

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HYDROLOGIC TESTS IN HOLE GB-2,
PROJECT GASBUGGY, RIO ARriba COUNTY,
NEW MEXICO

By

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ABSTRACT

Hole GB-2, completed in April 1967, 465 feet east of hole GB-1 (SW $\frac{1}{4}$ sec. 36, T. 29 N., R. 4 W.), was drilled to a depth of 3,662 feet below the kelly bushing. The hole penetrated the Ojo Alamo Sandstone from a depth of 3,478 to about 3,654 feet, as well as about 8 feet of the underlying Kirtland Shale.

From hydrologic tests of the Ojo Alamo Sandstone made April 17, 1967, the following data were obtained: specific conductance of the fluid removed from the hole, 1,400 micromhos during the earlier part of swabbing and 9,000 micromhos during the later part; temperature of formation fluid, 112^oF; calculated transmissivity, 2.85 gpd (gallons per day) per ft; and calculated relative specific capacity, 0.026 gpm (gallons per minute) per ft. These data are in close agreement with similar data obtained for hole GB-1 in February 1967.

INTRODUCTION

The initial hole, GB-1 (SW $\frac{1}{4}$ sec. 36, T. 29 N., R. 4 W.), at the proposed Gasbuggy Project site was hydrologically tested in February 1967, after the hole had been drilled through the Ojo Alamo Sandstone. Results of these tests are contained in open-file report, "Hydrologic tests in hole GB-1, Project Gasbuggy, Rio Arriba County, New Mexico.

Test hole GB-2, 465 feet east of GB-1 (see fig. 1), was drilled to a depth of 3,662 feet. The Ojo Alamo Sandstone, 3,478 to about 3,654 feet below the kelly bushing, was tested in this hole in April 1967. (The lower 8 feet of the hole penetrated Kirtland Shale.) The purpose of the test was to confirm the test data obtained from GB-1.

This report summarizes the activities of the U.S. Geological Survey during the hydrologic testing and presents a tabulation and an analysis of the data collected.

Messrs. F. C. Koopman and W. C. Ballance of the U.S. Geological Survey ran the tests and collected the data. El Paso Natural Gas Company and the Lawrence Radiation Laboratory personnel provided additional assistance.

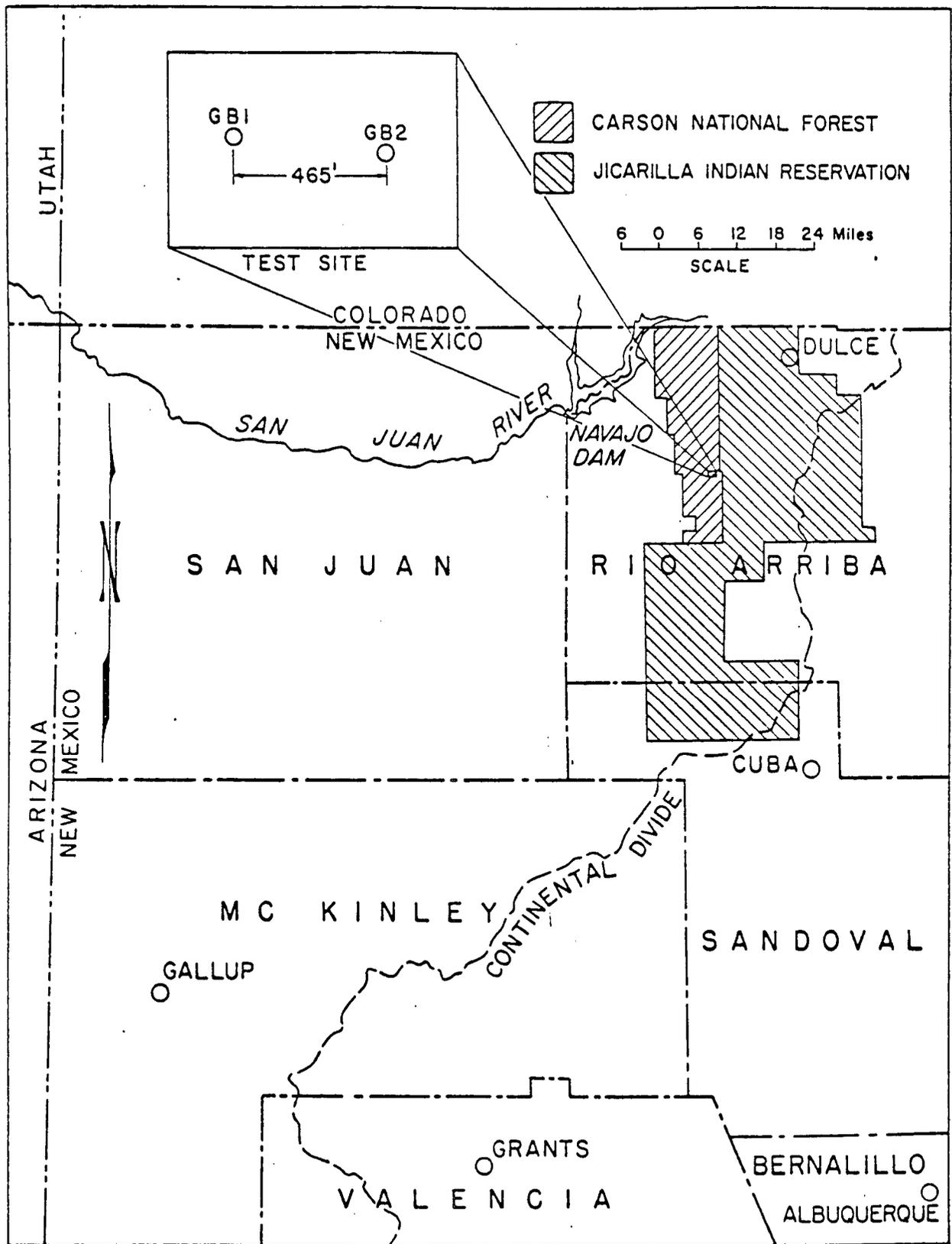


Figure 1.--Project Gasbuggy, site location of exploratory holes GB-1 and GB-2, Rio Arriba County, New Mexico.

HYDROLOGIC TEST OF THE OJO ALAMO SANDSTONE IN HOLE GB-2

On April 17, 1967, the Ojo Alamo Sandstone in hole GB-2 was hydrologically tested to confirm data collected during a similar test of sandstone in hole GB-1 in February 1967. The interval tested was from 3,478 to about 3,662 feet below the kelly bushing.

The kelly bushing, 13 feet above land surface, was used as a measuring point for all measurements made during the hydrologic testing. The altitude of the land surface, at hole GB-2, is 7,198.6 feet above mean sea level.

After hole GB-2 had been drilled to 3,662 feet, a Lynes packer was set on the end of the drill stem at a depth of 3,478 feet to isolate the Ojo Alamo Sandstone from the overlying formation. Tubing was then inserted into the drill stem to approximately 30 feet above the Lynes packer.

Swabbing to remove the drilling mud and to develop the Ojo Alamo Sandstone began at 0215 hours on April 17, 1967. The fluid level was lowered to approximately 1,500 feet below the kelly bushing and remained at about this depth as formation fluid was swabbed from the hole. The total swabbing time was 225 minutes. The fluid from the hole and the formation was collected in a 4,500 gallon storage tank. The amount of fluid produced by each swab and the total fluid swabbed from the hole and formation were determined by a staff gage on the storage tank. The data collected during the swabbing of the hole are tabulated in table 1.

Measurement of water-level recovery began at 0708 hours and continued until 1200 hours on April 17. Table 2 lists the data obtained during the recovery test.

Table 1.--Swabbing test of Ojo Alamo Sandstone in the depth interval
3,478 to 3,662 feet of hole GB-2, April 17, 1967

Swab run no.	Clock time	Staff gage (feet)	Gallons each swab	Approximate depth to top of fluid (feet)	Swab depth (feet)	Specific conductance of fluid (micromhos per cm at 25°)	Temp. of fluid (°F)
1	0215	0.11	41.47	--	1,000	--	--
2	0221	.42	116.87	--	1,500	--	--
3	0229	.92	188.50	--	1,800	1,400	70
4	0240	1.36	165.88	--	1,900	1,400	70
5	0250	1.65	109.33	--	1,900	--	--
6	0300	1.97	120.64	--	2,100	1,500	69
7	0319	2.27	113.10	--	2,200	--	--
8	0329	2.55	105.56	1,500	2,300	1,900	70
9	0342	2.95	150.80	1,500	3,000	1,900	70
10	0355	3.30	131.95	1,500	3,000	4,000	70
11	0410	3.64	128.18	1,500	3,000	--	--
12	0422	3.90	98.02	--	3,000	--	--
13	0435	4.18	105.56	--	3,000	6,200	79
14	0455	4.56	143.26	--	3,000	7,000	--
15	0507	4.83	101.79	--	3,000	--	--
16	0522	5.07	90.48	--	3,000	9,000	--
17	0533	5.34	101.79	--	3,000	--	--
18	0546	5.54	75.40	--	3,000	--	--
19	0600	5.65	51.47 ^{1/}	1,600	3,000	9,000	--

^{1/} Ten gallons were removed for chemical analyses.

All depth measurements are from kelly bushing.

Table 2.--Recovery of water level in hole GB-2 after swabbing test of
Ojo Alamo Sandstone, April 17, 1967

Clock time	Elapsed time (minutes)		t/t'	Depth to fluid level (feet)
	Since swabbing started (t)	Since swabbing stopped (t')		
0600	225	0	--	--
0708	293	68	4.31	1,367.0
0710	295	70	4.21	1,360.0
0715	300	75	4.00	1,341.7
0720	305	80	3.81	1,326.0
0725	310	85	3.65	1,310.0
0730	315	90	3.50	1,296.2
0735	320	95	3.37	1,282.5
0740	325	100	3.25	1,268.8
0745	330	105	3.14	1,255.2
0750	335	110	3.05	1,244.4
0755	340	115	2.96	1,233.2
0800	345	120	2.88	1,223.3
0805	350	125	2.80	1,213.4
0810	355	130	2.73	1,203.0
0815	360	135	2.67	1,194.5
0825	370	145	2.55	1,177.9
0835	380	155	2.45	1,163.5
0840	385	160	2.40	1,156.3
0845	390	165	2.36	1,149.0
0900	405	180	2.25	1,132.0
0915	420	195	2.15	1,117.4
0930	435	210	2.07	1,103.2
0945	450	225	2.00	1,092.5

Table 2.--Recovery of water level in hole GB-2 after swabbing test of
Ojo Alamo Sandstone, April 17, 1967--Continued

Clock time	Elapsed time (minutes)		t/t'	Depth to fluid level (feet)
	Since swabbing started (t)	Since swabbing stopped (t')		
1000	465	240	1.94	1,082.3
1015	480	255	1.88	1,072.9
1030	495	270	1.83	1,065.0
1045	510	285	1.79	1,057.0
1100	525	300	1.75	1,050.5
1115	540	315	1.72	1,045.0
1130	555	330	1.68	1,040.0
1145	570	345	1.65	1,035.0
1200	585	360	1.62	1,031.0

CHEMICAL QUALITY OF WATER SAMPLES FROM OJO ALAMO SANDSTONE

Water samples were collected for chemical analyses immediately before the swab test ended at 0600 hours on April 17, 1967. The specific conductance of the fluid removed from the hole during the earlier part of the swabbing was 1,400 micromhos. During the latter part of the test it was 9,000 micromhos. The thermometer in the pressure bomb showed that the temperature of the formation fluid was about 112°F.

ANALYSIS OF SWABBING TEST DATA

The following formation for computing the transmissivity (T) was used for analyzing the water-level recoveries.

$$T \text{ in gallons per day per foot} = \frac{264Q}{s} \log_{10} \frac{t}{t'} \text{ where:}$$

s = Residual drawdown

t = Time since swabbing began

t' = Time since swabbing stopped

Q = Swabbing rate in gallons per
minute

Time may be in any unit, as the term t/t' becomes dimensionless by cancellation of units. However, time in minutes is recorded in the data tables. Over one log cycle, $\log_{10} t/t'$ becomes unity; s equals Δs or change in s; and then $T = \frac{264Q}{\Delta s}$.

The swabbing rate (Q) was determined to be 9.5 gpm.

The values of t/t' ($\frac{\text{time since swabbing started}}{\text{time since swabbing stopped}}$) were plotted versus "s" (fluid level on semilogarithmic graph paper). Figure 2 shows these data plotted as points on the graph paper. Delta "s" (Δs , change in fluid level) is determined from the slope of the straight line drawn through these points. For one log cycle Δs was determined to be 880 feet. Therefore, transmissivity (T) = $\frac{2640}{\Delta s} = \frac{(264)(9.5)}{880}$

$$= 2.85 \text{ gpd per ft or } 0.1562 \text{ Darcy feet}$$

at prevailing field conditions.

The relative specific capacity of the Ojo Alamo Sandstone in GB-2 was calculated to be 0.026 gpm per ft. For an explanation of relative specific capacity refer to open-file report, "Hydrologic Tests in hole GB-1, Project Gasbuggy, Rio Arriba County, New Mexico."

SUMMARY

The Ojo Alamo Sandstone interval from 3,478 to about 3,662 feet below the kelly bushing in hole GB-2 was hydrologically tested on April 17, 1967. The following data were obtained: specific conductance of the fluid removed from the hole, 1,400 micromhos during the earlier part of the swabbing and 9,000 micromhos, during the later part of the swabbing; temperature of formation fluid, 112°F; calculated transmissivity, 2.85 gpd per ft; and calculated relative specific capacity, 0.026 gpm per ft. Similar data for hole GB-1 were: specific conductance of formation fluid at about 3,300 ft, 9,000 micromhos; temperature of formation fluid, 112°F; calculated transmissivity, 0.4 gpd per ft in the depth interval 3,475 to 3,575 feet below the kelly bushing and 2.6 gpd per ft in the depth interval 3,575 to 3,654 feet below the kelly bushing; and calculated relative specific capacity, 0.003 gpm per ft in the upper part of the zone and 0.016 gpm per ft in the lower part.

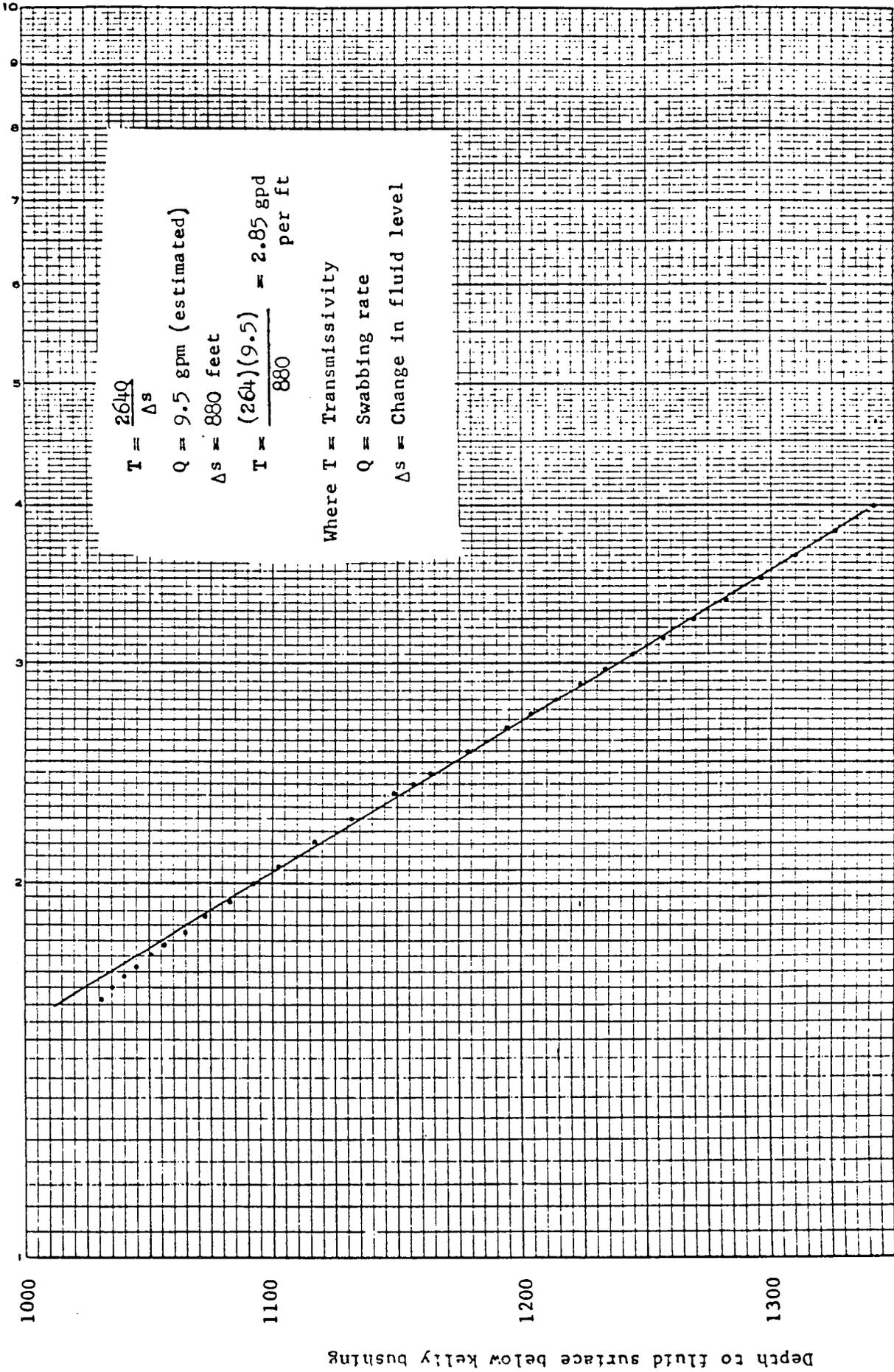


Figure 2.--Recovery of water level in hole GB-2 after swabbing test of Ojo Alamo Sandstone