SEARCH FOR A METEORITIC COMPONENT WITHIN THE CHICXULUB IMPACT STRUCTURE PEAK RING IMPACT MELT ROCKS: IMPLICATIONS FOR THE FATE OF THE PROJECTILE. J.-G. Feignon[1], T. Schulz[1,2], L. Ferrière[3], S. Goderis[4], S. J. de Graaff[4,5], P. Kaskes[4,5], T. Déhais[4,5], P. Claeys[4], and C. Koeberl[1], [1]Department of Lithospheric Research, University of Vienna, Vienna, Austria (jean-guillaume.feignon@univie.ac.at), [2]Institute for Geology and Mineralogy, University of Cologne, Cologne, Germany, [3]Natural History Museum, Vienna, Austria, [4]Research Unit: Analytical, Environmental & Geo-Chemistry, Department of Chemistry, Vrije Universiteit Brussel, Brussels, Belgium, [5]Laboratoire G-Time, Université Libre de Bruxelles, Brussels, Belgium.

Résumé: Les concentrations en éléments hautement sidérophiles (Ir, Pt, Re, Os) et les compositions isotopiques Re–Os ont été mesurées dans les impactites de l'anneau central de la structure d'impact de Chicxulub (Mexique). Les impactites ont une composition reflétant un mélange des roches cibles (dolerite, granite, et parfois carbonates), et ont été affectées par une importante altération hydrothermale. Un seul échantillon présente une faible signature météoritique potentielle (~0.01–0.05%). Les résultats sont cohérents avec les modèles impliquant un impact oblique (45–60°), où la majorité du volume du projectile est vaporisé et/ou éjecté en dehors du cratère.

Introduction: Constraining the degree of preservation of a meteoritic signature within an impact structure provides vital insights in the processes that occur during and after an impact cratering event, as well as information on the fate of the projectile. In 2016, the IODP-ICDP Expedition 364 drilling recovered a ~829 m continuous core (M0077A) of impactites and basement rocks within the peak ring of the ~200-km-diameter Chicxulub impact structure [1]. Within core M0077A, an iridium anomaly and a near-chondritic highly siderophile element (HSE) signature were identified in a 3-cm-thick gray-green marlstone layer at the top of the peak ring, below the Danian pelagic limestone [2]. This layer was deposited following the atmospheric fallout of fine-grained extraterrestrial material [2]. However, so far no unambiguous meteoritic contribution was detected in impact melt rock samples from the Expedition 364 drill core. Previous works on other drill cores have shown that most Chicxulub impactites contain a heterogeneously distributed chondritic component, up to 0.1% in a few samples [3, and references therein]. Thus, this study focuses on the search for a meteoritic component within impact melt rock and suevite samples from the peak ring.

Methods: In order to identify a possible meteoritic contribution within the impact melt rock samples from the peak ring, detailed geochemical investigations, including selected moderately (Cr, Co, Ni; 25 impact melt rock samples), and HSE (Ir, Pt, Re, Os) contents, as well as Re–Os isotopic analyses (12 impact melt rock samples), were completed. In addition, two suevite samples, as well as pre-impact lithologies (one amphibolite, one dolerite, one dacite, and two granite samples) of the Chicxulub peak ring, were also analyzed.

Results and discussion: Impact melt rock samples are generally of andesitic composition. Similar to major elements, moderately siderophile element contents (Cr, Co, Ni) of impact melt rocks reflect primarily a mixture between a felsic (granite) and a mafic (dolerite) components, with the incorporation of carbonate material in the upper impact melt rock unit (from 715.60 to 747.02 meters below seafloor).

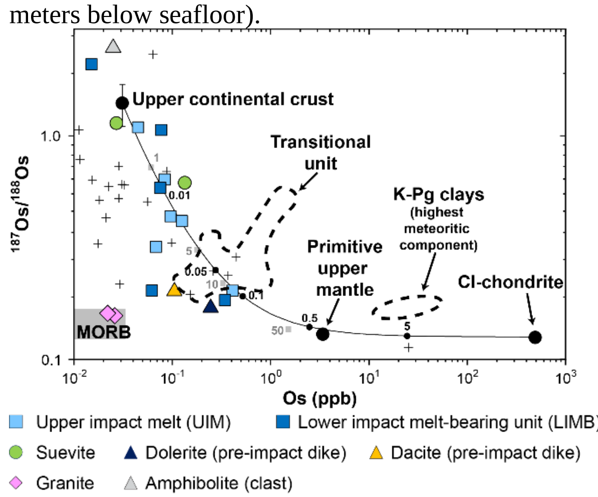

Figure 1. *Measured $^{187}Os/^{188}Os$ ratios versus Os content of the investigated samples. Impactites from the Expedition 364 drill core follow broadly the mixing line between compositions of the upper continental crust and CI-chondrite. Cross symbols represent the composition of impactites from previous drillings (see details in [3]).*

Concentrations of the HSEs in impact melt rocks and suevites are generally low (<39 ppt Ir, <96 ppt Os, <149 ppt Pt; similar to upper continental crust [4]), with only three of the investigated impact melt rock samples exhibiting an enrichment in Os (125, 344, and 410 ppt) and/or Ir (250 and 324 ppt) by one order of magnitude relative to the other samples. However, the dolerite shows a similar enrichment in the HSEs (245 ppt Os, 156 ppt Ir, and 346 ppt Pt) by roughly one order of magnitude relative to the other pre-impact lithologies. In contrast, granite, dacite, and suevite are depleted in Ir, with contents ranging from 1 to 10 ppt.

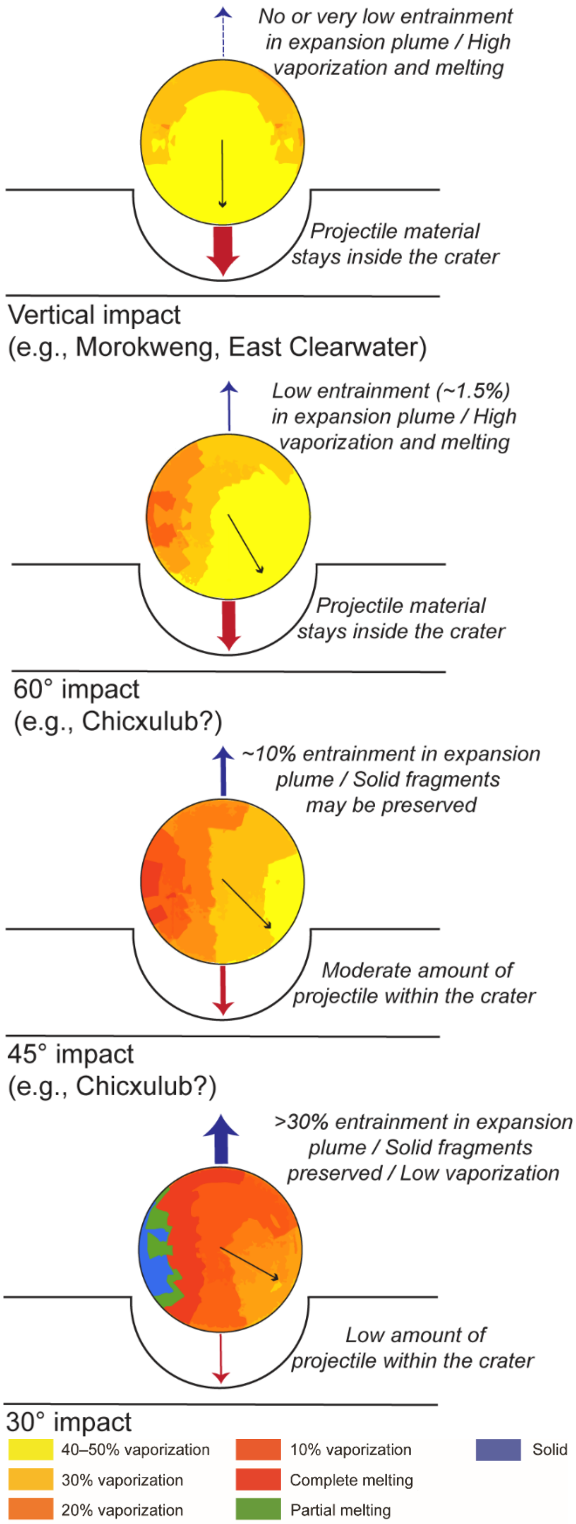

Figure 2. *Distribution of vaporization and melting inside a 10-km diameter projectile according to the impact angle relative to the target surface. Red and blue arrows show the distribution of the projectile material deposited within and ejected outside the transient crater, respectively (modified from [3]).*

The $^{187}Os/^{188}Os$ ratios of the impact melt rocks are highly variable, ranging from 0.18 to 2.09, probably reflecting heterogenous target rock contributions (Fig. 1). The presence of a significant (~20–60%, and up to 80–90%) mafic, unradiogenic dolerite ($^{187}Os/^{188}Os$ of 0.17) component within the impact melt rocks makes the unambiguous identification of an extraterrestrial component challenging. Moreover, granite samples display also unusual unradiogenic $^{187}Os/^{188}Os$ ratios (~0.16), while impact melt rock and suevite samples follow broadly a mixing trend between upper continental crust and chondritic/mantle material. Only one of the investigated samples of the upper impact melt rock unit could also be interpreted in terms of a highly diluted (~0.01–0.05%) meteoritic component (Fig. 1).

Importantly, the impact melt rocks and pre-impact lithologies were affected by a long-lived (>1 Myr) post-impact hydrothermal system [5], locally remobilizing Re and Os. The significant mafic contribution is rather likely in explaining the least radiogenic $^{187}Os/^{188}Os$ ratios.

This study shows that the amount of meteoritic material incorporated within the Chicxulub impact structure seems to be rather low and heterogeneously distributed. In contrast, a higher meteoritic contribution (up to ~5%) is found in distal K–Pg impact ejecta [6,7]. The low amount of meteoritic material preserved within the Chicxulub impact structure may result from a steeply inclined trajectory of the impactor (~45–60°, see Fig. 2), as suggested by numerical modeling [8]. The combination of these processes led to the currently observed compositions in the impactites within the Chicxulub impact structure (see details in [3]), and represents an important example of the challenges associated with the unambiguous identification of a meteoritic component at terrestrial impact structures.

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Acknowledgements: Thanks to ECORD, IODP-ICDP, the Yucatán Government, and Universidad Nacional Autónoma de México for drilling funding. University of Vienna doctoral school, FWO-Flanders, BELSPO, and VUB Strategic Research Program supported this research.