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Isotope hydrology of dripwaters in a Scottish cave and implications for stalagmite palaeoclimate research

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Abstract. Dripwater hydrology and hydrogeochemistry is particularly useful in constraining the meaning of speleothem palaeoclimate archives, for example using $\delta^{18}O$ signatures. Here, we calibrate the relationship between $\delta^{18}O$ in precipitation, percolation waters and contemporary calcite deposits, at Tartair cave, Sutherland, NW Scotland, an Atlantic site sensitive to regional changes both of temperature and precipitation. Monthly precipitation displayed a 7.1‰ range in $\delta^{18}O$, a negative linear relationship with rainfall amount, and no correlation with temperature. Autogenically-derived cave percolation waters show little variation in $\delta^{18}O$ during the same period and their annual weighted mean is the same as that of the local precipitation. This evidence together with hydrological data and electroconductivity values indicates that percolation waters are well mixed and dominated by stored water. Calculated values of $\delta^{18}O$ of calcite deposited in this cave environment indicate that the cave deposits are forming close to isotopic equilibrium and kinetic effects are negligible. Comparison of a high-resolution $\delta^{18}O$ stalagmite record with the instrumental record of climate indicates that isotopically heavy values are reflective of relatively cold, dry conditions (and vice-versa for warm, wet condition) and hence that stalagmite oxygen isotopes provide an appropriate means of investigating the palaeoclimate in this location.

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