INSIDE OF THE FLYNN CREEK IMPACT AND PROCESSES OF CENTRAL UPLIFT FORMATION: THE VIEW FROM HAWKINS IMPACT CAVE K. A. Milam[1], B. Deane[1], P. L. King[2], P. C. Lee[3], and M. Hawkins[4], [1]Dept. Earth & Planetary Sciences, Univ. of Tennessee, 306 EPSB, Knoxville, TN 37996-1410, kmilam@utk.edu, [2]Univ. of Western Ontario, Dept of Earth Sci., London, ON, N6A 5B7, Canada, [3]SETI Inst., NASA Ames Res. Center, Moffett Field, CA 94035-100, [4]DeKalb Co. H.S., Smithville, TN 37166.

Introduction: Hawkins Impact Cave (HIC) is one of few caves in the world developed in a central uplift of a complex crater. Discovered in 1989 by landowner Michael Hawkins (namesake) and mapped (277 m long) in 2003 [1], HIC lies in the core of the central uplift of the 3.8 km Flynn Creek impact crater (36˚17'N, 85˚40'W) in the Highland Rim physiographic province of north-central Tennessee, U.S. The 360 Ma impact occurred in flat-lying limestones, dolostones, and shale of the Lower Ordovician Knox Dolomite and Middle Ordovician Stones River Group [2]. Following impact, rocks were uplifted ~450 m above normal positions forming a central uplift [2-3]. Uplifted exposures consist primarily of westward dipping Stones River strata and lesser eastward-dipping rocks separated by a "chaotic breccia zone" [2].

Central Uplift Formation: Exposures in HIC provide a unique perspective into the processes of central uplift formation and their relative age relationships. Structural fabrics, similar to those observed in surface exposures of other central uplifts [4], are present in HIC. Bedding is dissected by extensive networks of listric microfractures (mfrs) and microfaults (mfs), indicating brittle failure of target rock during impact. Reverse and normal displacements (typically < 1 cm) along mfs represent localized compression and extension of target rock, likely during the contact/compression and modification stages of impact. Several sets of mfrs are cut by multiple generations of mfs. Monoclinic, antiformal, and much more complex folds also occur with mfrs and mfs in large (up to several hundred m^3) wedge-shaped megablocks of target rock.

Megablocks contain bedded to thinly-bedded carbonates with strike and dip orientations that vary from one block to the next. They are bound by narrow (< 1cm) major faults containing little or no breccia or cataclasis; dissimilar to fault breccias observed along major faults in other central uplifts. Major fault dissection of mfrs and mfs indicate subsequent movement after mfr/mf formation. Relative displacements are difficult to discern due to the paucity of slip indicators; however, drag folds are present along some major faults. Megablock rotation and transport likely occurred during uplift and subsequent collapse.

Development of HIC: Impact-related structures served as major controls on limestone dissolution and passage development in HIC. Water penetrated the cave from the southwest, preferentially dissolving limestone along major faults and at angles controlled by strike and dip directions of bedding inside of megablocks. As the water table continued to drop with base level, collapse along bedding planes and mfrs enlarged HIC passages. Passage morphology varies between megablocks and is affected by changes in structural fabric of the central uplift.

References: [1] Oeser et al. 2003, *TN Cave Survey*, Hawkins Impact Cave Map. [2] Roddy 1968, *Shock Met. of Nat. Materials*, Mono Books, pp. 291-322. [3] Roddy, 1979, *Proc. Lunar Planet Sci.10th*, pp. 2519-2534. [4] Milam & Deane 2005, *LPSC XXXVI*, Abs. # 2161.