43. GEOCHEMICAL SEARCH FOR THE CRETACEOUS/TERTIARY BOUNDARY IN HOLE 605, LEG 93[1]

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INTRODUCTION

Site 605 is located on the uppermost continental rise, 100 mi. southeast of Atlantic City, New Jersey. One of the main goals at Site 605 was to core a complete Cretaceous/Tertiary (K/T) boundary sequence, and for this purpose a 24-hr. cruise extension was given by the Deep Sea Drilling Project.

The oldest sediments cored at Site 605 are upper Maestrichtian argillaceous limestone (Hole 605, Subunit VB; Fig. 1). The terrigeneous silt content of the uppermost Maestrichtian is quite low, averaging about 3%, whereas the carbonate content is high, usually greater than 60%; the silt contains only traces of glauconite (Site 605 chapter, this volume). Within Subunit VB a K/T boundary was defined by planktonic foraminifers. It was expected to be spread over an extended vertical interval because of the continental margin depositional setting. Examination by the shipboard party (Site 605 chapter, this volume) showed that the K/T boundary occurs in Section 605-66-1, between 70 and 75 cm. At the contact, the foraminiferal *Globigerina pseudobulloides* Zone (P1c) (zonation of Smit and Romein, 1985) and the coccolith *Cruciplacolithus primus* Subzone (CP1a) overlie, respectively, the *Abathomphalus mayaroensis* and *Nephrolithus frequens* zones (Site 605 chapter, this volume). However, the thin K/T boundary clay, which is always present in complete sections, was not found (Smit and van Kempen, this volume), indicating either that the K/T boundary clay was not present or, more likely, that it was washed away during the coring operation.

The K/T boundary in well-preserved sections around the world is marked not only by mass extinction of taxa, but also by the enrichment in the boundary clay of the platinum-group elements (among them, only iridium is commonly measured) as well as Ni, Cr, Co, As, and Sb, and by the depletion in rare earth elements (REE) (e.g., Alvarez et al., 1980; Smit and Hertogen, 1980; Smit and Ten Kate, 1982). The most plausible explanation for the enrichment and depletion of the above elements (especially the platinum-group elements) in the K/T boundary clay is that they originated from the contribution of material derived from the impact of a large, extraterrestrial object (or several smaller objects) at the end of the Cretaceous. The recent report of shocked quartz grains in the K/T boundary clay of Montana (Bohor et al., 1984) is an independent and even more definite proof of a meteoritic impact at the K/T boundary.

Furthermore, in the K/T boundary clay at the same or other localities spherules of sanidine (Smit and Klaver, 1981), iron-aluminosilicate (Montanari et al., 1983) and montmorillonite (Kastner et al., 1984; Klaver et al., this volume.; J. Smit, unpubl. results for DSDP Hole 390A) were found. These spherules, all diagenetically altered after deposition, are regarded as a product of the impact(s). They are found worldwide, closely associated with the iridium anomaly (Smit and Romein, 1985).

Although the K/T boundary clay was not observed in Section 605-66-1, both the elemental and the mineralogical K/T signatures might be present, but smeared out over a large vertical interval (DePaolo and Kyte, in press). In order to check this, instrumental neutron activation analyses (INAA) were performed on samples closely spaced across the K/T contact determined by the Scientific Shipboard Party.

METHOD

From Section 605-66-1, at the intervals 24–26, 53–55, 64–66, 67–68, 73–74, 75–79, 92–95, and 136–140 cm, bulk samples were taken and analyzed by the routine instrumental neutron activation (INAA) method in use at the Interuniversity Reactor Institute in Delft (de Bruin, 1983).

RESULTS

The samples were first examined paleontologically by H. J. Droste and T. M. G. van Kempen. The foraminiferal zonation (Smit and van Kempen, this volume) is given in Figure 2. However, as already noted, a significant part of the biozonation is missing, probably because of drilling disturbance. The K/T boundary is drawn between 67–68 and 73–74 cm in Section 605-66-1. No spherules or shocked quartz grains were found in any of the samples.

The INAA results are given in Table 1 and Figure 2, showing concentration profiles for Ca, Th, Rb, REE (La, Sm and Yb), Hf, Zr, Fe, Cr, Co, Ni, As, Sb, and U. The Ca profile shows that Ca varies from 3–20%. As the Ca is incorporated mainly in calcium carbonate, it reflects the biogenic $CaCO_3$ content of the samples. All the other elemental profiles shown in Figure 2 correlate negatively, with some minor fluctuations, with the Ca profile. This is to be expected because, unlike Ca, these elements are concentrated in the terrigeneous fraction of the sediments. The concentration profiles show that besides the above variation no significant enrichments of

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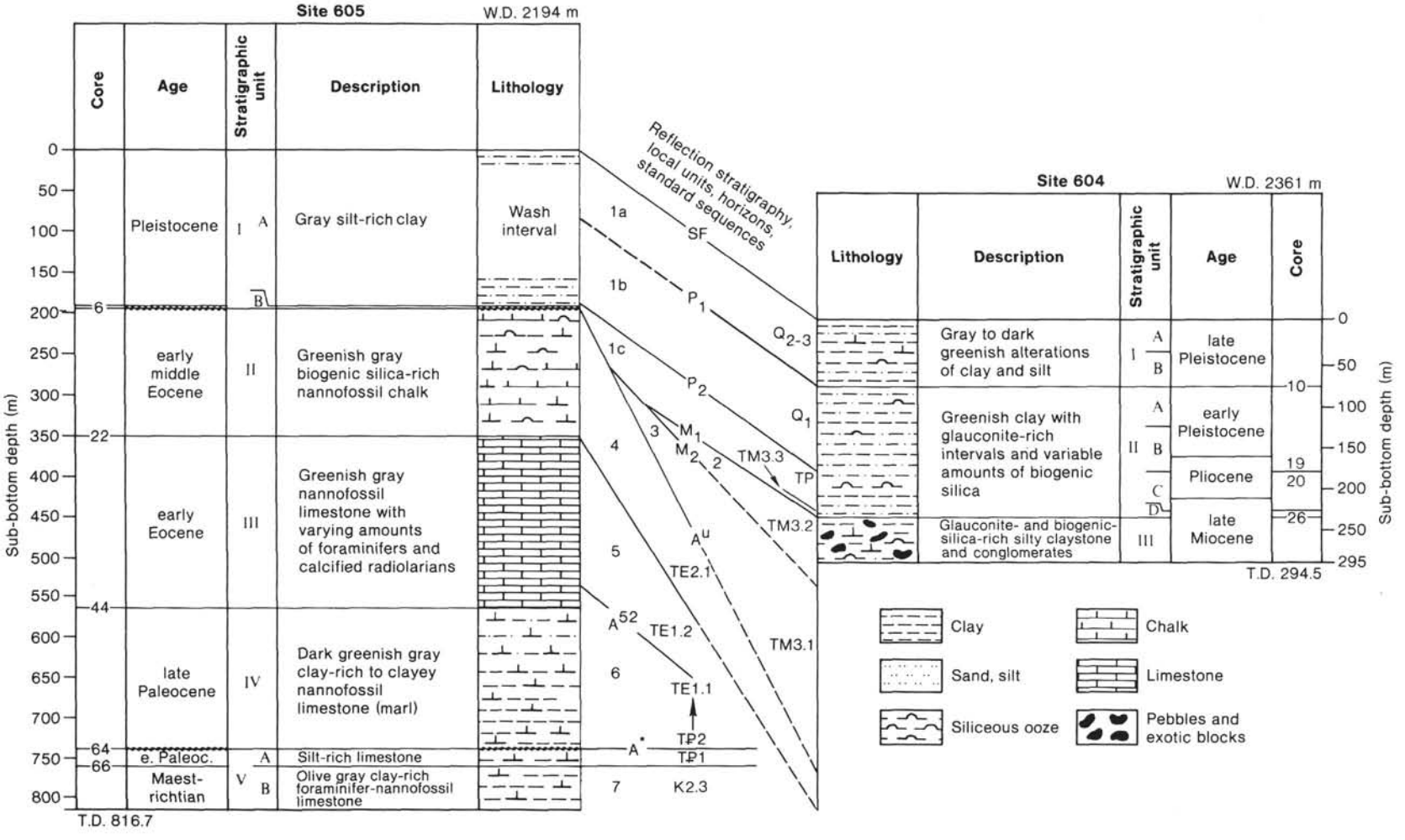

Figure 1. Stratigraphic summary of Sites 604 and 605. Units I–III and I–VI are local lithostratigraphic units. Standard seismic sequence notation after Vail et al., 1980.

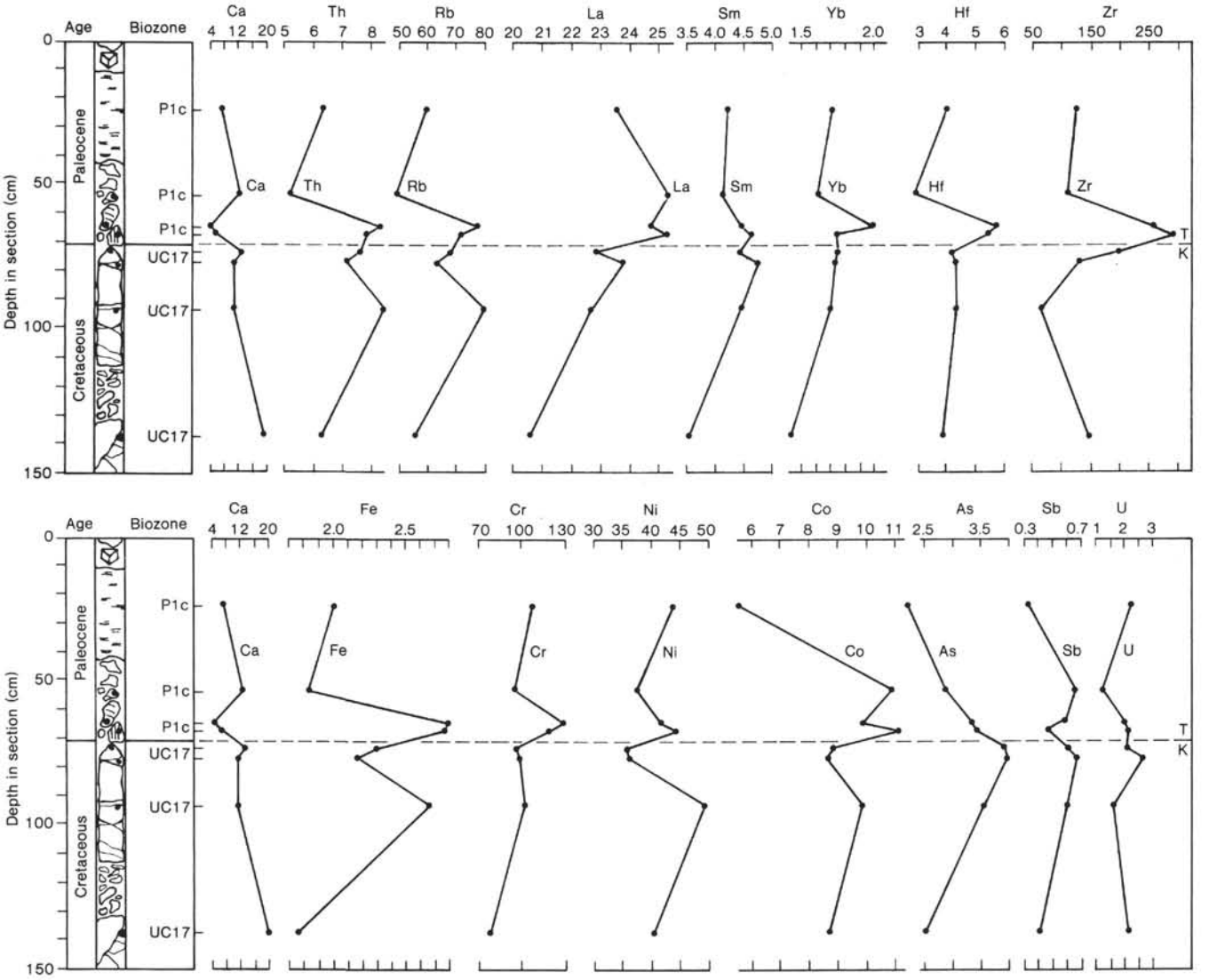

Figure 2. Concentration profiles for Ca, Th, Rb, La, Sm, Yb, Hf, Zr, Fe, Cr, Ni, Co, As, Sb, and U across the K/T boundary in Section 605-66-1. Note the negative correlation of Ca with all other elemental profiles. Ca and Fe in %, the remainder in ppm. UC17: *Abathomphalus mayaroensis* Zone (late Maestrichtian): P1c *Globigerina pseudobulloides* Zone (early Paleocene). Paleontological zonation after Smit and van Kempen, this volume. Note that P1c stands for P1b of other zonations. K/T : inferred Cretaceous/Tertiary boundary.

Ni, Cr, Co, As, and Sb or depletions in REE (La, Sm, and Yb) occur in any of the samples analyzed. The concentration of iridium in all of the samples is below the detection limit of the INAA method used (± 20 ppb).

CONCLUSIONS

None of samples close to the K/T boundary in Section 605-66-1 shows any of the geochemical and mineralogical signatures commonly observed in more than 63 complete K/T boundary sites all over the world. We interpret these missing signatures as caused by the severe drilling disturbance over the K/T boundary interval and not as a primary depositional characteristic of Site 605.

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Table 1. INAA results for samples from Section 605-66-1.

Element	24–26[a]	53–55	64–66	67–68	73–74	92–95	136–140
Na	0.78	0.75	0.76	0.77	0.66	0.71	0.55
K	1.24	1.07	1.54	1.57	1.13	1.40	11.18
Ca	7.24	11.80	3.79	5.33	12.37	10.90	17.90
Sc	8	8	10	9	9	10	8
Cr	107	94	128	118	94	100	7ɔ
Fe	2.07	1.82	2.78	2.72	2.29	2.65	1.73
Co	5	11	10	11	9	10	9
Ni	45	38	42	44	35	48	40
Cu	230	300	310	270	250	370	91
Zn	79	95	286	107	85	108	58
As	2	3	3	3	4	4	3
Br	12	12	8	8	4	6	6
Rb	60	48	77	71	68	80	55
Sr	444	515	548	542	724	722	884
Zr	125	106	262	290	194	65	146
Sb	0.3	0.7	0.6	0.5	0.6	0.6	0.4
Cs	3.6	2.8	4.0	3.9	4.1	4.4	3.6
Ba	305	394	313	275	349	359	289
La	23.6	25.4	24.7	25.3	22.9	22.6	20.4
Ce	41.0	37.8	47.5	50.7	43.3	44.2	36.5
Sm	4.19	4.26	4.45	4.58	4.42	4.45	3.49
Eu	0.79	0.68	0.84	0.86	0.77	0.79	0.68
Tb	0.56	0.43	0.96	0.54	0.56	0.49	0.52
Yb	1.71	1.61	2.06	1.74	1.75	1.70	1.41
Lu	0.34	0.30	0.37	0.41	0.32	0.33	0.28
Hf	4.04	2.83	5.70	5.42	4.17	4.30	3.81
Ta	0.74	0.58	0.89	1.09	0.63	0.77	0.67
Th	6.31	5.17	8.38	7.86	7.62	8.44	6.20
U	2.26	1.20	2.02	2.13	2.04	1.53	2.00

Note: Concentrations in ppm, except for Na, K, Ca, and Fe (%).
[a] cm interval in Section 605-66-1.