



Face-related differential Partitioning of Oxygen Isotopes in low Temperature Quartz

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The presence of stable isotope sector zoning, by analogy with elemental sector zoning, has been previously observed in some carbonate and silicate minerals. However, controversy about its systematic occurrence is still under debate in the scientific community.

Knowledge of the mechanisms affecting oxygen isotope partitioning at low temperatures represents an important parameter in the interpretation of fluid-rock interactions. Investigations using two different methods (SIMS and Laser-assisted fluorination) confirm the presence of isotopic sector zoning in hydrothermal quartz crystals from Alpine veins formed at low temperatures (200°C to <400°C). *In-situ* oxygen isotope SIMS measurements were performed in order to parallel the scale of the previously revealed trace element zoning in identical samples. A fine-scale growth zoning was highlighted, enhancing the possibility of changes in the fluid composition during growth. Furthermore, significant differences in the $\delta^{18}\text{O}$ values were found along the same growth zone between different faces, particularly pronounced in Al enriched zones, revealing the occurrence of oxygen isotope sector zoning in quartz. These late stage Al-rich zones also exhibit distinct values from the overall crystal, but they can be higher or lower. Possible effects of high aluminium concentrations on the quartz-water fractionations, evaluated using the Increment Method after Zheng (1991), indicate that only small differences in $\delta^{18}\text{O}$ values (0.1‰) are to be expected for a substitution of Si by Al of up to 3500 ppm of Al at 300°C. While there is a consistent tendency of

higher $\delta^{18}\text{O}$ values in the direction of $m > r > z$ faces, this face-dependent oxygen isotope partitioning is unlikely to be related to the growth rates of the faces. Also, differences between faces do not follow the direction expected for a structural control, as observed for trace element sector zoning (Jourdan *et al.*, submitted). Disequilibrium conditions or variable fractionations between water vapour or liquid and quartz, which could also lead to sector zoning, may explain discrepancies in the $\delta^{18}\text{O}$ values within single faces. The trends measured with the CO_2 laser method replicate those obtained with the SIMS, but are smaller in magnitude.

Reasons for sector zoning of trace elements and isotopes appear to be more complex than expected and different mechanisms may exist for the trace element and isotopic systems. Oxygen isotope sector zoning in minerals formed at temperatures below about 400°C may also be more important than previously thought.

References:

- Jourdan A-L., *et al.* (submitted): Evidence of growth and sector zoning in hydrothermal quartz from Alpine veins. *Eur. J. Mineral.*
- Zheng, Y-F. (1991): Calculation of oxygen isotope fractionation in metal oxides. *Geochim. Cosmochim. Acta*, **55**, 2299-2307.