Forum Comment

doi: 10.1130/G37683C.1

Mercury anomaly, Deccan volcanism, and the end-Cretaceous mass extinction

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In their study of Hg abundances across the Cretaceous-Paleogene (KPg) boundary, Font et al. (2016) discuss links between Hg abundances, Deccan volcanism, and the end-Cretaceous mass extinction, and conclude that a significant Hg concentration increase just below the KPg boundary at Bidart (France), which they consider to be a contributor to the biological crisis, should be ascribed to the Deccan volcanism outflow Phase-2.

However, an earlier interpretation (Lowrie et al., 1990) suggested that the Hg anomaly could have been enriched/scavenged by anoxia on the seafloor and subsequently penetrated into uppermost 10–50 cm of the Maastrichtian. Mercury is, therefore, post-depositional and cannot be directly related to either the Deccan traps eruptions or the Chicxulub impact event. We weigh the two interpretations in a few points here, and conclude that the interpretation relating the Hg supply to the Deccan trap Phase-2 eruptions is unlikely.

(1) In the Bidart section, the zone of the Hg anomaly extends to 50–75 cm below the KPg boundary. The discolored top of the Cretaceous is 50–60 cm thick. Bidart is part of the Basque basin, where at least six extended sections across the KPg boundary are very similar (Mount and Ward, 1986; Ward et al., 1991; Batenburg et al., 2011) and bed-for-bed comparable to one another. Batenburg et al. (2011) clearly showed that the very distinct marl-limestone bedding visible in all the sections is orbitally (Milankovitch-cycle) controlled, and that the layers can be correlated to the precession cycle, lasting on average 20.5 k.y. Three of these cycles are indeed depicted in Font et al.'s figure 2. The thickness of each precessional cycle just below the KPg boundary is ~120 cm, so the weathering zone and the almost coincident Hg anomaly below the KPg boundary represent less than half a cycle, and consequently represent <10 k.y. in duration. Phase 2 of the Deccan traps begins somewhere in the top of MagnetoChron 30N. The Chron 29–30 boundary is consistently 18 ± 1 precession cycles (Herbert, 1999; Batenburg et al. 2011; Westerhold et al. 2012) below the KPg boundary, thus roughly 370 k.y. Therefore, the Deccan traps Phase-2 should begin >370 k.y., which corresponds to ~20 m below the KPg boundary in the Bidart section. As a consequence, the Hg concentrations, if derived from the Deccan traps directly, should have been detected throughout the whole 20 m below the KPg boundary, and not be restricted to the top 50–60 cm.

(2) The Chicxulub impact event has led to mass mortality, and therefore to massive anoxia on the deep seafloor, where normally oxidative circumstances reign. The high Corg content, the widespread presence of pyrite and of C40:2 ketones (Yamamoto et al., 1996) indicate that the KPg boundary clay layer directly above the few-millimeter-thick Chicxulub ejecta was deposited under dysoxic conditions. Font et al. (2016) cite Grasby et al. (2013), who states "Dissolved Hg has strong affinity for organic matter (OM) in marine and freshwater environments" and is expected to be enriched/scavenged during that phase. Adding to the Hg enrichment in the anoxic boundary clay, a possible extraterrestrial source of Hg at the KPg boundary has been suggested by Meier et al. (2015). The anoxia easily penetrates, possibly aided by anaerobic microbial processes, several decimeters into the seafloor, in this case top Cretaceous, leading to dissolution-reprecipitation and enrichment of several elements, among which are U, Zn, S, As, Fe, and Mn. Mercury is presumably also scavenged by these post-depositional processes and reprecipitated below the sediment-water interface. A similar discoloration zone occurs also in the famous Gubbio section (e.g., Montanari, 1991). There, a white layer extends 30–50 cm below the Ir-bearing clay. The presumed zone of decreased magnetic susceptibility, earlier hypothesized by Font et al. (2016) as caused by the Deccan trap eruptions, (see also Font et al., 2011) coincides with the white reduced layer. Lowrie et al.(1990) concluded that the anoxia transforms the ferric Fe to ferrous Fe, explaining the decreased Fe content and susceptibility in that interval. The leached/discolored low-susceptibility intervals in Gubbio and Bidart are comparable in thickness (~50 cm), while their sedimentation rates differ by a factor of five. If the low-susceptibility, bleached zones and Hg anomaly were directly caused by external supply—hypothesized by Font et al. (2016) as derived from the Deccan traps—then the stratigraphic interval representing the duration of external supply should differ in thickness by a factor of five in both sections. This is clearly not the case.

Therefore, we conclude that the hypothesis of Deccan trap–derived Hg supply should be rejected in favor of the earlier hypothesized post-depositional geochemical leaching and reduction processes.

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