

Distinguishing Natural Methane vs. Impacts

Using Methane Prediction Factors

WHY IS STRAY GAS A CONCERN?

Stray methane gases and produced water associated with shale development have raised concerns about potential impacts to groundwater resources. Simple lines-of-evidence have been established to distinguish between naturally occurring methane vs impacts in residential water sources.

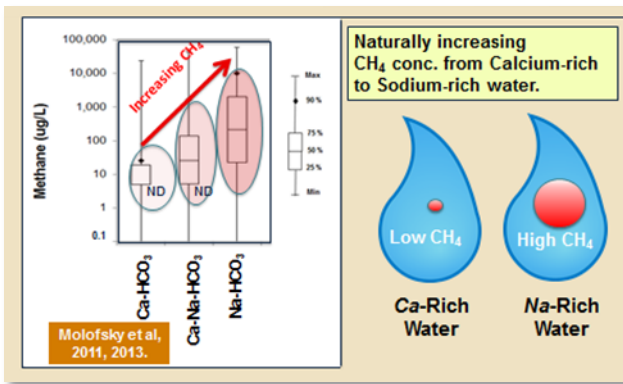
QUESTIONS:

1. What is normal water quality and variability?
2. What parameters should we analyze?
3. How do we analyze test results to distinguish natural methane concentrations from impact?

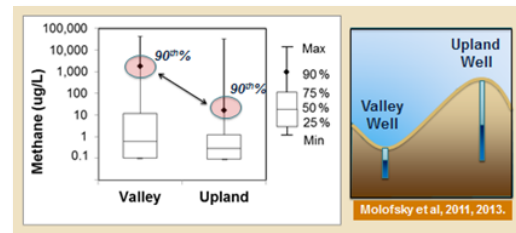
KEY PREDICTION FACTORS FOR NATURAL METHANE LEVELS:

Understanding three Prediction Factors (**Water type, Topography, and Redox state**) will help to answer the questions posed above.

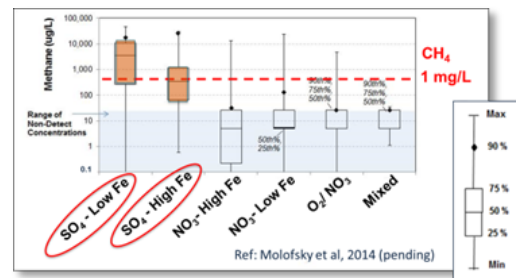
Water Type: Different water types have predictable methane distributions; elevated methane concentrations are typically associated with sodium-rich water types.



Topography: Methane concentrations correlate with topography; typically higher in valleys vs uplands.



Redox State: Redox closely correlates with methane concentrations in pre-drill samples. Higher natural methane occurs in advanced redox states.



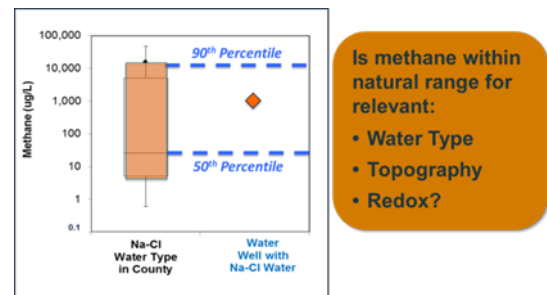
KEY PARAMETERS TO ANALYZE:

The following 22 parameters are useful indicators of natural conditions and possible impacts. Additional parameters may increase cost with no appreciable return.

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|---|--|
| <p>Water Quality</p> <ul style="list-style-type: none"> Alkalinity HCO₃ Cl⁻ Ca CO₃ pH, Sp. Cond. Diss. O₂ (field) SO₄ Na TDS <p>Organic</p> <ul style="list-style-type: none"> BTEX | <p>Gases</p> <ul style="list-style-type: none"> Diss. Ethane Diss. Methane Diss. Propane <p>Inorganic</p> <ul style="list-style-type: none"> Ba Br Fe K Mg Mn Sr |
|---|--|

DISTINGUISHING NATURAL VS. IMPACT:

Wells with post-drill methane concentrations exceeding expected ranges, based on aquifer dynamics and geochemistry, should be evaluated further.



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