PGE CONTENT OF IMPACT MELT AND SULFIDES AT THE CHICXULUB BASIN; EVIDENCE FOR PGE MOBILIZATION/FRACTIONATION? Burney, D.[1] and Neal, C.R.[1] [1]University of Notre Dame, Notre Dame IN, 46556; dburney@nd.edu.

Introduction: Platinum group elements (PGEs) are highly siderophile elements comprised of Ru, Rh, Pd, Os, Ir, and Pt. They are useful in tracing a variety of geological signatures (as planetary differentiation, core-mantle signatures in plume volcanism, understanding the effects of meteorite/asteroid impacts, as well as their environmental impact from catalytic converters [1 and references therin]. This study uses the PGEs to trace the heterogeneous distribution of impactor material at the Chicxulub impact crater through analysis of core matrials recovered during IODP Expedition 364 in 2016.

A drilling expedition (Expedition 364) in 2016 from the International Ocean Discovery Program (IODP) recovered new samples from the Chicxulub impact basin [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 killing the dinosaurs. 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]. For example the Ir concentrations for chondrites varies from 760 ppb in CV chondrites, to 360 ppb in L chondrites [5]. These concentrations while low are still above terrestrial values of low-ppb. 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 [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 this process difficult. There is a measured Ir anomaly at the time of the Chicxulub impact in outcrops around the Earth [7]. This is supported by the mass extinction occurring at the same time that shows that the climate effects of this impact was 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]. The global distribution of material will reduce the amount of PGEs present at Chicxulub, and any secondary mineralization has the capability to fractionate the PGEs from each other.

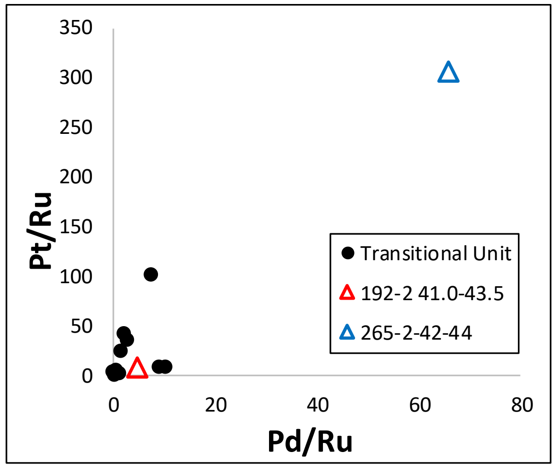

Figure 1: Pd/Ru vs Pt/Ru in the transitional unit and impact melt samples. Sulfide formation will fractionate the PGEs. Sulfides enrich Pt and Pd over Ir and Ru. The highly fractionated nature of 265-2-42-44 exemplifies sulfide crystallization.

This study aims to quantify PGE mobility and fractionation by analyzing distinct lithologies that were sampled during Expedition 364. 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 impact melt located below section 1G. If PGEs were mobilized it is possible that they are unfractionated within the impact melt. The third lithology is represented by two samples containing sulfides that are the result of secondary mineralization. These three lithologies will allow for the quantification of PGE deposition at the impact, mobility within impact melts, and enrichment in secondary sulfides. They will give an idea of the extent at which the PGEs become fractionated as these mechanisms take place. Ultimately, under ideal circumstances, the type of impactor that created the Chicxulub basin will be identified.

Samples: A section of core 40 R-1 records a transitional unit named 1G (616.58 to 617.33 mbsf) that bridges upper peak ring material below to post-impact sediments above. 192-2-41.0-43.5 is a suevite breccia with dark melt hosting lithic clasts of granitic, gneiss, and dolerite. Sample 265-2-42-44 is a clast poor impact melt. Several other samples will be analyzed in the future but are not reported here. These include 303-3-27-29.5 is an impact melt 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 will be isolated from the matrix via acid digestion. 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 suevite (192-2-41.0-43.5) has a PGE signature similar to the samples from the transitional unit (**Fig. 1**). The ratios of Pt and Pd to Ru show that there has been little to no fractionation of the PGEs from each other (**Fig. 1**). This is consistent with the transitional unit forming as the result of rapid deposition soon after the impact. Any re-mobilization of the PGEs is limited to the very top and possibly at the bottom, although those data are require confirmation. The middle of the transitional zone is thought to be from the result of rapid deposition and little to no post-deposition alteration/mobilization. The relatively low concentrations, and lack of fractionation of the PGEs for both the middle of the transitional unit as well as 192-2-41.0-43.5 is consistent with this depositional interpretation.

The impact melt (265-2-42-44) shows a fractionation of the PGEs manifested by an enrichment of Pt and Pd relative to Ru and Ir (**Figs. 1 & 2**). The formation of sulfides can fractionate the palladium-PGEs (PPGE: Pt, Rh, Pd) from the iridium-PGEs (IPGE: Ir, Os, Ru) [9]. The enrichment of Pt and Pd relative to Ru is consistent with sulfide fractionation (**Fig 1**). An enriched signature

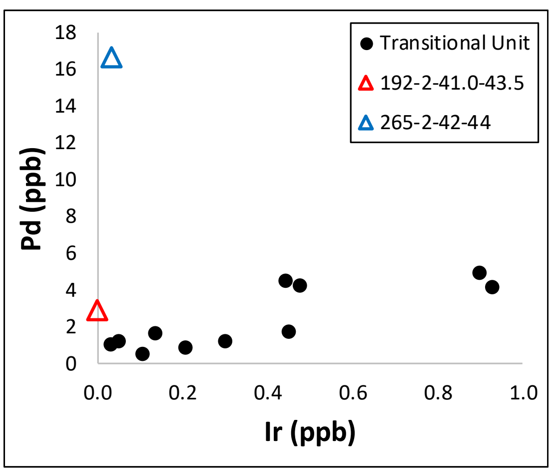

Figure 2: Ir vs Pd. The signature of the Chicxulub impactor is carried most heavily by Ir. While 265-2-42-44 is enriched in Pd relative to the transitional unit its lack of Ir shows that this is due to secondary mineralization, and re-mobilization of the PGEs.

of the extraterrestrial impactor that created the Chicxulub crater would elevate all of the PGEs. Since Ir and Ru are still only present at trace abundances the PGE ratios in 265-2-42-44 are not considered a pristine signature of the impactor but a the result of secondary sulfide mineralization. While no sulfides are seen in this sample they are present in other samples.

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. The concentrations of IPGEs is closer to that seen in bulk silicate Earth estimates (BSE: Ir = 3.19 ppb. Ru = 4.97 ppb) than that seen in C1 chondrites (Ir = 455 ppb; Ru = 710 ppb) [10,11]. Based on the measured enrichments of the PPGEs over the IPGEs, a positive identification of the type of chondrite that impacted at Chicxulub cannot be made.

Conclusions: Two samples collected during the IODP Expedition 364 in 2016 at the Chicxulub crater were analyzed for their PGE content. The lithologies are the product of impact processes and are compared directly to a shallower transitional unit that immediately above the impact horizon. The suevite sample (192-2-41.0-43.5) has similar PGE contents to the depleted, middle section of the transition zone. This shows that this sample has seen little to no fractionation of the PGEs from each other in the form of secondary mineralization. The impact melt (265-2-42-44) shows an enrichment of the PPGEs over the IPGEs which is an indicator of sulfide crystallization. Although elevated in some PGEs, the ratios of the PGEs within the impact melt do not allow for the possible identification of the type of chondritic impactor that created the Chicxulub crater. What is does indicate is post impact fractionation, possibly through hydrothermal processes.

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References: [1] Ely, J.C. et al. (1998) *GCA 157*, 219-234. [2] Morgan, J. et al. (2016) *Proceedings of the International Ocean Discovery Program v.364*. [3] Norman M.D. et al. (2002) *EPSL 202*, 217-228. [4] Gelinas, A. et al. (2004) *MaPS 39(6)*, 1003-1008. [5] Tagle, R. et al. (2004) *MaPS 39(6)*, 1009-1016. [6] Schulte, P. et al. (2010) *Science, 327(5970)*, 1214-1218. [7] Alvarez, W. et al. (1982) *Science, 216(4548)*, 886-888. [8] Zürcher, L. & Kring, D.A. (2004) *MaPS 39(7)*, 1199-1221. [9] Rehkämper, M. et al. (1997) *Science, 278(5343)* 1595-1598. [10] McDonough, W.F. & Sun, S.S. (1995) *Chemical Geology, 120(3-4)*, 223-253. [11] McDonough, W.F. (2003) *Treatise on Geochemistry, 2*, 568.