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# Use of isotopic and geochemical tracers to identify source waters, flow paths, and residence times of headwater catchments in Boulder Creek Watershed, Colorado

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Isotopic ($\delta^{18}$O and $^{3}$H (tritium)) and geochemical ($Na^{+}$, Si, and DOC) tracers were used to investigate residence times, source waters, and flow paths in four headwater catchments along a 2,310 m elevational gradient within the Boulder Creek Watershed. The amount and type of precipitation occurring across the elevational gradient was also produced. Precipitation totals from 2009 ranged from 563 mm at 1800 m to a high of 1214 mm at 3528 m. The precipitation was 85% snow at the highest elevation and only 32% snow at the lowest elevation. Application of a convolution integral to the $\delta^{18}$O values in precipitation and stream waters produced relatively short mean residence times ranging from 1.12 years in the alpine to 2.08 years in the lower montane ecosystem. Tritium analysis indicated relatively young surface water ages and supported the results from the residence time calculations. Two-component mixing models were run using $\delta^{18}$O to identify new and old waters and Silica (Si) to identify reacted and un-reacted waters. All streams consisted of greater then 50% old and greater than 50% reacted waters with the peaks in new and un-reacted water occurring during hydrograph recession. These results indicate that headwater catchments within Boulder Creek Watershed have relatively short groundwater residence times and that groundwater plays an important role in stream flow generation.