Particle abrasion within the Chicxulub ejecta blanket: Implications for the emplacement process

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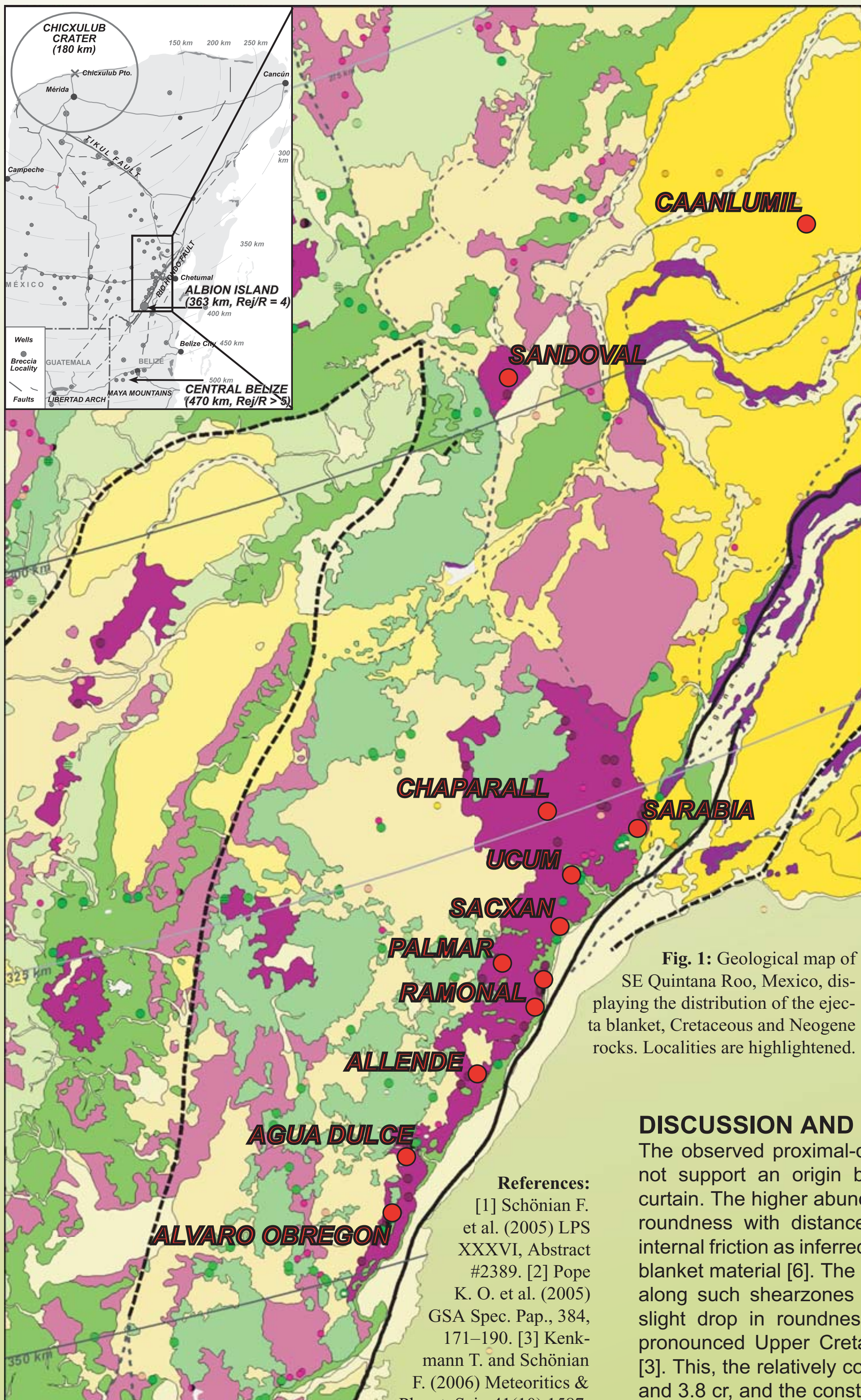
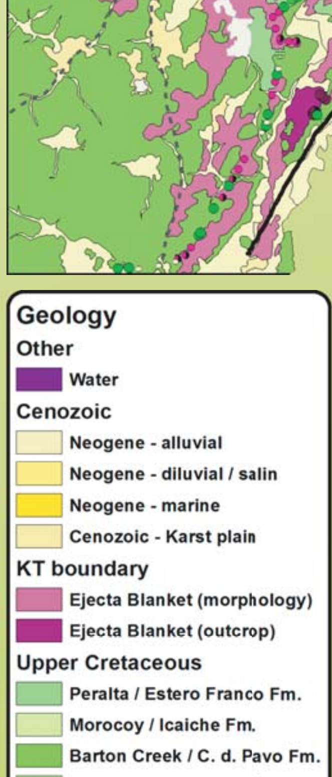


Fig. 1: Geological map of SE Quintana Roo, Mexico, displaying the distribution of the ejecta blanket, Cretaceous and Neogene rocks. Localities are highlightened.



INTRODUCTION

The ejecta blanket of the Chicxulub crater was identified and mapped over a large area on the southern Yucatán Peninsula [1, 2, 3], (Fig.1). It has been described as *diamictite* due to the abrasión of dolomite and limestone clasts. Abrasion features, such as polish and striations have been reported and were interpreted as resulting either from ablation and particle interactions within the ejecta curtain [4,5] or internal shearing in a cohesive and erosive secondary ejecta flow [3,6].

For this study 1575 clasts from 14 ejecta localities in Quintana Roo (Fig. 1) were collected, carefully cleaned and analyzed for superficial abrasion features. In order to statistically assess abrasion, their sphericity and roundness were determined using the intercept sphericity and the detailed roundness scale of [7].

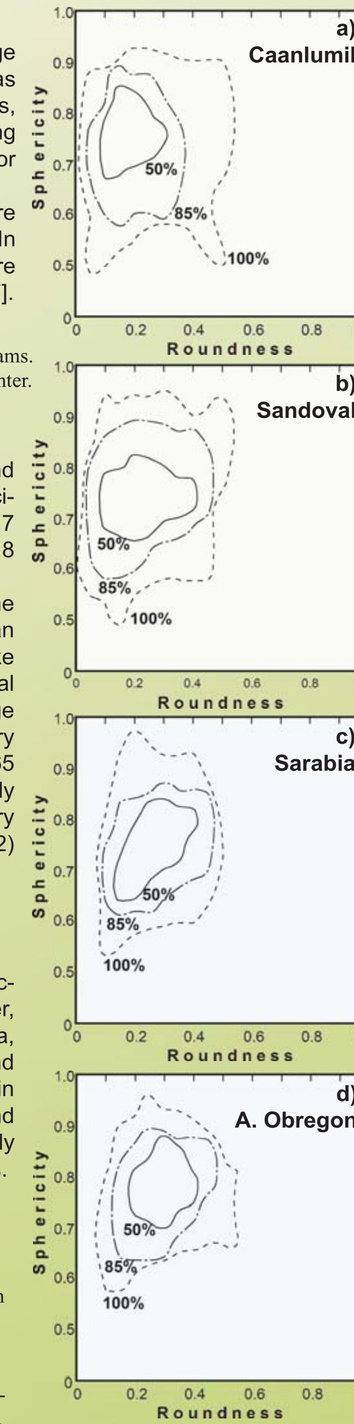


Fig. 2: Abrasion of clasts from 4 localities as roundness-sphericity-diagrams. Localities are 3.2, 3.3, 3.64 and 3.86 crater radii from the impact center.

SPHERICITY AND ROUNDNESS

Most of the clasts are platy or blocky fragments with rounded edges. A slight trend towards a rising sphericity with crater distance can be observed (Fig. 2): Sphericity is variable from 0.48 to 0.94 at <3.3 crater radii (cr, Fig. 2a/b). From 3.6 to 3.7 cr it rises to values between 0.56 and 0.97 (Fig. 2c), remains high from 3.7 to 3.8 cr (0.59-0.94) and is again variable beyond 3.8 cr (0.5-0.96, Fig. 2d).

Usually, pebbles of the ejecta blanket are angular to subangular. Only at the proximal localities (<3.6 cr) very angular clasts with a roundness of 0 or 0.05 can be observed (Fig. 3a) and beyond 3.7 cr subrounded fragments (0.45-0.6) make up a small percentage of the bulk composition (Fig. 3b). A clear proximal-distal relationship of roundness was found between 3.2 and 3.65 cr (Fig. 3a): Average roundness rises from 0.19 over 0.22 (angular) and 0.25 to 0.26 (subangular). Very angular clasts disappear. Average roundness remains largely constant from 3.65 to 3.8 cr, with values between 0.265 and 0.27. Only beyond this distance a slightly rising roundness with values around 0.28 can be observed (Fig. 3b). While very angular clasts are absent at this distance, the amount of angular clasts (0.1-0.2) remains remarkably constant between 3.7 and 3.9 cr.

POLISH AND STRIATIONS

Polished and striated clasts (Fig. 4a) are very rare <3.3 cr (<2% and <1% respectively). Their amount rises slightly around 3.6 cr to about 5% and 2.5%. However, at distances between 3.64 and 3.7 cr a significant rise from 15%/9% at Sarabia, over 22%/12% at Ucum to about 29%/25% at Palmar can be observed. Beyond 3.7 cr and up to 3.9 cr the amount of polished and striated clasts diminishes again and is highly variable from one to another locality (10-26% clasts with polish and 3-15% with striations). Throughout the study area clasts were recollected directly from shearzones (Fig. 4b), which suggests a genetic link between both features.

DISCUSSION AND CONCLUSIONS

The observed proximal-distal relationship of clast abrasion does not support an origin by particle interaction within the ejecta curtain. The higher abundance of abrasion features and the rising roundness with distance can best be explained by increasing internal friction as inferred from shearplanes observed in the ejecta blanket material [6]. The occurence of striated and polished clasts along such shearzones [3,6] further strengthens this view. The slight drop in roundness at 3.7 cr (Fig. 3a) coincides with a pronounced Upper Cretaceous paleorelief beyond this distance [3]. This, the relatively constant average roundness between 3.65 and 3.8 cr, and the constant amount of angular fragments beyond 3.7 cr is probably related to the erosion of fresh material from the heavily karstified subsurface. However, as a consequence of basal shearing, eroded particles should abrade rapidly, which explains the absence of very angular (0.05) clasts at these distances.

In summary, the observations on particle abrasion within the Chicxulub ejecta blanket are consistent with a cohesive and erosive secondary ejecta flow that followed ballistic emplacement and in-volves increasing viscosity and strain localization [3].

References:

[1] Schönian F. et al. (2005) LPS XXXVI, Abstract #2389. [2] Pope K. O. et al. (2005) GSA Spec. Pap., 384, 171–190. [3] Kenkmann T. and Schönian F. (2006) Meteoritics & Planet. Sci., 41(10),1587-1603. [4] Pope K. O. et al. (1999) EPSL, 170, 351-364. [5] Pope K. O., Ocampo A. C. (2000) LPS XXXI, Abstract #1419. [6] Schönian F. et al. (2003) 3rd Int. Conf. Large Met. Impacts, Abstract #4128. [7] Krumbein W. C. (1941) J. Sed. Petrol., 11(2), 73-79.

Fig. 3: Normalized roundness of clasts from 12 localities between 3.2 (Caanlumil) and 3.86 (A. Obregon) crater radii from the impact center. Note the disminuing amount of very angular (0.05) clasts in a) and the constant amount of angular (0.1-0.2) clasts in b).

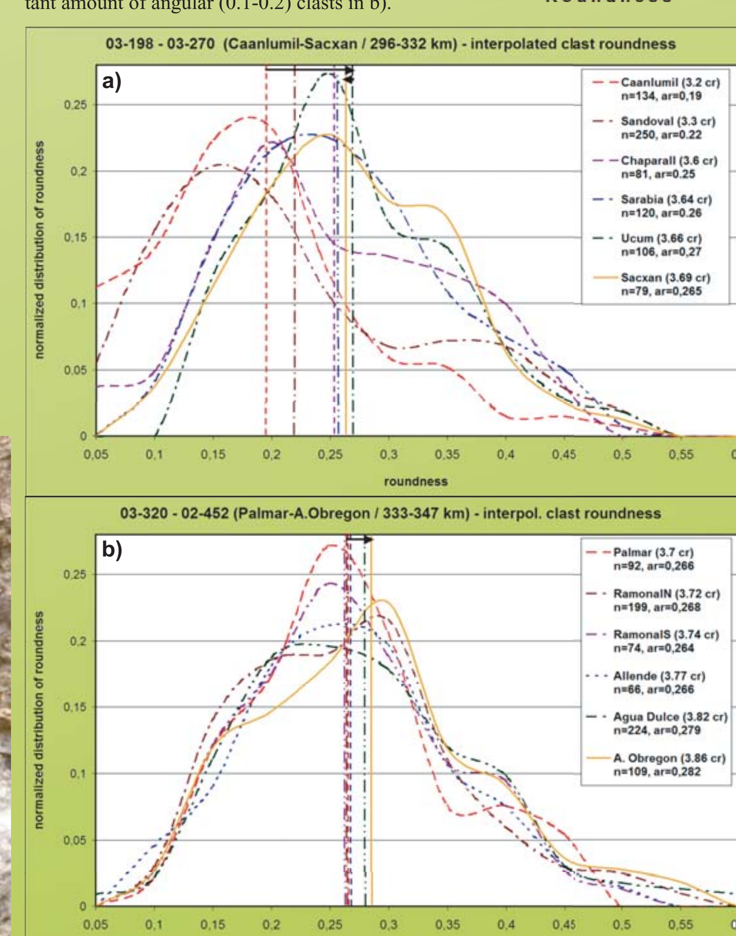


Fig. 4: a) Polished / striated clasts from various localities. b) A polished and striated clasts within a shearzone at Agua Dulce.