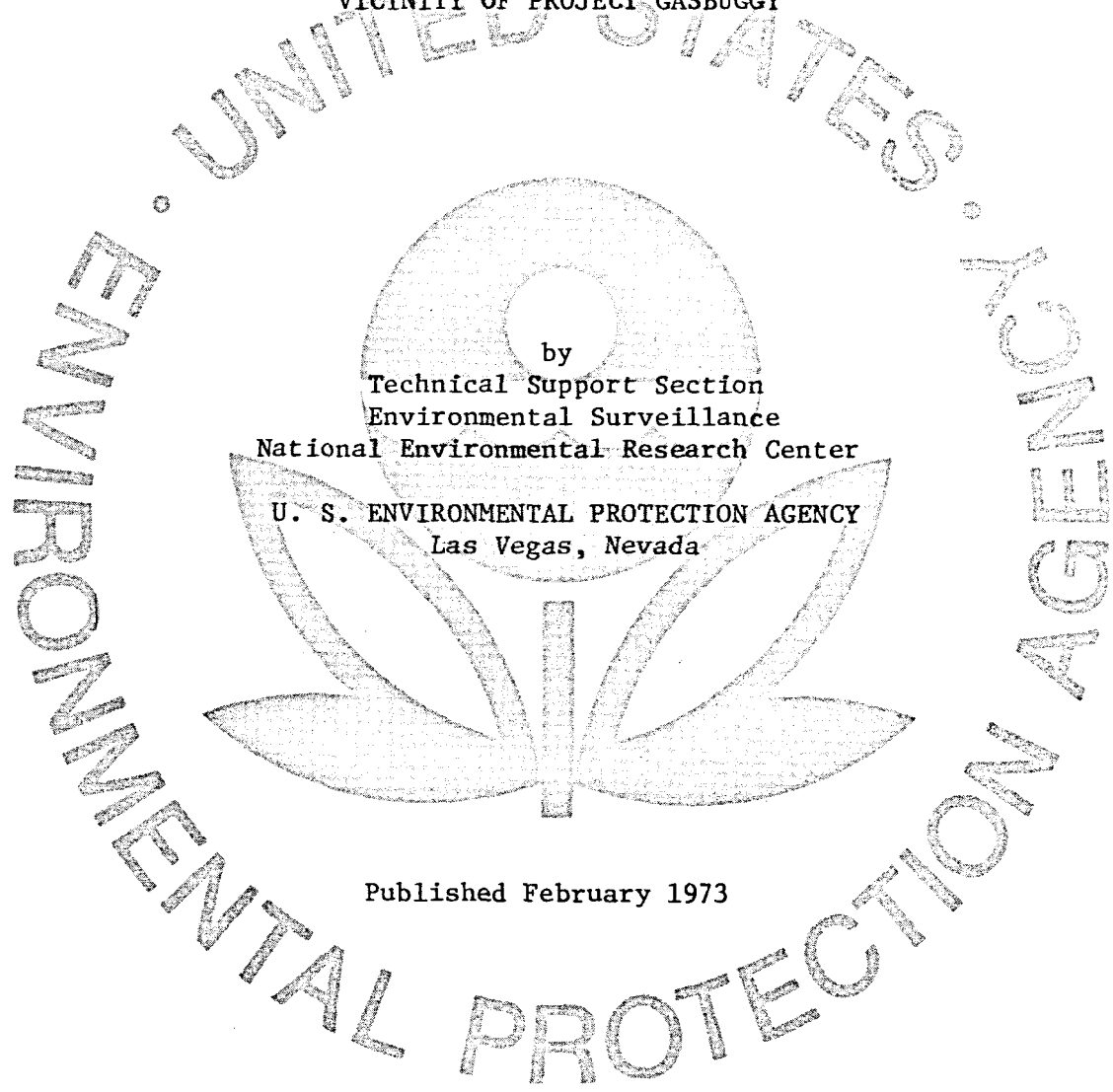
RESULTS OF SAMPLING NATURAL GAS WELLS IN THE VICINITY OF PROJECT GASBUGGY



by
Technical Support Section
Environmental Surveillance
National Environmental Research Center

U. S. ENVIRONMENTAL PROTECTION AGENCY
Las Vegas, Nevada

Published February 1973

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ABSTRACT

Project Gasbuggy was the first experiment to investigate the feasibility of using a nuclear explosion to stimulate production of natural gas from a gas bearing formation. The detonation occurred on December 10, 1967, and on October 30 and 31, 1969, production from 28 gas wells located within five miles of Gasbuggy surface ground zero was resumed. Radiological sampling of natural gas was established on Trunk L and Lateral L-7 since these collection lines represented gas from all 28 wells. Natural gas samples were taken once every three to four weeks from November 5, 1969, to November 10, 1970.

Samples were analyzed for radon-222, tritium, carbon-14, radiokryptons, and radioxenons. The samples were collected through particulate filters which were counted for gross alpha and gross beta activity and analyzed by gamma spectroscopy. The gas was collected in high pressure bottles for gas analysis. Only naturally occurring radon-222 was detected in the gas at concentrations from 12 to 59 pCi/l.

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INTRODUCTION

Project Gasbuggy was conducted to study the feasibility of natural gas production stimulation by fracturing a gas producing formation with nuclear explosives. The detonation was executed near Farmington, New Mexico, on December 10, 1967.

Operating under a Memorandum of Understanding with the Atomic Energy Commission, the National Environmental Research Center-Las Vegas (NERC-LV)* conducted a program of natural gas sampling to document levels of radioactivity in gas produced within 3 miles of the Gasbuggy surface ground zero (SGZ). Previous surveillance by NERC-LV for Project Gasbuggy included environmental surveillance for the Gasbuggy detonation[1], the Gasbuggy Emplacement Re-entry (GB-ER)[2], the GB-2R Re-entry Phase I[3], and the Production Test Phase[4]. Gas flow from the wells within 5 miles of Gasbuggy SGZ began October 30, 1969. The sampling program covered in this report began November 5, 1969, and ended November 10, 1970.

*Formerly the Southwestern Radiological Health Laboratory of the Public Health Service.

SURVEILLANCE PROGRAM

Before Project Gasbuggy was detonated on December 10, 1967, all natural gas wells within 5 miles of Gasbuggy SGZ (Figure 1) were taken off production. Trunk L and Lateral L-7, the gas gathering lines for all gas wells within 5 miles of SGZ were cut and capped on December 6, 1967. The wells were shut down to insure that no radioactivity from the Gasbuggy detonation entered the commercial natural gas being sent to homes and industry. On October 30, 1969, production from 27 of the 28 gas wells located within five miles of SGZ was resumed. On October 31 production was resumed on the 28th well.

Sampling of gas from these wells began on November 5, 1969. This program involved taking natural gas samples from both Trunk L (Figure 2) and Lateral L-7 (Figure 3). Samples were analyzed for radon-222, tritium, carbon-14, radioxenons, and radiokryptons. During collection the gas was passed through particulate filters which were counted for gross alpha, gross beta, and gamma activity.

In order to meet the objective that the natural gas not flow longer than 30 days between the collection of one sample and the reporting of the next sample analysis to the El Paso Natural Gas Company, samples were originally collected every three weeks. This time period was extended to 33 or 34 days so that fewer sampling missions would be necessary. The sampling frequency was changed to every four weeks on February 3, 1970.

To eliminate the need for taking natural gas samples periodically, a natural gas burner was developed by NERC-LV as a simple and inexpensive monitor for radioactivity in natural gas. During October 1970, this burner system was installed at Trunk L. The burner system consists of a combustion chamber with a condensation column exhaust and a few necessary control units. The indicator of residual radioactivity in the natural gas is tritium. A liquid scintillation analysis is made on the condensate water

and the tritium concentration in the natural gas is determined. The major disadvantage of this system at the present is that a sample of the condensate has to be collected and shipped to NERC-LV for analysis. Concurrently, a project is underway at NERC-LV to develop and test a tritium detection and printout system to complete the tritium monitor. This system could be secured at the site and utilized to provide continuous data on the natural gas at any given location[5].

EQUIPMENT AND PROCEDURES

Four-liter oxygen cylinders were connected by a quick-disconnent coupling to a sample manifold, including a pressure gauge and pressure filter holder (Millipore No. XX45 04700) containing a 47-mm-diameter Acropor membrane filter of 0.45 μm pore size manufactured by Gelman Instrument Co. The six sampling cylinders used for each collection were evacuated in the laboratory before each sampling mission. The Acropor filters were placed in their holders at the laboratory and were not removed until they were returned to the laboratory. Three gas samples were taken at each location using the same filter for all three samples at one location.

To collect a sample, the sample manifold, including the pressure filter holder, was connected to the trunk line (Figure 4). The manifold was purged by venting to the atmosphere and was then connected to the sampling cylinder. The cylinder was filled with gas and the pressure was recorded. Then the cylinder was emptied and the resulting pressure was recorded. This procedure was repeated seven times to flush the cylinder and ensure that a representative sample was obtained. After filling the cylinder for the eighth time, all valves were closed and the cylinder was disconnected from the manifold. The entire procedure was repeated for each gas sample taken. The total volume of gas passed through the filter was determined from the cylinder volume and the pressure readings made at each flushing.

During each sampling, a photograph was taken showing the assembled apparatus with the cylinder number, date, and pipe line designation plainly visible (Figure 2). At each location a psychrometer was used to obtain a wet bulb and a dry bulb temperature reading. All data collected were put on an individual data sheet (Appendix A) for each sample. These data included date and time of collection, location, names of collectors, cylinder number, wet and dry bulb temperatures, gas temperature if available, barometric pressure, meteorological conditions, and cylinder pressures filled and empty.

SAMPLE ANALYSIS

All samples were returned to Las Vegas by EPA aircraft for laboratory analysis. Radon analysis was performed by transferring a portion of the gas sample to a Lucas alpha scintillation counting cell for alpha counting of radon and its daughters[6]. Thirty-minute counts were made every half hour until a maximum count rate was achieved. Based on a 30-minute count and a sample volume of 125 ml, the minimum detectable concentration (MDC) for radon was 0.04 pCi/l. All MDC's are based on a 3σ counting error.

The other radionuclides were separated from each other by combusting the natural gas. The water of combustion was separated by freezing and all gases were adsorbed on charcoal at liquid nitrogen temperatures and separated from each other by a series of low temperature chromatographic steps. Samples were analyzed for tritium and carbon-14 by liquid scintillation spectrometry. Based on a 100-minute count and an approximate 4-liter sample of gas, the MDC's for tritium and carbon-14 were 1 pCi/l and 20 pCi/l, respectively. Samples were analyzed for xenon and krypton by beta counting in a glass envelope Geiger counter. Based on a 30-minute count and an approximate 12-liter sample of gas, the MDC for both xenon and krypton was 100 pCi/total sample[7,8].

The filters were counted for gross alpha and gross beta using a Beckman Wide Beta counter. Based on a 10-minute count, the MDC's for gross alpha

and gross beta were 1 pCi/total filter and 2 pCi/total filter, respectively. A gamma scan was performed on the filters using a gamma spectrometer. Based on a 10-minute count, the MDC for a single isotope was 50 pCi/total filter[7].

Sample results were recorded on a Natural Gas Sample Report Form (Appendix B). To expedite reporting, the written report was hand-carried to the Atomic Energy Commission, Nevada Operations Office, who reported the results to El Paso Natural Gas Company by telephone and mail.

RESULTS

Natural gas sampling results are given in Table 1 and filter sampling results are found in Table 2. Only naturally occurring radon-222 was found in any of the samples from either Trunk L or Lateral L-7. Baseline levels of radon-222 in natural gas in northwestern New Mexico (0.2 to 158.8 pCi/l)[9] were established before Project Gasbuggy. The levels in the wells sampled after the detonation remained the same following Project Gasbuggy as seen from the results. No tritium, carbon-14, radiokryptons, or radioxenons were detected.

SUMMARY

Natural gas samples from Trunk L and Lateral L-7, serving all 28 producing gas wells within 5 miles of Project Gasbuggy, were analyzed for tritium, carbon-14, radon-222, radiokryptons, and radioxenons. Only naturally occurring radon-222 was detected. Levels varied from 12 pCi/l to 59 pCi/l or about the same as before Project Gasbuggy. Particulate filter results showed no gross radioactivity levels above background for specific radionuclides.

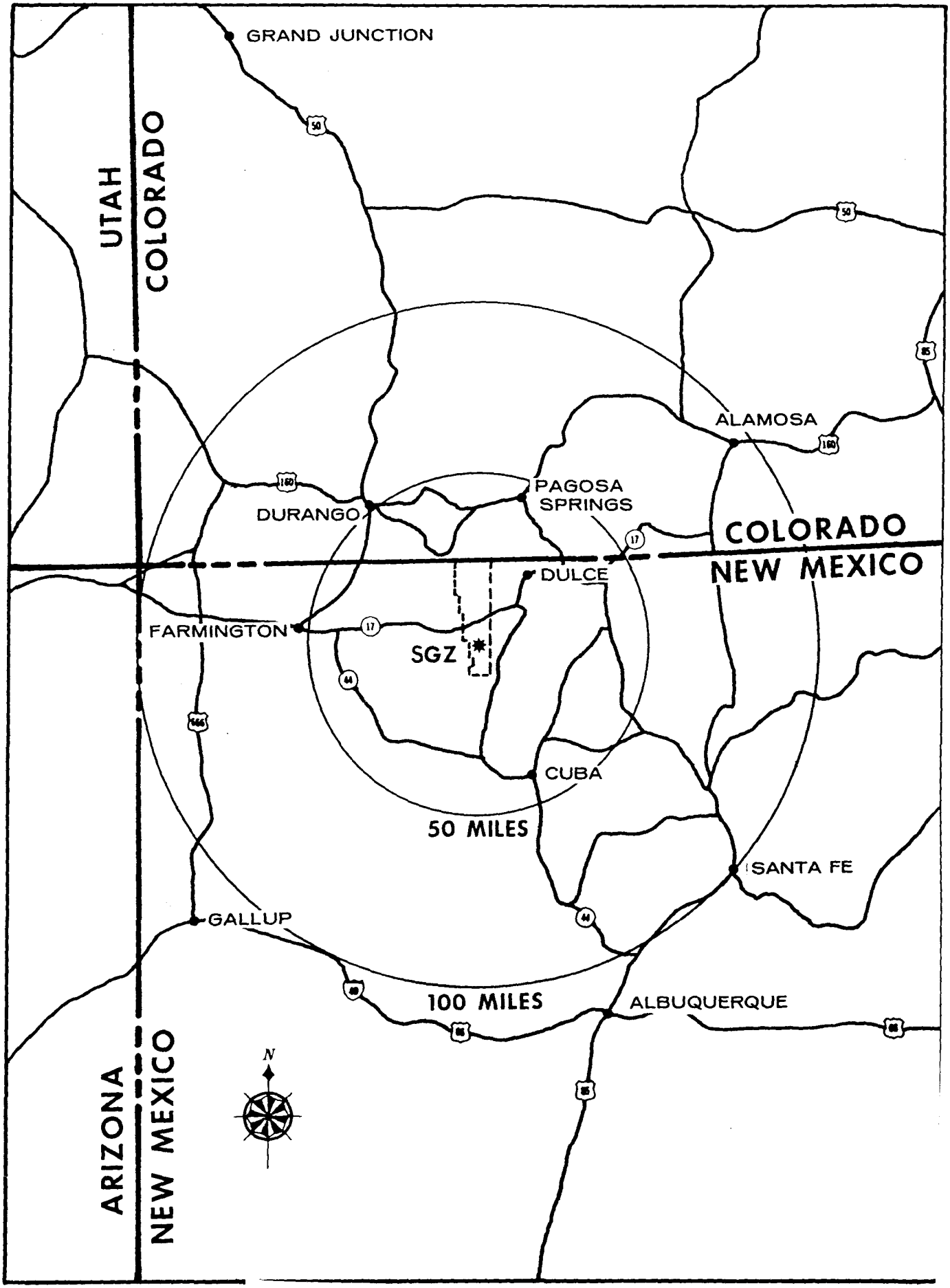

Figure 1. Gasbuggy area map.

Figure 2. Trunk L Sampling Location.

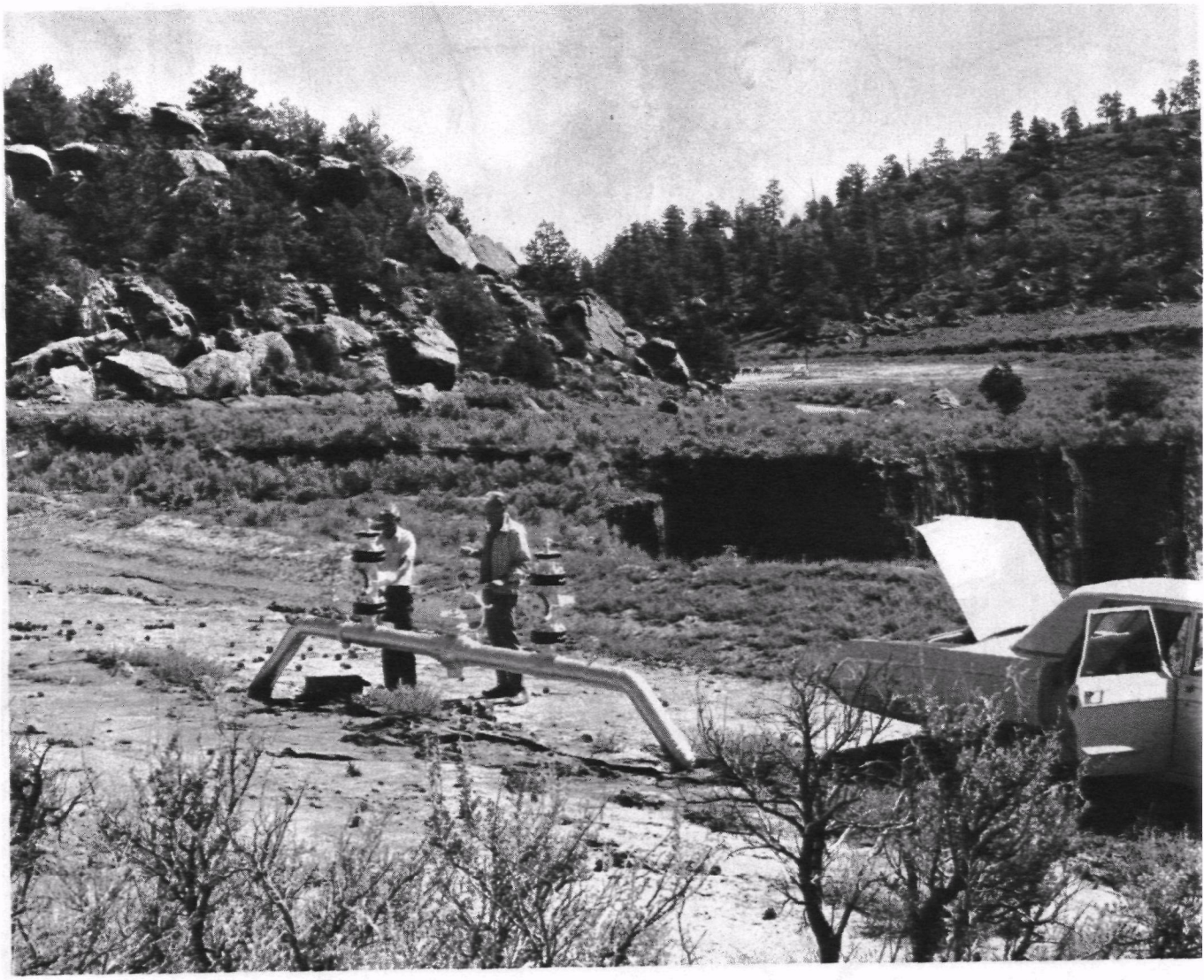

Figure 3. Lateral L-7 Sampling Location.

Figure 4. Sampling Equipment.

TABLE 1. NATURAL GAS SAMPLING RESULTS
(Concentrations (pCi/l))[1]

Sampling Date	^{222}Rn	^{14}C	^{3}H	Kr	Xe
November 5, 1969	28[2]	ND	ND	ND	ND
	31[3]	ND	ND	ND	ND
November 13, 1969	31	ND	ND	ND	ND
	21	ND	ND	ND	ND
December 2, 1969	35	ND	ND	ND	ND
	22	ND	ND	ND	ND
December 22, 1969	34	ND	ND	ND	ND
	19	ND	ND	ND	ND
January 13, 1970	35	ND	ND	ND	ND
	31	ND	ND	ND	ND
February 3, 1970	34	ND	ND	ND	ND
	22	ND	ND	ND	ND
March 3, 1970	38	ND	ND	ND	ND
	19	ND	ND	ND	ND
March 31, 1970	42	ND	ND	ND	ND
	21	ND	ND	ND	ND
April 28, 1970	45	ND	ND	ND	ND
	21	ND	ND	ND	ND
May 25, 1970	34	ND	ND	ND	ND
	20	ND	ND	ND	ND
June 23, 1970	14	ND	ND	ND	ND
	20	ND	ND	ND	ND
July 21, 1970	34	ND	ND	ND	ND
	18	ND	ND	ND	ND
August 17, 1970	42	ND	ND	ND	ND
	35	ND	ND	ND	ND
September 15, 1970	59	ND	ND	ND	ND
	31	ND	ND	ND	ND
October 13, 1970	38	ND	ND	ND	ND
	35	ND	ND	ND	ND
November 10, 1970	21	ND	ND	ND	ND
	12	ND	ND	ND	ND

[1]Extrapolated to time of collection
[2]Trunk L Results
[3]Lateral L-7 Results

ND - Not detectable

TABLE 2. FILTER SAMPLING RESULTS

Sampling Date	Volume (Liters)	Gross Alpha	Gross Beta	Gamma Scan
November 5, 1969	1800[1]	ND	ND	GSN
	2000[2]	ND	ND	GSN
November 13, 1969	1560	ND	ND	GSN
	1600	ND	ND	GSN
December 2, 1969	3200	ND	ND	GSN
	3600	ND	ND	GSN
December 22, 1969	2860	ND	ND	GSN
	3050	ND	ND	GSN
January 13, 1970	3125	ND	ND	GSN
	2730	ND	ND	GSN
February 3, 1970	1720	ND	ND	GSN
	2160	ND	ND	GSN
March 3, 1970	2880	ND	ND	GSN
	3150	ND	ND	GSN
March 31, 1970	2800	ND	ND	GSN
	3100	ND	ND	GSN
April 28, 1970	3000	ND	ND	GSN
	3200	ND	ND	GSN
May 25, 1970	3400	ND	ND	GSN
	3600	ND	ND	GSN
June 23, 1970	2900	ND	ND	GSN
	3100	ND	ND	GSN
July 21, 1970	2800	ND	ND	GSN
	3000	ND	ND	GSN
August 17, 1970	3300	ND	ND	GSN
	3700	ND	ND	GSN
September 15, 1970	2900	ND	ND	GSN
	3000	ND	ND	GSN
October 13, 1970	3200	ND	ND	GSN
	3300	ND	ND	GSN
November 10, 1970	3100	ND	ND	GSN
	3300	ND	ND	GSN

[1]Trunk L Results
[2]Lateral L-7 Results

ND - Not detectable

GSN - Gamma Spectrum negligible

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APPENDICES

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NATURAL GAS SAMPLE

CHECK LIST

1. Connect Filter
2. Purge Sample Line
3. Connect Sample Line (quick disconnect)
4. Photograph Sampling System
5. a. Fill Cylinder (1st time)
   b. Record pressure of filled cylinder
   c. Empty cylinder
   d. Record pressure of emptied cylinder
6. Repeat Step 5a-d (2nd time)
7. Repeat Step 5a-d (3rd time)
8. Repeat Step 5a-d (4th time)
9. Repeat Step 5a-d (5th time)
10. Repeat Step 5a-d (6th time)
11. Repeat Step 5a-d (7th time)
12. a. Fill cylinder (8th time)
    b. Record pressure of filled cylinder
13. Close all valves
14. Disconnect Sample Line
15. Disconnect Filter System from Cylinder
16. Complete Sampling tag and attach to Filter System
17. Complete Sampling tag and attach to Cylinder

COLLECTION DATA

DATE OF COLLECTION:_____

TIME OF COLLECTION:_____

LOCATION_____

COLLECTED BY (PHS):_____

(EPNG):_____

REMARKS:_____

CYLINDER NO.:_____

TEMPERATURE-DRY BULD:_____

WET BULB:_____

GAS TEMP. IF AVAILABLE_____

BAROMETRIC PRESSURE:_____

METEOROLOGICAL CONDITIONS:_____

NO. OF TIMES CYLINDER FILLED	CYLINDER FILLED PRESSURE	CYLINDER EMPTY PRESSURE
1		
2		
3		
4		
5		
6		
7		
8		

NATURAL GAS SAMPLE REPORT

COLLECTION INFORMATION

DATE OF REPORT:_____ COLLECTED BY (PHS):_____

DATE OF COLLECTION:_____ (EPNG):_____

TIME OF COLLECTION:_____ SAMPLE PRESSURE:_____

DATE OF ANALYSIS:_____ CYLINDER NO.:_____

LOCATION:_____ CYLINDER LAB NO.:_____

FILTER LAB NO.:_____

ANALYTICAL RESULTS

	AS COUNTED[1] (dpm)	CONCENTRATION (At collection time, pCi/l)
Gas Analysis		
Radon-222 activity		
Carbon-14 activity		
Tritium activity		
Krypton activity		
Xenon activity		
Pressure Filter Analysis		
Volume of Gas Sampled through Filter		
Gross Alpha		
Gross Beta		
Gamma Scan		

DETECTABLE LIMITS OF ANALYTICAL METHODS

Gas Analysis	Pressure Filter Analysis[5]
Radon-222 0.1 pCi/total portion counted[2]	Gross Alpha 1 pCi/total filter
Carbon-14 0.111 pCi/m. CO_2 @ STP[3]	Gross Beta 2 pCi/total filter
Tritium 0.4 pCi/ml of water collected[3]	Gamma Scan 50 pCi/total filter
Krypton 100 pCi/total portion counted[4]	

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[1]Variance is based on counting error only (2σ).

[2]Portion varies, but not less than 100 ml @ STP.

[3]This value is the result of CH_4 combustion.

[4]Portion varies, but not less than 15 liters.

[5]Based on 10 minute counting time.

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