PERMO-TRIASSIC VERTEBRATE EXTINCTIONS: A PROGRAM; E.C. Olson, University of California, Los Angeles

Since the time of my report on this subject at Snow-Bird 1 (1) a great deal of new information has become available. Concepts of the nature of extinctions have changed materially. My conclusion in that report that a catastrophic event was not responsible for the extinction of vertebrates has modified to the extend that hypotheses involving either the impact of a massive extra-terrestrial body or volcanism provide plausible but not currently fully testable hypotheses.

Data on the vertebrates come largely from the Russian Platform, Italy, Sinkiang in China, the Karroo Basin, Zimbawbe, Tanzania and Malagasy in Africa and India. The primary evidence of vertebrate extinctions is the fact that only one of the 90 known general of late Permian reptiles persisted into the early Triassic. This genus and 23 others known from the early Triassic form the basis of a new reptilian proliferation during the Triassic. The most evident aspect of the late Permian extinction is the demise of the principal contributors to the biomass among macro-organisms, the dicynodont reptiles, and the glossopteris flora. Clearly, as well, the infrastructure of the ecosystem was disrupted.

These changes resulted in a rapid decrease in organic diversity, as the ratio of origins of taxa to extinctions shifted from strongly positive to negative, with momentary equilibrium being reached at about the Permo-Triassic boundary (2).

The proximate causes of the changes in the terrestrial biota appear to lie in two primary factors: 1. strong climatic changes (global mean temperatures, temperature ranges, humidity) and 2. susceptibility of the dominant vertebrates (large dicynodonts) and the glossopteris flora to disruption of the equilibrium of the world ecosystem. The following proximate causes have been proposed: 1. rhythmic fluctuations in solar radiation, 2. tectonic events as Pangea assembled, altering land-ocean relationships, patterns of wind and water circulation and continental physiography, 3. volcanism, and 4. changes subsequent to impacts of one or more massive extra terrestrial objects, bodies or comets.

None of the hypotheses or a combination of two or more can be fully tested on the basis of data currently available. This problem, however, does not seem to be insoluble in the long run. Crucial to attainment of this goal is additional detailed information upon: 1. the geographic extent of the extinction at the Permo-Triassic (P/T) boundary, 2. the rapidity at which the extinction took place, 3. precise temporal correlation, or lack of it, the terrestrial changes in different parts of the world, and the correlation of these changes with those which took place in the marine biota, and 4. increased knowledge and understanding of the correlative physical parameters at the Permo-Triassic boundary including changes in the $\delta^{C}13$ level, sedimentary and mineralogical properties across the Permo-Triassic boundary (including the presence or absence of siderophiles, volcanic deposits, remnants of impact indicators), and fluctuations in the residual paleomagnetism).

Massive new data are required, but are not beyond reach. Field studies in all of the many regions in which continuous sequences occur are necessary, involving detailed tracing of all aspects of biotic and physical features across the boundary in both marine and non-marine sections. The materials and data resulting from such studies must be subjected to detailed, repeatable studies in analytical laboratories and the development of models to collate the information and provide for estimation of the significance of each of the multiple factors involved in analyses.

The biological data can supply important but not definitive information, in part because of unavoidable sampling difficulties and because the outcomes of some of the proposed ultimate causes probably cannot be distinguished. Definitive evidence must come from the physical parameters.

At present, the most extensive studies have been made in China in both non-marine and marine sections. These have, however, exploited only a small part of the potential, and physical data in particular need repeated testing and extension well beyond the few sections analysed in detail. The faunal situation in Africa offers valuable information which can be augmented by meticulous, small scale sequential studies combined with analyses of concurrent physical features. The Russian Platform sections would appear to offer chances for informative analyses as do those in Australia (floral and physical) and in Antarctica. Geographic extension would be of extreme value. In contrast to the studies at the K/T boundary, those at the P/T boundary are in their infancy and solutions of the many problems will come only from long term studies.

Cited References

1. E.C. Olson, 1982. Geological Society of America, special paper, 190:501-511.
2. M.I. Benton, 1985. Special Papers in Palaeontology, No. 33:185-202.