Triassic extinction tied to massive lava spills

Dating technique pins down massive eruptions that may have triggered mass extinction.

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Paul Olsen/Lamont-Doherty Earth Observatory

Basalt flows, like the black rock in this New Jersey quarry, are remnants of massive volcanic activity 200 million years ago.

The mass extinction that wiped out many species at the end of the Triassic period some 200 million years ago made way for the dinosaurs' domination of Earth for the next 135 million years. Now, researchers have determined the timing of a possible trigger for that Triassic extinction event with unprecedented precision.

Scientists have long suspected a link between the Triassic die-offs — one of the five largest mass extinctions to have struck Earth in the past 542 million years — and widespread volcanic activity that occurred at around the same time. The vast amounts of lava spilled from those eruptions, which covered an area slightly smaller than Australia, can now be found on four continents.

Radioactive dating techniques used in previous studies haven't been accurate enough to pin down exactly when those eruptions took place, says Terrence Blackburn, a geochronologist at the Carnegie Institution for Science in Washington DC. Some estimates have even suggested that the die-offs took place before the eruptions started, implying that the volcanism may have had only a peripheral role.

But by using a precise dating technique that charts the radioactive decay of uranium isotopes to lead in zircon crystals found within ancient lavas, Blackburn and his colleagues have determined that the volcanism took place in four phases. After examining lavas at seven sites in eastern North America and one in Morocco, the team concludes that the first and largest episode of volcanic activity began at the same time as the mass extinction. The results of the study were published today in *Science*[1].

Crystal clue

Zircons aren't normally found within lava deposits, says Blackburn. But as extremely thick layers of magma cool, zirconium, uranium and rare earth elements become concentrated in still-molten layers within the solidifying lava, providing the source material from which zircons can crystallize.

The first phase of eruptions began in what is now Morocco around 201.56 million years ago, the team reports. Fossils of pollen and other spore-like structures appear in sediment layers there just below the massive lava deposits, also known as flood basalts — a sign that ecosystems in this area were intact and functioning just before the onset of volcanism.

Within about 12,000 years, the wave of eruptions had spread to areas that are now located along the US east coast. During the first 30,000 years of this phase of volcanism, and possibly over a much shorter interval, more than 1 million cubic kilometres of magma had spilled forth — enough to smother an area the same size as the lower 48 US states to a depth of more than 100 metres, says Blackburn.

Subsequent, smaller episodes of volcanism occurred about 60,000 years, 270,000 years and 620,000 years after the first phase had begun, the team estimates.

"This work has taken dating to a higher level with super precision," says Paul Renne, a geochronologist at the University of California, Berkeley. "It adds to the notion that the [end-Triassic] extinctions and the flood basalts were linked."

However, it is still unclear what ultimately caused the die-offs, says Renne. It might have been the drastic swing in climate between short-term cooling induced by volcanic aerosols and long-term warming caused by carbon dioxide emissions. Alternatively, the extinction might have been caused by the resulting acidification of the oceans, or any of a dozen or more ecological insults proposed in previous studies, he notes. "This is good circumstantial evidence, but in some cases that's all you get," Renne says.

References

1. Blackburn, T. J. *et al*. *Science* http://dx.doi.org/10.1126/science.1234204 (2013).