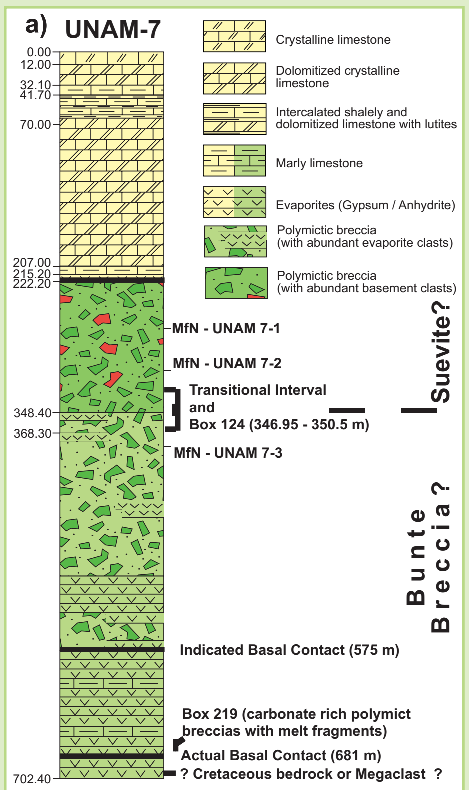
Additional Observations on the Impact Breccias of the Chicxulub Ejecta Blanket from the UNAM-7 Drill Core, Yucatán, Mexico

Frank Schönian[1], Tobias Salge[1], Dieter Stöffler[1] and Jaime Urrutia-Fucugauchi[2]
[1]Museum of Natural History, Humboldt-University of Berlin, Invalidenstr. 43, D-10115 Berlin, Germany
[2]Instituto de Geofísica, UNAM, Mexico City, Mexico
e-mail: frank.schoenian@museum.hu-berlin.de



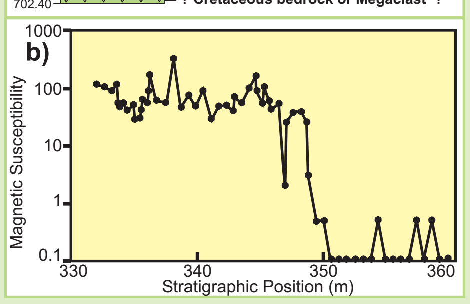


Fig. 1: a) Lithology of the UNAM-7 drill core, modified from Urrutia-Fucugauchi et al. 1996 ([2]). Note the loclities of samples, the transitional interval, the location of the boxes of Fig. 3 and the revised lower contact. **b)** Measured low-field magnetic susceptibility across the transition between the lower and upper unit with a significant drop between 348.4 and 350.5 m (see Fig. 3a; from Urrutia-Fucugauchi et al. 1996, [1])

INTRODUCTION

The Chicxulub Crater (~180 km, Fig. 2) is one of the rare cases where the continuous ejecta blanket of large impact structures on Earth can be studied. It is buried by 200 to >300 m of Tertiary sediments and is only accessible by drilling. In 1994/95 a shallow drilling program was carried out by the Universidad Nacional Autonoma de Mexico (UNAM) within and around the Chicxulub crater. 7 drill cores where recovered (2800 m in total), three of which encountered impact breccias (Fig. 2, UNAM-5, 110 km S from center, UNAM-7, 125 km SE from center, UNAM-6, 150 km SSE from the center, [1,2,3]). These breccias have been compared with the proximal 'Bunte Breccia' - 'Suevite' succession of the well studied Ries crater in Germany [5,6].

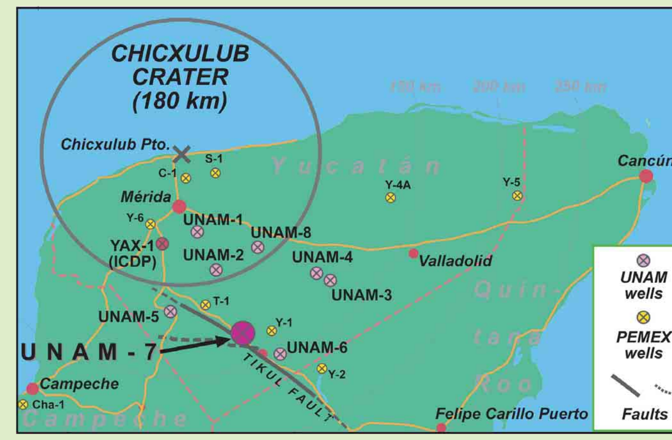


Fig. 2: Location of the UNAM and the PEMEX wells located within and around the Chicxulub crater on the Northern Yucatán Peninsula (Mexico)

THE BRECCIAS OF THE UNAM WELLS

The breccias from the UNAM wells have been described as 'Suevite' (UNAM-5 and upper breccia in UNAM-7) or as Bunte-Breccia-like deposit (UNAM-6 and lower breccia in UNAM-7, [2,3]). These two facies of the proximal ejecta blanket have been distinguished based on (a) abundance of basement versus evaporitic clasts and (b) variations in magnetic susceptibility [2,3]. (Fig.1)
Only the UNAM-7 core is thought to represent a complete Bunte Breccia / Suevite sequence similar to that of the Ries Crater (Fig. 1).

1. MATRIX PROPERTIES

Three matrix types of the impact breccias can be distinguished within the UNAM-7 core: (a) a poorly consolidated, greenish-grey, lithic matrix, (b) a poorly to well consolidated, greenish-yellowish-ocre vitreous or pelitic matrix, and (c) a well consolidated, greyish brown to dark brown carbonate-rich matrix. None of these types is exclusive, there are transitions between all of them (Fig. 3a, Fig. 4a and 4d). In the upper part of the succession gradual toabrupt changes from one to another type can be observed (Fig 3a). Sometimes there is a complex interfingering of units or pockets of different matrix types, displaying a inhomogeneous textures or breccia-in-breccia-type structures (Fig. 4b and 4c). In the lower succession the matrix becomes more carbonaceous, homogeneous, and well consolidated. Nevertheless, intercalations of lithic or vitreous, less

2. THE 'BUNTE BRECCIA' - 'SUEVITE' CONTACT AND THE BASE

The contact between the lower and the upper breccia unit is considered to be situated at 348.4 m [3] or 350.5 m [2] because of a significant drop in magnetic susceptibility within this interval (Fig. 1). Lithologically, no sharp contact between the two distinct units can be observed (Fig. 3a). The transition between the highly variable upper and the more lower breccia is transitional and covers almost 5 core boxes (122-126, appr. 344 m - 358 m, Fig. 3a). The basal contact occurs >100 m deeper than proposed ([1,2,3]) at around 681 m (Fig. 3b). This implies a total ejecta thickness of at least 459 m. The total depth of UNAM-7 is 702.4 m. The 21 m of anhydrite and marls at the base appears to be evenly horizontally bedded. Anhydrite clasts within the overlying breccia unit show as well an apparent horizontal bedding (cf. Fig. 1a).

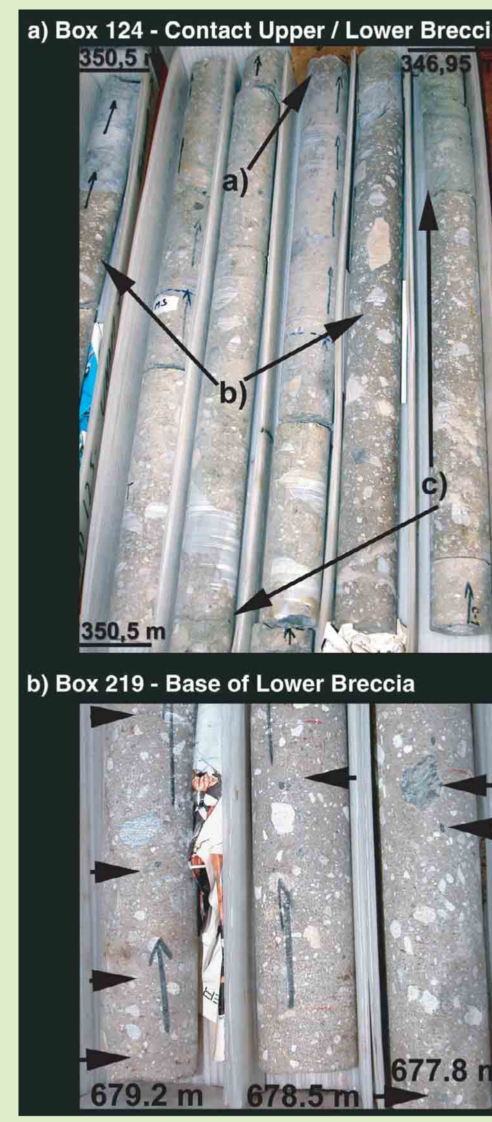


Fig. 3: a) Box 124 (348.95-350.5 m) of the UNAM-7 drill core with the proposed contact between the Bunte-Breccia-type lower and the suevitic upper breccia at point a. Note the repetition of lithologies (b and c) and the transition between different breccia types. b) Box 219 immediately above the lower contact of the breccia (Box 220) and well below (>100 m) the proposed lower contact. Note the polymict nature, the carbonate-rich brown matrix and the abundant greenish-grey to dark grey altered melt fragments (arrows).

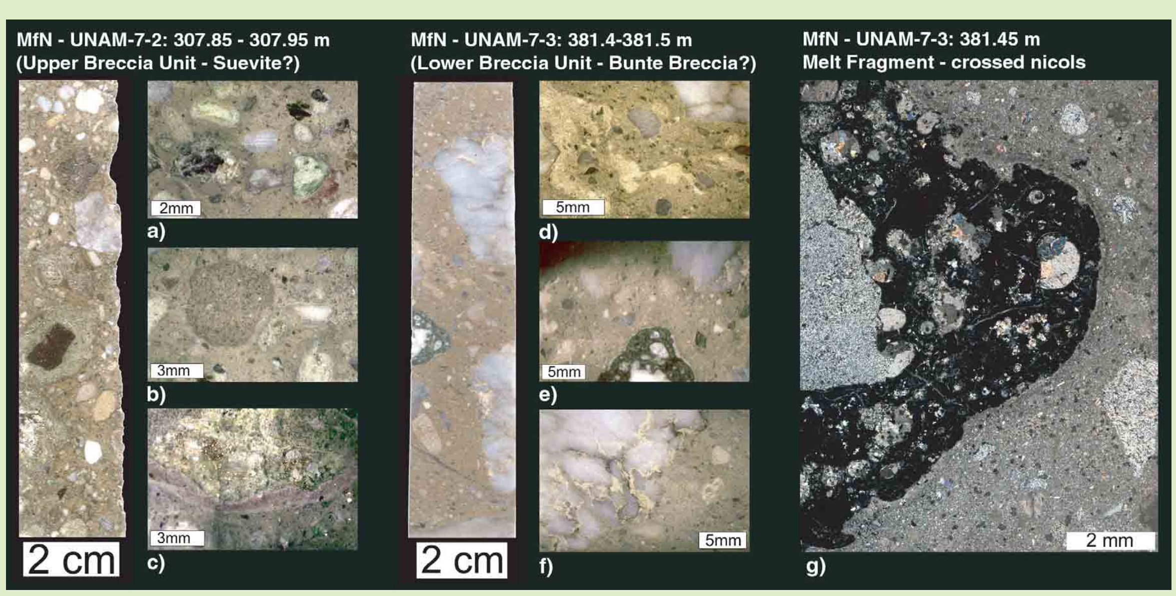


Fig. 4: Typical samples from UNAM-7. Note the polymict, very heterogeneous nature of the first sample with clasts with reaction rims and coatings of altered impact melt. The second sample is more homogeneous, but shows matrix variation and altered melt fragments as well, a) polymict breccia with evaporite and yellowish-green and greenish altered melt particles, b) altered melt particles, evaporite clasts and carbonate-rich intraclast within pelitic (vitreous) matrix, c) melt-rich breccia clast with brownish reaction rim, d) matrix variations from yellowish pelitic (vitreous) to carbonate-rich matrix, e) greenish breccia clast of altered melt (see g)), f) pelitic yellowish (vitreous) matrix in joints of an anhydrite clast, g) thin section photograph (crossed nicols) of e) - devitrified melt fragment (glass?) containing inclusions with secondary calcite and a lithic core, showing a brownish reaction rim.

3. SEDIMENTARY CLASTS, BASEMENT CLASTS AND MELT FRAGMENTS

There is an inverse relationship in abundance of sedimentary versus basement clasts. Carbonates are angular to subrounded and sometimes display a rim of altered impact glasses. Anhydrite clasts are generally angular (Fig. 3a) and do not show such rims. The size and frequency of anhydrite clasts increases towards the base. Basement clasts do preferently occur in the upper breccia, but are also present within the in the lower unit. Basement clasts are subangular to subrounded and do often display 'reaction rims' or coatings of green to yellowish-green altered melt. Altered melt fragments occur throughout the succession down to its base (Fig. 3b, Fig. 4g). Sometimes vitreous/pelitic fragments (Fig. 4d, altered melt?) interfinger with the matrix. Melt fragments show different shapes and do not rarely contain lithic cores or clasts (Fig. 4g). There appear to be three distinct types of melt particles (alteration products): a light-yellow / ocre to greenish, a

CONCLUSIONS

The two breccia units of UNAM-7 are lithologically different from the Ries ejecta and can not be described as a sequence of 'Bunte Breccia' and 'Suevite'. The complete succession should be defined as 'Suevite' (lithic impact breccia with melt particles, c.f. [7]). A distinct, melt-rich, highly polymict upper unit can be defined with a gradational instead of a sharp contact to the underlying breccia unit. The high melt production indicated by melt fragments throughout the succession is consistent with scaling laws that predict an unproportionally increase of melt with increasing crater diameter [9]. Impact angle and atmospheric turbulences might have had a significant effect on melt distribution within the ejecta blanket. A detailed description and analysis of the impact breccias of the UNAM wells and, if accessible, the PEMEX drill cores (T1, Y1, Y2, Y5a, and Y4, Fig. 2) outside the Chicxulub crater would provide the opportunity to better understand the processes that acted during crater excavation and early stage ejecta

REFERENCES

[1] Urrutia Fucugauchi et al. (1996) Geofísica Internacional, 35(2), 125-133. [2] Urrutia Fucugauchi et al. (1996) Geophys. Res. Let., 23(13), 1565-1568. [3] Rebolledo Vieyra M. et al. (2000) Int. Geol. Rev., 42(10), 948-978. [4] Hörz F. et al. (1983) Rev. Geophys. Space Phys., 21, 1667-1725. [5] Oberbeck V. R. (1975) Geophys. Space Phys., 13, 337-362. [6] Von Engelhardt W. (1990), Tectonophysics, 171, 259-273. [7] Stöffler D. and Grieve R. A. F. (1994), LPSC, XXV, 1347-1348. [8] Melosh H. J. (1989), Ox-ford Monogr. Geol. Geophys., 11, 245 p.

ACKNOWLEDGEMENTS

This work was supported by the graduate research program 503 of the German Science Foundation at the Museum of Natural History (DFG, GRK 503). We are very grateful to the UNAM, Mexico for the access to the UNAM drill cores. Special Thanks to Dr. Phillippe Claeys for providing sample material and to Elia Escobar Sanchez (Instituto de Geofísica, UNAM, Mexico) for logistic support.