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Oxygen isotopes in cherts record paleo-heat flow on Shatsky Rise (Western Pacific)

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A secular increase in chert oxygen isotope ratios over geological time has been linked to changes in paleo-seawater composition, temperature, basal heat flow, and diagenetic alteration, yet the exact controls remain unclear. Understanding the early diagenesis of cherts is key for resolving debates about the evolution of the Earth surface.

Diagenetic chert – (micro)crystalline SiO_2 – forms through the transformation of amorphous silica (opal-A) via dissolution-precipitation, with an intermediate opal-CT phase. Oxygen isotopes in chert record the temperature and ambient fluid composition of the opal-CT to quartz transition, which can be approximated using a novel numerical silica diagenesis model [1]. Assuming that cherts do not undergo any further modification, this allows investigating burial diagenesis as a driver of chert oxygen isotope signatures. We enhanced the model by incorporating ^{17}O computations, enabling predictions of $\Delta'^{17}O_{chert}$ alongside $\delta^{18}O_{chert}$. This refinement revealed a significant overlap of the measured Phanerozoic and Archean $\Delta'^{17}O_{chert}$ data and our proposed respective diagenetic scenarios.

Here we present a case study focusing on cherts from the Shatsky Rise, designed to test if the model accurately tracks (paleo-)heat-flow. The investigated drill cores cover a time span from the Cretaceous to Neogene. Sample specific heat-flows are well constrained, allowing for a direct comparison to heat-flow modelling results derived from the oxygen isotope data. Our silica diagenesis numerical model suggests that a ~9‰ variation in $\delta^{18}O_{chert}$ across modern oceanic crust cooling history can be explained by declining heat flow and variations in sediment accumulation rates. Our new data corroborates this result. While previous studies already suggested that chert oxygen isotopes reflect diagenetic temperatures, our approach facilitates site-specific heat flow reconstruction using O isotopes in cherts as a paleo-heat flow proxy and opens new avenues to exploit diagenesis for unprecedented insights into past environments.

[1] Tatzel, et al. (2022), *PNAS* 119.