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Did the Deccan Volcanism impact the Indian flora during the Maastrichtian?

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A B S T R A C T

The Deccan-associated sediments (Lameta and intertrappean deposits) hold great potential for understanding the role of Deccan Volcanism in the late Maastrichtian ecological upheaval. However, it is challenging to ascertain Deccan Volcanism driven floral changes on the Indian Plate due to unresolvedstratigraphyic and lack of well-dated terrestrial sequences. We provide a thorough palaeobotanical, palaeoclimatic and palaeobiogeographic review of the pre-Deccan (Lameta deposits) and *syn*-Deccan (intertrappean deposits) sequences. We present a detailed palynological analysis of C29R magnetochron intertrappean section from Yeotmal, central India, depicting episodic regional floral responses to volcanism. We have critically reviewed the Indian Maastrichtian palaeofloral and palaeoclimatic records within the best-resolved chronologies to clarify the spatiotemporal changes in palaeovegetation and palaeoclimate pertaining to the Deccan Volcanism. Furthermore, we evaluated the global fossil records of all the nearest living relatives of the studied assemblage to enhance our understanding of the genesis of the late Maastrichtian flora of the Deccan Volcanic Province.

Our study showcases three stages of the Maastrichtian floral succession, corresponding to a quiescent phase between two secondary magmatic pulses of the C29R Magnetochron. Palaeowildfires and massive magmatic outflow caused by the active volcanism severely damaged the pre-existing flora. Progressively, confined and diminished volcanism at Stage-I allowed few aquatic and herbaceous species to flourish within the accessible lacustrine habitats. The dormant volcanic activity at Stage-II, in conjunction with the warm (MAT - ~26 °C) and moist (MAP - ~2270 mm) conditions due to latitudinal shifting of the Indian Plate within the Inter Tropical Convergence Zone, facilitated rapid expansion and diversification of the low-lying megathermal angiosperm forest within various habitats along shallow embayments. The gradual resurgence of volcanic activity at Stage-III resulted in widespread wildfires and forest knockdowns. The swift revival of the hyper-diverse tropical flora during the quiescent phase (Stage-II) does not show long-term (millennial scale) adverse impact of the Deccan Volcanism on the Indian Maastrichtian flora. The palaeobotanical and palaeoclimatic review suggests a consistent subtropical to tropical climate on the Indian Plate during the late Maastrichtian. However, a shift in seasonality from a seasonally dry climate supporting gymnosperm-angiosperm flora during the pre-Deccan phase to a seasonally wet climate and angiosperm-dominated flora during the *syn*-Deccan phase is noticeable. Furthermore, the palaeobiogeographic analysis suggests that much of the Maastrichtian biodiversity on the Indian Plate is a consequence of floral influx from South America and Africa via the Kohistan-Ladakh Island arc. Nonetheless, 41.2 % of the palaeoendemic taxa in the studied palynoassemblage signify substantial in-situ evolution and diversification of tropical angiosperms on the Indian Plate. Consequently, the observed floral and climatic changes during the Maastrichtian period should not solely be attributed to the Deccan Volcanism but to a combination of variables. These include the shifting of the Indian Plate within the Inter Tropical Convergence Zone, enhanced warm and humid climate due to high CO_2 emissions, episodic nature of the Deccan Volcanism, persistence of rich spore and seed stock in legacy flora, better physiological adaptibility of angiosperms for wet climate regimes and tropical floral influx from contiguous biotic corridor.

1. Introduction

The impact of the Deccan Volcanism on biota has been the center of attraction as per the studies on biotic extinction and turnover during the late Maastrichtian (Keller, 2014; Fantasia et al., 2016; Keller et al., 2020; Callegaro et al., 2023). The Deccan volcanic eruptions continued for several hundred thousand years before and beyond the K-Pg boundary, suggesting it was one of the factors contributing to the K-Pg mass extinction (Courtillot et al., 1986; Schoene et al., 2019; Sprain et al., 2019; Hull et al., 2020). The emplacement of the enormous magmatic outpouring of >106 km^3 of the flood basalt (Schoene et al., 2019; Sprain et al., 2019; Hull et al., 2020) and abundant release of volatile gases SO_2,

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