nature

A Palaeozoic whodunnit

What caused a mass extinction event 250 million years ago?

Extinction: How Life on Earth Nearly Ended 250 Million Years Ago
by Douglas H. Erwin
Princeton University Press: 2006. 306 pp. \$24.95, £15.95

Michael Benton

Science is about being wrong as much as it is about being right. Thirteen years ago, Douglas Erwin wrote in his book *The Great Paleozoic Crisis* (Columbia University Press, 1993) that the extinction event at the Permo-Triassic boundary (PTB) 250 million years ago had lasted for as long as 10 million years and had many causes: volcanic eruptions, anoxia, acid rain, climate change, massive methane release from the ocean floor, and perhaps even meteorite impact. He termed this idea the 'Murder on the Orient Express' model, after Agatha Christie's mystery of the same name, in which it turned out that all 12 passengers in the train had contributed to the murder of the American millionaire Mr Ratchett.

D. H. ERWIN

Looking for clues: Jin Yugan studies rocks from the Late Permian, around the time of the mass extinction.

In his new book, *Extinction*, Erwin argues that the PTB event lasted for thousands, rather than millions, of years and that a much reduced panoply of killing agents was involved. Many of these trace back to the eruption of the Siberian Traps, 4 million cubic kilometres of flood basalt lavas that erupted for 600,000 years over a huge area of eastern Russia. In *Extinction*, Erwin documents a research programme in rapid evolution.

His earlier view was typical of the time, reflecting a partly explored topic, and the intervening decade has witnessed a remarkable advance in knowledge. In 1993, stratigraphic precision was lacking. Palaeontologists commonly identified a long-term decline in their favourite groups of organisms through the entire Late Permian, whereas we now recognize a precursor mass extinction some 10 million years before the big one at the PTB. The problem was that geologists had not established reliable dating schemes, and many fossils were tagged as little more than 'Upper Permian'. Another problem that Erwin highlighted evocatively in his 1993 book was that many of the best PTB sections lay in politically difficult areas, notably Iraq, Afghanistan, Kashmir and China.

Basic fieldwork in southern China through the 1990s has provided remarkable documentation of the Upper Permian and Lower Triassic sequences. Detailed study of the sediments and fossils has revealed the nature of the environmental changes, how the different groups of organisms fared before and after the event, and the order and timing of all this. Finally, technical improvements in radiometric dating have provided amazing levels of precision for dates on individual volcanic ash bands, with error bars as small as 0.2%; one team calculates the date of the PTB as 251.6 ± 0.6 Myr, and another as 252.6 ± 0.2 Myr, the difference depending on how the ashes are sampled.

Those who write about science should give us the grit, the sweat and the boredom. Erwin certainly gives a lively account of how the geology and palaeontology of the PTB event have been disentangled, and he has been a part of many of the advances. He takes us to the Guadalupe Mountains of Texas, Meishan in southern China, and the Karoo in South Africa. Erwin also introduces the scientific methods and debates in the field and laboratory. He writes of the enthusiasm and commitment of the geologists and palaeontologists in many lands, but portrays little of the hard work involved. One key paper on the palaeontology of the event, for example, was by Jin Yugan and colleagues (*Science* 289, 432-436; 2000), who showed that 94% of marine species died out precisely at the PTB in the Meishan section in south China, and that further steps of extinction continued for 200,000 years or more after that first crisis. This apparently simple result was based on hundreds of thousands of specimens of 333 species, documented by taking rock samples every few centimetres through 80 metres of rock section, and sorting them back in the lab. Misquoting Thomas Edison, scientific advances are 1% inspiration and 99% perspiration, and I feel we need more of the perspiration in this book.

Erwin is a palaeontologist, and that aspect of the story is well told. After all, the essence of a mass extinction is its biological impact, and yet extinction research is often hijacked by the geological factors that may have caused such a devastating loss of life. It's probably easier to pinpoint a massive volcanic eruption or an asteroid impact crater than to document the decline of ecosystems over time. Biology is complex, and it is no fault of the palaeontologists that they often fail to nail the answers to questions such as what caused the extinction, whether it was ecologically selective, and how life recovered afterwards. This was, after all, the nearest life ever came to annihilation — perhaps only 5% of species survived. And if the causes were Earth-bound — massive volcanic eruptions leading to acid rain, atmospheric heating and anoxia — then they hold more profound significance for many of our current concerns than if the event had been triggered by the *deus ex machina* of an asteroid impact. ■

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