Chicxulub ejecta blanket: New insights into the KT impact event

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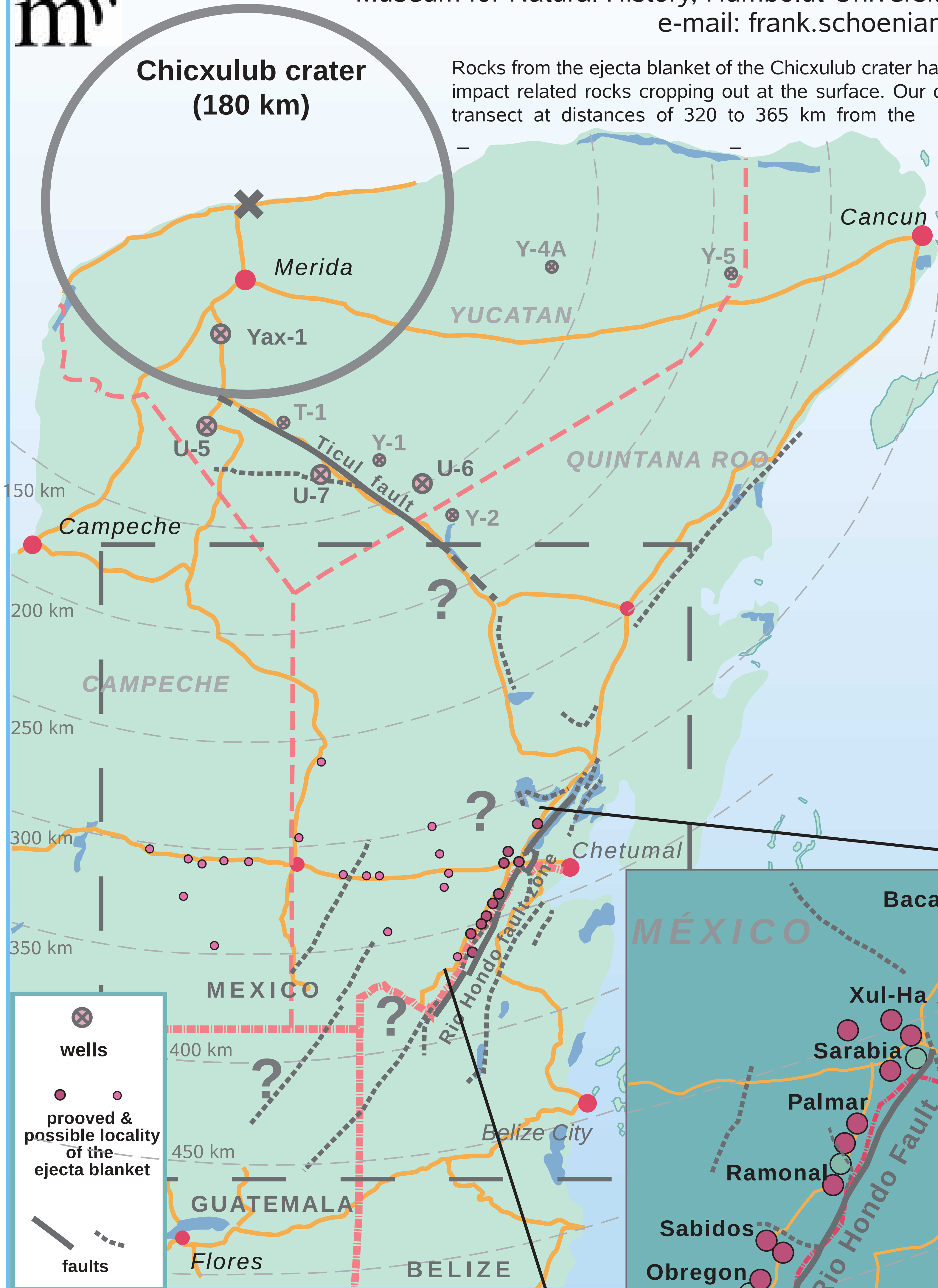


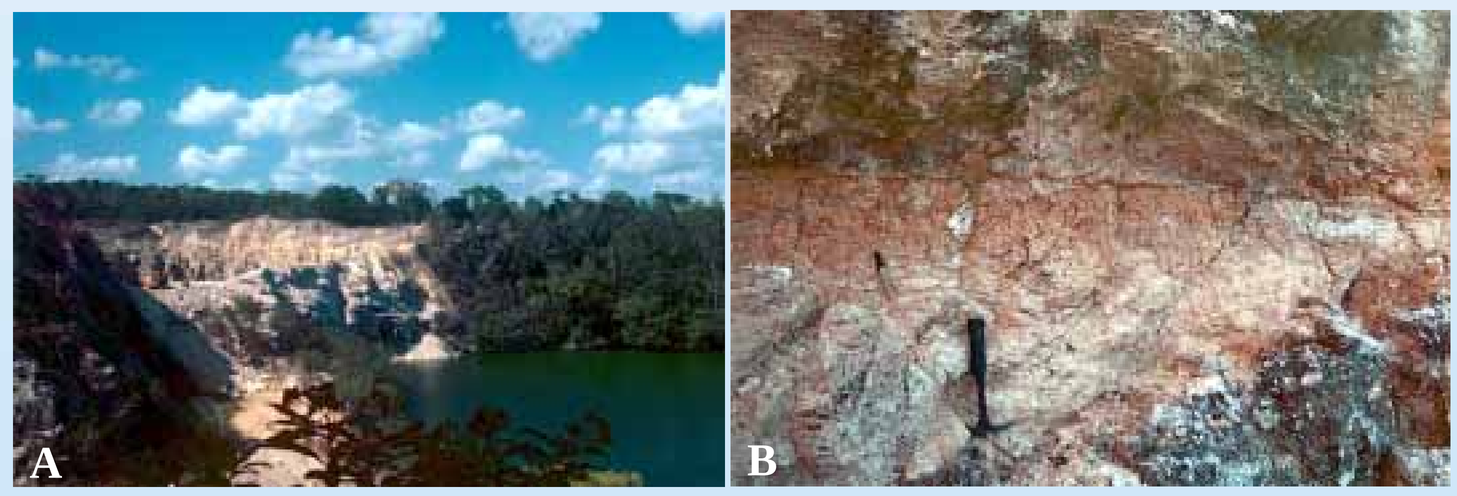
Rocks from the ejecta blanket of the Chicxulub crater have been found along the boundary of Mexico and Belize. With respect to the crater, they are the closest impact related rocks cropping out at the surface. Our detailed mapping has revealed, that they can be traced continuously along a NE-SW trending 65 km transect at distances of 320 to 365 km from the impact center. Additionally, several not yet confirmed localities on the Southern Yucatan Peninsula seem to allow to trace the ejecta blanket within a range of 230 to 375 km. Farther south, the blanket probably extends into the Tikal mountain range of northern Guatemala.

The knowledge of the distribution and petrography of the Chicxulub ejecta blanket will help to better constrain the impact event. It yields information on the impact angle, the crater excavation, and the amount of ejected, melted and vaporized material.

Proximal ejecta facies

Similar to ejecta blankets on Mars, the Chicxulub ejecta blanket can be subdivided into a proximal and a distal facies. The proximal facies is up to now only known from wells around the crater (PEMEX: Y-5A, Y-4, T-1, Y-2, and Y-1, [1]; UNAM: U-5, U-7, and U-6 [2],[3],[4]). It might reach the surface SE of the Ticul fault, within a radial range of 180-210 km from the impact center.

In the UNAM wells the ejecta blanket seems to resemble the breccia succession of the Ries crater (Germany). In U-5 155 m of a polymict, melt-rich breccia (suevite) with abundant basement clasts was cored, overlain by a 15 m, partly laminated, upward fining sequence of suevitic breccia (redeposited suevite, [3]). In U-7 a suevitic breccia is underlain by a melt-free polymict breccia (Bunte Breccia) with abundant gypsum and anhydrite clasts. In U-6 only the latter is present [3,4].



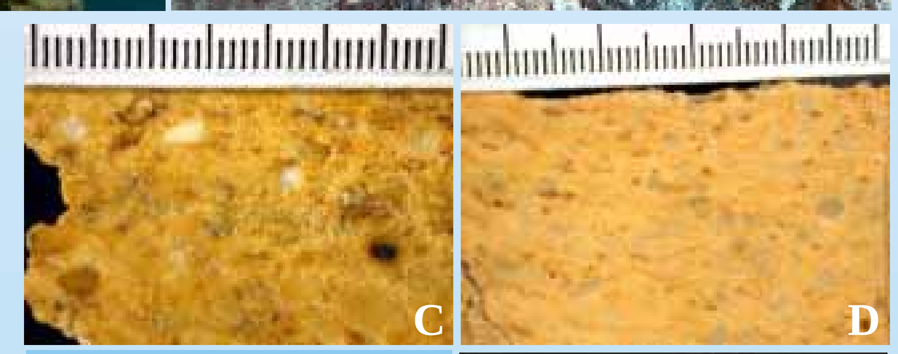
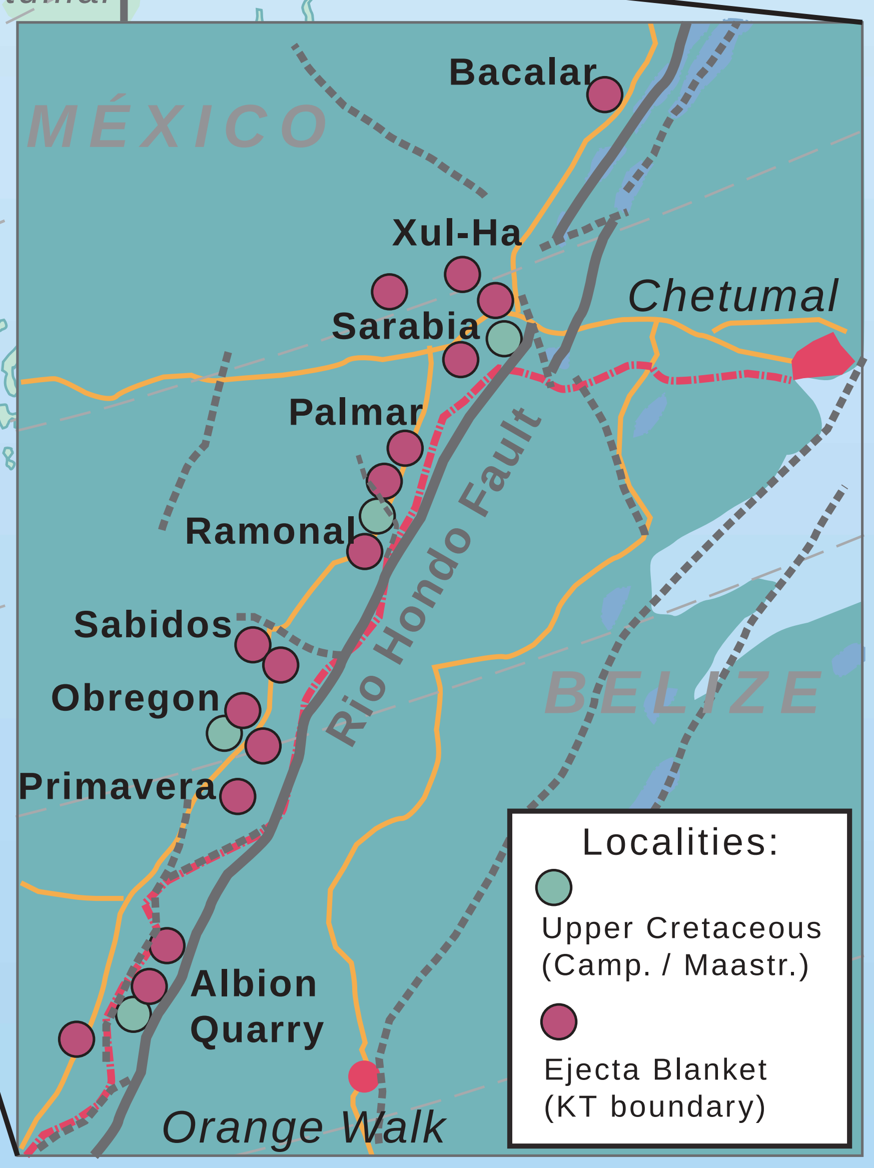


Fig. 1: The basal spheroid bed as exposed in the Albion quarry (A). It rests unconformably on Maastrichtian dolomites, seperated from them by a Caliche layer, indicating subaerial exposure prior to the impact (B). The bed consists of variable layers, some polymict, some strictly monomict (C, D). Spheroids up to 6 cm with different cores and coatings are present (E).



Distal ejecta facies

The distal ejecta blanket, mapped along the Rio Hondo fault zone, can be subdivided into two units: (a) a lower approximately 1 m thick spheroid bed and (b) an upper, very heterogeneous, suevite-like diamictite unit. The latter has a thickness of more than 20 m, but probably less than 100 m.

a) Spheroid bed

The spheroid bed is best exposed within the Albion quarry in NW-Belize [5]. It consists mainly of clay and dolomite spheroids of millimeter to centimeter size within a weakly consolidated clay matrix. Some spheroids reach 6 cm in diameter. They show variable lithologies and often exhibit carbonate or gypsum coatings. The spheroid bed is obtained from primary ejecta from the uppermost target lithologies. It has overrun all other ejecta material and was deposited first. Spheroids might have been formed by accretion similar to volcanic accretionary lapillis within an decoupled early time vapor cloud .

Distal ejecta facies

b) Albion Diamictite

The diamictite unit contains the vast majority of material from the ejecta blanket. It is characterized by a variable amount of altered impact glasses (green or red clay) derived from the vapor plume. The diamictite is polymict, highly unsorted, non-stratified and very variable in composition and sorting. Boulders of bedded limestone up to 5 m in diameter and clasts of all sizes are abundant.

Clasts, mainly dolomites and limestones, are subangular to subrounded, they sometimes display superficial striae, indicating strong particle interactions during transport. Crystalline and sandstone clasts from deeper seated target lithologies are very rare. Anhydrite and gypsum clasts were not observed.

The overall heterogeneity of the diamictite displays multiple stage mixing. Mixing occured primarily between molten impact glasses and the solid ejecta curtain material, probably induced by atmospheric disturbances (ring vortices, cf. [6]). However, the presence of large boulders at such distances rises questions, if such atmospheric tubulences can account for the final ejecta emplacement as suggested by [5].

The highly variable sorting and large boulders with matrix coatings indicate a turbulent flow. This implies that already at distances of 320 km (3.5 crater radii) from the impact center the mixed ejecta material has undergone a significant nonballistic transport path.

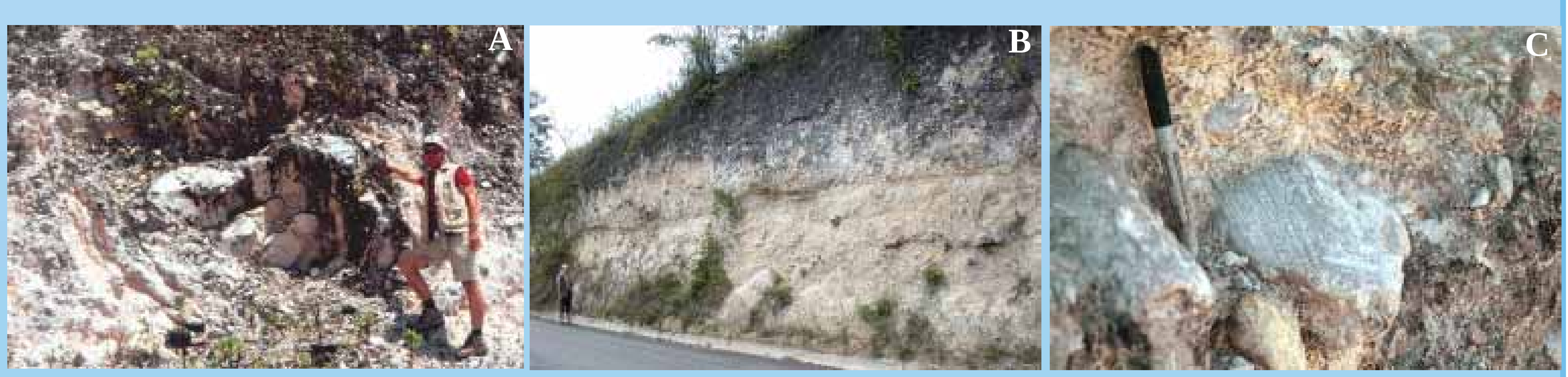


Fig. 2: Some examples from various outcrops of the highly variable diamictite. A: a matrix-coated dolomite boulder (Sarabia). B: distinct planar surfaces at Sabidos. C: strongly abraded dolomite clast from Albion Island. D-F: polished slabs of the diamictite, displaying heterogeneity in the content of altered impact glasses (green clays), sorting, roundness and the polymict nature (Albion Quarry, Palmar, Sarabia).

Implications for the KT impact event

The existence of huge amounts of ejecta blanket material in this region contradicts a low angle impact from the SE (cf. [7]). The ejecta blanket would then occur within the uprange forbidden zone of ejecta dispersal.

Laboratory experiments on vaporization have revealed a decoupling of a primary vapor cloud from the main vapor cloud and the ejecta curtain in a downrange direction for oblique impacts (< 30∞). This fast vapor cloud contains ricochet debris, melt and vapor from the upper target lithologies [8]. If the spheroid bed is derived from such a primary vapor cloud as suggested by [5], an impact with ~15∞ to 30∞ from N to NW would be the most plausible.

The suggested range of the impact angle is critical in numerical simulations and laboratory experiments on the effect of the impact angle on the production of climatologically active gases from the Chicxulub impact (c.f. [8],[9]).

The discrepancy between the abundance of evaporite clasts in the proximal and their scarcity in the distal ejecta facies might be explained either by primary differentiation of the ejected material and/or by secondary mixing with local materials during the ejecta flow.

To study the ejecta emplacement process and the impact event from the ejecta blanket, its outer limit as well as the transition between inner ballistic and outer ejecta flow facies should be found in the future. The amount of primary crater material and of reworked material from the carbonate plattform should be estimated in order to assess the primary excavation depth and the efficiency of secondary scouring.

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