Triple oxygen isotope systematics in evaporitic brines

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Assessing the water balance in arid regions is a challenging task in hydrology. Evaporation cannot be unambiguously quantified using H and O isotope measurements mainly due to the temperature sensitivity of the d-excess parameter (= $\delta D - 8 * \delta^{18}O$). The analysis of mass dependent $^{17}O/^{16}O$ and $^{18}O/^{16}O$ variations (expressed as ^{17}O-excess [1]) in natural evaporitic waters provides a tool that is insensitive to temperature variability [2].

We investigated the triple oxygen isotope composition of saline waters from the Salar de Llamara, a salt flat in the hyperarid Atacama Desert (N.-Chile). Samples were taken from a succession of 11 interconnected ponds along the outflow path from a groundwater spring with total dissolved solids increasing from 4 g/l to 173 g/l due to evaporation. In addition, pan evaporation experiments with four different starting waters were conducted *in-situ*.

Water samples were analysed as O_2 after fluorination with CoF_3 by dual-inlet IRMS. Average reproducibility of ^{17}O-excess is ± 8 per meg (1 SD) [2].

Evaporation along the flow path results in an increase in $\delta^{18}O$ by 16 ‰ and a decrease in ^{17}O-excess by 100 per meg. The observed trend can be accurately modeled taking into account evaporation, groundwater recharge, salt-effects, relative humidty and isotopic exchange with ambient vapor. The pan experiment, which simulates non-recharge conditions, shows a markedly different trend which is, however, accurately reproduced by the model when recharge is set to zero. In contrast, evaporation trends in d-excess do not discriminate between recharge and non-recharge conditions. This demonstrates a significant improvement of diagnostic capability in hydrologic studies of the triple oxygen isotope system over the conventionally applied $^{18}O/^{16}O$ – D/H system.

References:
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