North-Central Section - 43rd Annual Meeting (2-3 April 2009)
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FLOW PATH CHARACTERIZATION USING SPRING THERMOGRAPHS

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Karst aquifers dominate the local and regional hydrogeology in southeastern Minnesota where a thick sequence of Paleozoic carbonate and siliciclastic rocks are found. These aquifers can be defined as triple permeability systems, where flow occurs through the matrix of the rock, fractures and bedding planes, and conduits. Continuous monitoring at springs of physical and chemical parameters allows the relative influence of each of these three flow components to be quantified. Springs fed by larger permeability components show more variable behavior as defined by storm events. Springs fed predominantly by matrix permeability portray relatively stable behavior. Other factors including basin size, conduit development and surface connectivity can influence spring responses.

Temperature probes are stable, sturdy and economical environmental probes allowing their deployment in multiple springs for time-scales of years. Spring temperature time series are dependent on flow path length and flow rate of waters feeding that spring. We summarize here field data from 25 time series spring temperatures in SE MN. A few springs shows stable thermal behavior, with seasonal fluctuations of less than 0.02°C. Many springs exhibit annual sinusoidal temperature cycles, varying by less than a few °C, which can be months out of phase with surface temperatures. Other springs portray greater variability, fluctuating more than 10°C following snowmelt or storm events.

Springs with a sinusoidal annual response may be a measure of lower permeability matrix and fracture flow paths based on how far out of phase their maxima and minima are from seasonal surface temperatures. Rapid response following storm events provides a measure of the higher permeability flow fracture and conduit flow components. However, storm events are rarely a single, spike input which can complicate the analysis. Spring snowmelt often produces a periodic, repeating temperature signal over several days to weeks. Snowmelt can therefore provide an alternative input function to complex inputs from rain storms.

Temperature monitoring of springs can provide a low cost method to help elucidate bedrock

flow characteristics and basin size. Thermographs can be used to help design more efficient dye traces, especially in systems with flow paths that are months to years long.

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General Information for this Meeting

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