IS THE BEE BLUFF STRUCTURE IN S. TEXAS AN IMPACT CRATER? V.L. Sharpton and D.C. Nielsen, LPI, 3303 NASA Road One, Houston TX 77058.

The ~2.5 km diameter Bee Bluff structure, located in Zavala County, Texas, was originally proposed to be an impact crater on the basis of unusual structural features [1] such as large allochthonous sandstone blocks, numerous thrust faults, and isoclinal folds. Suspected target rocks include Eocene Carrizo Fm sandstones and Indio Fm calcareous shales. On the basis of a single quartz grain found to contain two sets of planar features parallel to ω [2], and the structural evidence listed above, Bee Bluff was added to the list of recognized terrestrial impact structures [3]. It also has been suggested that Bee Bluff could be the source crater for the N. American tektites [4]. As little is known about this interesting, and potentially important, structure, we are conducting a detailed analysis of outcrops within and around the proposed impact site. Here we report the results our investigation thus far.

Surface mapping. Topographic expression of the Bee Bluff structure is subtle with <15 m of relief on the present surface. The impression of circularity arises primarily from an arcuate ridge of sandstone outcrops extending along the southern half of the structure (Figure 1). In advancing the impact model this ridge was interpreted as the more resistant remains of the continuous ejecta blanket [1]. Along the axis of the ridge, beds are undeformed but along the flanks large allochthonous blocks dip steeply away from the axis and are locally overturned. Crossbedding indicates westward, axial transport, suggesting that this ridge could be a resistant channel deposit that is currently being exumed and undercut, producing the tilted blocks. Thrust faults with offsets of a few meters are common within the Bee Bluff structure and are seen in outcrops up to 3 km beyond the rim. While their abundance here is interesting, they are not unusual to the region and do not require an impact model. Larger thrusts have been reported [1] but, due to the difficulty of correlating strata within the Indio Fm, displacements remain problematic. Tight to isoclinal folds (meter scales and smaller) occur within float and outcrops of Carrizo sandstone forming the southern ridge. The large strains, complex axial surfaces, and lack of joints or foliations suggest these folds are primarily soft-sediment structures produced as the Carrizo sands were being fluvially deposited.

Petrography. To date we have examined 18 thin sections of sandstone and breccia samples collected within and around the Bee Bluff structure (Figure 1). Some of the samples contain severely fractured grains similar in appearance to Barringer Crater sands. The fractures are typically conchoidal and stained. Up to 1% of the quartz grains contain single or, rarely, multiple sets of planar features (lamellae). These features are usually stained, straight to slightly curved, and are visually similar to those of *weakly* shocked facies at known craters [5]. Quartz overgrowths are evident where the original grain boundaries are marked by conspicuous staining. Planar features present in such grains never cross the original grain boundaries, whereas many of the fractures do, suggesting that the fractures postdate the lamellae. We have measured the attitudes of the lamellae using standard universal stage techniques. Results (Figure 2) indicate a maximum between 20^{o} and 30^{o} corresponding to the ω $\{10\bar{1}3\}$ orientation and a lesser peak corresponding to the r, z $\{10\bar{1}1\}$ crystallographic index. The r, z orientation is characteristic of shock pressures between 50 and 100 kbar, which is the lower range for shock deformation features in quartz [6]. Planar features occurring along the ω crystallographic planes are indicative of higher pressures, ~100-380 kbar [5]. To test whether the planar features observed originated from a local shock event, control samples of Carrizo sandstone were collected 15 km and 135 km east of the crater. Planar features were found in all three samples taken 15 km east of Bee Bluff. The frequency and general characteristics of these features were comparable to those from within the impact area. Of the two samples collected 135 km away from the crater, we found 5 grains with planar features. The characteristics and attitudes of the planar features observed in samples from the Bee Bluff structure are similar to those found in weakly shocked facies at several well-studied impact craters [5,6]. We have found no indications, however, of higher levels of shock, such as diaplectic glass or multiple sets of numerous lamellae similar in appearance to those found in the floor rocks of craters such as Lake St. Martin or Barringer. In addition, we have found no occurrence of impact breccias at the site. The breccias we analyzed, including those along the walls of several shallow trenches at the crater margin, have ferruginous or calcareous matrices, abundant hematite, and altered clasts, suggesting that they are of sedimentary origin.

Substructure. Structure contour maps generated from well log information reveal a buried dome with ~60 m of structural relief located in the approximate center of the proposed impact site at a depth of <30 m. The morphology and position of this structure is suggestive of the uplift that might accompany formation of a crater this size in a sedimentary target. The preserved height of this feature, however, is only 20% that predicted by morphometric relationships of other complex craters in sedimentary targets [7]. In addition, the depth to the crater floor is constrained by structural relief is unusually shallow, <90 m, thus again indicating significant morphometric disparity between this structure and well-studied impact structures [7].

Preliminary assessment. Bee Bluff contains an unusual assemblage of surface features in a region that is otherwise geologically austere. Our observations to date, however, do not support an impact model for this feature. To the contrary, surface structures are unlike those observed at known impact sites and seem to have alternate explanations. Substructure indicates the feature is anomalously shallow for an impact crater, although a central peak is apparent. While infrequent occurrences of shocked quartz may indicate impact involvement, occurrences 135 km away are not compatible with the Bee Bluff impact model. As a working alternative to this model, we propose that the shocked grains predate deposition of the Carrizo and were shed from a shocked source region. If further work supports this model, it would be the first reported occurrence of inherited shocked detritus. We are currently mapping the distribution of shocked Carrizo grains.

References. [1] Wilson, W.F., and D. Wilson, *Geology 7*, 144-146, 1979. [2] Robertson, P.B., *Lunar Planet. Sci. XI*, 938-940, 1980. [3] Grieve, R.A.F., *Geol. Soc. Am. Sp. Paper 190*, 25-37, 1982; Grolier, M.J., *NASA Tech. Memo. 87567*, 539 pp, 1985; Grieve, R.A.F., and P.B. Robertson, *Geol. Surv. Canada Map 1658A*, 1987. [4] King, E.A., *Geology 7*, 328, 1979. [5] Engelhardt W., and T. Bertch, *Contr. Mineral. and Petrol. 20*, 203-234, 1969. [6] Horz, F., in *Shock Metamorphism of Natural Materials*, 243-254, 1968. [7] Grieve, R.A.F., P.B. Robertson, and M.R. Dence, *Proc. Conf. Multi-Ring Basins*, 37-58, 1981.

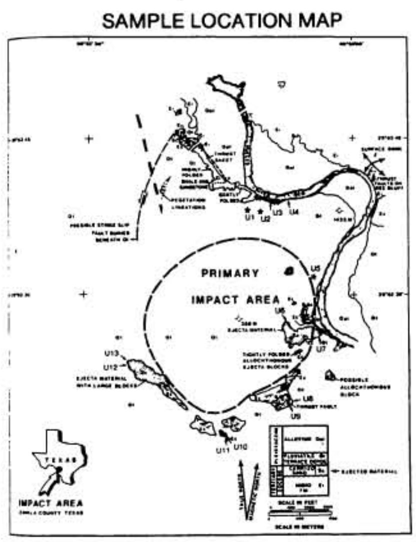

Figure 1

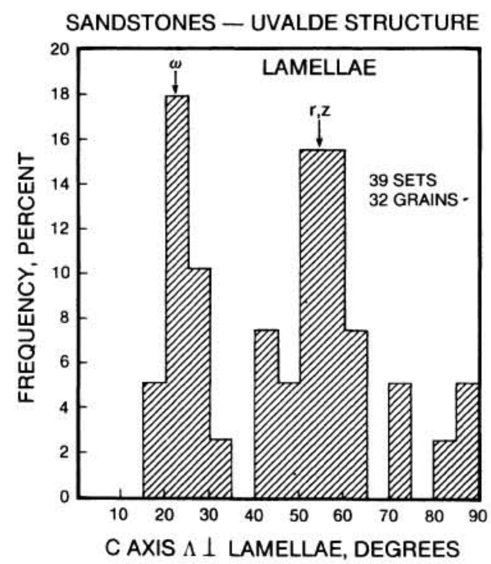

Figure 2