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Characterisation of post-burial alterations in Archean seafloor-derived lava and cherts: implications for the primitive terrestrial environments.

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The Archean surface conditions as well as the chemical composition of seawater solutes remain poorly constrained in part due to rarity of reliable geochemical proxies. The rare earth element patterns, Si and O isotopic compositions of Archean submarine rocks have been used to constrain the composition of contemporaneous seawater and the nature of its interactions with underlying and neighbouring rocks, with implications on the redox state and the ambient temperatures at the Archean Earth's surface (Geilert et al., 2014; Lowe et al., 2020). However, post-burial fluid-induced processes like metamorphism and weathering frequently appear to overprint the original signatures, leading to contentious debates on the significance of the observed geochemical compositions (Zakharov et al., 2021). Particularly, negative Ce anomalies measured in ancient BIFs, cherts and silicified lava were used to support the presence of oxygen-rich pockets in the anoxic Archean ocean. In opposite, La-Ce isochron of 3.3 Ga BIF samples from the Barberton greenstone belt has shown that negative Ce anomalies in these formations are not a pristine geochemical signature but reflect post-depositional modification (Bonnand et al., 2020). To constrain the post-burial evolution of cherts and silicified lava from the Archean seafloor cropping out in the Barberton greenstone belt (3.5-3.2 Ga), we have coupled (a) detailed petrographic data with (b) bulk-rock trace elements and La-Ce isotopic systematics (c) triple-O isotopic compositions of silica fractions, and (d) in-situ measurements of Si isotopes from different generations of quartz. Collectively, these data allow reconstructing the composition and temperature of the different fluids (i.e., diagenetic, metamorphic and weathering fluids) that interacted with the cherts and silicified lava after burial. By identifying the effects of these post-burial fluid-rock interactions, our database may unravel the redox state temperature, and composition of the Archean seawater, with unique implications for the primitive terrestrial environments and elemental fluxes into the Archean ocean.

References

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