THE CHICXULUB IMPACT STRUCTURE: SHOCK DEFORMATION AND TARGET COMPOSITION; J.M. Quezada Muñeton, Gerencia Divisional de Programación y Evaluación, PEMEX, Marina Nacional 329, C.P. 11311, Mexico City, Mexico, L.E. Marin, Geophysics Institute, UNAM, Mexico City, Mexico, C.P. 04510, V.L. Sharpton, G. Ryder, and B. C. Schuraytz, Lunar and Planetary Institute, 3600 Bay Area Blvd, Houston, TX 77058

Since Penfield and Camargo [1] first recognized that a 200-km-wide zone of concentric gravity and magnetic anomalies along northernmost Yucatán, Mexico, could represent a buried impact structure, an intriguing circumstantial case has been assembled in support of this proposal (e.g., [2]). A key element in evaluating the nature and age of the so-called Chicxulub structure is a sequence of upper Cretaceous rocks described as tuffs, bentonitic breccias, and andesitic rocks [3] recovered from PEMEX exploratory wells near its center. In a breccia sample (core interval N-14; 1208 to 1211 mbsl) from the Yucatán #6 (Y6) well, Hildebrand et al. [2] report finding quartz grains containing single and multiple sets of planar features in two xenoliths which they interpret as evidence of shock metamorphism. However, these workers failed to substantiate this interpretation via widely accepted techniques (e.g., [4]), nor could they diagnostically link the shock event with the underlying andesitic rocks from core interval N17 (1295.5-1299 mbsl) thus leaving considerable doubt as to whether the quartz microdeformation features or the andesitic rocks were the result of impact. We are conducting a detailed geochemical, petrographic, and geochronologic analysis of available upper Cretaceous core samples from Y6, including samples from N14 and N17. In Marin et al. [5] we discuss the age constraints on the Chicxulub structure and evaluate its possible connection to the K/T extinctions. Here we present the first detailed analysis of the upper Cretaceous breccias from well Y6, including conclusive evidence of shock metamorphism (Figure 1), fused glasses (Figure 2), impact melts of andesitic composition, and unmelted but shocked clasts of basement lithologies. We consider the discovery of the glasses and basement clasts to be particularly relevant to the potential link between the Chicxulub structure and the K/T boundary.

Our samples from Y6-N14 are from a well-sorted polymictic breccia comprising 40-60% angular-to-rounded clasts in an indurated light tan-to-grey lutitic matrix. The matrix is predominantly cryptocrystalline aluminosilicate phases (clays?) with subordinate amounts of calcite and fine-grained anhydrite. The clasts range in size from 2-10 mm (3-4 mm avg.) and, in approximate proportions, include: (i) 50% light green-to-grey fine-grained clasts of roughly andesitic composition (see Marin et al. [5]) consisting primarily of microcrystalline feldspar in a submicroscopic groundmass; (ii) 20% green-to-light amber highly vesiculated vitreous clasts displaying internal flow structure (Figure 2); (iii) 15% fine-to-coarse-grained silicate basement xenoliths; and (iv) 15% well-rounded anhydrite and carbonate clasts.

Evidence of shock metamorphism is abundant and unequivocal in the samples we have studied, and includes the following: (i) Planar deformation features in quartz (Figure 1) and feldspar grains are abundant in basement xenoliths and in xenocrysts in the fine-grained andesitic clasts and glasses. Up to five sets of features were measured per grain with a universal stage. The histogram in Figure 3 demonstrates these features correspond to the distinct crystallographic orientations characteristic of shock-produced microstructures in well-studied impact structures. Also apparent from this analysis is that the breccia contains a mixture of material from various shock zones (radial distances from the impact point; [6]) from Types A and B features (primarily c- and α-orientations) indicative of the low-pressure end of the shock spectrum (~6-10 GPa) through Types C and D (r-, z-, ξ-, and π-orientations) indicative of pressures up to 23 GPa. (ii) Shock mosaicism in quartz and feldspars is common, particularly in basement xenoliths, and is typically accompanied by planar features or patches of diaplectic glass. (iii) Diaplectic glass occurs in patches within basement clasts and as partially digested inclusions within glasses and melts. (iv) Fused glasses and impact melts. Inclusions of shocked grains and rock fragments (some partially digested) within the fine-grained andesitic clasts indicate these are impact melts. Similarly, several clasts of vesicular glass also contain independent evidence of shock metamorphism. Additional information on the composition of these melts is presented in Marin et al. [5].

Basement lithologies involved in the Chicxulub impact event are represented as shocked clasts in our breccia sample, all of which indicate a target dominated by medium- to high-grade metamorphic rocks. The predominant basement rock type is pink, coarse-grained granitic gneiss containing quartz and alkali feldspars. Grain boundary relationships within these clasts indicate substantial shearing and recrystallization prior to impact. Also common are clasts of quartz-mica schist, and microcrystalline quartz-rich felsite with a strong cataclastic texture (mylonite). Rare occurrences of pyroxene-bearing schist are observed as small clasts. Our analysis of basement clasts is ongoing and additional details on these clasts, as well as discoveries of additional basement lithologies will be forthcoming.
From our analysis of the Y6-N14 breccia we conclude that Chicxulub is unquestionably an impact structure containing andesitic melt rocks. Because it contains both impact glass and fine-grained melt as clasts, and because it is well-sorted, this breccia is not an exact analog to suevite breccia found at the 22 km Ries crater; but given the possible disparity in size between the two structures, and the presence of a water column at Chicxulub, an ejecta origin for the Chicxulub breccia cannot be ruled out. Whether primary ejecta or not, however, the basement clasts within this deposit suggest that, if Chicxulub is the proper age, it could account for the shocked mineral assemblage observed at the K/T boundary (e.g., [7]).


**Figure 1.** Shocked quartz grain with 3 sets of planar features. Scale = 0.2 mm

**Figure 2.** Impact glass clast from Y6-N14.
Same scale as in Figure 1.

**Figure 3.**

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