

# The oxygen isotopic composition of Precambrian cherts

E.C. PERRY<sup>1</sup> and L. LEFTICARIU<sup>2</sup>

1. Department of Geology and Environmental Geosciences, Northern Illinois University, DeKalb, IL, USA (perry@geol.niu.edu)
2. Department of Geological Sciences, Indiana University, Bloomington, IN, USA (lleftica@indiana.edu)

The oxygen isotopic composition of Precambrian cherts contains an interesting but incomplete record of Precambrian environments.  $\Delta_{\text{chert-water}} = f(T) \approx (\delta^{18}\text{O}_{\text{chert}} - \delta^{18}\text{O}_{\text{water}})$ . Therefore,  $\delta^{18}\text{O}_{\text{chert}} \approx (\Delta_{\text{chert-water}} + \delta^{18}\text{O}_{\text{water}})$ , and  $\delta^{18}\text{O}_{\text{chert}}$  is a function both of temperature of precipitation and of  $\delta^{18}\text{O}$  of the precipitating water. *Neither variable is independently constrained.* The most <sup>18</sup>O-enriched Paleoproterozoic cherts, from the Gunflint, Hamersley, and Kuruman Formations, which are primary precipitates from seas nearly saturated with silica, are depleted by 10‰ or more compared to modern chert; Archean chert is even more depleted.

Post-depositional alteration cannot explain these consistently low <sup>18</sup>O values [1], [2]. Therefore i) the early Precambrian  $\delta^{18}\text{O}_{\text{seawater}}$  was lower than the modern value, ii) early Precambrian surface temperature was higher (up to 60°C), or iii) both. Because neither explanation i) or ii) is completely viable, we explore other factors that may have been active in the Precambrian. Valley *et al.* (2005), indicate that crust-mantle interaction changed significantly about 2500 Myr ago. Therefore, Archean tectonic control of  $\delta^{18}\text{O}_{\text{seawater}}$  may have differed from modern control. *Perhaps the Archean ocean was **not** a hydrothermal system.*

Silica-secreting organisms were absent in the Paleoproterozoic and seawater silica concentration was probably  $\geq 60$  ppm (cf. modern value = 1-15 ppm). Terrestrial weathering of silicates was the probable primary source of the silica deposited in Paleoproterozoic iron formation. Silicate *weathering* would have taken place in fresh water with a  $\delta^{18}\text{O}$  distinctly lower than the  $\delta^{18}\text{O}$  of contemporary seawater. By analogy with phosphate and sulfate complexes, inorganic exchange of oxygen isotopes in silica complexes and gels may be extremely slow.

**Hypothesis:** *In a silica-saturated Paleoproterozoic ocean, chert was precipitated out of isotopic equilibrium with seawater; thus, despite their marine origin, silica complexes or gels and the resultant chert retained their freshwater isotopic signature* – a partial analog may be  $\delta^{18}\text{O}$  of  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  in evaporite deposits.

## References

- [1] Perry E. C. and Lefticariu L. (2003) *In: Treatise on Geochemistry*, vol. 7, pp. 99–113.
- [2] Knauth L. P. (2005) *Palaeogeograph. Palaeoclim. Palaeoecol.* **219**, 53–69.
- [3] Valley J. W., et al. (2005) *Contrib Mineral Petrol* **150**, 561–580.