Extant or Absent: Formation Water in New York Wells

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Introduction
The Energy Information Administration estimates the United States has 827 trillion cubic feet of potential natural gas resources in shale deposits and 2.5 million cubic feet of natural gas was consumed in the US during the year 2012 (U.S. EIA). One of the primary shale deposits is the Marcellus Shale, which is Devonian age (416-359.2 My), covers an area of 240,000 km², and underlies Pennsylvania, eastern West Virginia, and parts of Maryland, New York and Ohio (Karbo et al., 2013).

Concerns regarding the environmental impact of shale gas extraction include shallow groundwater contamination due to migration of methane, or formation water from the shale gas extraction site. Treatment, storage and disposal of saline flowback fluids after gas extraction could also be a source of water contamination.

Methods

- Groundwater chemistry data for drinking water wells were compiled from Project SWIFT (n=60), NURE (n=684), and the USGS (n=89) data in selected counties.
- The samples were categorized based on salinity (chloride concentration), Ca/Na, Br/Cl ratios.

Results

- Figure 2. Map of categorized water samples as high salinity (Cl≥20 mg/L) and low salinity (Cl<20 mg/L) against the NHD flowline data for the sampled counties. As well as, the NY Formation water presented in Warner, et al.
- Low salinity samples were categorized as Type A (dominated by Ca) or Type B (dominated by Na).
- High salinity samples were categorized as Type C or Type D based on the Br/Cl ratio.

Discussion

The plot of bromide vs. chloride concentrations for the characterized shallow groundwater and New York (NY) formation water indicates a linear relationship between Type D groundwater and NY formation water (Figure 5a). Assuming conservative mixing of NY formation water with shallow groundwaer, the calculated mixing line places Type D waters just below 1% formation water and 99% shallow groundwater. The relationship between bromide and chloride suggests the presence of formation water in shallow groundwater in NY. A plot of sodium versus chloride illustrates a linear trend for Type D waters (R²=0.776, Figure 5b) that appears to fall on the mixing line between shallow groundwater and NY formation water. There are no significant linear relationships between calcium, magnesium, and strontium versus chloride (Figures 6a – 6c) for Type D groundwater and NY formation water. If high salinity groundwater samples from NYs contain small percentages of formation water, we expect linear relationships between chloride and these other generally conservative ions. The absence of these linear relationships suggests high salinity could be associated with contamination by landfill leachate, septic effluent, road salt, or other potential sources of elevated salt. The water isotopes data for the Project SWIFT (Figure 7) shows no distinguishable relationship with the formation brines in the Warner paper. The formation waters do not fall on the Local Meteoric Water Line for the SWIFT well samples; such a small percentage of formation water mixing should not affect the water isotopes of the groundwater.

Future Work

- Determine if mixing of groundwater with others sources of salinity, such as road deicers, can explain the observed linear relationships.
- Strontium isotopes from groundwater samples will also be compared to those for NY formation water.

References


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