PGE Content of Impact Melt at the Chicxulub Basin; Evidence for PGE Mobilization/Fractionation?

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Introduction:

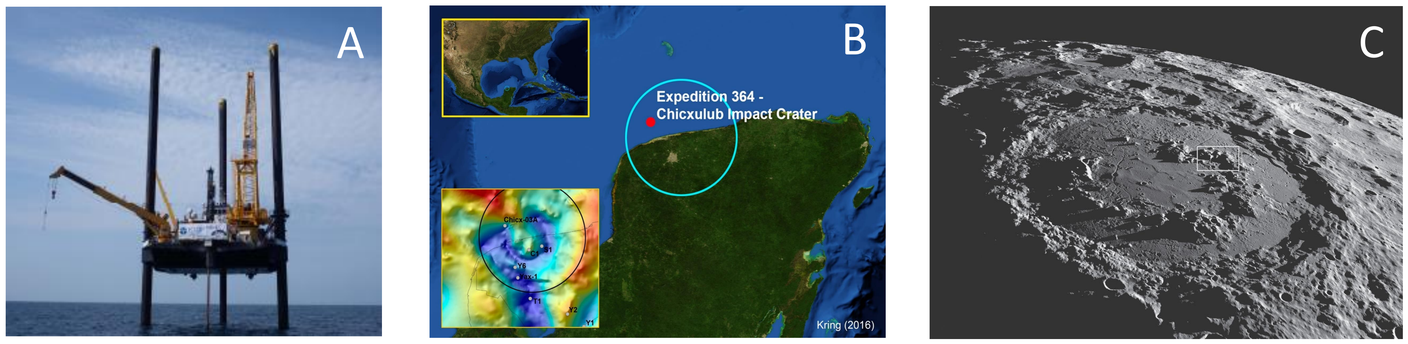

Fig 1: A, The classic peak-ring morphology exposed on Schrödinger basin on the Moon; B, The Chicxulub impact basin which is the only terrestrial impact basin with a preserved peak-ring morphology similar to Schrödinger basin; C, The expedition 364 drilling rig.

- IODP-ICDP drilling expedition 364 (Fig 1A) cored the Chicxulub Crater (Fig 1B) and recovered material from the central peak ring that has never been analyzed in previous studies.
- Peak rings can be seen on planetary bodies like Schrödinger basin on the Moon (Fig 1C) but Chicxulub is the only terrestrial example of a preserved peak ring impact basin morphology.
- What has this done with regards to emplacement of the platinum group elements (PGE)? Are the PGEs still most enriched in boundary layer formed at the time of impact or have they been enriched in impact melt lithologies that mobilized and are present deeper in the core?

Samples:

- Impact lithologies of varying textures were chosen: Clast-free impact melt, two impact melt breccias, suevite breccia, and a coarse impact melt breccia containing larger clasts (Fig 2B,C,D,F).
- Two sulfide samples were analyzed: one from directly beneath the transitional unit in core 40 (Fig 2A), and the other from deeper within core 295 (Fig 2E).
- A transect of samples across a "transitional unit" in core 40 which bridges pre-impact suevite below to post impact sediments above (Fig 2A).

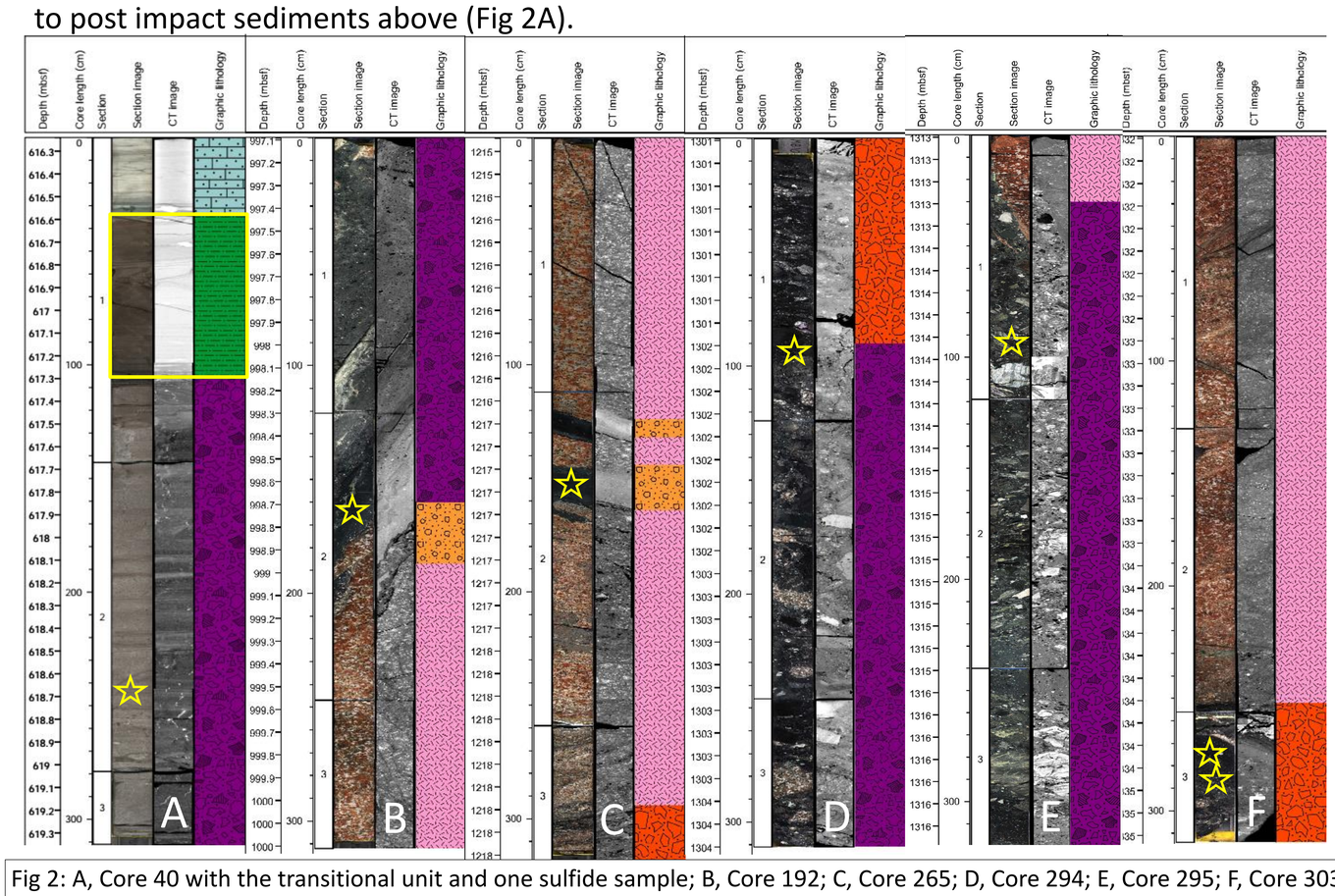

Fig 2: A, Core 40 with the transitional unit and one sulfide sample; B, Core 192; C, Core 265; D, Core 294; E, Core 295; F, Core 303. All yellow stars show where in the core samples were taken. Images from Gulick, S.P.S., et al. (2017) IODP Expedition 364 Report.

Methods:

- ~0.1g of powdered sample was digested via HF-HNO_3 methods followed by high-pressure Parr Bombs© with aqua regia.
- Samples were then run through cation exchange columns following the methods outlined in Ely, J.C. et al. (1999) *Chemical Geology, 157 (3-4), 219-234* to isolate the PGEs from the matrix.
- Data were reduced via standard edition as well as external calibration.

Results:

- All impact lithologies have higher Ir than the transitional unit (Figs. 3 & 4).
- One sulfide sample and the impact melt show fractionation within the PGEs but all lithologies overlap with the transitional unit (Figs. 3 & 4).

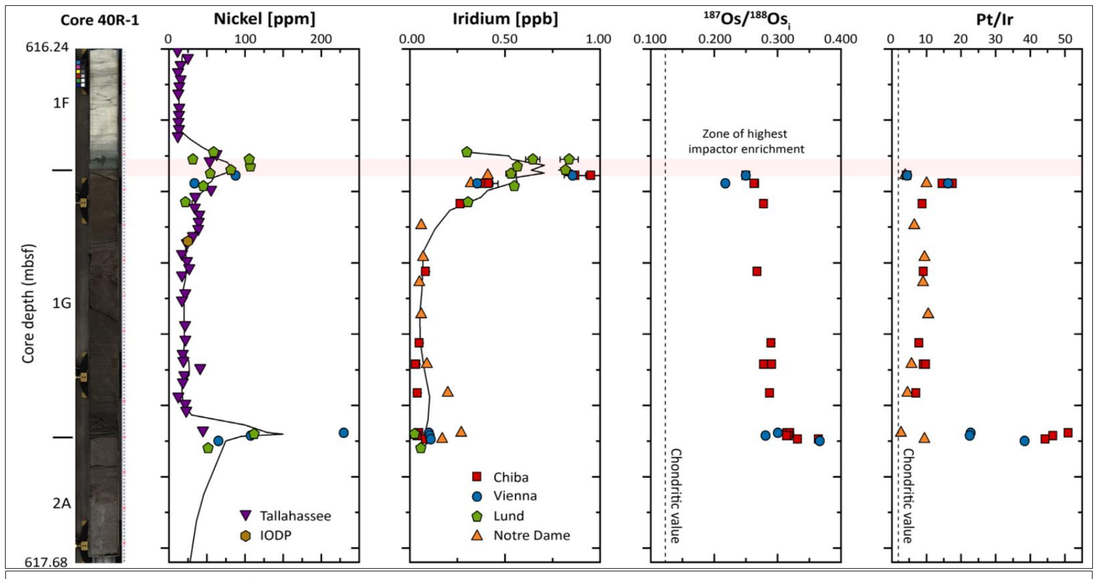

Fig 3: Concentration of PGEs (ppb) in the transitional unit.

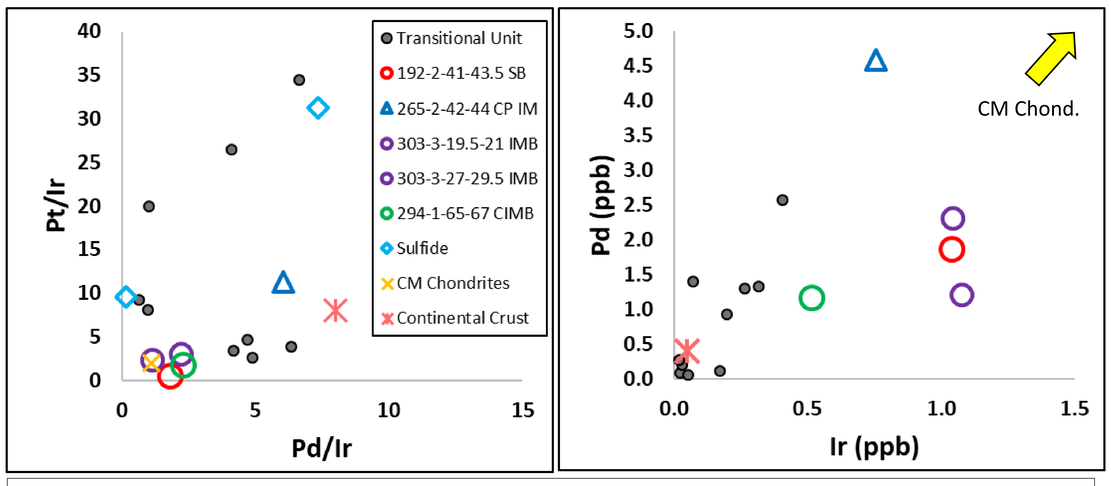

Figure 4: SB = Suevite Breccia, IM = Impact Melt, IMB = Impact Melt Breccia, CIMB = Coarse Impact Melt Breccia. The mass of the sulfide samples are unknown due to the digestion process so absolute concentrations cannot be calculated.

Discussion & Conclusions:

- The impact melt breccias all show enriched Ir relative to the transitional zone, however the coarse impact melt breccia has the lowest concentration of the impact lithologies.
- Depth (i.e. distance from the transitional unit) does not seem to play a role in PGE concentrations.
- Elevated PGE signature is present in all lithologies, but as clasts in the breccias become larger the signature is diluted and PGE fractionation is lowered. This may be due to melt-clast interactions or sampling that does not represent the true whole-rock composition.
- The most fractionated PGE signatures are in the clast-free impact melt and one sulfide sample collected directly beneath the transitional unit.
- The largest control on the PGE signature within the impact lithologies is the abundance of clasts within the material, not the proximity to the transitional unit.

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