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Using a Soil Gas Survey to Determine Methane Flux around a Plugged Gas Production Well

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Background/Objectives. Further investigation was required after it was observed that water had started flowing out from a plugged terrestrial gas production well. As the water pooled around the well, gas was observed to be bubbling to the surface in two locations. Two objectives had to be achieved: 1) determine the flux of and composition of the gas flowing from the well, and 2) determine the origin of the gas.

Approach/Activities. During the project planning it was decided to determine the gas flux using a floating flux chamber. However, community members pointed out that after rains, gas was seen to be bubbling from the ground in a much larger area around the well than just where the continuous gas flow was observed in the water around the well. To investigate the possibility that gas emission was taking place in a larger area around the well, the project team embarked on a soil gas survey during which methane, TPH, carbon dioxide and PID measurements were collected on a grid from shallow soil gas sampling points. Using this data, a much larger footprint of gas emission was found and the soil gas survey had to be expanded to cover the whole affected area. Using this method, the affected area was found to cover a radius of approximately 300 m around the well.

Basic statistical analyses of the soil methane data indicated a bimodal log-normal distribution. Based on these results the flux chamber measurements were expanded to also cover positions on the dry land around the well. Measuring positions were chosen according to the statistical distribution of soil gas methane to ensure that a representative spectrum of flux measurements would be completed. The results indicate a 74% correlation between flux chamber measurements and soil gas methane. For the higher soil gas values the correlation was found to be 90%. This enabled the use of the contoured soil gas data to estimate the total flux over the area, which was significantly higher than what could be expected from naturally emitting methane environments. The results also indicated that the observed gas eruptions in the water around the plugged well were minor in comparison to the methane emissions from the dry soil. The second objective was to determine whether the origin of the methane was a biogenic shallow source or whether the gas was flowing from the deeper thermogenic source that was originally targeted by the well. Gas samples for laboratory tests were collected from both the soil emission and the water body, where bubbling was observed, by using the flux chamber. Dissolved gas samples were also collected from the water surrounding the well. Samples were analysed for light petroleum hydrocarbons, stable isotopes and general atmospheric compounds. The gas was found to consist mostly of methane and the isotope analyses indicated that it was of thermogenic origin. The results therefore indicate clearly that the plugged well has formed a preferential flow path from the gas reservoir to the surface.

Results/Lessons Learned. The results from this case study show that soil gas surveys can be a helpful tool to obtain an estimate of the methane emissions around a gas production well. Without the soil gas survey, it would not have been possible to determine the extent of the emissions around the plugged well. Isotope analyses on the gas samples enabled clear fingerprinting of the source of the gas.