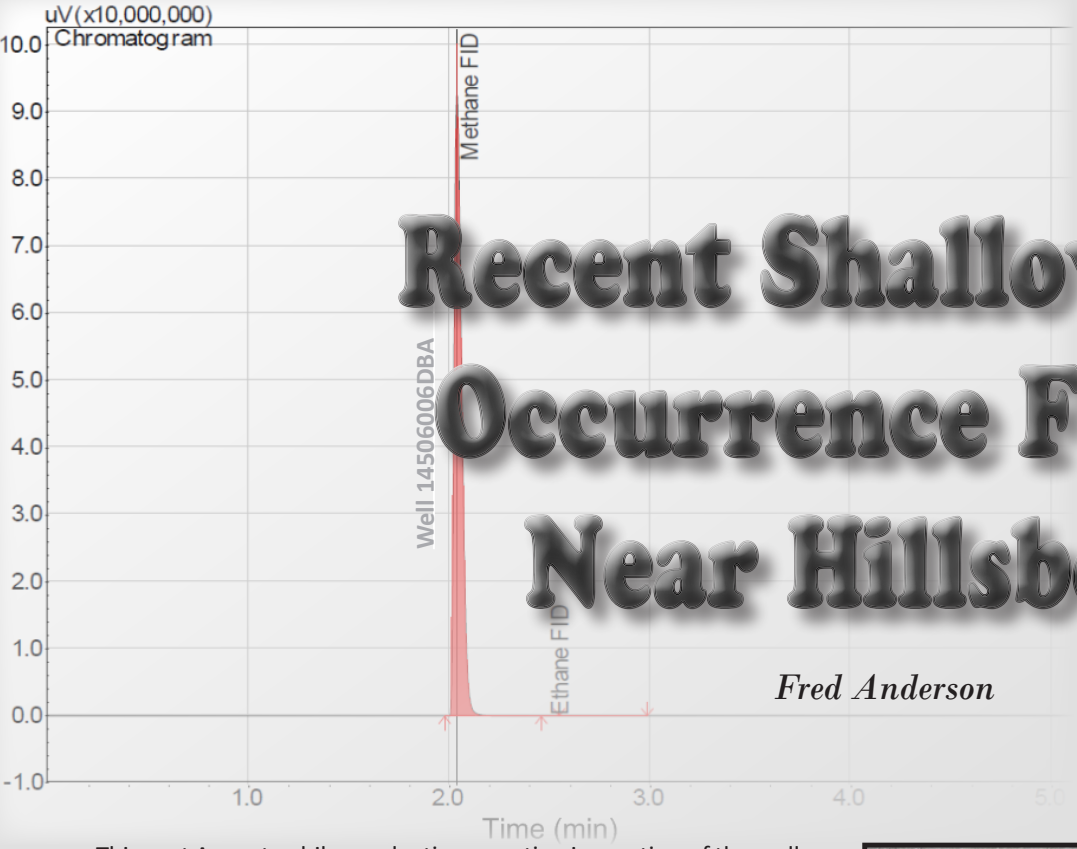

Recent Shallow Gas Occurrence Found Near Hillsboro

Fred Anderson

This past August, while conducting a routine inspection of the well field for a geothermal system at a construction site about a mile southwest of Hillsboro in Traill County, North Dakota Geological Survey Engineering Technician Kent Hollands happened upon gas bubbling up from the mud in several of the drillholes (figs. 1 and 2).

A mud and groundwater grab sample was collected from the site and found to be ignitable. The sample was sent to Isotech Laboratories in Illinois for gas composition analysis and stable isotope geochemistry – the same tests performed in an earlier study on a set of shallow gas samples collected from ground-water wells in eastern North Dakota by the author (Anderson, 2015).

Figure 1. Location of shallow gas occurrence found near Hillsboro in eastern North Dakota's Red River Valley. This shallow gas show is likely originating within the Hillsboro Aquifer.

Figure 2. Shallow gas bubbling up through mud in a drillhole at the geothermal well field site near Hillsboro. Several other drillholes in the well field exhibited the same behavior for an approximate two-week period but dissipated shortly thereafter.

The sample analysis yielded significant amounts of methane (58%) and nitrogen (35%), a small amount of oxygen (5%), very

Table 1 - Gas Composition of Sample Collected near Hillsboro, ND		
Constituent	**Chemical Formula**	**Concen - tration (mol%)**
Methane	CH_4	58.45
Ethane	C_2H_6	0.0011
Nitrogen	N_2	35.47
Argon	Ar	0.484
Oxygen	O_2	5.39
Carbon Dioxide	CO_2	0.18
Helium	He	0.0229
Hydrogen	H_2	--
Carbon Monoxide	CO	--
Ethylene	C_2H_4	--
Propane	C_3H_6	--
Propylene	C_3H_6	--
Butane[1]	C_4H_{10}	--
Pentane[1]	C_5H_{12}	--
Hexane+	C_6H_{14}+	--
BTU/ft^3 Dry		592
Specific Gravity[2]		0.736

-- Not detected
NA = Not Analyzed
1 includes n- and iso- compounds
2 calculated values
Note: Reported chemical compositions are normalized to 100%.
Mol. % is approximately equal to Vol. %.

Table 1. Shallow gas composition of a sample collected from a drillhole at the geothermal well field site near Hillsboro.

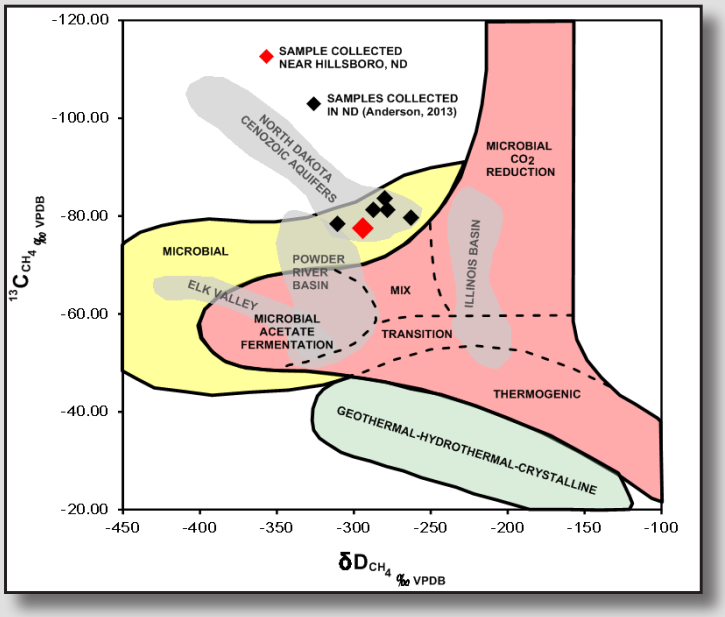

Figure 3. Methane isotope results from previous NDGS investigations and the recent sample collected near Hillsboro continue to be suggestive of shallow gas occurrences with an in-situ microbial methanogenic, and not a migrated or anthropogenic origin (modified from Pantano, 2012, and Whiticar, 1999). (Anderson, 2013) refers to samples collected by Fred Anderson during the 2013 field season.

low levels of ethane (0.001%), and carbon dioxide (0.18%), and minor amounts of argon and helium (table 1).

By virtue of its low carbon dioxide content, the gas composition of the Hillsboro sample is comparable to that of historical gas samples collected from environments within glacial deposits (Meents, 1960). It is also comparable to contemporary examples from other wells in eastern North Dakota (Anderson, 2015) where organic-rich, glacially derived aquifer sediments are generating measureable amounts of methane through natural decay processes (fig. 3).

Stable Isotope geochemistry also suggests an in-situ gas origin (meaning more specifically not a migrated one) for the Hillsboro sample. The conditions under which this type of gas is generated are commonly found in sedimentary aquifers containing organic material such as peat (Hoefs, 2015), bedded coals (Pantano et al., 2011) or detrital lignites in the sedimentary aquifer matrix (Anderson, 2009, 2015). Isotopes of carbon in methane provide additional clues as to the possible origin of the gas, which in this case support a microbial methanogenic origin consistent with previous samples collected from similar geologic environments throughout North Dakota (fig. 3).

The Hillsboro Aquifer, where this new occurrence is presumed to originate from, is composed of glacially derived sediments, several tens of feet thick, containing organic material described by Jensen and Bradley (1963) as "detrital lignites." This shallow aquifer is commonly found around 25 to 50 feet below land surface and covers an area, as currently mapped, of approximately 39 square miles. It has been suggested that smaller, more localized, perched aquifers capable of generating shallow gas may also be present in this area, and that the Hillsboro sample could have come from one of these. Previous field screening for methane by the NDGS in Traill County (Anderson and Hall, 2009), revealed a significant shallow gas show of 1,075 ppm (as methane in air) in a stock well, most likely completed in the Hillsboro Aquifer, (Section 13, T146N, R56W) approximately four and a half miles northwest of the Hillsboro occurrence. The current level of understanding of this hydrogeologic setting and recently observed gas shows make this area an excellent candidate for further study.

References

Anderson, F.J., 2009, Methane Occurrence in Glacial Buried-Valley Aquifer Systems in North Dakota: Geological Society of America Abstracts with Programs v. 41, no. 7, 75-11, p. 214.

Anderson, F.J., 2015, Geochemical Characterization of Natural Gas Occurrences in Selected Ground-Water Wells in North Dakota: North Dakota Geological Survey Geologic Investigations no. 183, 1:1,000,000 map poster.

Anderson, F.J., and Hall, B.N., 2009, Field Screening for Shallow Gas in Traill County, North Dakota: North Dakota Geological Survey Geological Investigations no. 88, 1:150,000 scale map poster.

Hoefs, J., 2015, Stable Isotope Geochemistry (7th ed.): Springer, p. 297-301.

Jensen, H.M., and Bradley, E., 1963, Ground Water in the Vicinity of Hillsboro, Traill County, North Dakota: North Dakota State Water Conservation Committee, North Dakota Ground Water Studies no. 55, 19 p.

Meents, W.F., 1960, Glacial Drift Gas in Illinois: Illinois State Geological Survey Circular 292, 58 p.

Pantano, C.P., McIntosh, J.C., and Anderson, F.J., 2011, Hydrogeochemical Controls on Microbial Coalbed Methane Accumulations in the Williston Basin, North Dakota: Geological Society of America Abstracts with Programs v. 43, no. 5, 206-5, p. 499.

Pantano, C.P., 2012, Hydrogeochemical Controls on Microbial Coalbed Methane Accumulations in the Williston Basin, North Dakota: Tucson, University of Arizona, M.S. Thesis, 77 p.

Whiticar, M.J., 1999, Carbon and hydrogen isotope systematics of microbial formation and oxidation of methane: Chemical Geology, v. 161, p. 291-314.