The heating rate controls chert $\delta^{18}O$

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The oxygen isotope composition of chert reveals an increasing trend throughout Earth's history. This trend has been explained by decreasing seawater temperatures [e.g. 1], increasing seawater $\delta^{18}O$ [e.g. 2], or by an overprinting of the rock record [3]. These hypotheses are called into question by recent evidence for constant seawater $\delta^{18}O$ [e.g. 4] and seawater temperatures <40°C in the Archean [5, 6].

To re-evaluate the utility of chert $\delta^{18}O$ in the framework of detritus-controlled rates of silica diagenesis [7], we have analyzed $\delta^{18}O_{VSMOW}$ at the bulk- and µm- scale of pure cherts and siliceous shales of Precambrian-Cambrian age from SE China. From bulk rock $\delta^{18}O$ we have calculated the $\delta^{18}O$ of the authigenic silica and measured $\delta^{18}O$ of silica in detritus-rich samples by SIMS.

Authigenic silica ranges from 12.6 to 24.9 ‰ $\delta^{18}O$ and correlates with detritus concentrations, an attribute of temperature-dependent oxygen isotope fractionation during opal-CT to quartz transformation. Peak diagenetic temperatures of *circa* 260°C, as determined by Raman spectrometry of carbonaceous material, show that chert reliably records the diagenetic $\delta^{18}O$ signature set during the final diagenetic silica dissolution-reprecipitation step.

Our work shows that $\delta^{18}O$ depends on the crustal thermal gradient, because the rate of silica polymorph transformation predominantly depends on temperature [e.g. 8] and because temperature exerts major control over $\delta^{18}O$. We calculate how thermal gradient and burial rate affect $\delta^{18}O$ of authigenic quartz. Our results suggest that at least a part of the long-term secular increase in $\delta^{18}O$ of chert is caused by decreasing geothermal gradients due to the cooling of the solid Earth.

[1] Knauth (2005) *Palaeogeogr. Palaeoclimatol. Palaeoecol.* **219**, 53–69. [2] Wallmann (2001) *Geochim. Cosmochim. Acta* **65**, 2469–2485. [3] Degens and Epstein (1962) *Am. Assoc. Pet. Geol. Bull.* **46**, 534–542. [4] Cummins *et al.* (2014) *Geochim. Cosmochim. Acta* **140**, 241–258, [5] Blake *et al.* 2010 *Nature* **464**, 1029–1032. [6] Pope *et al.* (2012) *Proc. Natl. Acad. Sci.* **109**, 4371–4376. [7] Isaacs et al. (1982) *Geology* 10, 304. [8] Ernst and Calvert (1969) *Am. J. Sci.* **267A**, 114–133.