

RECOGNIZING NATURAL GAS CONTAMINATION OF WATER WELLS IN A PETROLIFEROUS REGION

Barbara TILLEY and Karlis MUEHLENBACHS

1. Department of Earth and Atmospheric Sciences, 1-26 Earth Sciences Bldg., University of Alberta, Edmonton, Alberta, T6G 2E3, Canada.

Sixty years of petroleum development has resulted in over 500,000 petroleum wells drilled in the Western Canada Sedimentary Basin, many in agricultural areas that rely on groundwater. The impact on groundwater quality by petroleum development is increasingly becoming a societal concern triggered by intensive, recent CBM development. Carbon isotope values of gases vary within the basin (Tilley and Muehlenbachs, 2007) and can be used forensically to quantify natural gas contamination of groundwater.

As of May 2006, Alberta requires baseline testing of domestic water wells prior to CBM development. Surprisingly, many presumed pristine water wells contain effervescing methane ($\delta^{13}\text{C} = -85$ to -50 per mil) with traces of ethane ($\delta^{13}\text{C} = -70$ to -30 per mil), indicating that some of the water wells have already been contaminated. One farm water well (Figure 1) contained propane, butane and pentane in addition to methane and ethane. Figure 1 compares the isotopic compositions of gases from this problem water well, a neighboring pristine water well, and four nearby, recent, resource wells. The isotope ratios of the ethane in the resource wells and the problem well are similar, in sharp contrast to the neighboring water well, indicating contamination of the water well by deep gas. Mixing calculations (Jenden et al., 1993) indicate that gas from the problem water well is a 1:1 mixture of gas from the pristine water well and deep gas (as at a depth of 1793 m – 1 km away). However, propane and butanes in the problem water well are not identical to gas from the 1 km well, raising doubts as to the attribution of the contaminant source. An alternative deep source may be the 0.4 km well, sampled at 970 m, but finished to 1770 m.

Attributing specific contaminant sources to a given resource well has proven to be even more difficult in areas where there is ongoing CBM development. Landowners have filed complaints about gas contamination of their water wells. However, in one area, the problem gas seems to be attributable to previous conventional petroleum development rather than the current CBM drilling and production. Carbon isotope analyses of water wells in another area suggest a few per cent of CBM contamination in water wells. Unfortunately, lack of pre-drilling background water data prevents reliable quantification of the contamination.

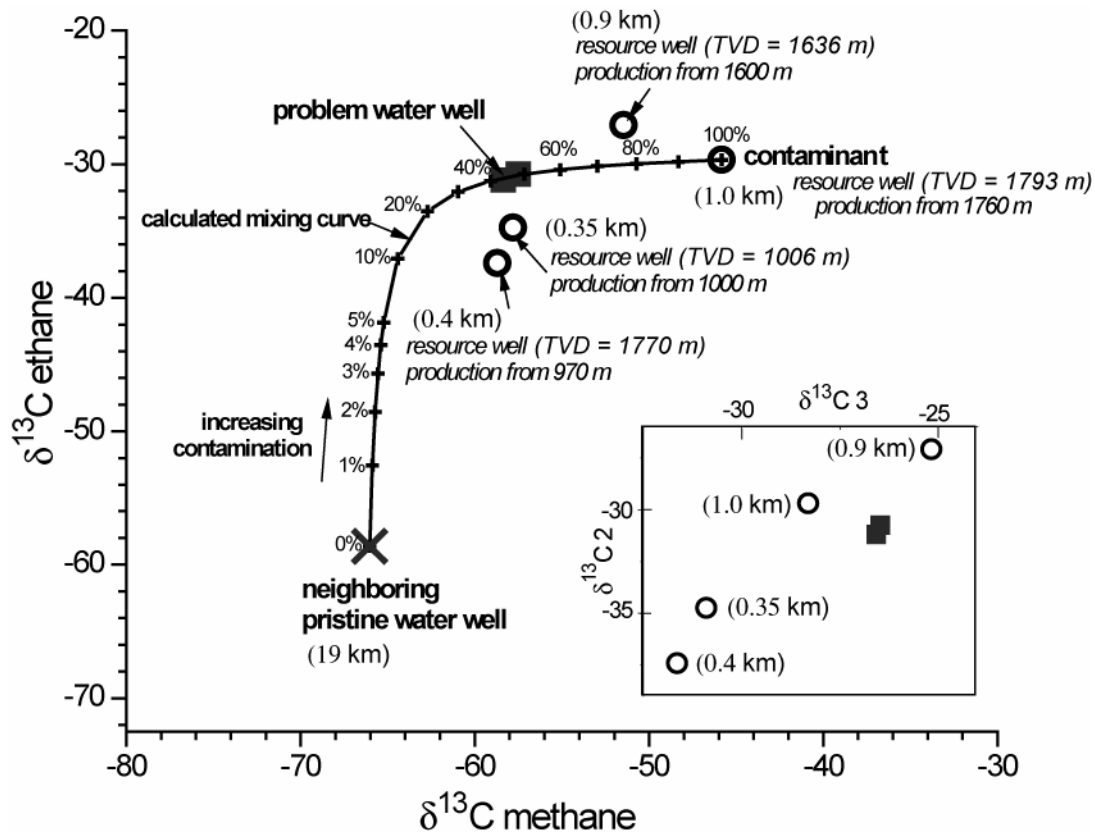


Figure 1. Gas contamination in a water well. Graph compares the carbon isotopic compositions of gas from one farm water well (black squares) sampled twice, 6 months apart, that contains in addition to methane and ethane also propane, butanes and pentanes. Data from four resource wells located a kilometer or less from the problem water well (actual distances in brackets), and a gas from a presumed pristine water well 19 km away, are also shown. The calculated mixing curve shows how the isotope ratios of gas change on mixing two gases with differing isotope ratios as well as differing proportions of methane and ethane (after Jenden et al., 1993). The methane and ethane isotope data can be explained if gas in the problem water well is an almost one to one mixture of shallow gas found in the pristine neighboring water well (99.5% methane; 0.5% ethane) and gas from 1760 m as in the resource well 1.0 km away from the problem well (78% methane and 13% ethane). The insert plots the isotopic compositions of propane versus ethane of the problem water well and the four resource gases. The propane in the water well is too high, relative to gas from the 1.0 km well, implying a deep contaminant source not identical to the one modelled.

REFERENCES

- Jenden, P.D., Drazan, D.J., Kaplan, I.R., 1993. Mixing of thermogenic natural gases in northern Appalachian Basin. *American Association of Petroleum Geologists Bulletin* 77, 980-998.
- Tilley, B., Muehlenbachs, K., 2006. Gas maturity and alteration systematics across the Western Canada sedimentary basin from four mud gas isotope depth profiles. *Organic Geochemistry* 37, 1857-1868.