Characterization of Groundwater Recharge and Flow in a Vermont Upland Watershed Using Stable Isotope Tracing Techniques

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Abstract

Precipitation and groundwater samples, collected weekly over an 18 month period from the uppermost watershed of the Browns River on the slopes of Mt. Mansfield, were analyzed for delta^{18}O, deltaD, and 3H composition. Differences in seasonal temperature and elevation are reflected in the delta^{18}O composition of precipitation, which ranges yearly over ~20 per mil (%). Mean annual delta^{18}O of precipitation decreases by 2.5 % per 1000 m of elevation gain.

The delta^{18}O of groundwater collected from seven residential wells within the basin varies only 2 % yearly, with the exception of a spring 300 m higher in elevation than the other wells, which shows a yearly variation of 4.3 %. In the warmer months (April to November), the delta^{18}O signature remains constant (within 0.2 %) , while in the colder months (December to March), the delta^{18}O composition varies by as much as 2 %, excepting the high spring, in which delta^{18}O varies throughout the year.

Flow in deep bedrock is well mixed, exhibiting a steady isotopic composition. The delta^{18}O variation detected in wells and springs during the colder months is likely caused by a decrease in evapotranspiration near the wells, which allows influx of recharge following precipitation events. During the warmer months, recharge to bedrock in the valley, where most of the wells are located, appears to be greatly reduced.

Measurements of 3H indicate that the age of groundwater at most of the sampling locations is less than 5 years. Two of the deep bedrock wells contain groundwater that may be between 21 and 34 years, based on comparison with historical tritium deposition. These ages suggest travel rates of 0.2 m/day to 6.6 m/day for groundwater flow in the fractured bedrock.