Geophysical Research Abstracts
Vol. 20, EGU2018-2297, 2018
EGU General Assembly 2018

Comparison of the Stable Isotope Composition of Groundwater at Three Fractured Rock Field Sites Having Thin Overburden

Stephanie Wright and Kent Novakowski
Queen's University, Civil Engineering, Kingston, Canada (stephanie.wright@queensu.ca)

Challenges are prevalent in the characterization and understanding of transport and flow processes in shallow fractured bedrock aquifer settings. Arrival time and residence time of stable isotopic tracers may reveal rates of recharge as well as transport mechanisms for surface contaminants in these settings. To enhance the understanding of this complex issue, the unique isotopic signature of oxygen and hydrogen in snowmelt has been used as a tracer for recharge to depth in multiple fractured rock aquifer systems. Three geologically distinct field sites in eastern Ontario, Canada, were used to compare these mechanisms. The three sites consist of an Ordovician limestone, a mixed Cambrian/Precambrian rock setting and a gneissic formation. These sites are overlain with thin or no overburden and range in topography from flat-lying to substantial topographic gradients in a valley setting. Seven multi-level wells totalling 19 piezometers were used to trace the 2017 snowmelt events across the sites. The wells range in total depth from 27 m to 55 m. Lysimeters were installed in shallow and deep pairs at the soil-bedrock interface in each location to collect a total of 83 isotope samples of recharge after undergoing soil attenuation. A total of 50 snow and 55 rain samples were also collected across all sites to characterize the seasonal isotopic inputs and constrain local meteoric waterlines. The analysis was conducted using cavity ringdown spectroscopy on a total of 395 samples (approximately 20 sample dates per piezometer) with an error of $\pm 1‰$ for hydrogen and $\pm 0.2‰$ for oxygen. The results show distinctly different isotopic responses in the crystalline units when compared to the sedimentary units. Prolonged responses to snowmelt recharge are seen in the crystalline wells at multiple sites having uniform transmissivity with depth. The snowmelt recharge appears dampened and phase shifted with increasing depth in this setting. This response is indicative of distant recharge zones and increased travel distances with depth. Where transmissivity is high in unconfined sedimentary units, rapid and localized responses to snow and rain events are observed with no long term trends. In confined sedimentary wells with lower transmissivity, virtually no change is observed, indicating little to no recent recharge. Distinct flow systems, however, can be identified at various depths in these sedimentary units, as well as some crystalline settings. Both water level and temperature data have been collected to assist in this interpretation and modelling, using a 1-D analytical solution for solute transport in a discrete fracture, was used to help unravel the transport processes over distance.