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Introduction: In 2016, the IODP-ICDP Expedition 364 drilling recovered a ~829 m continuous core (M0077A) of impactites and basement rocks within the ~200-km diameter Chicxulub impact structure peak ring [1]. An iridium anomaly and a near-chondritic highly siderophile element (HSE) signature were identified within the transitional unit of core M0077A, at the top of the peak ring, corresponding to the settling of atmospheric fallout of fine-grained extraterrestrial material [2]. However, so far no unambiguous meteoritic contribution was yet detected in impact melt rock samples from the Expedition 364 drill core. Interestingly, only a handful number of impact melt rocks from previous drill cores have been found to contain anomalies in some elements (such as in iridium), or display Os isotopic compositions that were interpreted as an impactor contribution [3–6], but those should be reconsidered based on new pre-impact lithologies sampled in core M0077A.

Samples and Methods: In order to identify a possible meteoritic contribution within the impact melt rock units from the peak ring, detailed geochemical investigations, including selected HSE and Re–Os isotopic analyses, were performed on 12 samples. 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: The impact melt rock samples are generally of andesitic composition, with major and trace element data reflecting primarily mixing between mafic and felsic components, with the incorporation of carbonate material in the upper impact melt rock unit (from 715.60 to 747.02 meters below seafloor). The siderophile elements (Cr, Co, Ni) in the impact melt rocks also reflect a similar mixture, with compositions ranging from granite (felsic) to dolerite (mafic), without any unambiguously detectable chondritic component. The concentration of the HSEs in the impact melt rocks and suevites are generally low (<39 ppt Ir, <96 ppt Os, <149 ppt Pt; similar to upper continental crust [7]) 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. Conversely, granites, dacite, and suevites are depleted in Ir, with contents ranging from 1 to 10 ppt. The $^{187}Os/^{188}Os$ ratios of the impact melt rocks are highly variable, ranging from 0.18 to 2.09, reflecting the heterogenous composition of the impact melt rocks. The presence of a mafic, unradiogenic ($^{187}Os/^{188}Os$ of 0.17 in the dolerite) 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 rocks and suevite follow broadly a mixing trend between upper continental crust and chondritic/mantle material. Based also on Cr and Ir contents, we hypothesize the presence of a possible, highly diluted meteoritic component, contributing up to ~0.01–0.05%, in only one of the investigated samples of the upper impact melt rock unit. Importantly, the impact melt rocks and pre-impact lithologies were affected by post-impact hydrothermal alteration processes, locally remobilizing Re and Os. Consequently, the interpretation of relatively HSE-enriched impact melt rock samples as having a meteoritic component remains ambiguous, as in the case of other impact structures in which mafic target rocks are present and/or substantial post-impact hydrothermal alteration occurs. Our study confirms that a heterogeneously distributed, but extremely low amount of meteoritic material (if any) occurs in impactites within the Chicxulub impact structure, in contrast to the distal K–Pg boundary ejecta, in which a significantly higher amount (e.g., ~5%) of meteoritic component is found [8,9]. Additionally, further investigations are underway in order to assess in which way pre-/post-impact hydrothermal alteration has affected the HSE budget and Os isotopic compositions of the impact melt rocks and pre-impact lithologies, especially granite (mobilization of Os).

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