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Ruthenium isotope composition of the K-Pg impactor and terrestrial impact structures

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We present a new tool for deducing the nature of the meteoritic component in impact-related terrestrial rocks and deposits. Our approach builds on nucleosynthetic Ru isotope variations among different meteorite groups [1] that could serve as a genetic fingerprint for the meteoritic component in impact rocks. We report the first Ru isotope data obtained for samples from the K-Pg boundary layer (Stevns Klint, Fishclay, Fonte D'Olio, Caravaca), and from several Phanerozoic impact structures (Brent, Clearwater East, Popigai, Rochechouart, Morokweng), as well as data for Archean spherule layers from Barberton (South Africa).

All analyzed impact-related samples exhibit well-resolved anomalies in e^{100}Ru (Figure 1). Samples from the K-Pg boundary layer have the most negative e^{100}Ru anomalies, indistinguishable from those of average carbonaceous chondrites (CC) and associated iron meteorites. In contrast, samples from other Phanerozoic impact structures and from Archean spherule layers from Barberton have less negative e^{100}Ru anomalies that are most similar to ordinary chondrites, IIE and IVA irons, and CI carbonaceous chondrites.

Our new, still limited Ru isotope data for terrestrial impact structures in conjunction with previously reported platinum-group-element concentration data [2-4] reveal that the projectiles for most Phanerozoic impacts derive from a population of bodies that formed from an inner solar system reservoir, best represented by ordinary chondrites. So far, the one and only exception from this composition are samples from the K-Pg boundary layer that exhibit carbonaceous chondrite-like Ru isotope compositions. This is consistent with previous constraints from Cr isotopes [5,6]. In contrast to Cr isotopes, owing to very low Ru concentrations in crustal target rocks, the Ru isotope signature of a given impact rock or deposit more directly corresponds to the meteoritic component because the Ru in these rocks will almost quantitatively be derived from the impactor.

Future work will be directed to determine Ru isotope signatures of other terrestrial and lunar impact rocks.

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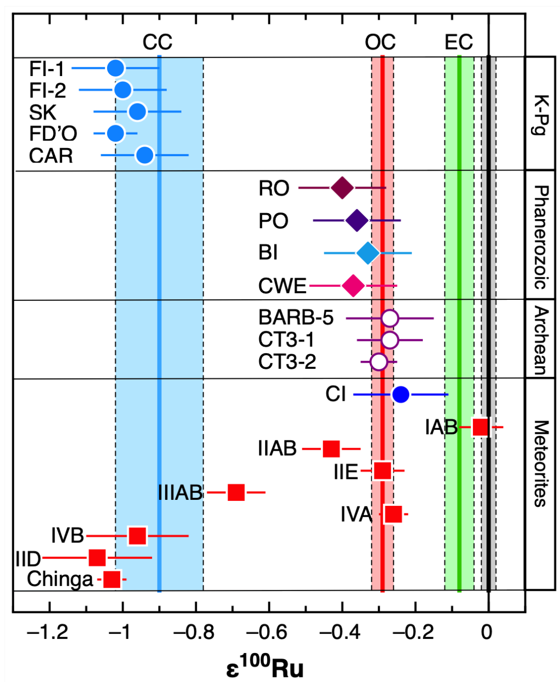

Fig. 1: ε^{100}Ru data for terrestrial impact-related rocks (FI: Fishclay, SK: Stevns Klint, FD'O: Fonte D'Olio, CAR: Caravaca, RO: Rochechouart, PO: Popigai, BI: Brent, CWE: Clearwater East, BARB-5 & CT3: Archean spherule layers) in comparison to group averages of meteorite data. Colored areas indicate average values of enstatite (EC), ordinary (OC) and carbonaceous (CC) chondrites and the modern terrestrial mantle (grey area) – with 95% conf. interval uncertainties; CI: CI chondrite; iron meteorite groups: IAB, IIAB, IID, IIE, IIIAB, IVA, IVB and Chinga (ungrouped).