An Analysis of Subsurface Wells: Seasonal Variability and Depth Influences
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Susquehanna Shale Hills Critical Zone Observatory (SSHCZ0)

The Garner Run site is a catchment containing Tussey Mountain, Leading Ridge, and the valley below which contains the shallow Garner Run stream. Garner Run is part of the larger SSHCZ0 site, located in Central Pennsylvania and lying upon Tuscarora Quartzite bedrock. As a CZO, it promotes a great deal of interdisciplinary study.

Drilling and Well Construction Subsurface Study

On August 8th-9th, 2015, a well with sampling sites at 7 feet, 20 feet, and 30 feet below the surface was drilled about 15 feet off of Harrys Valley Road in Garner Run. Drilling was accomplished with a Hydrocore Prospector and a joint effort of Brandon Forsythe and collaborators from Stone Environmental, Inc. and the University of Guelph⁶.

In order to sample from these sites, a peristaltic pump was used to purge the wells and pump sample water to be filtered and collected for further analysis.

Cation Analysis

In order to gain an idea of the groundwater chemistry, the major cations within the sample water were analyzed. To do so, samples were prepped in the field by the addition of 10% nitric acid to a well water sample contained in a plastic 15mL bottle.

These samples were then refrigerated until they could be analyzed by means of Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES) and ICP-MS (Mass Spectrometry).

Main Objective

Data for the three different depths at HV1 along with the surface water site (Garner Run Outlet, GRO) had been collected since September 13th, 2015. This data, cation analysis specifically, had not yet been analyzed, so in order to process this data, the questions were asked: Are there any trends that can be found throughout the few months of data? Can depth profiles be created for the different depths below the surface by averaging cation data?

Seasonal Variability

Graphs depicting aluminum, manganese, and phosphorus cation concentrations plotted against time (September 2015 - June 2016)

Depth Profile

Depth profiles help visualize concentrations of elements in groundwater within the subsurface. In this case, cation concentrations were averaged at four different depths below the surface (0 feet for GRO, and 7, 20, and 30 feet for HV1). The averaged values were then graphed on similar scales to help portray the change in concentration vs. depth.

Groundwater Cation Depth Profile

Discussion/Further Work

Cation concentrations, when plotted against time, show a loose trend of an initial peak followed by a lengthy flat during more recent sampling times. This seems to be accurate for most instances except for potassium concentrations in the 30 foot depth of HV1 and magnesium and sodium for the Garner Run Outlet. In the averaged depth intervals, cation concentrations seem to peak at the depth of 30 feet, except for aluminum and phosphorus concentrations which appear to decrease with an increase in depth below the surface. There could be many reasons for these found trends including precipitation events, weathering trends, etc.

However, drilling often disrupts the geochemistry of groundwater, and until more sampling occurs over time, there is no strong support that these trends are a result of drilling.

Observations

The majority of cation concentrations appear to peak during the September – October 2015 sampling periods. They then appear to experience a flat until the most recent sampling periods of June and July 2016. This appears to be accurate for all samples except magnesium and sodium for the Garner Run Outlet site and potassium for the 30 foot depth of HV1.

References

¹Brandley, et al. (2016). Designing a suite of measurements to understand the critical zone.
³SSHCO - Summary of Harkyss Valley (HV) Well 1, 2015.
⁴Photo courtesy of Sarah Shumaker.

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* Designates streamwater
* Designates groundwater from HV3 (3 feet)

* 0 = below detectable level