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Methane in Well Water from Lake Charles, Louisiana

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The Chicot aquifer underlies all or parts of 13 parishes in Southwestern Louisiana. The uses of the aquifer include agricultural, industrial and provides nearly 100% of the potable water for the area.

Southwestern Louisiana has a large natural gas industry and its associated distribution facilities. Agriculture is unique in this region in that there is extensive rice production and crawfish farming which results in large areas being seasonally flooded. Much of this coastal region consists of fresh and brackish marsh.

Methane gas has been found in varying concentrations throughout the environment. Concentrations of 1.6 ppm in atmospheric samples were reported by Stauffer et al. (1985). Relatively high concentrations of dissolved methane have been reported to occur in natural ecosystems as a result of leakage of hydrocarbon deposits, and also from biogenic sources (Barker and Fritz, 1981). In deep subsurface environments, such as groundwater, methanogenesis has also been reported (Barker and Fritz, 1981). Often the presence of methane in these deep subsurface systems is due to waste leachate contamination (Baedecker and Back, 1979).

Methane can degas from groundwater and accumulate in wells or buildings thereby posing a potential explosion hazard. In addition, groundwater containing dissolved methane can serve as a primary energy source for the development of microbial communities. Gunsalus et al. (1962) reported substantial microbial growth at the air-water interface of a methane-supersaturated well system in which microbial oxidation of methane provided the necessary energy for microbial growth. Microbial growth within a well system could create taste and odor problems among other things that would directly affect water quality.

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Several techniques have been used for the analysis of methane in groundwater. Buswell and Larson (1937) used a gallon milk can that had been equipped with valves and tubes for collecting water samples directly from a well. The concentration of methane present in these samples was then determined by volumetric analysis. More recent techniques for measuring methane in groundwater samples have involved headspace analysis using gas chromatography (Martens and Klump, 1980). A major problem in recovery of groundwater for determination of dissolved gaseous constituents such as methane is made difficult by degassing within a borehole or during pumping of a sample to the surface (Barber and Briegel, 1987). The technique described in this study overcomes many of the problems associated with collection and analysis of dissolved methane from groundwater supplies.

MATERIALS AND METHODS

Thirteen water wells, which serve as the drinking water supply for the City of Lake Charles, LA, were selected for this study. These wells varied in depth from 500 to 700 feet.

Five-gallon (18.9 Liters) tanks were obtained from the Coca-Cola Bottling Co. and equipped with one-way valves. Prior to sample collection, each tank was purged with nitrogen and then pressurized to 40 psi and weighed. These pressurized, preweighed tanks were then taken to the field, connected to a valve at each wellhead, and filled with water. A closed system was maintained during all sample collections. Each tank, containing a pressurized headspace, was then returned to the laboratory and weighed prior to headspace analysis.

For methane quantitation using headspace analysis, a Varian model 3700 gas chromatograph (GC) with FID was equipped with a Valco™ six port gas sampling valve (Figure 1). Valve placement and design was done by John Booker and Co., Austin, Texas. A Supelco 6' x 1/8" stainless steel column with 60/80 Chromosorb 102 was used for all analyses. Oven conditions were 40°C (2 min.) to 150°C at 5°C/min.

Custom methane mixtures were obtained from Lincoln Big Three, Inc. These were used for standardization throughout this study.

Gas flow from the pressurized tanks to the GC was controlled by a pressure line with quick-connect fittings and an inline flow-controller. Flow was maintained at approximately 20 ml/min. Two injections were made from each tank and the resulting methane concentrations were then averaged.

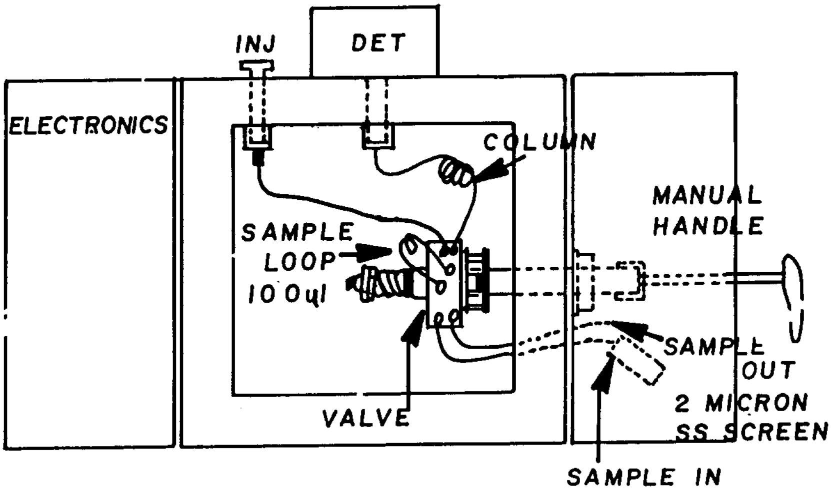

Figure 1. Varian model 3700 with gas sampling valve.

RESULTS AND DISCUSSION

Results of analyses are given in Table 1. Methane concentrations ranged from <0.1 ppm at well C1 to 553 ppm at well M2. Wells that had the highest methane concentrations (C2, M1, and M2) were located in the 500 ft sand. Methane gas in solution within the aquifer would be expected to move with the water toward areas of heavy withdrawals.

Table 1. Methane concentration analyzed in Lake Charles water wells.

Well ID	Depth (feet)	Methane Concentration (ppm)
C1	700	0.20
C2	500	481.00
C3	500	3.20
G1	500	<0.10
G2	700	50.00
G4	700	3.60
G5	700	6.60
G6	700	119.00
G7	700	72.00
M1	500	553.00
M2	500	409.00
CH1	500	23.00
CH2	500	47.00

Using a gas-entrapment method and a combustible-gas meter to determine the amount of gas in water, Hodges et al.

(1963) reported a normal background level of methane gas in groundwater in the Lake Charles area of 0.2 ppm. In addition, Hodges et al (1963) reported groundwater concentrations in this area ranging from 0.0 to 82 ppm. The higher concentrations recorded in the present study are likely due to differences in methodologies used and the fact that water usage over the past 28 years in this region has changed considerably.

Hodges et al. (1963) stated that two potential sources responsible for combustible gases in fresh-water aquifers are decaying plant residuum, commonly associated with production of marsh gases, and petroliferous compounds, commonly associated with oil and gas production. Another consideration as to the presence of methane in this area is the broad belt of fault systems that exist in this region (Hodges et al. 1963), thus allowing methane movement through fault zones.

The methodology tested in this study is a sensitive and effective way of measuring methane concentration in groundwater. Further studies are planned using additional wells to map concentration contours of methane in the groundwater of Southwestern Louisiana.

REFERENCES

Baedecker MJ, Back W (1979) Modern marine sediments as a natural analog to the chemically stressed environment of a landfill. J Hydrol 43:393-414.

Barber C, Briegel D (1987) A method for the in-situ determination of dissolved methane in groundwater in shallow aquifers. J Contaminant Hydrol 2:51-60.

Barker JF, Fritz P (1981) The occurrence and origin of methane in some groundwater flow systems. Can J Earth Sci 18:1802-1816.

Buswell AM, Larson TE (1937) Methane in ground waters. Jo AWWA 29:1978.

Gunsalus RP, Zeikus JG, Wolfe RS (1972) Microbial modification of ground water. University of Illinois Water Resources Center, Urbana-Champaign, IL, Research Report No. 57. 38 p.

Hodges AL, Rogers SM, Harder AH (1963) Gas and brackish water in fresh-water aquifers, Lake Charles, Louisiana, Published by Department of Conservation Louisiana Geological Survey and Louisiana Department of Public Works, Baton Rouge, LA, Water Resources Pamphlet No.13.

Martens CS, Klump JV (1980) Biogeochemical cycling in an organic-rich coastal marine basin. 1. Methane sediment-water exchange processes. Geochim Cosmochim Acta 44:471-490.

Stauffer B, Fischer G, Neftel A, Oeschgar H (1985) Increase of atmospheric methane recorded in Antarctic Ice core. Science 229:1386-1388.

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