Scientists zero in on the role of volcanoes in the demise of dinosaurs

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India's Deccan Traps is an ancient lava field covering about one-fourth of India that has been tied to the End-Cretaceous mass extinction some 66 million years ago. New research is helping to determine whether it played a significant role. Credit: Loÿc Vanderkluysen, Drexel University

Earth has experienced five major mass extinction events over the past 500 million years. Massive volcanic eruptions have been identified as the major driver of the environmental changes that precipitated at least three of these extinction events. The fifth and most recent event—the end-Cretaceous mass extinction—occurred 66 million years ago and was responsible for wiping out dinosaurs. Researchers have long debated

whether gas emissions from volcanic eruptions from the Deccan Traps (an enormous volcanic province located in India) or the impact of a large asteroid is most responsible for causing the climate changes that triggered that event. Now, a multi-institutional research team led by scientists from The Graduate Center, CUNY has analyzed the amount and timing of CO_2 outgassing (one of the main gases released by the Deccan Traps) to further determine the role that volcanism played in climate shifts around the time of the end-Cretaceous mass extinction.

Recent research has identified a global warming event that occurred several hundred thousand years before the end-Cretaceous extinction. Some scientists have linked the eruption of the Deccan Traps to this warming event, but there is debate over whether the lavas that erupted could have released enough CO_2 into the atmosphere to cause it. Adding to this mystery, the lava volumes that erupted during this time are relatively small compared to the volumes erupted during subsequent stages of Deccan Traps activity. A major challenge in this debate has been the lack of CO_2 data on Deccan magmas from this time.

"Our team analyzed Deccan Traps CO_2 budgets that coincided with the warming event, and we found that carbon outgassing from lava volumes alone couldn't have caused that level of global warming," said Andres Hernandez Nava, a Ph.D. student in The Graduate Center, CUNY's Earth and Environmental Science program and first author of a newly published paper in the *Proceedings of the National Academy of Sciences* journal detailing new findings about this event. "But, when we factored in outgassing from magmas that froze beneath the surface rather than erupting, we found that the Deccan Traps could have released enough CO_2 to explain this warming event."

For their study, the team—which included Hernadez Nava and Professor Benjamin Black from The Graduate Center and The City College of New York (CUNY); geochemist Sally Gibson from University of

Cambridge; geoscientist Robert Bodnar from Virginia Tech; geologist Paul Renne of University of California, Berkeley; and geochemist Loÿc Vanderkluysen of Drexel University—used lasers and beams of ions to measure the amount of CO_2 inside of tiny droplets of frozen magma trapped inside Deccan Traps crystals from the end-Cretaceous time period. They also measured the amounts of other elements, such as barium and niobium, which can serve proxies for how much CO_2 the magmas started out with. Finally, they performed modeling of the latest Cretaceous climate to test the impacts of Deccan Traps carbon release on surface temperatures.

The team's findings help fill a significant knowledge gap about how magmas interacted with climate during this crucial period in Earth's history. Their data show that CO_2 outgassing from Deccan Traps magmas can explain a warming of Earth's global temperatures by roughly 3 degrees Celsius during the early phases of Deccan volcanism, but that there was not nearly that much warming by the time we reached the mass extinction event, supporting the idea that later Deccan magmas were not releasing as much CO_2. These new insights disfavor the theory that volcanic CO_2 was a major driver of the most recent mass extinction.

"Our lack of insight into the carbon released by magmas during some of Earth's largest volcanic eruptions has been a critical gap for pinning down the role of volcanic activity in shaping Earth's past climate and extinction events," said Black, the study's principal investigator and a professor in the Earth and Environmental Science program at The Graduate Center CUNY and City College of New York. "This work brings us closer to understanding the role of magmas in fundamentally shaping our planet's climate, and specifically helps us test the contributions of volcanism and the asteroid impact in the end-Cretaceous mass extinction."

More information: Andres Hernandez Nava el al., "Reconciling early

Deccan Traps CO_2 outgassing and pre-KPB global climate," *PNAS* (2021). www.pnas.org/cgi/doi/10.1073/pnas.2007797118

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