PLANAR DEFORMATION FEATURES FOUND WITHIN A POSSIBLE IMPACT STRUCTURE, THE BRUSHY CREEK FEATURE, ST. HELENA PARISH, LA Connor Matherne[1], S. Karunatllake[1], D. R. Hood[1], J. Duxbury[1], A. Herr[1], P. Heinrich[2], M. Horn[2], A. Webb[1], A. Sivils[1], the Brushy Creek Exploration team. [1] Louisiana State University Geology and Geophysics (cmath31@lsu.edu), [2] Louisiana Geological Survey

Introduction: The Brushy Creek feature is a suspected impact crater located in St. Helena Parish, Louisiana. The proposed impact crater is 2 km in diameter with a current relief of 15 m (Fig. 1) and likely occurred less than 30,000 years ago [1]. The depression lies within a Pliocene aged alluvial sediment unit known as the Citronelle formation, characterized by reddish brown clay to coarse sand [2]. This formation is roughly 100 m thick within the Brushy Creek feature [3]. The Brushy Creek feature mainly consists of quartzarenite, of which, 10 to 100 % of the quartz was found to be highly fractured with some of the quartz grains containing up to two distinct planar deformation features (PDFs) (Fig. 2) distinctive of impact events [1]. Sampling was done using a drill core and surface samples from within the creek. The creek samples were taken due to the creek carrying material eroded from the potential rim, in addition to being the location of where previous PDFs were located [1].

Methods: A 25 foot (7.62 m) core was drilled near the center of the feature (Fig. 1) and was then sampled to create 17 thin sections. An additional 10 surface samples were taken throughout the creek. These samples were sieved to sand size grains (-1 – 4 φ) and treated for organics with H_2O_2 before being made into thin sections. Thin sections were scanned at a resolution of 800 dpi for archival purposes, and to additionally aid in spatially locating identified PDFs at later dates on differing equipment, or for other scientists. Thin sections were initially observed using polarized light microscopy to identify potential PDFs on the quartz grains. The potential grains were imaged in plane (PPL) and cross-polarized (XPL) light before being observed under cathodoluminescence (CL) and imaged once more. CL can reveal shock damage in the form of PDFs associated with impacts [3] . Additionally, CL is crucial for distinguishing between PDF features and tectonic deformation lamellae, where PDFs are generally straight and thin while lamellae are thicker and curvy [4]. The most distinguishing feature is the luminescence wavelength, where PDFs luminesce in the red to infrared wavelengths or are nonluminescent [5].

Results: Within the thin sections from the core, a total of 22 possible PDFs were imaged (Fig. 2, 3, 4), 4 of which show emission in the red wavelength (Fig. 3). In regards to the samples from within the creek, a total of 42 possible PDFs were imaged along with other high stress grains (Fig. 5). While these grains have not been

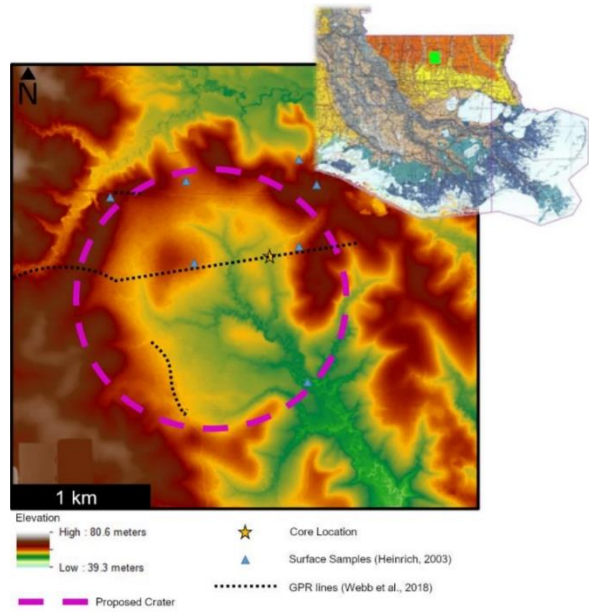

Figure 1: *LIDAR data of the location (ID: 3009011sw). The top right shows a geologic map of southeast Louisiana with the green square as the location of the feature.*

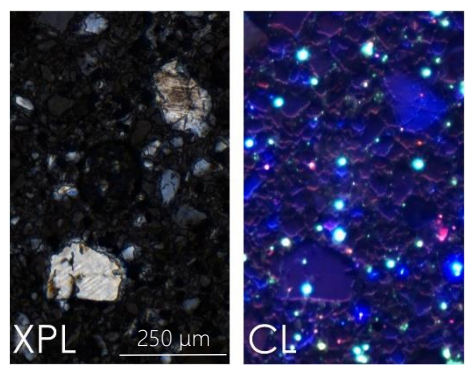

Figure 2: *A pair of grains that contain PDFs. The upper grain displays 2 orientations while the lower grain displays only 1 orientation. Neither grains are luminescent under CL in the optical range.*

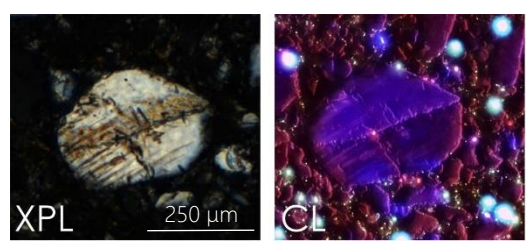

Figure 3: *PDFs in one direction that are luminescent in the red wavelength when observed using CL.*

imaged under CL, the CL system used for the thin sections from the core is only sensitive to the visible spectrum and lacks high resolution to resolve these single micron or less features. As seen with previous work, we confirm that this area is made up of nearly 100% quartz grains in addition to a heavy amount of fracturing seen throughout the thin sections with some of the fractures even possibly being planar fractures. All images mentioned above are stored and archived at the Planetary Science Laboratory of LSU and are available on request.

Implications and Conclusion: The thin sections created from samples within the Brushy Creek area show a multitude of different high pressure features. These include, planar fractures, grain deformation (Fig. 5), and planar deformation features (Fig. 2, 3, 4). These PDFs are consistent with an impact hypothesis [1,5], and would not be formed through other tectonic processes that have been considered to create this depression, such as volcanism or salt diapirism [1]. While some of these PDFs were luminescent in red wavelengths, many were not. Currently there is still much work to be done before conclusively categorizing the Brushy Creek Feature's origin. While many possible PDFs have been found by this and past studies [1], many need to be confirmed. Having a trained microscope operator familiar with PDFs observe the thin sections would not only avoid false positives for identification, but also would most likely increase the overall number discovered [6]. Lastly, the thin sections contain multiple zircons (Fig. 6) that could examined for high-pressure and high-temperature shock deformation of zircon, another feature indicative of impact events [9].

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References: [1] Heinrich P. V. (2003) *Gcags/Gcssepm, 53,* 323-323. [2] Otvos, E.G. (2004) Southeastern Geology, 43, pp.1-20 [3] Campbell, C. (1971) *Tulane dissertation.* [4] Boggs S., et al., (2010) Meteoritics & Planetary Science, 36(6), 783– 791. [5] Hamers, M. F., & Drury, M. R. (2011) *Meteoritics and Planetary Science, 46(12), 1814–1831.* [6] Ferrière, L. et al., (2009) Meteoritics & Planetary Science, 940(6), 925–940. [7] James P.B. and Ermakov A. I. (2018) LPSC 49. [8] Webb A., et al., (2018) LPSC 49. [9] Cavosie A., et al., (2018) *Geology* 46.10 (2018): 891-894.

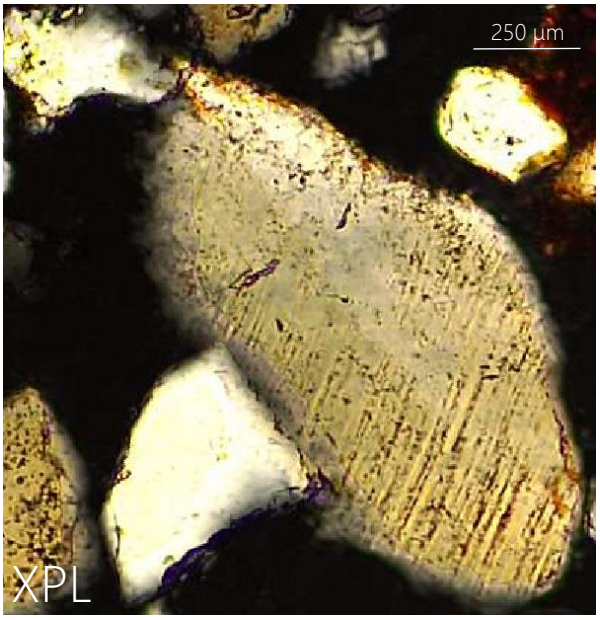

Figure 4: *One of the most prominent grains containing possible highly decorated PDFs from the creek samples.*

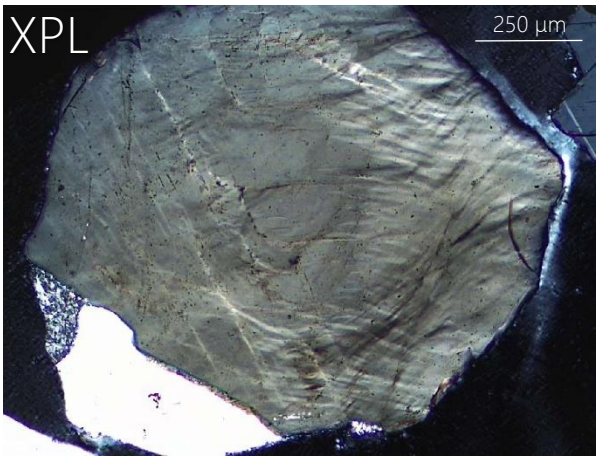

Figure 5: *Deformed quartz grain from the creek samples.*

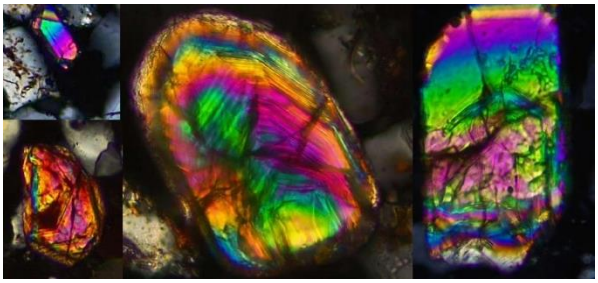

Figure 6: *Various zircons imaged in XPL from throughout the thin sections that could be used for future analysis of the Brushy Creek Feature.*