Slumping and a sandbar deposit at the Cretaceous-Tertiary boundary in the El Tecolote section (northeastern Mexico): An impact-induced sediment gravity flow

COMMENT

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Soria et al. (2001) report on slump features in a spherule deposit of the El Tecolote outcrop in northeastern Mexico and interpret this as evidence of widespread destabilization and collapse of the continental margin as a result of the Chicxulub impact. They further conclude that multiple spherule layers in northeastern Mexico are therefore likely slump induced. Though unattributed, the reference is to the recent discovery of three to four spherule layers in the late Maastrichtian Méndez Formation of northeastern Mexico (Stinnesbeck et al., 2001), which are interpreted as one or more latest Maastrichtian impact events, or a pre–Cretaceous-Tertiary (K-T) impact followed by repeated reworking of the original spherule deposit.

Soria et al.'s database consists of two closely spaced sections in the La Sierrita area, which they call El Tecolote. Our database in the same area includes over 20 stratigraphic sections, including El Tecolote (also called Mesa Juan Pérez), and an additional 17 sections to the southeast (Los dos Plebes, La Sierrita, Loma Cerca). This extensive database leads us to dismiss the collapsed margin hypothesis, as well as a Cretaceous-Tertiary boundary age for the spherule layers, as insupportable for the following reasons.

(1) The originally discovered spherule layer (unit 1) in northeastern Mexico is at the base of a thick siliciclastic deposit that was interpreted to be the result of the Chicxulub impact-generated megatsunami (Smit et al., 1996). The K-T boundary is invariably above this deposit, either immediately above it or above a 10–30-cm-thick marl layer that contains the planktic foraminiferal *Plummerita hantkeninoides* (CF1) zone assemblage that spans the last 300 000 k.y. of the Maastrichtian (Keller et al., l997). In addition, various horizons of bioturbation have been documented within the siliciclastic deposit that indicate that deposition occurred over an extended time period with repeated colonization of the ocean floor by invertebrates (Keller et al., l997; Ekdale and Stinnesbeck, l998). These data point to long-term deposition preceding the K-T boundary and are incompatible with a K-T age for the spherule unit 1, a K-T impact-generated tsunami interpretation (Smit et al., l996), or Soria et al.'s complex scenario of slumping and margin collapse ''after the ejecta's deposition and before the sandy unit deposition'' (p. 233) by the arrival of the impact-generated megatsunami.

(2) We discovered as many as three additional spherule layers in over 37 sections of the La Sierrita and El Peñón areas where they are interbedded with up to 9 m of late Maastrichtian zone CF1 marls below the spherule layer at the base of the siliciclastic deposit (Stinnesbeck et al., 2001). The number of spherule layers present depends on outcrop exposure, completeness of the sections, or seafloor topography and deposition occurring within the last 300 000 k.y. of the Maastrichtian. Soria et al. agree that the multiple spherule layers in the El Tecolote sections are within late Maastrichtian marls, but interpret them as the result of slumps that interjected the original K-T age spherule layer.

(3) Among over 37 sections spanning over 50 km of northwest-southeast–trending hills, only rare, small-scale, 1–3 m slumps were observed, like those described by Soria et al. Moreover, the two small slumps at El Tecolote are within a spherule layer and are not connected with the spherule layers above or below, and there is no continuity of these slumps between the two sections, contrary to the misleading depiction in Figure 1 of Soria et al. In fact, immediately adjacent strata to the El Tecolote slump are undisturbed spherule layers within the Méndez marls that indicate that the small slumps are isolated local features not connected to the unit 1 spherule layer. Similar localized slumps have been observed at Beloc, Haiti, where they are also confined to a spherule-rich layer and undisturbed sequences are present nearby (Keller et al., 2001).

(4) Evidence against a slump origin of the multiple spherule layers is also observed in the differing lithologic characteristics. The lowermost (oldest) spherule layer consists almost entirely of closely packed devitrified vesicular spherules and altered glass fragments, with a cement of spar calcite. The frequency of eutaxitic spherule textures, concave-convex contacts, and agglutination between spherules indicates that they were still hot and ductile during transport and primary deposition (Stinnesbeck et al., 2001). In some sections, the basal spherule layer resembles a microbreccia where the dominant component consists of angular to flaser-like shards with ''welding'' or plastic deformation of (?hot) glass around more rigid components, such as carbonate clasts and occasional shells of benthic foraminifera. Consequently, these layers clearly differ from the unit 1 spherule layer at the base of the siliciclastic deposits that contains abundant terrigenous debris. These lithological differences cannot be explained by a slump, but suggest that the lowermost spherule layer in the Méndez marls represents the oldest ejecta deposit, whereas the overlying spherule layers are either reworked and redeposited, or represent additional ejecta events.

It is unfortunate that Soria et al. did not investigate some of the other outcrops in the area to help evaluate the El Tecolote slumps, or examine the recent publications on this topic, and it is ironic that they emphasized the need ''to reexamine outcrops elsewhere with multiple exposures of spherules to test for slumps'' (p. 234). Their sweeping conclusion that the El Tecolote sections provide evidence for destabilization and collapse of the continental margin due to the effects of the Chicxulub impact is insupportable by the current database.

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