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Early Jurassic phytotoxicity due to Hg-remobilization

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The Central Atlantic Magmatic Province (CAMP) eruptions are generally regarded as the main driver of major environmental change and mass-extinction across the Triassic-Jurassic (TJ) boundary (~201.3 Ma), but the exact mechanisms linking volcanism and extinction, resilience, and recovery remain poorly constrained. Volcanogenic mercury (Hg) has been implicated as the cause for mutations in spores/pollen indicating severe ecological stress in terrestrial vegetation. Indeed, elevated sedimentary Hg concentrations coincide with the extinction interval at multiple sites across Europe. Here we show, palynological and geochemical records that gives insight in the dynamics between the Hg cycle and terrestrial vegetation, indicating repeated phytotoxicity in Early Jurassic deposits.

The abundance of mutagenic spores and the concentration of Hg are quantified in shallow marine sediments in the Schandelah-1 core (northern Germany) across the T/J boundary and the Early Jurassic (Hettangian). The results show increased mutagenic spore abundances with accompanying Hg/TOC anomalies across the end-Triassic extinction and within the lowermost Hettangian. This is consistent with studies from Sweden and Denmark and therefore confirming synchronous mutagenesis in and around coastal European margins. In addition, the Hettangian of Schandelah contains a record of long-term vegetational disturbance in the form of recurrent fern spikes and elevated mutagenic spore intervals, accompanied by Hg/TOC anomalies of similar magnitude. This suggests an overall link between volcanogenic pollution and vegetational disturbance. Based on qualitative analyses of organic matter (OM), which show an overall positive correlation between Hg concentration and terrestrial indicators, alternative sources for sedimentary Hg-enrichment such as vegetation reservoirs should be considered. This characterization of OM indicates an intermediate step in the Hg cycle, likely mediated by vegetation and/or climate feedbacks.

Atmospheric Hg-loading via volcanism can explain the synchronous enrichments of Hg concentrations at the TJ boundary interval in multiple sites across the globe. In contrast, the Hettangian anomalies of Schandelah-1, appear to be mainly driven by environmental/ecological perturbations corresponding to intensifying warm/humid conditions. Extreme seasonality alternating between high rainfall and droughts, perhaps due to eccentricity maxima, leading to increased soil erosion, wildfires and transport/degradation of terrestrial OM could potentially

recycle and redistribute Hg long after initial deposition. These implications suggest a more dominant role of climate-induced Hg-remobilization, rather than direct volcanic emissions, to the mutagenesis in terrestrial vegetation. This could, in addition, lead to asynchronous and local impacts mainly in the proximity of landmasses.