The timing of the deposition of the sandstone complex is controversial: Does the sandstone complex occur precisely at the K/T boundary as proposed by Bourgeois et al. (1988), Smit et al. (1992b), and Smit and Romein (1985)? Or does the unit predate the K/T boundary (Jiang and Gartner, 1986; Keller et al., 1993, 1994b; Stinnesbeck et al., 1993, 1994b)? The question has also been posed of whether the beds of the sandstone complex were deposited in one, pulsating event or during several events spread over several thousands of years (Keller et al., 1994b; Stinnesbeck et al., 1993).

The K/T sandstone complex is sedimentologically complex, differing in architecture and composition from place to place. Therefore, many different interpretations have been offered for its origin. The beds have been interpreted as nonmarine sandstones (Kellum, 1937; Muir, 1936), shallow-water deposits (Morgan, 1931), low-stand channel infills (Mancini and Tew, 1993; Savrda, 1991), storm deposits (Hansen et al., 1987), gravity flows (turbidite and debris flows) (Bohor and Betterton, 1993; Stinnesbeck et al., 1993), and tsunami deposits (Bourgeois et al., 1988; Smit et al., 1992b; Smit and Romein, 1985).

The oldest reports on the sandstone deposits at or near the K/T boundary in Mexico between the Upper Cretaceous Mendez and Paleocene Velasco formations date back to the 1930s (Kellum, 1937; Muir, 1936). They interpreted the sandsone unit as shallow-water or nonmarine deposits marking a hiatus and an unconformity. Muir (1936) described a "ripple marked" sandstone and/or a bentonite bed between the Mendez and Velasco (Tamesi) Formations. He reported the contact between the Mendez and the Velasco (Tamesi) Formations in the Arroyo de Mimbral (Membral) outcrop as follows: "The base of the Velasco fm consists of mixed material, including inclusions from the Mendez, filling irregularities at the unconformity between the two formations. Next comes a sandstone, variable in thickness and local in extent." The worm track and plant remains in the sandstones were seen as evidence for a nonmarine origin. Morgan (1931) noted an abrupt change in (planktic) faunal composition between the Mendez and Velasco shales and suspected an unconformity because a "bentonitic conglomerate" occurs at the base of the Velasco Formation in the Tampico area. Hay (1960) described an angular unconformity between the Mendez and Velasco Formations at Mimbral and in addition inferred a major regression at the K/T boundary.

In Texas, the conglomeratic Littig member of the Paleocene Kincaid Formation often unconformably overlies the Cretaceous Corsicana Formation where it marks a considerable hiatus (Jiang and Gartner, 1986; Hansen et al., 1987). However, in the Brazos River outcrops, 1 to 4.5 m of the Kincaid Formation is preserved below the Littig member, containing a graded sandstone unit at its base (here called the K/T sandstone complex). Ganapathy (1980) mentioned that the sandstone unit occurred just below the K/T iridium anomaly (and consequently assigned it a Late Cretaceous age) at Brazos River but did not further interpret it. Smit and Romein (1985) interpreted the Brazos River sandstone unit as a K/T boundary turbidite or tsunami-generated deposit, indicating a nearby impact. Hansen et al. (1987) lithologically subdivided the K/T sandstone unit in detail and mentioned a possible tsunami origin but favored a tempestite interpretation, later supported by Montgomery et al. (1992).

Bourgeois et al. (1988) elaborated on the tsunami interpretation and calculated high current velocities at an estimated water depth of 50 to 100 m, where even hurricane storm waves cannot transport coarse material. Hansen et al. (1987) and Bourgeois et al. (1988) suspected that the 25-cm-thick micritic or silty limestone and mudstone layers overlying the highest sandstone layers could represent silt and clay sediment that settled from the water column following the initiating—storm or tsunami—event. To test this idea, we performed a detailed analysis of the grain-size distribution in this interval (see below). Considerable confusion exists as to where the K/T boundary should be positioned in the Brazos River sections. For example, Hansen et al. (1987), Montgomery et al. (1992), and Smit and Romein (1985) favor a K/T boundary at the base of the sandstone complex, whereas Jiang and Gartner (1986) and Keller (1989a) favor a K/T boundary position at the top, or above the sandstone unit. The positioning of the K/T boundary is further discussed below.

In Alabama, the sandstone complex occurs as discontinuous irregular bedded sandstone bodies, known as the basal Clayton sands (see, e.g., Habib et al., 1992; Mancini and Tew, 1993; Mancini et al., 1989). Those sandstone bodies were interpreted—applying sequence stratigraphic methods—as transgressive infilling of low-stand channels (Mancini and Tew, 1993) or low-stand incised valley fills (Savrda, 1991). An origin by tsunami waves was shortly discussed but rejected (Savrda, 1991, 1993) Another approach was taken by Pitakpaivan et al. (1994) and Smit et al. (1994b), who reported pseudomorphs of impact spherules from the very base of the Clayton sands at Shell Creek and Moscow Landing, Alabama, suggesting a close temporal relation with the Chicxulub impact.

Recently, the K/T clastic complex has been studied in the classical Borrega Canyon–Arroyo de Mimbral section (Bohor, 1994; Keller et al., 1994b; Smit et al., 1992b; Stinnesbeck et al., 1994a) and in many other K/T outcrops in eastern Mexico (Alvarez et al., 1992b), Chiapas (Montanari et al., 1994), Guatemala (Hildebrand et al., 1994), and DSDP sites 540 and 536 (Alvarez et al., 1992a). Below we will report our observations on some of these sites.

METHODS

In this chapter, we present sedimentologic and stratigraphic data of surface outcrops in Alabama, Texas, Mexico, and Haiti. Foraminiferal faunas were studied in thin sections and washed residues, obtained using standard laboratory techniques. Thin sections were petrographically analyzed to evaluate variations in composition and texture of the different sublayers of the K/T sandstone unit, with the aim of establishing the (bio)stratigraphic and sedimentologic relationships of the pre-, syn-, and post-K/T units.

The grain-size distribution of the insoluble residue of