CONSTRAINTS ON EXCAVATION AND MIXING DURING THE CHICXULUB IMPACT EVENT;
Virgil L. Sharpton[1], Luis E. Marín[2], Benjamin C. Schuraytz[1]; Paul D. Spudis[1], and Graham Ryder[1], [1]*LPI, 3600 Bay Area Blvd, Houston, TX 77058 (713-486-2111);* [2]*Instituto de Geofisica, UNAM, Mexico City, Mexico 04510*

The only direct information on crater excavation depth (d_e) comes from estimating the amount of uplift on the central structures of complex craters formed in sedimentary rocks on Earth. Structural uplift (SU), as a proxy to d_e, has been estimated for 13 craters ranging in final crater diameter (D) between 3 and 25 km, and a power law fit to these data indicate that $SU = 0.06D^{1.1}$[1]. Although this is approximately the mean trend, and therefore preferred, there are substantial problems with extrapolating this trend to large basins. To estimate d_e at D=300 km, for example, would require extrapolating the trend over more than 10 times the total diameter range of the observations. Furthermore, analysis of the input data (Figure 1) shows considerable variability in SU over small D increments, *e.g.*, two D=24 km craters, Strangways and Ries, differ in estimated SU by 50%. This may be related to difficulties both in estimating SU and D for these heavily modified craters. But such scatter could also reflect real variations in SU at a given diameter. In either case, uncertainties of at least ±0.3 SU are probable. Because no single trend can account for all the measurements in the data set, a range of power law fits to these data are equally appropriate; *i.e.*,

$$SU = 0.07\left({}^{+0.09}_{-0.03}\right)D^{1.0\left({}^{-0.4}_{+0.3}\right)}.$$

This imparts substantial uncertainties to d_e measurements, particularly for large-basin-scale events of planetary significance. For example, the excavation depth of a 300 km basin conceivably could vary between 10 km and 100 km based on the SU data set. Clearly it would be useful to have an independent estimate of excavation depth for much larger impact basins to test the relationship from the smaller craters of [1].

Breccias and melt rocks produced during impact contain information on their depth of origin and if the target stratigraphy can be constrained, excavation depth can be estimated from the proportions of each protolith required to form the breccia or melt. For the D=180-300 km [2,3] Chicxulub structure, target stratigraphy is constrained by drill cores to a depth of ~3 km [4]. Seismic refraction studies and geophysical modeling [*e.g.*, 5] provide additional information on the depths to lower crust and mantle (Figure 1). Figure 2 shows feldspar compositions in lithic clasts from Chicxulub breccia samples. These feldspars are similar to those from the KT sections of the western U.S. [6] and indicate a granitic protolith. No indications of mantle lithologies or gabbroic clasts have been detected to date. Clasts with granulitic textures are present but rare; nonetheless, these clasts may indicate a minor component of lower crustal origin. Consequently, we have so far found no evidence that the impact event excavated mantle or substantial quantities of lower crust. This places a maximum constraint on d_e of ~25 km.

Major element chemistry [*e.g.*, 2,3] and isotope analysis [7] demonstrates that the ejected glasses found in KT outcrops in Haiti and the Chicxulub melt rocks are identical. Multiple linear regression analysis on major oxides of Chicxulub melt rocks and breccia clasts indicate that the melt rock is composed of $\geq$90% granite and $\leq$10% platform sediments. This is in close agreement with isotopic studies [7] that indicate both the Chicxulub melt rocks and Haitian glass spherules could be formed by a mixture of ~94% silicate basement and ~6% platform carbonate rocks. Given an

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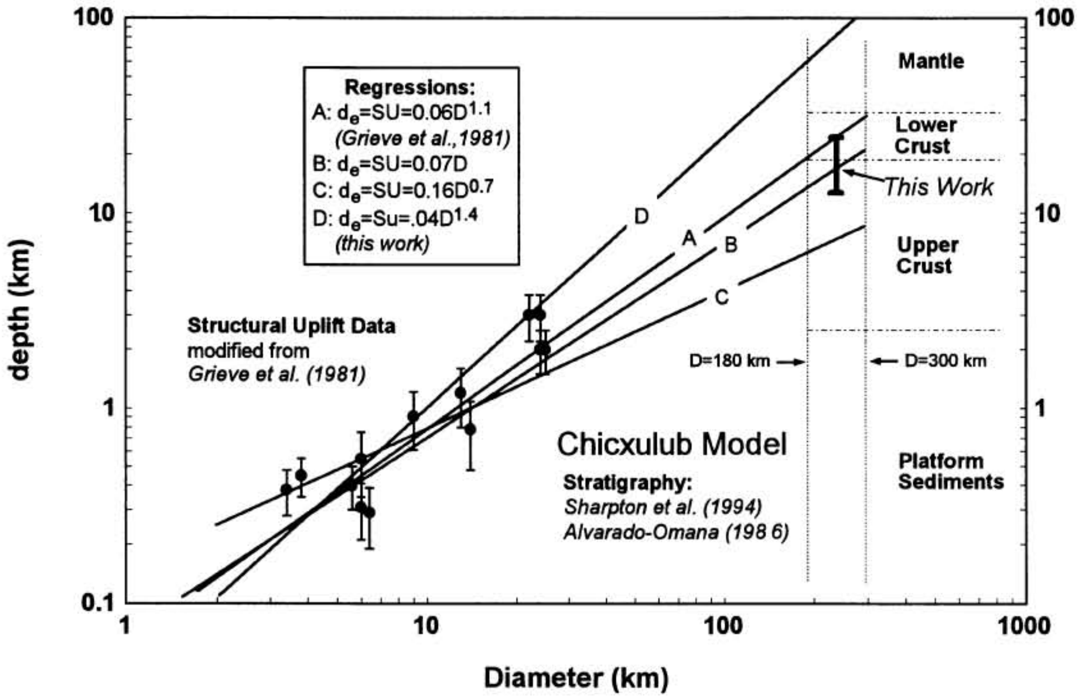
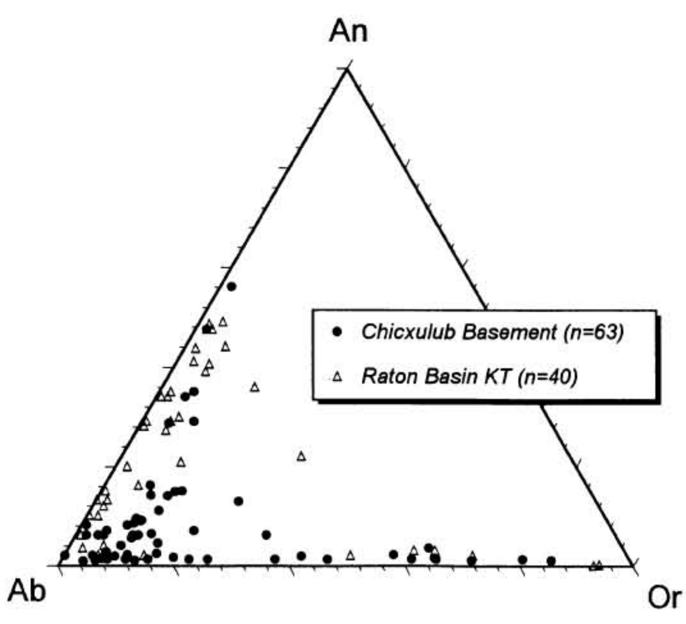
average pre-impact thickness of ~2 km for the platform cover in this region [8], and allowing for vaporization of carbonates near the impact point, silicate basement would have to be melted to a minimum depth of 15 to 20 km to provide these proportions. This provides the additional constraint that $d_e \gtrsim 15$ km.

Figure 1



Conclusions. The current constraints on d_e (15-25 km) of the Chicxulub impact basin are in good agreement with the estimate provided by the SU data of [1], suggesting that the relationship derived from the small terrestrial craters, $SU \simeq 0.07D$, is valid to diameters of at least a few hundred kilometers. With additional evaluation of Chicxulub samples and better stratigraphic constraints it may be possible to improve on this information.

Figure 2



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