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U-Pb geochronology of the Deccan Traps and relation to the end-Cretaceous mass extinction

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Despite the growing number of mass extinction events correlated with large igneous provinces, the mechanisms by which volcanic eruptions can lead to ecosystem collapse and biologic turnover remain poorly understood. A better understanding of these events requires high-resolution timelines for volcanic outpourings, geochemical and isotopic proxy records, and biostratigraphic data that cover the extinction and recovery intervals. It has long been known that the Cretaceous-Paleogene mass extinction event broadly correlates with the eruption of the Deccan Traps, but high-precision geochronology from these basalts has remained elusive, despite the role the traps could have played in ecosystem decline and recovery and the importance of assessing their timing relative to the Chicxulub impact event.

We have applied high-precision U-Pb CA-ID-TIMS geochronology to rocks from within the Deccan Traps that constrain the onset and termination of the main phase of volcanism. Because of the rarity of zircon in basalt, dated material includes both in situ zircon-bearing segregation veins within basalt flows and also volcanic ash beds found between individual basalt flows. The latter likely derive from distant, higher-Si explosive volcanic vents during periods of basaltic quiescence. We show that the duration of the main phase of the Deccan, which included >1.1 million cubic km of basalt, erupted in $\sim$750 kyr and began $\sim$250 kyr prior to recently published dates [1] for the Cretaceous-Paleogene mass extinction event. When combined with published paleomagnetic data from the Deccan traps [2,3], our data place the main phase of Deccan eruptions precisely within the geomagnetic polarity timescale and thus permit correlation of their onset with other stratigraphic records that lack geochronology. Our ages improve on the precision of existing geochronology for the Deccan Traps by 1-2 orders of magnitude and are a crucial starting point for more quantitative estimates of volcanic gas emissions that could be implicated in ecosystem decline prior to the Chicxulub impact and mass extinction event, as well as the potential affect on post-extinction biologic recovery. [1] Renne et al., 2013, Science 339, p. 684. [2] Chenet et al., 2008, J. Geophys. Res. 113. [3] Chenet et al., 2009, J. Geophys. Res. 114.