CAN SIDEROPHILE ELEMENT ABUNDANCES AND RATIOS ACROSS THE K-PG BOUNDARY BE USED TO DISCRIMINATE BETWEEN POSSIBLE TYPES OF PROJECTILES? S. Goderis[1,2], R. Tagle[3], J. Belza[3], J. Smit[4], A. Montanari[5], F. Vanhaecke[2], J. Erzinger[6], and Ph. Claeys[1], [1]Vrije Universiteit Brussel, Earth System Science, Dept. of Geology, BE-1050 Brussels, Belgium (Steven.Goderis@vub.ac.be), [2]Ghent University, Dept. of Analytical Chemistry, Krijgslaan 281 – S12, B-9000 Gent, Belgium, [3]Bruker Nano GmbH, Schwarzschildstrasse 12, 12489 Berlin, Germany, [4]Vrije Universiteit Amsterdam, Dept. of Sedimentology, de Boelelaan 1085, 1081HV Amsterdam, Netherlands, [5]Osservatorio Geologico di Coldigioco, Cda. Coldigioco 4, 62021 Apiro (MC), Italy, [6]Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum GFZ, Telegrafenberg, D-14473 Potsdam, Germany.

Introduction: Since the discovery over 30 years ago at Gubbio (Italy) and Caravaca (Spain) of an enrichment in the concentrations of iridium (Ir) and the other platinum group elements (PGE) by up to four orders of magnitude (Ir_{max} = 0.10-87 ng/g) compared to average continental crustal background levels, PGE anomalies have been detected in more than 120 Cretaceous-Paleogene (K-Pg) boundary sites worldwide [1,2]. Elevated Ir and other siderophile element abundances in roughly chondritic ratios are considered strong indicators for the presence of a meteoritic contribution in impact-related lithologies (melt rocks, impact ejecta material, etc.), delivered when an extraterrestrial object strikes Earth [3,4].

Possible projectile types? Although chondrite-normalized PGE patterns of individual K-Pg sites appear relatively flat (i.e. chondritic), siderophile element contents and inter-element ratios vary significantly between K-Pg locations, inter-laboratory measurements, and replicate analyses, so far hampering a precise identification of the projectile using (highly) siderophile elements [5,6].

Chromium isotope ratio measurements of several K-Pg boundary clays suggest a meteoritic component consistent with a carbonaceous chondritic projectile, likely type CM2 [e.g., 7,8]. This interpretation appears consistent with the characteristics of a 2.5 mm-diameter fossil meteorite recovered from K-Pg boundary sediments at Deep Sea Drilling Project Site 576 in the western North Pacific [9]. The fossil K-Pg meteorite was classified as a CV, CO, CR or CM carbonaceous chondrite based on its geochemical and petrographic characteristics: chondritic element ratios, 4-8% metals and sulfides, >200 µm large inclusions of mafic minerals that also contain metals, and 30-60% fine-grained matrix [9].

Platinum group element ratios: This work adds 113 unpublished PGE analyses of 38 K-Pg sections worldwide to the existing literature. The analytical protocol relied on for this purpose consisted of a combination of a nickel-sulfide fire assay pre-concentration technique and subsequent trace metal determination via inductively coupled plasma – mass spectrometry (ICP–MS). Through repeated determination of key siderophile elements (e.g., Cr, Co, Ni, and PGE), the importance of sampling, nugget effects, and analytical methodologies applied becomes more apparent. Even more critically, these analytical effects are superimposed by the local syn- and post-depositional conditions that have affected the pristine meteoritic signature of the K-Pg impactor, including potential fractionation during vaporization and condensation, terrestrial PGE input, sedimentation rate, reworking, diagenesis, bioturbation, and chemical diffusion.

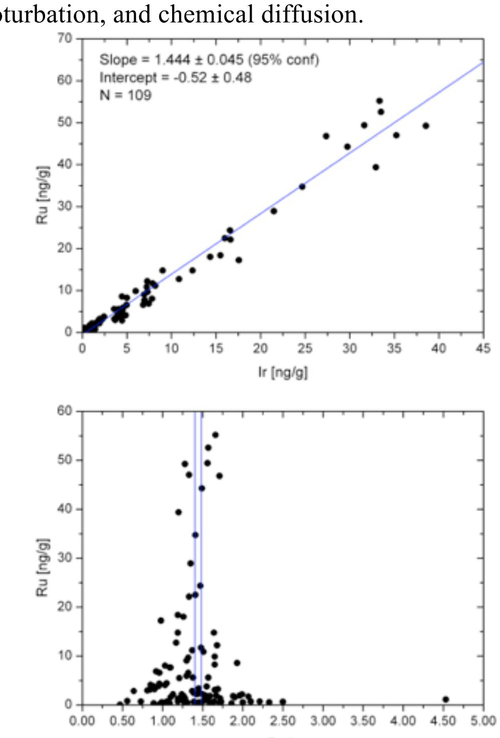

Fig. 1. Linear correlation of the Ru and Ir concentrations in the ejecta layer at the K-Pg boundary interval. The projectile elemental ratio (1.444 ± 0.045) is calculated from the slope of the regression line. Fig. 1B plots the determined Ru/Ir ratio against the Ru abundances to illustrate the distribution of the individual Ru/Ir ratios around the ratio determined by linear regression for the entire set of samples.

Only when considering improved databases of siderophile element concentrations in meteorites [10,11], in combination with linear regression analysis to calculate inter-element ratios from a large suite of ejecta deposit sites (Fig. 1) [3,4], the nature of the K-Pg projectile can be resolved in higher detail (Fig. 2).

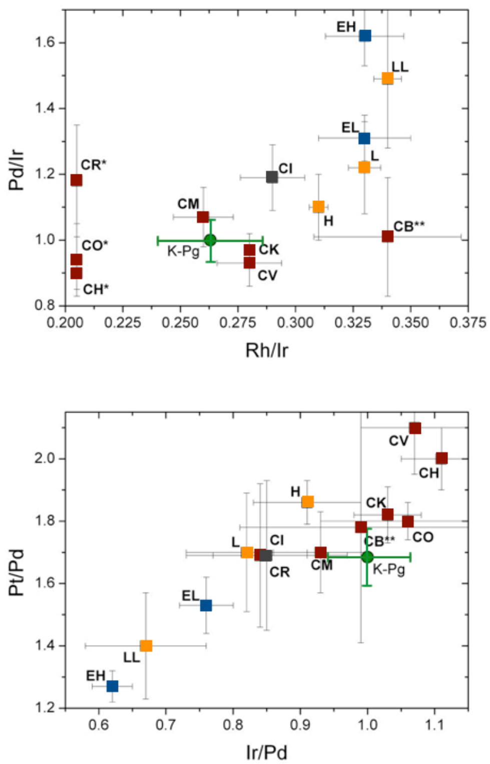

*Fig. 2. The projectile elemental ratios obtained for the K-Pg boundary layer compared to the element ratios in different types of chondrites. The ratios for the various chondrites used in this plot have been compiled by [10] (uncertainty corresponds to 1s). *Only one ratio known. **Metal fraction only.*

For projectile identification based on PGE ratios, the discrimination between different types of chondrites is most effective when combining elements characterized by lower condensation temperatures (e.g., Rh or Pd) with highly refractory PGE (e.g., Ir) [10]. This is a direct result of the fractionation processes that took place during chondrite formation. Application of this methodology to an extensive data set of continental and marine sites, ranging from very proximal to distal to the Chicxulub impact structure, confirms a carbonaceous chondritic impactor (type CM or CO).

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