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Terrestrial acidification and sudden end-Triassic „Waldsterben“

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The Triassic-Jurassic mass-extinction event (T/J; 199.6 Ma) is increasingly linked to the emplacement and subsequent degassing of the Central Atlantic Magmatic Province (CAMP), a large igneous province (LIP) roughly encompassing an area the size of the present-day United States. The environmental impact of flood basalt volcanism is predicted to be twofold: (1) while the release of sulfur (mostly SO_2 and some H_2S) would cause short-lived cooling and regional acidification of terrestrial ecosystems through formation of sulfuric acid (H_2SO_4) rain, (2) the release of CO_2 would lead to long-term global warming. Here, we provide evidence for both short-lived and global long-term effects of CAMP basalts from palynological, geochemical ($\delta^{13}C_{org}$) and clay mineral (XRD) records covering the T/J boundary in two cores drilled in Germany (Mingolsheim) and Sweden (Höllviken-2). Our C-isotopically constrained palynological records show that at the T/J boundary an arborescent flora dominated by seed ferns, conifers and cycads-ginkgophytes was abruptly replaced by a vegetation consisting of herbaceous ferns and fern allies. Similar „fern spikes“ have been documented across the Northern Hemisphere, but have thusfar not been reported from the Southern Hemisphere, consistent with the (supra-)regional, but not global, effects of sulfur emissions. During the Hettangian, this acidophile, low-light adapted flora was succeeded by an impoverished thermophilous vegetation dominated by conifers in response to CO_2-induced greenhouse warming. Brief terrestrial acidification is further

evidenced by the influx of abundant remains of fresh-water zygnematacean green algae, which bloom in present-day acidified freshwater lakes with pH $<$ 5. Enhanced chemical weathering and soil erosion is reflected by a strong increase in kaolinite in T/J boundary beds and the reworking of Paleozoic microfossils (including Silurian acritarchs) indicating bed-rock exposure on nearby Hercynian landmasses. Congruences between our observations and those for the Permian-Triassic boundary (251 Ma) suggest that the emplacement of LIPs could explain both these major Phanerozoic extinction events.