THE DRILL CORE DIARY: UNRAVELLING THE RAPID EMPLACEMENT OF SUEVITE AND IMPACT MELT PHASES WITHIN THE CHICXULUB IMPACT STRUCTURE. P. Kaskes[1,2], S. J. de Graaff[1,2], J.-G. Feignon[3], T. Déhais[1,2], S. Goderis[1], L. Ferrière[4], C. Koeberl[3], J. Smit[5], A. Wittmann[6], S.P.S. Gulick[7,8], V. Debaille[2], N. Mattielli[2], and Ph. Claeys[1]. [1]Analytical-, Environmental- and Geo-Chemistry, Vrije Universiteit Brussel, Brussels, Belgium (pim.kaskes@vub.be), [2]Laboratoire G-Time, Université Libre de Bruxelles, Brussels, Belgium, [3]Department of Lithospheric Research, University of Vienna, Vienna, Austria, [4]Natural History Museum, Vienna, Austria, [5]Department of Earth Sciences, Vrije Universiteit Amsterdam, Amsterdam, the Netherlands, [6]Eyring Materials Center, Arizona State University, Tempe, AZ, USA, [7]Institute for Geophysics & Department of Geological Sciences, Jackson School of Geosciences, University of Texas at Austin, Austin, Texas, USA, [8]Center for Planetary Systems Habitability, University of Texas at Austin, Austin, Texas, USA.

Introduction: The Chicxulub asteroid impact event on the Yucatán Peninsula (Mexico) ~66 Myr ago was one of the most catastrophic events in Earth's history, with planet-wide climatic and biotic consequences [e.g., 1]. Studying the petrography and geochemistry of target rock and impact lithologies from within the ~200-km-wide Chicxulub impact structure is crucial to constrain the timing and magnitude of impact-induced processes at 'ground-zero' and helps to better understand the formation of large impact structures in general.

The peak ring of the Chicxulub impact structure was drilled during the 2016 IODP-ICDP Expedition 364, revealing new insights in the nature and emplacement of proximal impactites [e.g., 2,3]. In contrast to previous boreholes in the southern part of this crater (e.g., Yucatán-6 and Yaxcopoil-1), the Expedition 364 M0077A drill core from the northern peak ring region recovered the first continuous impact melt rock and suevite (impact-melt-bearing polymict breccia) sequence on top of crystalline basement [2]. We studied in detail the petrography, sedimentology, and the major and trace element geochemistry of the ∼100-m-thick crater suevite succession from this drill core to understand its emplacement and to reconstruct the complex crater infill history of the first moments (minutes – hours) after the Chicxulub impact event.

Material & methods: A total of 212 suevite and impact melt rock samples between depths ~616.5 and 732 meters below seafloor (mbsf) were analyzed petrographically and geochemically, by SEM-EDS, µXRF mapping, and whole-rock ICP-OES, XRF, ICP-MS and INAA [4]. Phase-specific analyses on the clastic matrix and impact melt particles were carried out with EMPA. Digital image analysis on µXRF maps of thin sections was performed to quantify the degree of sorting and to determine modal abundances and particle parameters of various suevite clast types [5].

Results: The M0077A suevite is dominated by vitric melt particles, and, to a lesser degree, by microcrystalline melt particles and clasts from the sedimentary target (primary and reacted carbonates, no evaporites) and crystalline target (shocked granitoids and rare gneiss, amphibolite, and dolerite). The suevite sequence is deposited on top of a brecciated impact melt rock unit and is subdivided into three units that are distinct in their petrography (Fig. 1), geochemistry, and sedimentology, i.e., from base to top: (1) the ∼5.6-m-thick non-graded suevite, (2) the ∼89-m-thick graded suevite, and (3) the ∼3.5-m-thick bedded suevite units. The graded unit shows an upward-increasing sorting and is clearly depleted in CaO (∼20 wt%) and enriched in heavy REEs compared to the other units. Within the very well-sorted, bedded suevite unit, a rare 1.2 mm wide, silicate, glassy impact spherule is preserved (Fig. 1C), which is geochemically comparable to altered vitric melt particles. All suevite units have isolated Cretaceous planktic foraminifera preserved within their clastic matrix, suggesting that marine processes were responsible for the deposition of the entire sequence.

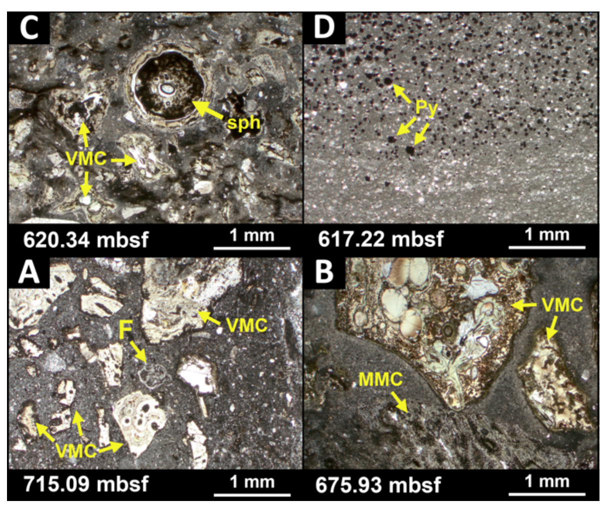

Fig. 1. PPL microphotographs of the M0077A suevite [4]. **(A)** Non-graded suevite unit with partly recrystallized planktic foraminifera (F) and vitric melt clasts (VMC). **(B)** Graded suevite unit with vitric and microcrystalline (MMC) melt clasts. **(C)** Bedded suevite unit with a rare impact spherule (sph). **(D)** Transitional unit with pyrite (Py) levels.

Discussion: We interpret that the returning ocean water that reached the northern peak ring (estimated to be

< 30 minutes after impact based on a simplified one-dimensional 'dam-break' model [3]) entered through a N-NE gap in the Chicxulub outer rim [3]. This ocean resurge was relatively poor in rock debris and caused intense quench fragmentation when it interacted with the underlying hot impact melt rock [6], resulting in the formation of the hyaloclastite-like, non-graded suevite unit (Fig. 2A). In the following hours, the crater was continually flooded by an ocean resurge rich in rock debris, which extinguished phreatomagmatic processes and deposited the ~89-m-thick graded suevite unit (Fig. 2B). After the energy of this resurge slowly dissipated, oscillating seiche waves took over the sedimentary regime and formed the bedded suevite unit (Fig. 2C).

The single impact spherule preserved at the base of this unit represents a melt droplet [7] that was quenched and ejected into the proximal Gulf of Mexico region in the first minutes after impact. It was then brought back in the final stage of the resurge into the crater to become part of the first seiches. The upper 20 cm of the bedded suevite unit is cross-bedded and rich in terrestrial biomarkers and charcoal, most probably transported by a reflected turbid tsunami from the nearest landmass in central Mexico. Based on modelling, these reflected tsunami waves have likely re-entered the impact basin within 24 hours after impact [3], providing a vital upper time constraint for the Chicxulub suevite deposition.

Finally, the overlying transitional layer is a micritic and pyritic siltstone with only rare melt particles (Fig. 1D). A green marlstone yielding a positive iridium anomaly (~1 ppb) marks the top part of this unit, indicating atmospheric fallout of the final ultrafine meteoritic matter [8]. This material is estimated to have been deposited up to 20 years after impact (Fig. 2D) [8].

Conclusions: The M0077A suevite sequence from the Chicxulub peak ring preserved a high-resolution record that provides a unique window for unravelling the dynamics and timing of marine cratering processes in the direct aftermath (< 1 day) of a large impact event. Correlating the M0077A record with other Yucatán drill cores will help to test to what extend the model of seawater ingress, ocean resurge, and seiches (Fig. 2) can be extrapolated across the Chicxulub crater region.

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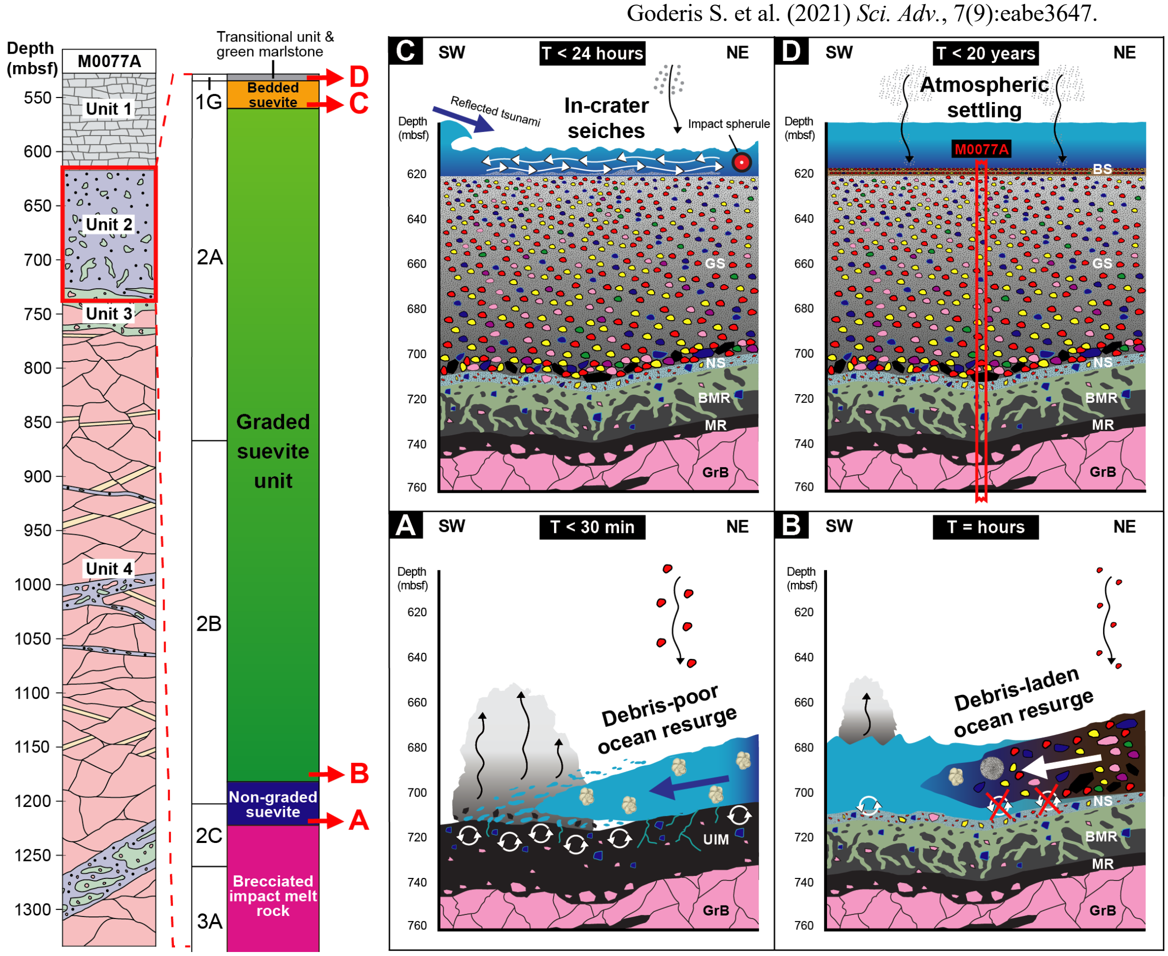

Fig. 2. Chicxulub M0077A drill core lithostratigraphy following [2,4], showing key moments in the deposition of the different suevite units, as highlighted with arrows on the core stratigraphy and as snapshot panels (A-D), modified from [4].