FLYNN CREEK IMPACT STRUCTURE: NEW INSIGHTS FROM BRECCIAS, MELT FEATURES, SHATTER CONES, AND REMOTE SENSING.

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Introduction: The Flynn Creek impact structure is located in Tennessee, USA (36°17’ N, 85°40’ W). The structure was first mapped as a crypto-volcanic by Wilson and Born in 1936 [1]. Although they did not properly identify the stratigraphy within the crater or the causal mechanism, they did correctly define the horizontal extent of the crater [2, 3]. More detailed surface and subsurface research by Roddy (1979) accurately described the crater as being an impact structure with a diameter of 3.8 km. It formed around 360 Ma, which corresponds to the interval between the deposition of the Nashville Group and the Chattanooga Shale [2, 4]. Although there is limited rock outcrop in the area, there are exposed surface faults, folds, and large outcrops of impact breccia within the crater.

Breccias: Roddy recognized three major types of breccia in the crater, including several subtypes. The major types include bedded breccia, non-bedded breccia, and megabreccia [3]. The breccias are typically poorly sorted and contain angular limestone and dolomite clasts derived from the Nashville, Stones River, and Knox Groups, which are Ordovician in age. Some of the breccias, however, are mainly composed of black shale clasts (Fig. 1) that are probably of Chattanooga Shale (Upper Devonian) affinity and do not appear to contain any limestone or dolomite clasts. This suggests an early syndepositional impact event rather than Ordovician or pre-Chattanooga Shale impact. Also, a dark, non-calcareous, fine-grained breccia with an occasional overlying tan to medium gray, fine-grained, non-calcareous, gradational unit that darkens upward occuring at the base of the Chattanooga Shale further illustrates the impact probably occurred during the Devonian and was followed by marine deposition of a fine-grained unit within the crater.

Figure 1. Impact breccia showing black shale clasts indicating an early Chattanooga Shale (Upper Devonian) syndepositional impact.

Melt and flow features: Shock metamorphic features, such as planar features in quartz and calcite, have been listed in the literature [5], but no detailed information has been published [4]. Thin sections from bedded and non-bedded breccia, however, have revealed linear inclusion planes (LIPs) similar to tectonic LIPs, minor spot melt at grain boundaries, rare flow textures (Fig. 2), pre-impact stylolites, and subgrain development. The LIPs and subgrain development may be related to post-impact deformation, but the presence of spot melt and flow textures further confirm the structure’s impact origin. Supplemental microprobe work is planned to identify the composition of the impact melts.

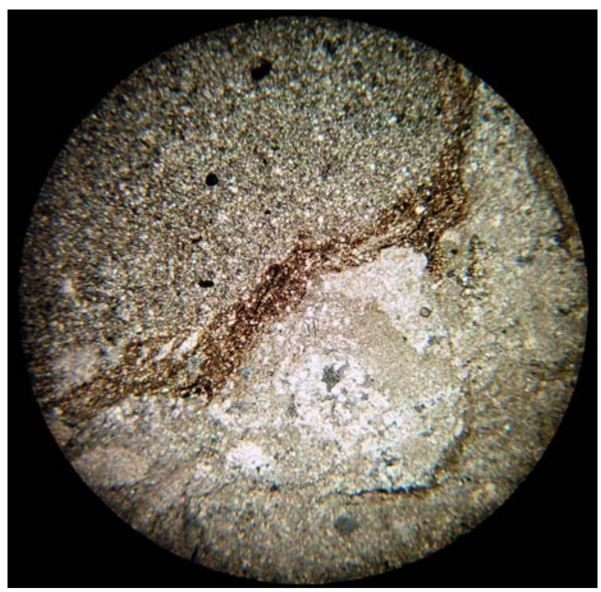

Figure 2. Thin section of a breccia unit displaying a flow texture and some minor spot melt. The 2.5x image is 4.25mm across and in plain light.

Shatter cones: Overall, shatter cones (Fig. 3) are rarely found at this site. The shatter cones have been found only near the central uplift in the Knox Group. Two shatter cone pairs were collected near the central uplift that were larger than the 1 cm shatter cones previously reported [4, 5].

Figure 3. A shatter cone developed in the Knox Dolomite from near the central uplift.

Remote sensing: Even though the crater is covered with vegetation, it can be identified by its characteristic internal radial drainage pattern. This pattern can most easily be distinguished in the visible band ratioed images (Fig. 4). Band ratioed imaging may be a useful technique for delineating other vegetation-covered craters.

Unsupervised classification and supervised classifications of visible and SWIR data could not delineate the structure. Arcuate and linear filters also did not identify any of the mapped surface faults because ASTER data resolution was not adequate to map small faults (displacements of <10 m).

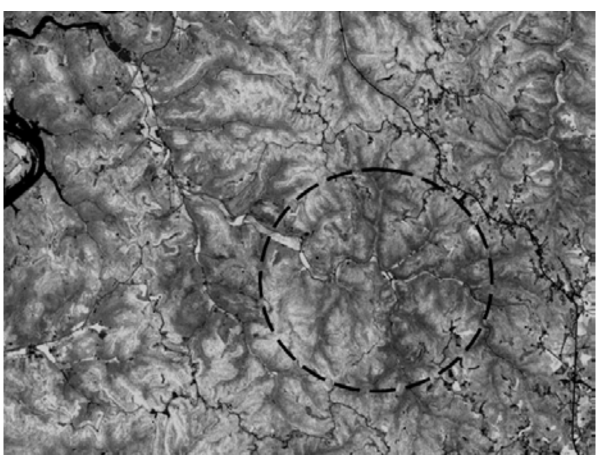

Figure 4. An ASTER 3N/1 band-ratioed image of the impact structure. The dash line represents the approximate outline of the crater. North is to the upper-left of the image.

Conclusions: Presence of spot melt and flow textures within some of the breccia thin sections further strengthens the theory that the Flynn Creek structure has an impact related origin. The ringed structure contains shatter cones, breccias, evidence of shock metamorphism, and melt. Some of the breccias contain black shale clasts indicating the impact was an early Chattanooga Shale (Upper Devonian) syndepositional impact rather than pre-Chattanooga Shale. A dark, non-calcareous, fine-grained breccia with an occasional overlying tan to medium gray, fine-grained, non-calcareous, gradational unit that darkens upward occurring at the base the Chattanooga Shale further demonstrates Devonian impact followed by the marine deposition of a fine-grained unit.

The Flynn Creek impact structure can be delineated by identifying a characteristic internal radial drainage pattern in band-ratioed images (visible wavelengths). Band-ratioed imaging may be a useful technique for delineating other vegetation-covered craters. Convolution filters, supervised classifications, and unsupervised classifications of visible and SWIR data could not delineate the structure.

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References: [1] Wilson C. W., Jr. and Born K. E. (1936) *J. of Geo., 44,* 815-835 [2] Roddy D. J., (1979) *LPS X,* 2519-2534 [3] Wilson C. W., Jr. and Roddy D. J. (1990) *TN Div. of Geo.,* 1:24,000 map [4] Koeberl C. and Anderson R. R. (1996) *GSA, Special Paper 302* [5] Roddy D. J. (1977) In *Impact and Explosion Cratering* (eds. Roddy D. J. et al.), 125-162.