The Study of Siderophile Elements in IIC Iron Meteorites

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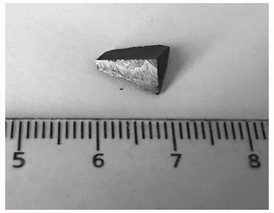
I. Overview

Introduction:

IIC iron meteorites are a magmatic group with little variation in Ga, Ge and Ni abundances. Previous studies indicate the IIC group formed as a result of fractional crystallization from a core with Ni, Ga, and Ge concentrated in the liquid and Ir in the solid [1]. Eight meteorites have previously been classified as IIC iron meteorites. IIC irons have been rarely studied and only limited chemical data have been published for this group since the late 1960's.



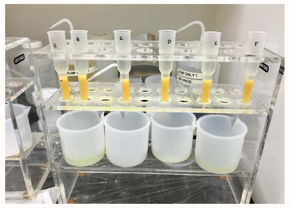
III. Methods

Siderophile element concentrations were obtained using:

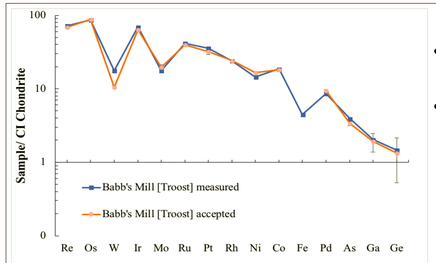
- A *New Wave* UP213 ultraviolet laser coupled to a *Thermo Finnigan Element 2* inductively coupled plasma mass spectrometer.

High precision HSE (Re, Os, Ir, Ru, Pt, Pd) data obtained by:

- Isotope dilution coupled with standard separation and mass spectrometric techniques.
- Thermal ionization mass spectrometry and ICP-MS.

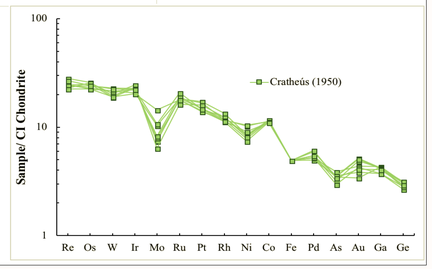


IV. Uncertainty



- Babb's Mill [Troost] used to assess accuracy
- The variation in concentrations range from 0.9 (Ge) to 21.0 (W) percent deviation from the accepted values.

- To assess precision, eight lines of measurements for Cratheús (1950) indicate a range of 0.6 (Co) to 10.1 (Mo) percent deviation from the measured mean.

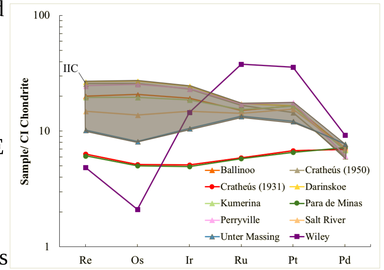


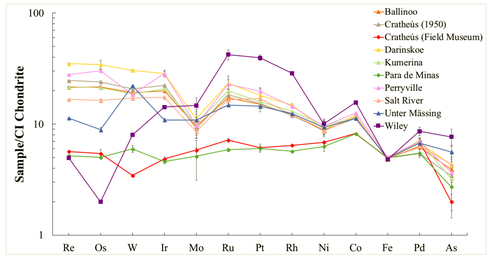
II. Significance

It has recently been shown that the IIC group may be isotopically, and therefore genetically, distinct compared with other iron meteorite groups [2]. The IIC group exhibits the largest Mo isotope anomaly of any iron meteorite group analyzed to date [2]. Recent studies of genetic isotopes, based on nucleosynthetic variations for certain elements (e.g., Mo, W), have shown that the group is enriched in both ^{94}Mo and ^{95}Mo, consistent with the group being of the carbonaceous chondrite (CC) genetic type [2]. Further, those IIC irons that have been examined are characterized by larger positive ^{183}W nucleosynthetic anomalies than other CC group irons, and the IIC meteorite Wiley has been reported to have an even larger positive ^{183}W anomaly [3] than the other IIC meteorites. Analysis of the seldom studied group IIC irons aids in diminishing the ambiguity of Wiley's classification and provides new insights to the chemical composition and evolution of CC type parent bodies.

V. Composition

- The *bona fide* IIC irons are characterized by decreasing abundances of Re, Os, Ir, Ru, and Pt, with little changes in Pd
- Cratheús from the Field Museum and Pará de Minas have nearly identical HSE abundances
- HSE abundance pattern for Wiley strongly deviates from the other IIC irons

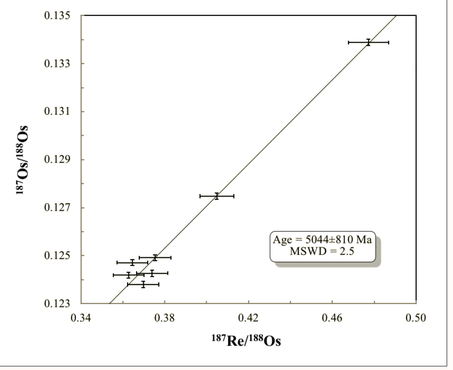




- The IIC irons show a slight depletion in volatile siderophile elements
- The 2σ variations are <15.3% deviation for all elements

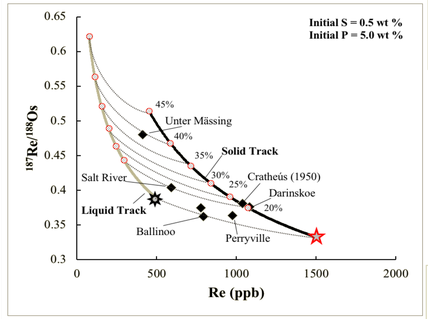
VI. ^{187}Re-^{187}Os Isotopic Systematics

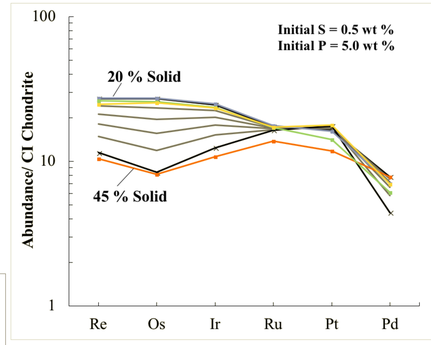
- ^{187}Re → ^{187}Os + β^- ($t_{1/2}$ = 41.6 Ga)
- The IIC irons fall along a primordial isochron with a crystallization age of 5044 ± 810 Ma
- Rhenium will be re-measured to a higher precision with new Spectrometer



VII. Crystallization sequence modeling

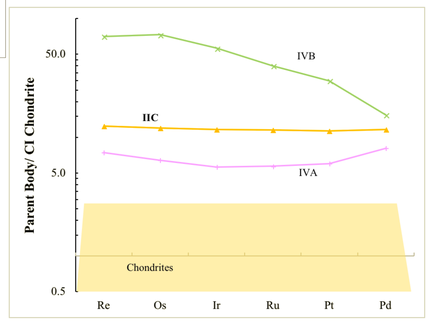
- The IIC irons can be successfully modeled through fractional crystallization, assuming 0.5 wt % S and 5 wt % P.
- Darinskoe (blue) and Unter Mässing (orange) match 20 and 45% solid crystallization, respectively.





- Fractional crystallization model can account for all IIC irons.

- The calculated composition for the initial core melt has a chondritic pattern.
- The HSE composition indicates the core was 11% the mass of the IIC parent body.



VIII. Conclusions

- Siderophile element normalized abundances suggest the IIC group represents a single carbonaceous parent body.
- Wiley's HSE abundance pattern deviates from the other IIC irons suggesting it formed from a different parent body.
- Cratheús (1931) was likely mislabeled at some point in it's history and is actually Para de Minas, a IVA iron.
- Only seven identified IIC iron meteorites: Ballinoo, Cratheús (1950), Darinskoe, Kumerina, Perryville, Salt River, and Unter Mässing can tentatively be related by fractional crystallization.
- The IIC group can be successfully modeled from 20 to 45% solid fractional crystallization with 0.5 wt % initial S and 5 wt % initial P concentrations.

IX. References

[1] Wasson J.T. (1969) *Geochim. Cosmochim. Acta* **33**, 859-876. [2] Poole et al. (2017) *EPSL* **473**, 215-226. [3] Kruijer T.S. et al. (2017) *PNAS* **114**, 6712–6716. [4] McCoy et al. (2011) *Geochim. Cosmochim. Acta* **75**, 6821-6843. [5] Buchwald (1975) **2**, 511.