The Cretaceous-Tertiary boundiary in the Betic Cordilieras and Basque Cantabrian basin: A comparative study of the platinum-group elements anomalies

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Introduction and aims

Extraterrestrial hypotheses explaining the mass extinction at the end of the Cretaceous were initially based on the high Ir content in the Cretaceous-Tertiary boundary (KTB) sediments. Anomalous Ir concentrations have been detected in both marine and continental sections. Although former studies mainly considered only the Ir anomaly, in our opinion the anomaly affects all the platinum-group elements (PGE). In this paper we present detailed PGE analyses of the Uppermost Maastrichtian, lowermost Danian and KTB to advance the knowledge of such anomalies and KTB event hypotheses.

Materials and methods

The sections studied were: 'Agost' (A) and 'Caravaca' (CA) in the Betic Cordilleras (Spain), and 'Monte Urko' (URT), 'Sopelana' (SO), 'Zumaya' (ZU), 'Hendaye' (HY) and 'Biarritz' (B) in the Basque Cantabrian basin (Spain and France). In most of these sequences the boundary is clearly marked by a 2–3 mm thick clayey layer, which is especially well preserved in the 'A', 'CA' and 'ZU' sequences. Neutron activation and ICP-Nickel Sulphide Fire Assay analyses were used for determination of the PGE content, with a detection limit of 1 ppb for all of these except Ir and Os, where the limit was 0.1 and 3 ppb respectively.

Results

Table 1 and Fig. 1 show the most significant results.

Discussion and conclusions

Some authors have suggested that the Ir could have been provided by volcanic sources (e.g. Olmez *et al.*,1986). Nonetheless, in the studied sections the Ir anomalies do not present an association with clearly volcanogenic products. On the other hand, such high concentrations suggest that cosmic material would have been a more probable source of these PGE anomalies. However, some characteristics of the Ir anomaly in the studied sections do not agree with an extraterrestrial derivation, such as enrichment above and below the KTB (Fig. 1), secondary peaks of Ir observed at 'SO', and the non-chondritic patterns of normalization to Cl in some sections (Martínez-Ruíz, 1993), although

TABLE 1. Concentration (ppb) of PGE and Au

Sample	Au	Ru	Rh	Pd	Os	Ir	Pt
A-KTB	23.00	43.00	12.00	27.00	5.00	24.40	26.00
CA-KTB	19.90	37.90	9.56	35.90	27.00	35.20	76.90
URT-KTB	2.43	1.98	1.23	6.00	1.28	2.20	6.00
SO-KTB	2.37	1.46	0.79	12.23	1.38	2.60	11.46
ZU-KTB	6.24	2.89	1.70	7.40	3.40	8.70	4.40
HY-KTB	1.02	1.05	0.91	1.08	1.06	0.99	1.03
B-KTB	1.76	5.28	–	6.43	5.68	5.77	6.47

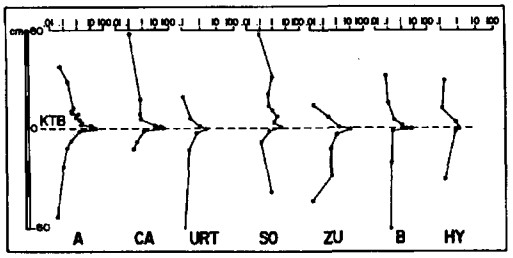

FIG. 1. Iridium concentration (ppb) in the dfferent studied sequences.

an extraterrestrial source can not be excluded, if we consider that different factors can affect PGE distribution (Evans *et al.*, 1993). These questions can be explained as follows:

1. Both synsedimentary deformations and modifications due to tectonic phenomena could have caused redistribution of the material in the KTh. Moreover, in many cases such phenomena imply that the KTB is not well preserved, and so Ir contents can be lower, as in the 'HY' section.

2. Resedimentation could explain the Ir enrichment above the KTB and the double Ir peak at 'SO' section. In fact, in this section the high Ir content above the KTB coincides with the presence of spherules, which suggest the presence at this level (sample to +1cm, 3.50 ppb of Ir) of material similar to that of the KTB.

3. Microbial activity is also an important factor, since microorganism processes could have lead to dispersion or concentration of PGE (Dyer *et al.*, 1989). In these sections, Martínez-Ruíz (1993) observed a general increase in the organic C content in the sample from the KTB in comparison with adjacent levels. Evidence for this is the abundance of either oxidised ('A' or 'CA') or well preserved ('ZU') pyrite.

4. During early diagenesis of the sediments, the presence of complex-forming elements such as chlorides and bromides (Mountain and Wood, 1988) and the pH and Eh conditions of the environment could have considerably modified the Ir and other PGE concentrations. The differences in the normalization to chondrites patterns obtained for the different sections could also be a result of the postdepositional history of the sediments.

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