THE DYCUS DISTURBANCE, A SECOND IMPACT CRATER IN JACKSON COUNTY, TENNESSEE?

B. Deane[1], K. A. Milam[1], K. R. Stockstill[2], and P. C. Lee[3], [1]Dept. of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN 37996-1410 (wdeane@utk.edu), [2]1680 East-West Rd., POST 602B, HIGP, University of Hawaii at Manoa, Honolulu, HI 96815, [3]SETI Inst., NASA Ames Res. Center, Moffett Field, CA 94035-1000.

Introduction. In spite of being located in the populous eastern United States, the Dycus Disturbance, a small, suspected impact structure in Jackson County, Tennessee, is all but unknown to the impact community. The purpose of this abstract is to draw attention to this feature, review the previous research which was conducted over a half century ago, and to present preliminary results from the current field work.

History. The scientific discovery and early research history of Dycus has been lost in the haze of time. Richard Stearns (Prof. Emeritus, Geol. Dept., Vanderbilt Univ.) believes his colleague, Charles W. Wilson, Jr. was told about, or discovered, the Dycus Disturbance while conducting field work in Jackson County sometime in the 1940s [1]. Wilson was no stranger to suspected impact craters, having published work on three other similar structures in Tennessee: Wells Creek, Flynn Creek and Howell [2,3,4].

In 1950, one of Wilson's graduate students, Robert M. Mitchum, Jr., made Dycus the subject of his thesis [5]. In a rather bold move for the tenor of the times, Mitchum proposed that Dycus was of meteoritic origin rather than a cryptovolcanic structure. Unfortunately, neither Wilson nor Mitchum followed up with a published article and with time, the Dycus thesis was all but forgotten. Compounding matters was that a published location [6] placed the structure on the wrong 1:24,000 USGS topographic map. However, in 2003, a reference to the Dycus thesis was noted [7] and on October 31, 2003, three of the authors successfully relocated Dycus and began the current study. The primary land owner informed us that the last time anybody had visited the feature was in 1964.

Location. The Dycus Disturbance (Figures 1 & 2) is located on private lands in hills to the northeast of Wartrace Creek along the north side of the Cordell Hull Reservoir on the Willette Topographic Quadrangle [8] at 85° 46' 50" W, 36° 22' 43" N. The feature is named after the small, rural community of Dycus, Tennessee, which no longer exists.

Regional Setting. Dycus occurs in the Highland Rim Physiographic Province on the northeast side of the Nashville Dome in north-middle Tennessee. This province is characterized by very flat-lying, Middle to Upper Ordovician to Lower Mississippian–aged sedimentary strata. In a major unconformity, the Silurian and most of Devonian is absent. The regional dip rarely exceeds 0.5° and is typically about 0.25°. Regional folding and faulting are rare within this area. Strata are composed of limestones, dolostones, sandstones, shales, and some siltstones. In this mature karst terrain, the hill slopes tend to be very steep and the valleys deep and narrow. Unfortunately, hill slopes are commonly covered with rubble, detrital material from overlying formations, and vegetation, so exposures are limited.

Figure 1. The view looking northeast from the bank of Wartrace Creek. The Dycus Disturbance lies between the hill immediately past the grassy field and the ridge partly obscured by fog. The arrows points to the same knob in both pictures.

Figure 2. Looking from the southwestern boundary of Dycus towards the northeast. The Cannon Limestone dips 2-6° to the northeast and forms the slope of the pasture in the foreground. The most intensely-deformed part of the structure occurs in the forested area in the center of this picture. The structure does not extend past the ridge.

Structure and Geology. Mitchum [5], described Dycus as a small, very localized feature that exhibits structural defomations such as folding, faulting, dipping beds, and even two over-turned beds. Stratigraphically, Dycus occurs in both the Middle to Upper Ordovician-aged Leipers and Catheys Formations, and the underlying, Middle Ordovician-aged Bigby-Cannon Limestones. These formations are primarily composed of limestone and dolostone [9]. There are no uncomformities.

As his primary goal, Mitchum created a 1:2400 scale map of the feature based upon a plane-table survey of four selected marker beds in the Leipers and Catheys Formation. The rectangular-shaped map covers an area 2500 ft (760 m) by 2900 ft (885 m) centered on the heart of the structure. However, the map does not cover the entire structure and the boundary of the Dycus Disturbance was not fully defined.

The survey suggested that Dycus has the shape of a half-circle (i.e., D-shaped) with a maximum radius of 2000 ft (0.6 km). Mitchum hypothesized that Dycus may extend under the hillside to the northeast.

Based upon his field work, Mitchum list five major elements that define the structure of Dycus [5, p. 15-16]:

1. "A small, relatively subordinate central uplift occupies the approximate center of the disturbance and marks the area of most intense deformation."

2. "Surrounding and subordinating the uplift is an annular depressed area that is accompanied by buckling and tight folding. The axes of the folds are roughly radial from the central uplift. The down-bowing has greater magnitude than the uplift, both vertically and horizontally, so that the center of the structure, although higher than the surrounding depressed area, is still lower than its normal altitude [about 140 ft or 40 m] in this vicinity."

3. "A gentle ring-shaped anticline occurs on the outer periphery of the down-warped area. This peripheral fold surrounds the central area for at least three-fourths of the circumference of the exposed half-circle."

4. "At least two normal faults occur outside the ring-shaped anticline."

5. "Outside the area of intense disturbance the rocks dip gently toward the center of deformation. This dip dies out with increasing distance from the center."

Central Uplift? Mitchum reported a small central uplift about 300 ft (100 m) across, with strata that has been uplifted about 70 ft (20 m) above the surrounding annular depressed area. This is also the area with the maximum deformation. Indeed, this is the most impressive part of Dycus to visit, with dips as high as 85°, tight folds, and an overall chaotic nature.

However, there are two problems with defining this area as a central uplift. First, a half century later, we know that the transition between simple and complex craters in sedimentary rock begins to occur at a diameter of about 2 km [10]. If Dycus is an impact feature and has a maximum radius of only 0.6 km, then it should be a simple crater. Second, this proposed central uplift is not in the center of the feature. Continuing to the northeast, beyond Mitchum's map, the same strata are exposed in Long Branch Hollow and lie well within the 0.6 km radius of this proposed central uplift. Our field investigation in Long Branch revealed flat-lying rock with no deformation. Therefore, the area of maximum deformation does not lie in the center of the structure, but rather defines the northeastern boundary.

D-shaped Morphology? While we have confined the occurrance of the deformation to the northeast, we have extended the northern boundary a couple hundred meters farther north with the discovery of bedding dipping 8° radially away from the structure (Figure 3). This raises the possibility that Dycus is shaped more like an oval, rather than a D.

Figure 3. This dipping bed defines the current northern limit of the Dycus Disturbance. Note the general lack of outcrops.

Dycus and Flynn Creek: Duel Impacts? Dycus is located only 13 km north northwest of the 3.8 km diameter Flynn Creek impact structure and both occur in Ordovician target rock. Could these two features be related temporally, for example, were there duel impactors or is Dycus a secondary of Flynn? As summarized in [11], the Chattanooga Shale was deposited as a marine mud inside the crater bowl of Flynn Creek to a maximum depth of 200 ft (60 m), as compared to an average regional thickness of 20 ft (6 m). We observed in Dycus that the Chattanooga Shale, which only occurs in limited exposures along the northern boundary, does not exhibit a similar increase in thickness. However, this does not exclude a relationship.

Is Dycus an Impact Structure? At this time, no unequivocal evidence has been found to confirm that Dycus is of impact origin. Macroscale features, such as shatter cones and breccias have not been observed. However, the deformation is a distinct anomaly in a region that is characterized by a very flat-lying, undisturbed lithology, and begs investigation. Our immediate goal is to finish delineating the boundary of this disturbance, continue the search for shock indicators, and to understand its nature.

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