Temporal Pattern of Naturally Occurring Methane Levels in Domestic Water Wells Overlying the Marcellus Shale in New York

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1. Introduction

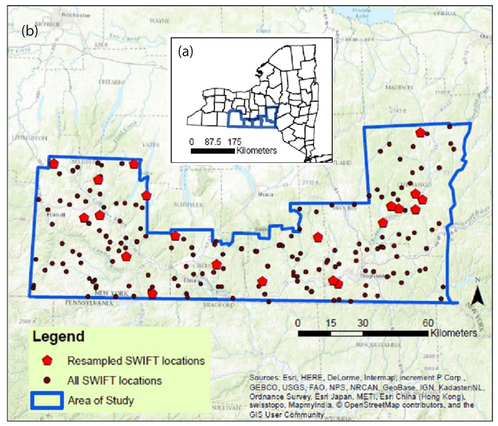


Figure 1: (a) New York state map outlining the five counties of interest in this study: Broome, Chemung, Chenango, Steuben, and Tioga. (b) 137 wells were sampled in 2013 across the study area. In 2014 and 2016, 27 of the wells with among the highest methane concentrations were resampled.

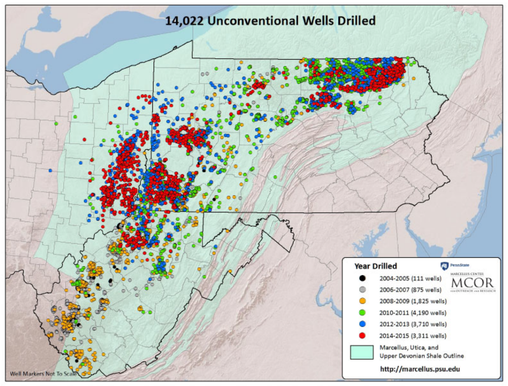
- The Shale –Water Interaction Forensic Tools Project (Project SWIFT), at Syracuse University analyzed relationships between hydrogeologic setting and methane levels in groundwater over the Marcellus Shale in Southern NY
  - o Developed a classification system of aquifer characteristics mostly related to naturally occurring methane: Na-richness, lowlands, and confined aquifers
  - o Acts as a baseline for natural methane levels in hydrofracking states with similar hydrogeology, such as Pennsylvania
  - o 30 out of 137 private wells sampled throughout Southern New York had among the highest methane levels (e.g. >0.01 mg/L)

Goal: Identify whether the high methane levels at those 30 wells are consistently high in the summers of 2013, 2014 and 2016

Purpose: Develop a time series of methane levels as a baseline record prior to unconventional drilling in southern New York

- High demand for unconventional natural gas extraction, especially in the Marcellus shale, has led to large increases in domestic gas production
- Currently New York State has a moratorium on hydraulic fracturing due to the potential environmental risks faulty gas well construction presents
- It is difficult to quantify how much methane in domestic wells is unconventional natural gas production-related versus naturally occurring
  - o Methane concentrations in groundwater can naturally fluctuate over time in response to hydrologic changes
  - o Baseline methane concentration data prior to drilling are not always available

Figure 2: Map of unconventional wells production in the Marcellus Shale from 2004-2015. The 246,049 km2 Marcellus formation expands beneath areas of New York, Ohio, West Virginia, Maryland, Pennsylvania, and Virginia. It is considered one of the top five natural gas reservoirs in the U.S.



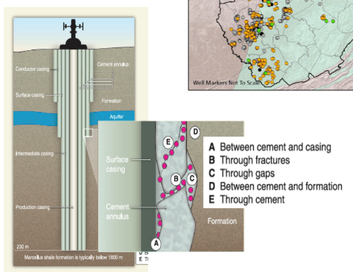


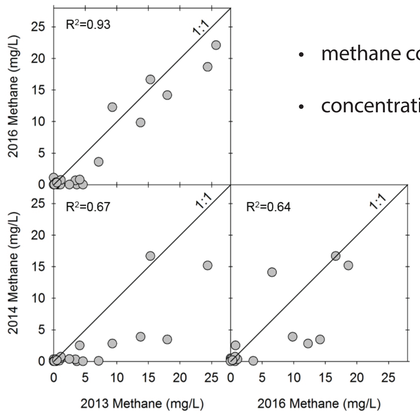
Figure 3: Examples of pathways from which methane can leak into surrounding aquifers. If gas well casings are improperly sealed, gases can leak from the well through fractures and pore spaces in the casing. Source: Vidic et al. 2013

2. Methods

- A subset of 26 wells with among the highest methane concentrations (>0.01 mg/L) were resampled at over 20 properties throughout southern New York
- The subset was analyzed for methane concentration, as well as major dissolved ion and metal concentrations using gas and ion chromatography

Figure 4: Sampling photo at field site. Well water was collected upstream from any water treatment systems and was purged to let out any water that may have been standing. For dissolved ion and metal analyses, samples were passed through a 0.45 µm filter and stored in 125 mL polypropylene bottles. For methane samples collected using the zero-headspace method. Source: Amanda Schulz, Laura Lautz

3. Results



- methane concentrations between 2013/2014 were significantly different at a 5% level.
- concentrations between 2014/2016 and 2013/2016 were not significantly different.

Figure 5: Regression pairs of CH 4 concentrations for three combinations of years. 2013/2016 had the closest relationship (R 2 = 0.93). There was no significant difference between CH 4 in 2016 and the previous years, but there was a significant difference between 2013/2014.

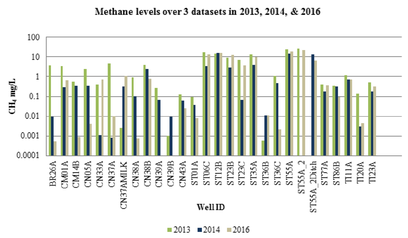


Figure 6: Methane concentrations compared annually. Each well reported was sampled at least twice in this study. Concentrations below the detection limit (> mg/L) were not graphed. In all three years of sampling, >10% of wells had methane concentrations above 10mg/L. Wells ranked with the highest methane levels (top 3 within each year) ranged between 14.09-25.7 mg/L, which the Office of Surface Mining classify as having near actionable concentrations (28 mg/L).

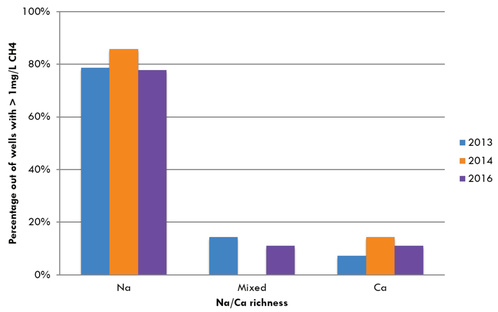


Figure 7: Percentage of wells with high CH4 (>1 mg/L) compared to water chemistry. Majority of the wells with high CH4 (78%-86%) were coincident with Na-dominant groundwater, while high CH4 wells with Ca-dominant chemistry ranged between 7%-14%.

- Water chemistry data is consistent with previous data of this study. There was no significant difference between water type of samples with >1 mg/L methane over the 3 years
- Na-rich valleys had the greatest number of wells with high methane (45%, n=4).

4. Discussion

- The significant difference between 2013/2014 may be a result of variable precipitation events between years
- The interannual time series shows a consistent pattern of methane concentrations, in 2013, 2014, and 2016
- The data supports Project SWIFT's conceptual model, in which wells characterized as lowland sodium-dominant groundwater are also likely to have high methane levels

5. Conclusion

- This study builds on previous research of natural methane occurrence southern NY that is being considered for unconventional natural gas production
- Further research on seasonal variations and hydrogeology of the region is needed to improve the reliability of the time series
- Times series will provide homeowners who reside near hydrofracking activity with water quality information

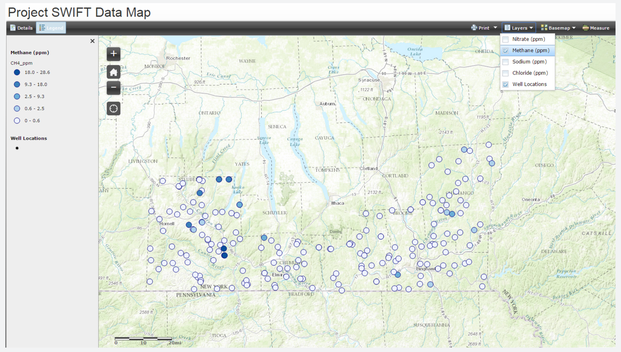


Figure 8: Project SWIFT provides a public interactive database based on water chemistry data, including methane concentrations, collected in the study.

6. Acknowledgements

Thank you to Laura Lautz and the SWIFT research group for inviting me onto this project, to John Kessler at the University of Rochester and Debra Driscoll at SUNY ESF for their analytical services, to Daniel Nothaft for helping me develop my oral and written communications skills, and to all the sponsors of RESESS for making this research experience possible. This material is based upon work supported by the National Science Foundation under Grant No.1261833.

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