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Release of mercury from black shale during contact metamorphism and the implications for mercury as a volcanic proxy

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Mercury is released to the atmosphere during volcanic eruptions and incorporated in living organisms. Bulk rock mercury concentrations, in particular when normalized to the content of total organic carbon (TOC), is a relatively new proxy in sedimentary successions for volcanic eruptions that links Large igneous provinces with environmental changes. Examples include the end-Permian, the PETM, the end-Triassic, and the Toarcian. Here we challenge the idea that mercury is a unique tracer for release from magma during volcanic eruptions and show that sediment-hosted mercury may get mobilized and released to the atmosphere by metamorphic and hydrothermal processes. We present new data from contact aureoles in black shale from the Karoo Basin (South Africa; the Karoo LIP) and from the Oslo Rift (Norway; the Skagerrak-centered LIP). During metamorphism, the TOC content decreased in the studied shales from background values (10–15 wt.% in two of the cases), to 0–1 wt.% near the intrusion contacts. We show that the mercury concentrations in the shales correlate with the TOC, and that the shales lost most of the mercury during heating and organic matter transformation. The aureole gas generated in the Karoo Basin, including the mercury, escaped to the early Jurassic atmosphere through explosive pipe structures. Our findings shows a need to revise the use of mercury as a tracer for volcanic eruptions, and to include volcanic-induced mobilization from the vast organic-bound mercury reservoirs in sedimentary basins.