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Iridium anomaly at the Cretaceous-Tertiary boundary in Texas

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A fifty-fold increase in the iridium content precisely at the Cretaceous-Tertiary boundary over background values has been found in the Brazos River section in Texas.

1. Introduction

An unusually high concentration of iridium and certain other noble metals has been found recently in marine sediments deposited precisely at the Cretaceous-Tertiary boundary [1–5]. This has led to an intense round of speculation regarding the nature of the terminal Cretaceous catastrophe, most of it centering around the collision of a larger extraterrestrial object with the earth [1–6]. We decided to explore just precisely what is the geographic extent of the iridium anomaly and what inconsistencies, if any, exist in the distribution pattern which would suggest further avenues for profitable study. In order to broaden the data base of the biotic changes at the Cretaceous-Tertiary boundary, and in order to characterize these changes more fully in the hemipelagic setting, a study was undertaken of the boundary interval as developed in surface outcrops in Texas. After preliminary studies established that one boundary interval, that developed along the Brazos River, represents essentially continuous sedimentation, a suite of closely spaced samples was analyzed for iridium content. The results of that study are presented here.

2. General setting

The Brazos River section is exposed along the bed and at the western bluff of the Brazos River in Falls County, Texas. Some 25 m of section is exposed in the river bed and in the bluff. The sediment is dark to light gray silty shale with about a one foot thick prominent ledge of hard, ruppled, fine sandstone or mudstone about 6 m below the top of the exposed section. Paleontological analysis suggests that the sediment was deposited in a middle to outer shelf setting and the

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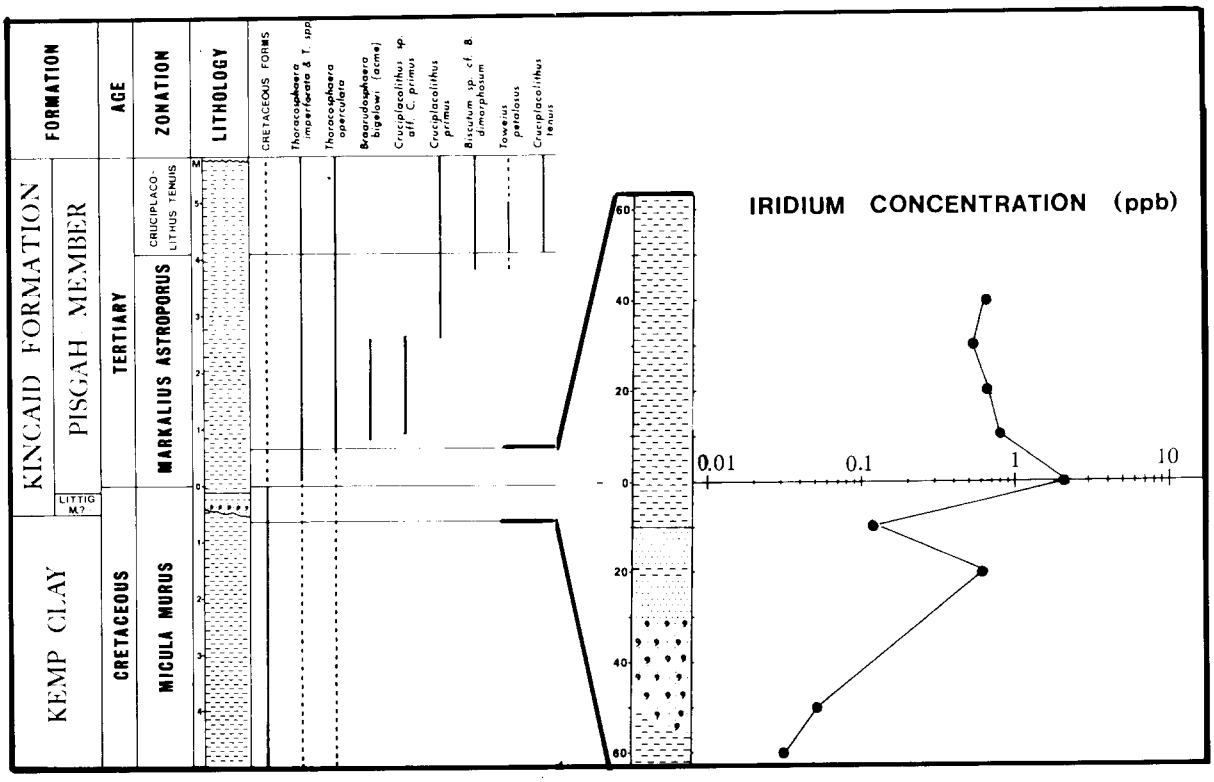

Fig. 1. A lithologic section of the Cretaceous-Tertiary boundary in Brazos River, Texas, with general succession of calcareous nannofossils. Note the peak in the iridium concentration precisely at the boundary.

succession of fossil coccoliths indicates that the Cretaceous-Tertiary boundary is approximately 10 cm above the top of the prominent sandstone bed. A lithologic section and the general succession of calcareous nannofossils is given in Fig. 1.

3. General paleontological evaluation

The calcareous nannofossils were studied in minute detail from the entire exposed section in order (a) to ascertain whether the section contains a hiatus or whether it represents continuous deposition, and (b) to document the nature of the calcareous nannoplankton succession across the boundary in hemipelagic sediment. The results indicate that the section does represent continuous deposition across the boundary interval, at least to the extent that no paleontologically resolvable hiatus can be recognized. The youngest Upper Cretaceous sediments are assignable to the late Maastrichtian *Micula murus* nannofossil zone, both markers for this zone, *Micula murus* and *Nephrolithus frequens* being present. Additionally rate specimens of *Micula prinsii*, a species previously recorded only from immediately below the Cretaceous-Tertiary boundary and at the very top of the Micular *murus* zone [7], also were recorded. These occurrences indicate that the youngest Cretaceous sediment exposed along the Brazos River is of the same age as the youngest Cretaceous sediment known. Therefore, it is logical to conclude that no hiatus exists at the top of the Cretaceous interval (unless it is assumed that at least an equivalent hiatus exists in every known Cretaceous-Tertiary boundary section).

The nannofossil succession immediately above the boundary indicates that the lowermost Tertiary also contains no significant hiatus. The lower Tertiary nannofossil zone, the Markalius astroporus

zone, is represented by 4 m of sediment. Moreover, the serial succession of *Thoracosphaera-Braarudosphaera-Cruciplacolithus* is the same succession of disaster forms and opportunists documented from the lowermost Tertiary interval in Spain [8,9], in southwestern France [10], in Israel [11], in Tunisia [10,12], and also resembles closely the nannofossil succession in the more condensed pelagic section of DSDP Site 384 in the western North Atlantic documented by Thierstein and Okada [13].

Unless one is willing to assume that in all of the above sections exactly the same hiatus exists at the base of the Tertiary, then there is only one alternative, namely that the paleontological record at all of these sites not only is nearly identical but also complete. Thus, since no hiatus exists at the top of the Cretaceous and none is present at the base of the Tertiary, the abrupt and profound biotic change at the boundary must indeed record a catastrophic event.

4. Iridium concentrations at the boundary

Nine samples, extending from 60 cm below the biostratigraphic boundary to 40 cm above it were analyzed for iridium by neutron activation analysis. Iridium concentrations range from a low of 0.032 ppb in the Upper Cretaceous marly sediment to 2,10 ppb precisely at the boundary (Table 1). Above the boundary the iridium content of the sediment drops off again but within the analyzed interval the concentration does not drop as low as it is below the boundary. The absolute value of the iridium concentration at the Cretaceous-Tertiary boundary in Texas is substantially less than at other boundary sections that have been analyzed [14.25 ppb (average of 2 analyses) in DSDP core 465A in the Pacific to 59.6 (average of 5 analyses) in the Fish Clay of Denmark]. However, it is clear that there is a fifty-fold increase in the iridium content precisely at the boundary over background values below the boundary in Texas.

TABLE 1

Abundance of iridium in the Cretaceous-Tertiary boundary samples from Brazos River section, Texas

Sample *	Ir (ppb)
−60 cm	0.031 ± 0.032
−50 cm	0.051 ± 0.034
−20 cm	0.61 ± 0.04
−10 cm	0.12 ± 0.02
0	2.10 ± 0.10
+10 cm	0.80 ± 0.15
+20 cm	0.67 ± 0.07
+30 cm	0.53 ± 0.05
+40 cm	0.63 ± 0.08

* Zero represents the boundary (see text). Negative and positive signs represent below and above the boundary level.

We have also measured the iridium content of a boundary clay sample from Dania cementworks quarry near Assens in northeast Jutland, precisely equivalent in age to the Danish Fish Clay [2], though of a distinctly different lithology and some 220 km west of Stevens Klint. The iridium content of this sample is 3.8 ± 0.8 ppb.

The iridium content of the Cretaceous-Tertiary boundary samples do show very large variation: 60 ppb in the Danish Fish Clay [2]; 26 ppb at Barranco del Gredero, Caravaca, Spain [3]; 14 ppb in the Central Pacific Core 465A [5]; 5 ppb at Gubbio, Italy [1]; 4 ppb at Dania and 2 ppb in Texas. The fifteen-fold difference in the iridium content between the Dania and the Fish Clay samples, which were deposited in the same marine basin though separated by 220 km, suggest that perhaps local variables such as sedimentation rate, marine chemical environment, organic matter, etc., may have played an important role in concentrating iridium and, presumably, other trace metals.

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