

SHORT NOTE

G. Keller · W. Stinnesbeck**Iridium and the K/T boundary at El Caribe, Guatemala**

Received: 12 April 1999 / Accepted: 16 October 1999

Introduction

At El Caribe, Guatemala, we reported the presence of up to 10–15% altered glass spherules near the top of the breccia, which is located stratigraphically near the K/T boundary, and linked these to the Chicxulub impact (Stinnesbeck et al. 1997). We also noted that analyses of Ir by R. Rocchia failed to show anomalous concentrations at the top of the breccia (Stinnesbeck et al. 1997, p. 703). In this short note we amend this statement and elaborate as to the actual Ir values reported by Rocchia and the precise stratigraphic position of the Ir analyses made by him in our section as well as the section collected by Fourcade et al. (1998). We then place these findings within the context of new geological studies in Haiti and Guatemala.

In our original publication we stated that “Some breccias contain up to approximately 10–15% spherules but no anomalous iridium concentrations were detected” (Stinnesbeck et al. 1997; R. Rocchia, pers. commun.). This statement is erroneous in that the samples analysed for us by R. Rocchia are above the breccia and no breccia samples were analysed in our study. However, in a separate study of the same outcrop locality by Fourcade et al. (1998), R. Rocchia analysed a breccia sample with altered spherules and recorded “a low but significant iridium concentration (0.4 ng/g)” (Fourcade et al. 1998, p. 50). This finding strengthens our observation that the top of the breccia

is linked to a spherule-producing event near the end of the Cretaceous, which may be the Chicxulub event.

The samples we sent to R. Rocchia for Ir analysis were from a 10-cm-thick shale interval between 30 and 40 cm above the top of the breccia (see Fig. 1). Three samples (C16, C17, C18) from the top of the marly limestone and base of the shale layer yielded only background values of 0.08 ng/g; sample C19 was lost. Sample C20 near the top of the shale layer yielded 0.23 ng/g and Fourcade et al. (1998, sample 7, p. 50) reported a value of 0.2 ng/g for the same interval; sample C21 at the base of the overlying marly limestone yielded 0.15 ng/g. In another shale layer 1.2 m above the top of the breccia, Fourcade et al. (1998, p. 50) reported another small Ir anomaly of 0.1 ng/g (Fig. 1). Hence, there are three intervals of elevated Ir values: at the K/T boundary, in the lower *Parvularugoglobigerina eugubina* (Pla) Zone, and near the base of the Plb-c Zone.

The K/T Ir anomalies are frequently above 1.0 ng/g; therefore, we do not generally consider Ir values of 0.1–0.2 ng/g as significant. However, our recent studies in Haiti and Guatemala reveal similar small multiple Ir anomalies as observed in the Guatemala sections, and that leads us to reconsider our previous viewpoint. An important aspect of these small Ir anomalies is that they are stratigraphically separated. The first and most significant Ir value (0.4 ng/g) is reported by Fourcade et al. (1998, p. 50) at the top of the breccia together with altered glass spherules within “a matrix of argillaceous limestone with very small planktonic foraminifera (*P. eugubina* and/or *E. fringa*)”.... “Danian species of dinoflagellate *Membranilarnacia?* *tenella* were also found”. This suggests that the spherule-bearing top of the breccia was deposited in the early Danian Zone P1a (*P. eugubina* Zone) as shown in Fig. 1 and similar to Haiti, as discussed herein.

The second intriguing aspect is the slightly elevated Ir concentration of 0.23 and 0.15 ng/g at the top of the shale layer and at the base of the overlying marly limestone, respectively, and approximately 40 cm

G. Keller
Department of Geosciences, Princeton University, Princeton,
NJ 08544, USA

W. Stinnesbeck (✉)
Geologisches Institut, Universität Karlsruhe, Postfach 6980,
D-76128 Karlsruhe, Germany
Tel.: +0721-6082137
Fax: +0721-6082138
e-mail: wolfgang.stinnesbeck@bio-geo.uni-karlsruhe.de

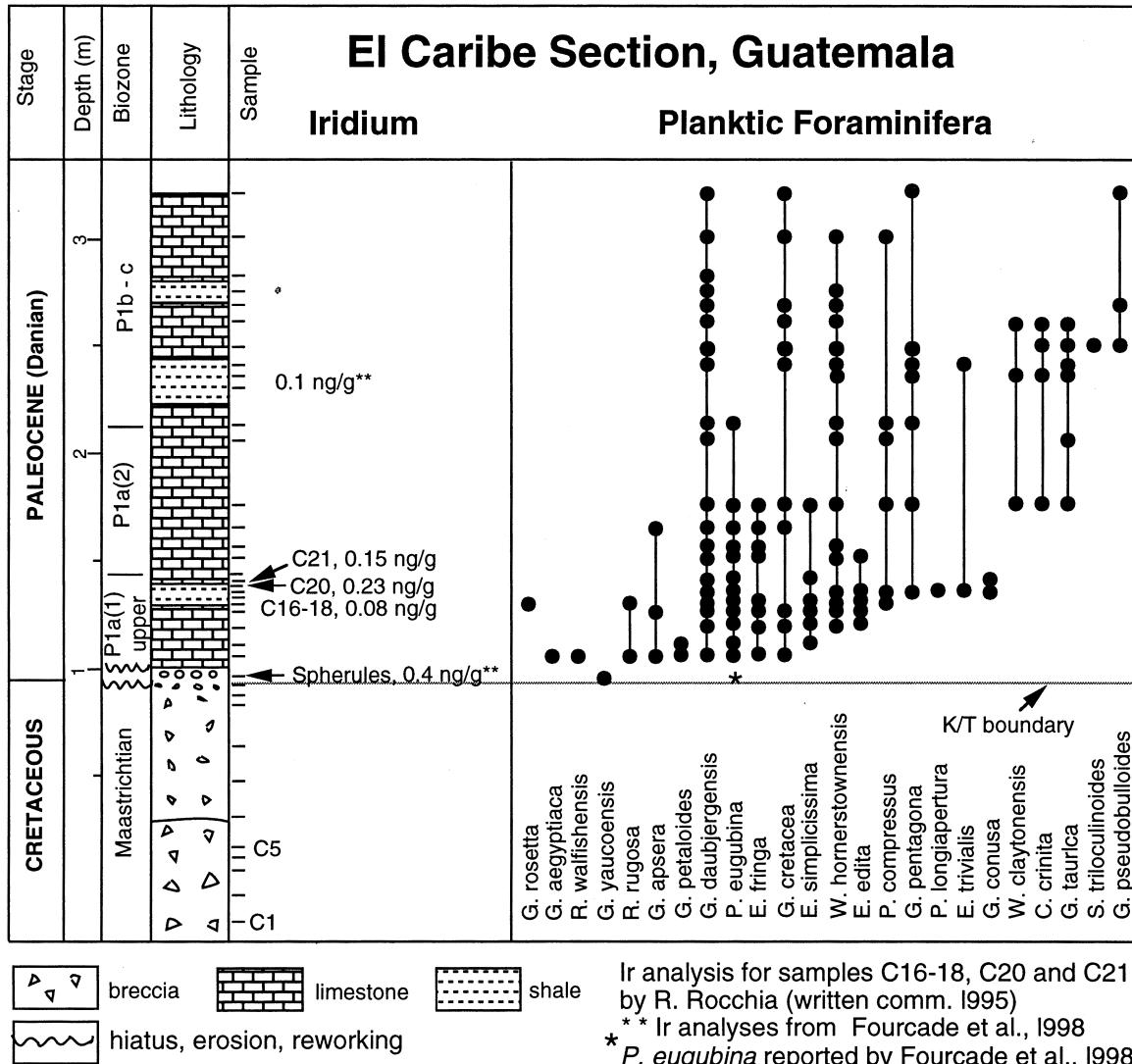


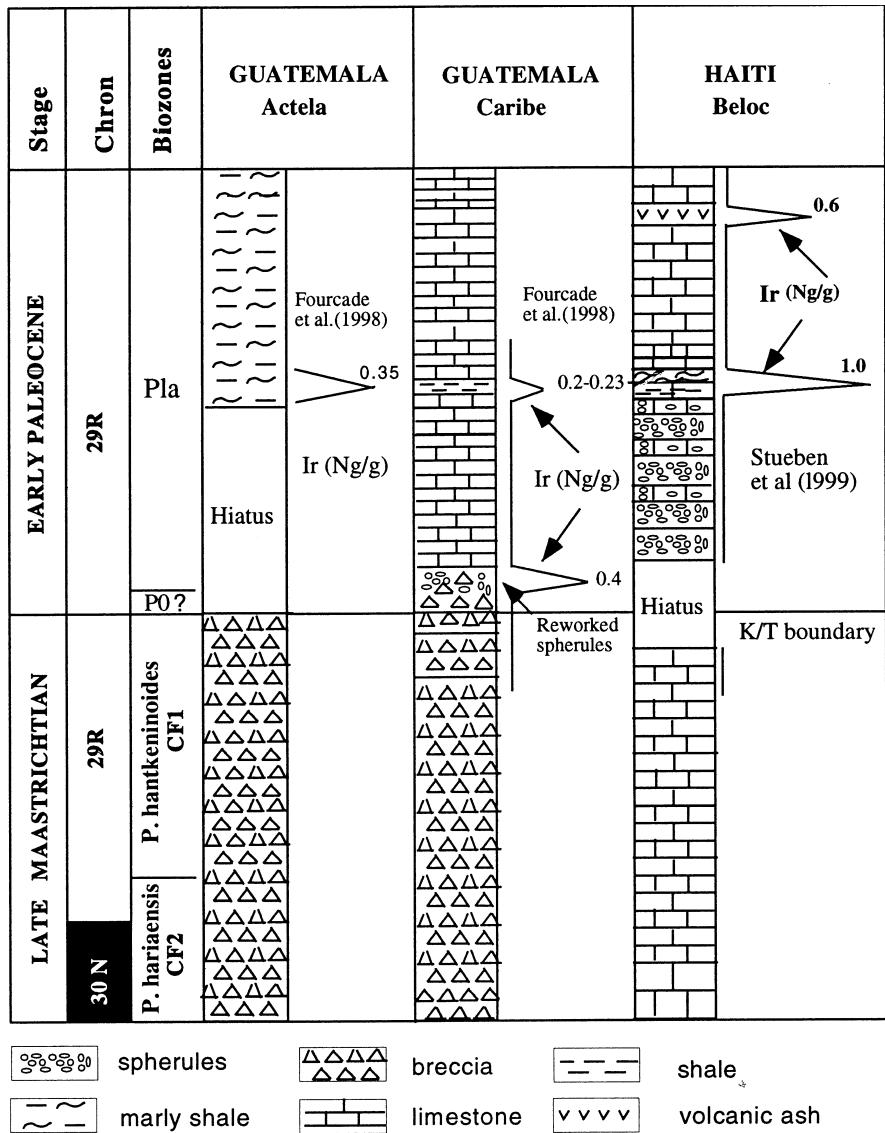
Fig. 1 Stratigraphic ranges of planktic foraminifera and occurrences of elevated Ir values across the K-T transition at El Caribe. Ir values from R. Rocchia (pers. commun.) and Fourcade et al. (1998)

above the breccia at the El Caribe section (Fig. 1). Stratigraphically, this shale layer is within the *P. eugubina* Zone (P1a); however, the presence of *Planorotalites compressus*, *Globanomalina pentagona* and *Eoglobigerina trivialis* indicates that this Ir enrichment is well above the basal Danian. Recently, Fourcade et al. (1998, p. 49) also reported a 0.35 ng/g Ir enrichment at the base of a marly shale layer that directly overlies the breccia at another Guatemala section at Actela. Our stratigraphic analysis of this section revealed 14 Danian species including *P. compressus*, *G. pentagona* and *E. trivialis* at this interval overlying an erosional surface of the breccia (Fig. 1; Stinnesbeck et al. 1997, p. 700). The presence of these Danian species indicates that the Ir enrichment at Actela is at the same stratigraphic interval within Zone P1a, as that

observed at the El Caribe section. This suggests that in Guatemala there are two Ir anomalies, one at or just above the K/T boundary (base Pla) and one within Pla (Fig. 2).

Our recent studies of new and expanded sections at Beloc, Haiti, reveal a similar sequence of events. There, the spherule-rich sediments are within the early Danian *P. eugubina* Zone as indicated by the presence of abundant tiny (<63 µm) early Danian planktic foraminiferal assemblages (P1a; Stinnesbeck et al. 1999; G. Keller et al., in preparation). Previous studies reported these spherule-rich deposits as K/T age based on analyses of the larger size fraction (>63 µm) which does not contain Danian species (e.g. Maurasse and Sen 1991; Jehanno et al. 1992; Leroux et al. 1995; Lamolda et al. 1997). This misleading age assignment, and the presence of spherules interpreted as impact glass, mixed within bioclastic debris, led Bralower et al. (1998) to interpret these deposits as a "K/T boundary cocktail". The presence of early Danian faunas in the spherule-rich deposits in Haiti and Guatemala

Fig. 2. Correlation of K/T boundary sections in Guatemala (Caribe, Actela) and Haiti (Beloc). Note that at the Caribe and Beloc sections the spherule-rich layers are in early Danian (Zone P1a) sediments. All three sections contain small Ir anomalies in the Danian Zone P1a. The K/T and Pla Ir anomalies are separated by pelagic sediments (marls and limestones). This suggests that in addition to the K/T event, a second and possibly third Ir-producing event occurred within Zone Pla



indicates that the K/T boundary cocktail consists of reworked sediments within the early Danian *P. eugubina* (Pla) Zone.

In the Haiti sections we observed an Ir concentration of 1.0 ng/g above the spherule-rich deposit and within the lower part of Zone Pla (Stüben et al. 1999). This anomaly is stratigraphically equivalent to the Ir anomalies in Zone Pla at Caribe and Actela (Fig. 2) and does not appear to be the result of reworking and postdepositional transport of Ir (Stüben et al. 1999). Another Ir anomaly of 0.6 ng/g was observed in the upper Pla Zone (G. Keller et al., in preparation). Thus, it is possible that there are multiple Ir-producing events during the K/T transition. Additional studies are necessary to document the stratigraphic distribution of Ir enrichments in the early Danian.

Acknowledgements We are grateful for discussions with T. Adatte, D. Stüben, J. de la Cruz, C. de Leon and R. Rocchia, and for helpful comments by the reviewer W. Kuhnt and one

anonymous reviewer. This study was supported by the Deutsche Forschungsgemeinschaft (grants Sti 128/2-2 and 2-3).

References

- Bralower TJ, Pauli CK, Leckie RM (1998) The Cretaceous-Tertiary boundary cocktail: Chicxulub impact triggers margin collapse and extensive sediment gravity flows. Geology 26:331–334
- Fourcade E, Rocchia R, Gardin S, Bellier J-P, Debrabant P, Masure E, Robin E, Pop WT (1998) Age of the Guatemala breccias around the Cretaceous-Tertiary boundary: relationships with the asteroid impact on the Yucatan. C R Acad Sci Paris 327:47–53
- Jehanno C, Boclet D, Froget L, Lambert B, Robin E, Rocchia R, Turpin L (1992) The Cretaceous-Tertiary boundary at Beloc, Haiti: no evidence for an impact in the Caribbean area. Earth Planet Sci Lett 109:229–241
- Lamolda M, Aguado R, Maurasse FJ-MR, Peryt D (1997) El transito Cretáceo-Terciario en Beloc, Haití: registro micropaleontológico e implicaciones bioestratigráficas. Geogaceta 22:97–100

- Leroux H, Rocchia R, Froget L, Orue-Etxebarria X, Doukhan J, Robin E (1995) The K/T boundary of Beloc (Haiti): compared stratigraphic distributions of boundary markers. *Earth Planet Sci Lett* 131:255–268
- Maurasse FJ-MR, Sen G (1991) Impacts, tsunamis, and the Haitian Cretaceous-Tertiary boundary layer. *Science* 252:1690–1693
- Stinnesbeck W, Keller G, Cruz J de la, DeLeon C, Macleod N, Whittaker JE (1997) The Cretaceous-Tertiary boundary in Guatemala-Limestone breccia deposits from the South Peten Basin. *Geol Rundsch* 86:686–709
- Stinnesbeck W, Keller G, Adatte T, Lopez-Oliva JP, Stüben D, Kramar (1999) Multiple events across the K/T boundary in northeastern Mexico and Haiti: relationship to the Chicxulub impact? GAC-MAC Joint Annual Meeting, Sudbury 1999, Abstract vol 24:123
- Stüben D, Berner Z, Kramar U, Eckhardt JD, Stinnesbeck W, Adatte T, Keller G (1999) Geochemical evidence for a multi-event at the K/T boundary at Beloc / Haiti? GAC-MAC Joint Annual Meeting, Sudbury 1999, Abstract vol 24:123–124