COMPOSITION AND CHARACTERISTICS OF THE CHICXULUB EJECTA PLUME. A. Wittmann[1], T. Kenkmann[1], L. Hecht[1], D. Stöffler[1], [1]Institut für Mineralogie, Museum für Naturkunde, Humboldt-Universität zu Berlin, Invalidenstrasse 43, 10115 Berlin, Germany; axel.wittmann@museum.hu-berlin.de

Introduction: This study aims to constrain physical boundary conditions and their temporal variation during the evolution of the ejecta plume at Chicxulub. Therefore, the continuous suevite-like deposits of the ICDP-Chicxulub drill-core Yaxcopoil-1 (Yax-1) were systematically analyzed with regard to their compositions, and shapes, sizes, and orientations of melt particles (MPs).

Samples and methods: Digital photographs of about 60 half-core pieces and 17 photographs of thin sections of samples of the suevite –like units at Yax-1 were processed by image analysis software. Particle areas, shape-preferred orientations and lengths vs. widths were measured. Four different MP types were distinguished based on color, shapes, content of phenocrysts, and previous petrographical characterization [1, 2]:

Type 1 is amoeboid to angular, dark green and very rarely exhibits phenocrysts.

Type 2 exhibits shard morphologies and abundant vesicles, is light green and bears variable amounts of plagioclase phenocrysts.

Type 3 contains abundant plagioclase and diopside phenocrysts, One sub-type („schlieren“) exhibits reddish-white colors, schlieren-textures and corroded, sub-angular margins. Another sub-type („BMR“) is grey-green and displays angular shapes. Transitions between these sub-types occur.

Type 4 is sub-angular and dark brown to black. It may contain vesicles and schlieren and exhibits abundant, finely dispersed Fe-(Ti)-oxide crystals, possibly indicating elevated f_{O_2} [3].

Thin sections of about 40 drill core samples served to confirm the identification of particles. The whole rock compositional variation of MPs was determined by defocused EMP analyses on some 90 MPs of selected thin sections.

Preliminary results: The modal composition of Yax-1 on the half-core scale (diamonds) and thin section scale (squares) is presented in Fig. 1. The matrix component was calculated as the remaining area after deduction of the bulk clast area. Particle size distribution is shown in Fig. 2. The 95 % confidence intervals of the mean particle area per sample and the respective standard deviations on the half-core scale indicate good size sorting in the USS (unit abbreviations from Fig.1) and LSS together with a gradual increase in mean grain size with depth. Mean particle sizes are in the mm^2 range for the USS and LSS and in the cm^2 range in the remaining units. Type 1 MPs are significantly smaller on average than the other MP types. Aspect ratios of MPs at the half-core scale indicate an increase from the US to the SD. At the thin section scale, the USS particles have significantly higher aspect ratios. Orientations vary with regard to MP type and suevite unit. Alignment in a sub-horizontal direction is most prominent in the USS, and recognizable in the LSS and SD. The other units appear unsorted and rather chaotic, thus suggesting more turbulent emplacement conditions of MPs that were not subjected to sorting. Type 1 and 4 MPs exhibit the most distinct alignment, while type 2 MPs exhibit the least alignment.

Geochemistry: The major element composition of the MP types does not vary significantly. This may indicate derivation from a homogenized bulk impact melt that underwent modifications to the characteristic MP types during the ejection process and subsequent alteration. An enrichment of all MPs in Na_2O and CaO corresponds to an increase in relative frequency of phenocrysts in the BMR and neighboring units. Relatively high contents of CaO and MgO possibly reflect the ubiquitous presence of diopside as a phenocryst phase in the MPs of this unit. In the neighboring LS (bottom) and MS (top) units, plagioclase phenocrysts predominate. A metasomatic overprint finds expression in an enrichment of K_2O in the lowermost units of the sequence. FeS is the main iron bearing phase in the lowermost three suevite-like units including the BMR. The overlying airfall suevites contain iron oxides. They are finely dispersed in the dark type 4 MPs. This may be indicative of oxidating conditions within the ejecta plume during the ejection of these MPs.

Discussion: The airfall suevite units are characterized by a size sorting in the LSS and USS and distinct alignment of MPs. Grain sizes in the USS are compatible with early stage nucleation products from an impact vapour cloud [4]. However, the USS-US airfall deposits represent a mixture of variably quenched MPs that were deposited in close proximity. This indicates that some MPs were more quickly quenched or that type 3 MPs had a higher enthalpy that was used to crystallize phenocrysts. Alternatively, subsolidus growth of phenocrysts from elevated f_{H_2O} in the MPs could have been responsible for this phenomenon [3]. Otherwise, this heterogeneous of devitrification of MP types that underwent different degrees of quenching may be an effect of reworking during the turbulent deposition of the ejecta plume, which could explain the occurrence of breccia-in-breccia textures in the airfall suevites. The occurrence of type 4 MPs could serve as a proxy for regions of elevated f_{O_2} or f_{H_2O} in the ejecta plume, e.g., the wet "warm fireball" of [5]. An alternative explanation of the type 4 MP is that they were derived from a distinct target lithology [1]. However, we did not find conclusive supporting evidence in the EMS data for this theory. A thermal gradient of annealing is indicated from top to bottom of the sequence from an increase of the abundance of liquidus phase phenocrysts, and the distribution of characteristic shock features in zircon [6]. Aspect ratios and shape-preferred orientations confirm this theory as they indicate a flattening or ductile deformation trend of highly viscous MPs in the MS and LS units. Therefore, the MPs in these units must have been subjected to conditions above the glass softening temperature of about 680 °C after deposition.

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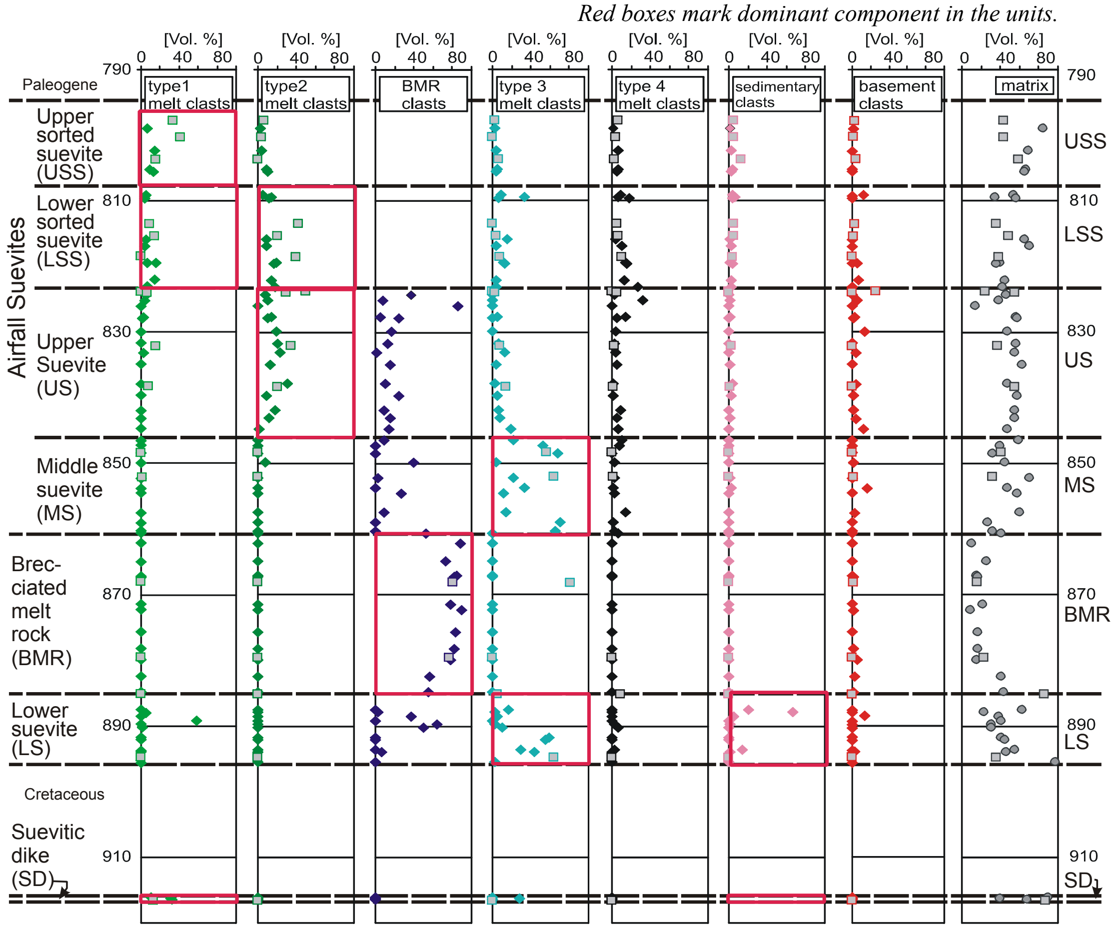
References: [1] Hecht et al. (2004) MAPS 39, 1169-1186. [2] Stöffler, D. et al. (2004) MAPS 39, 1035–1067. [3] Engelhardt, W. v. et al. (1995) MAPS 30, 279-293. [4] de Niem, D. (2002) GSA Special Paper 356, 631-644. [5] Alvarez et al. (1995) Science 269, 930-935. [6] Wittmann et al. (in press) Shock metamorphosed zircon in terrestrial impact craters. MAPS.

Fig. 1 Modal composition of the suevite-like units in Yax-1. Red boxes mark dominant component in the units.



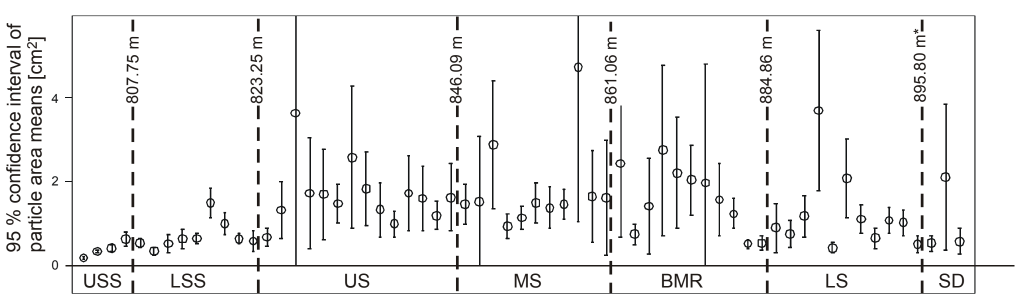


Fig. 2 Particle sizes in Yax-1.