GRAVITY TRANSECT PROFILE AND PDF/PF COMPARISONS FROM THE BEE BLUFF STRUCTURE.

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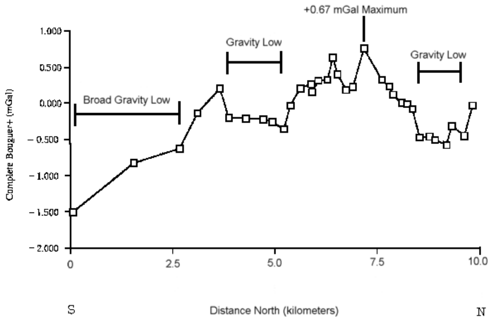
Introduction: The Bee Bluff structure is a 2.5 kilometer circular feature in the Gulf coastal plain sediments in south Texas. Possibilities of an impact origin were raised by the presence of anomalous faults and folds [1] and the presence of quartz grains displaying PDFs [2][3]. An objection to this explanation is the presence of quartz grains displaying PDFs far removed from the structure's location in the same rock formations as those found at the Bee Bluff structure [4]. Possible explanations for this discrepancy include a non-impact origin for the Bee Bluff structure, with the grains being imported in from another impact structure [4], or that the structure is larger and this may account for the wide distribution of shocked quartz [5]. One way to test for the presence of a larger eroded structure would be a gravity transect across the feature. In addition, we also reexamined the planar features that were measured from the structure and in the same formations outside of the structure [3]. Our findings are summarized in the following sections.

Gravity Profile: Negative gravity anomalies are often found at impact structures due to fracturing of target material [6][14] With larger impact structures, a positive anomaly may be present due to uplift of denser material closer to the surface [6][14]. With this in mind, we conducted a gravity transect along US highway 83 which crosses near the center of the structure in a north/south direction. Although the transect would not give a complete picture of anomaly, it should detect its presence and provide information that would allow assessment of its size. Gravity data were then reduced and corrected to the complete Bouguer correction. The resultant profile is shown in Figure 1 where the anomaly appears as a central high with a peak of +0.67 mGals with –0.5 mGal lows on either side of this high. This profile is similar to other gravity profiles from impact structures having denser rocks uplifted in their centers [6][14].

In addition, this central gravity high may be greater since this profile does not bisect the exact center of the structure. The borders between the central high and flanking lows of the anomaly appear to correlate with the circular expression seen in aerial photographs. If the outer boundaries of the gravity lows do correspond to the edge of an impact structure, then it would be one of about 6.75 kilometers across. Although the magnitudes of the anomalies are less than would be expected from an impact structure of this size, their reduced intensity could be the result of removal of shattered material from the structure by erosion of the Nueces river. Extensive terrace deposits cover much of this structure and beyond, masking its true extent. Although not specifically analyzed, the broad gravity low to the south of the structure could be the result of a regional decrease in gravity to the south and/or the effect of erosion of denser material and replacement by less dense alluvial deposits.

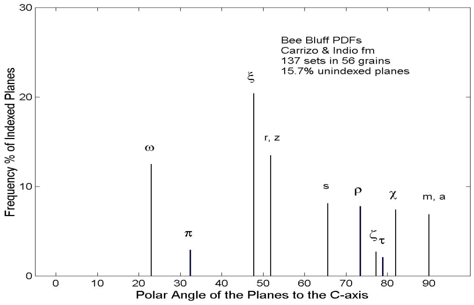
Figure 1. Complete Bouguer profile of the Bee Bluff structure.



Planar Deformation Features and Planar Fractures: Planar features that were previously measured and reported from the Carrizo and Indio formations, both within and outside the structure [3], were reexamined and reclassified either as planar fractures (PFs) or planar deformation features (PDFs) according to established criteria [7][8]. The goal of this exercise was to further clarify the occurrence of quartz grains displaying PDFs and to better define variations in their orientations from different locations. The planar lamellae were then plotted as separate PF and PDF diagrams. From all of the Bee Bluff sample locations measured up to this time, the dominant orientations observed correspond to the ξ, r,z and ω crystal planes (Figure 2). This pattern is similar to one observed from the Tookoonooka structure [9]. In comparison, the PFs show a similar pattern, but with much more reduced frequencies and an increase in higher angle PF frequency. Similar trends are observed in PDFs and PFs from the Foelsche structure [10].

Individual sample locations within the structure display variations as to which PDF orientation(s) are the most dominant. Several locations have the ξ orientation as the most predominantly occurring (HW-03, LRE-02, and LRE-11). In addition, the fact that these locations occur as an arc on the outer portion of the circular feature and also are in different formations, suggests an in-situ origin for the PDFs. Other dominant orientations are observed from different locations near the structure's center. At one location (LRE-10) the ω orientation dominates, while a few hundred meters away high angle orientations dominate (LRE-06).

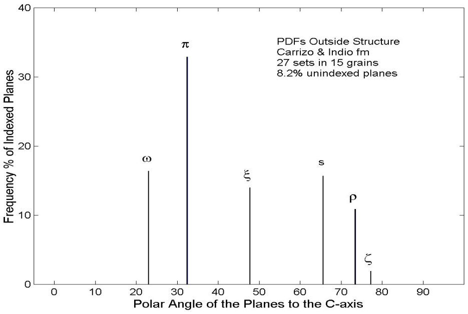
Figure 2. PDFs from the Bee Bluff structure.



PDF orientation patterns in each sample from the structure are consistent with impact structures in porous sedimentary targets [13]. The variations that are observed between samples from different locations in the structure probably reflects the variations in porosity of the target material at the time of impact [2]. If the quartz grains were transported to the structure from another source, such variations in dominant orientations would probably not be seen. Additional support for lack of transport is the angular nature of many of the grains' edges that do display PDFs. If they had been transported an appreciable distance, these edges would have been worn away.

PDFs Outside the Bee Bluff Structure: Within the structure itself, about 10% of the quartz grains display PDFs. Outside of the structure about 2% of the quartz grains examined display PDFs. In addition, these grains display a different PDF frequency orientation with the π orientation being the most common (Figure 3). Within the Bee Bluff structure this orientation is rare with a frequency of 3%. Outside the structure in the same formations it comprises 32% of the PDF orientations. This orientation frequency is more consistent with targets in non-porous materials similar to orientation patterns found at Gosses Bluff in low porosity sandstones [13]. Other impact structures that have a similar orientation frequency include the Tenoumer [11] and Roter Kamm structures in Africa [12]. Also these quartz grains displaying PDFs appear more rounded than those found at the Bee Bluff structure. Given that their PDF orientation pattern is different from those found at the Bee Bluff structure, and their more rounded appearance, a likely explanation for their origin is from the eroded debris of another impact structure.

Figure 3. PDFs outside the Bee Bluff structure.



Conclusions: Although the gravity anomaly measured is less than what would be expected from a structure 6.75 kilometers across, its shape is consistent with those found at other impact structures. The PDF orientation patterns found at the structure are consistent with other known impact structures and the differences in dominant orientations from various locations within the structure suggests an in-situ origin for the PDFs. In addition, the angular nature of the quartz grains supports this possibility. In contrast, the PDFs in quartz grains found outside the structure have a different orientation pattern. The grains also appear more rounded than those from the structure, which suggests that their presence could be explained as eroded debris from another impact structure.

References: [1] Wilson, W. F., and Wilson, D. H. (1979) Geology 7, 144-146. [2] Robertson, P. B. (1980) LPSC XI, 938-940. [3] Jurena, D. J. et al. (2001) LPSC XXXII, Abstract #1828. [4] Sharpton, V. L., and Nielsen, D. C. (1988) LPSC XIX, 1065-1066. [5] Melosh, H. J. Personal Communication. [6] Pilkington, M. and Grieve, R. A. F. (1992) Rev. Geoph., 30, 2, 161-181. [7] Stöffler, D. and Langenhorst, F. (1994) Meteoritics & Planet. Sci. 29, 155-181. [8] Alexopoulos, J. S. et al. (1988) Geology 16, 796-799. [9] Gostin, V. A. and Therriault, A. M. (1997) Meteoritics & Planet. Sci., 32, 593-599. [10] Haines, P. W. and Rawlings, D. J. (2002) Meteoritics & Planet. Sci., 37, 269-280. [11] French, B. M. et al. (1970) JGR, 75, 23, 4396-4406. [12] Degenhardt, J. J. et al. (1994) GSA Special Paper 293, 197-208. [13] Grieve, R. A. F. et al., (1996) Meteoritics & Planet. Sci., 31, 6-35. [14] Grieve, R. A. F. and Pilkington, M. (1996) AGSO Aust. Jour. Geophys. 16, 399-420.