MARINE RESURGE SEQUENCES AND INTERPRETED PROCESSES AT FLYNN CREEK IMPACT STRUTURE, TENNESSEE. L. De Marchi[1] J. Ormö[2], D. T. King Jr.[1], and D. R. Adrian[1] [1] Geosciences, Auburn University, Alabama USA (lzd0034@auburn.edu), [2]Centro de Astrobiología (INTA-CSIC), Spain.

Introduction: Roddy [1-4] first presented evidence that the Flynn Creek impact structure is a Late Devonian, 3.8-km diameter, complex impact crater, which formed in an epicontinental shelf sea. These early works by Roddy established Flynn Creek as the first interpreted marine-target impact crater on Earth. The Flynn Creek impact structure is located in north-central

Tennessee USA (36° 17' N; 85° 40' W) and is well exposed at the surface. The crater has a terraced rim with an asymmetric ("pear-shaped") outline (Fig. 1), and displays a central uplift surrounded by a breccia-filled crater moat [4-6]. The target stratigraphic section was nearly flat-lying, mostly poorly consolidated, Upper Ordovician carbonates ranging from Knox Group through Catheys-Leipers Formation [4-6]. Almost all rim exposures consist of Catheys-Leipers Formation, whereas the central uplift exposures consist primarily of Knox and Stones River Groups [4-6]. Central uplift-flanking breccias are mainly coarsening upward slump deposits [7], whereas the upper moat shows normal graded breccias (this study). Upper Devonian Chattanooga Shale deposition had likely begun at the time of impact, but comprised a very thin, poorly consolidated target layer. The main phase of Chattanooga deposition is the regional postimpact deposit [4-6, 8].

Methods: Analysis of two drill cores, one in the northeastern moat area (FC77-3) and one in the southwestern moat area (FC67-3) was completed using granulometric line-logging and statistical analysis following the method applied to similar deposits in Lockne, Tvären, and Chesapeake Bay (CBIS) marine-target impact craters [9, 10]. In addiction, petrographic analysis have been carried in order to complement line-logging results and to identify possible impact related microstructures.

Results: Drill core FC77-3 from the northwestern quadrant of the crater moat area contains a moat-filling impact breccia sequence spanning a total thickness of 27.1 m, whereas FC-67-3 from the southeastern quadrant of the crater moat area displays a similar breccia sequence spanning a total thickness of 28.1 m, which includes an interval of missing drill-core from 33.9 to 37.6 m depth. Line-logging shows both drill cores containing three main parts: the lower part is a relatively coarse and poorly sorted basal breccia. This is overlain by an intermediate or middle breccia with varying sizes and sorting, which is followed by a better sorted, normally graded breccia unit (Fig. 2). Additional direct observations of the core and petrographic descriptions show, at the bottom of the deposit, a thin layer characterized by milimetric to centimetric angular clasts in a light gray matrix, being similar to fall-back deposit characteristics. Two occurrences of clasts with "breccia in breccia" texture, showing fall back characteristics, were observed in both drill cores, being located at 22.5 meters depth in FC77-3 (middle part) and at 26.8 meters depth in FC63-3 (begginnig of upper part). Petrographic analysis also allowed indentification of melt fragments (Fig. 3) which are now been analyzed regarding composition and distribution along the cores.

Conclusions: Our data set from the drill cores shows sedimentological characteristics of fall back deposition, followed by slumping, then water-rich marine resurge deposition in which particles entrained in the return flow of water were deposited during the late modification stage of the marine impact event (Fig.4). Especially the "breccia-in-breccia" intraformational clasts indicate reworking of fall-back deposits on the top of the central-uplift area, being incorporated into the crater moat deposit due to erosion and redepositiong by slumping (FC77-3) and resurging water (FC67-3). We suggest the "breccia in breccia" clasts to originate from the central uplift area instead of the crater rim considering the proximity between drill cores and crater center although a rim provenience can not be excluded.

References: [1] Roddy D. J. (1966) *The Paleozoic crater at Flynn Creek,Tennessee*, Ph.D. thesis, Cal Tech. [2] Roddy D. J. (1968) In *Shock Metamorphism of Natural Materials*, Mono Book Corporation, Baltimore, 291-322. [3] Roddy D. J. (1977) In *Impact and Explosion Cratering*, Pergamon, New York, 277-308. [4] Roddy D. J. (1979) *LPSC X* Abstracts, 2519-2534. [5] Evenick J. C. (2006) *Field Guide to the Flynn Creek Impact Structure*, U. Tennessee, Knoxville. [6] Gaither T. A., et al. (2015) *LPSC XLVI* Abstracts, #2089. [7] Adrian D. A. et al. (2017) *Meteoritics and Planetary Science* (in press). [8] Schieber J., and Over D. J. (2005) In *Understanding Late Devonian and Permian-Triassic Biotic and Climatic Events: Towards an Integrated Approach*, Elsevier, New York, 51-70. [9] Ormö J. et al. (2007) *Meteoritics and Planetary Scienc*e 42, 1929-1944. [10] Ormö J. et al. (2009) *Geological Society of America Special Papers* 458, 617-632.

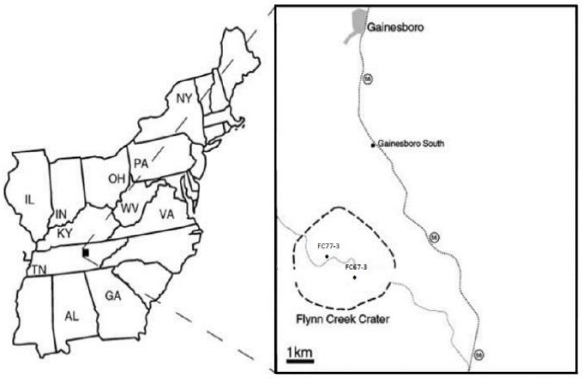

Figure 1. Flynn Creek location and drill cores (modified from [8]).

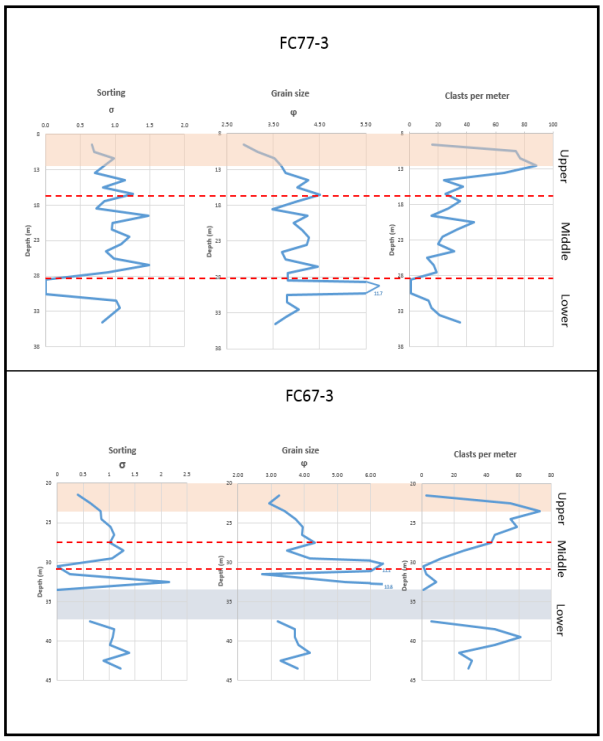

Figure 2. Main granulometric statistics from line logging of drill cores FC77-3 and FC67-3. Red-shaded area indicates where the clast cut-off size (5mm) affects the statistics, red-dashed lines separates lower, middle, and upper deposits, and gray shaded area indicates core loss.

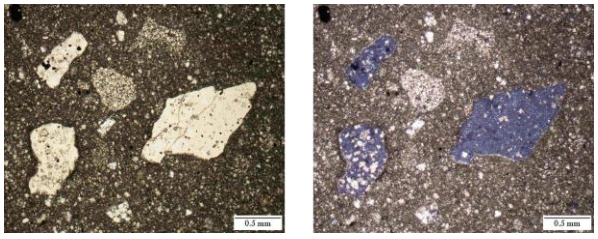

Figure 3. Plane light (left) and cross polarized view (right) of melt fragments with dolomitic inclusions.

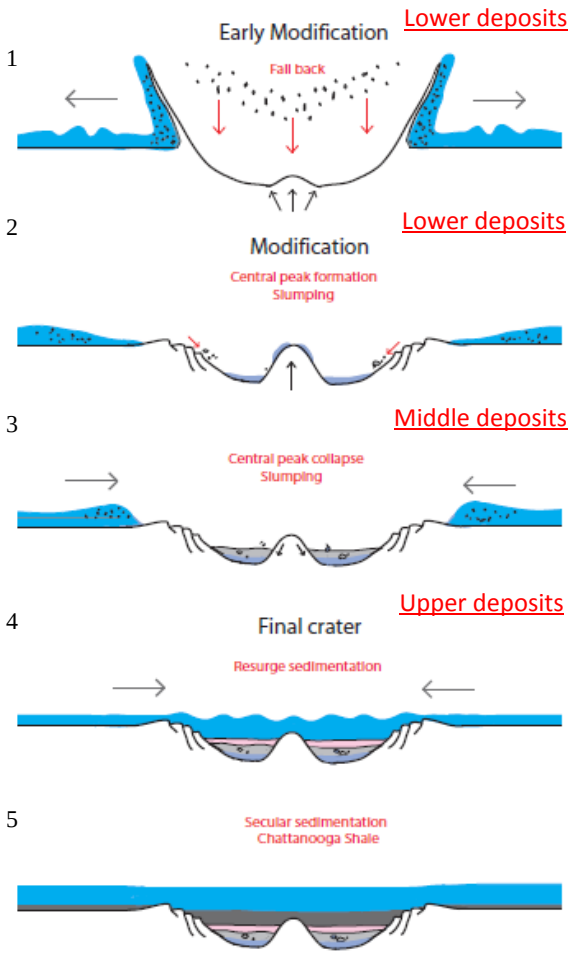

Figure 4. Impact process diagram showing the relation between formation stage and deposits.