Cuban K/T catastrophe

SIR—The possibility of a Caribbean location for the asteroid or comet impact that marked the end of the Cretaceous period was first raised by Pszczolkowski[1]. Recently, Hildebrand and Boynton[2] have suggested that a half-metre-thick unit at the marine Cretaceous/Tertiary (K/T) boundary in Haiti, containing abundant altered microtektites and tektites, is an ejecta layer resulting from an impact in the Colombian basin.

This ejecta unit, originally described as a volcanogenic turbidite[3], and later found to contain an iridium anomaly[4], is almost 20 times thicker than similar non-marine units described from the western interior of North America. Our measurement of shocked quartz grain sizes had previously indicated that the site of the K/T impact must have been near the North American continent[5,6]. The thickening of the impact ejecta layer southward among the North American sites[7], together with the unusual thickness of the Haitian ejecta layer, enlarged our curiosity about a possible impact site in the Caribbean region.

The geological literature of the Greater Antilles reveals that Palmer[8] described the uppermost member of the Cretaceous succession at the K/T boundary in Cuba as the "Big Boulder Bed". This remarkable unit contains near its base huge (up to 12-metre[6]) clasts and smaller boulders of limestone, sandstone and exotic igneous and metamorphic rock types, in a finer matrix. The exotic lithologies are mostly alien to the pre-Cenozoic geology of Cuba, as exposed today. Furthermore, of the three members of the Upper Maastrichtian (uppermost Cretaceous) described by Palmer[9], only the Big Boulder Bed is found in every province of Cuba.

The average size of the boulders in this unit increases from north to south across the island, indicating a southerly source[9]. Beds containing this unit reach 350 m in thickness[1], and include serpentinite bodies several hundred metres in length[8]. A boulder bed 52 m thick has also been encountered at the top of the Cretaceous in offshore drilling on Pedro Bank, southwest of Jamaica[10].

Underlying the Big Boulder Bed (revised and renamed in more recent publications[11]) in Pinar del Rio and La Habana provinces is a more calcareous sandstone unit containing inverted cone-shaped "concretions" (ref. 9), with their bases lying parallel to the bedding planes. Palmer named this unit the "Cone Sandstone Member" and ascribed the cone-shaped structures to subaerial weathering[7].

We propose that the Big Boulder Bed is an impact ejecta blanket proximal to a large, complex impact crater lying to the south of the western half of Cuba. This location for the K/T crater is ~ 1,350 km from the site proposed by Hildebrand and Boynton[2] in the Colombian basin. This ejecta blanket was probably emplaced partially ballistically, and partially as a fluidized bed[12]. The boulders of exotic lithology (target rocks) in the unit match the trace minerals found in K/T ejecta layers elsewhere in the world[13]. The cone-shaped concretions in the underlying sandstone might be either shatter cones caused by the impact, or fluid escape conduits.

Faults paralleling the southern coast of western Cuba[14] could represent ring faulting associated with complex crater development and modification[12]. A strong positive gravity anomaly south of the ring faulting and centred on the present coast may be due to impact melt sheets emplaced during crater formation. We note further that the Isle of Pines off the south coast of western Cuba, composed of schist and marble, might represent a central uplift feature; an impact centred here would have formed a crater ~225 km in diameter. Alternatively, the Isle of Pines may be only part of a multiple ring complex[13], allowing for a larger impact structure whose radius is constrained only by the curved pre-Tertiary bedrock arc of western Cuba. Further onshore and oceanographic field work will be needed to confirm details of the location, size and effects of the impact.

Note added in proof: Hildebrand and Boynton have just reported their discovery of shocked quartz grains in the Haitian K/T boundary layer[15].

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Opening plant calcium channels

SIR—Vesicle preparations of the vacuolar membrane (tonoplast) of plant cells, like those of the endoplasmic reticulum of animal cells, exhibit inositol 1,4,5-trisphosphate ($InsP_3$)-gated Ca^{2+} release[1,2]. But even in membrane preparations highly enriched for tonoplast, the total extent of Ca^{2+} release never exceeds 30 per cent, and is frequently less than 20 per cent, of the non-bound Ca^{2+}. This limited Ca^{2+} release raises the question of whether the vesicle preparations comprise sub-populations of membranes of variable intracellular origin, as appears to be the case from analogous studies on animal cells[3].

The issue may have been neatly resolved by the recent patch clamp analysis of $InsP_3$-elicited currents in red beet vacuoles[4]. A comparison of microscopic (single channel) and macroscopic (membrane) currents enabled the author of that study to estimate the density of $InsP_3$-gated channels as about 1,200 channels per vacuole of mean radius (r_{vac}) = 23 μm. The mean radius of tonoplast vesicles (r_{ves}) prepared by density gradient centrifugation is about 1 per cent of this value[5], and the probability that a given vesicle contains an $InsP_3$-gated channel is therefore 1,200 × $(r_{ves}/r_{vac})^2$, or only 0.12. Thus, the finding that plant tonoplast preparations exhibit only limited Ca^{2+} release can be explained entirely on the basis of the relatively high surface/volume ratio of the vesicles in comparison with the parent organelle.

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SIR—We wish to draw attention to the significance of the recent report[1] that inositol 1,4,5-trisphosphate ($InsP_3$) opens Ca^{2+} channels in the vacuolar membrane (tonoplast) of higher plants. This finding has broad implications for the regulation of ion transport at this membrane during signal transduction.

The dominant ionic channel in the tonoplast, the slow vacuolar (SV) channel[2] is weakly selective for cations rather than anions, and is activated by Ca^{2+} ions on the cytosolic side over a concentration range