PGE CONTENT OF IMPACT MELT AND SULFIDES IN THE PEAK RING OF THE CHICXULUB CRATER; EVIDENCE FOR PGE MOBILIZATION/FRACTIONATION.

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Introduction: The highly siderophile/chalcophile platinum group elements (PGEs) are comprised of Ru, Rh, Pd, Os, Ir, and Pt. They are useful in tracing a variety of geological processes (e.g. planetary differentiation, core-mantle contributions to plume volcanism, sulfide saturation in magmatic systems, the flux of meteorite/asteroid impacts, as well as their environmental impact from catalytic converters [1 and references therin]). This study uses PGEs to trace the heterogeneous distribution of impactor material at the Chicxulub impact crater through analysis of core matrials recovered during International Ocean Discovery Program (IODP) Expedition 364 in 2016 [2].

The impactor that created Chicxulub collided with Earth ~65.5 million years ago and was large enough to have a global effect that caused one of the largest mass extinctions in Earth's history. One of the capabilities of the PGEs is to identify different types of impactors as different bollides have elevated yet variable PGE contents [3-5]. One caveat to this approach is that the PGEs must be present in measurable concentrations, and they cannot be fractionated from each other as the ratio is what is needed for identification [3-5].

The Chicxulub impact basin is one of the largest and best preserved impacts in the geologic record, and provides the opportunity to study impacts and their effects on a planetary body [6]. Previous samples recovered from Chicxulub were analyzed for PGEs, however attempts to identify the impactor were unsuccessful due to differential mobility of these elements [4,5]. The recent expansion of the samples available for analysis because of Expedition 364 has provided the opportunity to further attempt this on different lithologies.

The size of the Chicxulub impact makes the process of impactor identification difficult. A large fraction of the impactor was ejected from the crater, distributing material worldwide producing the Ir anomaly that initially triggered the search for the Chicxulub Impact Basin. [7]. This is supported by the mass extinction occurring at the same time that shows that the climatic effects of this impact were also global. There is also evidence of hydrothermal systems develeloping post-impact that had the capability to precipitate secondary minerals at and around the impact site [8]. Any secondary mineralization has the capability to fractionate the PGEs from each other.

By examining several Expedition 364 lithologies, we hope to quantify PGE mobility and fractionation. The first is the transitional unit (1G) that is located stratigraphically just above the impact horizon. A series of samples has been analyzed that extends from the top of 1G down to the base. The second lithology analyzed is two samples of injected impact melt located below section 1G. It was hoped that if PGEs were mobilized, they would have remained unfractionated within the impact melt . The third "lithology" is represented by two samples containing sulfides that are the result of secondary mineralization. These three will give an idea of the extent at which the PGEs become fractionated as impact and post-impact mechanisms take place. Under ideal circumstances, the type of impactor that created the Chicxulub impact basin could be identified.

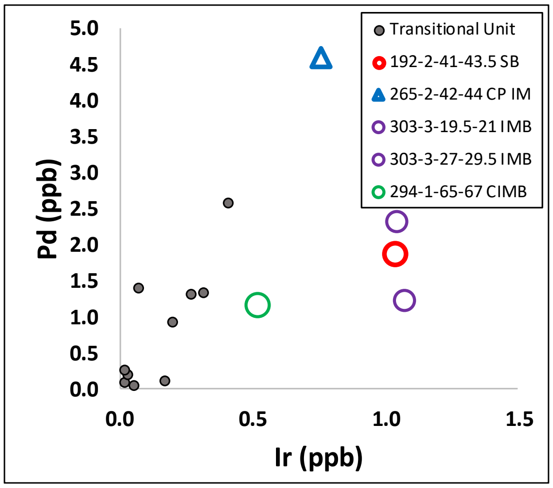

Figure 1: Ir vs Pd shows that the clast-free impact melt has the highest concentrations of Pd while the sample containing the largest clasts (294-1-65-67) has a lower concentration of PGEs comparable to the transitional unit. This shows that the impact melt has a fractionated PGE content with higher Pd but not Ir. SB = Suevite Breccia, CP IM = Clast Poor Impact Melt, IMB = Impact Melt Breccia, and CIMB = Coarse Impact Melt Breccia. Sulfides samples could not have absolute abundances determined due to poor constraints on the sample mass.

Samples: The transitional unit, 1G, occurs in a section of core 40 R-1 (616.58 to 617.33 mbsf) that bridges upper peak ring material below to post-impact sediments above. Sample 192-2-41.0-43.5 is a suevite breccia with dark melt hosting lithic clasts of granitoid rock, gneiss, and dolerite. Sample 265-2-42-44 is a clast poor impact melt. Sample 294-1-65-67 is an impact melt breccia with coarse clasts of granite, gneiss, and secondary sulfide phases. Samples 303-3-19.5-21 and 303-3-27-29.5 are impact melts from the base of the core with clasts of granite, gneiss, and quartzite. Sulfides (pyrite) from 40-2-105-107 and 297-1-93-95 were isolated from the matrix via peroxide acid digestion. All other samples were digested using HF-HNO_3 followed by aqua regia in high pressure parr bombs. The PGEs were separated via cation exchange chromatography and analyzed using solution mode high resolution ICP-MS. All digestion and analytical procedures are described in [1].

Results and Discussion: The impact melt sample that is relatively free of clasts (265-2-42-44) shows a higher Pd content than the other whole-rock samples (**Fig. 1**). The other samples that contain larger clasts of regional lithologies such as granite and gneiss still show an impact signature with respect to Ir, but do not have the same enrichment in Pd as the clast-free impact melt (**Fig. 1**). While great care was taken to only digest impact melt veins from the samples, the high temperature interactions between the impact melt and the clasts are sure to have mixed to varying degrees, potentially diluting the PGEs. This becomes apparent in **Fig 2** when ratios Pt/Ir and Pd/Ir are plotted. The impact melt that does not contain many clasts shows a higher PPGE signature than the samples that have clasts. Again the most clast-rich sample (192-2-41-43.5) shows one of the more PPGE depleted signatures.

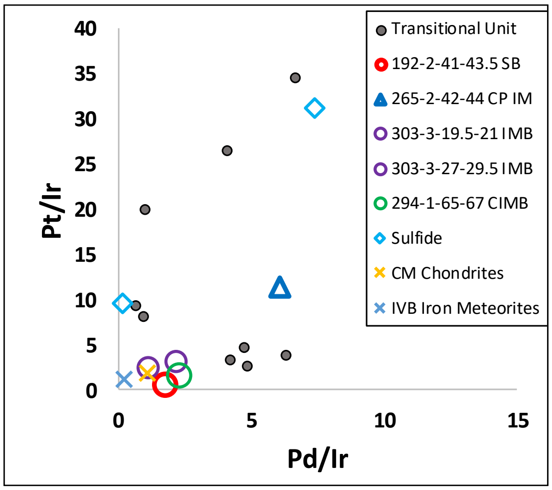

Figure 2: Pd/Ir vs Pt/Ir. Of the two sulfide samples, the one recovered from core 40 (the transitional unit) shows the lower PGE ratios while the deeper sulfide sample has the higher ratios. The clast-free impact melt is distinct from the other impact melt breccias with a higher clast component. This may be the result of clast-melt interactions depleteding Pt and Pd relative to Ir.

The sulfide samples are from two different depths; one is from core 40, the transitional unit, while the other is much deeper from core 297. The sulfide sample from core 40 plots closer to the origin of **Fig. 2** relative to the deeper sulfide sample, which has higher Pd/Ir and Pt/Ir values. This shows that while Ir may still be present at the transitional unit, the other PGEs may have suffered more mobilization (and fractionation) and be present at higher concentrations in secondary deposits.Overall, the sulfides and clast-free impact melt samples have the least chondritic PGE ratios while the clast-rich breccias have the more chondritic PGE ratios.

The type of meteorite that made the Chicxulub impact is suspected to be a form of chondrite. While different types of chondrites have been shown to have different PGE ratios, these ratios are not as large as those seen in 265-2-42-44. Based on the measured enrichments of the PPGEs (Rh, Pt, and Pd) over the IPGEs (Os, Ir, and Ru), a positive identification of the type of chondrite that impacted at Chicxulub cannot be made.

Conclusions: The clast-free impact melt shows higher concentrations of PGEs than the clast bearing lithologies. This shows that clast-melt interactions diluted the PGEs as the melt was injected through the host-rock. The sulfide samples are distinct depending on the depth they were recovered from. The sample from the transitional unit has PGE ratios comparable to the other whole-rock samples recovered from that core, while the deeper sulfide sample has more enriched Pt and Pd relative to Ir when compared to the transitional unit. Overall, the most enriched impact melt sample does not yield data that can identify the type of impactor that created the Chicxulub Impact basin due to the enrichments of PPGEs over the IPGEs.

Acknowledgements: Thank you to the Expedition 364 crew, Sean P.S. Gulick, Joanna V. Morgan, David Kring, Steven Goderis, and Honami Sato for their work sampling, measuring, and interpreting the Chicxulub impact.

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