



Timing, tempo and paleoenvironmental implications of Deccan volcanism relative to the KTB extinction, what we can learn from the red bole record?

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Deccan Traps erupted in three main phases with 6% total Deccan volume in phase-1 (C30n), 80% in phase-2 (C29r) and 14% in phase-3 (C29n). Recent studies indicate that the bulk (80%) of Deccan trap eruptions (phase-2) occurred over a relatively short time interval in magnetic polarity C29r. U-Pb zircon geochronology shows that the main phase-2 began 250 ky before the Cretaceous-Tertiary (KT) mass extinction and continued into the early Danian suggesting a cause-and-effect relationship.

In India a strong floral response is observed as a direct consequence of volcanic phase-2. Shortly after the onset of Deccan phase-2, the floral association dominated by gymnosperms and angiosperms was decimated as indicated by a sharp decrease in pollen and spores coupled with the appearance of fungi, which mark increasing stress conditions as a direct result of volcanic activity. The inter-trappean sediments deposited in phase-2 are characterized by the highest alteration CIA index values suggesting increased acid rains due to SO₂ emissions. In addition, a sharp decrease in pollen and spores coupled with the appearance of fungi mark increasing stress conditions, which are likely a direct result of volcanic activity. Bulk organic geochemistry points to a strong degradation of the indigenous organic matter, suggesting that the biomass was oxidized in acidic conditions triggered by intense volcanic activity.

Closer to the eruption center, the lava flows are generally separated by red weathered horizons known as red boles that mark quiescent periods between basalt flows. Red boles have increasingly attracted the attention of researchers to understand the climatic and paleoenvironmental impact of Continental Flood Basalts (CFB). Recent advances in U-Pb dating of Deccan lava flows, studies of weathering patterns and paleoclimatic information gained from multiproxy analyses of red bole beds (e.g., lithology, mineralogy, geochemistry) yield crucial evidence of environmental changes triggered by volcanic activity. Red boles consist mainly of red silty clays characterized by concentrations of immobile elements such as Al and Fe³⁺ ions that are typical of paleo-laterites which probably developed during the short periods of weathering between eruptions. At least 30 thick red bole layers are present in C29r below the KT boundary between lava flows of phase-2 that erupted over a time span of about 250 ky. The short duration exposures of these red boles are reflected in the mineralogical and geochemical data that indicate rapid weathering (high CIA) linked to increasing acid rains. δD and $\delta^{18}O$ measured on smectite clays from the red boles approximate the meteoric water composition that prevailed during Deccan eruptions. Preliminary isotopic data from red boles deposited during the main phase-2 suggest significant and rapid changes in rainfall intensity and/or altitude linked to the accumulation of a 3100m thick basalt pile that erupted over a short period of time.