced hydrothermal system at Flynn Creek crater is of considerable scientific interest because of the implications for the origin and evolution of life on early Earth [16-17], and possibly on Mars [18-20].

Current Research and Methods: The objective of our current research is to investigate potential impact melt formation and hydrothermal mineralization within the central uplift and crater moat. Forty-two polished thin sections were made to investigate the compositions and textures of the breccia matrix, clasts, and minerals, and to identify the presence of impact melt and hydrothermal mineralization and alteration. These thin sections are derived from three drill cores from the crater moat (FC78-07 and FC79-09) and from the central uplift (FC79-12). Thin sections were examined using standard petrographic techniques, to indentify impact melt and/or hydrothermal alteration products and textures. Four thin sections were then further examined using a JSM-6480LV scanning electron microscope (SEM) at Northern Arizona University. Backscattered electron imaging (BSE) and electron dispersive spectroscopy (EDS) were used to qualitatively examine the samples.

Results: ***Petrography and SEM Analyses.*** The four thin sections from the central uplift drill core FC79-12 are clastic breccias, composed primarily of target rock dolomite, limestone, and shale clasts, and a fine to coarse grained matrix derived from these lithologies.

The samples also contain regions of isotropic material (Fig. 1). The isotropic material forms a matrix around both lithic clasts and individual minerals, which display both euhedral and rounded crystal forms. EDS analyses of this isotropic material shows it is composed of silica. Lithic clasts present within this apparently glassy matrix include dolomite, limestone, and shale (as in the dominant clastic matrix). Minerals present within both the glassy and clastic matrices include calcite, dolomite, quartz, K-feldspar, pyrite, and wollastonite (Figures 2, 3).

Discussion and Future Work. Recently, Adrian et al. [21] analyzed similar samples from the FC77-1 drill core via micro-FTIR and micro-Raman spectroscopic analysis and determined that this isotropic material, while petrographically indistinguishable from glass, is composed of cryptocrystalline SiO_2. Our EDS results corroborate this finding. Pyrite and wollastonite, common products of hydrothermal alteration, as well as large, euhedral, unshocked calcite and dolomite crystals, will be targeted for characterization in future electron microprobe work. We will conduct stable isotope (e.g., carbon, oxygen, and hydrogen) investigations to further characterize the post-impact hydrothermal system.

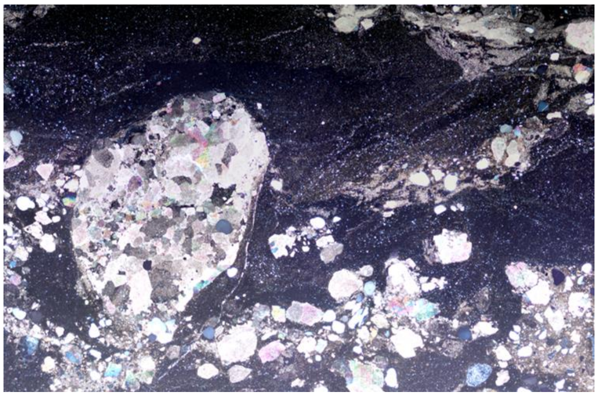

Figure 1. Photomicrograph (crossed polars) of isotropic matrix (with lithic and mineral inclusions) that we interpret as cryptocrystalline silica melt. From drill core FC79-12, depth 750 m.

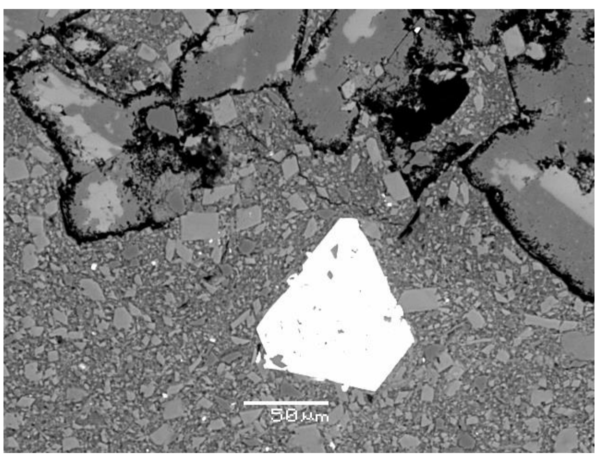

Figure 2. BSE image of euhedral pyrite within clastic breccia. From drill core FC79-12, depth 574 m.

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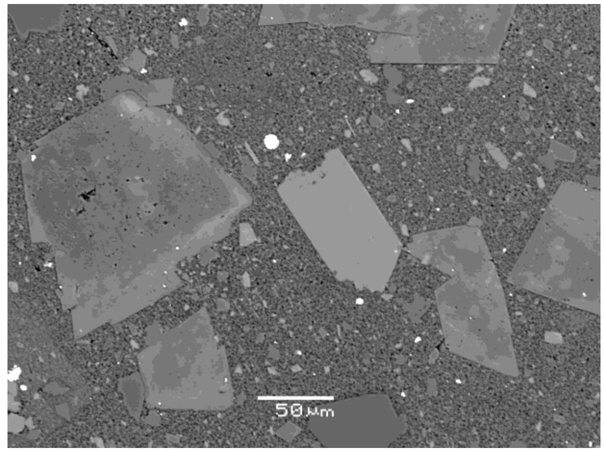

Figure 3. Dolomite, quartz (bottom center), and K-feldspar (center) crystals within fine grained clastic matrix. From drill core FC79-12, depth 789 m.

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