THE CRETACEOUS-TERTIARY BOUNDARY AT BRAZOS RIVER, EAST TEXAS. A. R. Huffman, Center for Tectonophysics and Dept. of Geophysics, Texas A&M University, College Station, TX 77843-3113, J. H. Crocket, Dept. of Geology, McMaster University, Hamilton, Ontario L8S 4M1, and S. Gartner, Dept. of Oceanography, Texas A&M University, College Station, TX 77843-3113.

The K/T boundary is exposed along the banks of the Brazos River in East Texas at several locations. Boundary sediments were deposited in a quiet, mid- to outer-shelf environment (100-150 meters water depth) with deposition of mostly marl in the late Maastrichtian (Jiang and Gartner, 1986). The K/T transition at Brazos is quite remarkable, with the Kemp Clay overlain on a scoured surface by a high energy deposit (storm deposit of Keller, 1988; Bourgeois et al., 1988). This deposit, which consists of a fossiliferous, poorly sorted, coarse, pebbly sand overlain by a cross-bedded, high-energy current deposit has been described recently as being tsunamogenic in nature (Hildebrand and Boynton, 1988a; and Bourgeois et al., 1988). Above this deposit is a 1 cm gray, sandy clay layer followed by an 8 cm massive, unfossiliferous chalk. Above the carbonate unit, deposition of mudstone continues, indicating a return to normal outer shelf environment of deposition. The deposition of mudstone (now the Kinkaid Formation) is interrupted abruptly at 17 cm above the carbonate unit by the deposition of a 2 cm brown clay (Hildebrand and Boynton, 1988a). This brown layer, which looks remarkably like the Raton K/T "magic layer", has been identified as the K/T boundary based on nannofossils (Jiang and Gartner, 1986) trace-element chemistry (Hildebrand & Boynton, 1988b), and planktonic forams (Keller and Benjamini, 1988). Above this "boundary layer", the Paleocene clay unit is divided into 3 beds of ~5 cm each, with high silt and sand content in the lowermost bed. Each 5 cm bed is separated by a thin (<1 mm) unit of brown clay. Recent excavation of the Brazos 1 outcrop indicates that the boundary clay layer is very variable in thickness and morphology.

The interpretation of the lower sand deposit as an impact generated tsunami layer presents an interesting problem in that there appears to be several thousand years of deposition between the tsunami deposit and the "magic layer". This temporal constraint requires that either (1) the tsunami deposit and magic layer were not generated by the same process, (2) there is more than one impact event recorded at the Brazos site, or (3) the tsunami(?) deposit is from a terrestrial process unrelated to the K/T event. Recent work in Pennsylvanian strata of N.W. Oklahoma (Fruit and Elmore, 1988) indicates that such deposits are not unique to the K/T boundary and may be caused by phenomena other than tsunami.

Previous work at the Brazos River K/T section includes some sedimentology (Hansen et al., 1987; Bourgeois et al., 1988), micropaleontology (Jiang and Gartner, 1986; Hansen et al., 1987; Keller, 1988; and Keller and Benjamini, 1988), and trace-element geochemistry (Ganapathy et al., 1981; and Hildebrand and Boynton, 1988b). Current work being done at Texas A&M University and McMaster University includes preliminary analysis of mineral separates for evidence of shock-deformation and trace-element chemistry of selected samples using Instrumental and Radiochemical Neutron Activation Analysis.

A preliminary sampling program was completed on the Brazos 1 K/T section located 500 m south of the FM 413 bridge. The samples (n=12) included background samples of Kemp Clay and Kincaid Formation, along with a representative sample from each stratigraphic unit across the K/T transition. Sample aliquots were analyzed for 47 elements by INAA, for Ir by RNAA, and for carbon content in a LECO WR-12 carbon analyzer. Mineral separates were obtained and analyzed by optical microscopy in flat stage and universal stage projection.

Analysis of 1000 grains in each thin section revealed the presence of tectonic lamellae, rare shock mosaicism, and fracturing of quartz and feldspar. No shock lamellae have been found in any of the samples. Additional sections are being analyzed to confirm this observation. The greatest intensity of fracturing and mosaicism occurs in and just above the boundary clay.

The background value for Ir in the Tertiary Kincaid formation (2 meters above K/T) is 0.410 ppb, slightly higher than the Cretaceous Kemp Clay value of 0.2 to 0.3 ppb. Geochemical analysis reveals that Iridium is enriched over a 50 cm section at Brazos 1. A 2-fold enrichment over background is observed in the cross-bedded sand, increasing to 3-fold in the chalk and overlying sand and reaching a maximum of 7-fold (2.16 ppb) in the boundary clay. Above the

boundary, iridium decreases to just above background, for 5 cm, and then increases again to over 1 ppb for 10 cm. Enrichments for As, Sb, and Se occur at several locations in the transition, but not synchronous with the Ir enrichments. A similar series of non-synchronous enrichments of As, Sb, Sc and other elements was reported recently for Walvis Ridge, South Atlantic Ocean (Huffman, et al., 1988). Values for other elements indicate that there are no significant differences between the chemistry of the Kemp and Kincaid formations, supporting the contention that the late Cretaceous and early Tertiary source areas were the same. The non-synchroneity of Ir, As, Se, Sb, and other enrichments raises an important question; is the temporal resolution at other K/T sites sufficient to guarantee that different elemental signatures have not been combined into a single unit? In addition, the diffusive and chemical transport of exotic elements such as iridium by terrestrial processes is poorly understood and leaves significant uncertainties in any interpretation of such data. These problems may explain some of the confusion regarding iridium, chalcophile, and other geochemical signatures that may occur in the same unit at some K/T sections.

The Ir and other chemical evidence suggests that a single, instantaneous event is not recorded at the Brazos K/T section. The chemo- and time-stratigraphic sequence supports a gradual transition over a period of 10^3 - 10^5 years, rather than a catastrophic event of short duration. The scarcity of shocked minerals relative to those at Raton Pass (e.g., Izett, 1987) is of concern since the boundary clay at Brazos is similar in color and general appearance to the Raton "magic layer". Taking into account the differences in environment of deposition, the chemistry of the Brazos boundary clay is not very different from the Raton layer. Unfortunately, investigations at Raton and many other localities have, until now, focused on only the magic layer, making comparisons of chemostratigraphy between the Brazos and other sites impossible. It is clear that more detailed chemical and sedimentological analysis of all K/T sites is in order; the chemostratigraphy and phase provenance of exotic elements above and below the K/T transition may affect current interpretations of the K/T boundary event.

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