Methane-Concentration and Methane-Isotope Data for Ground Water and Soil Gas in the Animas River Valley, Colorado and New Mexico, 1990–91

by Daniel T. Chafin, David M. Swanson, and David W. Grey

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 93-4007

Prepared in cooperation with the
COLORADO OIL AND GAS CONSERVATION COMMISSION,
LA PLATA COUNTY, and the
SOUTHERN UTE TRIBAL COUNCIL

Denver, Colorado
1996

Supersedes Interim Report Published in 1993

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Director

For additional information write to:

District Chief
U.S. Geological Survey
Box 25046, MS 415
Denver Federal Center
Denver, CO 80225

Copies of this report can be purchased from:

U.S. Geological Survey
Earth Science Information Center
Open-File Reports Section
Box 25286, MS 517
Denver Federal Center
Denver, CO 80225

CONTENTS

PLATE

(Plate is in pocket)

FIGURES

TABLES

CONVERSION FACTORS, ABBREVIATED TERMS, WATER-QUALITY UNITS, AND VERTICAL DATUM

Multiply	By	To obtain
atmosphere (atm)	101.3	kilopascal
centimeter (cm)	0.3937	inch (in.)
foot (ft)	0.3048	meter
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.40	millimeter (mm)
mile (mi)	1.609	kilometer
liter (L)	0.2642	gallon
liter per minute (L/min)	0.2642	gallon per minute

Degree Celsius (°C) may be converted to degree Fahrenheit (°F) by using the following equation:

$$°F = 9/5\ (°C) + 32$$

Degree Fahrenheit (°F) may be converted to degree Celsius (°C) by using the following equation:

$$°C = 5/9\ (°F-32)$$

Degree Kelvin (K) may be converted to degree Celsius (°C) by using the following equation:

$$°C = K-273.15$$

Other terms and abbreviations used in this report:

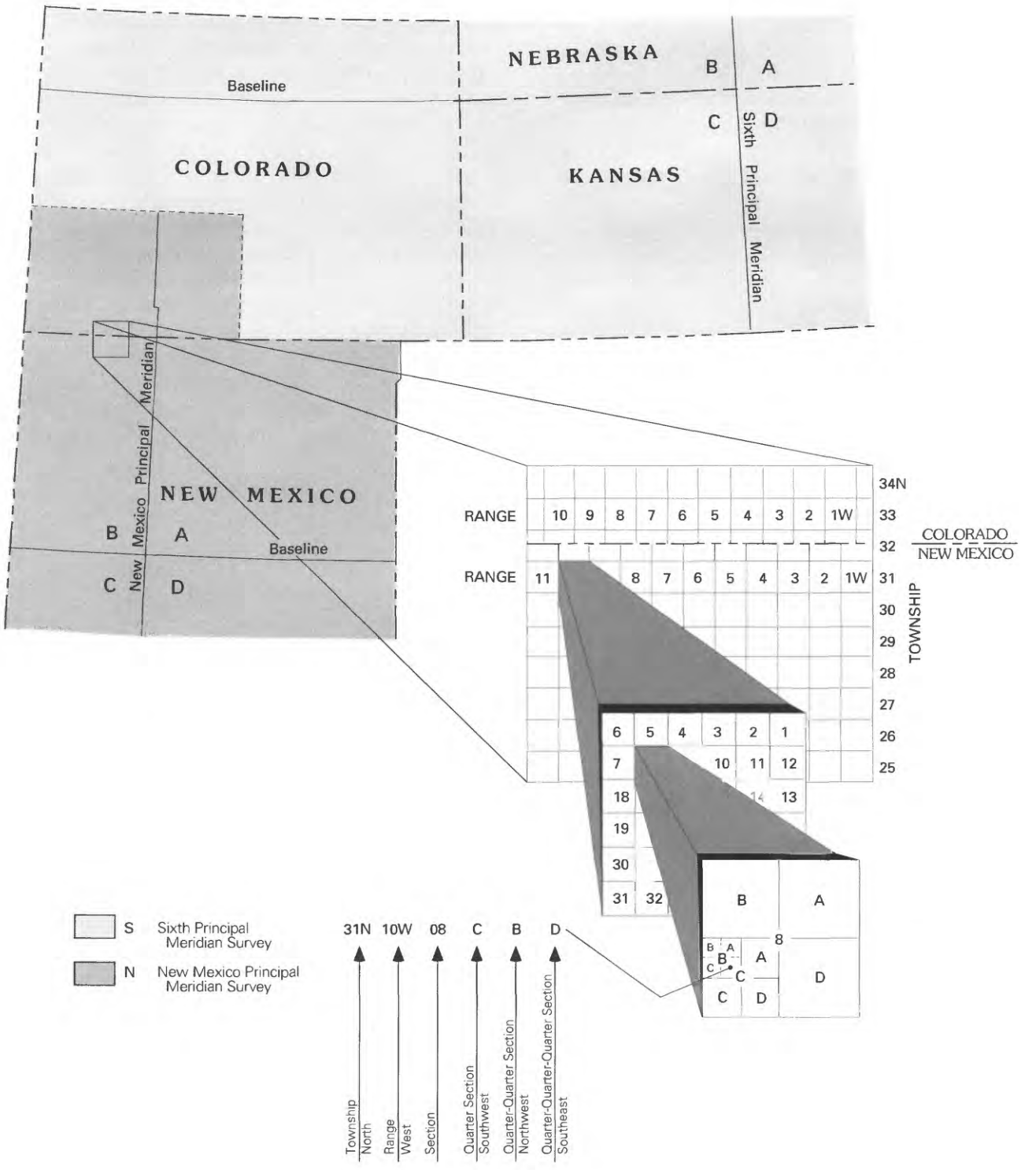
microgram (μg)
microgram per milliliter (μg/mL)
micrometer (μm)
microsiemens per centimeter at 25 degrees Celsius (μS/cm)
milligram (mg)
milligram per liter (mg/L)
milligram per liter of gas (mg/L_g)
milliliter (mL)

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

SYSTEM FOR NUMBERING WELLS

Well locations (land-net locations) in this report are based on the U.S. Bureau of Land Management system of land subdivision and indicate the position of the wells by township, range, section, and position within the section. This method of well location is shown in the figure on the following page. All of the locations in this report are north of the New Mexico baseline and west of the New Mexico principal meridian.

The land-net system indicates location by using three numbers followed by two to four letters. The first number indicates the township; the second number, the range; and the next two numbers, the section in which the well is located. The letters following the section number indicate the location of the well within the section. The first letter usually denotes the quarter section; the second, the quarter-quarter section; and the third, the quarter-quarter-quarter section. The letters are assigned within the section in a counterclockwise direction, beginning with A in the northeastern quarter and followed by B in the northwestern quarter, C in the southwestern quarter, and D in the southeastern quarter. Letters are assigned within each quarter section and within each quarter-quarter section in the same manner. The final letter "X" indicates that the well is centered in the smallest section subdivision listed. Map locations in irregular sections were derived by alignment of the section template at the southeastern corner and along the southern boundary of the section and extending template subdivisions into uncovered section areas where necessary. A few locations for wells near Durango in Township 34 North have a "U" for the first letter, which denotes a section south of the northern boundary of the Southern Ute Indian Reservation. For example, 31N-10W-08CBD indicates a well inventoried in the southeastern quarter of the northwestern quarter of the southwestern quarter of section 8, Township 31 North, Range 10 West.


NEBRASKA
B
A
C
D
Baseline
COLORADO
KANSAS
Sixth Principal Meridian
New Mexico Principal Meridian
NEW MEXICO
B
A
C
D
Baseline
RANGE
10 9 8 7 6 5 4 3 2 1W
RANGE
11 8 7 6 5 4 3 2 1W
34N
33
32
31
30
29
28
27
26
25
TOWNSHIP
COLORADO
NEW MEXICO
6 5 4 3 2 1
7 10 11 12
18 13
19
30
31 32
B A
8
B A
C C D
C D
S Sixth Principal Meridian Survey
N New Mexico Principal Meridian Survey
31N 10W 08 C B D
Township North
Range West
Section
Quarter Section Southwest
Quarter-Quarter Section Northwest
Quarter-Quarter-Quarter Section Southeast

Methane-Concentration and Methane-Isotope Data for Ground Water and Soil Gas in the Animas River Valley, Colorado and New Mexico, 1990–91

By Daniel T. Chafin, David M. Swanson, *and* David W. Grey

Abstract

Important shallow water supplies in alluvium and Tertiary sedimentary rocks overlying Cretaceous gas-bearing formations in the San Juan Basin in Colorado and New Mexico locally are contaminated by methane. Recent development of coal-bed methane from the Cretaceous Fruitland Formation has caused public concern about the possibility of increasing contamination of shallow ground-water supplies. In July 1990, the U.S. Geological Survey, in cooperation with the Colorado Oil and Gas Conservation Commission, La Plata County, and the Southern Ute Tribal Council, Colorado, began a study in the Animas River Valley between Durango, Colorado, and Aztec, New Mexico. The purpose of this study is to map the occurrence of methane in shallow ground water and to identify possible sources of and migration pathways for methane. This report addresses the data-collection phase of the study.

This report presents data collected by the U.S. Geological Survey mostly during August 1990–May 1991. These data consist of: (1) Records of water wells and gas wells; (2) water-quality data, including methane concentrations, from wells and springs in the Animas River Valley; (3) concentrations of methane in soil gas near water wells and springs and adjacent to gas-well casings within about one-half mile of the Animas River Valley; and (4) molecular composition and methane-isotope data for gas samples collected from ground-water headspace, soil, and gas-well production casings.

Water-quality data consist of onsite and laboratory measurements of concentrations of methane and other dissolved constituents in water samples collected from wells and springs. Seventy-one wells and 1 spring in Colorado were sampled, and 132 wells and 1 spring in New Mexico were sampled. Onsite measurements were made for determination of specific conductance, pH, temperature, and dissolved-methane concentrations. At 68 selected sites, additional water samples were collected for onsite determination of alkalinity and laboratory determinations of calcium, magnesium, sodium, potassium, sulfate, chloride, bromide, silica, iron, and manganese concentrations. Onsite methane-concentration measurements of soil-gas and water samples were made with a portable organic gas analyzer equipped with a chromatographic column. Dissolved-methane concentrations were determined by measuring the concentration of methane in headspace gas.

Soil-gas concentrations were measured near 192 ground-water sites and adjacent to the casings of 352 gas wells. Gas was collected from 16 water samples, from 3 soil seeps in open fields, from 10 soil columns adjacent to gas-well casings and 1 soil column adjacent to a cathodic-protection well, and from 30 gas wells. These samples were analyzed for molecular composition and carbon-13 content of methane. Seventeen of these samples were selected for analysis of deuterium content of methane.

INTRODUCTION

Shallow ground water is locally contaminated with methane in the northwestern part of the San Juan Basin where aquifers are underlain by gas-bearing Cretaceous rocks. Important domestic water supplies are obtained from alluvium and Tertiary sedimentary rocks overlying these gas-bearing rocks. Recent development (especially during the late 1980's) of coal-bed methane from the Fruitland Formation in the San Juan Basin has caused public concern about the possibility of increasing methane concentrations in shallow ground water. The Animas River Valley, one of the most populated areas in the San Juan Basin, is underlain by productive gas fields in the Dakota Sandstone, Mesaverde Group, Pictured Cliffs Sandstone, and the Fruitland Formation.

In July 1990, the U.S. Geological Survey (USGS), in cooperation with the Colorado Oil and Gas Conservation Commission, La Plata County, and the Southern Ute Tribal Council, began a study of methane in shallow ground water beneath the Animas River Valley between Durango, Colorado, and Aztec, New Mexico (fig. 1).

The purpose of this study is to investigate possible sources of and migration pathways for methane contamination of shallow ground water in the study area. The specific objectives of the study are to:

1. Map the presence of methane in shallow ground water;

2. Attempt to differentiate among areas where increased methane concentrations result from leaking gas wells, areas where increased methane concentrations result from upward movement through geologic units and fractures, and areas where methane is produced within shallow aquifers;

3. Assess the current chemical quality of potable ground water and evaluate the potential for contamination by upward movement of water with large dissolved-solids concentrations; and

4. Qualitatively describe ground-water flow between the Fruitland Formation and near-surface water supplies (shallow aquifers and surface water).

Purpose and Scope

This report addresses the data-collection phase of this study and presents data collected by the U.S. Geological Survey, mostly during August 1990–May 1991. These data consist of: (1) Information about location and construction of sampled water wells, springs, and gas wells; (2) water-quality determinations, including methane concentrations, from domestic wells and springs in or adjacent to the Animas River Valley; (3) concentrations of methane in soil gas near water wells and adjacent to gas-well casings within about 0.5 mi of the Animas River Valley; and (4) molecular and methane-isotope data for gases from ground water, soil, and gas wells. The locations of sampling sites are shown on plate 1.

Acknowledgments

The authors appreciate the cooperation of homeowners in the study area who allowed access to their property and thank the Aztec District of the New Mexico Oil Conservation Commission for the information used in the construction of the gas-well data base. In addition, the authors acknowledge the Gas Research Institute and the Amoco Production Company for providing supplementary information that was useful in this study.

COLLECTION AND ANALYSIS OF SAMPLES

Results of analyses of water samples from 203 wells and 2 springs were used to map the presence of methane in ground water, to determine relations between methane concentrations and other factors, and to select water samples for molecular and methane-isotope analyses of headspace gas. Information about sampled wells and springs was obtained from well or spring owners when they were contacted for permission to sample. This information was checked against permits filed with the Colorado and New Mexico State Engineer offices. Permits were not available for many sampled wells and springs; therefore, the reliability of construction data for these wells could not be verified. The primary aquifer tapped by a well was determined from information provided by owners, well logs (if available), and field observations.

Most ground-water samples were collected from wells used to obtain drinking water and water for yard irrigation and livestock. Piped public-supply water is available in the study area between Aztec and Cedar Hill, New Mexico, although many homeowners have opted not to use it. One public-supply well and two springs were sampled. Samples were collected at as many sites as possible in areas where wells were sparse and at selected sites in areas where wells were distributed more densely. Because the well distribution is denser in the New Mexico part of the study area than in the Colorado part, more wells were sampled in the New Mexico part of the study area than in the Colorado part. Seventy-one water wells and 1 spring in Colorado were sampled, and 132 water wells and 1 spring in New Mexico were sampled. Initial sampling was done during August–October 1990. Water from 20 sites in the Cedar Hill, New Mexico, area was resampled randomly during February 20–25, 1991. The purpose of resampling was to test seasonal effects on variations in concentrations of methane in ground water.

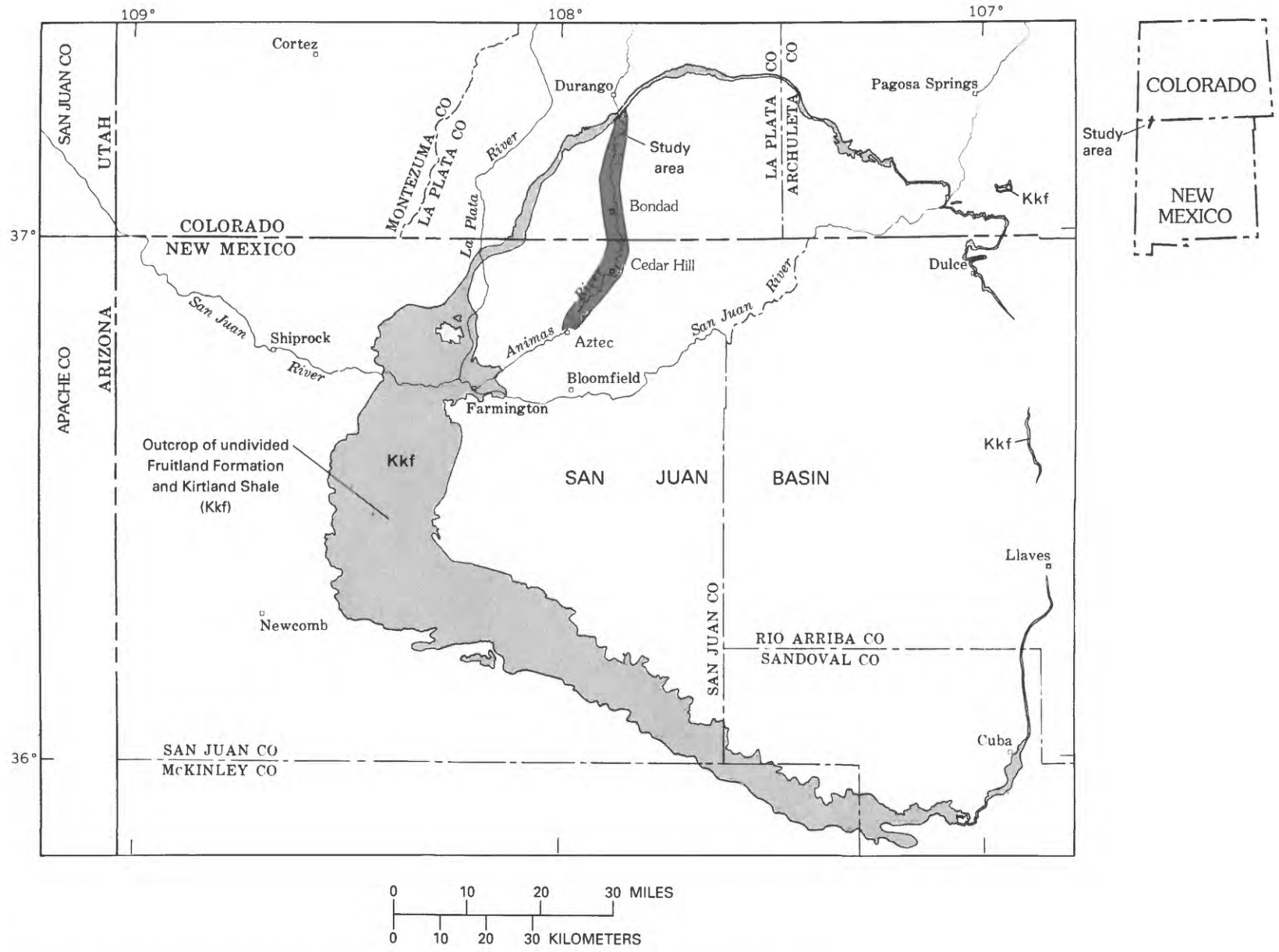


Figure 1. Location of the study area in the San Juan Basin (modified from Fassett and Hinds, 1971).

Soil-gas-methane concentrations were measured at 192 ground-water sites, by the casings of 352 gas wells (and some associated cathodic-protection wells) within 0.5 mi of the Animas River Valley, and at 4 open-field soil seeps. The purpose of these measurements was to determine relations between soil-gas-methane concentrations and dissolved-methane concentrations at water-quality sites, between soil-gas-methane concentrations at water-quality sites and gas wells, and to select soil-gas samples for molecular and methane-isotope analyses.

Gas from 16 water samples, from 3 soil seeps in open fields, from 10 soil columns adjacent to gas-well casings and 1 column adjacent to a cathodic-protection well, and from 30 gas wells were collected for analyses of molecular composition and carbon-13 content of methane. The purpose of this sampling was to provide information about possible sources of methane in shallow ground water and soil.

Well Purging and Sample Collection

Before water-quality samples were collected, each water well was prepumped to purge the casing of standing water. At least one casing volume of water was prepumped. Casing volume was estimated from well depth and casing diameter at the surface. Water was pumped and collected from outside faucets that were as close as possible to the well. The timed discharge rate was used to calculate the time required to prepump one casing volume from the well.

Water-Quality Determinations

Following prepumping, water samples were collected from the same outside faucet for onsite measurements and laboratory analyses. Specific conductance, pH, temperature, and dissolved-methane concentrations were measured onsite for each water sample. Laboratory analyses of 68 selected water samples were made for determinations of concentrations of major dissolved ions and selected trace elements. These determinations were for calcium, magnesium, sodium, potassium, sulfate, chloride, bromide, silica, iron, and manganese. Samples for all of these determinations were filtered through a cellulose acetate filter with 0.45-μm pores. Samples for all determinations except sulfate, chloride, and bromide were stabilized with nitric acid. Laboratory analyses were done at the USGS National Water-Quality Laboratory in Arvada, Colorado, according to methods described in Fishman and Friedman (1989). Incremental alkalinity titrations were performed onsite for samples collected for laboratory determinations.

Soil-Gas Sample Collection

Soil-gas samples were collected by inserting a perforated steel tube 3 to 4 ft into the ground. Soil gas was withdrawn from the tube by means of a small battery-operated vacuum pump. After prepumping for 1 minute to purge the tube, a gas sample was withdrawn with a gas-tight syringe and immediately injected into a gas chromatograph.

Soil-gas samples at ground-water sites generally were collected 50 to 100 ft downvalley from the well or spring. Soil-gas samples generally were collected within 1 ft of gas-well and cathodic-protection-well casings. Generally, several samples were collected from various locations around the casings, and the maximum concentrations are reported.

Determination of Methane Concentrations

Methane concentrations were measured onsite with a Century OVA–128GC Organic Vapor Analyzer (OVA) equipped with a 24-in., Porapak-N, 80/100-mesh gas-chromatograph column capable of separating methane, ethane, and heavier hydrocarbon gases. The incorporated detector is the flame-ionization type. Hydrogen gas was the carrier gas and the fuel supply. Methane eluted in about 20 seconds following injection, whereas ethane eluted in about 2 minutes at 75°F. Actual elution times varied with ambient temperatures in the field environment. Chromatograms were recorded with an accessory chart recorder.

The chromatograph signal response varied slightly with onsite conditions. Calibrations indicated that the response was 10 percent greater at 25°F than at 75°F. Because most ground-water analyses were done between 50 to 85°F, the actual response variability caused by temperature variations probably was less than 10 percent. The response also varied with ambient atmospheric pressure. However, this variation probably was small because the difference in elevation between the highest ground-water-sample site (6,470 ft) and the lowest ground-water-sample site (5,610 ft) was small. This elevation difference corresponds to about a 3-percent difference in mean barometric pressure; pressure variation because of weather changes is similar. Onsite calibration checks indicated that the overall variation in accuracy was about ±20 percent. This variation is acceptable for analyses done with a field instrument.

Standardization of the Organic Vapor Analyzer

The OVA was standardized with a 95-parts-per-million (volume-to-volume basis, ±5 percent) methane-in-air standard obtained commercially. A 1-L, Teflon gas-sampling bag was filled with this standard gas to ambient atmospheric pressure. Ambient atmospheric pressure was established by use of a bleed tube connected to the gas-supply line. After the bag was slightly overpressured, the standard tank was closed, and the clamp on the bleed tube was opened, which allowed excess pressure to bubble the methane under about 1 cm of water until bubbling stopped. The clamp was closed, and atmospheric pressure was determined with a barometer and recorded. Ambient temperature was determined with a thermometer and recorded.

The Ideal Gas Law was used to calculate the concentration of methane in the gas-sampling bag:

$$P'V = nRT \quad (1)$$

where

P' = partial pressure of methane, in atmospheres;
V = volume, in milliliters;
n = moles of methane;
R = gas constant (82.06 atm mL mole^{-1}K^{-1});
and
T = temperature, in degrees Kelvin.

The following equations were substituted into equation (1) to provide the appropriate units and the partial pressure of the 95-parts-per-million methane standard:

$$P' = (P)\ (95 \times 10^{-6}\text{mL } CH_4/\text{mL}) \quad (2)$$

and

$$n = m/M, \quad (3)$$

where,

P = ambient pressure, in atmospheres;
m = mass of methane, in milligrams;
and
M = molecular weight of methane (16,040 milligrams per mole).

These substitutions, rearrangement, and use of the appropriate units yield the final equation for the concentration of methane, C_s (in micrograms per milliliter), in the sample bag:

$$C_s = m/V = 18.57\frac{P}{T} \quad (4)$$

The OVA was calibrated by means of three injections of each of the following volumes of the standard gas: 0.050, 0.100, 0.250, 0.500, and 0.750 mL. The mass of methane injected, m_s (in micrograms), for each of these volumes, v_s (in milliliters), was calculated by:

$$C_s = m_s/v_s \quad (5)$$

or

$$m_s = C_s v_s$$

Average peak areas were plotted against the masses of methane injected to generate a standard calibration plot.

Onsite Measurements of Methane Concentrations in Water and Soil Samples

Peak areas that resulted from injection into the OVA of known volumes of gas from headspaces over water samples or from soil columns, v_s (in milliliters), were used to determine concentrations of methane. The peak area of the sample methane and standard calibration plot were used to determine the mass of methane, m_s (in micrograms), in a gas sample injected into the OVA. The concentration of methane in the sample, C_s (in milligrams per liter), was then calculated using equation (5) or, if a 1-mL sample aliquot was diluted 43 times by injection into a 43-mL vial, then

$$C_s = (m_s/v_s)\ (43\text{ mL}/1\text{ mL}) \quad (6)$$

Some soil-gas samples required even larger dilution factors. Those factors were substituted for 43 in equation (6).

Dissolved-methane concentration was determined by analyzing headspace gas and by calculating the concentration of methane remaining in the water sample (assuming equilibration). The steps involved in this procedure were as follows:

1. Two 43-mL septum vials (one for backup) were quickly filled with gently flowing sample water and immediately capped without air-bubble inclusion.
2. A 20-mL headspace was produced in each vial by injecting 20 mL of air into the upside end of the inverted vial with a 20-mL glass syringe tipped with a 3.5-in., 18-gage needle and allowing water to be ejected from the vial through a 1.5-in., 18-gage needle inserted about 0.1 in. into the downside, septum-capped end of the vial.
3. Each vial was shaken gently and laid on its side (at a small angle to prevent headspace contact with the septum) for 20 minutes, during which

time it was shaken occasionally; ambient temperature was recorded. This duration was assumed to be long enough to allow equilibrium to develop between methane concentrations in dissolved and headspace-gas phases.

4. A volume of headspace gas, v_s (0.5 mL or less), was extracted from a vial and injected into the OVA. Larger methane concentrations caused off-scale peak heights and required dilution of the sample and another injection into the OVA. For example, a 43-times dilution was accomplished by injecting 1 mL of headspace gas into a 43-mL vial filled with ambient air.

5. The resulting methane peak area and the standard calibration plot were used to determine the mass of injected methane, m_s. The headspace concentration of methane, C_s (in milligrams per liter), was determined by using equation (5) or (6) or equation (6) with the appropriate dilution factor substituted for larger dilutions.

6. The partial pressure of methane in the headspace, P', was determined by substituting equation (3) into equation (1), rearranging, and substituting specific sample variables, m_s and v_s,

$$P' = m_s RT/Mv_s = C_s RT/M \qquad (7)$$

7. The aqueous methane concentration, C' (in milligrams per liter), at assumed equilibrium with the headspace methane concentration in the vial was determined from the partial pressure of methane in the headspace, P', and the Bunsen solubility coefficient, β_T. β_T expresses the volume of methane in milliliters (normalized to conditions of 1 atm partial pressure of methane and 273.15 K) soluble in 1 mL of water at a given temperature and at equilibrium with a partial pressure of methane of 1 atm (Yamamoto and others, 1976, p. 80). Freshwater Bunsen coefficients tabulated for temperatures from 0°C to 30°C were obtained from Yamamoto and others (1976, p. 80). By using equation (7), a concentration of 715.6 mg/L_g is obtained for the normalized β_T conditions of 1 atm partial pressure of methane and 273.15 K. Henry's law states that at equilibrium the aqueous concentration of a relatively insoluble gas is directly proportional to its partial pressure (Freeze and Cherry, 1979, p. 95). Therefore, the concentration of dissolved methane in the vial (C') is a function of the partial pressure of methane in the headspace and the Bunsen solubility coefficient for the temperature in the vial:

$$C' = 715.6\ P'\beta_T\ \mathrm{mgL^{-1}atm^{-1}} \qquad (8)$$

8. The concentration of methane in the 20-mL volume of headspace, C_s, was exsolved from the 23 mL of water. C' represents the concentration of methane remaining in the 23 mL of water after equilibration. Therefore, the concentration of methane (in milligrams per liter) in the original water sample, C_W, must be corrected for the quantity of methane lost to the headspace by using:

$$C_W = \frac{C_s\,(20\ \mathrm{mL}) + C'\,(23\ \mathrm{mL})}{23\ \mathrm{mL}} \qquad (9)$$

Example Calculation of Methane Concentration

Measurement of the dissolved-methane concentration in water from a well at 33N-10W-13DDC can be used to illustrate the use of the standard calibration plot for the OVA and equations (6) through (9). After creation of a 20-mL headspace in the 43-mL sample vial and a 20-minute wait, 1 mL of headspace gas at 28°C (301 K) was extracted with a gas-tight syringe and injected into a 43-mL vial filled with ambient air. A 0.050-mL (v_s) aliquot was extracted from this dilution vial and was injected into the OVA. The resulting methane peak is shown in the inset for figure 2. A nominal peak area (actually twice the peak area) was calculated by multiplying the base width (2.5 units) by the base height (21.5 units) to obtain 54 squared units. Use of this nominal peak area and the calibration plot (fig. 2) indicates that 0.024 μg (m_s) of methane was injected into the OVA. Equation (6) was used to determine the concentration of methane in the undiluted headspace gas (C_s):

$$C_s = (m_s/v_s)\ (43\ \mathrm{mL}/1\ \mathrm{mL})$$

$$C_s = (0.024\ \mu\mathrm{g}/0.050\ \mathrm{mL})\ (43)$$

$$C_s = 21\ \mu\mathrm{g/mL\ (or\ mg/L)}.$$

The method of calculation through this step applies to either a headspace-gas or a soil-gas concentration. The remaining steps apply only to calculation of the concentration of methane in a water sample as collected.

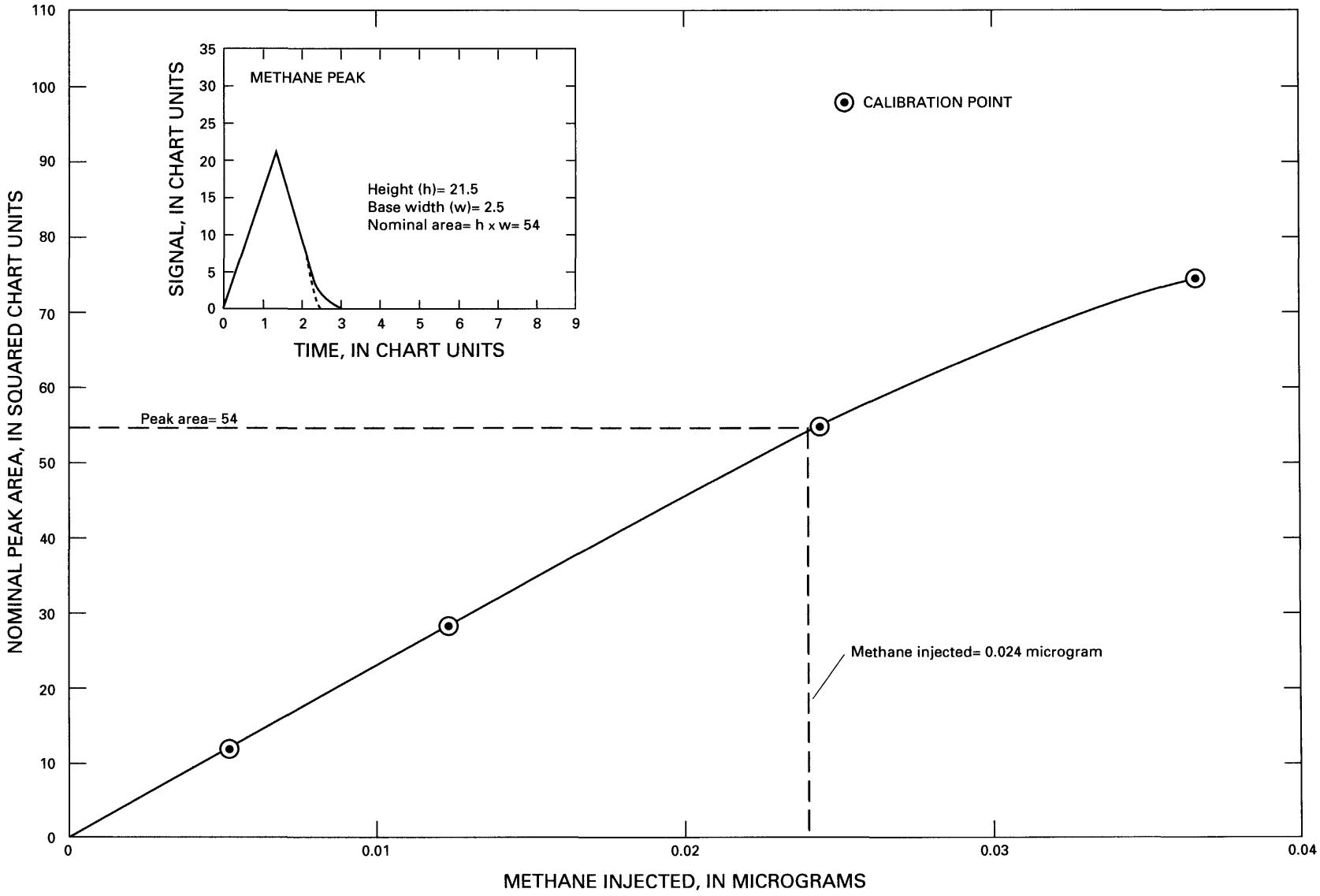


Figure 2. Use of methane peak and standard calibration plot to determine mass of methane injected into Organic Vapor Analyzer.

The partial pressure of methane in the undiluted headspace gas (P') was determined for 28°C (301K) by using C_s and equation (7).

$$P' = C_s RT/M$$

$$P' = \frac{(21 \text{ mg L}^{-1})(82.06 \text{ atm mL mole}^{-1}\text{K}^{-1})(301\text{K})}{(16,040 \text{ mg mole}^{-1})(1,000 \text{ mL L}^{-1})}$$

$$P' = 0.032 \text{ atm}.$$

The partial pressure of methane (P'), the Bunsen coefficient for 28°C ($\beta_{28°C} = 0.02994$), and equation (8) were used to calculate the concentration of dissolved methane at equilibrium with the headspace gas (C'):

$$C' = 715.6 P' \beta_T \text{ mg L}^{-1} \text{ atm}^{-1}$$

$$C' = 715.6 \text{ (0.032 atm)(0.02994) mg L}^{-1} \text{ atm}^{-1}$$

$$C' = 0.69 \text{ mg L}^{-1}.$$

Finally, the concentration of methane in the water sample as collected (C_W) was calculated by using C_s and C' in equation 9:

$$C_W = \frac{C_s(20 \text{ mL}) + C' (23 \text{ mL})}{23 \text{ mL}}$$

$$C_W = \frac{21 \text{ mg L}^{-1} (20 \text{ mL}) + 0.69 \text{ mg L}^{-1} (23 \text{ mL})}{23 \text{ mL}}$$

$$C_W = 19 \text{ mg L}^{-1}$$

Collection of Gases for Molecular and Isotopic Analyses

Gas from ground water was collected for determination of molecular and isotopic composition by means of a dynamic headspace-gas sampler. This sampler consisted of an 800-mL, cylindrical, clear plastic chamber with water-inflow and gas-collection ports at the top and a water-outflow port at the bottom (fig. 3). In addition, a syringe-septum port was mounted at the top to allow measurement of the concentration of methane in the headspace. Water was pumped into the chamber, and a headspace volume of about 100 mL was produced by stopping the flow, unclamping the tube connected to the gas-collection port, and allowing some water to drain. The tube was reclamped, and flow was resumed at a rate of about 2 L/min, which caused substantial turbulence and bubbling in the chamber. Periodically, samples of headspace gas were extracted by syringe from the septum port and injected into the portable gas chromatograph to determine the approximate concentration of methane. This concentration was used to determine whether the headspace gas contained sufficient methane (5 percent) for reliable laboratory determination of the carbon-13 content of methane. A dissolved concentration of about 2 mg/L generally was required to obtain sufficient headspace concentration. After sufficient methane was present in the headspace (generally 30 to 60 minutes), the headspace gas was collected in a 473-mL glass bottle having a bracket-mounted top and a rubber seal ring. The bottle previously had been filled with fresh sample water. Collection was done by opening the gas-collection port and by restricting the flow of water through the water-outflow port by pinching the water-outflow hose, thereby forcing the headspace gas through a tube into the sample bottle, which was inverted and submerged under water. About 0.1 mL of 17-percent benzalkonium chloride biocide was added with a syringe to the water remaining in the bottle to prevent bacterial degradation of gases, and the bottle was sealed under water to minimize contamination by ambient air.

Soil-gas samples from gas wells and the cathodic-protection well generally were collected within 1 ft of the casing. Samples were collected first through a perforated steel tube inserted 3 to 4 ft in the ground as described in the section "Soil-Gas Sample Collection." The methane concentration was measured as described in the subsection "Onsite Measurements for Water and Soil Samples." If sufficient methane was present for reliable chemical and isotopic analysis, a sample was taken by allowing a water-filled sample bottle to drain through tubing almost completely, which drew soil gas into the bottle through another tube connected to the soil-gas-sampling tube. Biocide was added, and the bottle was sealed while inverted under water.

Production gas from gas wells generally was collected from valved ports in the gage house. Several gas wells were not producing; however, gas from those wells was collected from the production tubes on the casing heads. Gas was sampled by allowing it to blow through a tube into a water-filled sample bottle that was inverted and submerged under water. The sample was preserved and sealed as described above.

All gas samples were analyzed for chemical content and methane carbon-13 content by the U.S. Geological Survey in Denver, Colorado. Concentrations of air components, hydrocarbons, and carbon dioxide were determined by means of thermal-conductivity gas chromatography. The methane was collected from a port and converted to carbon dioxide in a vacuum combustion system. The stable carbon isotopic ratios of the carbon dioxide were measured by means of mass spec-

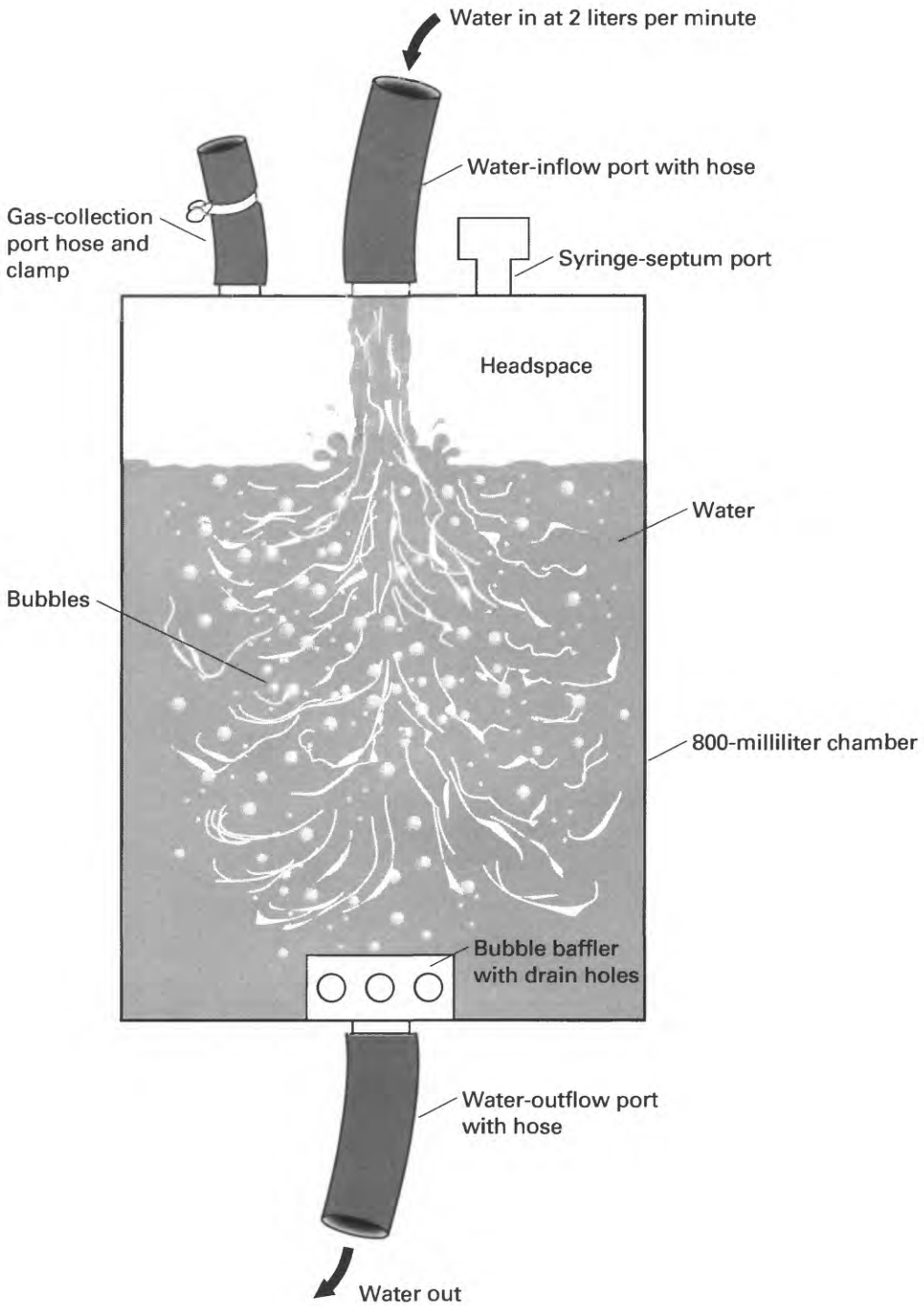


Figure 3. Schematic diagram showing sideview of headspace-gas sampler.

trometry. These ratios are reported in the ∂-notation per thousand (per mil) deviations, relative to the Peedee belemnite marine carbonate standard. Selected samples were analyzed by a contract laboratory using similar methods to determine methane hydrogen-isotope ratios. These ratios are reported in ∂-notation per thousand deviations, relative to the Standard Mean Ocean Water (SMOW) standard.

PRESENTATION OF DATA

Well location and construction information for selected water wells and springs are listed in table 1. Results for water-level and water-quality measurements for these wells and springs and results for nearby soil-gas measurements are listed in table 2. Gas-well information and maximum concentrations of methane measured in soil gas adjacent to gas-well casings and some cathodic-protection wells are listed in table 3. Molecular-composition and methane-isotope data for gas from water, open-field soil seeps, soil adjacent to gas-well casings, and gas wells are listed in table 4.

Table 1. Records of sampled water wells and springs

[Depths of wells are in feet below land surface; altitudes of land surface are shown in feet above sea level; --, no data; Fm, Formation; ~, year approximate]

Number on plate 1	Well or spring owner	Station number	Land-net location	Year drilled	Total depth of well	Altitude of land surface	Aquifer
1	James Rosenau	371312107512701	34N-09W-09DBC	--	25	6,370	Animas Fm
2	Jim Sinton	371253107511801	34N-09W-09DCD	--	180	6,400	Animas Fm
3	Colorado Ute Electric Association	371242107512901	34N-09W-07AAA	1985	199	6,440	Animas Fm
4	Charles Weekly	371225107513801	34N-09W-07ADC	1983	300	6,470	Animas Fm
5	David Wylie	371211107514601	34N-09W-07DBD	1983	200	6,450	Animas Fm
6	Roy Peterson	371204107515001	34N-09W-07DCA	1985	380	6,450	Animas Fm
7	Jolius Roastinger	371148107520701	34N-09W-18BAA	1984	262	6,420	Animas Fm
8	Peter Kewitt	371127107521701	34N-09W-18CAB	1978	162	6,310	Animas Fm
9	Glenn Wycoff	371126107522401	34N-09W-18CBA	1977	110	6,330	Animas Fm
10	Robin Converse	371013107523001	34N-09W-19CCC	1984	190	6,260	Animas Fm
11	Tom Joerger	371002107522801	34N-09W-30BBC	1987	73	6,220	Valley fill
12	Arabella Williams	370852107525301	34N-10W-36ACD	1983	136	6,240	Animas Fm
13	LaDonna Bellman	370852107522701	34N-09W-31BCC	1981	126	6,240	Animas Fm
14	Ron Ollier	370848107531801	34N-10W-36CAB	--	250	6,200	Animas Fm
15	Mark Goldfarb	370847107530701	34N-10W-36CAA	1965	69	6,200	Animas Fm
16	Rainbow Springs Trout Ranch[1]	370836107520801	34N-09W-31CDB	--	0	6,400	Terrace deposits
17	R.L. Robertson	370804107524701	33N-10W-01ADC	1972	50	6,260	Terrace deposits
18	Steven McCullough	370733107523801	33N-10W-12AAA	1969	116	6,240	Animas Fm
19	Hinio Tucson	370730107533601	33N-10W-12BBB	1970	94	6,160	Animas Fm
20	Chuck Atwood	370715107522201	33N-09W-07BCA	1987	220	6,250	Animas Fm
21	Dorene Fickett	370714107524701	33N-10W-12ADB	1976	65	6,230	Terrace deposits
22	W.J. Hallock	370655107523901	33N-10W-12DAD	1984	140	6,210	Terrace deposits
23	Jack Benton	370653107525501	33N-10W-12DCA	1971	49	6,185	Terrace deposits
24	Skip White	370650107522701	33N-09W-07CCB	1982	40	6,230	Animas Fm
25	Rusty Bonsor	370645107534301	33N-10W-11DDD	1986	86	6,150	Nacimiento Fm
26	Katherine Dale	370638107530501	33N-10W-13BAA	1986	150	6,185	Animas Fm
27	Gerald Zink	370637107525001	33N-10W-13ABA	~1935	50	6,180	Terrace deposits
28	Gary Pasco	370632107535101	33N-10W-14AAC	1958	65	6,150	Terrace deposits
29	Neal Edwards	370630107522901	33N-09W-18BBC	1980	120	6,215	Animas Fm
30	Winona Morgan	370627107525101	33N-10W-13ACA	1946	63	6,185	Animas Fm

Table 1. Records of sampled water wells and springs--Continued

Number on plate 1	Well or spring owner	Station number	Land-net location	Year drilled	Total depth of well	Altitude of land surface	Aquifer
31	Tony Schweikle	370612107522201	33N-09W-18CBA	1975	110	6,220	Animas Fm
32	Andy Chilton	370603107522901	33N-09W-18CBC	1982	130	6,175	Animas Fm
33	Don Carrol	370602107524001	33N-10W-13DAC	1974	52	6,175	Terrace deposits
34	Seven Mazzone	370601107524801	33N-10W-13DX	--	41	6,170	Terrace deposits
35	James Standifer	370552107521801	33N-09W-18CCD	1985	140	6,190	Animas Fm
36	Terry Obery	370548107524701	33N-10W-13DDC	1985	150	6,170	Animas Fm
37	Carl Johnson	370508107530701	33N-10W-24CDA	--	70	6,130	Terrace deposits
38	Karen Harrison	370450107530701	33N-10W-25BAA	~1975	55	6,130	Terrace deposits
39	Patty Haneman	370443107531901	33N-10W-25BAC	1982	230	6,150	Nacimiento Fm
40	Lawrence Craig	370443107530301	33N-10W-25ABC	1940	43	6,120	Terrace deposits
41	Joe Williams	370442107525101	33N-10W-25ACA	1976	60	6,110	Terrace deposits
42	Gerald Brown	370437107530201	33N-10W-25ACB	1950	130	6,110	Nacimiento Fm
43	John Gamble	370437107524201	33N-10W-25ADB	1986	260	6,090	Nacimiento Fm
44	Jerry Schane	370430107531801	33N-10W-25BDC	1979	110	6,150	Nacimiento Fm
45	Neal Short	370412107530701	33N-10W-25CDA	1905	50	6,120	Terrace deposits
46	David Huffman	370403107525201	33N-10W-25DCD	1981	127	6,090	Nacimiento Fm
47	Randy McKee	370359107530401	33N-10W-36ABB	~1950	72	6,120	Nacimiento Fm
48	Randy McKee	370355107524101	33N-10W-36AAC	1984	142	6,110	Nacimiento Fm
49	Edith Rhodes	370347107525201	33N-10W-36ACA	--	180	6,090	Nacimiento Fm
50	Lester Davis	370347107520801	33N-09W-31BDB	1977	218	6,080	Nacimiento Fm
51	Doyle Hartman	370343107521701	33N-09W-31BDC	1983	140	6,060	Nacimiento Fm
52	Jack Kloepfer	370337107524901	33N-10W-36ACD	~1950	130	6,080	Nacimiento Fm
53	Carl Weston	370337107522801	33N-09W-31CBB	1986	217	6,060	Nacimiento Fm
54	Catherine Sutton	370332107525301	33N-10W-36DBA	1987	140	6,080	Nacimiento Fm
55	Catherine Sutton	370332107525302	33N-10W-36DBA	1961	35	6,080	Terrace deposits
56	Rick Heinz	370323107520901	33N-09W-31CDB	1983	12	6,020	Valley fill
57	David Temple	370319107525201	33N-10W-36DCA	1980	199	6,070	Nacimiento Fm
58	Carl Weston	370316107522701	33N-09W-31CCC	1968	201	6,040	Nacimiento Fm
59	Maurice Walter	370301107523701	32N-10W-01AAD	1960	112	6,050	Nacimiento Fm
60	Trans Ohio Bank	370257107523301	32N-10W-01ADA	1975	128	6,040	Nacimiento Fm

Table 1. Records of sampled water wells and springs--Continued

Number on plate 1	Well or spring owner	Station number	Land-net location	Year drilled	Total depth of well	Altitude of land surface	Aquifer
61	Junior Bonds	370248107524501	32N-10W-01ADC	1945	60	6,060	Nacimiento Fm
62	Bill Mullins	370245107523001	32N-09W-06CBC	--	25	6,025	Terrace deposits
63	Junior Bonds	370208107523301	32N-10W-12AAD	1946	80	6,000	Nacimiento Fm
64	Jenny Boyer	370133107524601	32N-10W-12DDC	1960	121	6,080	Nacimiento Fm
65	Blanton Cogburn	370127107522801	32N-09W-07CCC	1987	140	5,980	Nacimiento Fm
66	John Goldman	370117107522801	32N-09W-18BBC	--	120	5,985	Nacimiento Fm
67	Blanton Cogburn	370117107522501	32N-09W-18BBD	1973	50	5,970	Terrace deposits
68	Foy Cogburn	370104107522701	32N-09W-18BCC	1967	170	5,990	Nacimiento Fm
69	Foy Cogburn	370103107522501	32N-09W-18BCD	1966	60	5,970	Nacimiento Fm
70	Robert Kinslow	370055107522801	32N-09W-18CBB	--	80	6,015	Nacimiento Fm
71	Richard Banes	370054107522001	32N-09W-18CBD	1962	14	5,950	Valley fill
72	L. Dean Johnson	370003107520301	32N-09W-19CAA	--	58	5,930	Valley fill
73	Patricia Johnson	365938107521701	32N-10W-10CDD	1977	280	6,000	Nacimiento Fm
74	Donna Gilbert	365911107522001	32N-10W-15BDC	--	116	5,970	Nacimiento Fm
75	R. Shindledecker	365910107520701	32N-10W-15ACC	1983	102	5,925	Nacimiento Fm
76	James Wilkerson	365902107523301	32N-10W-15CBA	1983	155	5,990	Nacimiento Fm
77	Leroy Bussel	365855107522101	32N-10W-15CAC	--	44	5,940	Terrace deposits
78	Wesley Bond	365838107523101	32N-10W-22BBA	1943	70	5,940	Nacimiento Fm
79	Linn Blancett	365838107520801	32N-10W-22BAA	1976	99	5,930	Nacimiento Fm
80	Pat Knepp	365818107525701	32N-10W-21ACD	1982	105	5,960	Nacimiento Fm
81	James Welles	365807107522701	32N-10W-22CBD	1974	20	5,885	Terrace deposits
82	Fred Clark	365803107524301	32N-10W-21DAD	1967	104	5,910	Nacimiento Fm
83	Mitch Waggoner	365758107525801	32N-10W-21DCA	1981	70	5,950	Nacimiento Fm
84	Dwayne Lewis	365752107530301	32N-10W-21DCD	1980	255	6,060	Nacimiento Fm
85	James Musgrove[1]	365751107525201	32N-10W-21DDC	--	0	5,880	Nacimiento Fm
86	Ray Kysar	365733107523801	32N-10W-27BCB	1980	38	5,880	Terrace deposits
87	Ray Kysar	365717107524101	32N-10W-28DAA	--	39	5,890	Terrace deposits
88	Ray Kysar	365655107524601	32N-10W-33AAA	--	29	5,860	Terrace deposits
89	Lanier Clark	365637107524501	32N-10W-33ADD	~1925	50	5,860	Valley fill
90	Jay Riley	365636107524801	32N-10W-33ADD	1980	42	5,870	Valley fill

Table 1. Records of sampled water wells and springs--Continued

Number on plate 1	Well or spring owner	Station number	Land-net location	Year drilled	Total depth of well	Altitude of land surface	Aquifer
91	Faye Warren	365632107524801	32N-10W-33ADD	1984	80	5,870	Valley fill
92	Stanley Lanier	365632107524201	32N-10W-33ADD	1976	49	5,850	Valley fill
93	Paul Rouse	365626107523701	32N-10W-34CBA	~1900	23	5,860	Valley fill
94	Clarence Hunter	365625107531101	32N-10W-33DBB	~1950	48	5,880	Valley fill
95	Bill Townsend	365625107525201	32N-10W-33DAB	1980	45	5,860	Valley fill
96	Maxine Welch	365623107523301	32N-10W-34CBD	1977	40	5,850	Valley fill
97	Thomas McCartney	365622107530001	32N-10W-33DBD	1987	76	5,880	Valley fill
98	Keith Benfield	365621107532501	32N-10W-33CAC	1982	75	5,880	Valley fill
99	Benson Leeper	365619107533001	32N-10W-33CBD	1980	70	5,880	Valley fill
100	Mary Brimhall	365619107531101	32N-10W-33DBC	1982	60	5,860	Valley fill
101	Jim Englert	365618107530801	32N-10W-33DBC	--	60	5,860	Valley fill
102	Richard Lopez	365618107523501	32N-10W-34CBD	1979	31	5,840	Valley fill
103	Joe Anderson	365617107525901	32N-10W-33DCA	1965	33	5,855	Valley fill
104	Jimmy Reiter	365617107523401	32N-10W-34CCA	1987	28	5,850	Valley fill
105	Benson Leeper	365616107533601	32N-10W-33CCA	1984	60	5,870	Valley fill
106	Gene Brown	365614107531301	32N-10W-33CDA	~1935	36	5,865	Valley fill
107	Benson Leeper	365613107534501	32N-10W-32DDA	1946	40	5,860	Valley fill
108	Donald Martinez	365613107523901	32N-10W-34CCA	~1920	30	5,840	Valley fill
109	Robert McClanahan	365613107523201	32N-10W-34CCA	--	15	5,850	Valley fill
110	Inez McCloud	365612107532501	32N-10W-33CDB	1935	35	5,850	Valley fill
111	Wilbur Brewer	365610107531801	32N-10W-33CDD	1978	62	5,860	Valley fill
112	Benson Leeper	365609107534501	32N-10W-32DDD	1950	40	5,850	Valley fill
113	George Betz	365609107531101	32N-10W-33DCC	~1900	60	5,860	Valley fill
114	Lee Flaherty	365605107540001	32N-10W-32DDC	1962	26	5,850	Valley fill
115	Henry Knowlton	365604107542001	31N-10W-05BAA	1975	14	5,810	Valley fill
116	Caleb Dickson	365604107530101	31N-10W-04ABA	1985	40	5,835	Valley fill
117	James Duke	365604107523801	31N-10W-03BBB	1981	35	5,835	Valley fill
118	Keith Rhodes	365603107541101	31N-10W-05ABB	1974	12	5,810	Valley fill
119	John Zoller	365603107531001	31N-10W-04ABB	1986	55	5,855	Valley fill
120	Charles Head	365603107524601	31N-10W-04AAA	1979	99	5,850	Nacimiento Fm

Table 1. Records of sampled water wells and springs--Continued

Number on plate 1	Well or spring owner	Station number	Land-net location	Year drilled	Total depth of well	Altitude of land surface	Aquifer
121	Ken Stanley	365602107533301	31N-10W-04BBA	~1950	35	5,830	Valley fill
122	Bill Metz	365558107525601	31N-10W-04AAC	1976	66	5,850	Valley fill
123	Glen Rhodes	365553107540001	31N-10W-05AAC	1968	10	5,815	Valley fill
124	Marshall Johnson	365553107532901	31N-10W-04BBD	1978	26	5,820	Valley fill
125	Melvin Johnson	365553107530401	31N-10W-04ABD	~1955	40	5,840	Valley fill
126	Frank Nordstrom	365552107531201	31N-10W-04ACB	1977	28	5,830	Valley fill
127	Dutchman Hills Water Company	365550107531701	31N-10W-04BDA	1978	90	5,820	Nacimiento Fm
128	Dutchman Hills Water Company	365549107531701	31N-10W-04BDA	1978	70	5,820	Nacimiento Fm
129	Keith Englehart	365548107543501	31N-10W-05BCA	1985	60	5,810	Valley fill
130	Jerry Marcotte	365548107535201	31N-10W-05ADA	--	30	5,825	Valley fill
131	Laverne Hill	365545107532901	31N-10W-04BCD	~1960	30	5,825	Valley fill
132	Glen Rhodes	365538107540701	31N-10W-05DBA	1963	45	5,820	Valley fill
133	Pat Cugnini	365533107544601	31N-10W-05CBC	--	40	5,820	Valley fill
134	Helen Moss	365531107535901	31N-10W-05DAC	1971	42	5,830	Valley fill
135	Paul Kennedy	365528107541301	31N-10W-05DBC	1965	33	5,820	Valley fill
136	Bryan Burge	365523107540301	31N-10W-05DCA	1982	60	5,830	Nacimiento Fm
137	Jim Wilson	365523107535301	31N-10W-05DDB	1983	62	5,850	Nacimiento Fm
138	Ronald Osborn	365522107543101	31N-10W-05CDB	1980	4	5,800	Valley fill
139	Bud Beasley	365521107541101	31N-10W-05DCB	1982	40	5,820	Valley fill
140	Wright McEwen	365518107542901	31N-10W-05CDC	1990	35	5,815	Valley fill
141	Mike Carruthers	365513107545401	31N-10W-07AAA	~1940	20	5,795	Valley fill
142	Jess Satathite	365513107541301	31N-10W-05DCC	1986	35	5,820	Valley fill
143	John Brandenburg	365500107545401	31N-10W-07AAD	1988	42	5,790	Valley fill
144	Enrique Del Vito	365457107542801	31N-10W-08BDB	~1950	25	5,810	Valley fill
145	Flora Griffin	365450107542501	31N-10W-08BDD	~1950	40	5,820	Valley fill
146	Lee Flaherty	365439107545601	31N-10W-07DAD	1987	30	5,780	Valley fill
147	C.A. Dickens	365437107543801	31N-10W-08CBD	1978	40	5,785	Valley fill
148	Odus Johns	365433107550901	31N-10W-07DCA	1983	35	5,785	Valley fill
149	Bill Greenhalgh	365426107552501	31N-10W-07CDD	1978	60	5,800	Valley fill
150	Willard Hottell	365421107544301	31N-10W-08CCD	--	19	5,770	Valley fill

Table 1. Records of sampled water wells and springs--Continued

Number on plate 1	Well or spring owner	Station number	Land-net location	Year drilled	Total depth of well	Altitude of land surface	Aquifer
151	Geraldine Powers	365407107554201	31N-10W-18BCA	~1955	32	5,870	Valley fill
152	Terry Kennedy	365403107555701	31N-10W-18BCB	1980	35	5,790	Valley fill
153	David Tingstrom	365400107561001	31N-11W-13ADC	1982	60	5,780	Valley fill
154	Charles Martin	365353107555201	31N-10W-18CBB	1980	25	5,750	Valley fill
155	Len Chapman	365352107553301	31N-10W-18CAB	1985	20	5,740	Valley fill
156	Darwin Wilson	365352107552901	31N-10W-18CAA	--	22	5,765	Valley fill
157	Lewis Oltmanns	365347107562201	31N-11W-13DBD	1976	18	5,730	Valley fill
158	Olan Pousson	365343107554801	31N-10W-18CBD	1981	26	5,740	Valley fill
159	Williard Gore	365338107561701	31N-11W-13DCA	--	40	5,730	Valley fill
160	William Stallings	365337107564301	31N-11W-13CDB	1977	45	5,760	Valley fill
161	Ronald Custer	365331107555801	31N-11W-13DDD	1983	45	5,765	Valley fill
162	Don Norman	365318107560001	31N-11W-24AAD	--	50	5,760	Valley fill
163	Bob Nyce	365307107563501	31N-11W-24BDD	--	28	5,730	Valley fill
164	John Durham	365307107560001	31N-11W-24ADD	1981	92	5,780	Valley fill
165	Roger Bixler	365303107561501	31N-11W-24ACD	1969	30	5,750	Valley fill
166	Charles Turner	365252107562701	31N-11W-24DBC	1978	38	5,740	Valley fill
167	Leon Spiller	365248107563001	31N-11W-24CDA	1971	30	5,740	Valley fill
168	Leon Knowlton	365242107574301	31N-11W-23CDD	1988	40	5,720	Valley fill
169	Stan Maynes	365242107571001	31N-11W-23DDD	1975	30	5,715	Valley fill
170	S.E. Winters	365240107561601	31N-11W-24DCD	1981	101	5,790	Valley fill
171	Irvin Randlemon	365238107564501	31N-11W-24CDC	1987	47	5,730	Valley fill
172	Charles Randlemon	365223107565701	31N-11W-25BCB	1967	65	5,750	Valley fill
173	James Hall	365212107575001	31N-11W-26BDC	1980	49	5,795	Valley fill
174	M. Shackleford	365210107570101	31N-11W-25CBB	1957	90	5,755	Valley fill
175	James Almond	365205107575301	31N-11W-26CBA	1978	18	5,685	Valley fill
176	Mozelle Mickey	365203107582701	31N-11W-27DBD	--	125	5,725	Valley fill
177	Carlos Marquez	365202107570501	31N-11W-26DAD	1981	69	5,760	Valley fill
178	Charles McFarland	365200107572501	31N-11W-26DBD	1947	42	5,730	Valley fill
179	Theron Whipple	365158107571101	31N-11W-26DAC	~1975	90	5,750	Valley fill
180	Everett Lee	365154107581801	31N-11W-27DDB	--	35	5,670	Valley fill

Table 1. Records of sampled water wells and springs--Continued

Number on plate 1	Well or spring owner	Station number	Land-net location	Year drilled	Total depth of well	Altitude of land surface	Aquifer
181	C.E. Awtrey	365152107583201	31N-11W-27DCA	1988	54	5,680	Valley fill
182	C.E. Awtrey	365147107583501	31N-11W-27DCC	--	47	5,690	Valley fill
183	Jim Houston	365143107575501	31N-11W-35BBA	1982	23	5,675	Valley fill
184	Lois Scott	365137107581801	31N-11W-34AAC	--	22	5,665	Valley fill
185	Ernest Phelps	365136107583301	31N-11W-34ABC	1978	25	5,665	Valley fill
186	Dwayne Lillywhite	365130107585101	31N-11W-34BDB	1979	79	5,700	Valley fill
187	Emma Giles	365128107572301	31N-11W-35ACA	1980	100	5,740	Valley fill
188	Bruce Krueger	365127107581901	31N-11W-34ADB	1982	22	5,665	Valley fill
189	Lawton Williams	365117107585501	31N-11W-34CAB	--	30	5,665	Valley fill
190	Don Taylor	365116107581501	31N-11W-34DAB	1983	10	5,665	Valley fill
191	Stanley Campbell	365113107575301	31N-11W-35CBA	1972	90	5,735	Nacimiento Fm
192	Houston Perry	365103107581501	31N-11W-34DDA	1957	42	5,695	Valley fill
193	Carl Sexton	365057107583901	31N-11W-34DCC	1982	34	5,670	Valley fill
194	Don Taylor	365052107582501	30N-11W-03ABA	1970	40	5,660	Valley fill
195	Dewey Sexton	365045107584701	30N-11W-03BAD	1980	36	5,665	Valley fill
196	All Miller	365038107590201	30N-11W-03BCA	1988	25	5,640	Valley fill
197	K.C. Longwell	365035107584001	30N-11W-03ACB	~1970	21	5,660	Valley fill
198	Andres Martinez	365029107591201	30N-11W-03BCC	1966	32	5,630	Valley fill
199	Buster Jaquez	365028107591301	30N-11W-04DAA	1981	14	5,630	Valley fill
200	Joe Gomez	365024107593201	30N-11W-04DBA	~1965	40	5,640	Valley fill
201	Jeff Houser	365020107584501	30N-11W-03CAD	1984	36	5,660	Valley fill
202	Buster Jaquez	365016107590401	30N-11W-03CBD	1981	28	5,640	Valley fill
203	Kathy Daddow	365014107592801	30N-11W-04DDB	--	7	5,610	Valley fill
204	Howard Stinson	365004107591501	30N-11W-04DDD	1978	30	5,645	Valley fill
205	Ken Shultz	364942107590201	30N-11W-10BCD	1977	72	5,670	Valley fill

[1]Spring owner.

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs

[Water levels are in feet below land surface; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; IT, incremental titration; mg/L, milligrams per liter; mg/L_g, milligrams per liter of gas; <, less than; µg/L, micrograms per liter; --, no data]

Number on plate 1	Date sampled	Water level	Specific conductance (µS/cm)	pH (standard units)	Temperature, water (°C)	Alkalinity dissolved, onsite, IT (mg/L as $CaCO_3$)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
1	08-28-90	14.3	1,000	7.3	12.0	--	--	--	--	--
2	08-28-90	62.5	730	7.9	17.0	182	517	41	5.4	140
3	08-27-90	87.0	820	8.6	16.0	--	--	--	--	--
4	08-27-90	170.1	540	8.9	16.0	179	300	2.4	<.01	120
5	10-19-90	142.1	519	8.9	15.0	--	--	--	--	--
6	09-05-90	76.1	769	8.0	16.5	--	--	--	--	--
7	08-28-90	140.7	600	8.9	17.0	144	335	3.1	<.01	130
8	08-27-90	--	655	8.5	14.0	--	--	--	--	--
9	08-29-90	--	623	8.8	14.0	216	391	3.7	.23	140
10	08-27-90	64.7	760	8.5	12.0	196	436	13	.88	160
11	08-29-90	10.2	788	8.0	13.0	--	--	--	--	--
12	08-24-90	32.2	832	8.3	12.5	--	--	--	--	--
13	08-24-90	15.8	825	7.0	13.5	356	482	92	17	63
14	08-21-90	47.3	880	8.5	13.0	277	502	5.0	.13	190
15	11-19-90	14.9	786	7.5	12.0	230	--	--	--	--
16	08-24-90	--	680	7.1	11.0	318	387	96	16	27
17	08-24-90	37.4	869	7.2	12.0	--	--	--	--	--
18	08-24-90	22.5	785	7.2	13.0	--	--	--	--	--
19	08-21-90	23.2	1,520	7.9	13.5	--	--	--	--	--
20	08-23-90	50.4	888	7.5	12.5	337	507	42	8.9	140
21	08-23-90	33.8	690	7.3	11.5	--	--	--	--	--
22	08-23-90	29.8	703	8.7	13.0	--	--	--	--	--
23	08-23-90	18.3	732	7.2	15.0	--	--	--	--	--
24	08-22-90	--	737	7.2	14.0	--	--	--	--	--
25	08-21-90	53.0	980	8.2	13.0	290	579	6.7	.22	220
26	08-23-90	13.4	728	7.7	13.0	253	424	39	9.0	110
27	08-22-90	--	762	7.2	12.0	--	--	--	--	--
28	08-20-90	48.2	1,010	7.6	12.5	--	--	--	--	--
29	08-22-90	47.5	810	7.6	13.0	267	509	23	4.4	160
30	08-22-90	20.5	710	7.4	17.0	--	--	--	--	--

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Water level	Specific conductance (μS/cm)	pH (standard units)	Temperature, water (°C)	Alkalinity dissolved, onsite, IT (mg/L as $CaCO_3$)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
31	08-22-90	--	665	8.0	17.0	--	--	--	--	--
32	08-21-90	22.0	803	7.5	12.0	--	--	--	--	--
33	08-23-90	9.5	829	7.1	13.0	--	--	--	--	--
34	08-23-90	17.3	774	7.1	13.0	--	--	--	--	--
35	08-22-90	30.7	850	7.3	14.0	316	516	78	17	93
36	08-20-90	21.9	710	7.6	12.5	257	414	39	6.0	110
	11-15-90	26.9	644	7.7	12.0	--	--	--	--	--
	03-06-91	27.2	740	7.1	12.0	--	--	--	--	--
37	08-16-90	35.5	852	7.3	15.0	--	--	--	--	--
38	08-15-90	33.3	572	7.5	12.5	187	334	58	14	40
39	08-15-90	52.6	1,210	8.2	14.0	174	676	11	.15	240
40	08-15-90	24.9	918	7.3	12.0	--	--	--	--	--
41	08-17-90	11.3	952	7.1	11.0	382	570	100	37	61
42	08-17-90	--	1,130	7.7	13.0	288	814	32	1.3	250
43	08-16-90	--	1,260	7.4	12.0	405	719	48	5.9	220
44	08-14-90	62.8	919	7.8	15.0	--	--	--	--	--
45	08-14-90	23.6	667	7.4	13.0	--	--	--	--	--
46	08-16-90	--	802	7.7	12.0	217	474	16	1.4	160
47	08-14-90	--	547	7.5	13.5	--	--	--	--	--
48	08-13-90	--	690	7.9	13.0	--	--	--	--	--
49	08-10-90	15.9	564	7.6	12.0	188	328	62	8.1	45
50	08-08-90	49.0	893	8.1	14.0	213	506	17	.33	170
51	08-17-90	--	1,950	8.0	13.0	--	--	--	--	--
52	08-09-90	19.6	758	8.4	12.5	171	423	13	.21	140
53	08-07-90	43.0	1,190	7.9	13.0	260	760	21	.45	250
54	10-29-90	39.8	795	7.7	12.0	243	507	51	10	120
55	10-29-90	10.8	780	7.2	13.5	272	493	100	23	36
56	08-09-90	7.9	622	7.1	14.0	264	--	--	--	--
57	10-10-90	56.8	720	7.8	13.0	237	481	41	4.2	130
58	08-06-90	46.6	1,780	7.6	12.5	282	916	60	9.4	270
59	10-25-90	16.3	900	7.8	12.0	251	524	43	4.4	140
60	08-20-90	11.9	898	7.3	13.0	--	--	--	--	--

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Water level	Specific conductance (µS/cm)	pH (standard units)	Temperature, water (°C)	Alkalinity dissolved, onsite, IT (mg/L as $CaCO_3$)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
61	08-14-90	--	769	7.3	15.5	276	478	110	21	29
62	08-29-90	11.3	888	7.1	16.0	--	--	--	--	--
63	08-13-90	--	1,460	7.1	11.5	408	924	110	35	160
64	08-29-90	72.9	2,880	7.2	14.5	275	2,040	190	42	420
65	08-30-90	21.6	3,250	7.9	14.0	225	2,230	110	8.9	730
66	09-04-90	33.4	1,410	8.3	13.0	--	--	--	--	--
67	08-30-90	--	960	8.5	12.0	--	--	--	--	--
68	08-30-90	--	4,800	6.9	12.0	--	--	--	--	--
69	08-30-90	13.7	2,770	7.2	16.0	--	--	--	--	--
70	08-30-90	--	1,210	8.4	20.0	198	668	8.8	.6	240
71	08-29-90	3.2	604	7.4	18.0	--	--	--	--	--
72	09-10-90	6.1	705	7.4	15.0	--	--	--	--	--
73	09-04-90	--	4,050	8.1	15.0	77	2,040	45	.72	730
74	09-05-90	--	773	7.5	13.5	--	--	--	--	--
75	09-05-90	15.9	757	7.2	15.0	--	--	--	--	--
76	09-10-90	68.1	2,790	7.5	14.0	501	1,670	40	18	550
77	09-05-90	22.8	740	7.2	16.0	252	432	110	18	19
78	09-11-90	--	845	7.1	13.0	--	--	--	--	--
79	09-10-90	--	650	7.3	14.0	--	--	--	--	--
80	09-06-90	59.7	3,300	7.2	15.5	--	--	--	--	--
81	09-07-90	2.5	1,330	7.1	17.0	--	--	--	--	--
82	09-06-90	19.5	1,240	8.1	13.5	234	727	22	3.5	240
83	09-19-90	37.4	1,050	7.4	14.5	--	--	--	--	--
84	09-11-90	94.7	5,200	7.3	15.5	323	2,970	150	19	890
85	09-11-90	--	775	7.3	14.0	--	--	--	--	--
86	09-06-90	10.0	959	7.1	14.5	--	--	--	--	--
87	09-07-90	22.9	900	7.1	14.0	345	525	120	29	25
88	09-07-90	15.0	1,080	7.2	14.0	--	--	--	--	--
89	09-12-90	22.0	1,130	7.1	14.5	--	--	--	--	--
	02-20-91	26.0	1,235	6.8	13.5	--	--	--	--	--
90	09-14-90	28.5	774	7.2	15.5	270	464	100	23	31
	02-22-91	32.8	1,060	6.9	13.0	--	--	--	--	--

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Water level	Specific conductance (µS/cm)	pH (standard units)	Temperature, water (°C)	Alkalinity dissolved, onsite, IT (mg/L as $CaCO_3$)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
91	09-13-90	25.6	649	6.9	15.5	--	--	--	--	--
92	09-13-90	--	1,200	7.0	16.5	351	680	130	30	69
	02-21-91	--	1,630	6.9	11.0	--	--	--	--	--
93	09-13-90	--	660	7.4	17.0	--	--	--	--	--
	02-19-91	--	960	6.9	11.5	--	--	--	--	--
94	09-12-90	37.3	610	7.4	14.5	--	--	--	--	--
	02-25-91	49.5	730	6.9	13.5	--	--	--	--	--
95	09-19-90	23.0	680	7.4	15.0	--	--	--	--	--
96	09-13-90	11.2	620	7.3	16.0	186	366	90	13	20
	02-21-91	13.5	970	7.2	9.0	--	--	--	--	--
97	09-14-90	26.0	720	7.5	15.0	--	--	--	--	--
	02-22-91	36.1	655	7.3	13.0	--	--	--	--	--
98	09-17-90	32.0	833	7.3	14.0	--	--	--	--	--
	02-25-91	51.4	1,160	6.9	13.5	--	--	--	--	--
99	09-18-90	37.3	746	7.3	14.5	--	--	--	--	--
	02-20-91	66.7	1,110	7.0	14.0	--	--	--	--	--
100	09-17-90	--	613	7.4	14.0	--	--	--	--	--
	02-21-91	--	730	7.3	14.5	--	--	--	--	-
101	09-12-90	20.7	675	7.3	15.5	--	--	--	--	--
102	09-12-90	7.5	640	7.3	14.5	197	377	82	16	28
103	09-20-90	15.9	832	7.0	17.5	271	505	120	17	31
	02-22-91	--	765	7.2	10.0	--	--	--	--	--
104	09-14-90	8.0	625	7.4	14.0	199	372	86	15	22
105	09-18-90	34.3	1,020	7.4	15.0	264	605	82	18	120
106	09-13-90	17.5	840	7.0	14.5	--	--	--	--	--
	02-21-91	29.5	700	6.9	13.5	--	--	--	--	--
107	09-17-90	--	790	7.3	16.0	247	477	100	23	38
108	09-12-90	--	615	7.3	17.5	--	--	--	--	--
109	09-13-90	9.2	862	7.0	17.0	--	--	--	--	--
	02-22-91	10.4	795	7.0	11.5	--	--	--	--	--
110	09-11-90	--	775	7.1	15.0	--	--	--	--	--

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Water level	Specific conductance (µS/cm)	pH (standard units)	Temperature, water (°C)	Alkalinity dissolved, onsite, IT (mg/L as $CaCO_3$)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
111	09-19-90	20.8	820	7.1	16.0	--	--	--	--	--
112	09-17-90	--	748	7.1	15.0	--	--	--	--	--
	02-20-91	--	752	6.7	14.5	--	--	--	--	--
113	09-12-90	25.1	715	7.4	14.0	--	--	--	--	--
	02-21-91	41.6	894	7.2	14.0	--	--	--	--	--
114	09-11-90	12.3	2,790	7.4	15.5	247	2,090	230	41	390
115	09-11-90	3.2	578	7.4	17.5	--	--	--	--	--
	02-25-91	6.4	675	7.0	12.0	--	--	--	--	--
116	09-17-90	22.7	631	7.3	16.5	--	--	--	--	--
	02-22-91	32.8	730	7.1	15.0	--	--	--	--	--
117	10-15-90	--	623	7.4	17.0	--	--	--	--	--
118	09-10-90	5.2	2,250	7.4	15.0	--	--	--	--	--
119	09-20-90	30.3	643	7.4	15.0	--	--	--	--	--
	02-20-91	43.4	605	6.9	15.0	--	--	--	--	--
120	09-18-90	17.5	1,950	7.4	15.5	247	805	57	7.8	230
121	09-14-90	25.0	745	7.2	16.0	267	433	110	17	24
	02-20-91	32.2	765	6.9	15.0	--	--	--	--	--
122	09-19-90	26.7	684	7.3	16.0	--	--	--	--	--
123	09-27-90	4.8	1,660	7.1	18.0	289	1,000	160	40	120
124	09-19-90	6.7	690	7.5	14.5	223	426	98	15	26
125	09-17-90	13.9	665	7.2	16.5	--	--	--	--	--
	02-25-91	23.8	770	6.7	14.5	--	--	--	--	--
126	09-19-90	8.4	688	7.3	16.0	--	--	--	--	--
127	09-20-90	--	10,000	8.2	13.0	129	6,020	120	4.7	2,000
128	09-20-90	--	730	7.4	13.0	243	428	100	15	28
129	09-24-90	--	3,400	7.1	14.0	--	--	--	--	--
130	09-24-90	17.6	1,110	7.1	16.0	--	--	--	--	--
131	09-20-90	6.0	985	7.2	14.5	--	--	--	--	--
132	09-27-90	--	710	7.2	16.0	--	--	--	--	--
133	09-24-90	21.1	870	7.2	14.0	--	--	--	--	--
134	09-27-90	--	850	6.9	14.5	--	--	--	--	--
135	09-27-90	--	665	7.2	16.0	--	--	--	--	--

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Water level	Specific conductance (µS/cm)	pH (standard units)	Temperature, water (°C)	Alkalinity dissolved, onsite, IT (mg/L as $CaCO_3$)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
136	09-27-90	21.3	980	7.3	14.0	222	593	93	14	91
137	09-27-90	30.6	1,180	7.4	15.5	--	--	--	--	--
138	09-26-90	--	700	7.5	17.0	254	434	110	13	23
139	10-01-90	6.6	828	7.3	14.5	--	--	--	--	--
140	09-26-90	--	680	7.3	17.0	--	--	--	--	--
141	09-24-90	--	2,500	7.1	14.0	--	--	--	--	--
142	10-01-90	7.3	910	7.2	14.5	--	--	--	--	--
143	09-24-90	23.0	600	7.3	16.5	--	--	--	--	--
144	10-01-90	20.8	1,320	7.3	15.0	236	964	170	27	98
145	10-01-90	13.4	1,650	7.2	15.0	--	--	--	--	--
146	09-24-90	8.6	900	7.2	13.0	297	508	120	20	50
147	10-01-90	4.0	775	7.1	13.0	--	--	--	--	--
148	09-25-90	16.7	828	7.1	14.5	--	--	--	--	--
149	10-18-90	--	795	7.1	15.0	--	--	--	--	--
150	10-02-90	6.4	1,080	7.1	14.0	311	--	--	--	--
151	09-25-90	17.0	1,220	7.0	15.5	--	--	--	--	--
152	09-25-90	--	870	7.2	15.5	--	--	--	--	--
153	09-26-90	--	1,140	7.1	14.5	--	--	--	--	--
154	09-25-90	7.0	1,290	7.1	15.0	297	847	140	34	94
155	10-01-90	9.7	1,600	7.1	14.0	--	--	--	--	--
156	10-04-90	5.9	2,900	7.2	18.0	244	2,020	150	21	480
157	09-26-90	5.2	1,810	7.3	14.0	274	1,160	150	40	170
158	10-02-90	8.1	2,140	7.3	16.0	306	1,510	190	32	260
159	10-02-90	13.3	2,870	7.6	14.0	--	--	--	--	--
160	09-26-90	21.1	873	7.2	16.0	--	--	--	--	--
161	10-03-90	--	720	7.2	14.0	--	--	--	--	--
162	10-02-90	27.4	740	7.1	16.0	--	--	--	--	--
163	10-03-90	6.9	800	7.1	16.0	--	--	--	--	--
164	10-03-90	46.4	420	7.3	14.0	--	--	--	--	--
165	10-02-90	23.2	905	7.1	14.0	--	--	--	--	--

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Water level	Specific conductance (µS/cm)	pH (standard units)	Temperature, water (°C)	Alkalinity dissolved, onsite, IT (mg/L as $CaCO_3$)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
166	10-03-90	11.2	690	7.3	14.5	--	--	--	--	--
167	10-04-90	--	915	7.1	13.0	--	--	--	--	--
168	09-26-90	26.0	973	7.1	14.5	--	--	--	--	--
169	10-04-90	--	710	7.3	15.5	--	--	--	--	--
170	10-03-90	--	1,020	7.3	14.0	--	--	--	--	--
171	10-03-90	12.9	785	7.2	14.5	--	--	--	--	--
172	10-05-90	38.8	775	7.2	13.5	--	--	--	--	--
173	10-04-90	18.5	1,420	7.1	14.0	--	--	--	--	--
174	10-04-90	38.2	1,020	7.2	14.0	301	607	110	20	89
175	10-05-90	--	1,070	7.0	15.0	--	--	--	--	--
176	10-18-90	--	7,000	7.2	15.0	--	--	--	--	--
177	10-09-90	--	1,360	7.2	14.0	288	916	140	24	130
178	10-05-90	26.7	1,040	7.1	14.5	--	--	--	--	--
179	10-15-90	38.3	1,200	7.2	14.0	--	--	--	--	--
180	10-18-90	10.3	923	7.2	15.0	--	--	--	--	--
181	10-18-90	17.5	3,320	7.1	15.0	--	--	--	--	--
182	10-18-90	32.6	2,280	7.2	14.0	--	--	--	--	--
183	10-03-90	3.3	1,100	7.2	12.5	--	--	--	--	--
184	10-09-90	8.8	2,740	7.1	15.0	395	2,030	220	60	320
185	10-16-90	--	858	7.2	14.0	--	--	--	--	--
186	10-16-90	--	1,770	7.2	14.0	--	--	--	--	--
187	10-05-90	--	1,010	7.1	14.5	--	--	--	--	--
188	10-15-90	5.9	2,170	7.1	15.0	--	--	--	--	--
189	10-16-90	23.9	754	7.4	13.5	--	--	--	--	--
190	10-09-90	3.9	1,870	7.2	14.0	--	--	--	--	--
191	10-09-90	16.6	2,740	7.2	15.0	--	--	--	--	--
192	10-05-90	20.4	2,150	7.3	15.0	154	1,580	200	37	230
193	10-15-90	--	750	7.2	15.0	--	--	--	--	--
194	10-16-90	19.7	1,160	7.2	14.0	--	--	--	--	--
195	10-15-90	--	925	7.2	15.0	--	--	--	--	--

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Water level	Specific conductance (µS/cm)	pH (standard units)	Temperature, water (°C)	Alkalinity dissolved, onsite, IT (mg/L as $CaCO_3$)	Dissolved solids, sum of constituents (mg/L)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)
196	10-17-90	--	838	7.1	12.0	--	--	--	--	--
197	10-16-90	5.2	959	7.2	14.0	--	--	--	--	--
198	10-17-90	4.3	959	7.1	13.5	--	--	--	--	--
199	10-17-90	4.7	1,180	7.2	14.0	--	--	--	--	--
200	10-18-90	31.3	910	7.1	15.0	--	--	--	--	--
201	10-16-90	--	1,590	7.1	14.0	--	--	--	--	--
202	10-17-90	3.7	1,300	7.1	14.0	--	--	--	--	--
203	10-17-90	2.4	1,390	7.1	16.5	354	997	210	22	78
204	10-17-90	4.8	725	7.2	15.0	--	--	--	--	--
205	10-16-90	26.9	2,200	6.9	13.5	--	--	--	--	--

Number on plate 1	Date sampled	Potassium, dissolved (mg/L as K)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Bromide, dissolved (mg/L as Br)	Silica, dissolved (mg/L as SiO_2)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Methane, dissolved (mg/L)	Methane, in soil gas (mg/L_g)
1	08-28-90	--	--	--	--	--	--	--	<.005	<.005
2	08-28-90	.79	190	21	.14	9.2	5	4	<.005	--
3	08-27-90	--	--	--	--	--	--	--	.068	<.005
4	08-27-90	.25	44	14	.12	12	4	12	11	<.005
5	10-19-90	--	--	--	--	--	--	--	<.005	<.005
6	09-05-90	--	--	--	--	--	--	--	<.005	<.005
7	08-28-90	.29	69	46	.37	12	17	3	2.8	<.005
8	08-27-90	--	--	--	--	--	--	--	<.005	<.005
9	08-29-90	.29	80	26	.09	11	<3	4	.010	<.005
10	08-27-90	.45	100	35	.12	9.1	9	2	<.005	--
11	08-29-90	--	--	--	--	--	--	--	<.005	<.005
12	08-24-90	--	--	--	--	--	--	--	<.005	<.005
13	08-24-90	2.7	55	23	.19	16	18	3	<.005	<.005
14	08-21-90	.34	42	88	.14	10	19	7	16	<.005
15	11-19-90	--	--	--	--	--	--	--	.040	<.005

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Potassium, dissolved (mg/L as K)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Bromide, dissolved (mg/L as Br)	Silica, dissolved (mg/L as SiO_2)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Methane, dissolved (mg/L)	Methane, in soil gas (mg/L_g)
16	08-24-90	1.6	27	11	0.16	18	<3	<1	<0.005	--
17	08-24-90	--	--	--	--	--	--	--	<.005	<.005
18	08-24-90	--	--	--	--	--	--	--	<.005	<.005
19	08-21-90	--	--	--	--	--	--	--	<.005	<.005
20	08-23-90	1.3	80	22	.18	11	4	6	.54	<.005
21	08-23-90	--	--	--	--	--	--	--	<.005	<.005
22	08-23-90	--	--	--	--	--	--	--	<.005	<.005
23	08-23-90	--	--	--	--	--	--	--	<.005	<.005
24	08-22-90	--	--	--	--	--	--	--	<.005	<.005
25	08-21-90	.46	140	29	.05	8.6	22	5	.49	<.005
26	08-23-90	1.6	83	20	.10	9.6	6	<1	<.005	<.005
27	08-22-90	--	--	--	--	--	--	--	<.005	<.005
28	08-20-90	--	--	--	--	--	--	--	<.005	<.005
29	08-22-90	.76	120	31	.23	9.2	8	<1	.72	<.005
30	08-22-90	--	--	--	--	--	--	--	<.005	<.005
31	08-22-90	--	--	--	--	--	--	--	<.005	<.005
32	08-21-90	--	--	--	--	--	--	--	<.005	<.005
33	08-23-90	--	--	--	--	--	--	--	<.005	<.005
34	08-23-90	--	--	--	--	--	--	--	<.005	--
35	08-22-90	1.7	97	27	.21	13	<3	<1	<.005	<.005
36	08-20-90	1.8	74	20	.16	9.0	<3	10	19	<.005
	11-15-90	--	--	--	--	--	--	--	9.0	--
	03-06-91	--	--	--	--	--	--	--	4.5	--
37	08-16-90	--	--	--	--	--	--	--	.006	<.005
38	08-15-90	1.3	86	14	.02	8.4	5	3	1.6	<.005
39	08-15-90	.49	160	150	.34	9.8	13	12	5.0	<.005
40	08-15-90	--	--	--	--	--	--	--	2.4	<.005
41	08-17-90	2.6	110	19	.05	11	230	32	.80	<.005
42	08-17-90	.95	280	67	.26	9.5	170	81	5.3	<.005
43	08-16-90	1.9	150	40	.13	10	9	<1	27	<.005
44	08-14-90	--	--	--	--	--	--	--	<.005	<.005
45	08-14-90	--	--	--	--	--	--	--	<.005	<.005

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Potassium, dissolved (mg/L as K)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Bromide, dissolved (mg/L as Br)	Silica, dissolved (mg/L as SiO_2)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Methane, dissolved (mg/L)	Methane, in soil gas (mg/L_g)
46	08-16-90	0.62	120	36	0.18	9.2	13	7	0.025	<0.005
47	08-14-90	--	--	--	--	--	--	--	<.005	<.005
48	08-13-90	--	--	--	--	--	--	--	<.005	--
49	08-10-90	2.0	76	13	.03	9.2	<3	<1	<.005	<.005
50	08-08-90	.69	110	71	.27	8.9	<3	7	.46	<.005
51	08-17-90	--	--	--	--	--	--	--	.031	<.005
52	08-09-90	.60	110	48	.14	8.2	<3	25	2.3	<.005
53	08-07-90	.94	280	42	.20	9.4	11	6	<.005	<.005
54	10-29-90	2.1	130	35	.05	11	28	3	28	<.005
55	10-29-90	3.5	130	26	.05	11	93	8	.26	<.005
56	08-09-90	--	--	--	--	--	--	--	.007	<.005
57	10-10-90	1.6	100	51	.09	9.2	8	29	.96	<.005
58	08-06-90	1.4	44	350	.87	10	620	230	7.4	<.005
59	10-25-90	2.1	140	34	.13	9.1	17	100	2.6	<.005
60	08-20-90	--	--	--	--	--	--	--	.059	<.005
61	08-14-90	2.7	120	17	.05	11	910	380	.26	<.005
62	08-29-90	--	--	--	--	--	--	--	<.005	<.005
63	08-13-90	1.4	320	41	.10	12	19	<1	<.005	<.005
64	08-29-90	2.8	910	300	.73	11	120	88	.10	<.005
65	08-30-90	3.0	230	1,000	.98	8.9	64	140	.48	<.005
66	09-04-90	--	--	--	--	--	--	--	.56	<.005
67	08-30-90	--	--	--	--	--	--	--	<.005	<.005
68	08-30-90	--	--	--	--	--	--	--	<.005	<.005
69	08-30-90	--	--	--	--	--	--	--	<.005	<.005
70	08-30-90	.65	80	210	.55	8.4	39	13	17	<.005
71	08-29-90	--	--	--	--	--	--	--	<.005	<.005
72	09-10-90	--	--	--	--	--	--	--	<.005	<.005
73	09-04-90	2.3	12	1,200	.89	7.5	250	74	39	<.005
74	09-05-90	--	--	--	--	--	--	--	<.005	<.005
75	09-05-90	--	--	--	--	--	--	--	<.005	<.005
76	09-10-90	2.6	490	260	.45	11	55	52	.29	<.005
77	09-05-90	2.5	99	21	.05	11	9	3	<.005	<.005
78	09-11-90	--	--	--	--	--	--	--	<.005	<.005
79	09-10-90	--	--	--	--	--	--	--	<.005	<.005
80	09-06-90	--	--	--	--	--	--	--	.009	<.005

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Potassium, dissolved (mg/L as K)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Bromide, dissolved (mg/L as Br)	Silica, dissolved (mg/L as SiO_2)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Methane, dissolved (mg/L)	Methane, in soil gas (mg/L_g)
81	09-07-90	--	--	--	--	--	--	--	<0.005	<0.005
82	09-06-90	1.1	160	150	.16	10	18	12	1.4	<.005
83	09-19-90	--	--	--	--	--	--	--	.90	<.005
84	09-11-90	3.7	820	880	1.0	8.9	190	470	3.6	.065
85	09-11-90	--	--	--	--	--	--	--	.98	--
86	09-06-90	--	--	--	--	--	--	--	<.005	<.005
87	09-07-90	2.4	110	19	.05	13	3	1	1.2	<.005
88	09-07-90	--	--	--	--	--	--	--	<.005	<.005
89	09-12-90	--	--	--	--	--	--	--	<.005	<.005
	02-20-91	--	--	--	--	--	--	--	<.005	--
90	09-14-90	2.4	110	23	.06	10	2,000	620	.009	.005
	02-22-91	--	--	--	--	--	--	--	<.005	--
91	09-13-90	--	--	--	--	--	--	--	<.005	--
92	09-13-90	5.9	120	100	.13	13	49	1,400	.71	<.005
	02-21-91	--	--	--	--	--	--	--	<.005	--
93	09-13-90	--	--	--	--	--	--	--	<.005	--
	02-19-91	--	--	--	--	--	--	--	<.005	--
94	09-12-90	--	--	--	--	--	--	--	<.005	<.005
	02-25-91	--	--	--	--	--	--	--	<.005	--
95	09-19-90	--	--	--	--	--	--	--	<.005	<.005
96	09-13-90	2.8	97	23	.05	9.0	66	2	<.005	.5
	02-21-91	--	--	--	--	--	--	--	.87	--
97	09-14-90	--	--	--	--	--	--	--	<.005	<.005
	02-22-91	--	--	--	--	--	--	--	<.005	--
98	09-17-90	--	--	--	--	--	--	--	<.005	<.005
	02-25-91	--	--	--	--	--	--	--	<.005	--
99	09-18-90	--	--	--	--	--	--	--	.007	<.005
	02-20-91	--	--	--	--	--	--	--	.011	--
100	09-17-90	--	--	--	--	--	--	--	<.005	<.005
	02-21-91	--	--	--	--	--	--	--	<.005	--
101	09-12-90	--	--	--	--	--	--	--	<.005	-
102	09-12-90	3.1	98	22	.05	10	170	3	<.005	<.005
103	09-20-90	3.7	130	29	.05	11	800	140	.005	<.005
	02-22-91	--	--	--	--	--	--	--	.041	--
104	09-14-90	4.2	95	21	.04	9.5	410	20	.050	<.005
105	09-18-90	2.2	130	82	.11	11	560	640	.080	<.005

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Potassium, dissolved (mg/L as K)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Bromide, dissolved (mg/L as Br)	Silica, dissolved (mg/L as SiO_2)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Methane, dissolved (mg/L)	Methane, in soil gas (mg/L_g)
106	09-13-90	--	--	--	--	--	--	--	<0.005	--
	02-21-91	--	--	--	--	--	--	--	<.005	--
107	09-17-90	2.2	130	25	.07	11	8	<1	<.005	<.005
108	09-12-90	--	--	--	--	--	--	--	<.005	--
109	09-13-90	--	--	--	--	--	--	--	<.005	<.005
	02-22-91	--	--	--	--	--	--	--	<.005	--
110	09-11-90	--	--	--	--	--	--	--	<.005	<.005
111	09-19-90	--	--	--	--	--	--	--	<.005	<.005
112	09-17-90	--	--	--	--	--	--	--	<.005	--
	02-20-91	--	--	--	--	--	--	--	<.005	--
113	09-12-90	--	--	--	--	--	--	--	<.005	--
	02-21-91	--	--	--	--	--	--	--	<.005	--
114	09-11-90	3.5	1,200	66	.25	8.6	370	3,600	.20	<.005
115	09-11-90	--	--	--	--	--	--	--	<.005	<.005
	02-25-91	--	--	--	--	--	--	--	<.005	--
116	09-17-90	--	--	--	--	--	--	--	<.005	<.005
	02-22-91	--	--	--	--	--	--	--	.075	--
117	10-15-90	--	--	--	--	--	--	--	<.005	<.005
118	09-10-90	--	--	--	--	--	--	--	.13	<.005
119	09-20-90	--	--	--	--	--	--	--	<.005	<.005
	02-20-91	--	--	--	--	--	--	--	<.005	--
120	09-18-90	2.2	160	190	.19	8.9	690	110	15	<.005
121	09-14-90	2.1	86	21	.04	11	6	1,500	.63	<.005
	02-20-91	--	--	--	--	--	--	--	<.005	--
122	09-19-90	--	--	--	--	--	--	--	<.005	<.005
123	09-27-90	5.8	250	240	.26	10	28	530	.45	<.005
124	09-19-90	2.9	110	26	.06	12	1,600	1,200	2.7	<.005
125	09-17-90	--	--	--	--	--	--	--	<.005	<.005
	02-25-91	--	--	--	--	--	--	--	.54	--
126	09-19-90	--	--	--	--	--	--	--	<.005	<.005
127	09-20-90	4.9	2,100	1,700	1.6	9.0	140	490	33	<.005
128	09-20-90	2.6	100	26	.05	9.3	170	790	1.7	<.005
129	09-24-90	--	--	--	--	--	--	--	<.005	<.005
130	09-24-90	--	--	--	--	--	--	--	<.005	<.005

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Potassium, dissolved (mg/L as K)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Bromide, dissolved (mg/L as Br)	Silica, dissolved (mg/L as SiO_2)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Methane, dissolved (mg/L)	Methane, in soil gas (mg/L_g)
131	09-20-90	--	--	--	--	--	--	--	<0.005	<0.005
132	09-27-90	--	--	--	--	--	--	--	<.005	<.005
133	09-24-90	--	--	--	--	--	--	--	<.005	<.005
134	09-27-90	--	--	--	--	--	--	--	<.005	<.005
135	09-27-90	--	--	--	--	--	--	--	<.005	<.005
136	09-27-90	1.3	210	38	.08	12	44	4	1.1	<.005
137	09-27-90	--	--	--	--	--	--	--	.21	<.005
138	09-26-90	1.8	100	22	.05	10	910	260	.38	.032
139	10-01-90	--	--	--	--	--	--	--	<.005	<.005
140	09-26-90	--	--	--	--	--	--	--	<.005	<.005
141	09-24-90	--	--	--	--	--	--	--	<.005	<.005
142	10-01-90	--	--	--	--	--	--	--	<.005	<.005
143	09-24-90	--	--	--	--	--	--	--	<.005	<.005
144	10-01-90	1.1	470	41	.12	12	1,000	2,200	.014	.005
145	10-01-90	--	--	--	--	--	--	--	<.005	<.005
146	09-24-90	2.6	110	17	.06	9.9	<3	<1	<.005	<.005
147	10-01-90	--	--	--	--	--	--	--	.005	<.005
148	09-25-90	--	--	--	--	--	--	--	<.005	<.005
149	10-18-90	--	--	--	--	--	--	--	.008	<.005
150	10-02-90	--	--	--	--	--	--	--	<.005	<.005
151	09-25-90	--	--	--	--	--	--	--	<.005	<.005
152	09-25-90	--	--	--	--	--	--	--	<.005	<.005
153	09-26-90	--	--	--	--	--	--	--	<.005	<.005
154	09-25-90	2.8	340	45	.13	13	160	8	<.005	<.005
155	10-01-90	--	--	--	--	--	--	--	<.005	<.005
156	10-04-90	4.0	1,100	110	.16	12	73	840	.11	<.005
157	09-26-90	3.2	460	150	.13	14	960	2,600	.080	<.005
158	10-02-90	4.9	730	100	.12	12	1,100	750	.024	<.005
159	10-02-90	--	--	--	--	--	--	--	<.005	<.005
160	09-26-90	--	--	--	--	--	--	--	.018	<.005
161	10-03-90	--	--	--	--	--	--	--	<.005	<.005
162	10-02-90	--	--	--	--	--	--	--	<.005	<.005
163	10-03-90	--	--	--	--	--	--	--	<.005	<.005
164	10-03-90	--	--	--	--	--	--	--	<.005	<.005
165	10-02-90	--	--	--	--	--	--	--	<.005	<.005

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Potassium, dissolved (mg/L as K)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Bromide, dissolved (mg/L as Br)	Silica, dissolved (mg/L as SiO_2)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Methane, dissolved (mg/L)	Methane, in soil gas (mg/L_g)
166	10-03-90	--	--	--	--	--	--	--	<0.005	<0.005
167	10-04-90	--	--	--	--	--	--	--	<.005	<.005
168	09-26-90	--	--	--	--	--	--	--	<.005	<.005
169	10-04-90	--	--	--	--	--	--	--	<.005	<.005
170	10-03-90	--	--	--	--	--	--	--	<.005	<.005
171	10-03-90	--	--	--	--	--	--	--	<.005	<.005
172	10-05-90	--	--	--	--	--	--	--	.13	<.005
173	10-04-90	--	--	--	--	--	--	--	<.005	<.005
174	10-04-90	2.0	170	22	.10	13	130	45	4.9	<.005
175	10-05-90	--	--	--	--	--	--	--	<.005	<.005
176	10-18-90	--	--	--	--	--	--	--	<.005	<.005
177	10-09-90	1.9	400	35	.13	12	190	24	1.5	<.005
178	10-05-90	--	--	--	--	--	--	--	<.005	<.005
179	10-15-90	--	--	--	--	--	--	--	<.005	<.005
180	10-18-90	--	--	--	--	--	--	--	<.005	<.005
181	10-18-90	--	--	--	--	--	--	--	<.005	<.005
182	10-18-90	--	--	--	--	--	--	--	<.005	<.005
183	10-03-90	--	--	--	--	--	--	--	<.005	<.005
184	10-09-90	3.3	1,100	88	.14	4.6	230	1,300	<.005	<.005
185	10-16-90	--	--	--	--	--	--	--	<.005	<.005
186	10-16-90	--	--	--	--	--	--	--	<.005	<.005
187	10-05-90	--	--	--	--	--	--	--	<.005	<.005
188	10-15-90	--	--	--	--	--	--	--	<.005	<.005
189	10-16-90	--	--	--	--	--	--	--	<.005	<.005
190	10-09-90	--	--	--	--	--	--	--	<.005	<.005
191	10-09-90	--	--	--	--	--	--	--	<.005	<.005
192	10-05-90	1.1	1,000	11	.05	4.1	980	38	.32	<.005
193	10-15-90	--	--	--	--	--	--	--	<.005	<.005
194	10-16-90	--	--	--	--	--	--	--	<.005	<.005
195	10-15-90	--	--	--	--	--	--	--	<.005	<.005
196	10-17-90	--	--	--	--	--	--	--	<.005	<.005
197	10-16-90	--	--	--	--	--	--	--	<.005	<.005
198	10-17-90	--	--	--	--	--	--	--	<.005	<.005
199	10-17-90	--	--	--	--	--	--	--	<.005	<.005
200	10-18-90	--	--	--	--	--	--	--	<.005	<.005

Table 2. Water-level and water-quality measurements and nearby soil-gas-methane concentrations for selected water wells and springs--Continued

Number on plate 1	Date sampled	Potassium, dissolved (mg/L as K)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Bromide, dissolved (mg/L as Br)	Silica, dissolved (mg/L as SiO_2)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Methane, dissolved (mg/L)	Methane, in soil gas (mg/L_g)
201	10-16-90	--	--	--	--	--	--	--	<0.005	<0.005
202	10-17-90	--	--	--	--	--	--	--	<.005	<.005
203	10-17-90	4.0	420	31	.07	14	2,100	2,800	.077	<.005
204	10-17-90	--	--	--	--	--	--	--	<.005	<.005
205	10-16-90	--	--	--	--	--	--	--	<.005	<.005

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings

[ft, feet; mg/L_g, milligrams per liter of gas; GAS, producing or shut-in single-completion gas well; DA, hole drilled and abandoned; 2GAS, producing or shut-in dual-completion gas well; PA, gas well plugged and abandoned; WOC, gas well waiting on completion when sampled; FL, Fruitland Formation coals; PC, Pictured Cliffs Sandstone; LS, Lewis Shale; MV, Mesaverde Group; DK, Dakota Sandstone; --, producing formation not applicable; <, less than]

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
			COLORADO				
S. Ute 32-9, 6-1	32N-09W-06ADB	1990	3,475	GAS	FL	04-25-91	0.3
Block 6, 5-6	32N-09W-06ADB	1960	5,700	GAS	PC	04-25-91	.02
Mechel 5	32N-09W-06BBD	1969	4,314	GAS	LS	10-23-90	<.005
Dakota Ute 2	32N-09W-06BBD	1969	4,583	GAS	MV	10-23-90	<.005
Ben Ute 3	32N-09W-06BCA	1969	7,398	GAS	DK	10-10-90	.03
S. Ute B-1	32N-09W-07CCB	1965	7,448	GAS	DK	05-01-91	.3
NE Cox Canyon 1-7	32N-09W-07CCC	1964	7,705	GAS	MV	05-01-91	<. 005
Block 13, 5-18	32N-09W-18ABD	1960	5,990	GAS	MV	04-25-91	<.005
Carter Ute 7-A	32N-09W-19CBA	1981	5,707	GAS	MV	02-05-91	<.005
Carter Ute 734	32N-09W-19CCA	1990	2,851	GAS	FL	02-04-91	<.005
Carter Ute 7	32N-09W-19CCA	1960	5,464	GAS	MV	02-04-91	<.005
S. Ute 19-1, 32-9	32N-09W-19DDA	1981	5,650	GAS	MV	04-25-91	<.005
S. Ute 20-5, 32-9	32N-09W-20CCB	1989	3,097	GAS	FL	04-25-91	.03
Bonds 1-1	32N-10W-01AAC	1987	2,750	GAS	FL	10-24-90	<.005
Bondad 3-1	32N-10W-01ADB	1963	2,414	DA	--	05-01-91	<.005
Bonds 1-E	32N-10W-01ADB	1980	7,485	GAS	DK	10-24-90	<.005
NE Cox Canyon 2-1	32N-10W-01ADB	1963	5,354	GAS	MV	10-24-90	<.005
Bonds 3-1	32N-10W-01BCA	1988	2,800	GAS	FL	10-26-90	.3
NE Cox Canyon 3-1	32N-10W-01BCA	1986	5,510	2GAS	MV/FL	10-26-90	.03
Bonds 1	32N-10W-01BDC	1965	7,620	GAS	DK	10-26-90	<.005
Bonds 2-1	32N-10W-01CBD	1988	2,906	GAS	FL	10-26-90	<.005
NE Cox Canyon 1-1	32N-10W-01CBD	1963	5,608	GAS	MV	10-26-90	.9
Bonds 2-E	32N-10W-01CCA	1983	7,693	GAS	DK	10-26-90	<.005
Bonds 3-E	32N-10W-01DCB	1983	7,665	GAS	DK	10-26-90	.01
Cedar Hill 32-10, 7	32N-10W-12AAA	1956	5,223	GAS	MV	10-22-90	<.005
S. Ute 1-12, 2E	32N-10W-12ADB	1985	7,732	GAS	DK	10-11-90	<.005
S. Ute 1-12, 1	32N-10W-12BDA	1980	7,732	GAS	DK	05-02-91	9
Carter Ute 5	32N-10W-12CBD	1958	5,922	GAS	MV	05-03-91	<.005
S. Ute 1-12, 1E	32N-10W-12CCA	1984	8,217	GAS	DK	05-03-91	280
S. Ute 1-12, 3E	32N-10W-12DCA	1985	7,704	GAS	DK	12-10-90	80
						03-05-91	350

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings--Continued

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
			COLORADO--Continued				
Sever 1	32N-10W-13ADB	1958	5,418	GAS	MV	10-31-90	<0.005
Carter Ute 105	32N-10W-24DAD	1988	2,987	GAS	FL	02-05-91	.005
Bondad 33-9, 24-6	33N-09W-06BBD	1960	5,315	GAS	MV	05-03-91	<.005
Clovis A-1	33N-09W-06DCD	1987	3,050	GAS	FL	04-24-91	.09
Bondad 33-9, 13	33N-09W-06DDB	1956	5,490	GAS	MV	04-24-91	<.005
Alva Short PLA6, B-1	33N-09W-18BDB	1988	3,080	GAS	FL	04-25-91	.005
Bondad 33-9, 14	33N-09W-18BDB	1958	5,454	GAS	MV	04-25-91	<.005
Koon 3-E	33N-09W-19BCA	1983	7,587	GAS	DK	11-01-90	<.005
Bondad 33-9, 31	33N-09W-19BCA	1961	5,224	GAS	MV	11-01-90	<.005
Koon 1-E	33N-09W-19CAC	1983	7,587	GAS	DK	12-05-90	2
S. Ute 33-9, 30-1	33N-09W-30BDB	1978	5,480	2GAS	MV/PC	05-01-91	<.005
Spatter 2	33N-09W-31BDB	1956	5,050	GAS	MV	10-23-90	0.05
Spatter 4	33N-09W-31BDC	1973	7,387	GAS	DK	10-23-90	<.005
Spatter 1	33N-09W-31CCA	1954	7,661	DA	--	05-02-91	38
Bryce 1	33N-09W-31CCD	1938	2,240	DA	--	10-10-90	1,200
Bryce 1-X	33N-09W-31CCD	1942	4,835	PA	--	05-03-91	200
Spatter 3	33N-09W-31DBB	1957	5,300	PA	--	10-23-90	<.005
Animas 1-1	33N-10W-01BDA	1961	7,500	2GAS	DK/MV	11-05-90	<.005
S. Ute 3-1	33N-10W-01BDB	1990	2,681	GAS	FL	11-05-90	<.005
Animas 2-1	33N-10W-01CDA	1980	5,170	GAS	MV	11-21-90	470
						03-26-91	120
Bondad 33-10 Com 104	33N-10W-01DAC	1990	2,610	GAS	FL	11-19-90	<.005
Bondad 33-10-1, 9	33N-10W-01DDB	1956	5,250	GAS	MV	11-19-90	.01
Medina A-PLA6, 1	33N-10W-11DCA	1990	2,602	GAS	FL	11-23-90	2
Bondad 33-10, 5	33N-10W-11DX	1956	5,215	GAS	MV	11-23-90	.01
Bondad 33-10, 103	33N-10W-12BAC	1989	2,532	GAS	FL	11-21-90	<.1
Bondad 33-10, 12	33N-10W-12BAC	1956	5,156	GAS	MV	11-21-90	.03
Elmer Dunkel 1	33N-10W-12DBA	1990	2,782	GAS	FL	11-19-90	.005
Bondad 33-10, 10	33N-10W-12DBD	1956	5,230	GAS	MV	11-19-90	.03
Davies A-PLA 6-1	33N-10W-13BAC	1989	2,540	GAS	FL	11-21-90	<.005
Bondad 33-10, 7	33N-10W-13BBD	1957	5,161	GAS	MV	11-20-90	35

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings--Continued

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
			COLORADO--Continued				
Ute B-1	33N-10W-13DBD	1961	5,252	GAS	MV	11-01-90	0.01
Bondad 33-10, 17	33N-10W-14DBD	1960	5,294	GAS	MV	11-23-90	<.005
S. Ute 33-10, 23-2	33N-10W-23AAC	1980	5,350	GAS	MV	11-23-90	2
Craig 1-E	33N-10W-24AAC	1984	7,600	GAS	DK	11-01-90	14
Ute C-2	33N-10W-24AAC	1984	5,350	GAS	MV	11-01-90	25
S. Ute 33-10, 24-3	33N-10W-24BAC	1990	2,605	GAS	FL	10-31-90	5
S. Ute 33-10, 24-1	33N-10W-24BAC	1964	5,311	GAS	MV	11-21-90	<.005
Craig 2-E	33N-10W-24BDB	1984	7,657	GAS	DK	11-21-90	.005
Craig 3-E	33N-10W-24CBD	1985	7,875	GAS	DK	10-30-90	21
S. Ute 33-10, 24-2	33N-10W-24CDB	1980	5,443	GAS	MV	10-30-90	.005
Craig 1	33N-10W-24DBC	1975	7,585	GAS	DK	10-31-90	65
Ute C-1	33N-10W-24DBD	1963	5,260	GAS	MV	10-31-90	<.005
Sharp 3-E	33N-10W-25AAD	1983	7,559	GAS	DK	10-31-90	.01
Bondad 33-10, 1-25	33N-10W-25ABD	1955	2,392	DA	--	05-02-91	<.005
Bondad 33-10, 3	33N-10W-25ABD	1955	5,199	GAS	MV	10-31-90	430
						03-05-91	220
Sharp 1-E	33N-10W-25BAC	1980	7,651	GAS	DK	10-30-90	.005
Sharp 2-E	33N-10W-25CAC	1983	7,623	GAS	DK	10-30-90	.1
Sharp 1	33N-10W-25DBC	1972	7,518	GAS	DK	10-30-90	<.005
M.F. Sharp 1	33N-10W-25DDB	1990	2,595	GAS	FL	10-30-90	<.005
S. Ute A-3	33N-10W-26DAC	1965	7,662	GAS	DK	10-29-90	<.005
S. Ute 1-26	33N-10W-26DAC	1957	5,382	GAS	MV	10-29-90	<.005
S. Ute A-2	33N-10W-35DAB	1965	7,845	GAS	DK	11-23-90	<.005
Bondad Ute 1-36	33N-10W-36BBD	1989	3,300	GAS	FL	11-23-90	2
Bondad 33-10, 6	33N-10W-36BDB	1956	5,318	GAS	MV	10-29-90	<.005
Bondad 33-10, 24	33N-10W-36DAC	1966	7,418	GAS	DK	10-10-90	320
Bondad 33-10, 18	33N-10W-36DBD	1957	5,190	GAS	MV	10-25-90	<.005
Wheeler 7U-1	34N-09W-07CAC	1986	2,621	GAS	FL	04-23-91	25
Koshak B-1	34N-09W-08BDB	1989	2,740	GAS	FL	11-05-90	14
Koshak A-1	34N-09W-08DBC	1988	2,555	GAS	FL	11-05-90	.02
Isgar A-1	34N-09W-18BDA	1989	2,595	GAS	FL	04-25-91	.07

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings--Continued

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
			COLORADO--Continued				
Beaston 4-30	34N-09W-30BAC	1989	3,053	GAS	FL	04-24-91	<0.005
Fee 30-1	34N-09W-30BDB	1960	7,991	GAS	MV	04-24-91	3
Dowler 1-A	34N-09W-30CAC	1981	5,796	GAS	MV	04-24-91	<.005
Beaston 2-31	34N-09W-31BDB	1959	5,600	PA	--	04-24-91	.09
MIR 31-1	34N-09W-31DBC	1988	2,879	GAS	FL	04-24-91	<.005
MIR 1-31	34N-09W-31DCB	1959	7,920	GAS	DK	04-24-91	.01
S. Ute Mobil 1-24	34N-10W-24DCA	1990	2,721	GAS	FL	04-23-91	<.005
Bondad 34-10, 7	34N-10W-24DDB	1962	5,300	GAS	MV	04-23-91	<.005
S. Ute Mobil 2-25	34N-10W-25BAC	1990	2,805	GAS	FL	04-24-91	<.005
Bondad 34-10, 5	34N-10W-25BDB	1962	5,330	GAS	MV	04-23-91	<.005
S. Ute Mobil 1-25	34N-10W-25DCA	1991	2,590	GAS	FL	04-23-91	20
Bondad 34-10, 4-25	34N-10W-25DDB	1960	5,382	GAS	MV	04-23-91	<.005
Bondad 34-10, 2	34N-10W-35DCA	1957	5,226	PA	--	11-23-90	<.005
S. Ute Mobil 36-1	34N-10W-36ADB	1990	2,717	GAS	FL	11-19-90	.01
Bondad 34-10, 3X	34N-10W-36BDB	1962	5,185	GAS	MV	11-05-90	<.005
Bondad 34-10, 3	34N-10W-36BDB	1958	5,170	PA	--	11-05-90	<.005
Animas 1	34N-10W-36CX	1981	5,200	GAS	MV	11-23-90	<.005
Bondad 34-10, 1	34N-10W-36DBD	1959	7,620	2GAS	DK/MV	11-05-90	<.005
			NEW MEXICO				
Coldiron Com A-1M	30N-11W-02BDB	1982	7,027	2GAS	DK/MV	03-15-91	<.005
Calloway 1	30N-11W-03AAC	1954	2,369	PA		03-14-91	<.005
Zella Calloway 1	30N-11W-03AAC	1962	6,986	GAS	DK	03-14-91	<.005
Lester 1	30N-11W-03ADB	1975	4,760	2GAS	MV/PC	03-15-91	.7
Lester 1-A	30N-11W-03BBD	1980	4,701	GAS	MV	03-14-91	.007
Sexton 1	30N-11W-03BBD	1954	2,197	GAS	PC	03-14-91	460
						03-27-91	1,100
Fee 3A	30N-11W-03CAC	1980	4,722	GAS	MV	04-04-91	.005
Bandy 1	30N-11W-03CDA	1954	2,230	GAS	PC	04-04-91	<.005
Fee 3	30N-11W-03DAC	1983	5,010	2GAS	MV/PC	04-30-91	<.005
Coldiron Com A-1M	30N-11W-02BCA	1982	7,027	2GAS	DK/MV	03-15-91	<.005

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings--Continued

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
			NEW MEXICO--Continued				
Hampton 2	30N-11W-03DCA	1953	2,285	PA	--	04-04-91	0.006
Haynie 2	30N-11W-04ABD	1980	6,860	2GAS	DK/MV	03-25-91	<.005
Haynie 1	30N-11W-04ACA	1954	2,238	PA	--	04-01-91	<.005
Bobbie Herrera 1	30N-11W-04CAC	1979	2,350	2GAS	PC/FL	04-01-91	<.005
Fee 4	30N-11W-04DAC	1980	4,863	GAS	MV	04-04-91	<.005
Ona Magee 1	30N-11W-04DDB	1961	6,778	GAS	DK	04-04-91	.1
Roberts 1	30N-11W-04DDB	1954	2,167	GAS	PC	04-30-91	21
Thomas 1	30N-11W-09AAC	1953	2,154	GAS	PC	04-01-91	<.005
Fee 9-A	30N-11W-09ABD	1981	4,812	GAS	MV	04-04-91	<.005
Hampton D-1	30N-11W-10ABD	1962	6,906	GAS	DK	04-05-91	<.005
Hampton 3	30N-11W-10ABD	1956	4,757	GAS	MV	04-05-91	<.005
Hampton 3-A	30N-11W-10BBD	1977	4,842	GAS	MV	04-04-91	<.005
Scott 7	31N-10W-03ABC	1955	5,365	GAS	MV	12-14-90	.06
Scott 12	31N-10W-03ACA	1975	2,979	GAS	PC	12-13-90	.02
Scott 13	31N-10W-03BDB	1975	2,904	GAS	PC	12-14-90	16
Scott 7-A	31N-10W-03BCD	1976	5,425	GAS	MV	12-13-90	.9[a]
						03-27-91	no data[a]
Lucerne A-6	31N-10W-03CCA	1978	3,255	PA	--	12-12-90	130
Lucerne A-3	31N-10W-03CCA	1955	5,656	GAS	MV	12-12-90	49
Wood Com A-1	31N-10W-04ABD	1984	2,694	GAS	FL	12-05-90	.4
Usselman Com 1	31N-10W-04ABD	1954	5,075	GAS	MV	12-05-90	.008
Usselman Com B-1	31N-10W-04ACA	1977	2,970	GAS	PC	12-07-90	.005
Usselman Com 1-A	31N-10W-04BCD	1978	5,182	GAS	MV	12-04-90	<.005
Usselman Com C-1	31N-10W-04BCD	1978	2,984	GAS	PC	12-04-90	<.005
Scott 6	31N-10W-04CAC	1954	5,417	GAS	MV	12-11-90	<.005
Scott 10	31N-10W-04CCA	1975	2,957	GAS	PC	12-11-90	<.005
Scott 6-A	31N-10W-04DBD	1977	5,535	GAS	MV	12-11-90	97
						04-15-91	370
Lucerne A-10	31N-10W-04DDB	1978	3,115	GAS	PC	12-13-90	<.005
Marcotte Com C-1	31N-10W-05ABD	1979	2,854	GAS	PC	04-30-91	<.005
Marcotte Com 1	31N-10W-05ADB	1953	5,160	GAS	MV	01-17-91	2
McEwen Com 1-A	31N-10W-05BBC	1976	5,400	GAS	MV	01-24-91	<.005

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings--Continued

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
			NEW MEXICO—Continued				
McEwen Com B-1	31N-10W-05BBB	1978	3,098	GAS	PC	01-24-91	0.005
McEwen Com 1	31N-10W-05CDB	1953	5,167	GAS	MV	01-18-91	.2
McEwen Com C-1	31N-10W-05CDC	1979	2,885	GAS	PC	01-18-91	.03
Marcotte Com 1-A	31N-10W-05DAC	1978	5,151	GAS	MV	12-11-90	<.005
Sammons Com G-1	31N-10W-06AAC	1978	2,888	GAS	PC	02-06-91	<.005
Sammons Com I-1	31N-10W-06ABD	1985	2,734	GAS	FL	02-06-91	<.005
Sammon Com A-1	31N-10W-06ABD	1953	5,084	GAS	MV	02-06-91	<.005[b]
Primo 1-A	31N-10W-06BX	1975	5,114	2GAS	MV/PC	02-07-91	<.005
Primo Federal 1	31N-10W-06CAC	1953	5,135	GAS	MV	03-04-91	<.005
Flaherty 1	31N-10W-06CBD	1978	2,900	GAS	PC	03-04-91	<.005
Sammons Com A-1A	31N-10W-06DDB	1976	5,150	GAS	MV	02-07-91	<.005
Sammons Com H-1	31N-10W-06DDB	1978	2,869	GAS	PC	02-07-91	2
Hutchin B-1	31N-10W-07ACA	NC	2,810	WOC	FL	02-07-91	<.005
Hutchin LS-1	31N-10W-07ACA	1954	5,128	GAS	MV	02-07-91	<.005
Hutchin LS-2	31N-10W-07ACA	1980	2,819	GAS	PC	02-07-91	.008
Larcher 1A	31N-10W-07BAC	1976	5,200	GAS	MV	03-04-91	<.005
Larcher 4	31N-10W-07BDB	1977	2,875	GAS	PC	02-07-91	<.005
Larcher 310	31N-10W-07CAB	1990	2,632	GAS	FL	03-07-91	<.005
Larcher 1	31N-10W-07CAC	1953	5,071	GAS	MV	03-04-91	400
						03-27-91	550
Larcher 3	31N-10W-07CDB	1977	2,735	GAS	PC	03-07-91	<.005
Hutchin 1-A	31N-10W-07DDB	1978	5,200	2GAS	MV/PC	02-28-91	<.005
Marcotte Pool 1	31N-10W-08ACA	1953	5,247	GAS	MV	02-27-91	<.005
Boyd Com 1-A	31N-10W-08BAC	1976	5,175	GAS	MV	01-18-91	<.005
Boyd Com C-1	31N-10W-08BBD	1979	2,801	GAS	PC	02-07-91	.1
Boyd Com 1	31N-10W-08CCA	1953	7,436	GAS	MV	02-28-91	16
Boyd Com B-1	31N-10W-08CCA	1977	2,786	GAS	PC	02-28-91	.02
Scott 14	31N-10W-08DAC	1975	2,969	GAS	PC	02-27-91	<.005
Marcotte 1-A	31N-10W-08DCA	1979	5,438	GAS	MV	02-27-91	.008
Lucerne A-2	31N-10W-09ABD	1954	5,360	GAS	MV	12-12-90	<.005
Lucerne A-7	31N-10W-09ADB	1978	3,133	GAS	PC	12-12-90	<.005

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings--Continued

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
			NEW MEXICO--Continued				
Lucerne A-1A	31N-10W-09BAC	1979	5,488	GAS	MV	12-11-90	<0.005
Scott 11	31N-10W-09BAC	1975	2,996	GAS	PC	12-11-90	.008
Lucerne A-1	31N-10W-09CBD	1954	5,353	GAS	MV	02-27-90	<.005
Lucerne A-4A	31N-10W-10BAC	1978	5,668	2GAS	MV/PC	12-12-90	<.005
Scott 22	31N-10W-17AAC	1976	2,961	GAS	PC	02-28-91	.3
Scott 4	31N-10W-17ADB	1952	5,341	GAS	MV	02-28-91	<.005
Scott 9	31N-10W-17BAC	1975	2,968	GAS	PC	02-28-91	<.005
Hudson 5-A	31N-10W-17BDB	1977	5,427	GAS	MV	03-07-91	.009
McCoy Com A-1	31N-10W-18ADB	1952	5,005	GAS	MV	02-19-91	<.005
McCoy Com A-1A	31N-10W-18BDB	1977	4,988	GAS	PC	02-11-91	180
McCoy B-1	31N-10W-18BDB	1983	2,640	GAS	PC	02-11-91	.3
Caneple Com C-1	31N-10W-18CAC	1972	2,584	GAS	PC	02-11-91	<.005
Caneple Com 1	31N-10W-18CDB	1954	4,950	GAS	MV	02-11-91	<.005
Crandell 7	31N-10W-18DAC	1978	2,802	PA	--	02-19-91	<.005
Caneple Com 1-A	31N-10W-18DAC	1976	5,200	GAS	MV	02-19-91	<.005
Crandell 1	31N-10W-19AAC	1951	5,246	GAS	MV	02-19-91	<.005
Crandell 4	31N-10W-19AAC	1969	2,775	GAS	PC	02-19-91	.2
Crandall 2-A	31N-10W-19BAC	1976	5,218	GAS	MV	02-19-91	.3
Crandell 6	31N-10W-19BAC	1969	2,696	GAS	PC	02-19-91	560
Crandell 2	31N-10W-19CCA	1953	5,070	GAS	MV	02-15-91	460
Crandell 5	31N-10W-19CCA	1969	2,714	GAS	PC	02-15-91	240
Pierce 2-A	31N-10W-30BCA	1977	5,343	GAS	MV	02-13-91	<.005
Pierce 5	31N-10W-30BCA	1969	2,730	GAS	PC	02-13-91	.04
Mudge LS-8	31N-11W-12AAC	1954	5,250	GAS	MV	03-07-91	<.005
Mudge LS-8A	31N-11W-12DAC	1979	5,325	GAS	MV	03-07-91	<.005
Ridenour Com A-1	31N-11W-13ACA	1989	2,772	GAS	FL	03-07-91	<.005
Larcher 2	31N-11W-13ACA	1976	2,705	GAS	PC	03-12-91	<.005
Ridenour Com 1	31N-11W-13ADB	1954	5,057	GAS	MV	03-07-91	<.005
Randleman 3	31N-11W-13BBD	1970	2,578	GAS	PC	03-12-91	<.005
Randleman 1-A	31N-11W-13BCA	1976	5,063	GAS	MV	03-12-91	<.005

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings--Continued

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
			NEW MEXICO--Continued				
Randleman 1	31N-11W-13CAC	1951	4,980	GAS	MV	03-12-91	<0.005
Randleman 2	31N-11W-13CCA	1970	2,633	PA	--	05-01-91	<.005
Ridenour Com 1-A	31N-11W-13DDB	1977	4,950	GAS	MV	02-11-91	<.005
Canepele Com B-1	31N-11W-13DDB	1971	2,569	GAS	PC	02-11-91	<.005
Neil LS-1A	31N-11W-14DBD	1957	5,011	GAS	MV	03-12-91	100
Neal Com 2-E	31N-11W-14DCA	1984	7,160	GAS	DK	03-12-91	<.005
Neil LS-10	31N-11W-14DDB	1972	2,716	GAS	PC	03-12-91	<.005
Nye LS-1	31N-11W-23AAC	1953	5,062	GAS	MV	03-12-91	.02
Mudge LS-31	31N-11W-23AAC	1972	2,596	GAS	PC	03-12-91	<.005
Mudge LS-7A	31N-11W-23BDB	1978	5,182	GAS	MV	03-13-91	<.005
Mudge LS-50	31N-11W-23BDB	1981	2,599	GAS	PC	03-13-91	<.005
Mudge LS-37	31N-11W-23CAC	1972	2,567	GAS	PC	03-13-91	<.005
Mudge LS-7	31N-11W-23CCA	1955	4,945	GAS	MV	03-13-91	<.005
Nye LS-1A	31N-11W-23DCA	1979	5,022	GAS	MV	02-11-91	8
Mudge LS-32	31N-11W-23DCA	1972	2,490	GAS	PC	02-11-91	120
Jensen 1	31N-11W-24AAC	1970	2,547	GAS	PC	02-08-91	<.005
Ruple 1-A	31N-11W-24ABD	1976	5,043	GAS	MV	02-08-91	<.005
Turner 1	31N-11W-24BDC	1953	4,911	GAS	MV	02-08-91	20
Turner 3	31N-11W-24BDX	1970	2,494	GAS	PC	02-08-91	.01
Turner 1-A	31N-11W-24CCA	1976	4,950	GAS	MV	02-12-91	<.005
Turner 2	31N-11W-24CDB	1969	2,574	GAS	PC	02-12-91	.6
Ruple 2	31N-11W-24DCA	1970	2,546	GAS	PC	02-15-91	<.005
Ruple 1-X	31N-11W-24DCX	1951	4,951	GAS	MV	02-15-91	140
Bruington 2	31N-11W-25AAC	1969	2,647	GAS	PC	02-13-91	.005
Bruington 1	31N-11W-25ACA	1953	4,969	GAS	MV	02-12-91	<.005
Bruington 3	31N-11W-25BAC	1970	2,520	GAS	PC	02-08-91	500
						03-27-91	520
Bruington 1-A	31N-11W-25BCA	1977	5,018	GAS	MV	02-15-91	<.005
Zachary Pool 1	31N-11W-25CAC	1955	4,890	GAS	MV	02-14-91	.9
Heaton LS-28	31N-11W-25CAC	1972	2,650	GAS	PC	02-14-91	<.005
Heaton LS-26	31N-11W-25DAC	1971	2,743	GAS	PC	02-13-91	<.005

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings--Continued

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
		NEW MEXICO--Continued					
Zachary 1-A	31N-11W-25DBD	1980	5,274	GAS	MV	02-13-91	46
Randleman Pool 1	31N-11W-26ABD	1957	4,775	GAS	MV	02-12-91	<.005
Randleman 2	31N-11W-26ABD	1975	2,543	GAS	PC	02-12-91	<.005
Randleman 1-A	31N-11W-26BCD	1979	5,031	2GAS	MV/PC	03-13-91	180
Wilmuth Pool 1	31N-11W-26CDB	1958	4,793	PA	--	02-12-91	.3
Wilmuth 2	31N-11W-26CDB	1985	2,470	GAS	PC	02-12-91	55
Wilmuth 1-A	31N-11W-26DDC	1986	5,072	2GAS	MV/PC	02-14-91	<.005
Calloway Pool 1	31N-11W-27ABD	1953	4,890	GAS	MV	03-13-91	<.005
Federal 100-A	31N-11W-27CCA	1984	5,200	GAS	MV	05-01-91	<.005
Federal 1	31N-11W-27CDB	1983	2,670	GAS	FL	03-13-91	<.005
Calloway 1-A	31N-11W-27DCA	1988	5,109	GAS	MV	03-13-91	<.005
Heaton Com B-3E	31N-11W-33ABD	1983	7,040	GAS	DK	03-25-91	170
Heaton LS-6	31N-11W-33ABD	1956	4,944	2GAS	MV/PC	03-25-91	<.005
Myra Cummings 1	31N-11W-33CDA	1962	6,937	GAS	DK	04-01-91	<.005
Oliver 2	31N-11W-33CDB	1954	2,394	GAS	PC	04-01-91	<.005
Oliver 3	31N-11W-33DCA	1954	2,367	GAS	PC	03-25-91	<.005
Heaton 1-A	31N-11W-33DDB	1978	4,982	GAS	MV	04-01-91	<.005
Calloway LS-2	31N-11W-34ADC	1957	4,704	2GAS	MV/PC	03-14-91	<.005
Turner A-1A	31N-11W-34BAC	1981	5,020	GAS	MV	03-13-91	<.005
Flood 1	31N-11W-34BAC	1957	2,474	GAS	PC	03-13-91	<.005
Turner A-1	31N-11W-34CAC	1957	4,670	2GAS	MV/PC	04-30-91	570
Calloway LS-3	31N-11W-34DCA	1974	2,421	PA	--	04-30-91	<.005
Wallace Com 1	31N-11W-35ADA	1957	4,867	GAS	MV	02-14-91	<.005
Wallace Com 3	31N-11W-35ADB	1978	2,652	GAS	PC	02-14-91	<.005
Wallace Com 2	31N-11W-35BAC	1958	2,388	GAS	PC	02-15-91	.1
F.J. Titt 2	31N-11W-35CCA	1964	7,030	GAS	MV	03-14-91	<.005
Alston 1	31N-11W-35CDB	1951	5,028	GAS	PC	03-15-91	<.005
F.J. Titt 2-A	31N-11W-35DCA	1978	4,987	2GAS	MV/PC	03-15-91	.6
Beaver Lodge Com 2-A	31N-11W-36BAC	1978	5,189	GAS	MV	02-13-91	.2
Pubco State Com 4	31N-11W-36CBD	1990	2,469	GAS	FL	03-15-91	390

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings--Continued

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
			NEW MEXICO--Continued				
Pubco State Com 1	31N-11W-36CBD	1955	4,860	GAS	MV	03-15-91	<0.005
Stull 1	32N-10W-10CBD	1956	5,480	GAS	MV	02-04-91	<.005
Stull 100	32N-10W-10DBD	1989	2,675	GAS	FL	02-04-91	<.005
San Juan 32-9, 300	32N-10W-11CAA	1990	3,247	GAS	FL	03-08-91	.1
San Juan 32-9, 55	32N-10W-11CAD	1957	5,900	GAS	MV	03-08-91	<.005
San Juan 32-9, 48	32N-10W-14CAC	1957	6,030	GAS	MV	03-08-91	<.005
Heizer 1	32N-10W-15ABD	1955	5,265	GAS	MV	02-04-91	<.005
Heizer 100	32N-10W-15ACB	1989	2,702	GAS	FL	02-04-91	.005
Bonds Com 100	32N-10W-15CCA	1990	2,717	GAS	FL	02-05-91	<.005
Bonds Pool 1	32N-10W-15CCA	1956	5,320	GAS	MV	02-05-91	22
Burroughs Com A-2	32N-10W-16ACA	1958	5,754	GAS	MV	02-06-91	<.005
Burroughs Com A-100	32N-10W-16ACD	1989	3,099	GAS	FL	02-06-91	<.005
El Paso Com C-4	32N-10W-16CDB	1956	5,637	GAS	MV	02-01-91	<.005
Burroughs Com A-2A	32N-10W-16DCA	1979	5,825	GAS	MV	02-01-91	<.005
Payne 3	32N-10W-20ACA	1954	5,555	PA	--	01-28-91	<.005
Payne 3-E	32N-10W-20ADD	1990	7,900	GAS	DK	02-01-91	.2
Payne 6	32N-10W-20DAC	1984	3,121	GAS	FL	01-28-91	5
Payne 1-A	32N-10W-20DDB	1978	5,725	GAS	MV	01-28-91	<.005
Holmberg Com D-1	32N-10W-21ABD	1989	3,300	GAS	FL	01-28-91	280
Sullivan Com B-1	32N-10W-21ABD	1954	5,610	GAS	MV	01-28-91	<.005
Payne 2-A	32N-10W-21BBD	1980	7,800	2GAS	DK/MV	01-28-91	<.005
Payne Federal 8	32N-10W-21CAC	1984	7,810	GAS	FL	01-28-91	<.005
Payne 2	32N-10W-21CAC	1954	5,609	GAS	MV	01-28-91	<.005
Sullivan Com B-1A	32N-10W-21DDB	1977	5,300	GAS	MV	01-18-91	<.005
Payne 4	32N-10W-22ACA	1954	5,750	GAS	MV	02-05-91	<.005
Sullivan Com 1-A	32N-10W-22BBD	1981	5,217	GAS	MV	01-14-91	<.005
Sullivan Com 1	32N-10W-22CCA	1954	5,300	GAS	MV	01-16-91	<.005
Payne 4-A	32N-10W-22DDA	1980	8,400	2GAS	DK/MV	03-08-91	560
San Juan 32-9, 80	32N-10W-23CCA	1973	3,894	DA	--	03-08-91	<.005
San Juan 32-9, 27	32N-10W-23CDB	1955	6,265	GAS	MV	03-08-91	<.005

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings--Continued

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
			NEW MEXICO--Continued				
Payne 11	32N-10W-27AAC	1987	8,425	GAS	DK	03-08-91	<0.005
Payne 5	32N-10W-27AAC	1954	6,287	GAS	MV	03-08-91	<.005
Keys Com E-1	32N-10W-27BAC	1972	2,601	GAS	FL	01-16-91	<.005
Keys Com A-1A	32N-10W-27BAD	1977	5,375	GAS	MV	01-16-91	<.005
Keys Com A-2	32N-10W-27BDB	1981	7,461	GAS	DK	01-16-91	.6
Keys Com G-1R	32N-10W-27CAC	1988	2,960	GAS	FL	01-14-91	120
Keys Com A-1	32N-10W-27CAC	1953	5,243	GAS	MV	01-14-91	.09
Payne Federal 5-A	32N-10W-27DCA	1976	5,770	2GAS	MV/PC	01-17-91	<.005
Holmberg Com 1	32N-10W-28ABD	1954	5,370	PA	--	01-03-91	.006
Holmberg Com A-1	32N-10W-28ABD	1972	2,679	GAS	FL	01-14-91	<.005
Holmberg Com C-1	32N-10W-28AX	1988	3,029	GAS	FL	01-14-91	<.005
Schneider Com 1-A	32N-10W-28BCA	1977	5,525	GAS	MV	01-25-91	.006
Schneider Com 1	32N-10W-28CBD	1953	5,410	GAS	MV	01-22-91	<.005
Schneider Com B-1	32N-10W-28CCA	1976	3,050	GAS	FL	01-24-91	10
Schneider Com C-1	32N-10W-28CCA	1984	7,630	GAS	DK	01-22-91	.2
Schneider Com B-1S	32N-10W-28CCA	1981	2,853	GAS	FL	01-22-91	.1
Holmberg Com 1-A	32N-10W-28DDB	1978	5,270	GAS	MV	02-26-91	<.005
Scott 100	32N-10W-29ADB	1987	2,980	GAS	FL	01-25-91	<.005
Scott 1	32N-10W-29ADB	1952	5,504	GAS	MV	01-25-91	<.005
Scott LS-3A	32N-10W-29DAC	1978	5,741	GAS	MV	01-25-91	.008
Scott 2-A	32N-10W-31DAC	1976	5,416	2GAS	MV/PC	02-06-91	.05
Valentine Com 1	32N-10W-32AAC	1953	5,289	GAS	MV	01-22-91	<.005
Valentine Com B-1	32N-10W-32AAC	1976	2,960	GAS	PC	01-22-91	.006
State Com BW-1	32N-10W-32ABD	1981	2,713	GAS	FL	01-23-91	2
Valentine Com 1-A	32N-10W-32BBD	1976	5,381	GAS	MV	01-25-91	<.005
Valentine Com C-1	32N-10W-32BCA	1978	3,070	PA	--	01-25-91	<.005
State Com BX-1	32N-10W-32CAC	1982	2,878	GAS	FL	01-24-91	29
Martinez A-1	32N-10W-32CDB	1953	5,290	GAS	MV	01-24-91	<.005[c]
Martinez Com H-1	32N-10W-32CDB	1973	3,020	GAS	PC	01-24-91	<.005
Martinez Com A-1A	32N-10W-32DBD	1978	5,358	GAS	MV	01-24-91	240
						03-06-91	530

Table 3. Gas-well records and maximum methane concentrations measured in soil gas adjacent to gas-well casings--Continued

Gas-well lease and number	Land-net location	Year completed	Total depth (ft)	Well type and status	Producing formation(s)	Date sampled	Maximum soil-gas-methane concentration (mg/L_g)
			NEW MEXICO--Continued				
Carr Com 1	32N-10W-32DBD	1978	2,955	GAS	PC	01-23-91	<0.005
Ealum Com C-1	32N-10W-33ACA	1982	2,805	PA	--	01-03-91	<.005
Ealum Com C-1R	32N-10W-33ACA	1987	2,955	GAS	FL	01-03-91	<.05
Ealum Com 1	32N-10W-33ADB	1953	5,320	PA	--	01-03-91	<.005
Cahn Com 1	32N-10W-33BAC	1977	2,812	PA	--	01-23-91	<.005
Cahn Com 2	32N-10W-33BCA	1976	2,946	PA	--	01-23-91	<.005
Ealum Com 1-A	32N-10W-33BCA	1976	5,400	GAS	MV	01-23-91	<.005
Compton Com 1	32N-10W-33CBC	1979	3,000	PA	--	01-23-91	.005
Cahn Com 1-S	32N-10W-33CBD	1988	2,983	GAS	FL	01-22-91	<.005
Uptegrove Com 1	32N-10W-33CBD	1953	5,270	GAS	MV	01-22-91	<.005
Gardner Com 1	32N-10W-33DAC	1979	2,926	PA	--	12-07-90	.006
Uptegrove Com 1-A	32N-10W-33DAC	1977	5,250	GAS	MV	12-07-90	<.005
Scott 18	32N-10W-34AAC	1977	3,154	PA	--	04-02-91	<.005
Scott 102	32N-10W-34AAC	1988	3,005	GAS	FL	12-14-90	<.005
Scott 5	32N-10W-34ADA	1954	5,315	GAS	MV	12-14-91	<.005[d]
Leeper Com B-1	32N-10W-34BAD	1977	2,851	PA	--	03-27-91	1
Jaquez Com F-1	32N-10W-34BAD	1984	7,426	GAS	DK	01-16-91	610
						03-06-91	460
Leeper Com 1-A	32N-10W-34BAD	1976	5,308	GAS	MV	01-16-91	13
Leeper Com D-1Y	32N-10W-34CAC	1984	2,685	GAS	FL	12-07-90	6
Leeper Com D-1	32N-10W-34CBC	1984	663	DA	--	05-01-91	<.005
Leeper Com C-1	32N-10W-34CDA	1977	3,089	GAS	PC	01-17-91	<.005
Leeper Com 1	32N-10W-34CDB	1953	5,065	GAS	MV	12-07-90	<.005
Scott 5-A	32N-10W-34DAD	1977	5,464	GAS	MV	12-14-90	<.005
Scott 19	32N-10W-34DCA	1976	3,022	GAS	PC	01-17-91	<.005

[a]Maximum concentration measured adjacent to cathodic-protection well was 560 milligrams per liter of gas.

[b]Maximum concentration measured adjacent to cathodic-protection well was 7 milligrams per liter of gas.

[c]Maximum concentration measured adjacent to cathodic-protection well was 10 milligrams per liter of gas.

[d]Maximum concentration measured adjacent to cathodic-protection well was 30 milligrams per liter of gas.

Table 4. Molecular-composition and methane-isotope data for gas from well water, open-field soil seeps, soil adjacent to gas-well casings, and gas-well production casings at selected sites

[Numbers in parentheses in the "Site description" column in the "Well-Water Gas" sections are site numbers in tables 1 and 2 and on plate 1; letter designations in parentheses in "Site description" column in "Gas-Well Production Gas" sections indicate producing formation: DK, Dakota Sandstone; FL, Fruitland Formation coals; MV, Mesaverde Group; PC, Pictured Cliffs Sandstone; gas wetness, W, is defined as the percentage of methane (C_1) divided by the sum of the percentages of methane, ethane (C_2), propane (C_3), iso-butane plus n-butane (C_4), and iso-pentane plus n-pentane (C_5): $W = C_1/(C_1+C_2+C_3+C_4+C_5)$; $\partial^{13}C_1$, delta carbon-13 of methane; ∂D_1, delta deuterium of methane; $\partial^{13}C_1$ values are reported relative to the Peedee belemnite marine carbonate standard; ∂D_1 values are reported relative to Standard Mean Ocean Water; <, less than; --, no data; IS, insufficient percentage of methane for reliable determination]

Site description	Land-net location	Date sampled	Air (percent)	Air-free percentage								Gas wetness, W (fraction)	$\partial^{13}C_1$ (per mil)	∂D_1 (per mil)
				Carbon dioxide	Methane	Ethane	Propane	iso-Butane	n-Butane	iso-Pentane	n-Pentane			
COLORADO														
Well-Water Gas														
Robert Kinslow (70)	32N-09W-18CBB	11-07-90	40.1	0.00	98.81	1.20	<0.01	<0.01	<0.01	<0.01	<0.01	0.988	-52.15	-150
Carl Weston (58)	33N-09W-31CCC	11-16-90	41.0	.32	98.00	1.66	<.01	<.01	<.01	<.01	<.01	.983	-41.73	-139
Maurice Walter (59)	32N-10W-01AAD	11-14-90	78.5	.00	99.67	<.01	<.01	<.01	<.01	<.01	<.01	1.00	-25.20	--
Terry Obery (36)	33N-10W-13DDC	11-15-90	55.6	.81	99.19	<.01	<.01	<.01	<.01	<.01	<.01	1.00	-30.73	--
Gerald Brown (42)	33N-10W-25ACB	11-29-90	89.9	62.4	37.62	<.01	<.01	<.01	<.01	<.01	<.01	1.00	IS	--
John Gamble (43)	33N-10W-25ADB	11-29-90	57.5	2.17	95.39	2.45	<.01	<.01	<.01	<.01	<.01	.975	-36.96	-158
Patty Haneman (39)	33N-10W-25BAC	11-30-90	68.7	.00	98.21	1.79	<.01	<.01	<.01	<.01	<.01	.982	-41.96	-178
Jack Kloepfer (52)	33N-10W-36ACD	11-16-90	91.6	1.44	85.77	12.80	<.01	<.01	<.01	<.01	<.01	.870	-41.49	--
Charles Weekly (4)	34N-09W-07ADC	11-15-90	70.7	.00	100.0	<.01	<.01	<.01	<.01	<.01	<.01	1.00	-59.66	-162
Ron Ollier (14)	34N-10W-36CAB	11-15-90	40.7	.00	100.0	<.01	<.01	<.01	<.01	<.01	<.01	1.00	-37.16	--
Open-Field Soil-Seep Gas														
Junior Bonds	32N-09W-06BCD	11-14-90	15.0	3.15	95.88	0.72	0.24	<.01	<.01	<.01	<.01	.990	-37.84	--
Soil Gas Adjacent to Gas-Well Casing														
S. Ute 1-12, 3E	32N-10W-12DCA	03-05-91	77.4	10.8	86.66	2.47	<.01	<.01	<.01	<.01	<.01	.972	-41.01	--
Animas 2-1	33N-10W-01CDA	03-26-91	76.6	8.45	90.32	.77	.47	<.01	<.01	<.01	<.01	.986	-41.81	-188
Bondad 33-10, 3	33N-10W-25ABD	10-31-90	70.3	10.5	77.72	8.70	2.19	.51	.30	<.01	<.01	.869	-35.87	--
Bondad 33-10, 24	33N-10W-36DAC	12-04-90	33.4	.84	88.09	6.35	3.66	.57	.48	<.01	<.01	.888	-42.73	--

Table 4. Molecular-composition and methane-isotope data for gas from well water, open-field soil seeps, soil adjacent to gas-well casings, and gas-well production casings at selected sites--Continued

Site description	Land-net location	Date sampled	Air (percent)	Air-free percentage								Gas wetness, W (fraction)	$\partial^{13}C_1$ (per mil)	∂D_1 (per mil)
				Carbon dioxide	Methane	Ethane	Propane	iso-Butane	n-Butane	iso-Pentane	n-Pentane			
COLORADO–Continued														
Gas-Well Production Gas														
Ben Ute 3 (DK)	32N-09W-06BCA	03-05-91	17.3	2.99	97.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.00	-32.79	-168
Bonds 1-1 (FL)	32N-10W-01AAC	04-02-91	.5	4.92	94.84	.23	<.01	<.01	<.01	<.01	<.01	.998	-42.22	-203
N.E. Cox Canyon 2-1 (MV)	32N-10W-01ADB	10-04-91	.6	2.97	96.39	.63	<.01	<.01	<.01	<.01	<.01	.994	-33.79	--
S. Ute 1-12, 3E (DK)	32N-10W-12DCA	03-05-91	1.5	2.76	97.03	.20	<.01	<.01	<.01	<.01	<.01	.998	-32.62	--
Animas 2-1 (MV)	33N-10W-01CDA	03-26-91	5.0	1.71	94.04	3.51	.62	.13	<.01	<.01	<.01	.957	-36.85	-179
Davies A-PLA 6-1 (FL)	33N-10W-13BAC	04-02-91	2.9	5.45	94.29	.26	<.01	<.01	<.01	<.01	<.01	.997	-42.37	--
Craig 1-E (DK)	33N-10W-24AAC	10-04-91	.8	3.90	95.74	.37	<.01	<.01	<.01	<.01	<.01	.996	-32.89	--
Ute C-2 (MV)	33N-10W-24AAC	04-02-91	6.7	2.46	94.30	2.94	.30	<.01	<.01	<.01	<.01	.967	-37.68	--
Craig 3-E (DK)	33N-10W-24CBD	03-05-91	1.5	4.06	95.73	.20	<.01	<.01	<.01	<.01	<.01	.998	-33.04	--
Bondad 33-10, 3 (MV)	33N-10W-25ABD	10-31-90	5.3	2.35	93.17	3.68	.67	.13	<.01	<.01	<.01	.954	-38.14	--
M.F. Sharp 1 (FL)	33N-10W-25DDB	04-03-91	.9	3.73	95.82	.44	<.01	<.01	<.01	<.01	<.01	.995	-41.91	--
Bondad 33-10, 24 (DK)	33N-10W-36DAC	12-04-90	21.4	2.93	97.09	<.01	<.01	<.01	<.01	<.01	<.01	1.00	-32.99	--
Koshak B-1 (FL)	34N-09W-08BDB	11-05-90	3.1	.78	99.21	<.01	<.01	<.01	<.01	<.01	<.01	1.00	-43.20	--
S. Ute Mobile 36-1 (FL)	34N-10W-36ADB	04-02-91	1.1	6.90	92.89	.21	<.01	<.01	<.01	<.01	<.01	.998	-43.56	--
Bondad 34-10, 3X (MV)	34N-10W-36BDB	04-02-91	2.2	2.17	96.26	1.42	.15	<.01	<.01	<.01	<.01	.984	-35.24	--
Bondad 34-10, 1 (DK)	34N-10W-36DBD	04-02-91	.8	2.87	96.95	.17	<.01	<.01	<.01	<.01	<.01	.998	-31.86	--

Table 4. Molecular-composition and methane-isotope data for gas from well water, open-field soil seeps, soil adjacent to gas-well casings, and gas-well production casings at selected sites--Continued

Site description	Land-net location	Date sampled	Air (percent)	Air-free percentage								Gas wetness, W (fraction)	$\partial^{13}C_1$ (per mil)	∂D_1 (per mil)
				Carbon dioxide	Methane	Ethane	Propane	iso-Butane	n-Butane	iso-Pentane	n-Pentane			
NEW MEXICO														
Well-Water Gas														
Charles Head (120)	31N-10W-04AAA	12-04-90	34.9	0.91	96.31	2.31	0.45	<0.01	<0.01	<0.01	<0.01	0.972	-40.82	-42
Marshall Johnson (124)	31N-10W-04BBD	11-30-90	88.6	66.7	33.33	<.01	<.01	<.01	<.01	<.01	<.01	1.00	IS	--
D.H. Water Co. (127)	31N-10W-04BDA	12-03-90	67.4	22.0	77.97	<.01	<.01	<.01	<.01	<.01	<.01	.984	-38.11	-114
D.H. Water Co. (128)	31N-10W-04BDA	11-30-90	97.0	.00	98.37	1.56	<.01	<.01	<.01	<.01	<.01	1.00	IS	--
M. Shackleford (174)	31N-11W-25CBB	12-04-90	93.8	13.9	74.11	12.0	<.01	<.01	<.01	<.01	<.01	.861	IS	--
Patricia Johnson (73)	32N-10W-10CDD	11-07-90	26.8	.00	99.97	<.01	<.01	<.01	<.01	<.01	<.01	1.00	-67.71	-208
Open-Field Soil-Seep Gas														
Benson Leeper	31N-10W-05AAA	03-26-91	27.1	2.25	96.98	.77	<.01	<.01	<.01	<.01	<.01	.992	-40.98	--
Lanier Clark	32N-10W-34BCB	03-26-91	50.5	.99	98.52	.48	<.01	<.01	<.01	<.01	<.01	.995	-43.99	--
Soil Gas Adjacent to Gas-Well Casing														
Sexton 1	30N-11W-03BBD	03-27-91	6.1	1.35	86.94	7.57	2.77	.50	.64	.16	<.01	.881	-39.25	--
Scott 7-A[1]	31N-10W-03BCD	03-05-91	41.0	.47	98.78	.75	<.01	<.01	<.01	<.01	<.01	.993	-43.86	--
Scott 6-A	31N-10W-04DBD	04-15-91	4.9	.00	93.61	4.24	1.56	.27	.33	<.01	<.01	.936	-40.57	--
Larcher 1	31N-10W-07CAC	03-27-91	38.3	6.03	80.83	8.23	3.47	.55	.68	.21	<.01	.860	-34.82	--
Bruington 3	31N-11W-25BAC	03-27-91	.9	.36	89.59	6.35	2.54	.42	.61	.14	<.01	.899	-40.31	--
Martinez Com A-1A	32N-10W-32DBD	03-06-91	32.3	2.10	97.25	.65	<.01	<.01	<.01	<.01	<.01	.993	-43.81	--
Jaquez Com F-1	32N-10W-34BAD	03-06-91	22.0	1.37	89.45	6.23	2.18	.26	.50	<.01	<.01	.907	-38.61	--

Table 4. Molecular-composition and methane-isotope data for gas from well water, open-field soil seeps, soil adjacent to gas-well casings, and gas-well production casings at selected sites--Continued

Site description	Land-net location	Date sampled	Air (percent)	Air-free percentage								Gas wetness, W (fraction)	$\partial^{13}C_1$ (per mil)	∂D_1 (per mil)
				Carbon dioxide	Methane	Ethane	Propane	iso-Butane	n-Butane	iso-Pentane	n-Pentane			
NEW MEXICO–Continued														
Gas-Well Production Gas														
Sexton 1 (PC)	30N-11W-03BBD	03-27-91	29.7	0.64	87.66	7.57	2.83	0.50	0.64	0.16	<0.01	0.882	-39.72	--
Scott 7A (MV)	31N-10W-03BCD	03-05-91	1.3	4.57	93.88	.40	.29	.24	.47	.09	.08	.984	-42.69	--
Wood Com A-1 (PC)	31N-10W-04ABD	03-27-91	1.3	3.14	94.48	1.67	.56	.14	<.01	<.01	<.01	.975	-42.42	--
Usselmann Com 1 (MV)	31N-10W-04ABD	03-27-91	1.2	.85	85.76	8.57	3.36	.54	.78	.15	<.01	.865	-41.55	-206
Scott 6-A (MV)	31N-10W-04DBD	04-15-91	2.2	1.74	88.55	6.30	2.31	.40	.57	.07	.06	.901	-42.03	--
Marcotte Com 1 (MV)	31N-10W-05ADB	04-02-91	.9	.93	85.13	8.79	3.53	.59	.87	.09	.09	.859	-41.82	--
Larcher 1 (MV)	31N-10W-07CAC	03-27-91	2.2	.77	83.67	9.30	4.20	.75	1.08	.11	.11	.843	-41.80	--
Bruington 3 (PC)	31N-11W-25BAC	03-27-91	1.6	.25	89.70	6.34	2.55	.43	.60	.13	<.01	.899	-40.27	-193
Bruington 1-A (MV)	31N-11W-25BCA	04-02-91	1.1	.60	84.84	9.12	3.61	.61	.94	.20	.10	.853	-42.19	-203
Pubco State Com 4 (FL)	31N-11W-36CBD	04-02-91	1.2	.17	90.29	5.89	2.53	.45	.55	.07	.06	.904	-41.95	--
Martinez Com A-1A (MV)	32N-10W-32DBD	03-06-91	1.7	.86	84.89	9.00	3.57	.62	.87	<.01	<.01	.856	-41.75	--
Ealum Com C-1R (FL)	32N-10W-33ACA	04-03-91	1.0	4.21	95.46	.32	<.01	<.01	<.01	<.01	<.01	.997	-43.09	--
Jaquez Com F-1 (DK)	32N-10W-34BAD	03-06-91	1.9	2.87	96.44	.45	.23	<.01	<.01	<.01	<.01	.993	-42.62	-208
Leeper Com 1-A (MV)	32N-10W-34BAD	04-03-91	.9	.95	86.14	8.38	3.09	.52	.75	.09	.08	.870	-41.11	-204

[1] Sample collected adjacent to cathodic-protection well.

SUMMARY

Shallow ground water obtained from alluvium and Tertiary sedimentary rocks overlying Cretaceous gas-bearing formations in the northwestern part of the San Juan Basin locally is contaminated by methane. Recent development of coal-bed methane from the Cretaceous Fruitland Formation has caused public concern about the possibility of increasing contamination of shallow ground water, especially in the Animas River Valley, one of the most populated areas in the San Juan Basin.

In July 1990, the U.S. Geological Survey began a study of methane contamination of ground water in the Animas River Valley between Durango, Colorado, and Aztec, New Mexico. The purpose of the study is to identify the possible sources of and migration pathways for methane in shallow ground water in the study area. This report addresses the data-collection phase of the study and presents data collected by the U.S. Geological Survey mostly during August 1990–May 1991.

Results of analyses of water samples from 203 wells and 2 springs were used to map the presence of methane in ground water, to determine relations between methane concentrations and other factors, and to select water samples for molecular and methane-isotope analyses of headspace gas. Soil-gas-methane concentrations were measured at 192 ground-water sites, by the casings of 352 gas wells (and some associated cathodic-protection wells) within 0.5 mi of the Animas River Valley, and at 4 open-field soil seeps. Gas from 16 water samples, from 3 soil seeps in open fields, from 10 soil columns adjacent to gas-well casings and 1 column adjacent to a cathodic-protection well, and from 30 gas wells were collected for analyses of molecular composition and carbon-13 content of methane.

Methane concentrations were measured onsite with an organic gas analyzer equipped with a gas-chromatograph column capable of separating methane and ethane. Onsite calibration checks indicated that the overall variation in accuracy was about ±20 percent.

Selected gas samples were analyzed for concentrations of air components, hydrocarbons, and carbon dioxide by the U.S. Geological Survey in Denver, Colorado, by means of thermal-conductivity gas chromatography. Some of these samples also were analyzed for methane hydrogen-isotope ratios at a contract laboratory.

REFERENCES CITED

Fassett, J.E., and Hinds, J.S., 1971, Geology and fuel resources of the Fruitland Formation and Kirtland Shale of the San Juan Basin, New Mexico and Colorado: U.S. Geological Survey Professional Paper 676, 76 p.

Fishman, M.J., and Friedman, L.C., eds., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.

Freeze, R.A., and Cherry, J.A., 1979, Groundwater: Englewood Cliffs, N.J., Prentice-Hall, Inc., 604 p.

Yamamoto, Sachio, Alcauskas, J.B., and Crozier, T.E., 1976, Solubility of methane in distilled water and seawater: Journal of Chemical and Engineering Data, v. 21, no. 1, p. 78–80.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1996 - 774-216 / 00091 REGION NO