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LETTERS

Sedimentology of the K-T Boundary

Gerta Keller, in her letter of 29 April (p. 641), takes Richard A. Kerr to task for perceived inaccuracies in his report on the conference "New Developments Regarding the KT Event and Other Catastrophes in Earth History" and an associated field trip to northeastern Mexico (Research News, 11 Mar., p. 1371). Among her criticisms is the charge that Kerr misrepresented the opinions of sedimentologists, five of whom had been invited by Robert Ginsburg under auspices of the Global Sedimentary Geology Program of the International Union of Geological Sciences to be neutral participants in the field trip. As two of the latter group quoted by Kerr, we write to clarify several points misrepresented by Keller, which we believe were accurately reported by Kerr.

Why would sedimentologists all regard Cretaceous-Tertiary (K-T) boundary sandstones 1 to 7 meters thick as unusual? Because of a zone (about 1 meter thick) of peculiar spherules at the base together with the position of the sandstones between fine, thoroughly burrowed mudstones, which Keller interprets as having accumulated about 400 meters below sea level. Deposition of sand at such depths requires unusual currents, such as previously postulated episodic, gravity-driven turbidity currents, which flow downslope. We rejected this mechanism because the deposits do not closely resemble familiar products of turbidity currents and (especially) because we observed evidence of upslope as well as downslope transport. Further, the lack of animal burrows, together with planar lamination through most of the succession, suggested rapid accumulation from strong currents. Final deposition by waning currents or waves was indicated by rippled lamination in the top centimeters, which also display postdepositional burrows indicative of a return to normal, tranquil conditions. Finally, the boundary sandstones are relatively thin but geographically widespread and lack any transitional thin, sandy laminae within either the adjacent underlying or overlying mudstones; apparently, sand deposition both began and ended very abruptly.

There was, as Kerr reported, consensus that the boundary strata reflect a brief (hours to days), exceptionally energetic, discrete event requiring unusual conditions for the accepted environment of deposition. We believe that, although some details of genesis remain obscure, the preponderance of evidence is consistent with accumulation of these strata under the influence of exceptional tsunami-generated processes. Furthermore, their position at the K-T boundary, their similarity to other unusual boundary deposits around the Gulf of Mexico, and their geographic proximity to the giant Chicxulub crater are compelling reasons for neutral observers to endorse an impact-related cause.

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Dioxin Effects

Is dioxin a human carcinogen? In his letter of 18 March (p. 1545), Stephen S. Sternberg expresses fear that we will wait in vain for the definitive epidemiological study that answers this question. Admittedly, the observational epidemiologist's approach has limitations that affect its value, especially for cancers such as soft tissue sarcoma and malignant lymphoma, whose incidence and mortality have been rising steadily and rapidly in both sexes in most parts of Europe, particularly in the countries of the European Union (*1*), since 1960. In Italy, the number of deaths caused by soft tissue sarcoma rose in 15 years from 0.09% to 0.23% of all cancer deaths. The incidence of and mortality from non-Hodgkins lymphoma increased by 35% between 1970 and 1985 (*2*).

One could reasonably argue whether this trend of cancer patterns is the result of increased exposure to chemical carcinogens or of improved diagnosis and registration rates. I believe, however, that a comprehensive study of the population involved in the accident in Seveso, Italy (*3*), could overcome the disadvantages of the small size of the exposed populations and further considerably our knowledge of this matter.

Bertazzi *et al.* (*4*) have reported an excess of some cancers, among them soft tissue sarcoma and non-Hodgkins lymphoma, in

two groups of the selected population and have assumed a causal relationship with an exposure to dioxin. Yet the occurrence of the excess of incidence of those cancers seems not to be consistent with the level of exposure. It would be helpful to examine whether there is a correlation between the amount of dioxin absorbed (most probably in food during the first weeks after the accident), that is, the actual body burden of dioxin in individuals whose cancer has been diagnosed, and cancer incidence.

Some concentrations of dioxin in the blood of a few of those individuals have been reported by Moccarelli (*5*), and the mean values (142 to 334 parts per trillion) were higher than the background concentrations of an unexposed population. However, an analysis of the relationship between these concentrations and the cancer sites is not included in the paper.

Zober and Papke (*6*), in a study of individuals exposed in the 1953 dioxin accident at the Badische Anilin-Soda Fabrik, Ludwigshafen, Germany (four of whom died as a result of cancer), found a high concentration of dioxin either in the blood or in biopsy material 34 to 36 years after exposure. All samples (blood, adipose tissue, liver, kidney, and bone marrow) had dioxin concentrations that were 40 to 100 times higher than average background concentrations in unexposed individuals.

Similarly, Manz *et al.* (*7*) and Flesch-Janys (*8*) found a positive association between the level of dioxin exposure and cancer in a group of chemical workers with the highest exposure to dioxin, according to their location in the plant. Thus, there seems to be a correlation between the amount of dioxin absorbed and the development of cancer, as has been found in experimental animals.

Of even greater interest would be to examine the same values in children age 19 and under with leukemia or thyroid cancer in the Seveso population studied by Bertazzi *et al.* (*9*), where exposure may have lasted longer than in the adult population because of ingestion of dioxin-contaminated soil.

Studies of selected groups of individuals from the Seveso region according to their dioxin body burden [the highest found so far in humans (*10*)], would allow comparisons of tissue from patients with the same concentrations of dioxin and the possible association of health effects with a certain amount of exposure.

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Quantum Uncertainty Principle: No Loopholes

According to Gary Taubes' Research News article "Heisenberg's heirs exploit loopholes in his law" (11 Mar., p. 1376), the Heisenberg uncertainty principle

> holds that any measurement of a quantum mechanical system . . . will disturb the system in an unpredictable manner. The more precise the measurement, the greater the disturbance.

The stage having been set in that imprecise manner, it is then possible to say that

> researchers . . . have managed to show that the Heisenberg uncertainty principle . . . has loopholes that—with sufficient ingenuity—can be profitably exploited. The result is a series of experiments . . . to extract information from a quantum mechanical system without disturbing the variable being measured.

Finally, something more precise enters.

> To prove the concept . . . physicists will have to make a pair of measurements of the same system. The first measures the variable of interest, and the second remeasures it, showing that the variable hasn't been disturbed by the initial measurement. . . . The loophole these physicists are exploiting is the possibility of channeling all the uncertainty generated by measuring one quantum variable (a laser beam *intensity*, for example) onto a related variable, known as the conjugate observable (the beam's *phase*) [italics mine].

So says Gary Taubes.

The quantum uncertainty principle is part and parcel of the quantum degree of freedom (*1*). Such a degree of freedom is characterized by two *complementary* variables, so called because they have the same spectrum of values, and the precise measurement of one of