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# Coastal ecosystem responses to late stage Deccan Trap volcanism: the post K–T boundary (Danian) palynofacies of Mumbai (Bombay), west India

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**Abstract**

The Deccan Trap continental flood basalt eruptions of India occurred c. 67–63 Ma, thus spanning the Cretaceous–Tertiary boundary (65 Ma). Deccan eruptions were coeval with an interval of profound global environmental and climatic changes and widespread extinctions, and this timing has sparked controversy regarding the relative influence of Deccan volcanism upon end-Cretaceous catastrophic events. If Deccan Trap activity was capable of affecting global ecosystems, evidence should be present in proximal Indian sedimentary facies and their palaeontological contents. The impact of late stage Deccan volcanism upon biota inhabiting Mumbai (Bombay) Island's post K–T boundary lagoonal systems is documented here. Sediments (or "intertrappeans") which accumulated within these lagoons are preserved between Trap lavas that characterise the closing stages of this flood basalt episode.

Mumbai Island Formation intertrappean faunal and floral communities are conspicuously distinct from those common to many pre K–T boundary, late Maastrichtian intertrappeans across the Deccan province. The latter sedimentary intercalations mostly developed in cognate semiarid, palustrine ecosystems; by contrast, those around Mumbai evolved in sheltered, peripheral marine settings, within subsiding continental margin basins unique to this late Deccan stage, and under an increasingly humid Danian climate. Geochemical analyses reveal that Mumbai sedimentation and diagenesis were intimately related to local explosive volcanic and regional intrusive activity at c. 65–63 Ma. Although tectonic and igneous events imprinted their signatures throughout these sedimentary formations, organisms usually sensitive to environmental perturbations, including frogs and turtles, thrived. Critically, palynofacies data demonstrate that, whilst plant material deposition was responsive to environmental shifts, there were no palpable declines in floral productivity following Mumbai pyroclastic discharges. Therefore, it is implausible that this late stage explosive volcanism influenced major ecosystem collapses globally.


*Keywords:* K–T boundary; Deccan Traps (India); Flood basalt; Mass extinction; Palaeoecology; Palynofacies

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## 1. Introduction

Continental flood basalt provinces are laterally extensive lava accumulations of substantial thickness and low topographic relief (Rampino and Stothers, 1988). India's dominantly tholeiitic Deccan Trap flood basalt province presently extends across approximately one sixth of the subcontinent, encompassing up to $10^6$ km$^2$ of its western portion (Deshmukh, 1982; Fig. 1). The basalts include Traps downfaulted into the Arabian Sea west of Mumbai (Bombay) and forming part of the Seychelles microcontinent (Tandon, 2002; Devey and Stephens, 1991), and possibly originally occupied a volume of up to $10^6$ km$^3$ prior to their erosion (Courtillot et al., 1986).

The duration of the whole Deccan volcanic episode remains a polemic issue, and advocates exist for both a brief (<1 m.yrs., e.g., Duncan and Pyle, 1988; Hofmann et al., 2000) and extended (e.g., Widdowson et al., 2000; Sheth et al., 2001a) period of activity. This theme is particularly pertinent when assessing the effects of flood basalt volcanism upon local, regional and even global ecosystems. A rapid emplacement of an entire flood basalt province would theoretically prove more detrimental than a series of events separated by protracted dormant intermissions. Proof of quiescent phases exists in the form of sedimentary sequences that accrued between the Traps. Subsequent extrusives often preserved these "intertrappeans", and evidence can be sought within them regarding the influence of volcanism upon sedimentary systems, microclimates and biota.

Because substances released during mafic eruptions are less likely to reach potentially damaging stratospheric levels than those expelled by felsic volcanism, the effects of late stage, increasingly felsic, explosive Mumbai volcanism are of interest. Controversially, a study of massive, well-constrained pyroclastic events (Erwin and Vogel, 1992) found that these did not reduce the ecological diversities of land and marine ecosystems on regional or global scales, and hence were unlikely to be responsible for mass extinctions. A bolide impacting Mexico's Chicxulub platform (Hildebrand et al., 1991) is broadly accepted to have exacerbated, if not singularly forced, end Maastrichtian extinctions across the

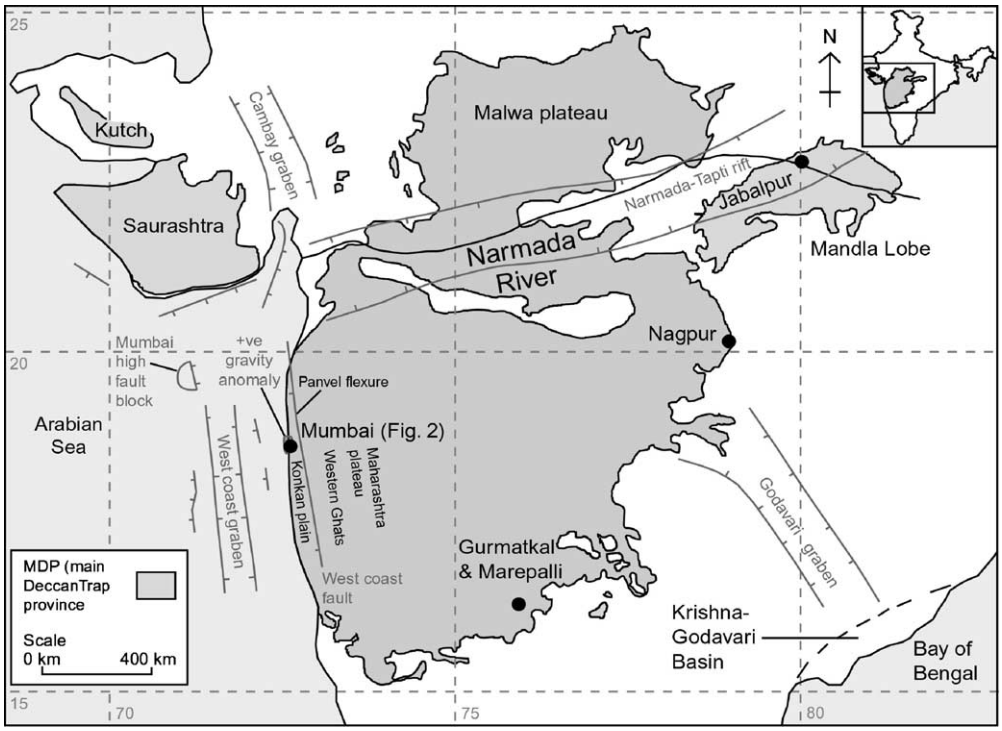


Fig. 1. Present-day Deccan Trap outcrop extent. Major tectonic structures redrawn from Biswas (1991).