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Hydrochemical and isotopic variability of cave drip water along an elevation gradient and Holocene paleoenvironmental reconstruction, Vancouver Island, Canada.

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Coeval paleoclimate records from adjacent speleothems sometimes display significant differences in isotope and trace element geochemistry. These differences have been ascribed to modification of the external climate signal by complex hydrogeochemical processes in the epikarst and vadose zone. We aim to contribute to the growing body of knowledge of controls on drip water hydrogeochemistry with a specific focus on inter and intra differences between trios of neighbouring drips in each of three caves located at increasing elevation at the head of Tahsis Inlet, a fiord on the Pacific coast of Vancouver Island, Canada. Custom drip monitoring stations provided records of discharge, temperature and specific electrical conductivity (SpC) at 15 minute intervals, while monthly bulk water samples were collected over more than 18 months in 2004-2006 for analysis. The climate is coastal temperate coniferous rainforest, with mean annual temperature of 9.8^{o}C and precipitation of 4000 mm. The summers are dryer while snow packs form above $\sim$500 m ASL in the winter.

The drip discharges were generally low, averaging 50 mL/day (excluding one outlier at 372 mL/day), and non-seasonal although some trending suggests response to lower frequency inter-annual patterns. While SpC was similarly non-seasonal, most drips do display high-frequency variations in discharge, SpC, and temperature in response to more transient events. None of the drips showed increase discharge due to a spring melt water flush or autumnal shift to a positive water budget. Concentrations of Ca,

Mg, and Sr, and ratios between them were temporally consistent and non-seasonal. Good correlation was found between drip discharge and Ca concentration but the relationships with Mg and Sr were more complex. Clear seasonality was observed in the drip water δD and δ^{18}O with average amplitude of $\sim$8.2 permil and $\sim$1.0 permil for all drips, which is damped compared to that typical of the meteoric water of this region (δD = 45 permil, δ^{18}O=5.9 permil average meteoric for 1978-82). In all cases, the drip seasonality was 5-6 months out of phase with the meteoric water, despite recharge-responses observed in the 15-minute data indicating that some proportion of the drip waters are fast recharge water. Given the temporally consistent trace element concentration, all waters are assumed to be reaching equilibrium with the host rock. Altitudinal gradients are evident in some components. The drip water isotopic 'lapse rate' is $\sim$0.2 permil 100 m^{-1} which is $\sim$60% of that anticipated for meteoric water. Cave temperatures are 9.4, 7.3, and 6.4^{o}C for the three caves at 8, 500, and 740 m ASL. Mg and Sr concentrations do not vary consistently with the temperature gradient, displaying instead an inverse relationship with drip discharge.

This improved knowledge of cave drip waters is now serving as the foundation for robust Holocene paleoenvironmental records from Vancouver Island. The speleothem calcite δ^{18}O for samples from the different caves ranges over $\sim$1 permil but the offset between samples within the same cave is also $\sim$1 permil; there is no a clear altitudinal pattern and the subtle isotopic lapse rate observed in the drip waters is not observed in the contemporary calcite. The speleothem records from Tahsis Inlet and others elsewhere on Vancouver Island do provide clear paleohydrological records which we interpret as including early Holocene deglaciation initiated $\sim$12 ka, with possible neo-glacial advances centered on $\sim$7.5 and $\sim$3 ka. Glazed glass plates are presently under each studied drip point and detailed study of the calcite from these will provide additional understanding of the climate-drip-speleothem system in this region.