How the event that killed off the dinosaurs wiped out life in Antarctica

2 June 2016, by James Witts, University Of Leeds

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The Cretaceous–Paleogene mass extinction 66m years ago was the most recent of five similar crises to have devastated life on Earth over the last 540m years. It rapidly killed off an estimated 76% of species around the globe, including, most famously, the dinosaurs.

But exactly how this event affected different areas of the globe has not been entirely understood. Some scientists have suggested that creatures living at high latitudes could have been sheltered from the worst effects of the mass extinction. Now our new research, published in the journal *Nature Communications*, reveals that this wasn't the case – even marine molluscs in Antarctica were affected.

Scientists are still debating what caused the extinction. Many researchers believe it was a sudden crisis, triggered by a catastrophic asteroid impact. This formed the 200km Chicxulub crater, today buried off Mexico's Yucatan Peninsula. It also produced a thin layer of rock found all over the world known as the "K–Pg boundary". This "fallout" layer is rich in debris from the asteroid impact and an element called Iridium, rare on Earth but common in space rocks. It coincides with many of the extinctions in the fossil record to within 32,000 years – a geological blink of an eye.

Others suggest a more gradual extinction occurred, related to natural climate and sea level changes over millions of years. Massive volcanic outpourings in what is now continental India – the Deccan Traps – may also have contributed by emitting climate-changing gases into the atmosphere. Scientists recently dated the remains of these huge eruptions and discovered they occurred in a 700,000-year period around the K–Pg boundary. There are even suggestions that the asteroid impact may have intensified the volcanism in a deadly one-two punch.

Cretaceous-Paleogene clay layer (gray) in the Geulhemmergroeve tunnels in the Netherlands. Finger is on the actual K–Pg boundary.

Antarctica's well-preserved fossils

Our research focused on Seymour Island, a site which has been described as the "Rosetta Stone" of Antarctic palaeontology. A small island less than 20km across, located to the east of the Antarctic Peninsula, the rocks here preserve an amazing fossil record of marine and terrestrial life dating from around 69m to 35m years ago. Because Seymour Island is at such high latitudes, no plants grow there, so rocks and fossils are beautifully preserved and exposed for study.

The rocks we examined and collected fossils from were originally deposited in shallow water. Due to the warmer global climates of the time, Cretaceous Antarctica, while located over the South Pole, was covered in rainforests and probably looked similar to parts of modern South America or New Zealand.

Cretaceous rocks on Seymour Island. Credit: Vanessa Bowman, BAS

Empty oceans

In total, I examined over 6,000 fossils collected by my colleagues during field trips to Seymour Island, dated as being ~69m to 65.5m years old. Our goal was to assess how marine biodiversity changed before, during and after the extinction event in Antarctica. We also looked at findings by other scientists, to enable us to compare data from marine fossils with evidence for how the local climate and environments changed through time.

We focused on the fossil record of molluscs; marine creatures that naturally secrete a hard shell which is easily preserved in the fossil record. Three main groups of mollusc were present in the late Cretaceous and Paleogene rocks on Seymour Island. Bivalves (clams), gastropods (marine snails), and ammonites (distant relatives of modern squid and octopus with a hard shell). We also looked at the fossils of other creatures such as sharks and marine reptiles that would have been closer to the top of the food chain, but which do not tend to preserve quite as frequently as fossils.

66m-year-old fossil clams, preserved on Seymour Island. Credit: Jane Francis, BAS

Our results reveal that, while there was some fluctuation in the diversity of species, rates of extinction were generally low until an apparently sudden extinction event in the layer right below the K–Pg boundary, where 65–70% of species disappeared. Many common fossils extend to directly beneath the layer of rock containing evidence for the asteroid impact, and several disappear just above – suggesting they survived initially, but were doomed to extinction in the strange, empty oceans following the event.

Crucially, we did find evidence for climate and environmental changes in Antarctica before and after the extinction – sea level changes and climate warming and cooling – some of which may be related to the eruption of the Deccan Traps. But these events do not seem to coincide with any significant decline in species numbers, or evidence for collapse of the marine ecosystem prior to the K–Pg boundary. Importantly, the percentage of marine species that disappeared on Seymour Island is actually the same as seen at K–Pg boundary sites at low latitudes, indicating the event was just as severe all over the world. This, along with how suddenly the extinction seems to have occurred, provides support for the asteroid impact hypothesis.

We now want to look at how life in Antarctica bounced back after the mass extinction. Did it take millions of years for ecosystems to recover, or did it happen much more rapidly? What happened to the species that survived? We know that most groups of animals that dominate modern ecosystems on Earth today, such as mammals, can trace the roots of their current success back to this extinction event. They were able to replace previously successful groups such as dinosaurs that disappeared. Can we see the same pattern for different groups of animals that lived at high latitudes?

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