

Methane Occurrences associated with Coal-Bearing Strata in Ground-Water Wells in Western North Dakota

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Introduction

Over the past three years hydrogeologists from the University of Arizona have been working with the ND Geological Survey in an investigation into the origins of methane gas (CH_4) observed in ground-water wells in the coal-bearing regions of the state. Of specific interest was how ground-water flow and water chemistry influence the occurrence and distribution of methane in groundwater associated with lignites. As part of this investigation, Dr. Jennifer McIntosh, Assistant Professor of Hydrogeology, and graduate students from the University of Arizona's Department of Hydrology and Water Resources, have collected groundwater and dissolved gases from domestic water supply wells (fig. 1) that occur in areas where bedded lignites are present in western North Dakota (fig. 2). Funding for these investigations has been



Figure 1. Dr. Jennifer McIntosh tests groundwater field parameters prior to collecting groundwater and dissolved gas samples from a water-supply well at the Beulah Bay Campground, near the southern shores of Lake Sakakawea in north-central Mercer County. This particular well is completed in sedimentary rocks with bedded lignites that occur above, below, and within the completed interval.

provided in part by a U.S. Geological Survey National Coal Resource Data System grant to the ND Geological Survey.

Description of Field Activities

The author accompanied the University of Arizona researchers into the field during their first visit to the region in September of 2009. Eleven domestic water supply wells were sampled, predominantly in northwestern North Dakota. In May of 2010, Jennifer returned with her students and collected samples from 11 additional domestic wells across western North Dakota. In June of 2010, the author conducted follow-up groundwater sampling on three wells of interest based on their shallow geologic settings

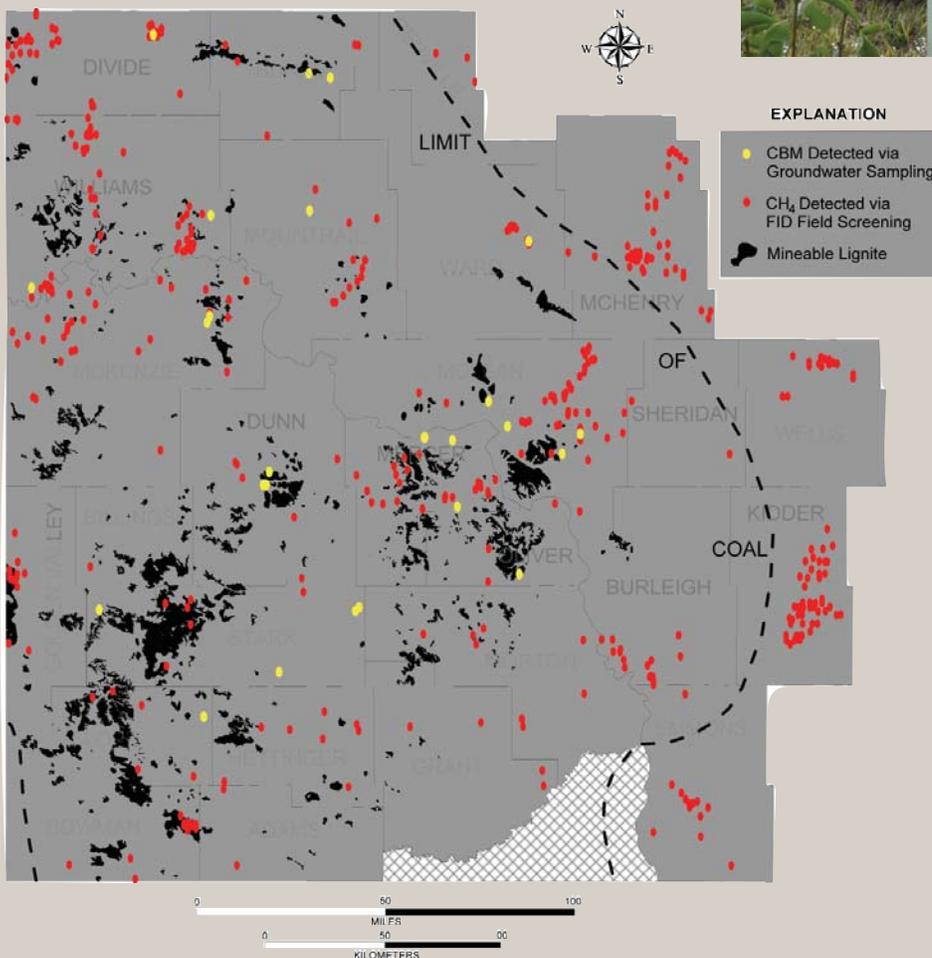


Figure 2. Locations of domestic water wells sampled (yellow dots) for the occurrence of coal-bed methane (CBM) associated with the occurrence of bedded lignites in western North Dakota. Red dots mark the locations of ground-water wells where methane occurrences have been found through Flame-Ionization Detector (FID) field screening. The proximity of these occurrences to areas of mineable lignite (in black), as delineated by Murphy (2006), is shown.

and previous testing results. These wells were located in Divide County in northwestern North Dakota, Ward County in north-central North Dakota, and Sargent County in southeastern North Dakota. Jennifer and graduate student Chris Pantano returned in August of 2011, and sampled 14 additional domestic wells located across the coal-bearing regions of the central and southern Williston Basin.

Wells with Methane Shows in Coal Bearing Regions

Through their fieldwork, the University of Arizona researchers have observed 26 occurrences of methane gas in ground-water. These occurrences add to the 509 found by the ND Geological Survey in coal-bearing counties during field work completed from 2006 to 2010 (fig. 2). One well in Divide County and two in Mercer County are noteworthy based upon the high amounts of methane detected in these wells (table 1).

A ground-water well (163-97-26CBB1) in northeastern Divide County, just a few miles east of Crosby, returned very high amounts of methane during shallow gas field screening conducted by the ND Geological Survey in 2009. This led to follow-up sampling of the well for ground-water geochemistry and gas composition in 2010. During sampling, gas was observed bubbling out of solution prior to sample collection (fig. 3). The results of gas composition analysis, conducted by Isotech Labs in Illinois, reported methane concentrations of greater than 75 mole % in this well.

Water-supply wells at the Beulah Bay Campground, in north-central Mercer County, were also sampled for the second time in 2011. Detected methane amounts in these wells have been commonly greater than 70 mole %. Waters from these wells were tested after local officials notified the ND Department of Health that wells at the campground were fizzing with gas bubbles that on occasion could be ignited with a match (fig. 4).

Possible Methane Generation Pathways

The isotopic composition of carbon in methane and carbon dioxide has been used to infer possible sources of generation in coal-bearing sedimentary basins over the past two decades (Strapoc et al., 2011). The methane discovered in the shallow coal-bearing strata in North Dakota is microbial in origin. Isotopic data suggest it was generated through both the common mechanism of carbon dioxide reduction and, more rarely, by acetate fermentation



Figure 3. Natural gas bubbling out of solution from ground-water collected from an observation well in Divide County, just east of Crosby. The groundwater analyzed from this well had detected amounts of methane at 75 % of total reported gas composition. This well is screened in unconsolidated sand and gravels lying above sedimentary bedrock of the Fort Union Group. The Fort Union Group commonly contains detrital as well as bedded lignites.

(Pantano et al., 2011) (fig. 5). This supports other evidence that the methane in the shallow subsurface across North Dakota, especially in the western part of the state where coals are found, is generated *in-situ* and is not likely to have migrated from deeper geologic units. Further, it has been hypothesized (Pantano et al., 2011) that the migration of shallow groundwater through multiple coals in the shallow subsurface removes oxygen and sulfate, providing a geochemical environment favorable for microbial generation of methane.

Well Location	CH ₄	N ₂	CO ₂	O ₂	C ₂ H ₆ +
163-97-26CBB1 (Divide Co.)	75.12	22.74	1.60	0.17	0.0011
147-87-33CCD (Mercer Co.)	70.23	27.25	1.95	0.51	0.0052
147-87-33CDD (Mercer Co.)	73.04	22.58	2.91	1.46	0.0054

Gas composition in mol %.

Table 1. Gas composition of groundwater in selected wells associated with lignite coals in western North Dakota.

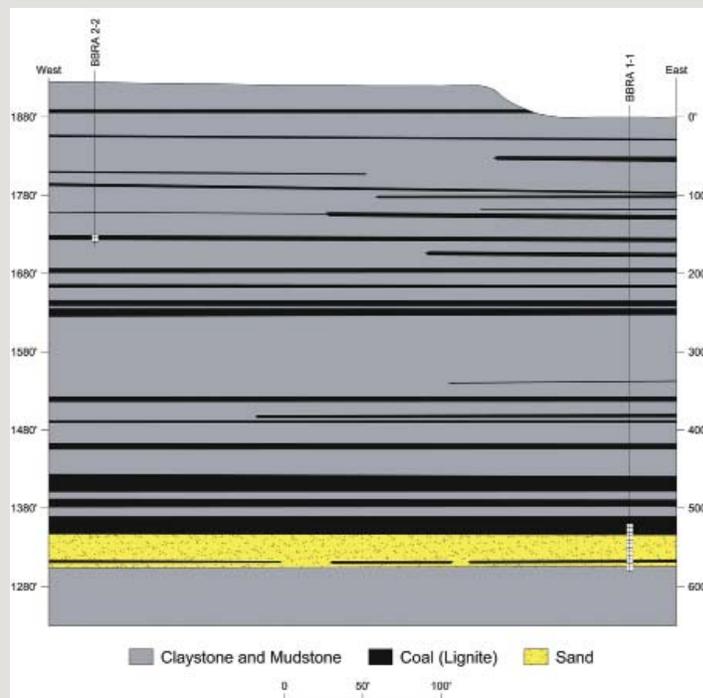


Figure 4. Well construction and lithologic section of water-supply wells at the Beulah Bay Campground in northern Mercer County near the southern shores of Lake Sakakawea. Twenty-three coal beds within Fort Union Group (Tertiary) strata are in this hydrogeologic setting.

