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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Federal Center, Denver, Colorado 80225

HYDRAULIC TESTING OF WELLS
IN CENTRAL NEVADA

June 1970

Open-file report

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CONTENTS

	Page
Abstract.	1
Introduction.	2
Techniques of testing and sampling	3
Conditions affecting testing and sampling.	3
Analysis of test data.	4
Hydraulic testing of hole UCe-11.	5
Well history	5
Lithologic log	5
Hydrologic conditions.	5
Hydraulic testing of hole UCe-16.	7
Well history	7
Lithologic log	7
Artesian conditions.	8
Intervals tested and sampled	8
Zone 1, 1,687 to 1,850 feet.	8
Zone 2, 3,536 to 3,734 feet.	10
Zone 3, 3,772 to 3,970 feet.	10
Zone 4, 4,144 feet to total depth.	12
Hydraulic testing of hole UCe-17.	15
Well history	15
Lithologic log	15
Composite hydrostatic head	15
Intervals tested and sampled	16
Tracejector study.	16
Zone 1, 3,139 to 3,339 feet.	18
Zone 2, 3,800 to 4,000 feet.	18
Zone 3, 4,012 to 4,212 feet.	21
Zone 4, 4,486 to 4,686 feet.	21

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CONTENTS

	Page
Hydraulic testing of hole UCe-17--Continued	
Zone 5, 4,620 to 4,820 feet	24
Zone 6, 5,240 to 5,440 feet	24
Zone 8, 6,130 to 6,330 feet	27
Zone 9, 6,430 to 6,630 feet	27
Zone 10, 6,745 to 6,945 feet	29
Zone 11, 7,050 to 7,250 feet	33
Zone 12, 7,257 to 7,457 feet	33
Zone 14, 1,770 to 1,840 feet	35
Zone 15, 785 to 915 feet	38
Hydraulic testing of hole UCe-18	40
Well history	40
Lithologic log	40
Composite hydrostatic head	41
Intervals tested and sampled	41
Tracejector study	43
Zone 1, 6,390 to 6,514 feet	43
Zone 2, 6,149 to 6,514 feet	43
Zone 3, 5,920 to 6,080 feet	45
Zone 4, 5,634 to 5,794 feet	45
Zone 5, 5,020 to 5,180 feet	48
Zone 6, 5,804 to 5,914 feet	48
Zone 7, 5,530 to 5,640 feet	49
Zone 8, 5,300 to 5,410 feet	52
Zone 9, 4,555 to 4,747 feet	52
Zone 10, 4,060 to 4,190 feet	54
Zone 11, 406 to 598 feet	54
Zone 12, 4,795 to 4,995 feet	54

CONTENTS

	Page
Hydraulic testing of hole HTH-1	56
Well history	56
Lithologic log	56
Composite hydrostatic head	56
Intervals tested and sampled	57
Tracejector study.	57
Zone 1, 3,590 to 3,665 feet.	59
Zone 2, 2,950 to 3,010 feet.	62
Zone 3, 2,640 to 2,710 feet.	62
Zone 4, 2,400 to 2,460 feet.	66
Zone 5, 2,200 to 2,300 feet.	66
Zone 6, 1,850 to 1,980 feet.	69
Zone 7, 1,660 to 1,720 feet.	69
Zone 8, 1,400 to 1,500 feet.	72
Zone 9, 950 to 1,150 feet.	77
Zone 10, 700 to 850 feet	77
Aquifer performance test in holes HTH-1 and HTH-2	80
Physical conditions.	80
Purpose of the test.	80
Type of test and conditions.	81
Analysis of aquifer-test data.	81
Hydraulic testing of hole UCe-20.	85
Well history	85
Lithologic log	85
Composite hydrostatic head	86
Intervals tested and sampled	86
Tracejector study.	86
Zone 1, 4,859 to 5,306 feet.	88

CONTENTS

	Page
Hydraulic testing of hole UCe-20--Continued	
Zone 2, 5,179 to 5,306 feet.	88
Zone 3, 5,050 to 5,306 feet.	92
Zone 4, 4,928 to 5,046 feet.	92
Zone 5, 4,859 to 4,928 feet.	95
Zone 6, 5,330 to 6,000 feet.	95
Zone 7, 5,900 to 6,000 feet.	95
Zone 8, 5,510 to 6,000 feet.	98
Zone 9, 5,330 to 6,000 feet.	98
Zone 10, 4,990 to 5,050 feet	101
Zone 11, 5,050 to 5,110 feet	101
Zone 12, 5,420 to 5,480 feet	104
Zone 13, 700 to 720 feet	104
Zone 14, 2,200 to 2,220 feet	107
Selected references	110

ILLUSTRATIONS

Figure 1. Hydrology and lithology in hole UCe-11	6
2. Hydrology and lithology in hole UCe-16	9
3. Swab test of zone 2 (3,536 to 3,734 feet), hole UCe-16 March 27 and 28, 1967	11
4. Swab test of zone 3 (3,772 to 3,970 feet), hole UCe-16 March 28 and 29, 1967	13
5. Hydrology and lithology in hole UCe-17	17
6. Tracejector survey of hole UCe-17, while pumping	19
7. Injection test of zone 1 (3,139 to 3,339 feet), hole UCe-17 June 25, 1967.	20
8. Swab test of zone 3 (4,012 to 4,212 feet), hole UCe-17 June 17, 1967	22
9. Injection test of zone 4 (4,486 to 4,686 feet), hole UCe-17 June 24, 1967.	23

ILLUSTRATIONS

	Page
Figure 10. Injection test of zone 5 (4,620 to 4,820 feet), hole UCe-17 June 25, 1967	25
11. Injection test of zone 6 (5,240 to 5,440 feet), hole UCe-17 June 24, 1967	26
12. Injection test of zone 8 (6,130 to 6,330 feet), hole UCe-17 June 23, 1967	28
13. Injection test of zone 9 (6,430 to 6,630 feet), hole UCe-17 June 23, 1967	30
14. Injection test of zone 10 (6,745 to 6,945 feet), hole UCe-17 June 22, 1967	31
15. Swab test of zone 10 (6,745 to 6,945 feet), hole UCe-17 June 23, 1967.	32
16. Injection test of zone 11 (7,050 to 7,250 feet), hole UCe-17 June 22, 1967	34
17. Injection test of zone 12 (7,257 to 7,457 feet), hole UCe-17 June 21, 1967	36
18. Swab test of zone 14 (1,770 to 1,840 feet), hole UCe-17 June 24, 1967	37
19. Hydrology and lithology in hole UCe-18.	42
20. Tracejector survey of hole UCe-18, while pumping.	44
21. Swab test of zone 2 (6,149 to 6,514 feet), hole UCe-18 May 23 and 24, 1967	46
22. Swab test of zone 3 (5,920 to 6,080 feet), hole UCe-18 June 1, 1967.	47
23. Swab test of zone 6 (5,804 to 5,914 feet), hole UCe-18 June 4, 1967.	50
24. Swab test of zone 7 (5,530 to 5,640 feet), hole UCe-18 June 5, 1967.	51
25. Swab test of zone 8 (5,300 to 5,410 feet), hole UCe-18 June 6, 1967.	53
26. Hydrology and lithology in hole HTH-1	58
27. Tracejector survey of hole HTH-1, while pumping	60

ILLUSTRATIONS

Page

Figure 28.	Injection test of zone 1 (3,590 to 3,665 feet), hole HTH-1 July 30, 1967.	61
29.	Swab test of zone 1 (3,590 to 3,665 feet), hole HTH-1 July 30 and 31, 1967	63
30.	Injection test of zone 2 (2,950 to 3,010 feet), hole HTH-1 July 31, 1967.	64
31.	Injection test of zone 3 (2,640 to 2,710 feet), hole HTH-1 August 1, 1967	65
32.	Injection test of zone 4 (2,400 to 2,460 feet), hole HTH-1 August 1, 1967	67
33.	Injection test of zone 5 (2,200 to 2,300 feet), hole HTH-1 August 2, 1967	68
34.	Injection test of zone 6 (1,850 to 1,980 feet), hole HTH-1 August 3, 1967	70
35.	Swab test of zone 6 (1,850 to 1,980 feet), hole HTH-1 August 3, 1967	71
36.	Injection test of zone 7 (1,660 to 1,720 feet), hole HTH-1 August 3, 1967	73
37.	Swab test of zone 7 (1,660 to 1,720 feet), hole HTH-1 August 4, 1967	74
38.	Injection test of zone 8 (1,400 to 1,500 feet), hole HTH-1 August 4, 1967	75
39.	Swab test of zone 8 (1,400 to 1,500 feet), hole HTH-1 August 4, 1967	76
40.	Injection test of zone 9 (950 to 1,150 feet), hole HTH-1 August 4, 1967	78
41.	Time-drawdown graph for observation well HTH-2.	82
42.	Lithology and zones of hydraulic testing in hole UCe-20	87
43.	Tracejector survey of hole UCe-20, while jetting.	89
44.	Injection test of zone 1 (4,859 to 5,306 feet), hole UCe-20 December 19, 1967	90
45.	Injection test of zone 2 (5,179 to 5,306 feet), hole UCe-20 December 20, 1967	91

ILLUSTRATIONS

	Page
Figure 46. Injection test of zone 3 (5,050 to 5,306 feet), hole UCe-20 December 21, 1967	93
47. Injection test of zone 4 (4,928 to 5,046 feet), hole UCe-20 December 22, 1967	94
48. Injection test of zone 5 (4,859 to 4,928 feet), hole UCe-20 December 22, 1967	96
49. Injection test of zone 7 (5,900 to 6,000 feet), hole UCe-20 January 2, 1968	97
50. Swab test of zone 8 (5,510 to 6,000 feet), hole UCe-20 January 3, 1968	99
51. Injection test of zone 9 (5,330 to 6,000 feet), hole UCe-20 January 3, 1968	100
52. Injection test of zone 10 (4,990 to 5,050 feet), hole UCe-20 January 4, 1968	102
53. Injection test of zone 11 (5,050 to 5,110 feet), hole UCe-20 January 4-5, 1968	103
54. Swab test of zone 11 (5,050 to 5,110 feet), hole UCe-20 January 5, 1968	105
55. Injection test of zone 13 (700 to 720 feet), hole UCe-20 January 6, 1968	106
56. Injection test of zone 14 (2,200 to 2,220 feet), hole UCe-20 January 8, 1968	108

TABLES

Table 1. Summary of hydraulic tests in hole UCe-16	14
2. Summary of hydraulic tests in hole UCe-17	39
3. Summary of hydraulic tests in hole UCe-18	55
4. Summary of hydraulic tests in hole HTH-1.	79
5. Summary of hydraulic tests in hole UCe-20	109

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HYDRAULIC TESTING OF WELLS IN CENTRAL NEVADA

by

George A. Dinwiddie

ABSTRACT

This report, prepared in support of the U.S. Atomic Energy Commission's underground nuclear testing program in central Nevada, presents basic data obtained during hydraulic tests in six exploratory holes before February 1968.

Hole UCe-11 penetrated alluvium and welded tuff. A short hydraulic test run on this hole indicated that the welded tuff has a low permeability. The composite water level was about 360 feet below land-surface datum.

Hole UCe-16 penetrated alluvium, welded tuff, bedded tuff, and rhyolite. After completion, the well was flowing. Relative specific capacities of the tested zones ranged from an estimated 0.0003 gallon per minute per foot of drawdown to "high", and static water levels of the tested zones ranged from about 100 feet below land-surface datum to 19.29 feet above land-surface datum.

Hole UCe-17 penetrated, alluvium, tuff, and tuffaceous sediments. The composite water level was 528 feet below land-surface datum; relative specific capacities of the tested zones ranged from an estimated 0.0003 gallon per minute per foot of drawdown to "high"; and static water levels of the tested zones ranged from about 575 to an estimated 1,150 feet below land-surface datum.

Hole UCe-18 penetrated alluvium, lake beds, rhyolite, and bedded tuff. The composite water level was 196 feet below land-surface datum; relative specific capacities of the tested zones ranged from "low" to "high"; and static water levels of the tested zones ranged from about 190 to 330 feet below land-surface datum.

Hole HTH-1 penetrated alluvium, welded tuff, and tuffaceous sediments. The composite water level was 553 feet below land-surface datum; relative specific capacities of the tested zones ranged from an estimated 0.0003 gallon per minute per foot of drawdown to "very high"; and static water levels of the tested zones ranged from 547 to 558 feet below land-surface datum.

Results of a pumping test indicated that the velocity of ground-water movement in two zones (700-850 feet and 950-1,150 feet) was about 0.5 foot per day.

Hole UCe-20 penetrated alluvium, welded tuff, and tuffaceous conglomerate. The composite water level was 215 feet below land-surface datum; relative specific capacities of the tested zones ranged from 0.000015 gallon per minute per foot of drawdown to "very high"; and static water levels of the tested zones ranged from 215 to about 340 feet below land-surface datum.

INTRODUCTION

Hydraulic testing and sampling in wells in central Nevada is done (1) to supplement and improve knowledge of the general hydrologic environment of the area for better prediction of direction and velocity of ground-water movement, (2) to determine the water/rock chemistry and radiochemistry for improved understanding of radionuclide transport characteristics and for evaluation of the effect and distribution of shot-produced contaminants, (3) to determine certain hydraulic characteristics for engineering and design of chambers in specific lithologic zones, and (4) to provide information about water supplies for drilling, construction projects, and camp sites. This report presents the basic data obtained during the hydraulic tests made before February 1968.

Hydraulic tests in deep exploratory holes in central Nevada were performed by the Hydrologic Task Force under the direction of George A. Dinwiddie, U.S. Geological Survey, Task Force Leader. The Task Force consists of personnel from the U.S. Geological Survey, Water Resources Division; the Desert Research Institute, Center for Water Resources Research, University of Nevada System; and Teledyne Isotopes, Palo Alto Laboratories. During the hydraulic tests, personnel from these three organizations comprising the Hydrologic Task Force worked as a group to perform the required duties.

Techniques of Testing and Sampling

Specific intervals of the holes were tested and sampled by using inflatable straddle packers. The intervals were selected according to apparent characteristics of hydrology, lithology, and hole conditions as interpreted from geologic reports and downhole geophysical logs. After the packers were set, the tubing was filled with water. During release (injection) of this water into the formation, the rate of decline of the water level was measured. When possible, static conditions were attained before continuing to the next step. Then samples of formation water were swabbed from the tested interval until reasonably stable conditions of temperature, pH, specific conductance, and appearance were attained. The amount of water swabbed was recorded. After swabbing, the rate of rise (recovery) of the water level was measured.

Additional hydraulic testing was done in wells HTH-1 and HTH-2. A submersible pump was installed in HTH-1 and water-level reaction was observed in both wells during an aquifer-performance test.

Conditions Affecting Testing and Sampling

Drilling mud and lost circulation material were added to some of the holes during drilling. These additives proved to be a handicap to proper testing and sampling because most of the foreign material remained in the fractures. Some additives remaining in the formation made water samples worthless for chemical and radiochemical analysis.

Hole conditions are important to testing with straddle packers. During the testing program, many zones of specific interest could not be satisfactorily tested because packer seats were not available.

Analysis of Test Data

Specific capacity of a well is yield per unit of drawdown during pumping such as gallons per minute per foot of drawdown. Relative specific capacity is similar to specific capacity in that the units and implications are similar. However, relative specific capacity is different in that it is derived from a short test of a defined interval rather than from a long test of an entire well. Relative specific capacity is determined by the volume change of water in tubing for a 1-minute interval of time as related to the departure of the water level during this time interval from the static conditions. The same time interval is not used for every test because of measuring and testing techniques.

The term "high" used in conjunction with relative specific capacity indicates that the reaction of the water level during testing was so fast that measurements could not be made and relative specific capacity could not be calculated. The term "low" indicates that the reaction of the water level during testing was very slow and that a figure reported for relative specific capacity probably would be greatly in error.

HYDRAULIC TESTING OF HOLE UCe-11

Well History

Hole UCe-11, at N. 1,401,350.93 ft and E. 626,475.43 ft, Nevada coordinate system, central zone, Nye County, Nevada, was spudded in on January 5, 1967, and had reached a depth of 4,206 feet when released to the Hydrologic Task Force for hydraulic testing and sampling on April 19, 1967. Its casing record is as follows:

7 $\frac{5}{8}$ -inch OD to 33 feet (cemented)

4 $\frac{1}{2}$ -inch OD to 4,047 feet

Lithologic Log

The following lithologic log for hole UCe-11 is from D. L. Hoover, U.S. Geological Survey.

Elevation: 5,789 feet

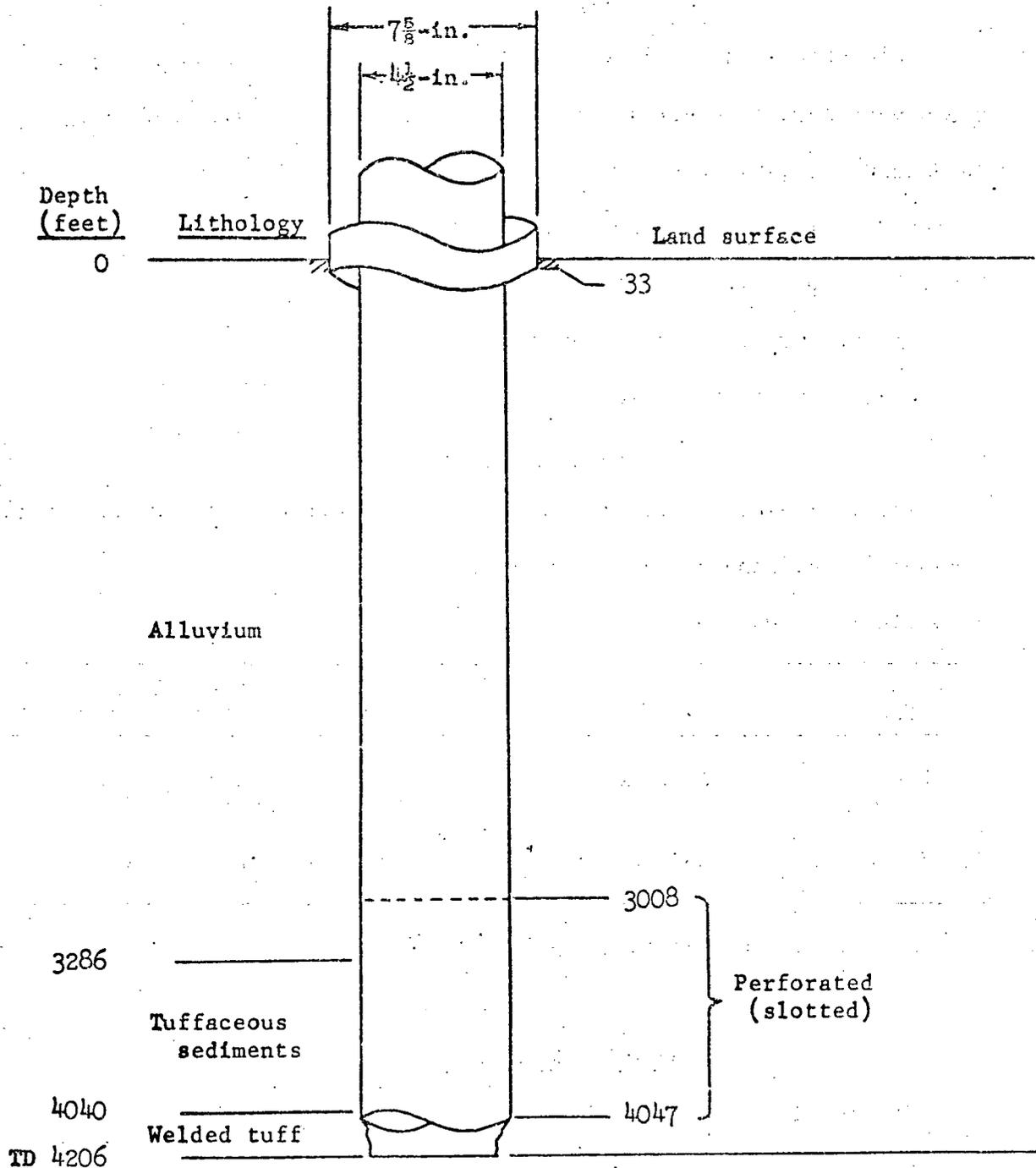
Footage (in feet)	Rock type	Stratigraphic correlations
0 - 3,286	Alluvium	Alluvium derived primarily from Morey Peak area tuffs
3,286 - 4,202	Welded tuff	Tuffs of Morey Peak (?)

A generalized summary of hydrology, lithology, and construction is presented in figure 1.

Hydrologic Conditions

The static water level is about 360 feet below land-surface datum. An attempt was made to test the hydrologic characteristics of the bed-rock (welded tuff) below the casing; however, hole conditions were not

Composite water level: When last measured,
water was at 360± feet below lsd.



/// Cemented areas

Packer held only long enough, during hydraulic testing, to determine that the top of the welded tuff has a very low permeability.

Figure 1.--Hydrology and lithology in hole UCe-11.

good enough and the packers would not hold. One packer setting held long enough to determine that the interval from about 4,100 feet to total depth has a very low permeability.

HYDRAULIC TESTING OF HOLE UCe-16

Well History

Hole UCe-16, at N. 1,472,000 ft and E. 561,000 ft, Nevada coordinate system, central zone, Nye County, Nevada, was spudded in on February 20, 1967, and had reached a depth of 4,353 feet when released to the Hydrologic Task Force for hydraulic testing and sampling on March 25, 1967. Its casing record is as follows:

20-inch OD to 52 feet (cemented)

13 $\frac{3}{8}$ -inch OD to 1,687 feet (cemented)

Lithologic Log

The following lithologic log for hole UCe-16 is from D. L. Hoover, U.S. Geological Survey.

Elevation: 6,875 \pm 25 feet

Footage (in feet)	Rock type	Stratigraphic correlations
0 - 1,104	Alluvium	
1,104 - 1,361	Welded tuff	Tuffs of Shingle Pass (?)
1,361 - 1,471	Vitric to argillized bedded tuff	
1,471 - 4,353	Rhyolite	

Artesian Conditions

Water in hole UCe-16 was first tapped at a depth of 48 feet. UCe-16 was drilled with mud to 1,688 feet and the water inflow was controlled; however, after the cement had been drilled out and the hole had been cleaned to 1,688 feet, water began to flow at the surface. The shut-in pressure, measured just above ground level, was about 14 psi (pounds per square inch) when the hole was 1,948 feet deep. The water-flow rate was 745 gpm when the hole was 4,048 feet deep. Four zones of increased flow were reported as the hole was drilled at depths of 1,706; 1,742; 1,773; and 1,835 feet. Four zones of decreased flow were reported as the hole was drilled at depths of 3,726; 3,960; 4,065; and 4,322 feet. While the hole was being drilled at these depths, the waterflow would stop for periods of time ranging from 1 to $1\frac{3}{4}$ hours and then resume.

Intervals Tested and Sampled

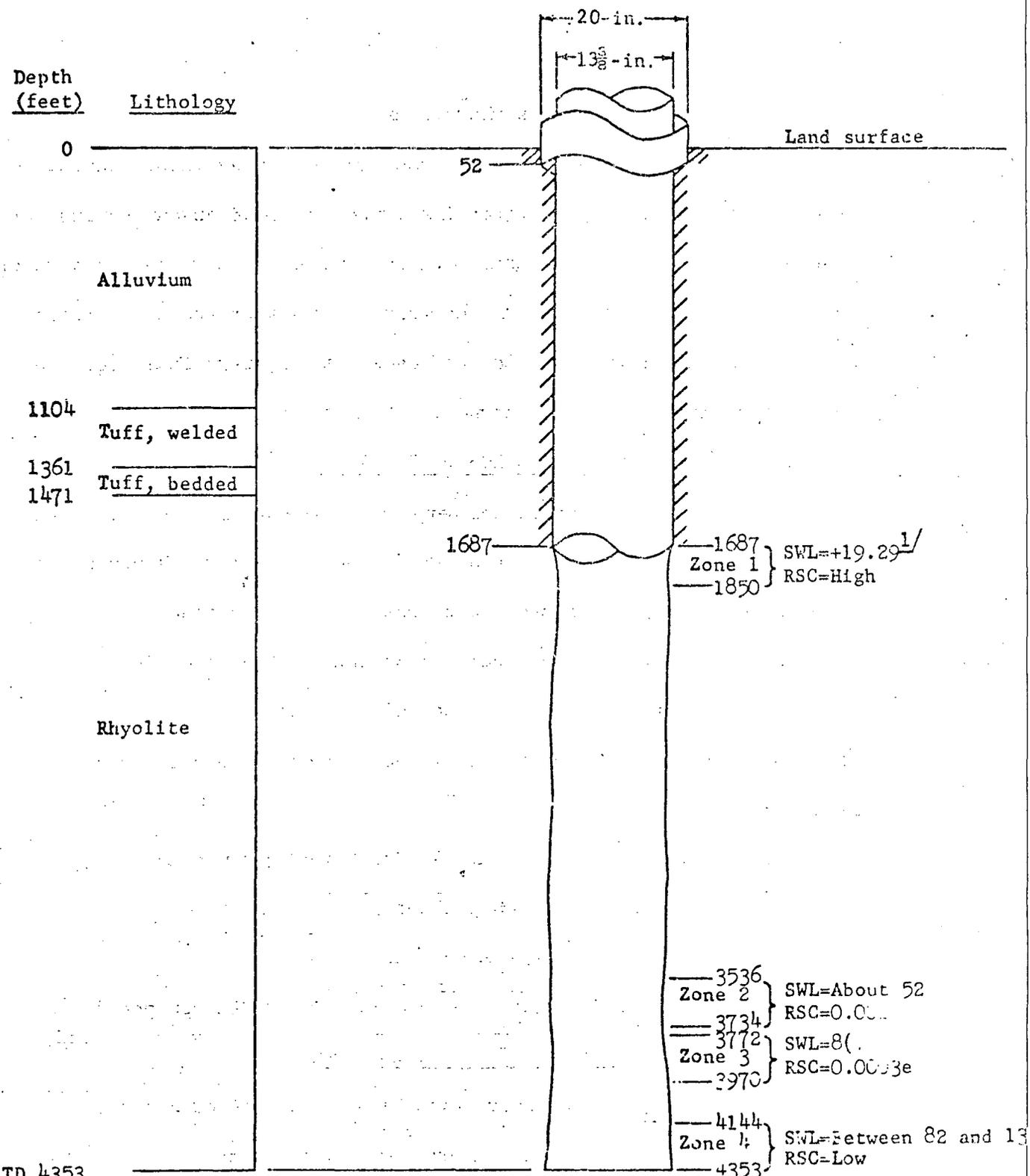
<u>Zone</u>	<u>Depth (feet)</u>
1	1,687 to 1,850 (sampled)
2	3,536 to 3,734 (sampled)
3	3,772 to 3,970
4	4,144 to total depth (sampled)

These intervals and a generalized summary of hydrology, lithology, and construction are presented in figure 2.

Zone 1, 1,687 to 1,850 feet

With the discharge line rigged above the floor the average rate of flow was about 8 gpm. About 2,500 gallons of water were allowed to flow from this zone; then the water was shut in and the resultant pressure

Composite water level = flowing.



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1/ Water level is above lsd.

/// Cemented.

e Estimated.

SWL Static water level, in feet from land-surface datum.

RSC Relative specific capacity, in gallons per minute per foot of drawdown.

Figure 2.--Hydrology and lithology in hole UCe-16.

buildup was recorded by measuring the rise of the water level in open plastic tubing. Maximum pressure occurred before the first reading was obtained at 1 minute. The water level then declined gradually and was observed for more than 7 hours. The last measurement indicated a water level of 19.29 feet above lsd, and this is assumed to be near static conditions. Reaction of the water level after shut-in indicates that the permeability of this interval of the formation is high.

Zone 2, 3,536 to 3,734 feet

The static level after recovery was between 47.6 and 55.6 feet below lsd and is assumed to be about 52 feet below lsd. Recovery after swabbing was slow; therefore, water was added to the tubing after 320 minutes of recovery in order to approach static conditions.

Relative specific capacity calculated using the time interval from the 18th to the 19th minute of the recovery test data (fig. 3) follows:

$$\text{Head loss} = 2,932.6 - 2,911.4 = 21.2 \text{ feet per minute}$$

$$Q = (0.162)(21.2) = 3.43 \text{ gallons per minute}$$

$$\text{Drawdown} = 2,922 - 64 = 2,858 \text{ feet}$$

$$\text{Relative specific capacity} = 3.43/2,858 = 0.001 \text{ gpm per foot}$$

Zone 3, 3,772 to 3,970 feet

The recovery of the water level after swabbing was very slow. Water was added to the tubing in order to approach static conditions; but, because of the slow reaction of the water level, the static water level of 8 feet below land-surface datum might be greatly in error.

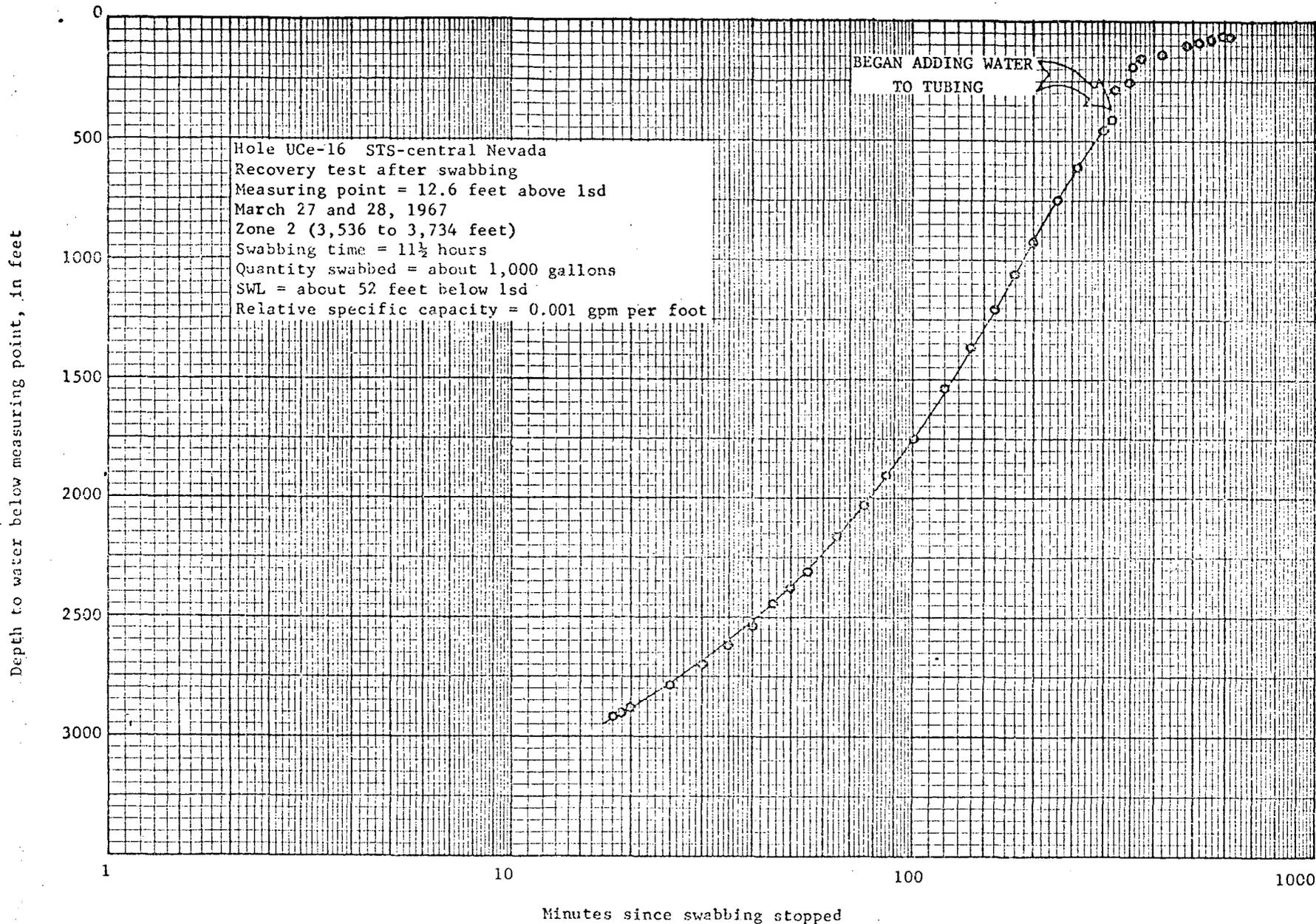


Figure 3.--Swab test of zone 2 (3,536 to 3,734 feet), hole UCe-16, STS-central Nevada, March 27 and 28, 1967.

However, this static water level is used for computing values of relative specific capacity, and the amount of error introduced probably is negligible because of the large drawdown that is involved.

An approximate relative specific capacity based on interpolated values of water levels in the time interval from the 80th to the 81st minute of the recovery test data (fig. 4) follows:

$$\text{Head loss} = 2,783.9 - 2,779.5 = 4.4 \text{ feet per minute}$$

$$Q = (0.162)(4.4) = 0.71 \text{ gallons per minute}$$

$$\text{Drawdown} = 2,782 - 20 = 2,762$$

$$\text{Relative specific capacity} = 0.71/2,762 = 0.0003 \text{ gpm per foot}$$

Zone 4, 4,144 feet to total depth

The recovery of the water level after swabbing was very slow. The recovery data are not sufficient to compute values for relative specific capacity. Water was added to the tubing in order to approach static conditions; but, because of the slow reaction of the water level, the static water level could not be determined exactly. However, it was determined to be between 82 and 138 feet below lsd.

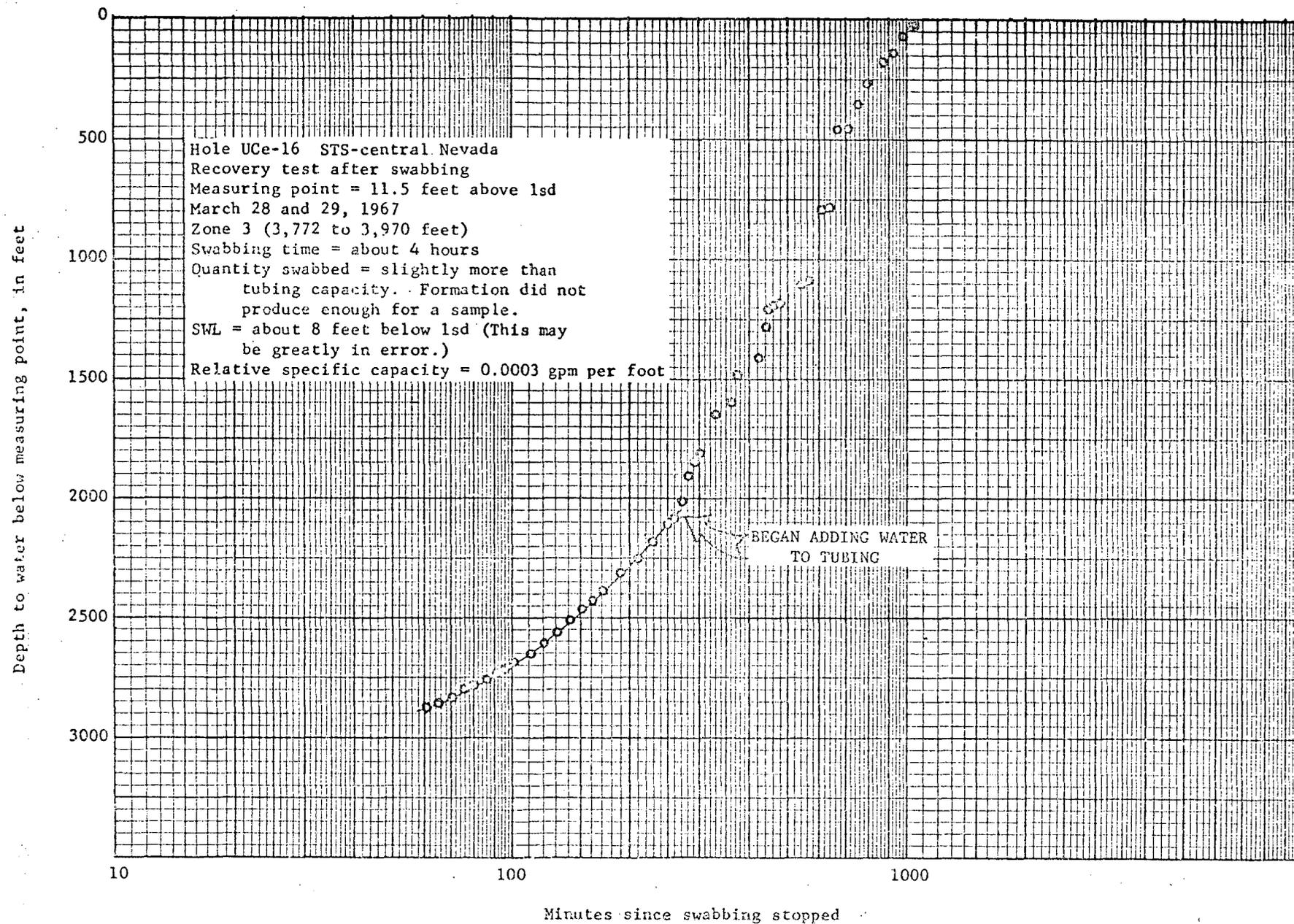


Figure 4.--Swab test of zone 3 (3,772 to 3,970 feet), hole UCe-16, STS-central Nevada, March 28 and 29, 1967.

Table 1.--Summary of hydraulic tests in hole UCe-16
(e Estimated. Usually estimated because of estimated static water level.)

Zone		1	2	3	4	Units
Tested interval		1,687 to 1,850	3,536 to 3,734	3,772 to 3,970	4,144 to Total depth	Feet
Static water level	Injec.	-	-	-	-	Feet below land-surface datum
	Recov.	+19.29 ^{1/}	About 52	8(?)	Between 92 and 138	Feet below land-surface datum
Relative specific capacity	Injec.	-	-	-	-	Gpm per foot of drawdown
	Recov.	High	0.001	e0.0003	Low	Gpm per foot of drawdown
Maximum water temperature		118	128	-	124	°F
Specific conductance		800	660	-	750	Micromhos per cm at 25°C
Packer communication	Top	No	No	No	No	--
	Bottom	No	Yes	Yes	Yes	--
Total water swabbed		About 2,500 (flowing)	1,000	Tubing capacity+	-	Gallons

^{1/} Water level in zone 1 is above lsd and was measured in plastic tubing.

Note: The hydraulic potential apparently decreases with depth.

HYDRAULIC TESTING OF HOLE UCe-17

Well History

Hole UCe-17, at N. 1,430,621.72 ft and E. 628,171.70 ft, Nevada coordinate system, central zone, Nye County, Nevada, was spudded in on April 11, 1967, and had reached a depth of 7,978 feet when released to the Hydrologic Task Force for hydraulic testing and sampling on June 13, 1967. Its casing record is as follows:

20-inch OD to 34 feet (cemented)

13³/₈-inch OD to 500 feet (cemented)

9⁵/₈-inch OD to 2,278 feet (cemented)

Lithologic Log

The following lithologic log for hole UCe-17 is from D. L. Hoover, U.S. Geological Survey.

Elevation: 6,545 feet

Footage (in feet)	Rock type
0 - 2,100	Alluvium
2,100 - 2,620	Partly welded tuff, zeolitized
2,620 - 2,700	Densely welded tuff
2,700 - 2,800	Zeolitized bedded tuff and tuffaceous sandstone
2,800 - 5,560	Partly to densely welded tuff, locally argillized
5,560 - 5,660	Tuffaceous sediments
5,660 - 6,105	Densely welded tuff, argillized
6,105 - 6,800±	Interbedded tuffaceous sediments and nonwelded(?) tuff
6,800± - 7,100	Densely welded tuff, hydrothermally(?) altered

Composite Hydrostatic Head

The composite hydrostatic head was measured with the deep-well measuring device ("iron horse") during the static tracejector study on July 11, 1967. The water level was 528 feet below lsd.

Intervals Tested and Sampled

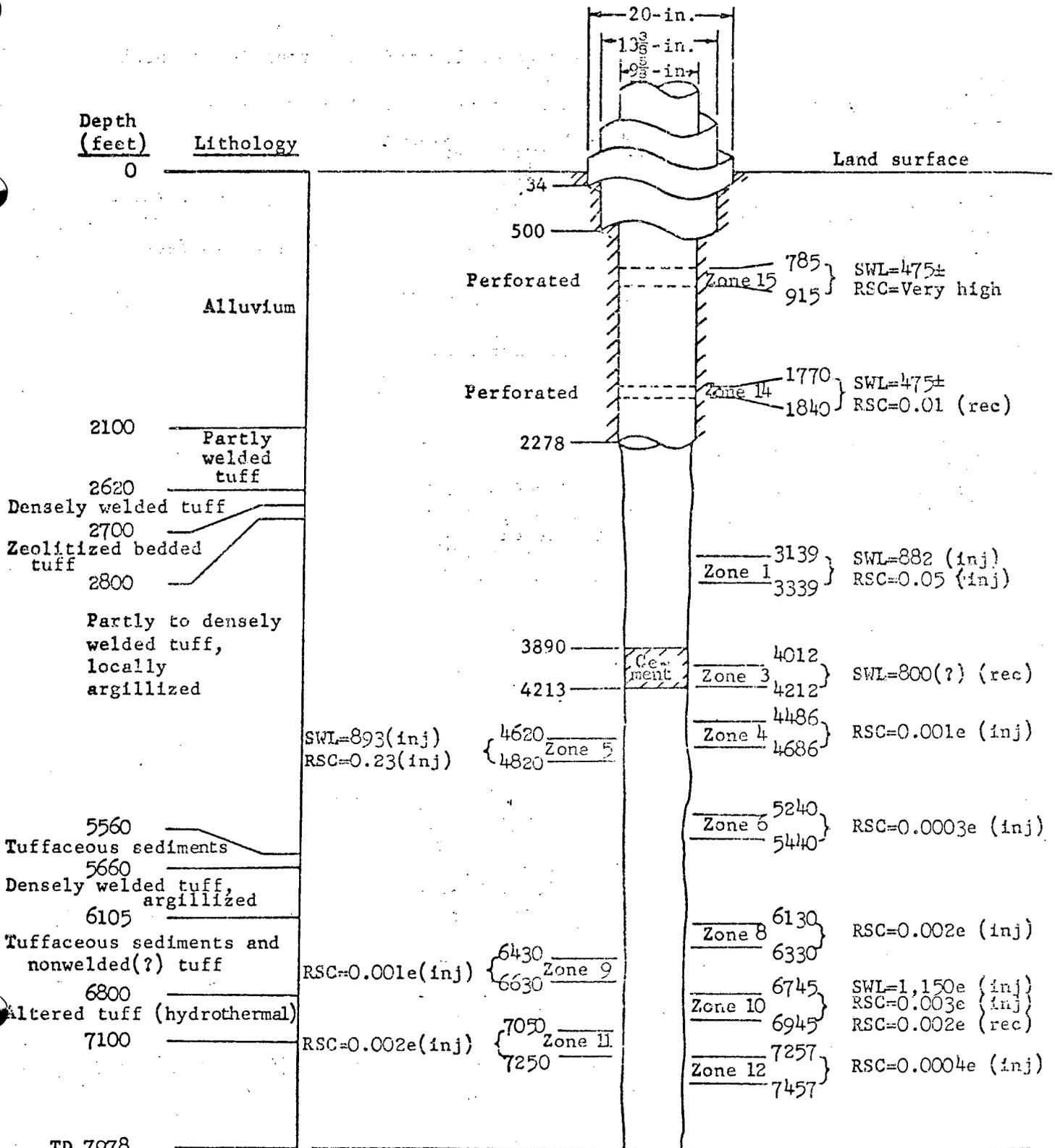
<u>Zone</u>	<u>Depth (feet)</u>
1	3,139 to 3,339 (sampled)
2	3,800 to 4,000
3	4,012 to 4,212 (sampled)
4	4,486 to 4,686
5	4,620 to 4,820 (sampled)
6	5,240 to 5,440
7	Deleted
8	6,130 to 6,330
9	6,430 to 6,630
10	6,745 to 6,945 (sampled)
11	7,050 to 7,250
12	7,257 to 7,457
13	Deleted
14	1,770 to 1,840 (sampled)
15	785 to 915

These intervals and a generalized summary of hydrology, lithology, and construction are presented in figure 5.

Tracejector Study

Significant results were obtained from tracejector studies under both pumping and static conditions. The results indicate a definite potential for downward flow. Under static conditions, vertical flow in the borehole was downward at a rate between 20 and 27 gallons per minute to a point at about 4,740 feet below land-surface datum. At this depth, most of the flow went into the formation. Below this depth, some downward flow (less than 6 gallons per minute) and continual loss to the rock was observed. There was no measurable flow in the borehole below a depth of 6,420 feet.

Composite water level = 528 feet below lsd.



TD 7978

/// Cemented areas.
e Estimated.

SWL Static water level, in feet below land-surface datum.
RSC Relative specific capacity, in gallons per minute per foot of drawdown.

Figure 5.--Hydrology and lithology in hole UCe-17.

Major water-contributing zones generally indicate zones of highest permeability in the borehole. Major water-contributing zones in hole UGe-17 (fig. 6) were observed or surmised at depths ranging from 785 to 915 feet (perforated casing in alluvium), from 1,770 to 1,840 feet (perforated casing in alluvium), and from about 4,735 to about 4,745 feet (uncased borehole in partly to densely welded tuff).

Zone 1, 3,139 to 3,339 feet

The static water level after injection was 882 feet below lsd. Relative specific capacity is computed only from injection data because recovery data after swabbing is inadequate to determine either relative specific capacity or static water level.

Relative specific capacity calculated using the time interval from the 8th to the 9th minute of the injection test data (fig. 7) follows:

$$\text{Head loss} = 492.26 - 348.96 = 143.3 \text{ feet per minute}$$

$$Q = (0.162)(143.3) = 23.2 \text{ gallons per minute}$$

$$\text{Drawdown} = 882 - 420.61 = 461.39 \text{ feet}$$

$$\text{Relative specific capacity} = 23.2/461.39 = 0.05 \text{ gpm per foot}$$

Zone 2, 3,800 to 4,000 feet

No significant results were obtained from zone 2 because it was learned after the test that the packers probably had not worked properly. Therefore, the validity of data obtained by testing is doubtful.

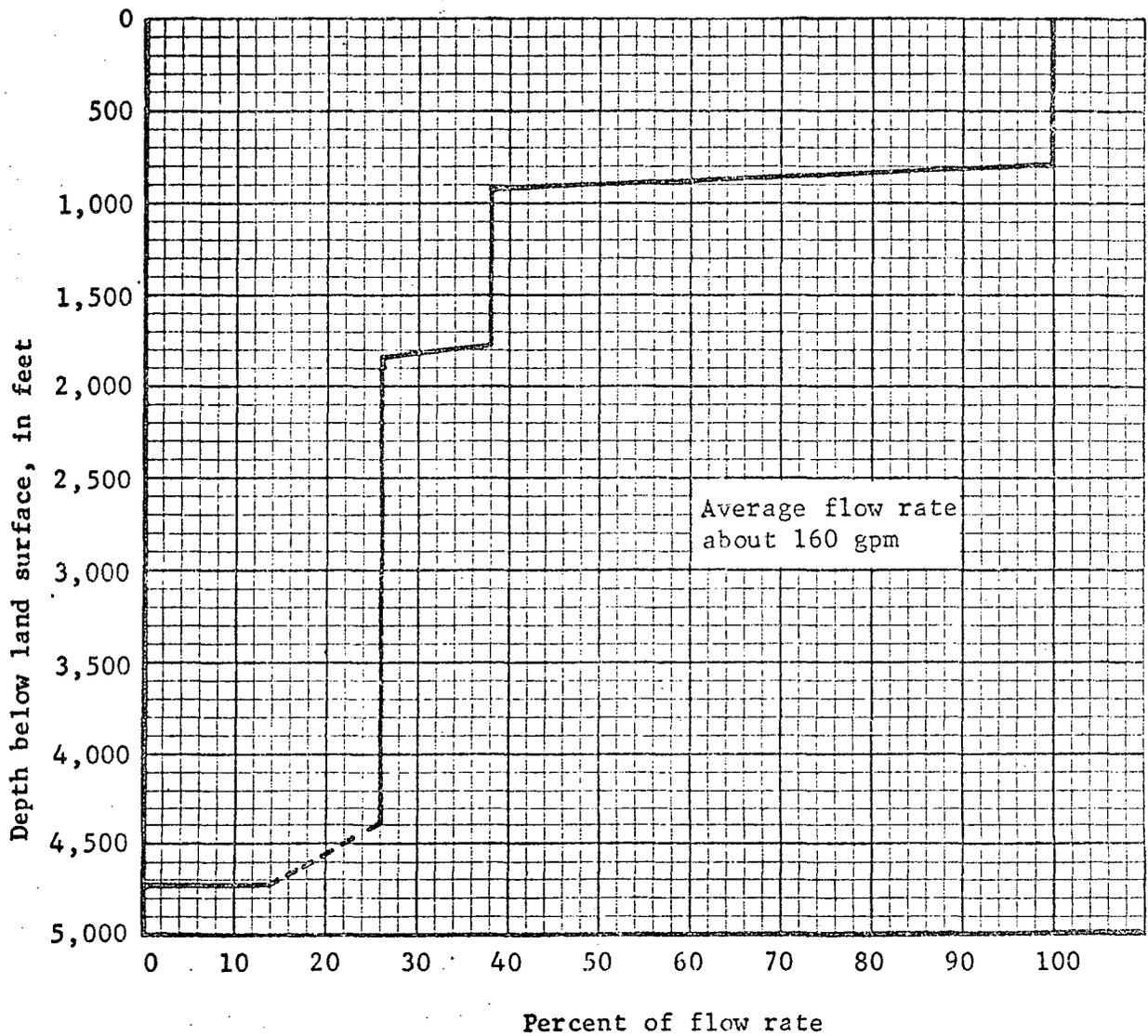


Figure 6.--Tracejector survey of hole UCe-17, Hot Creek Valley, Nevada, while pumping.

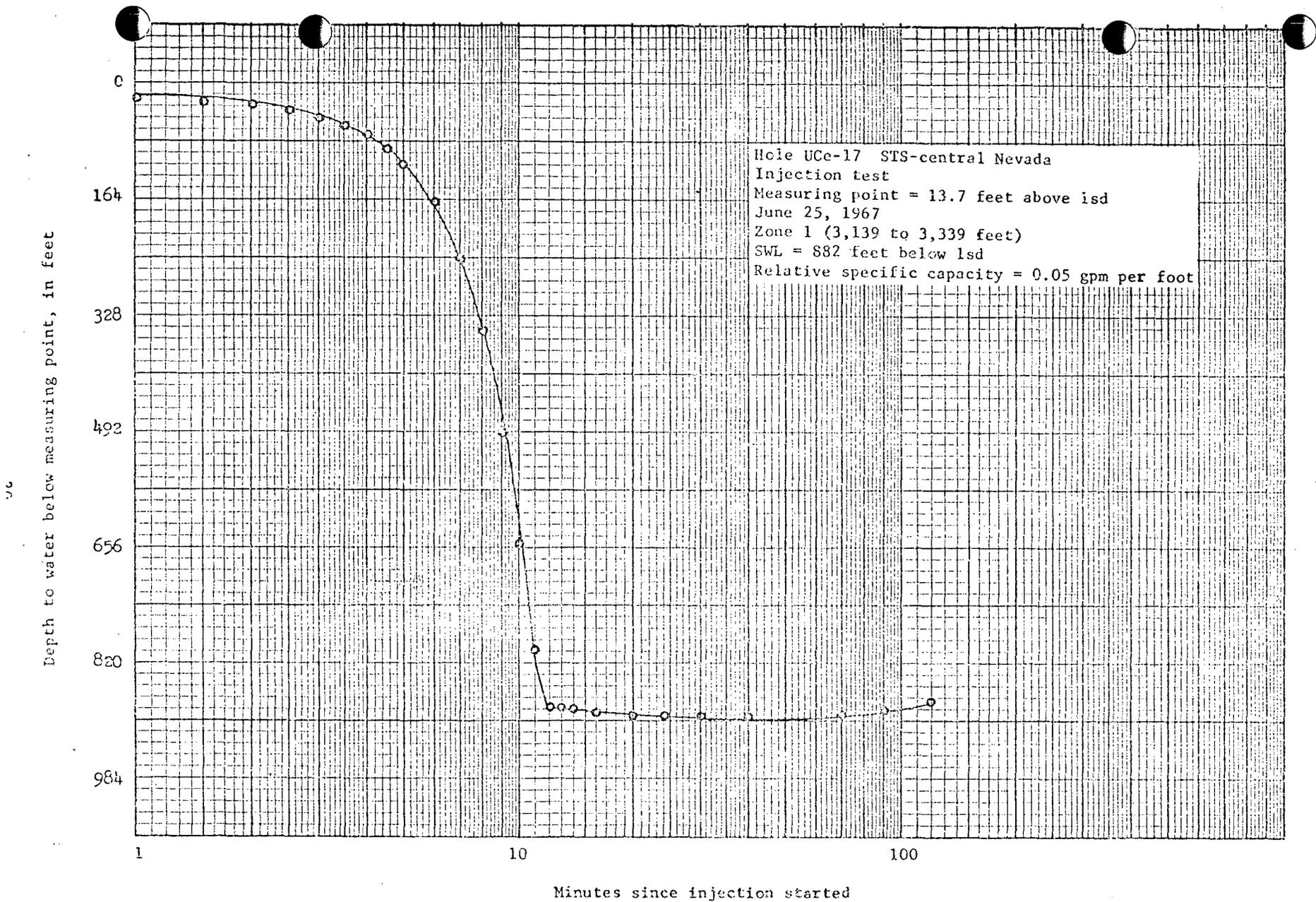


Figure 7.--Injection test of zone 1 (3,139 to 3,339 feet), hole UCe-17, STS-central Nevada, June 25, 1967.

Zone 3, 4,012 to 4,212 feet

During drilling of UCe-17, it was necessary to use cement in the interval from 3,890 to 4,213 feet; therefore, a figure for relative specific capacity would be meaningless. However, there were some openings in the cement and water could be swabbed from the formation. Recovery of the water level after swabbing was very slow; however, projection of the recovery data (fig. 8) indicates that the static water level in zone 3 probably is 800 feet or more below land-surface datum.

Zone 4, 4,486 to 4,686 feet

Static water level was not measured either after injection or after swabbing because of the extremely long time involved in waiting for the level to become static. Measurements of water-level decline during injection were made for an hour; measurements of water-level rise after swabbing were inaccurate and abandoned because of soap suds on top of the water column. Relative specific capacity was computed from injection data and an assumed static level of 885 feet below land-surface datum based on static levels in zones 1 and 5.

Relative specific capacity calculated using the time interval from the 8th to the 9th minute of the injection test data (fig. 9) follows:

$$\text{Head loss} = 48.9 - 43.5 = 5.4 \text{ feet per minute}$$

$$Q = (0.162)(5.4) = 0.87 \text{ gallons per minute}$$

$$\text{Drawdown} = 885 - 46 = 839 \text{ feet}$$

$$\text{Relative specific capacity} = 0.87/839 = 0.001 \text{ gpm per foot}$$

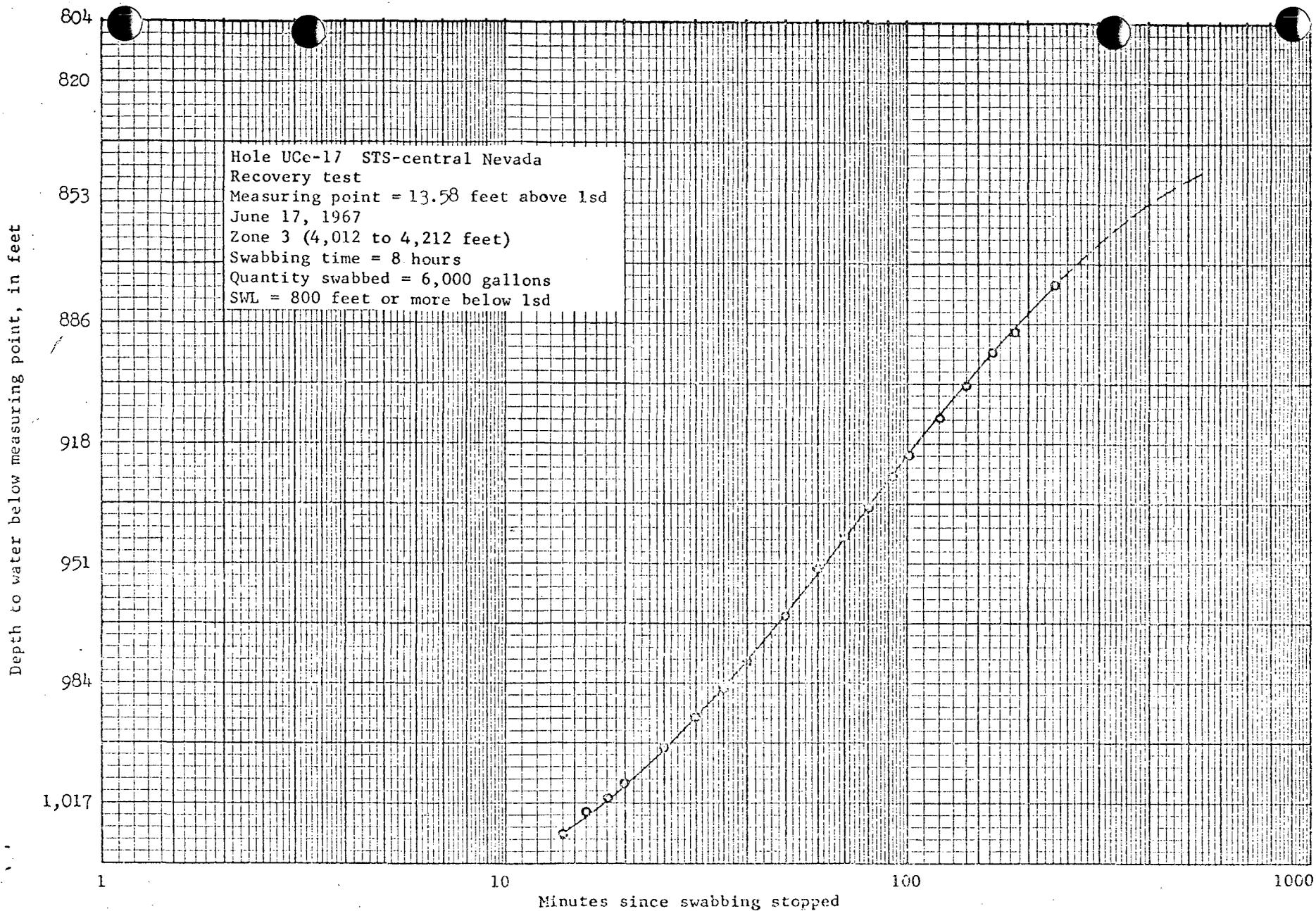


Figure 8.--Swab test of zone 3 (4,012 to 4,212 feet), hole UCe-17, STS-central Nevada, June 17, 1967.

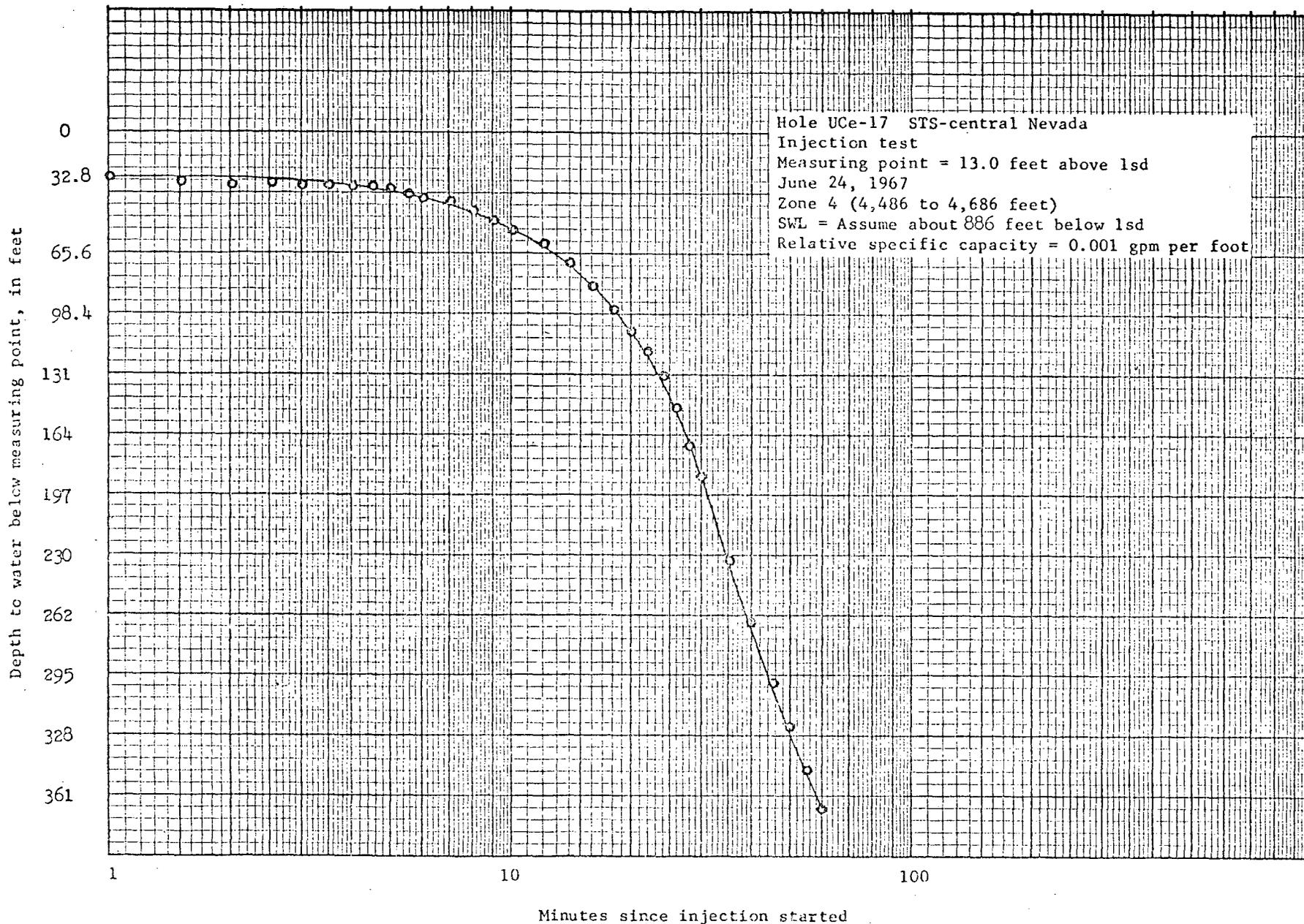


Figure 9.--Injection test of zone 4 (4,486 to 4,686 feet), hole UCe-17, STS-central Nevada, June 24, 1967.

Zone 5, 4,620 to 4,820 feet

The static water level after injection was 893 feet below lsd.

A recovery test was not successful in this zone because soap used during drilling made measurements impossible. Relative specific capacity is computed from injection data.

Relative specific capacity calculated using the time interval from $1\frac{1}{2}$ to $2\frac{1}{2}$ minutes of the injection test data (fig. 10) follows:

$$\text{Head loss} = 837.25 - 627.30 = 209.95 \text{ feet per minute}$$

$$Q = (0.162)(209.95) = 34.01 \text{ gallons per minute}$$

$$\text{Drawdown} = 893 - 742 = 151 \text{ feet}$$

$$\text{Relative specific capacity} = 34.01/151 = 0.23 \text{ gpm per foot}$$

Zone 6, 5,240 to 5,440 feet

Static water level was not measured either after injection or after swabbing because of the extremely long time involved in waiting for the level to become static. Measurements of water-level decline during injection were made for 30 minutes. Relative specific capacity was computed from injection data and an assumed static level of 475 feet below lsd. This static level is incorrect, but it will give the maximum possible relative specific capacity.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection test data (fig. 11) follows:

$$\text{Head loss} = 13.28 - 12.46 = 0.82 \text{ feet per minute}$$

$$Q = (0.162)(0.82) = 0.133 \text{ gallons per minute}$$

$$\text{Drawdown} = 475 - 0.89 = 474.11$$

$$\text{Relative specific capacity} = 0.133/474.11 = 0.0003 \text{ gpm per foot}$$

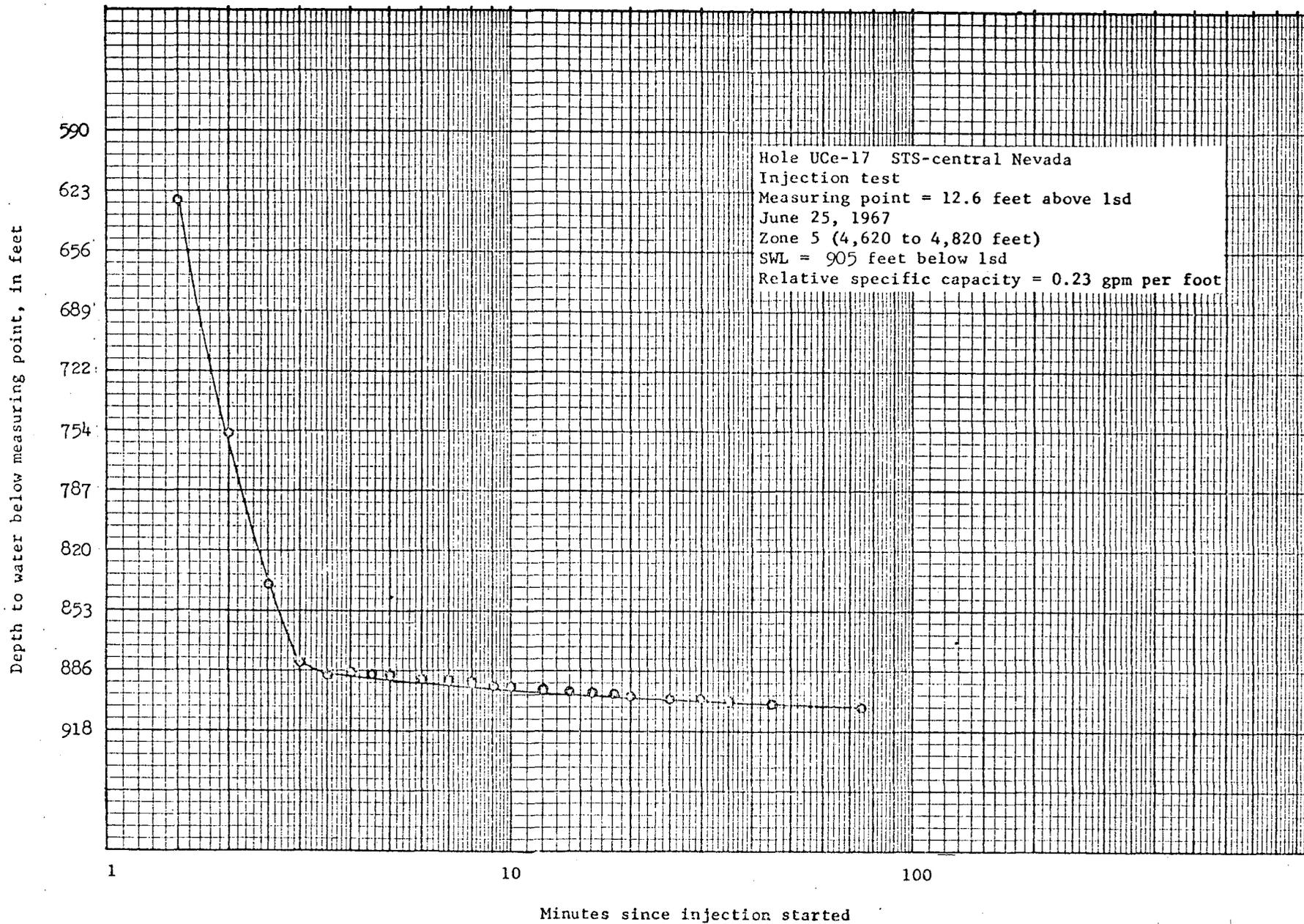


Figure 10.--Injection test of zone 5 (4,620 to 4,820 feet), hole UCe-17, STS-central Nevada, June 25, 1967.

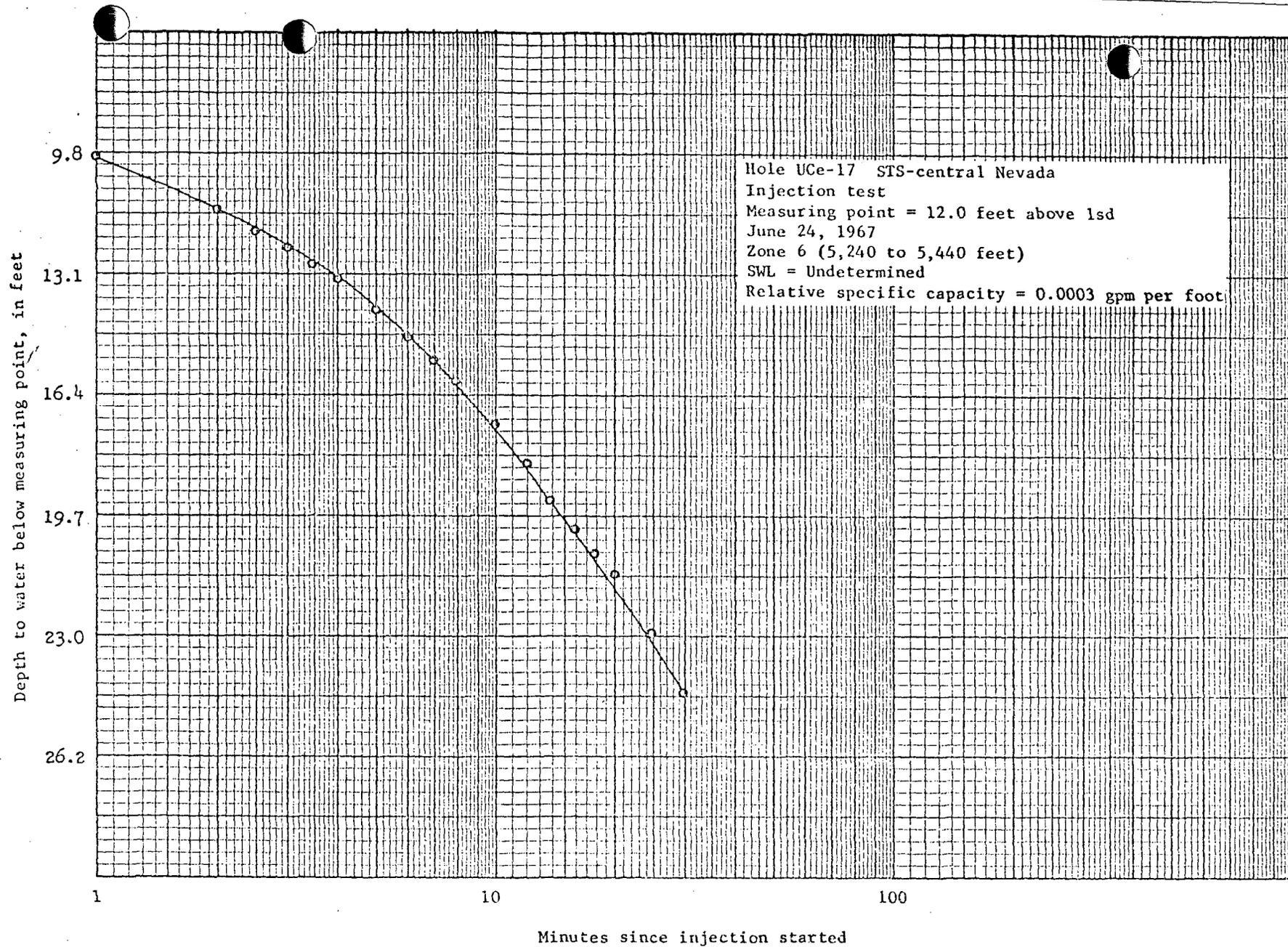


Figure 11.--Injection test of zone 6 (5,240 to 5,440 feet), hole UCe-17, STS-central Nevada, June 24, 1967.

Zone 8, 6,130 to 6,330 feet

Static water level was not measured either after injection or after swabbing because of the extremely long time involved in waiting for the level to reach equilibrium. Measurements of water-level decline during injection were made for 30 minutes. Relative specific capacity was computed from injection data and an assumed static level of 475 feet below lsd. This static level is incorrect, but it will give the maximum possible relative specific capacity.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection test data (fig. 12) follows:

$$\text{Head loss} = 69.01 - 62.58 = 6.43 \text{ feet per minute}$$

$$Q = (0.162)(6.43) \approx 1.04 \text{ gallons per minute}$$

$$\text{Drawdown} = 475 - 41.4 = 433.6 \text{ feet}$$

$$\text{Relative specific capacity} = 1.04/433.6 = 0.002 \text{ gpm per foot}$$

Zone 9, 6,430 to 6,630 feet

Static water level was not measured either after injection or after swabbing because of the extremely long time involved in waiting for the level to become static. Measurements of water-level decline during injection were made for more than 100 minutes. Relative specific capacity was computed from injection data and an assumed static level of 475 feet below lsd. This static level is incorrect, but it will give the maximum possible relative specific capacity.

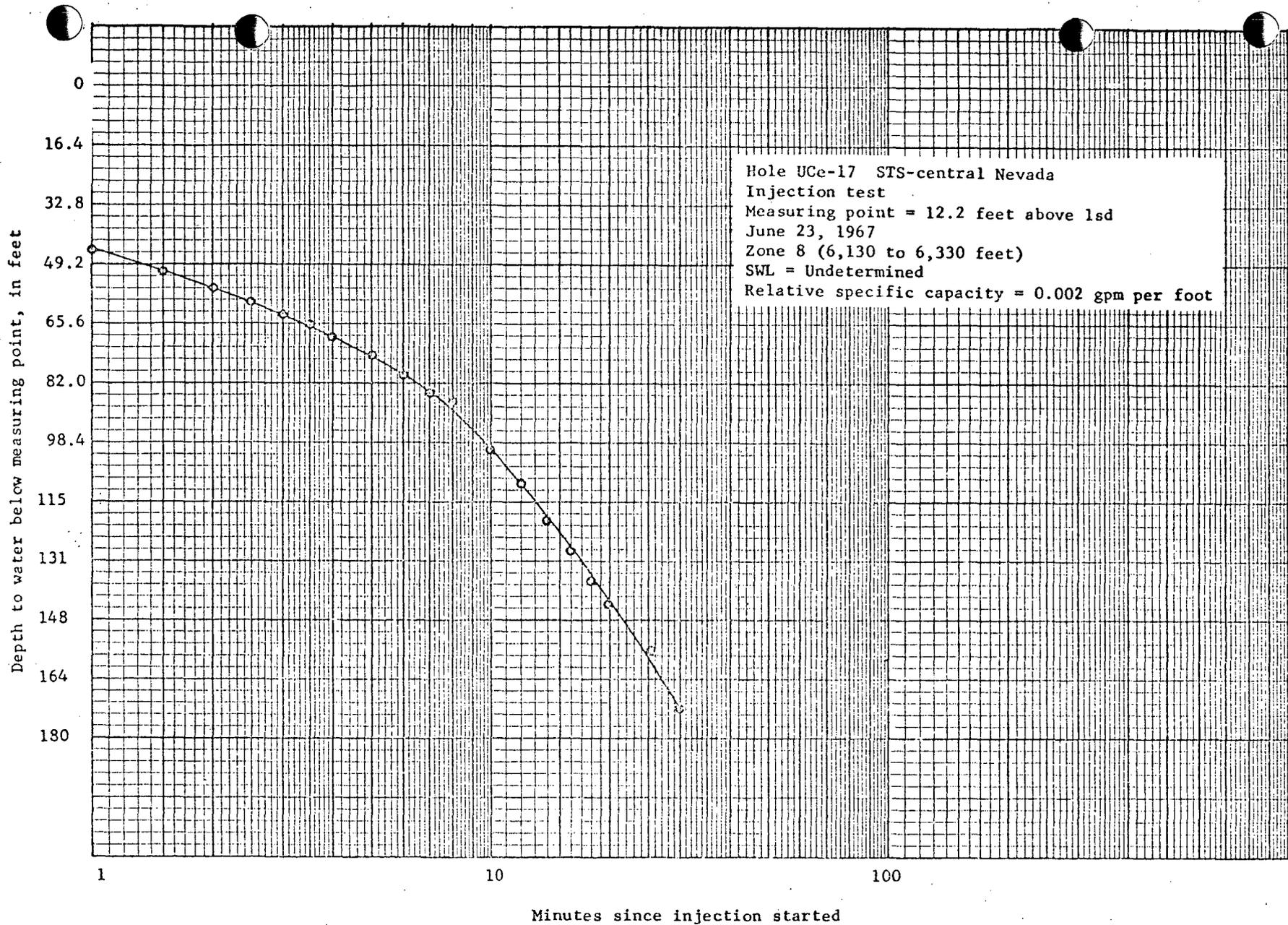


Figure 12.--Injection test of zone 8 (6,130 to 6,330 feet), hole UCe-17, STS-central Nevada, June 23, 1967.

Relative specific capacity calculated using the time interval from the 4th to the 5th minute of the injection test data (fig. 13) follows:

$$\text{Head loss} = 43.85 - 40.64 = 3.21 \text{ feet per minute}$$

$$Q = (0.162)(3.21) = 0.52 \text{ gallons per minute}$$

$$\text{Drawdown} = 475 - 18.11 = 456.89 \text{ feet}$$

$$\text{Relative specific capacity} = 0.52/456.89 = 0.001 \text{ gpm per foot}$$

Zone 10, 6,745 to 6,945 feet

Projection of the semi-logarithmic plot of water-level decline during injection indicates that the static water level in this zone probably is about 1,150 feet below land-surface datum. Actual measurements of the water level were made at depths of as much as 1,072 feet below land-surface datum. Relative specific capacity was computed from both injection and recovery data and from the estimated static level of 1,150 feet below lsd.

Relative specific capacity calculated using the time interval from the 5th to the 6th minute of the injection test data (fig. 14) follows:

$$\text{Head loss} = 306.35 - 293.13 = 13.22 \text{ feet per minute}$$

$$Q = (0.162)(13.22) = 2.14 \text{ gallons per minute}$$

$$\text{Drawdown} = 1,150 - 299.73 = 850.27 \text{ feet}$$

$$\text{Relative specific capacity} = 2.14/850.27 = 0.003 \text{ gpm per foot}$$

Relative specific capacity calculated using the time interval from 9½ to 10½ minutes of the recovery test data (fig. 15) follows:

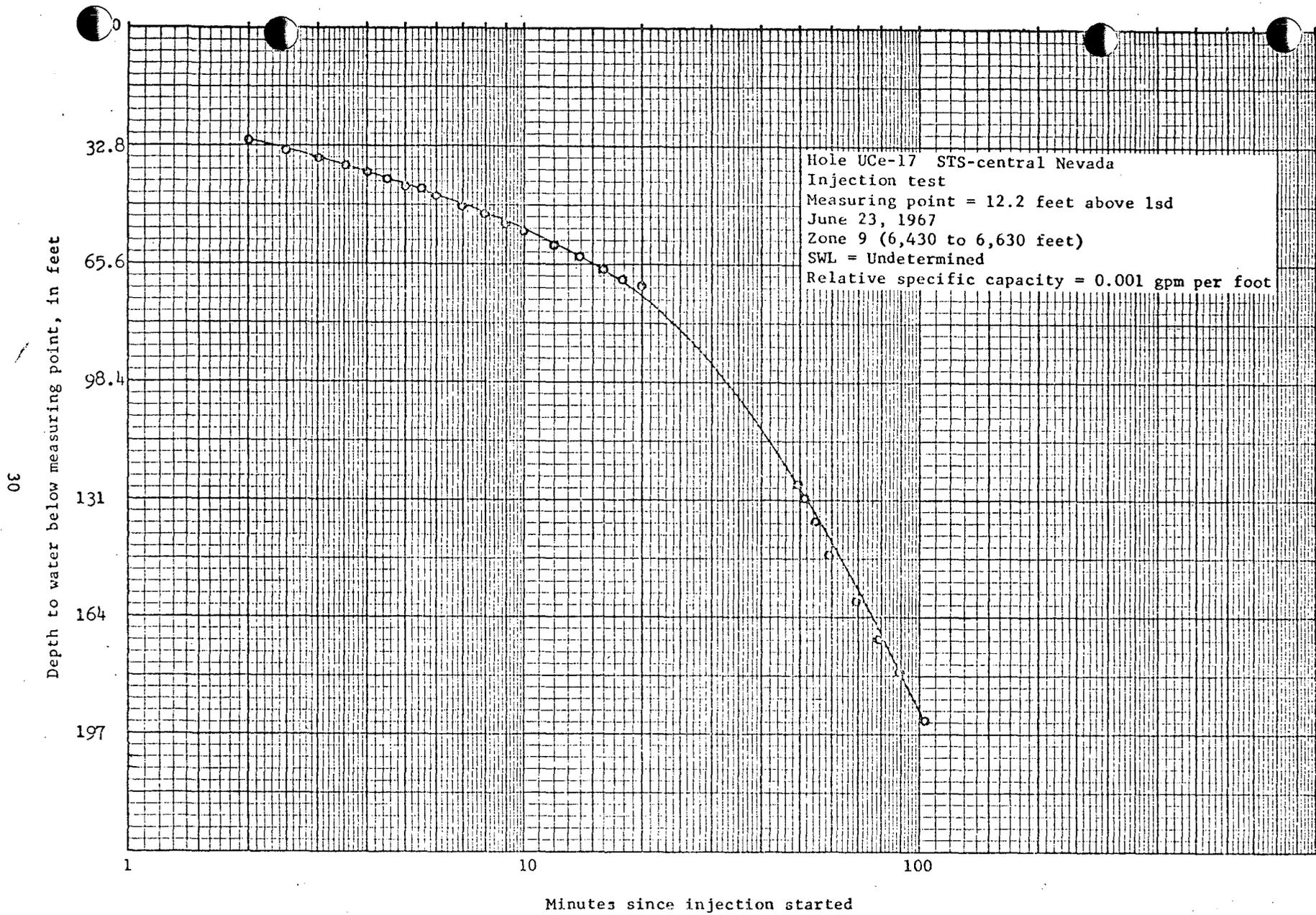


Figure 13.--Injection test of zone 9 (6,430 to 6,630 feet), hole UCe-17, STS-central Nevada, June 23, 1967.

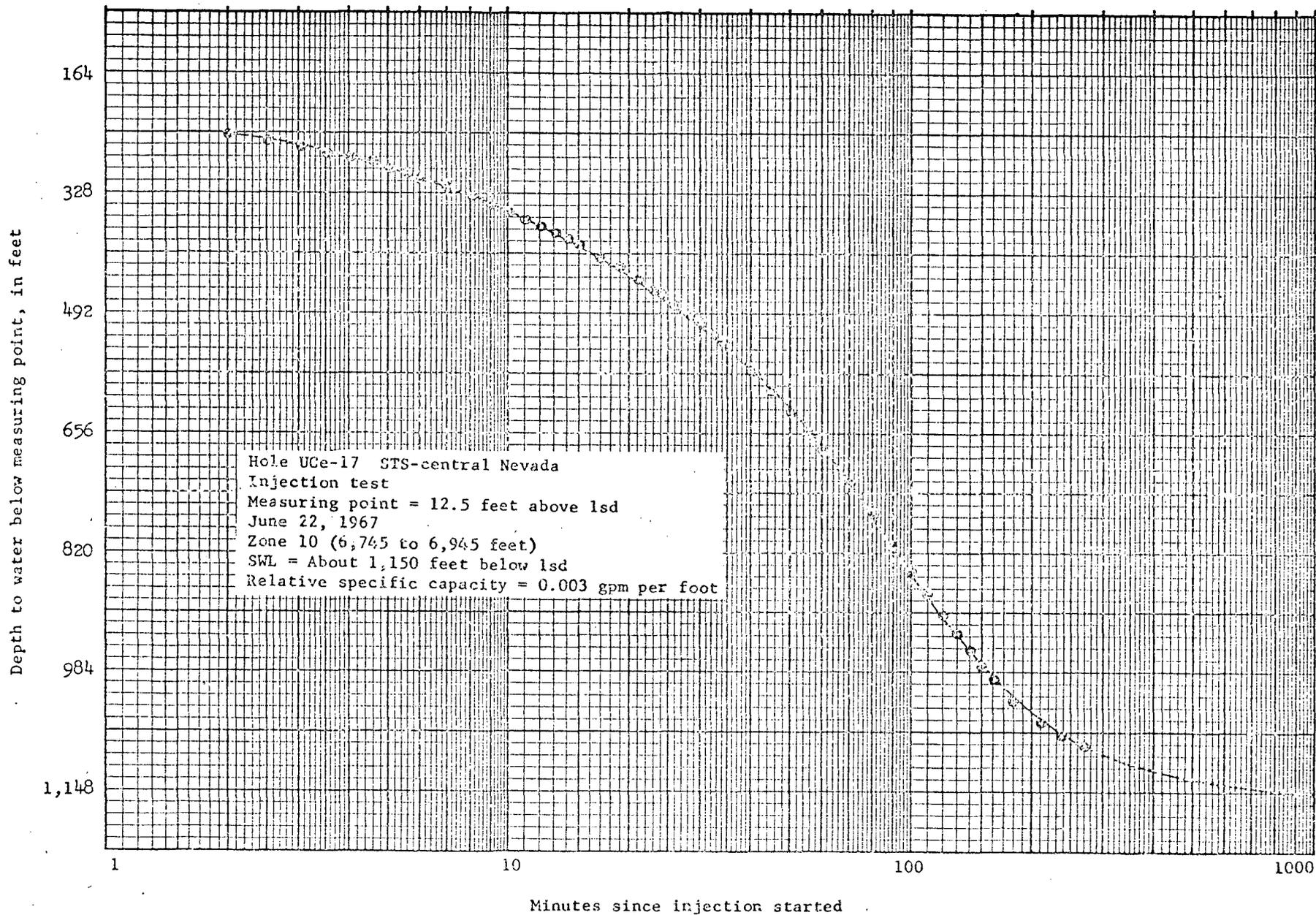


Figure 14.--Injection test of zone 10 (6,745 to 6,945 feet), hole UGe-17, STS-central Nevada, June 22, 1967.

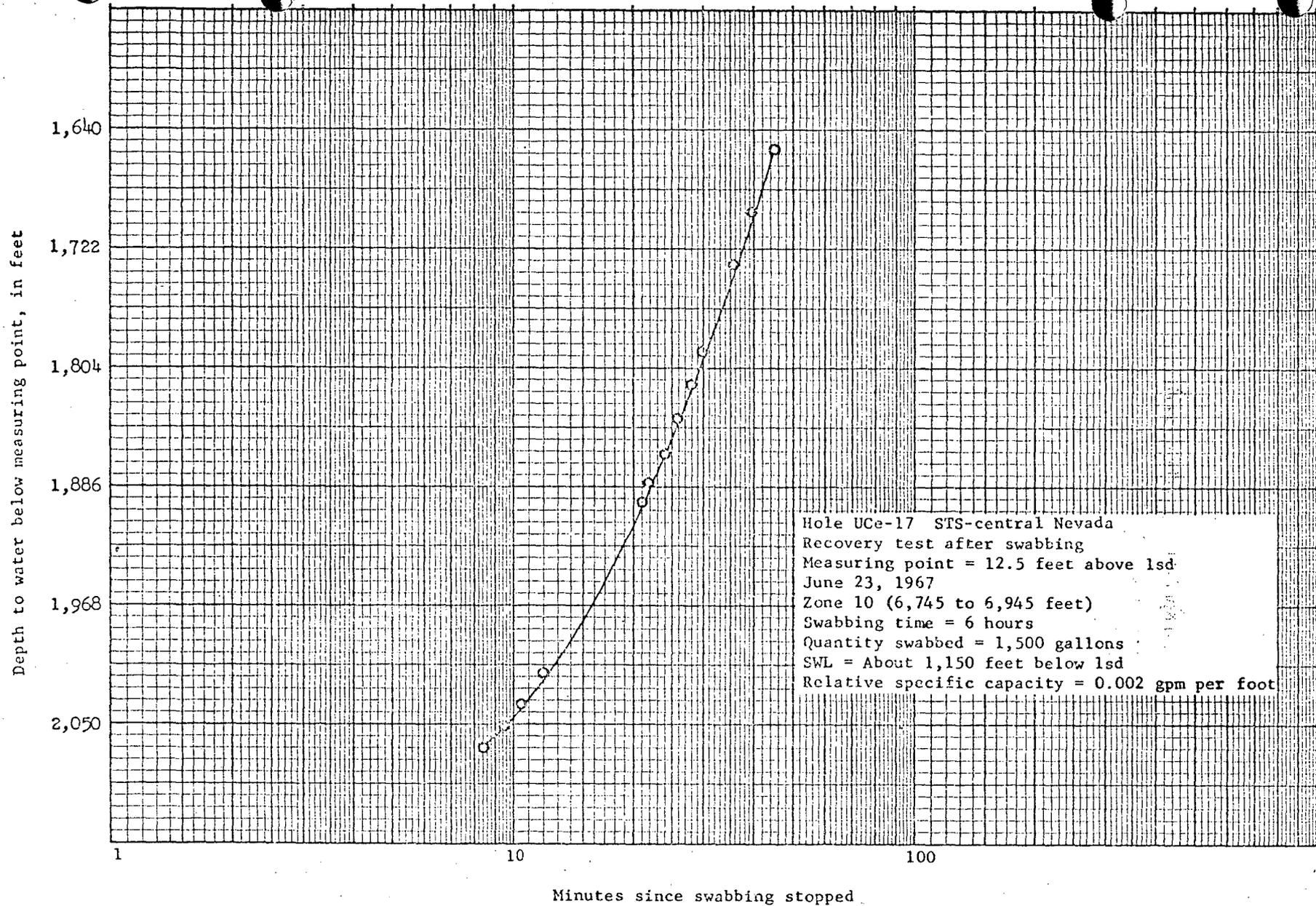


Figure 15.--Swab test of zone 10 (6,745 to 6,945 feet), hole UCe-17, STS-central Nevada, June 23, 1967.

Head loss = 2,050.6 - 2,037.1 = 13.5 feet per minute

$Q = (0.162)(13.5) = 2.19$ gallons per minute

Drawdown = 2,044 - 1,150 = 894 feet

Relative specific capacity = $2.19/894 = 0.002$ gpm per foot

Zone 11, 7,050 to 7,250 feet

Static water level was not measured either after injection or after swabbing because of the extremely long time involved in waiting for the level to become static. Measurements of water-level decline during injection were made for 155 minutes. Relative specific capacity was computed from injection data and an assumed static level of 880 feet below lsd. This static level probably is incorrect, but it will give a reasonable estimate of relative specific capacity.

Relative specific capacity calculated using the time interval from the 5th to the 6th minute of the injection test data (fig. 16) follows:

Head loss = 97.8 - 89.6 = 8.2 feet per minute

$Q = (0.162)(8.2) = 1.33$ gallons per minute

Drawdown = 880 - 93.7 = 786.3 feet

Relative specific capacity = $1.33/786.3 = 0.002$ gpm per foot

Zone 12, 7,257 to 7,457 feet

Static water level was not measured either after injection or after swabbing because of the extremely long time involved in waiting for the level to become static. Measurements of water-level decline during injection were made for 400 minutes. Relative specific capacity was

Depth to water below measuring point, in feet

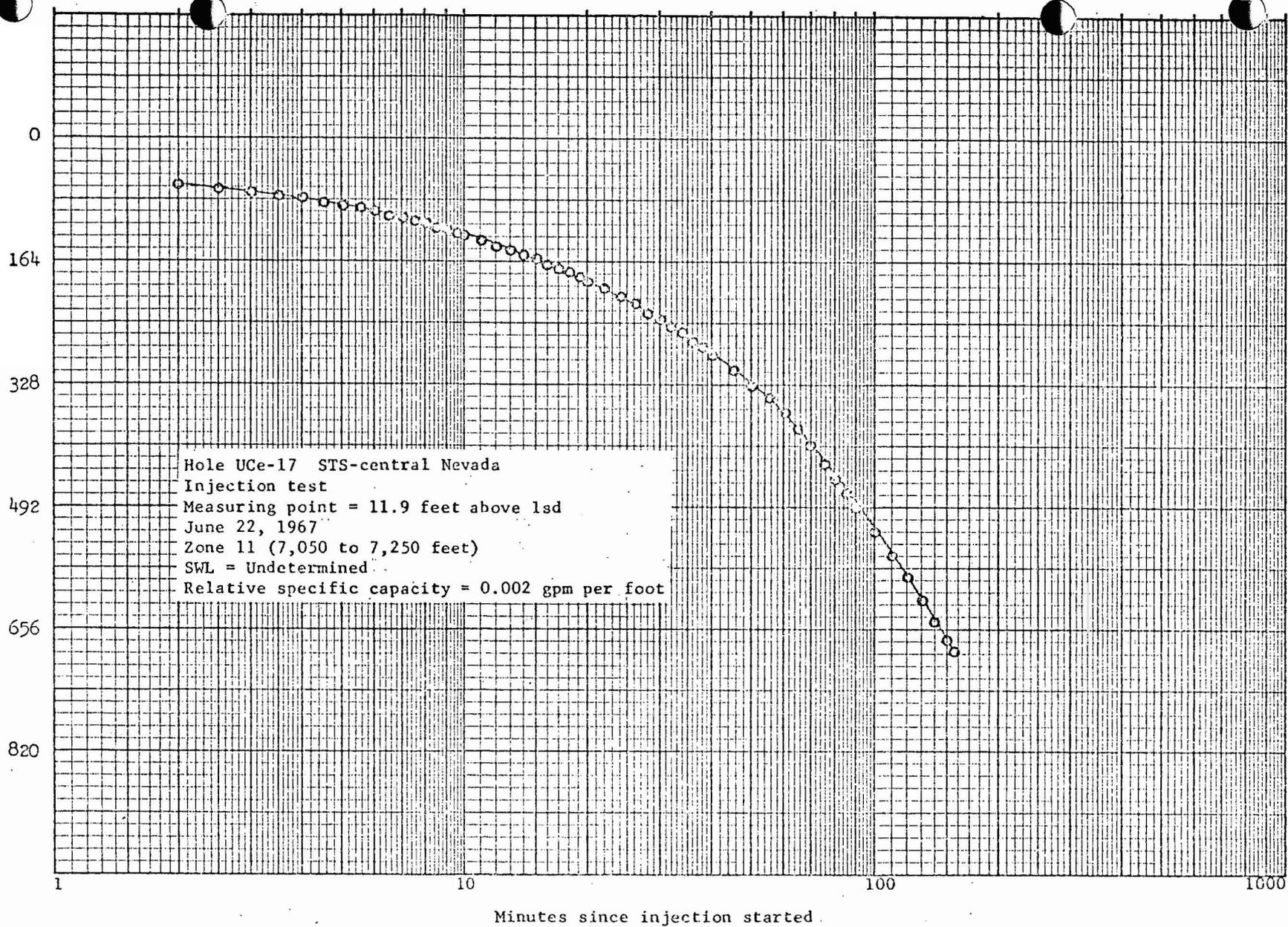


Figure 16.--Injection test of zone 11 (7,050 to 7,250 feet), hole UCe-17, STS-central Nevada, June 22, 1967.

computed from injection data and an assumed static level of 880 feet below lsd. This static level probably is incorrect, but it will give a reasonable estimate of relative specific capacity.

Relative specific capacity calculated using the time interval from the 9th to the 10th minute of the injection test data (fig. 17) follows:

$$\text{Head loss} = 46.8 - 44.8 = 2.0 \text{ feet per minute}$$

$$Q = (0.162)(2.0) = 0.324 \text{ gallons per minute}$$

$$\text{Drawdown} = 880 - 45.8 = 834.2 \text{ feet}$$

$$\text{Relative specific capacity} = 0.324/834.2 = 0.0004 \text{ gpm per foot}$$

Zone 14, 1,770 to 1,840 feet

The static level after both injection and swabbing was about 475 feet below lsd. The rate of decline of the water level during injection was so fast that data with which to compute relative specific capacity are not available. However, relative specific capacity was computed from recovery data after swabbing.

Relative specific capacity calculated using the time interval from the 8th to the 9th minute of the recovery test data (fig. 18) follows:

$$\text{Head loss} = 540.9 - 537.2 = 3.7 \text{ feet per minute}$$

$$Q = (0.162)(3.7) = 0.6 \text{ gallons per minute}$$

$$\text{Drawdown} = 525.22 - 475 = 50.22 \text{ feet}$$

$$\text{Relative specific capacity} = 0.6/50.22 = 0.01 \text{ gpm per foot}$$

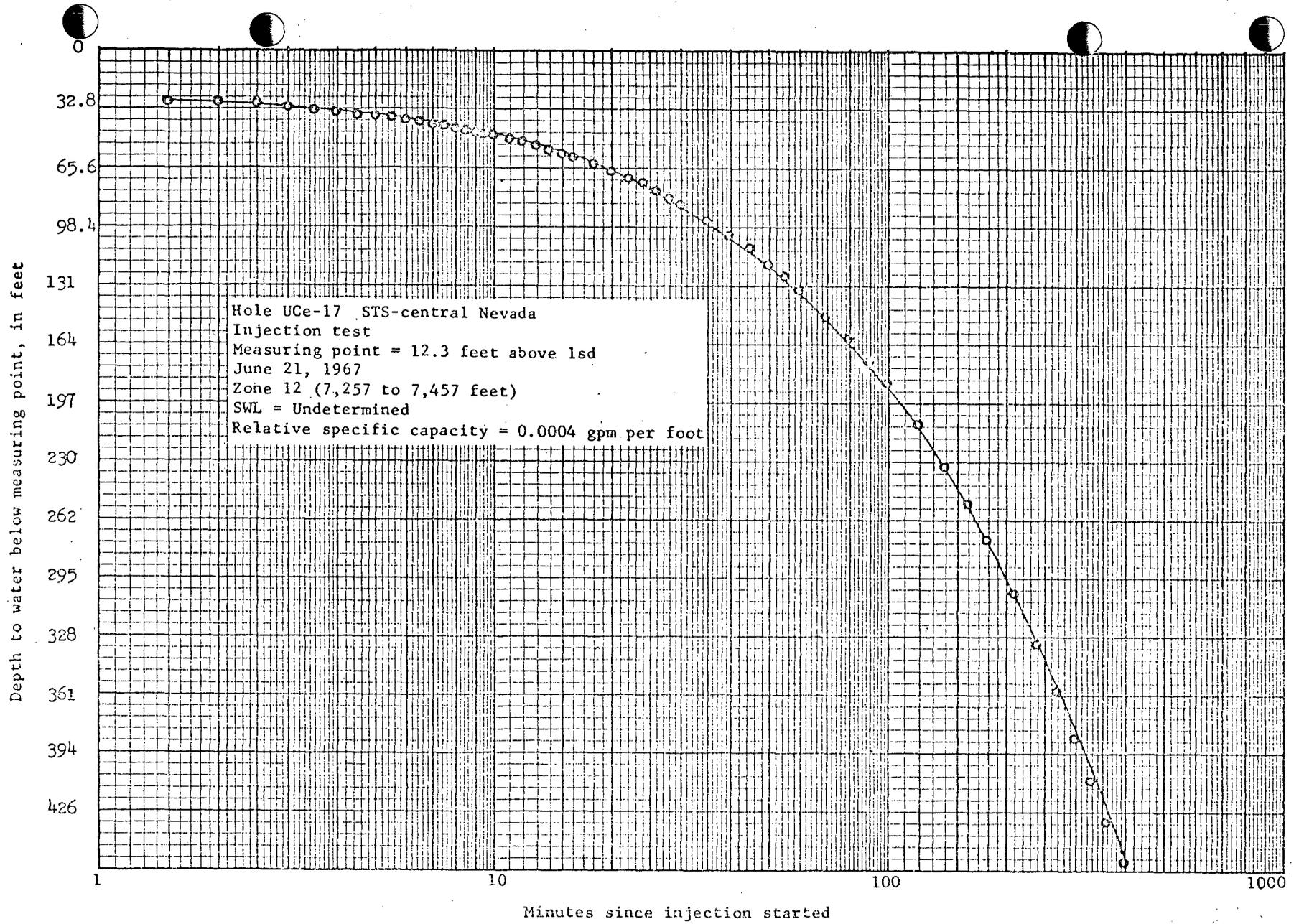


Figure 17.--Injection test of zone 12 (7,257 to 7,457 feet), hole UCe-17, STS-central Nevada, June 21, 1967.

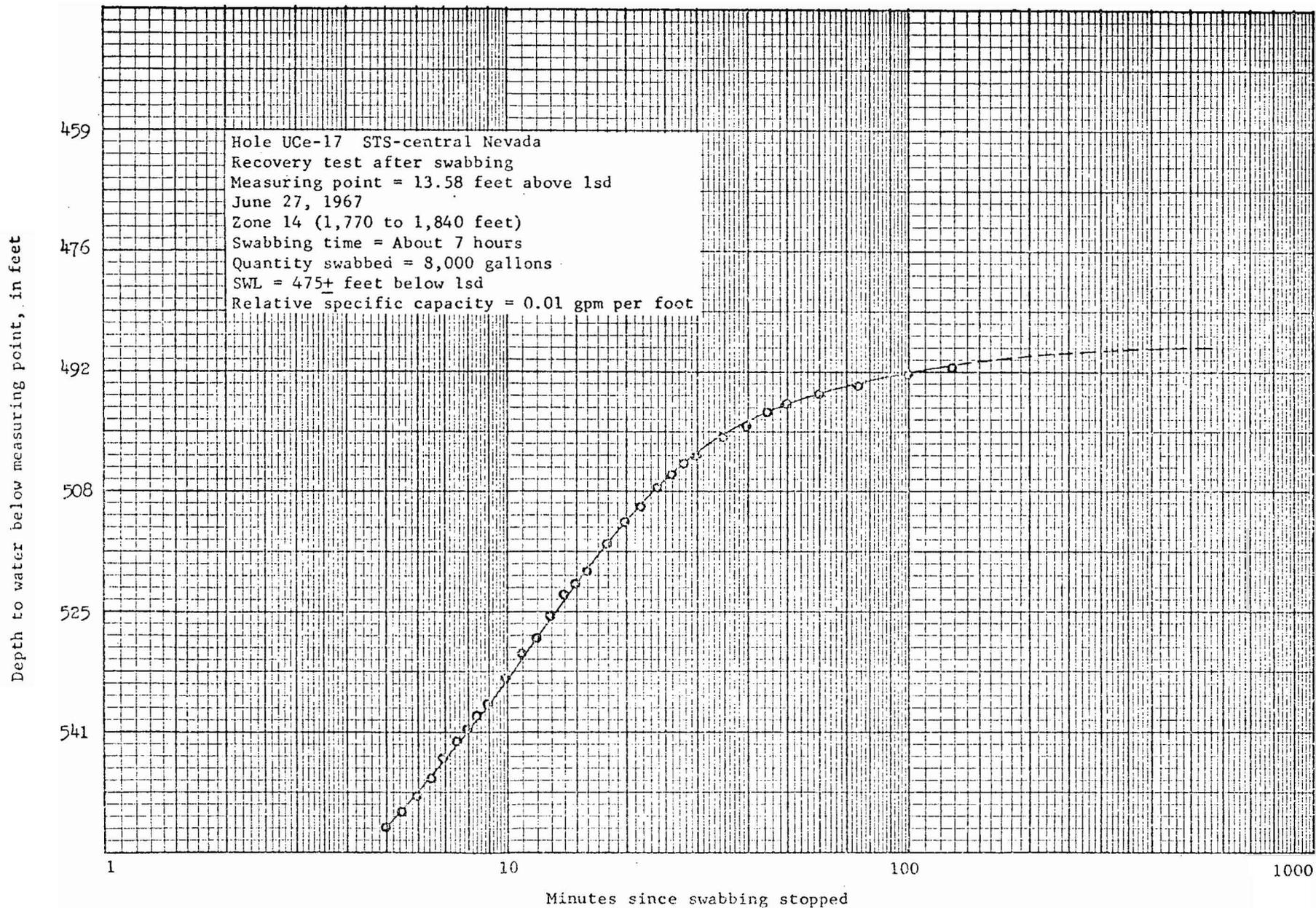


Figure 18.--Swab test of zone 14 (1,770 to 1,840 feet), hole UCe-17, STS-central Nevada, June 27, 1967.

Zone 15, 785 to 915 feet

The static level after both injection and swabbing was about 475 feet below lsd. The rate of water-level movement during injection and after swabbing was so fast that data with which to compute relative specific capacity are not available. However, the rapid reaction indicates that relative specific capacity is high.

Table 2.--Summary of hydraulic tests in hole UCe-17
(e Estimated.)

Zone		1	2	3	4	5	6	8	9	10	11	12	14	15	Units
Tested interval		3,139 to 3,339	3,800 to 4,000	4,012 to 4,212	4,486 to 4,686	4,620 to 4,820	5,240 to 5,440	6,130 to 6,330	6,430 to 6,630	6,745 to 6,945	7,050 to 7,250	7,257 to 7,457	1,770 to 1,840	785 to 915	Feet
Static water level ^{1/}	Injec.	882	-	-	-	893	-	-	-	e1,150	-	-	475±	475±	Feet below land-surface datum
	Recov.	-	-	800(?)	-	-	-	-	-	-	-	-	475±	475±	Feet below land-surface datum
Relative specific capacity	Injec.	0.05	-	Cemented	e0.001	0.23	e0.0003	e0.002	e0.001	e0.003	e0.002	e0.0004	High	Very high	Gpm per foot of drawdown
	Recov.	-	-	Cemented	-	-	-	-	-	e .002	-	-	0.01	Very high	Gpm per foot of drawdown
Maximum water temperature		98	-	93	82	95	-	-	-	85	-	-	74	65	°F
Specific conductance		430	-	360	1,200	900	-	-	-	610	-	-	450	350	Micromhos per cm at 25°C
Packer communication	Top	Yes	No	Yes	No	Yes	No	No	No	No	No	No	Yes	No	--
	Bottom	-	No	No	-	-	-	-	-	-	-	-	No	No	--
Total water swabbed		10,000	-	6,000	3,000	5,000	530	700	350	1,500	630	-	8,000	400	Gallons

^{1/} Composite water level = 528 feet below land surface datum.

Note: The hydraulic potential apparently decreases with depth. Specific capacity of this well was 0.37 gallons per minute per foot of drawdown after 13 hours of pumping at an average rate of 170 gallons per minute.

HYDRAULIC TESTING OF HOLE UCe-18

Well History

Hole UCe-18, at N. 1,396,833.40 ft and E. 635,840.13 ft, Nevada coordinate system, central zone, Nye County, Nevada, was spudded in on March 10, 1967, and had reached a depth of 6,514 feet when released to the Hydrologic Task Force for hydraulic testing and sampling on May 23, 1967. Its casing record is as follows:

20-inch OD to 80 feet (cemented)

13 $\frac{3}{8}$ -inch OD to 1,206 feet (cemented)

9 $\frac{5}{8}$ -inch OD to 4,797 feet (cemented)

Lithologic Log

The following lithologic log for hole UCe-18 is from D. L. Hoover, U.S. Geological Survey.

Elevation: 5,763 feet

Footage (in feet)	Rock type
0 - 4,205	Alluvium and fanglomerate
4,205 - 4,378	Lake beds and gypsum
4,378 - 6,448	Rhyolite
	Argillized and highly fractured or breccia zones at: 4,708 - 4,782 5,310 - 5,404 5,442 - 5,542 5,856 - 5,878 5,982 - 6,030 6,308 - 6,384
6,448 - 6,514	Bedded tuff, zeolitized and argillized

Composite Hydrostatic Head

The composite hydrostatic head was measured with the deep-well measuring device ("iron horse") on September 1, 1967. The water level was 196 feet below land-surface datum.

Intervals Tested and Sampled

<u>Zone</u>	<u>Depth (feet)</u>
1	6,390 to 6,514
2	6,149 to 6,514 (sampled)
3	5,920 to 6,080 (sampled)
4	5,634 to 5,794 (sampled)
5	5,020 to 5,180 (sampled)
6	5,804 to 5,914 (sampled)
7	5,530 to 5,640 (sampled)
8	5,300 to 5,410 (sampled)
9	4,555 to 4,747 (sampled)
10	4,060 to 4,190
11	406 to 598 (sampled)
12	4,795 to 4,995 (sampled)

These intervals and a generalized summary of hydrology, lithology, and construction are presented in figure 19.

Composite water level = 196 feet below lsd.

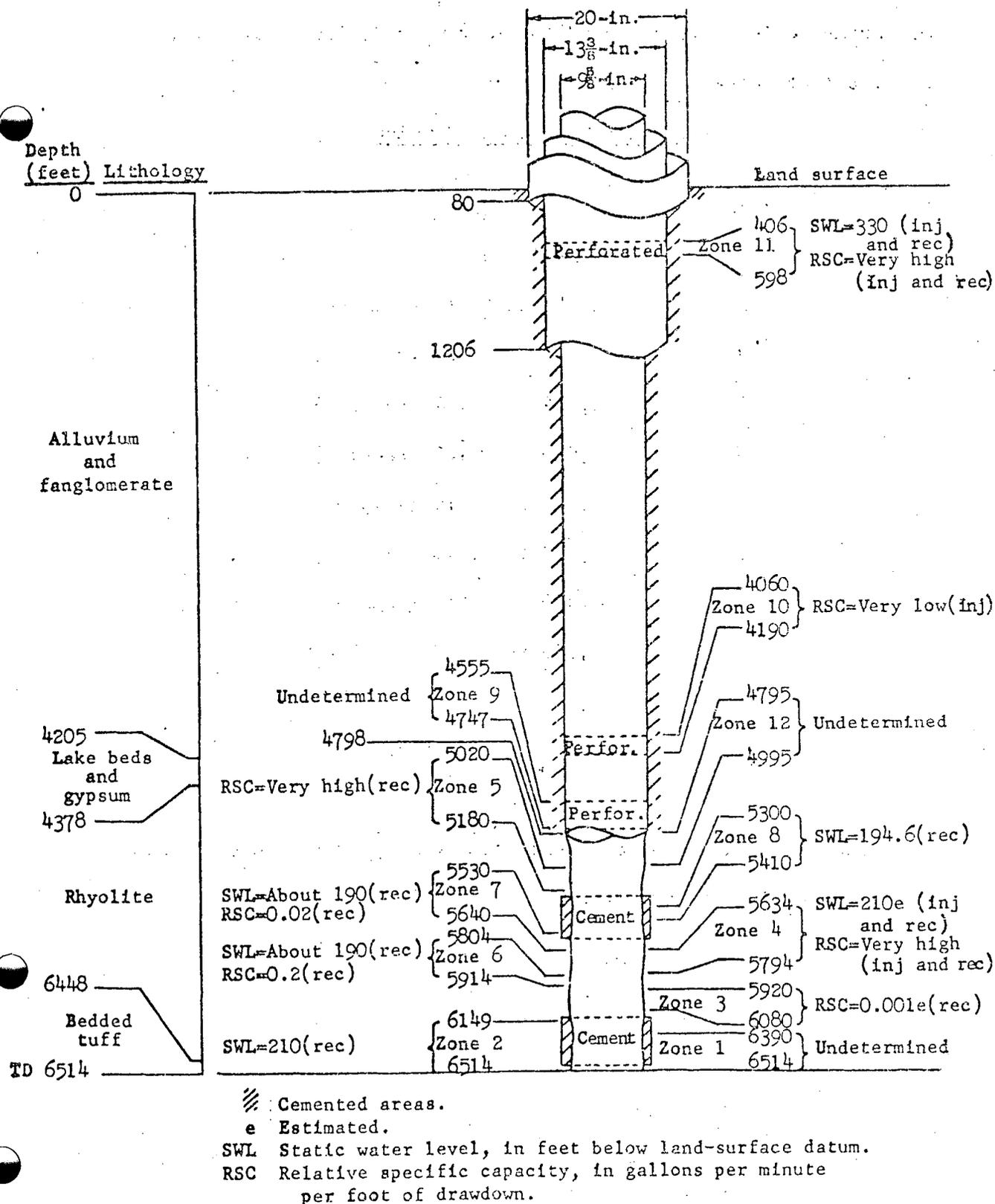


Figure 19.--Hydrology and lithology in hole UCe-18.

Tracejector Study

The borehole was open to the formations from 4,798 to 6,335 feet during the static-condition tracejector survey. The results of the survey indicate a potential for downward flow in this interval of the rhyolite. Vertical flow in the borehole was downward at a rate of about 6 gpm with inflow at a depth of 5,020 feet and total outflow at a depth of about 5,685 feet. There was no measurable flow in the borehole under static conditions either above 5,020 feet or below 5,685 feet.

Major water-contributing zones generally indicate zones of highest permeability in the borehole. Major water-contributing zones in hole UCe-18 during pumping (fig. 20) were observed or surmised at depths from 406 to 598 feet (perforated casing in alluvium), at about 5,020 feet (uncased borehole in rhyolite), and at about 5,685 feet (uncased borehole in rhyolite).

Zone 1, 6,390 to 6,514 feet

A hydraulic test of this zone was attempted, but the test was unsuccessful. Therefore, the packer was moved 200 feet uphole and a larger section (zone 2) of hole was tested.

Zone 2, 6,149 to 6,514 feet

The static level measured after recovery from swabbing was about 210 feet below land-surface datum. Relative specific capacity is computed only from recovery data. Measurements of the water-level rise after swabbing were made for 420 minutes. This zone was cemented during drilling, and relative specific capacity determined from testing would be a minimum.

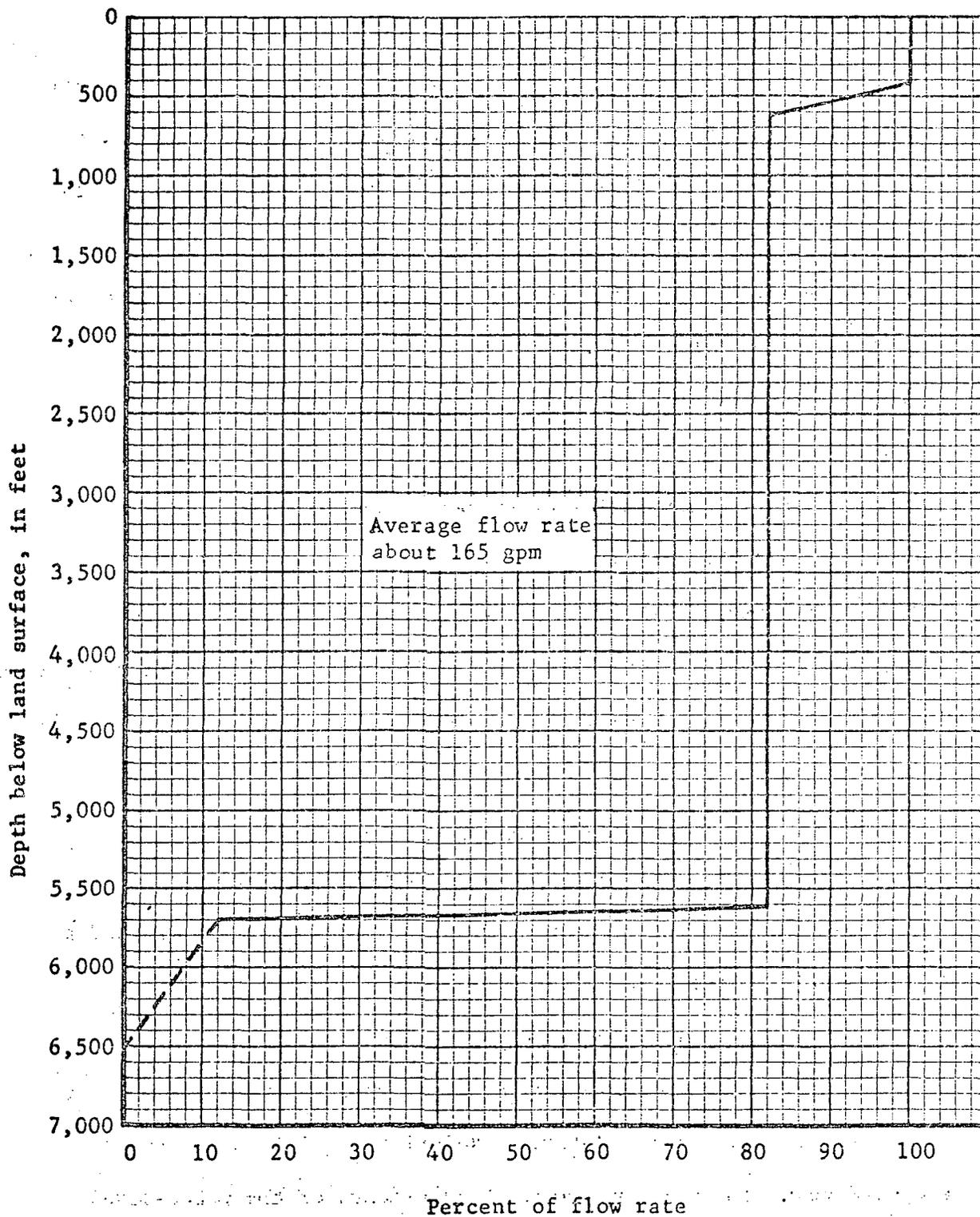


Figure 20.--Tracejector survey of hole UCe-18, Hot Creek Valley, Nevada, while pumping.

Relative specific capacity calculated using the time interval from the 16th to the 17th minute of the recovery test data (fig. 21) follows:

$$\text{Head loss} = 868.5 - 832.0 = 36.5 \text{ feet per minute}$$

$$Q = (0.162)(36.5) = 5.91 \text{ gallons per minute}$$

$$\text{Drawdown} = 837.2 - 210 = 627.2 \text{ feet}$$

$$\text{Relative specific capacity} = 5.91/627.2 = 0.009 \text{ gpm per foot}$$

Zone 3, 5,920 to 6,080 feet

Static water level was not measured because of the extremely long time involved in waiting for the level to become static. Measurements of water-level recovery after swabbing were made for 500 minutes; however, measurements were not obtained during the first 2½ hours because the measuring device was not working. A reasonable estimate of relative specific capacity was computed from recovery data and an assumed static level of 210 feet below lsd.

Relative specific capacity calculated using the time interval from the 160th to the 161st minute of the recovery test data (fig. 22) follows:

$$\text{Head loss} = 1,550.1 - 1,539.6 = 10.5 \text{ feet per minute}$$

$$Q = (0.162)(10.5) = 1.70 \text{ gallons per minute}$$

$$\text{Drawdown} = 1,532 - 210 = 1,322 \text{ feet}$$

$$\text{Relative specific capacity} = 1.70/1,322 = 0.001 \text{ gpm per foot}$$

Zone 4, 5,634 to 5,794 feet

An attempt was made to measure the static water level during injection and after swabbing, but because of soap in the water an accurate measurement was not possible. The static level is very close to 210 feet

Depth to water below measuring point, in feet

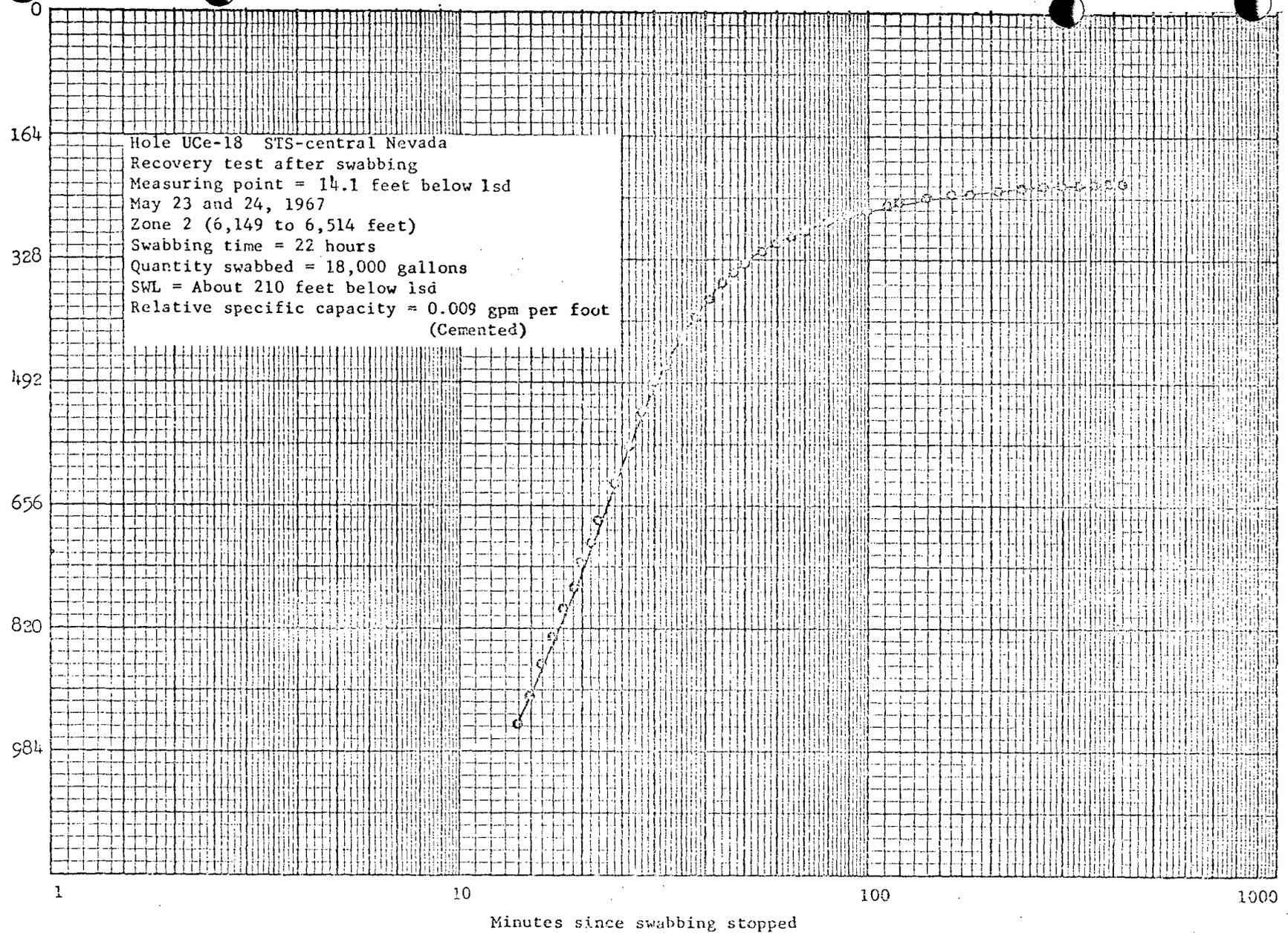


Figure 21.--Swab test of zone 2 (6,149 to 6,514 feet), hole UCe-18, STS-central Nevada, May 23 and 24, 1967.

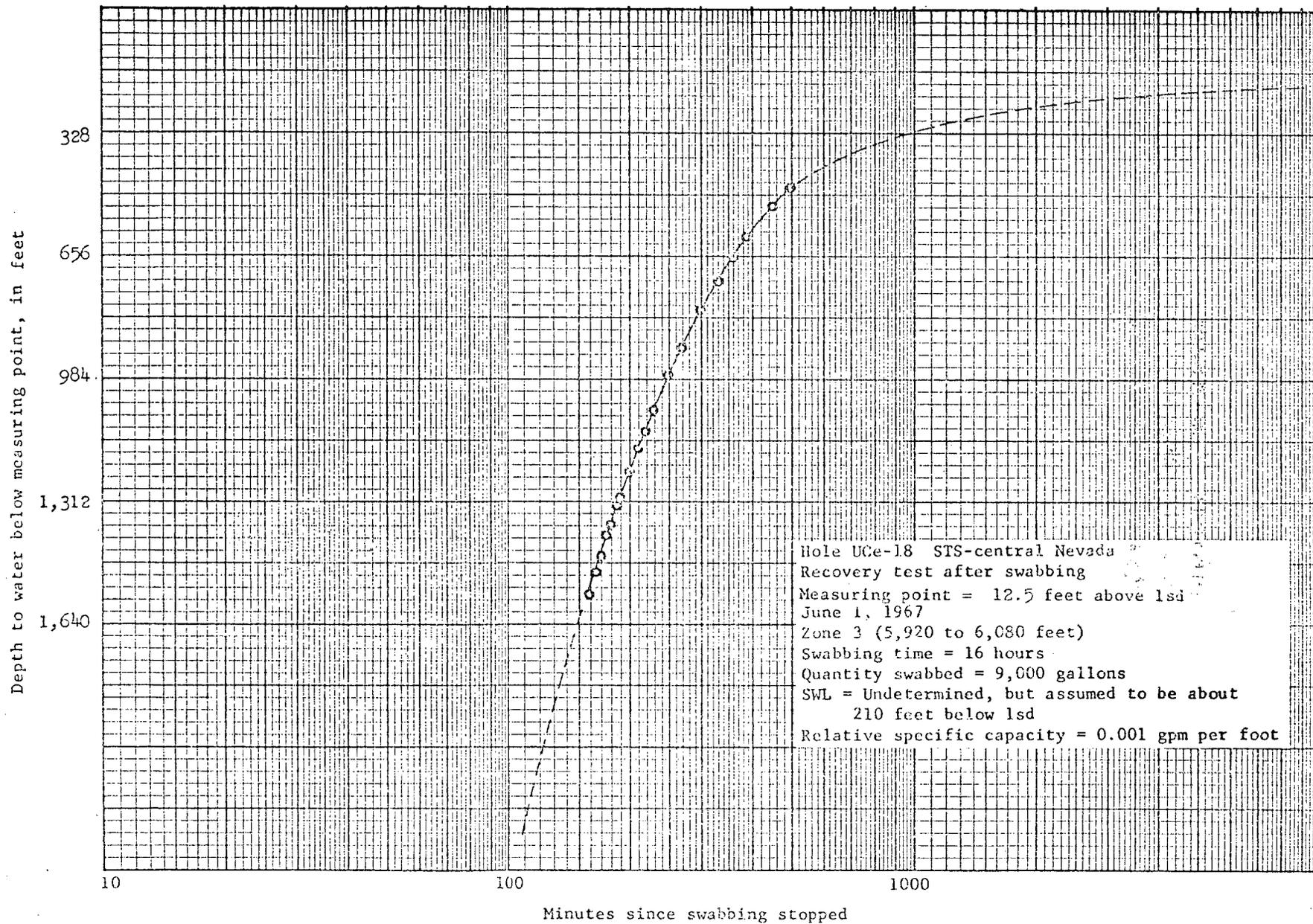


Figure 22.--Swab test of zone 3 (5,920 to 6,080 feet), hole UCe-18, STS-central Nevada, June 1, 1967.

below lsd. The movement of the water level was very fast during both injection and recovery; therefore, the relative specific capacity could not be computed. The permeability of this part of the formation probably is very high. This is substantiated by both the static- and dynamic-condition tracejector studies.

Zone 5, 5,020 to 5,180 feet

An attempt was made to measure the water-level rise after swabbing and the static water level after recovery. The indicated static water level is about 325 feet below lsd; however, this is probably incorrect because the static-condition tracejector study indicated that this zone contributes flow and that flow from this zone goes down the bore-hole and exits in and near zone 4 which has an apparent static level of about 210 feet below lsd. Also, analysis of pressure charts indicates that there was some communication around the upper packer in zone 5.

The reaction of the water level was very fast during recovery after swabbing; therefore, the relative specific capacity could not be computed. However, the permeability of this part of the formation probably is very high. This is substantiated by the static-condition tracejector study.

Zone 6, 5,804 to 5,914 feet

The static level after recovery was about 190 feet below lsd. The measurements of the water-level recovery after swabbing were unreliable because of soap in the water, but the static level is assumed to be reasonable. The relative specific capacity was computed from recovery data, which were obtained for 250 minutes.

Relative specific capacity calculated using the time interval from the 9th to the 10th minute of the recovery test data (fig. 23) follows:

$$\text{Head loss} = 335.7 - 245.0 = 90.7 \text{ feet per minute}$$

$$Q = (0.162)(90.7) = 14.7 \text{ gallons per minute}$$

$$\text{Drawdown} = 261.5 - 190 = 71.5 \text{ feet}$$

$$\text{Relative specific capacity} = 14.7/71.5 = 0.2 \text{ gpm per foot}$$

Zone 7, 5,530 to 5,640 feet

The static water level after recovery was about 190 feet below lsd. Some of the measurements of the water-level recovery after swabbing were unreliable because of soap in the water, but the static level is assumed to be reasonable. The relative specific capacity was computed from recovery data, which were obtained for 80 minutes.

Relative specific capacity calculated using the time interval from the 7th to the 8th minute of the recovery data (fig. 24) follows:

$$\text{Head loss} = 242.5 - 238.6 = 3.9 \text{ feet per minute}$$

$$Q = (0.162)(3.9) = 0.63 \text{ gallons per minute}$$

$$\text{Drawdown} = 227.4 - 190 = 37.4 \text{ feet}$$

$$\text{Relative specific capacity} = 0.63/37.4 = 0.02 \text{ gpm per foot}$$

This relative specific capacity is based on test data obtained from a 110-foot section, and the relative specific capacity for a 200-foot section in similar material probably would be slightly less than twice the reported figure.

Depth to water below measuring point, in feet

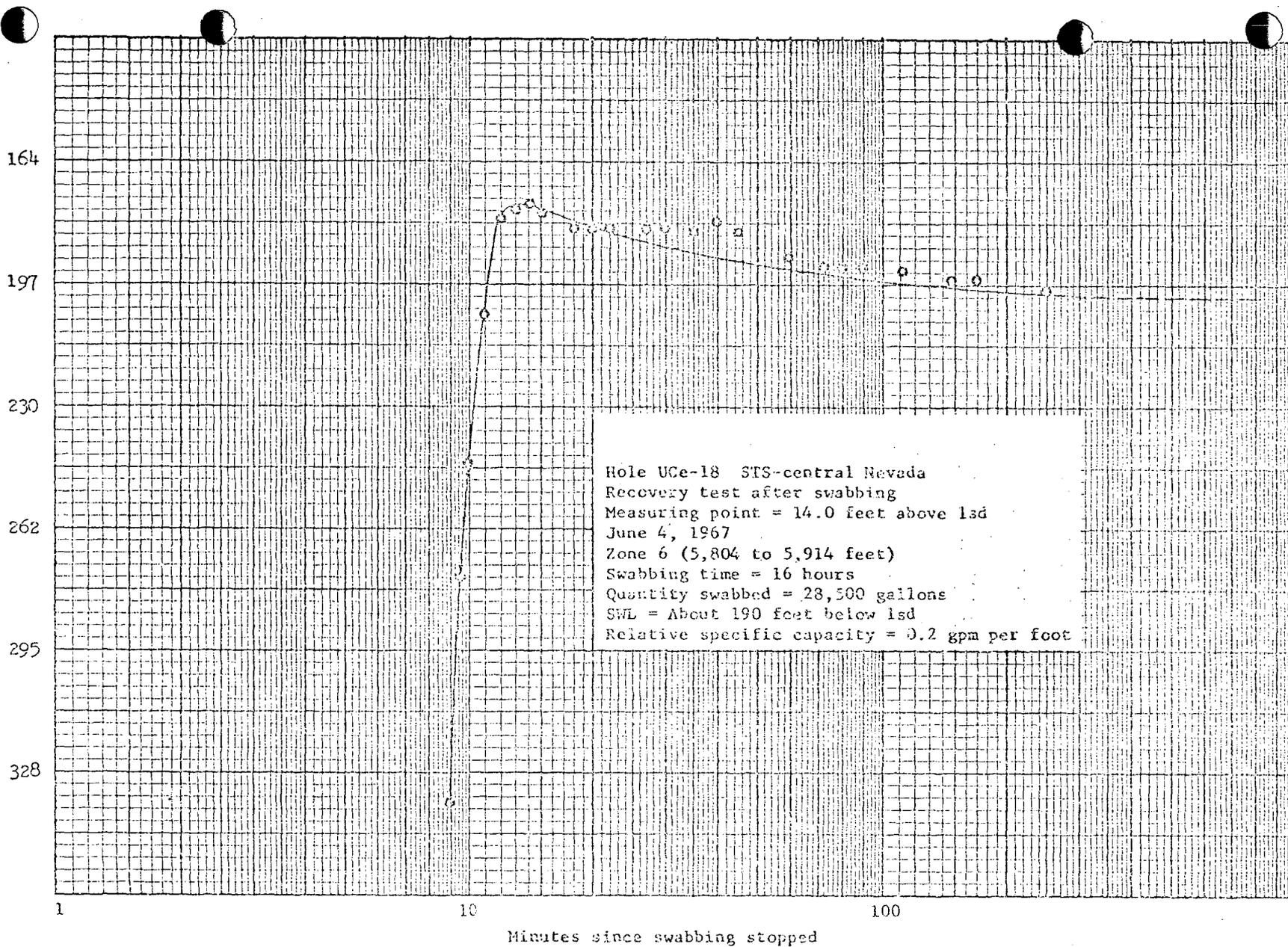


Figure 23.-- Swab test of zone 6 (5,804 to 5,914 feet), hole UCe-18, STS-central Nevada, June 4, 1967.

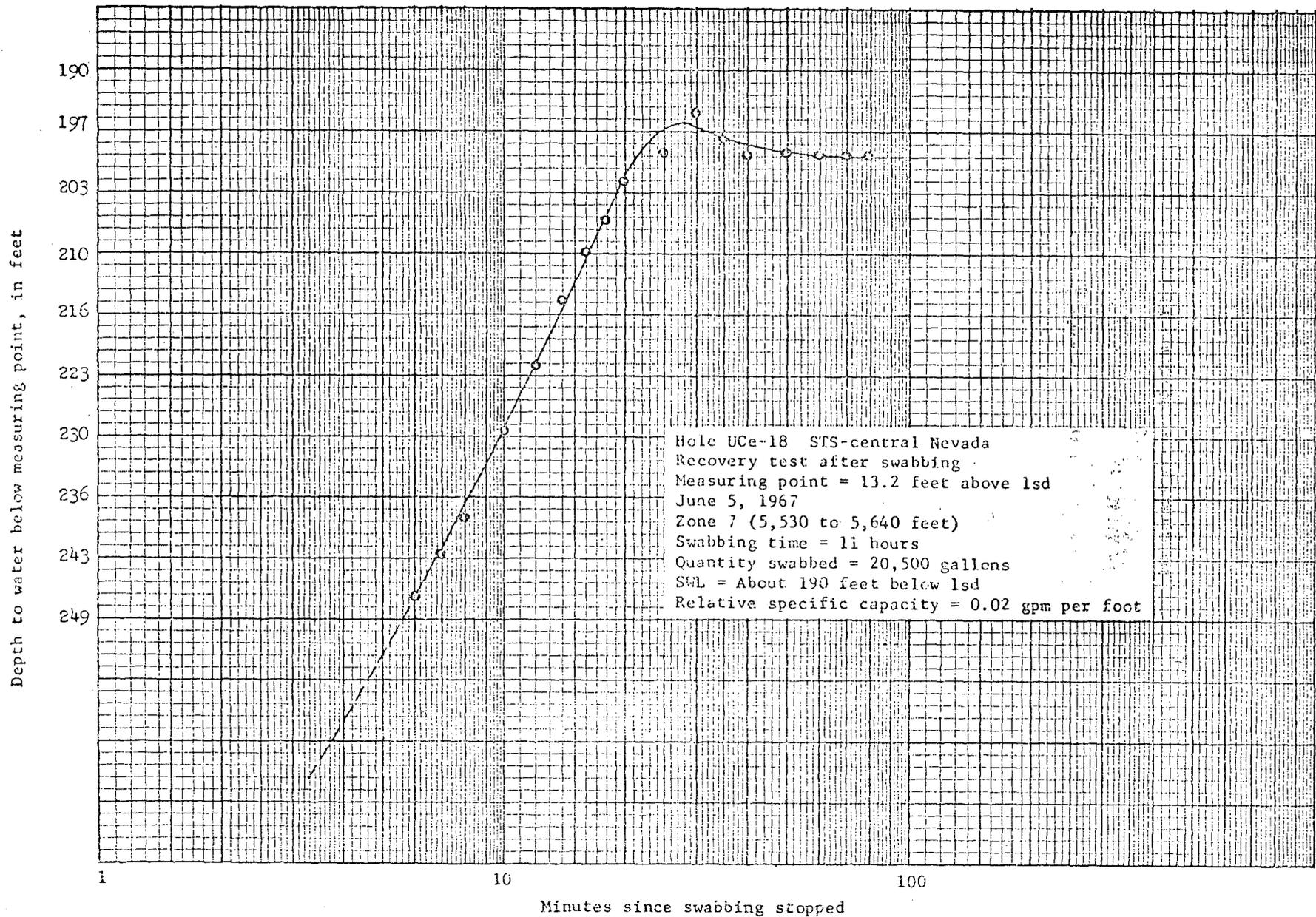


Figure 24.--Swab test of zone 7 (5,530 to 5,640 feet), hole UCe-18, STS-central Nevada, June 5, 1967.

Zone 8, 5,300 to 5,410 feet

The static water level after recovery was 194.6 feet below lsd. The water level was reasonably stable during the last 30 minutes of the 2-hour test, and the static level probably is accurate. The relative specific capacity was computed from recovery data. This zone was cemented during drilling, and relative specific capacity determined from test data would be a minimum.

Relative specific capacity calculated using the time interval from the 9th to the 10th minute of the recovery data (fig. 25) follows:

$$\text{Head loss} = 265.9 - 262.2 = 3.7 \text{ feet per minute}$$

$$Q = (0.162)(3.7) = 0.60 \text{ gallons per minute}$$

$$\text{Drawdown} = 250.3 - 194.6 = 55.7 \text{ feet}$$

$$\text{Relative specific capacity} = 0.60/55.7 = 0.01 \text{ gpm per foot}$$

This relative specific capacity is based on test data obtained from a 110-foot section, and the relative specific capacity for a 200-foot section in similar material would probably be slightly less than twice the reported figure.

Zone 9, 4,555 to 4,747 feet

The static water level after recovery was about 330 feet below lsd. However, pressure charts indicate hydraulic communication around the upper packer; therefore, this static level is probably a reflection of hydrostatic head of some overlying, more permeable zone. Data from this test are unsatisfactory for calculating relative specific capacity.

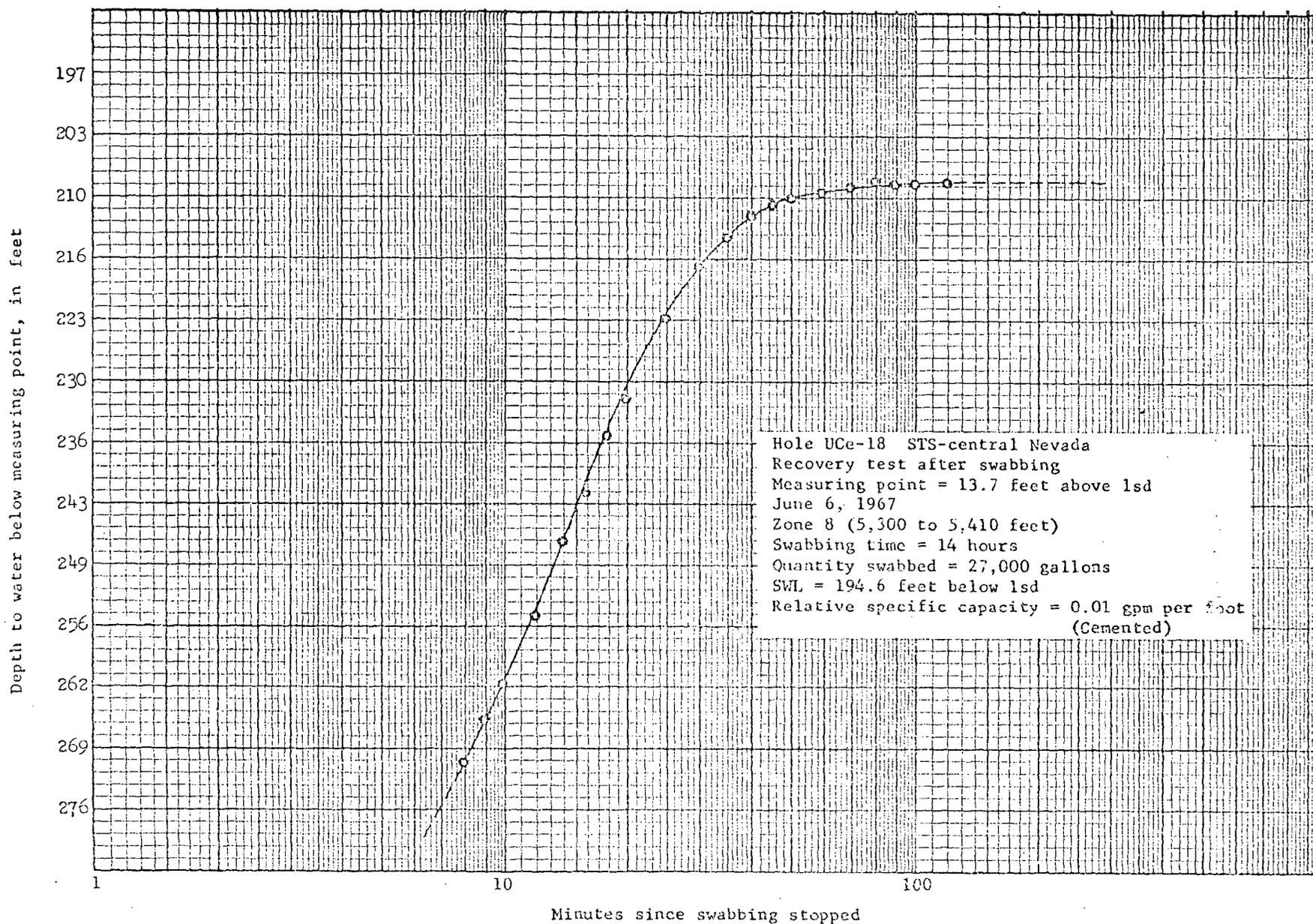


Figure 25.--Swab test of zone 8 (5,300 to 5,410 feet), hole UCe-18, STS-central Nevada, June 6, 1967.

Zone 10, 4,060 to 4,190 feet

Static water level was not measured either after injection or after swabbing because of the extremely long time involved in waiting for the level to become static. This zone was tested through perforated casing and cement, and the low permeability could be a function of communication with the aquifer rather than aquifer characteristics. Measurements of water-level decline were made for 100 minutes, but relative specific capacity was not computed because the data were not good enough.

Zone 11, 406 to 598 feet

Static water level was 330 feet below lsd in this zone. The rate of water movement during hydraulic testing was so fast that data for computing relative specific capacity could not be obtained. However, the rapid reaction indicates that the relative specific capacity is high.

Zone 12, 4,795 to 4,995 feet

Static water level was about 330 feet below lsd after recovery from swabbing. The pressure recorder above the top packer failed, and any bypass of fluid around the top packer cannot be proven. However, it is doubtful that the upper packer was well seated, based on the static water level and the characteristics of water-level reaction during recovery. If this reaction of the water level indicates the real aquifer characteristics, then the relative specific capacity of this section is high.

Table 3.--Summary of hydraulic tests in hole UCe-18
(e Estimated.)

Zone	1	2	3	4	5	6	7	8	9	10	11	12	Units	
Tested interval	6,390 to 6,514	6,149 to 6,514	5,920 to 6,080	5,634 to 5,794	5,020 to 5,180	5,804 to 5,914	5,530 to 5,640	5,300 to 5,410	4,555 to 4,747	4,060 to 4,190	406 to 598	4,795 to 4,995	Feet	
Static water level	Injec.	-	-	-	e210	-	-	-	-	-	-	330	-	Feet below land-surface datum
	Recov.	-	210	-	e210	-	About 190	About 190	194.6	-	-	330	-	Feet below land-surface datum
Relative specific capacity	Injec.	Cemented	Cemented	-	Very high	-	-	-	Cemented	-	Very low	Very high	-	Gpm per foot of drawdown
	Recov.	Cemented	Cemented	e0.001	Very high	Very high	0.2	0.02	Cemented	-	-	Very high	-	Gpm per foot of drawdown
Maximum water temperature	-	118	105	118	107	129	120	130	112(?)	-	92	99	°F	
Specific conductance	-	2,950	3,000	3,000	3,000	2,900	3,000	3,000	1,400(?)	-	1,200	1,800	Micromhos per cm at 25°C	
Packer communication	Top	Single packer	Single packer	No	No	Very slight	No	Slight	Slight	Yes	Yes	No	Recorder failed	--
	Bottom	No	Lost	Lost	Lost	No	--							
Total water swabbed	1,400	18,000	9,000	16,000	17,500	28,500	20,500	27,000	28,000	1,750	14,500	22,000	Gallons	

1/ Composite water level = 196 feet below lsd.

Note: Comparison of static levels in both alluvial and bedrock sections indicates potential for upward movement of water.

Specific capacity of this well was 3.1 gallons per minute per foot of drawdown after 9 hours of pumping at an average rate of 168 gallons per minute.

HYDRAULIC TESTING OF HOLE HTH-1

Well History

Hole HTH-1, at N. 1,411,442.75 ft and E. 629,720.11 ft, Nevada coordinate system, central zone, Nye County, Nevada, was spudded in on June 28, 1967, and had reached a depth of 3,704 feet when released to the Hydrologic Task Force for hydraulic testing and sampling on July 24, 1967. Its casing record is as follows:

13 $\frac{3}{8}$ -inch OD to 52 feet (cemented)

9 $\frac{5}{8}$ -inch OD to 3,704 feet (cemented)

Cement plug inside 9 $\frac{5}{8}$ -inch casing from 3,695 to 3,704 feet.

The casing and cement were shot perforated with two shots per foot in 12 zones. These zones are identified as the tested intervals.

Lithologic Log

The following lithologic log for hole HTH-1 is from D. L. Hoover, U.S. Geological Survey.

Elevation: 6,010.8 feet

Footage (in feet)	Rock type
0 - 2,390	Alluvium
2,390 - 2,468	Densely welded tuff
2,468 - 3,704	Tuffaceous sediments

Composite Hydrostatic Head

The composite hydrostatic head was measured with the deep-well measuring device ("iron horse") on July 28, 1967. The water level was 553 feet below land-surface datum.

Intervals Tested and Sampled

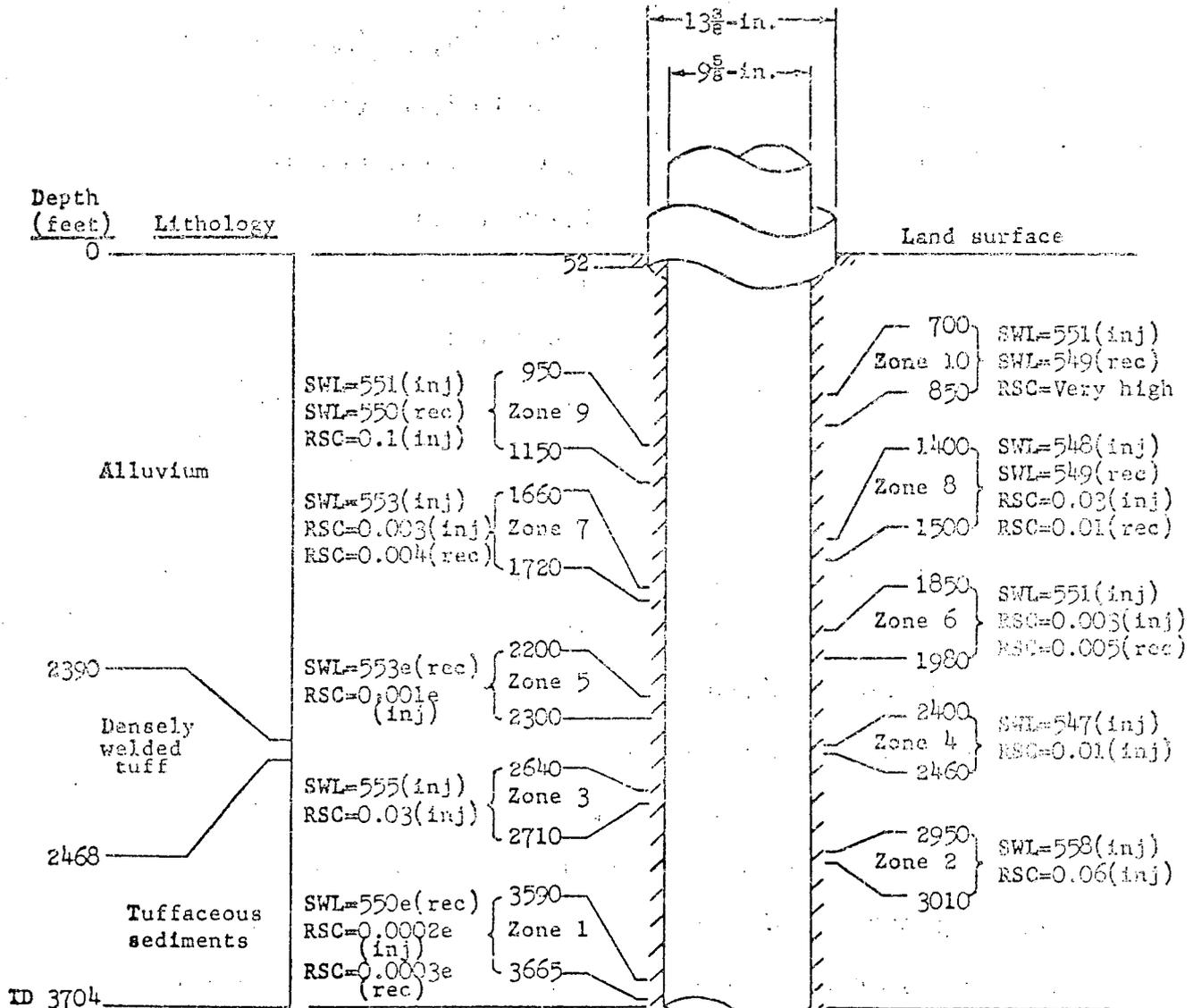
<u>Zone</u>	<u>Depth (feet)</u>
1	3,590 to 3,665
2	2,950 to 3,010 (sampled)
3	2,640 to 2,710 (sampled)
4	2,400 to 2,460 (sampled)
5	2,200 to 2,300
6	1,850 to 1,980
7	1,660 to 1,720
8	1,400 to 1,500 (sampled)
9	950 to 1,150 (sampled)
10	700 to 850 (sampled)
11 (above water)	355 to 510
12 (above water)	150 to 345

These intervals and a generalized summary of hydrology, lithology, and construction are presented in figure 26.

Tracejector Study

Results of the static-condition tracejector study indicate that zone 4 (2,400 to 2,460 feet), in densely welded tuff, is probably a zone of primarily lateral flow. However, there is potential for vertical flow from zone 4 both upward into the alluvium and downward into tuffaceous sediments. During the study, flow from zone 4 was upward at a rate of more than 3 gpm and downward at a rate of more than 4 gpm.

Composite water level = 553 feet below lsd.



/// Cemented areas. Tested intervals are shot perforated.

e Estimated.

SWL Static water level, in feet below land-surface datum.

RSC Relative specific capacity, in gallons per minute per foot of drawdown.

Figure 26.--Hydrology and lithology in hole NTH-1.

Major water-contributing zones generally indicate zones of highest permeability in the borehole. However, since the casing is perforated in only the most permeable zones of hole NTH-1, as inferred by geophysical logs, the dynamic-condition tracejector study while pumping indicates merely proportionate contributions from the most permeable zones (fig. 27). Of significance, however, is the lack of flow from zones 1 and 6 during the dynamic study. This condition indicates that zones 1 and 6 are probably less permeable than some of the other zones.

Zone 1, 3,590 to 3,665 feet

The movement of the water level during both injection and recovery was very slow; therefore, the static level was estimated by adding water to the tubing after swabbing and observing the reaction. By this means, the static level was determined to be about 550 feet below lsd. Relative specific capacity was computed from both injection and recovery data; however, sand was flowing into the hole and the ports of the tool may have been at least partially plugged. Therefore, the figures for relative specific capacity might be low.

Relative specific capacity calculated using the time interval from the 4th to the 5th minute of the injection test data (fig. 28) follows:

$$\text{Head loss} = 164.03 - 163.54 = 0.49 \text{ feet per minute}$$

$$Q = (0.162)(0.49) = 0.079 \text{ gallons per minute}$$

$$\text{Drawdown} = 550 - 150.87 = 399.13 \text{ feet}$$

$$\text{Relative specific capacity} = 0.079/399.13 = 0.0002 \text{ gpm per foot}$$

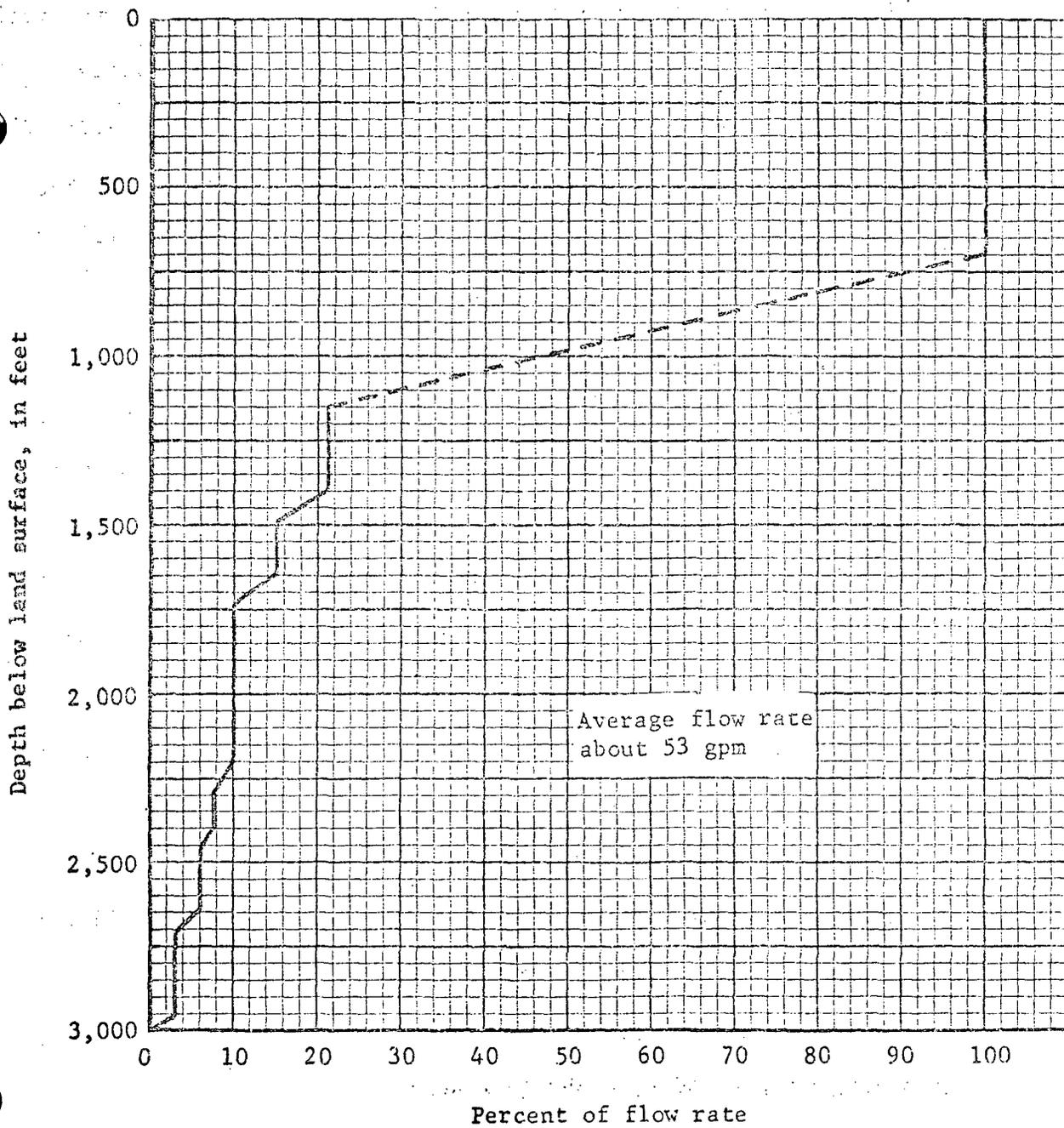


Figure 27.--Tracejector survey of hole HTH-1, Hot Creek Valley, Nevada, while pumping.

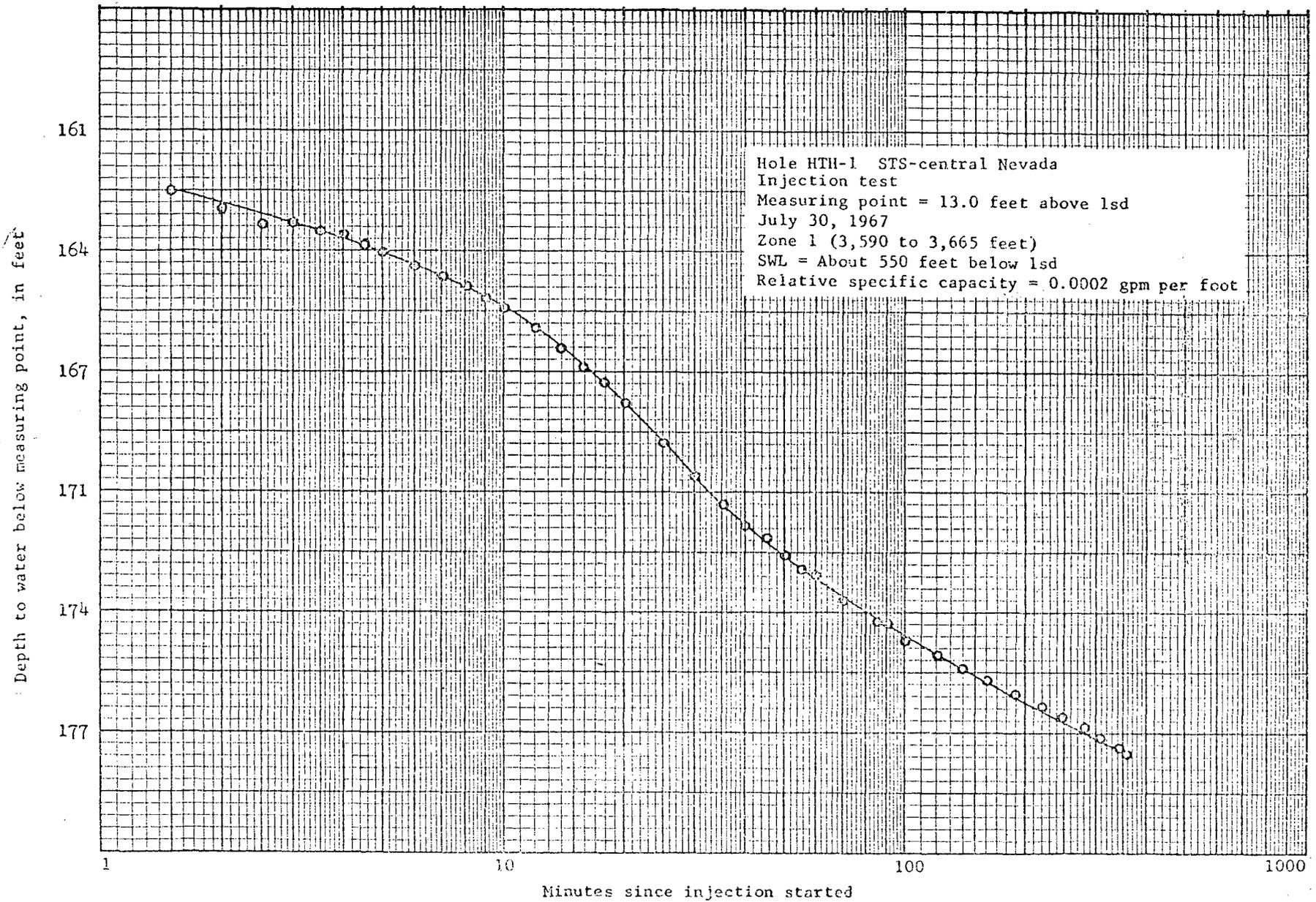


Figure 28.--Injection test of zone 1 (3,590 to 3,665 feet), hole HTH-1, STS-central Nevada, July 30, 1967.

Relative specific capacity calculated using the time interval from the 9th to the 10th minute of the recovery test data (fig. 29) follows:

$$\text{Head loss} = 1,380.5 - 1,378.8 = 1.7 \text{ feet per minute}$$

$$Q = (0.162)(1.7) = 0.28 \text{ gallons per minute}$$

$$\text{Drawdown} = 1,366.6 - 550 = 816.6 \text{ feet}$$

$$\text{Relative specific capacity} = 0.28/816.6 = 0.0003 \text{ gpm per foot}$$

Zone 2, 2,950 to 3,010 feet

The static water level after injection was 558 feet below lsd.

Relative specific capacity was computed from injection data. Recovery data were not used because of suspected sanding problems after swabbing.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection test data (fig. 30) follows:

$$\text{Head loss} = 557.34 - 552.16 = 5.18 \text{ feet per minute}$$

$$Q = (0.162)(5.18) = 0.84 \text{ gallons per minute}$$

$$\text{Drawdown} = 558 - 542.74 = 15.26 \text{ feet}$$

$$\text{Relative specific capacity} = 0.84/15.26 = 0.06 \text{ gpm per foot}$$

Zone 3, 2,640 to 2,710 feet

The static water level after injection was 555 feet below lsd.

Relative specific capacity was computed from injection data. Recovery data were not used because of suspected sanding problems after swabbing.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection test data (fig. 31) follows:

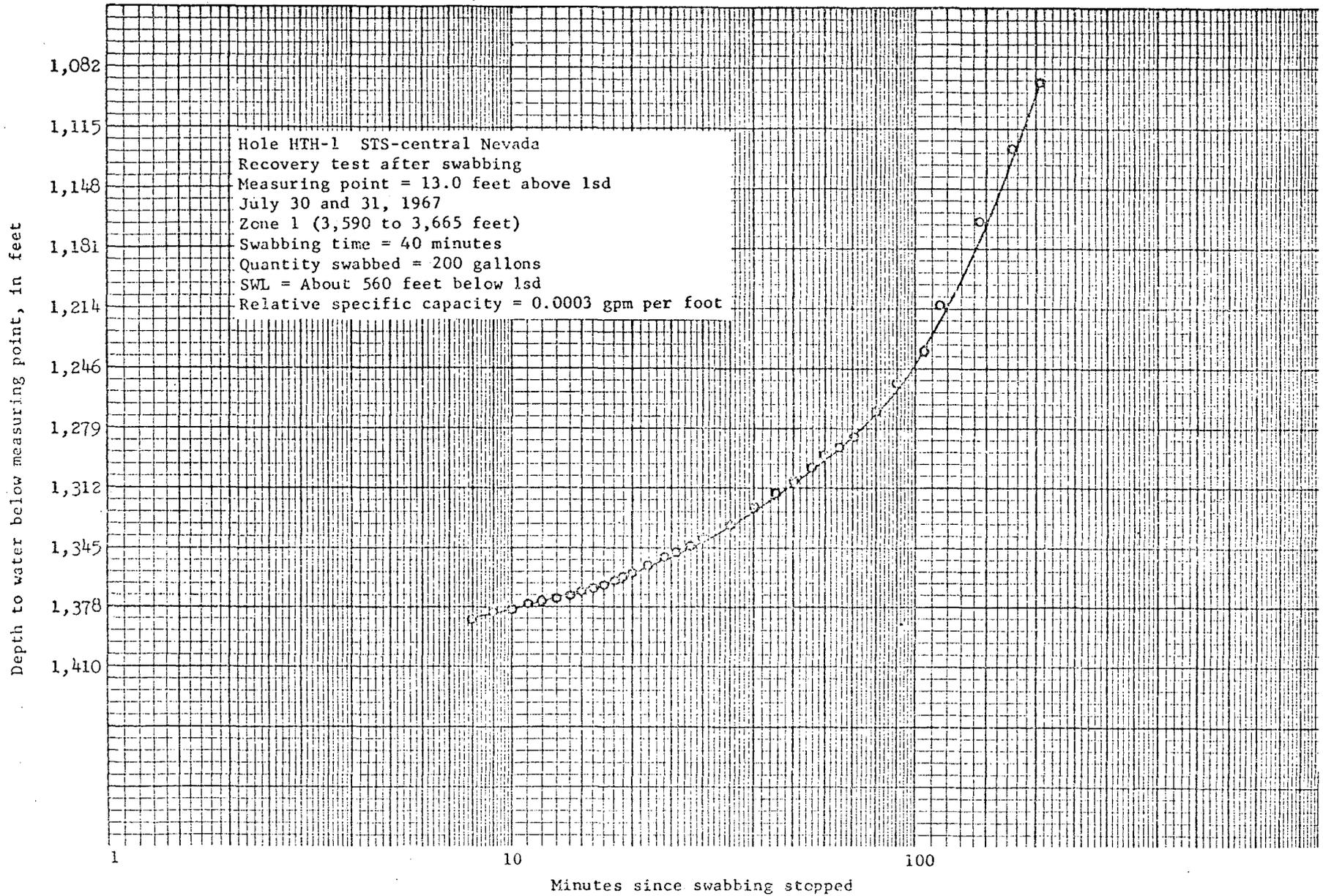


Figure 29.--Swab test of zone 1 (3,590 to 3,665 feet), hole HTH-1, STS-central Nevada, July 30 and 31, 1967.

Depth to water below measuring point, in feet

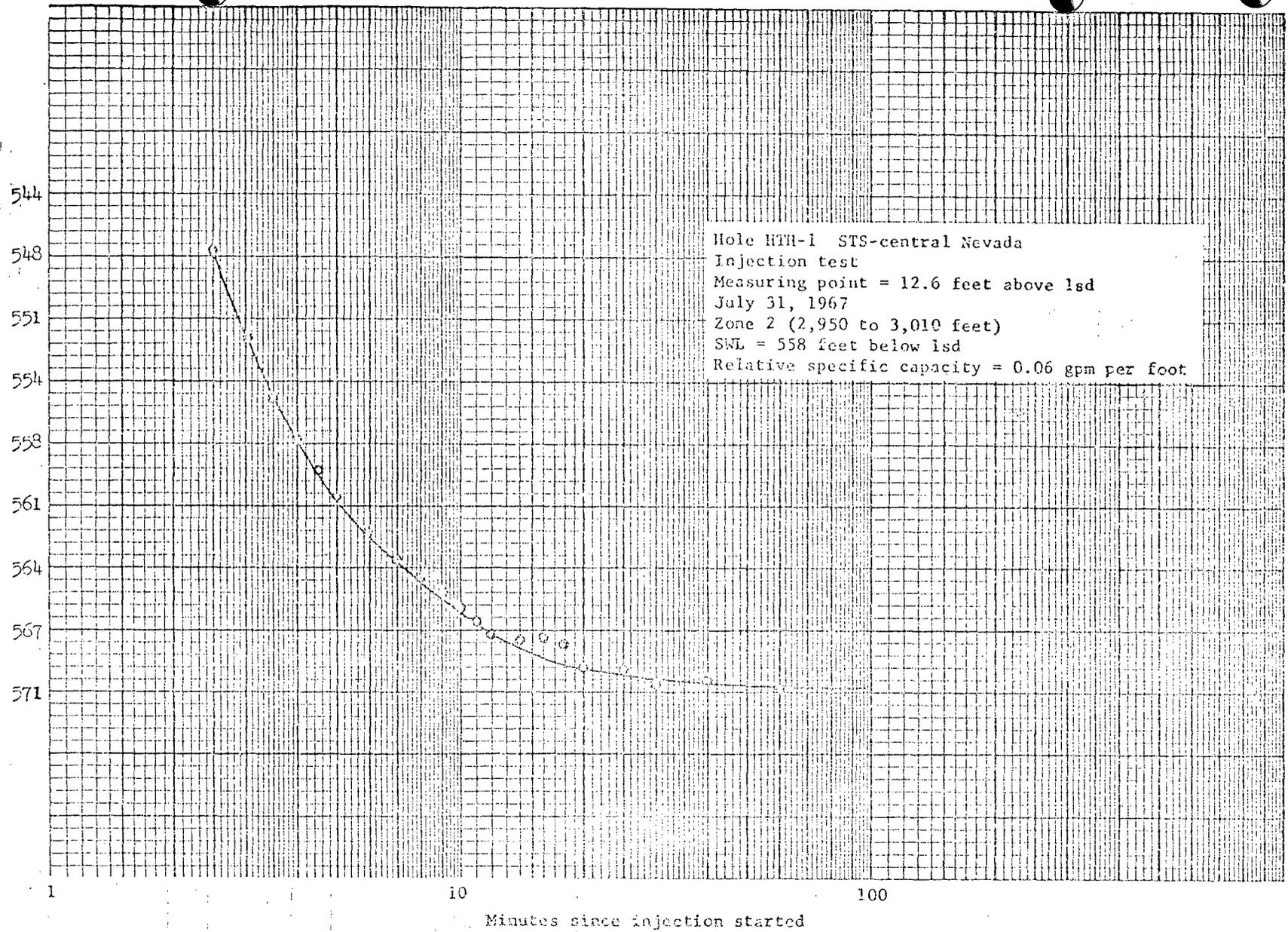


Figure 30.--Injection test of zone 2 (2,950 to 3,010 feet), hole NTH-1, STS-central Nevada, July 31, 1967.

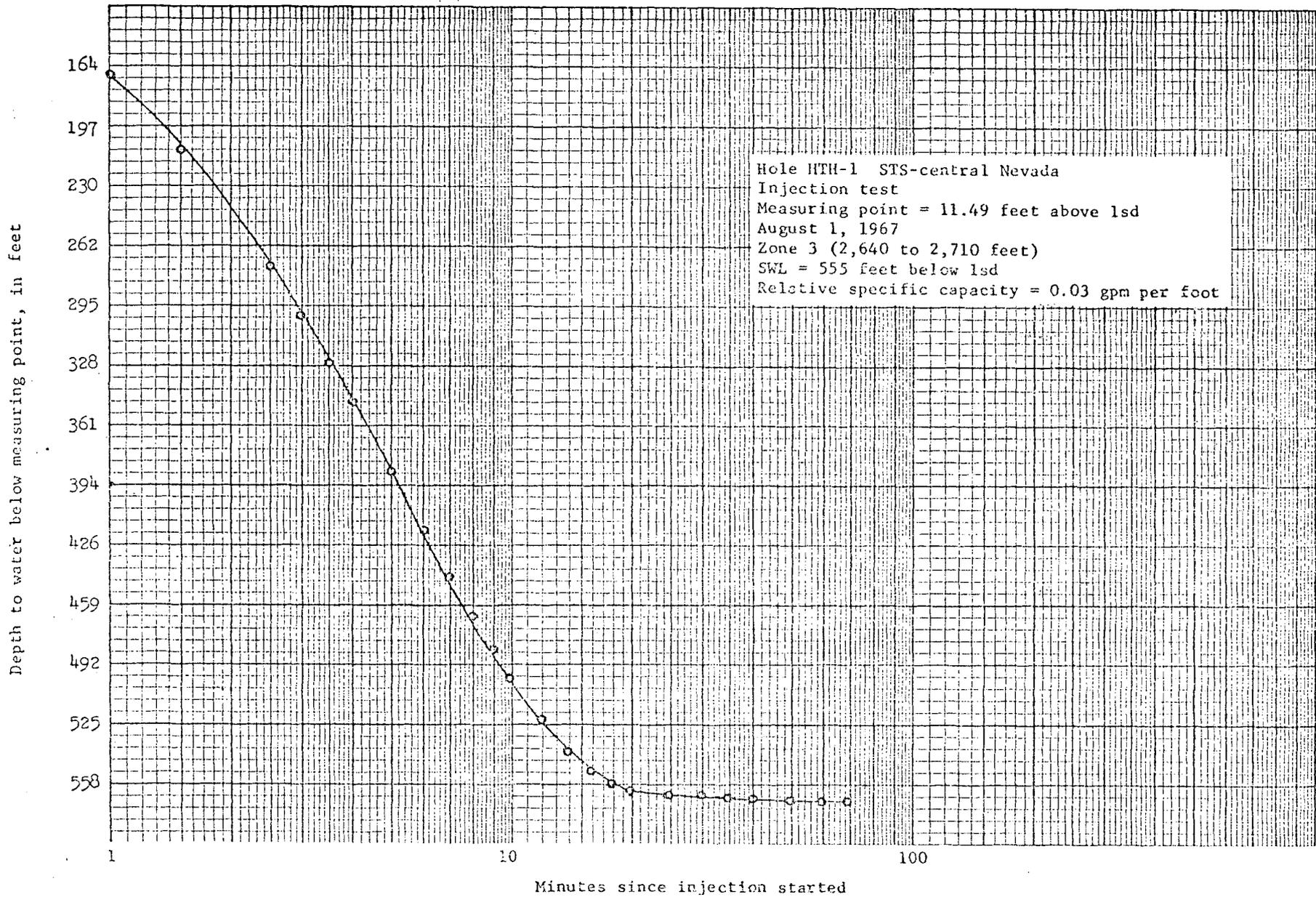


Figure 31.--Injection test of zone 3 (2,640 to 2,710 feet), hole HTH-1, STS-central Nevada, August 1, 1967.

Head loss = $348.2 - 300.6 = 47.6$ feet per minute

$Q = (0.162)(47.6) = 7.7$ gallons per minute

Drawdown = $555 - 315.7 = 239.3$ feet

Relative specific capacity = $7.7/239.3 = 0.03$ gpm per foot

Zone 4, 2,400 to 2,460 feet

Static water level after injection was 547 feet below lsd. Relative specific capacity was computed from injection data. Recovery data were not used because of suspected sanding problems after swabbing.

Relative specific capacity calculated using the time interval from the 4th to the 5th minute of the injection test data (fig. 32) follows:

Head loss = $184.3 - 157.1 = 27.2$ feet per minute

$Q = (0.162)(27.2) = 4.4$ gallons per minute

Drawdown = $547 - 157.9 = 389.1$ feet

Relative specific capacity = $4.4/389.1 = 0.01$ gpm per foot

Zone 5, 2,200 to 2,300 feet

The movement of the water level was very slow during both injection and recovery; therefore, the static level was estimated by adding water to the tubing during recovery after swabbing and observing the movement. By this means, the static level was determined to be about 550 feet below lsd. Relative specific capacity was computed from injection data.

Relative specific capacity calculated using the time interval from the 4th to the 5th minute of the injection test data (fig. 33) follows:

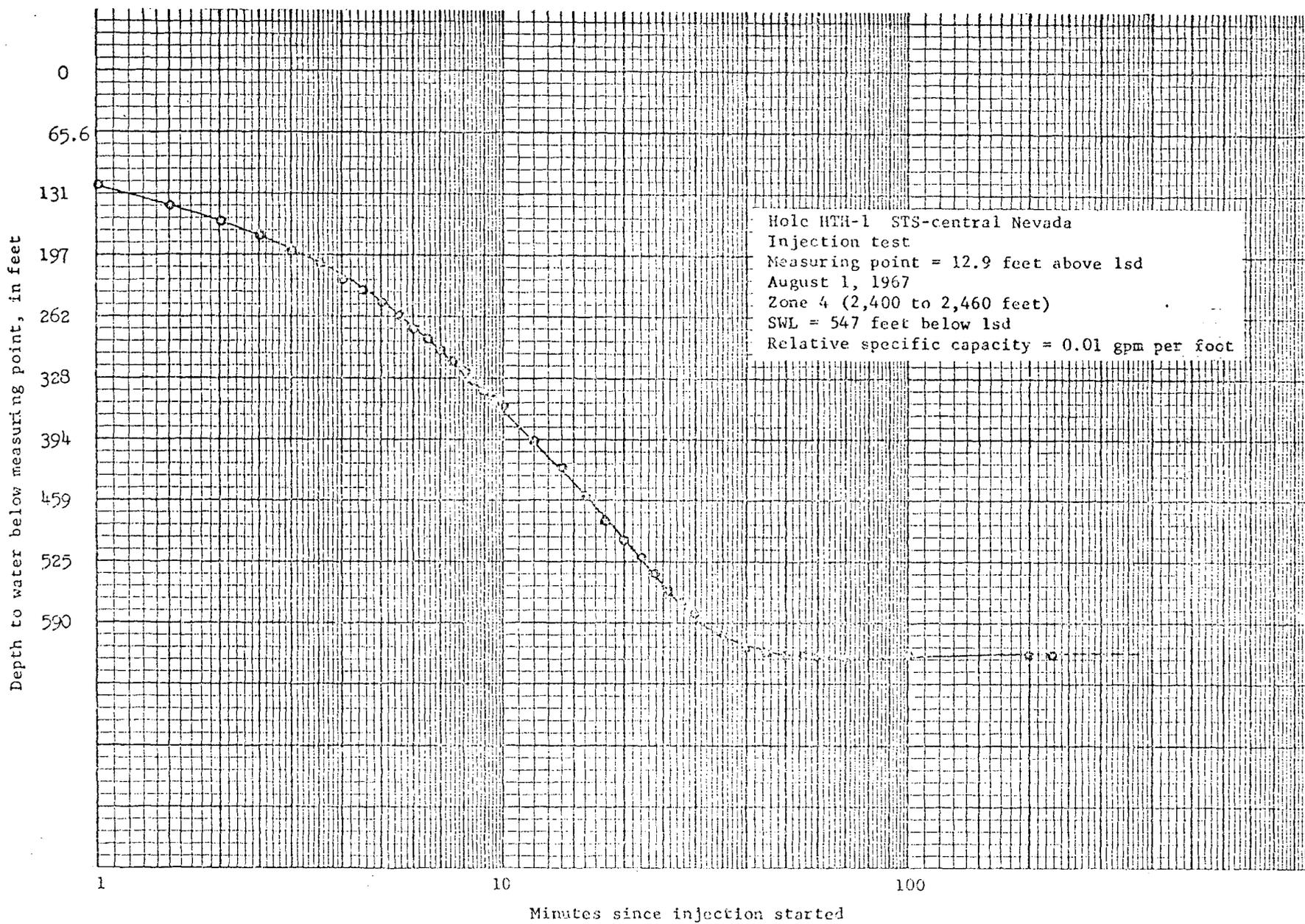


Figure 32.--Injection test of zone 4 (2,400 to 2,460 feet), hole HTH-1, STS-central Nevada, August 1, 1967.

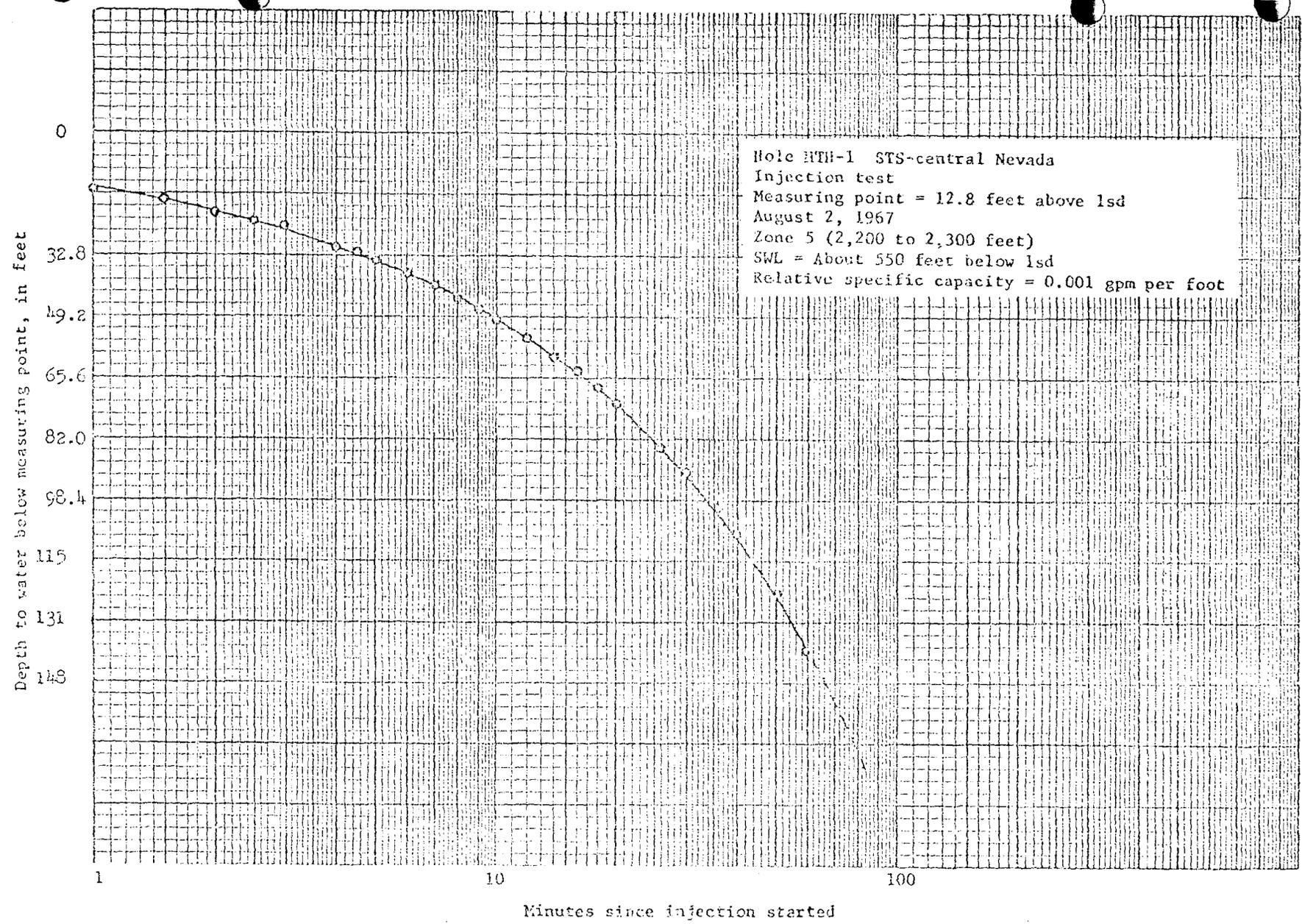


Figure 33.--Injection test of zone 5 (2,200 to 2,300 feet), hole NTH-1, STS-central Nevada, August 2, 1967.

Head loss = $33.88 - 29.98 = 3.90$ feet per minute

$Q = (0.162)(3.9) = 0.63$ gallons per minute

Drawdown = $550 - 19.21 = 530.79$ feet

Relative specific capacity = $0.63/530.79 = 0.001$ gpm per foot

Zone 6, 1,850 to 1,980 feet

The static water level, determined from projection of the injection-test data graph, was 551 feet below lsd. Relative specific capacity was computed from both injection and recovery data.

Relative specific capacity calculated using the time interval from the 7th to the 8th minute of the injection test data (fig. 34) follows:

Head loss = $94.14 - 84.79 = 9.35$ feet per minute

$Q = (0.162)(9.35) = 1.51$ gallons per minute

Drawdown = $551 - 76.58 = 474.4$ feet

Relative specific capacity = $1.51/474.4 = 0.003$ gpm per foot

Relative specific capacity calculated using the time interval from the 7th to the 8th minute of the recovery test data (fig. 35) follows:

Head loss = $1,558 - 1,530 = 28$ feet per minute

$Q = (0.162)(28) = 4.5$ gallons per minute

Drawdown = $1,532 - 551 = 981$ feet

Relative specific capacity = $4.5/981 = 0.005$ gpm per foot

Zone 7, 1,660 to 1,720 feet

The static water level, determined from projection of the injection-test data graph, was 553 feet below lsd. Relative specific capacity was computed from both injection and recovery data.

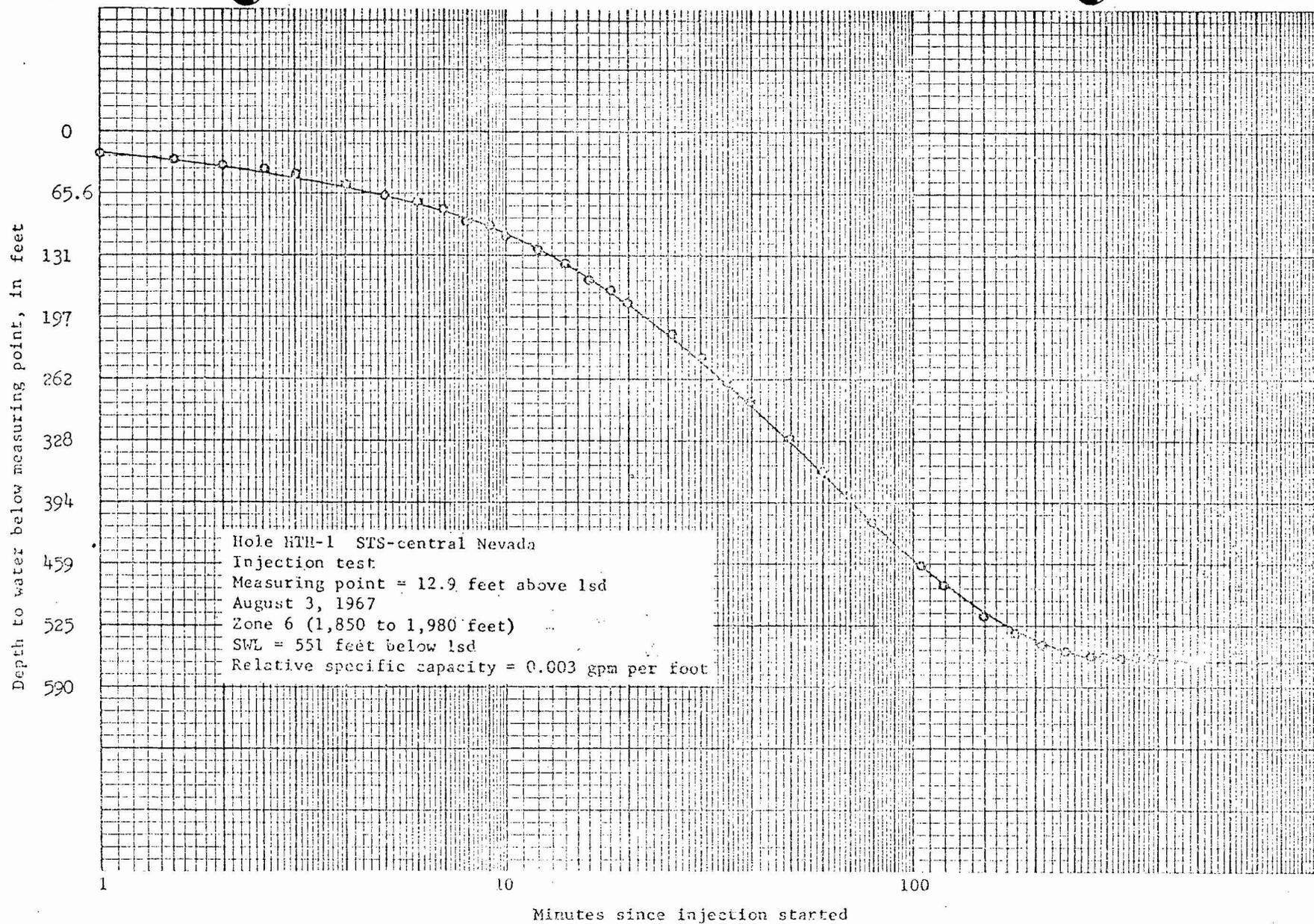


Figure 34.--Injection test of zone 6 (1,850 to 1,980 feet), hole HTH-1, STS-central Nevada, August 3, 1967.

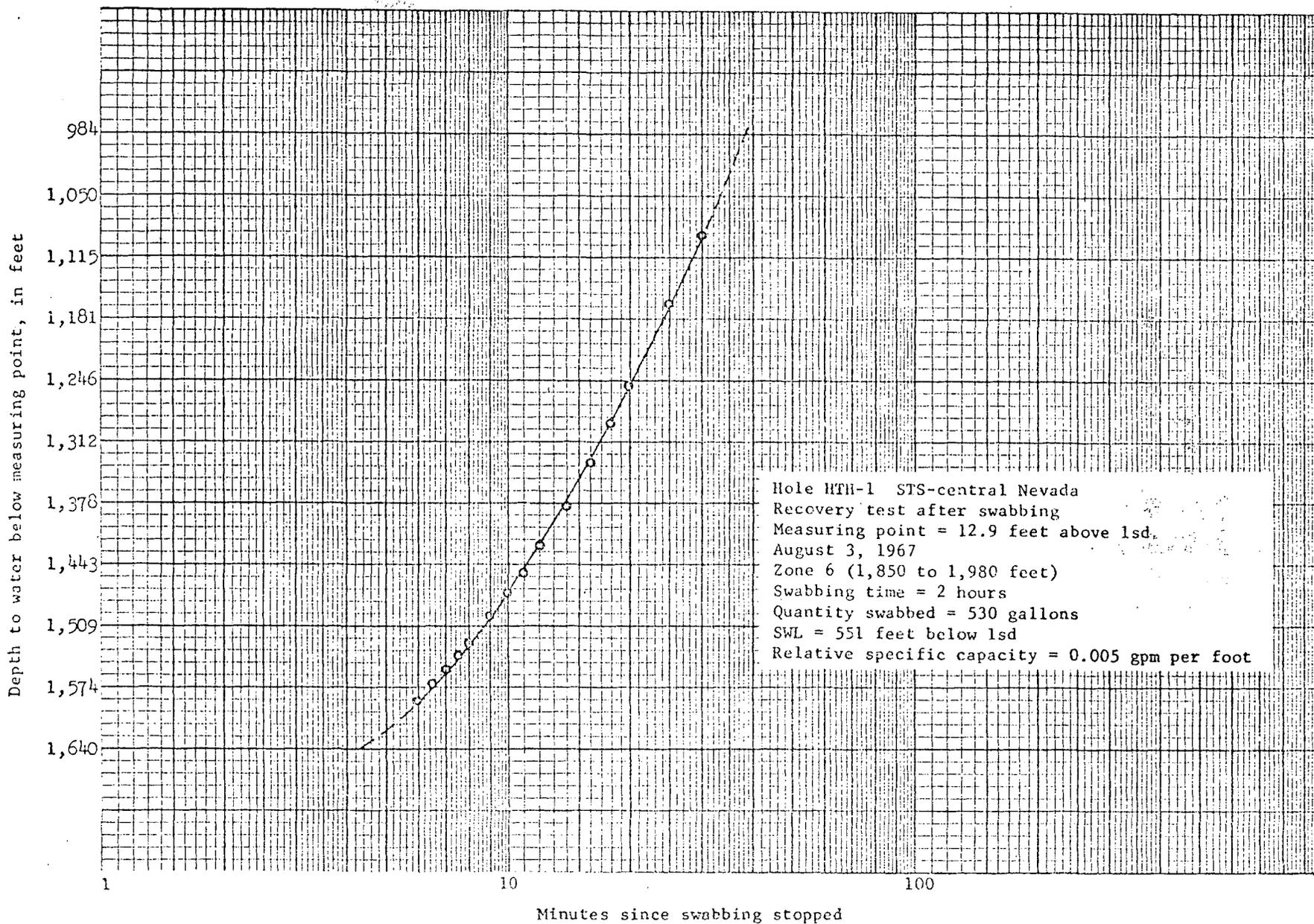


Figure 35.--Swab test of zone 6 (1,850 to 1,980 feet), hole HTH-1, STS-central Nevada, August 3, 1967.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection test data (fig. 36) follows:

$$\text{Head loss} = 49.86 - 40.41 = 9.45 \text{ feet per minute}$$

$$Q = (0.162)(9.45) = 1.53 \text{ gallons per minute}$$

$$\text{Drawdown} = 553 - 31.63 = 521.4 \text{ feet}$$

$$\text{Relative specific capacity} = 1.53/521.4 = 0.003 \text{ gpm per foot}$$

Relative specific capacity calculated using the time interval from the 6th to the 7th minute of the recovery test data (fig. 37) follows:

$$\text{Head loss} = 1,402.6 - 1,379.8 = 22.8 \text{ feet per minute}$$

$$Q = (0.162)(22.8) = 3.69 \text{ gallons per minute}$$

$$\text{Drawdown} = 1,377.6 - 553 = 824.6 \text{ feet}$$

$$\text{Relative specific capacity} = 3.69/824.6 = 0.004 \text{ gpm per foot}$$

Zone 8, 1,400 to 1,500 feet

Static water level was 548 feet below lsd after injection and was 549 feet below lsd after recovery from swabbing. Relative specific capacity was computed from both injection and recovery data.

Relative specific capacity calculated using the time interval from the 4th to the 5th minute of the injection test data (fig. 38) follows:

$$\text{Head loss} = 325.7 - 283.2 = 42.5 \text{ feet per minute}$$

$$Q = (0.162)(42.5) = 6.88 \text{ gallons per minute}$$

$$\text{Drawdown} = 548 - 289.8 = 258.2 \text{ feet}$$

$$\text{Relative specific capacity} = 6.88/258.2 = 0.03 \text{ gpm per foot}$$

Relative specific capacity calculated using the time interval from the 7th to the 8th minute of the recovery test data (fig. 39) follows:

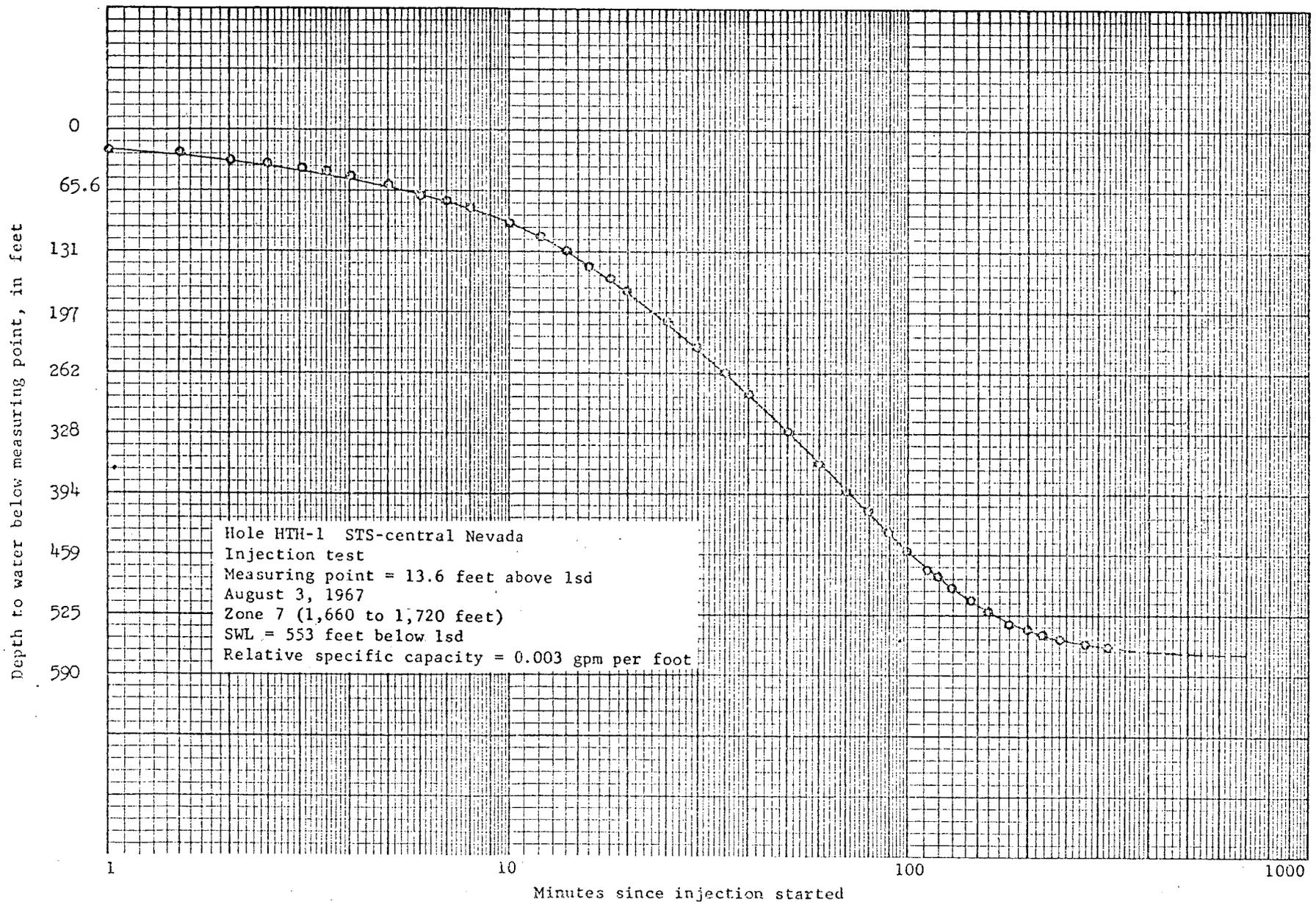


Figure 36.--Injection test of zone 7 (1,660 to 1,720 feet), hole HTH-1, STS-central Nevada, August 3, 1967.

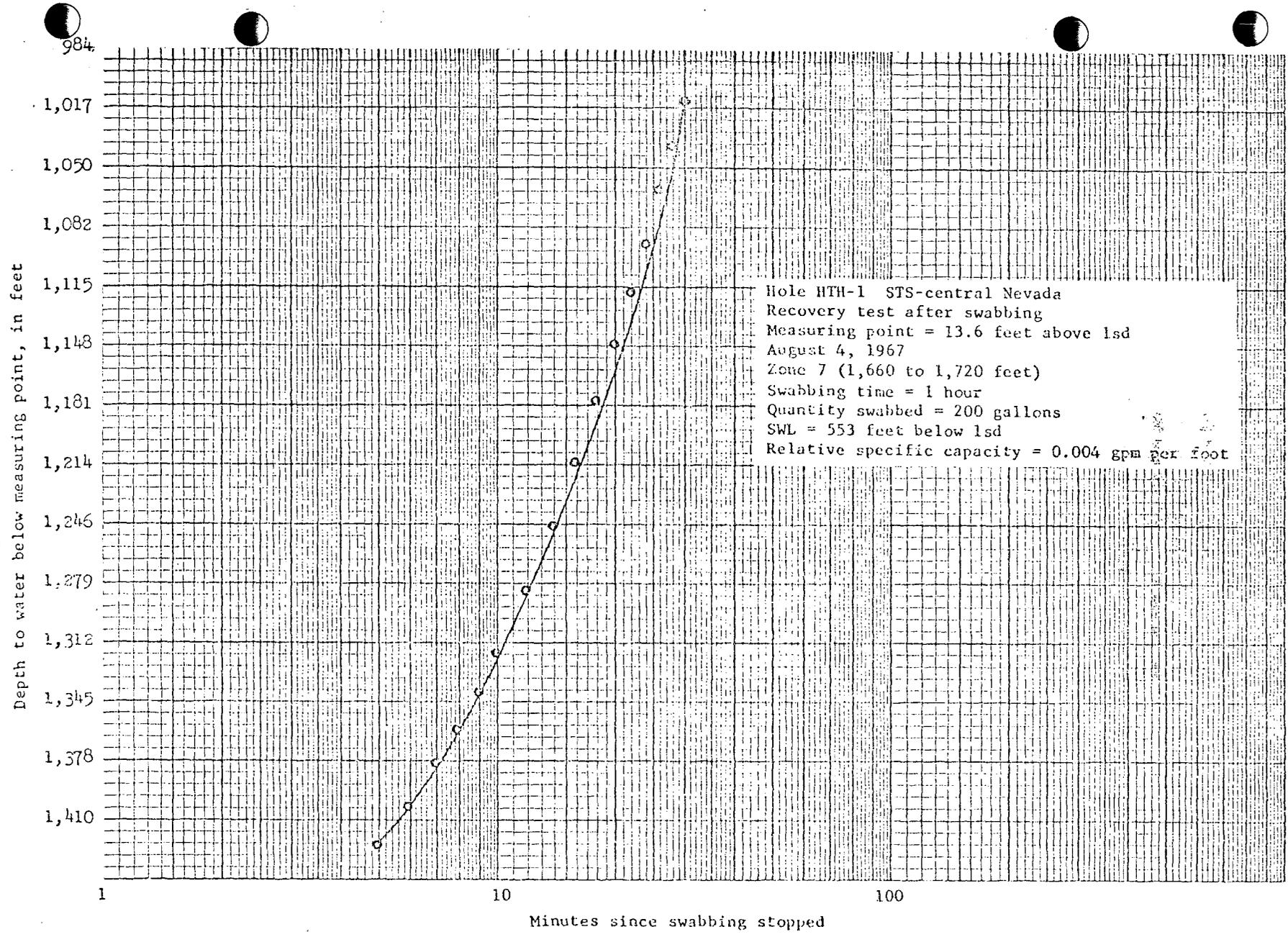


Figure 37.--Swab test of zone 7 (1,660 to 1,720 feet), hole HTH-1, STS-central Nevada, August 4, 1967.

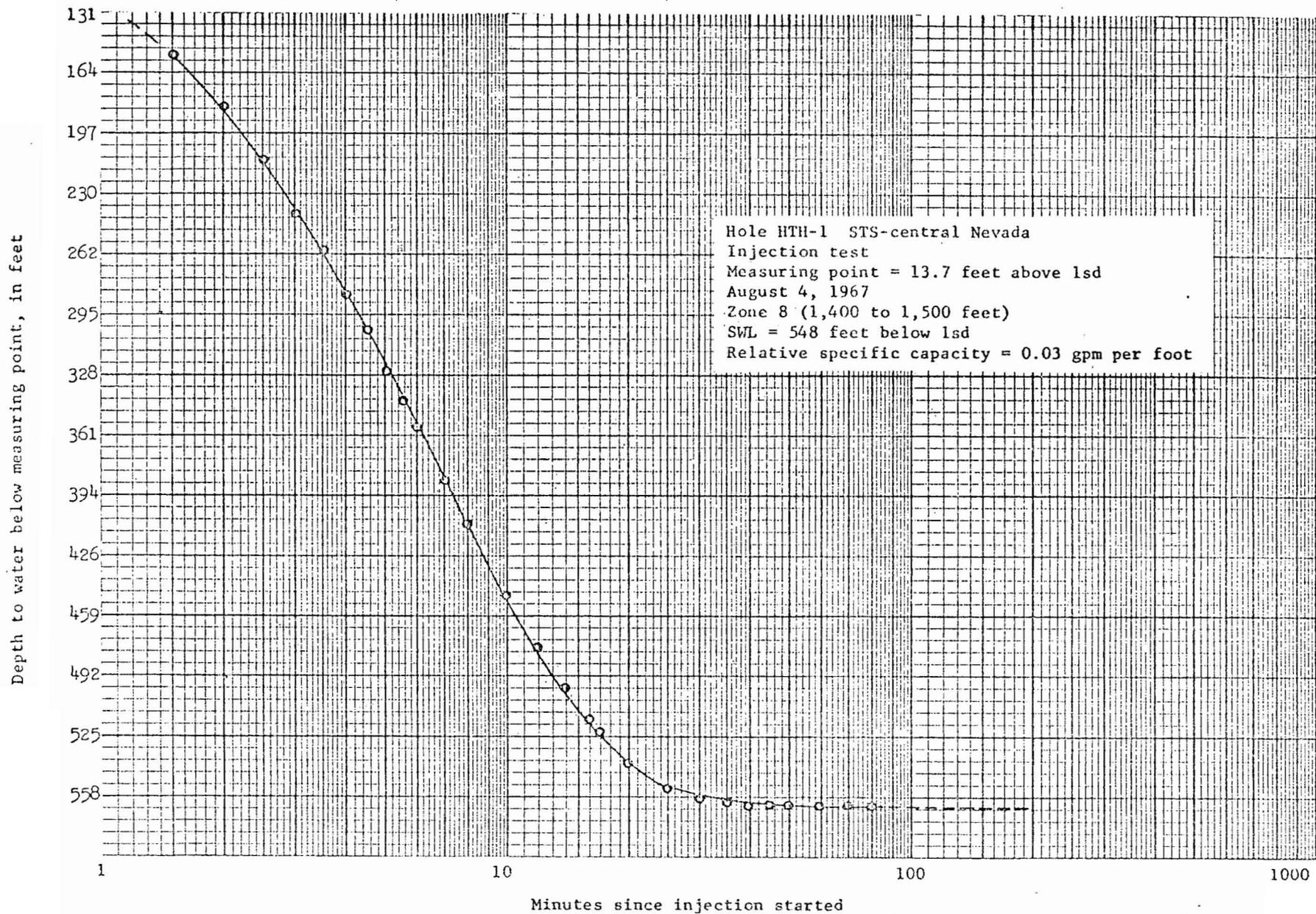


Figure 38.--Injection test of zone 8 (1,400 to 1,500 feet), hole HTH-1, STS-central Nevada, August 4, 1967.

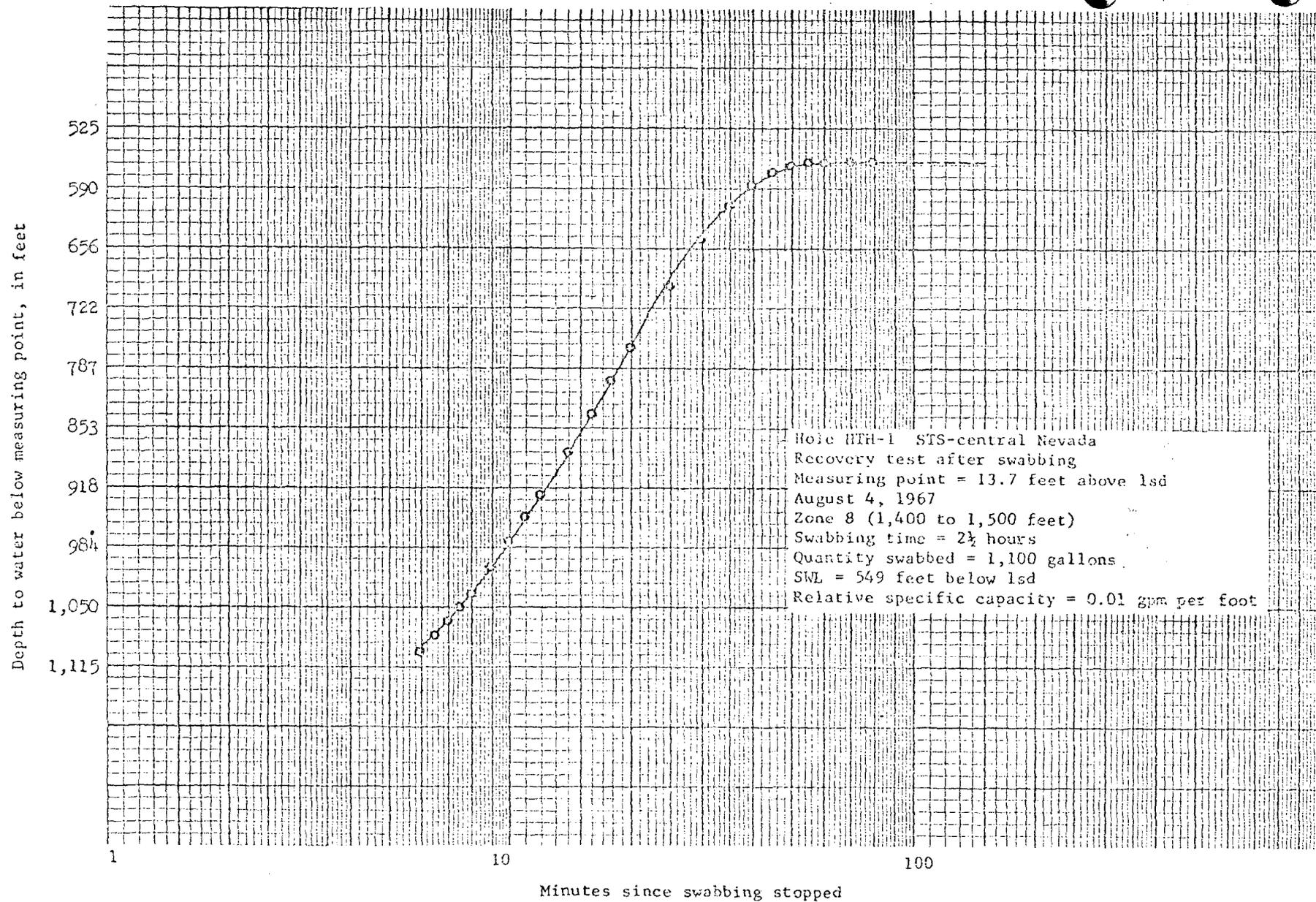


Figure 39.--Swab test of zone 8 (1,400 to 1,500 feet), hole HTH-1, STS-central Nevada, August 4, 1967.

Head loss = $1,064.5 - 1,035.4 = 29.1$ feet per minute

$Q = (0.162)(29.1) = 4.71$ gallons per minute

Drawdown = $1,036.3 - 549 = 487.3$ feet

Relative specific capacity = $4.71/487.3 = 0.01$ gpm per foot

Zone 9, 950 to 1,150 feet

Static water level was 551 feet below lsd after injection and was 550 feet below lsd after recovery from swabbing. Relative specific capacity was computed only from injection data because the first recovery measurements after swabbing were not reliable.

Relative specific capacity calculated using the time interval from the 5th to the 6th minute of the injection test data (fig. 40) follows:

Head loss = $550.4 - 537.1 = 13.3$ feet per minute

$Q = (0.162)(13.3) = 2.15$ gallons per minute

Drawdown = $551 - 532.1 = 18.9$ feet

Relative specific capacity = $2.15/18.9 = 0.1$ gpm per foot

Zone 10, 700 to 850 feet

Static water level was 551 feet below lsd after injection and was 549 feet below lsd after recovery from swabbing. The movement of the water level during both injection and recovery was so fast that measurements were not accurate; therefore, relative specific capacity could not be computed. There was some difficulty with the water-level measuring device. The difference between static levels after injection and after recovery is probably due to measurement errors.

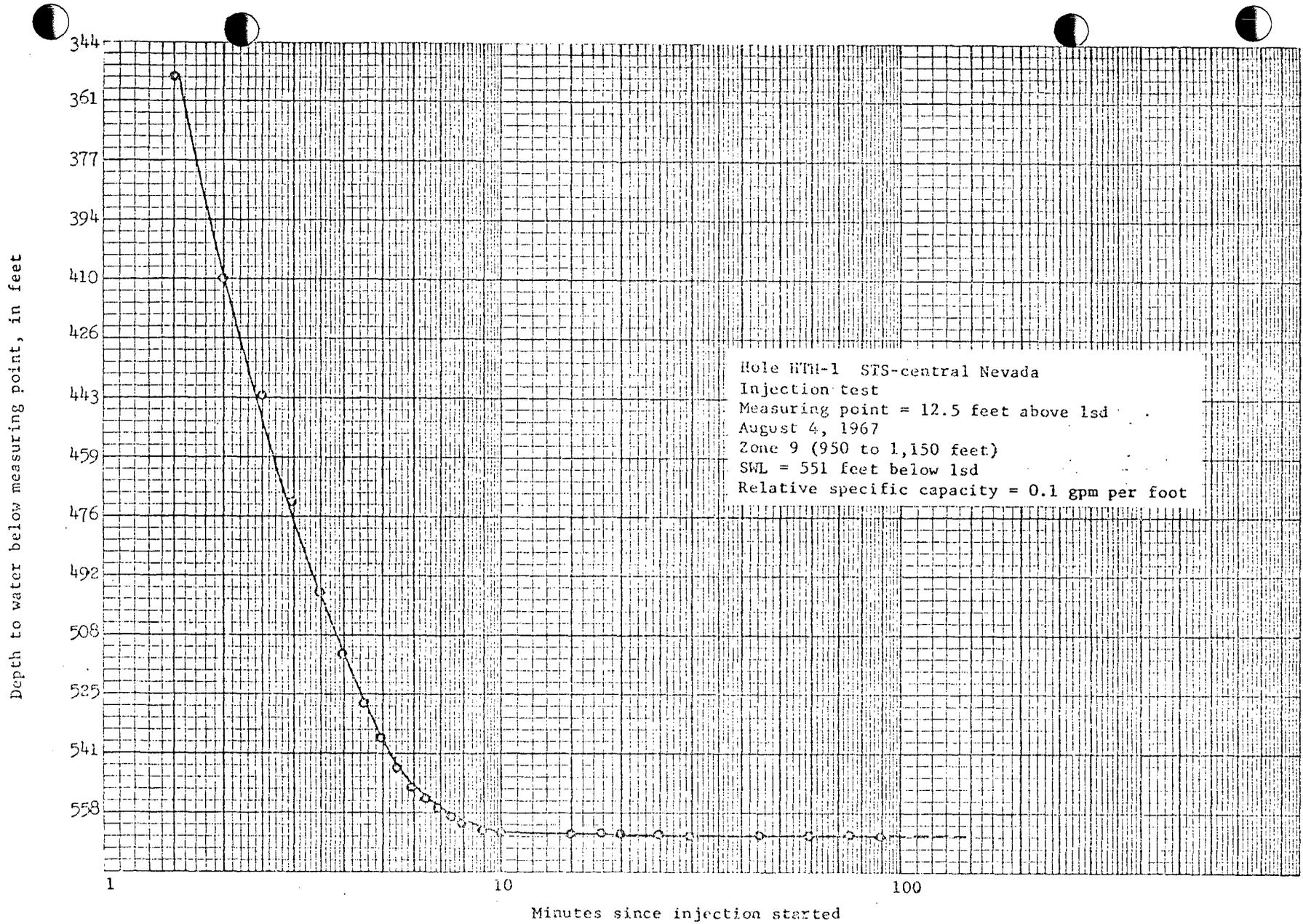


Figure 40.--Injection test of zone 9 (950 to 1,150 feet), hole HTH-1, STS-central Nevada, August 4, 1967.

Table 4.--Summary of hydraulic tests in hole HTH-1
(e Estimated.)

Zone		1	2	3	4	5	6	7	8	9	10	Units
Tested interval		3,590 to 3,665	2,950 to 3,010	2,640 to 2,710	2,400 to 2,460	2,200 to 2,300	1,850 to 1,980	1,660 to 1,720	1,400 to 1,500	950 to 1,150	700 to 850	Feet
Static water level ^{1/}	Injec.	-	558	555	547	-	551	553	548	551	551	Feet below land-surface datum
	Recov.	e550	-	-	-	e550	-	-	549	550	549	Feet below land-surface datum
Relative specific capacity ^{2/}	Injec.	e0.0002 ^{3/}	0.06	0.03	0.01	e0.001	0.003	0.003	0.03	0.1	Very high	Gpm per foot of drawdown
	Recov.	e.0003 ^{3/}	-	-	-	-	.005	.004	.01	-	Very high	Gpm per foot of drawdown
Maximum water temperature		-	91	91	81	-	83	84	77	76	72	°F
Specific conductance		-	570	500	730	-	660	610	440	220	285	Micromhos per cm at 25°C
Packer communication	Top	No	No	No	No	No	No	No	No	No	No	--
	Bottom	No	No	Yes	No	No	No	No	No	No	No	--
Total water swabbed		200	3,400	7,700	1,550	300	530	200	1,100	5,300	875	Gallons

^{1/} Composite water level = 553 feet below lsd.

^{2/} Relative specific capacity is reported for the thickness of tested interval and not for 200-foot section.

^{3/} Ports may have been sanded in because sand was filling in hole badly.

Note: There is potential for flow from the alluvium-bedrock contact zone upward into the alluvium and downward into the tuffaceous sediments. However, the well is in an area of principally lateral flow. Specific capacity of the intervals 700 to 850 feet and 950 to 1,150 feet was 6.8 gallons per minute per foot of drawdown after 7 days of pumping at an average rate of 122 gallons per minute.

AQUIFER-PERFORMANCE TEST IN HOLES HTH-1 AND HTH-2

Physical Conditions

Hole HTH-1, the pumped well, was drilled to a depth of 3,704 feet and penetrated alluvium from 0 to 2,390 feet, densely welded tuff from 2,390 to 2,468 feet, and tuffaceous sediments from 2,468 to 3,704 feet. The well was cased and cemented throughout its entire depth, after which specific zones were shot perforated. The perforated zones were selected on the basis of greatest permeability as inferred by analysis of the geophysical logs. Isolated tests of hydraulic characteristics showed that zone 9 (from 950 to 1,150 feet) and zone 10 (from 700 to 850 feet) were the most permeable. These two zones are important because of contaminant movement. In order to concentrate the effects of the test within the zones of principal interest, these zones were isolated by use of a retrievable bridge packer. A pump was then installed above the packer.

Hole HTH-2, the observation well 500 feet from HTH-1, was drilled so that the effects of pumping HTH-1 could be observed and data could be analyzed. Drilled to a depth of 1,000 feet, it penetrated alluvium. The well was cased with blank casing from 0 to about 500 feet and with slotted casing from about 500 feet to 1,000 feet.

Purpose of the Test

This aquifer-performance test was deemed necessary to determine transmissivity, field coefficient of storage, and rate of ground-water and contaminant movement.

Type of Test and Conditions

The aquifer performance test consisted of pumping well HTH-1 for a period of 10,008 minutes and measuring water-level changes in wells HTH-1 and HTH-2 during both pumping and recovery after pumping. The conditions of the test were variable drawdown, with time, at a constant discharge. The average pumping rate was 122 gallons per minute. Some difficulties arose toward the end of the test when the rate of discharge fluctuated slightly. The fluctuation was particularly critical because the maximum drawdown in HTH-2 was only 0.56 foot.

Analysis of Aquifer-Test Data

Preliminary analysis of the test data indicated that a mathematical treatment concerned with leaky artesian conditions would be the best means of evaluating the data. Results of this treatment are presented on figure 41.

Equations applied to leaky-artesian conditions (Walton, 1962) are as follows:

$$T = 114.6QW(u, r/B)/s \quad \text{and}$$
$$u = 2693r^2 S/Tt, \quad \text{or} \quad S = Tut/2693r^2$$

where:

s = drawdown in observation well, in feet

r = distance from pumped well to observation well, in feet

Q = discharge, in gallons per minute

t = time after pumping started, in minutes

T = coefficient of transmissivity, in gallons per day per foot

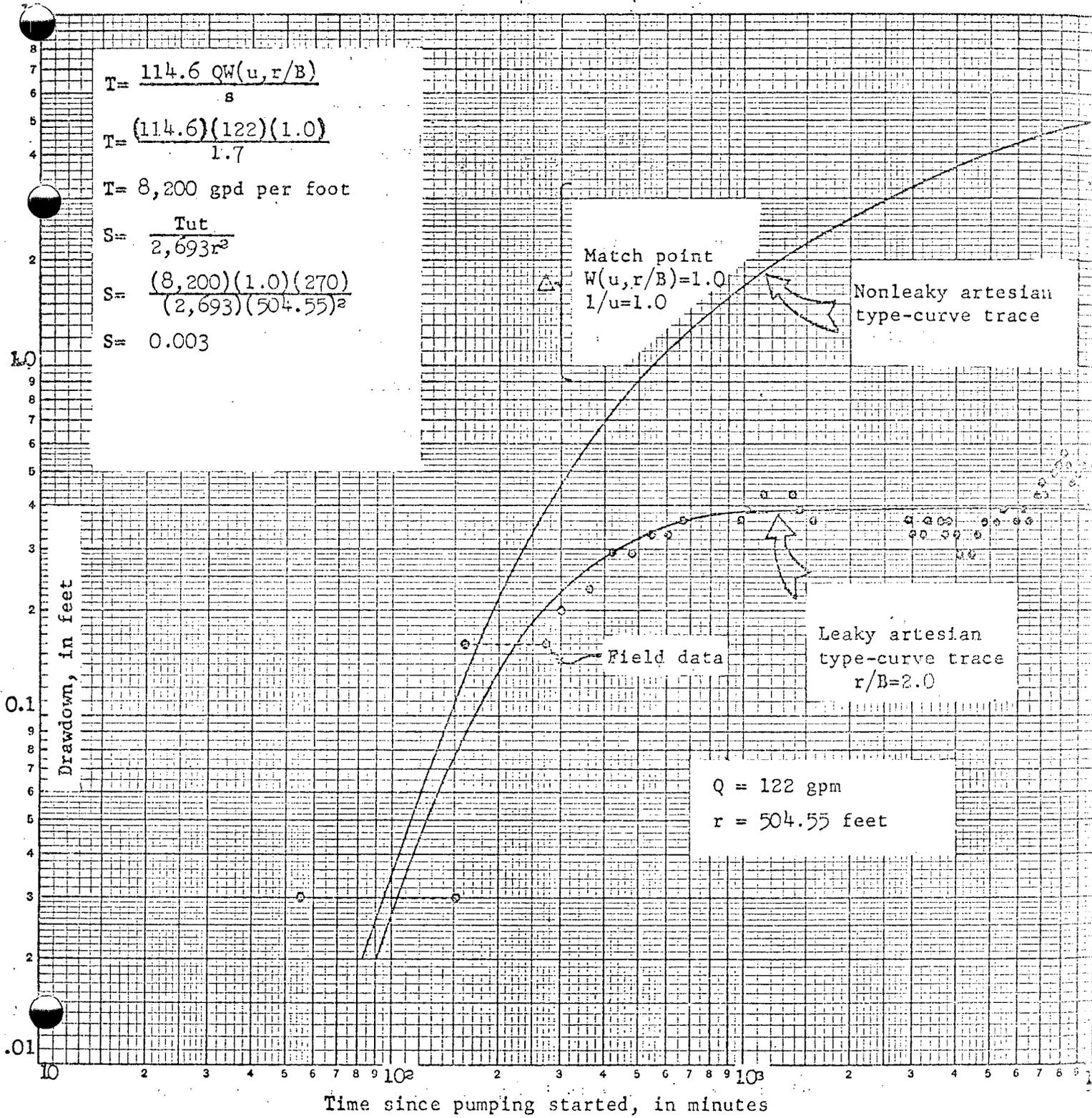


Figure 41.--Time-drawdown graph for observation well HTH-2, STS-central Nevada.

S = coefficient of storage of aquifer

W(u,r/B) = well function for leaky artesian aquifers

where:

$$r/B = r/\sqrt{T/(P'/m')}$$

P' = coefficient of permeability of confining bed, in gallons per day per square foot

m' = thickness of confining bed through which leakage occurs, in feet.

When the equations are applied to the drawdown data from HTH-2, the observation well, the transmissivity of the aquifer is 8,200 gpd per foot and the coefficient of storage of the aquifer is 3×10^{-3} . Converting transmissivity to a field coefficient of permeability (P_f) is simply a matter of dividing the transmissivity (T) by the aquifer thickness (m):

$$P_f = \frac{T}{m}$$

However, the complexity of the hydraulic system tested through the hydrologic test holes results in a range of values for aquifer thickness from the combined thickness of the most permeable beds (zones 9 and 10 in HTH-1) to the entire saturated thickness from the static water level to the bottom of zone 9 in HTH-1. Therefore, this range in aquifer thickness (350 to 597 feet) results in a range of field coefficient of permeability from 14 to 23 gpd per square foot:

$$P_f = \frac{T}{m} = \frac{8,200}{350} = 23 \text{ gpd per square foot}$$

and

$$P_f = \frac{T}{m} = \frac{8,200}{597} = 14 \text{ gpd per square foot.}$$

Pore velocity of ground-water movement is computed from the following equation, using Darcy's Law:

$$v = \frac{P_f I}{7.48 \theta}$$

where:

v = velocity, in feet per day

I = hydraulic gradient

θ = effective porosity (fractional).

The hydraulic gradient was determined by using elevations of water levels in holes UCe-11, MTH-1, and UCe-17. The gradient is about 4 feet per 100 feet from northwest to southeast, toward the principal drainage in the area. Assuming an effective porosity of 20 percent, considered a reasonable estimate in the type of material tested, the range of velocity of ground-water movement downgradient would be from 0.4 to 0.6 feet per day.

$$v = \frac{P_f I}{7.48 \theta} = \frac{(14) (0.04)}{(7.48) (0.20)} = 0.4 \text{ foot per day}$$

$$v = \frac{P_f I}{7.48 \theta} = \frac{(23) (0.04)}{(7.48) (0.20)} = 0.6 \text{ foot per day.}$$

HYDRAULIC TESTING OF HOLE UGe-20

Well History

Hole UGe-20, at N. 1,399,868.46 ft and E. 628,092.75 ft, Nevada coordinate system, central zone, Nye County, Nevada, was spudded in on November 10, 1967, and had reached a depth of 5,306 feet when, because of unfavorable hole conditions, it was released to the Hydrologic Task Force for hydraulic testing and sampling on December 19, 1967. The hole was again released for hydraulic testing and sampling on December 31, 1967, at a total depth of 6,000 feet. Its casing record is as follows:

20-inch OD to 30 feet (cemented)

13 $\frac{3}{8}$ -inch OD to 536 feet (cemented)

9 $\frac{5}{8}$ -inch OD to 4,859 feet (cemented)

Lithologic Log

The following lithologic log for hole UGe-20 is from William Barnes, U.S. Geological Survey.

Elevation: 5,759 feet

Footage (in feet)	Rock type
0 - 3,320	Alluvium
3,320 - 3,347	Zeolitized slightly welded tuff
3,347 - 4,788	Indurated tuffaceous conglomerate
4,788 - 4,804	Zeolitized partly welded tuff
4,804 - 4,838	Zeolitized densely welded tuff
4,838 - 4,882	Partly welded tuff
4,882 - 6,000	Moderately to densely welded tuff

Composite Hydrostatic Head

The composite hydrostatic head was measured with the deep-well measuring device ("iron horse") during a lull in testing. The water level was 215 feet below lsd.

Intervals Tested and Sampled

<u>Zone</u>	<u>Depth (feet)</u>
1	4,859 to 5,306
2	5,179 to 5,306
3	5,050 to 5,306
4	4,928 to 5,046
5	4,859 to 4,928
6	5,330 to 6,000
7	5,900 to 6,000
8	5,510 to 6,000
9	5,330 to 6,000
10	4,990 to 5,050
11	5,050 to 5,110
12	5,420 to 5,480 (sampled)
13	700 to 720
14	2,200 to 2,220

These intervals and a generalized summary of hydrology, lithology, and construction are presented in figure 42 and table 5.

Tracejector Study

A tracejector study under static conditions indicates no measurable vertical movement of water in the borehole. This lack of movement under static conditions indicates very little hydrostatic head difference in the vertical, insufficient permeability for measurable exchange of water from one zone to another, or both.

Composite water level = 215 feet below lsd

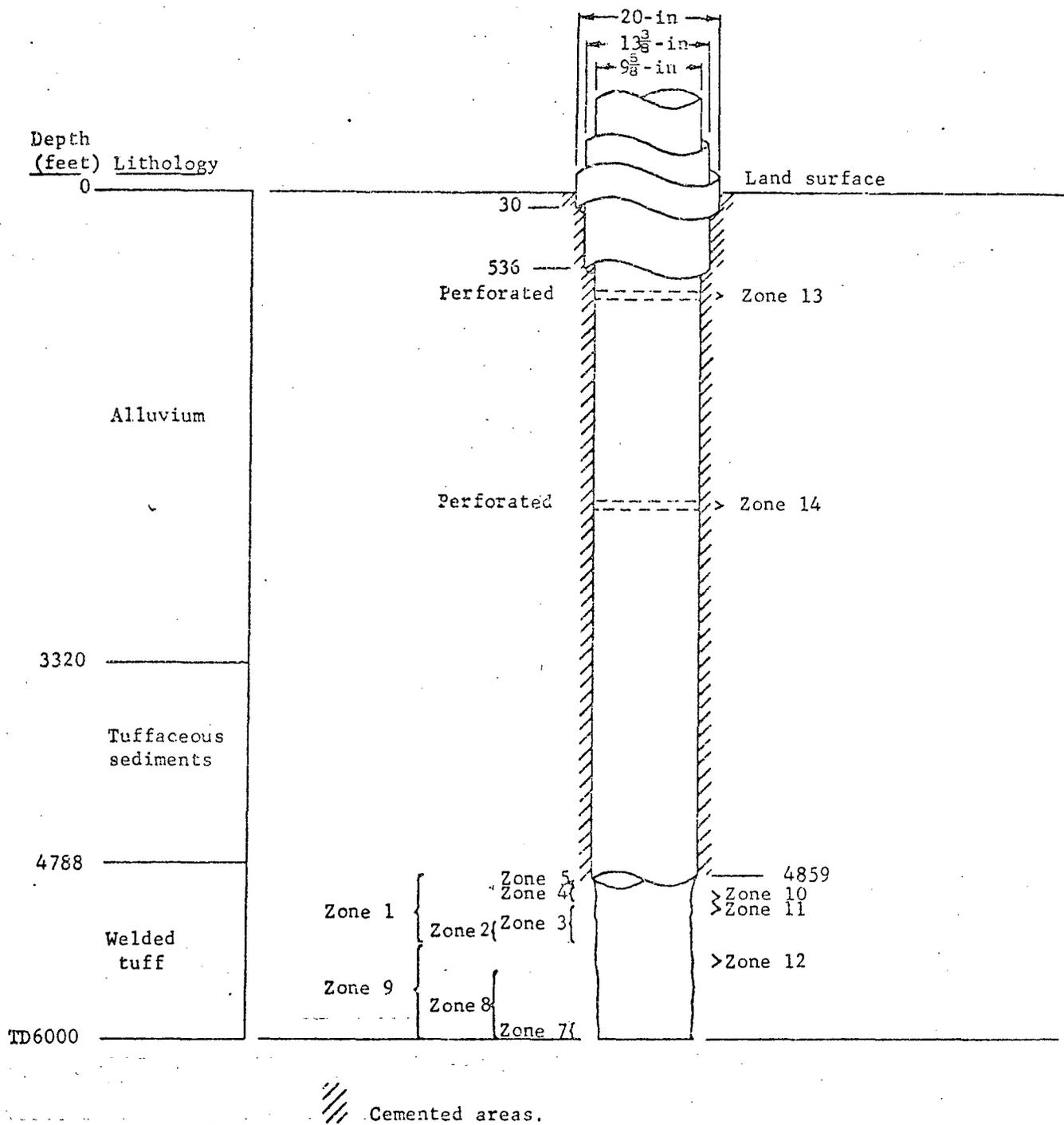


Figure 42.--Lithology and zones of hydraulic testing in hole UCe-20.

A tracejector study under dynamic conditions during jetting of water at a rate of about 150 gallons per minute indicates that most of the jetted water came from a depth of about 5,440 feet (fig. 43).

Zone 1, 4,859 to 5,306 feet

The static level after injection was 1,356 feet below lsd. However, later measurements of water levels indicate that this is too deep and probably is a reflection of dewatering by jetting. Static water level probably is about 230 feet below lsd.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection-test data (fig. 44) follows:

$$\text{Head loss} = 673.4 - 598.3 = 75.1 \text{ feet per minute}$$

$$Q = (0.162)(75.1) = 12.2 \text{ gallons per minute}$$

$$\text{Drawdown} = 1,368.6 - 637.8 = 730.8 \text{ feet}$$

$$\text{Relative specific capacity} = 12.2/730.8 = 0.017 \text{ gpm per foot}$$

Zone 2, 5,179 to 5,306 feet

Static water level was not measured because of the extremely long time involved in waiting for the level to become static. Relative specific capacity was computed from injection data and an assumed static level of about 1,356 feet below lsd.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection-test data (fig. 45) follows:

$$\text{Head loss} = 14.14 - 14.01 = 0.13 \text{ feet per minute}$$

$$Q = (0.162)(0.13) = 0.021 \text{ gallons per minute}$$

$$\text{Drawdown} = 1,356 - 0.17 = 1,355.8 \text{ feet}$$

$$\text{Relative specific capacity} = 0.021/1,355.8 = 0.000015 \text{ gpm per foot}$$

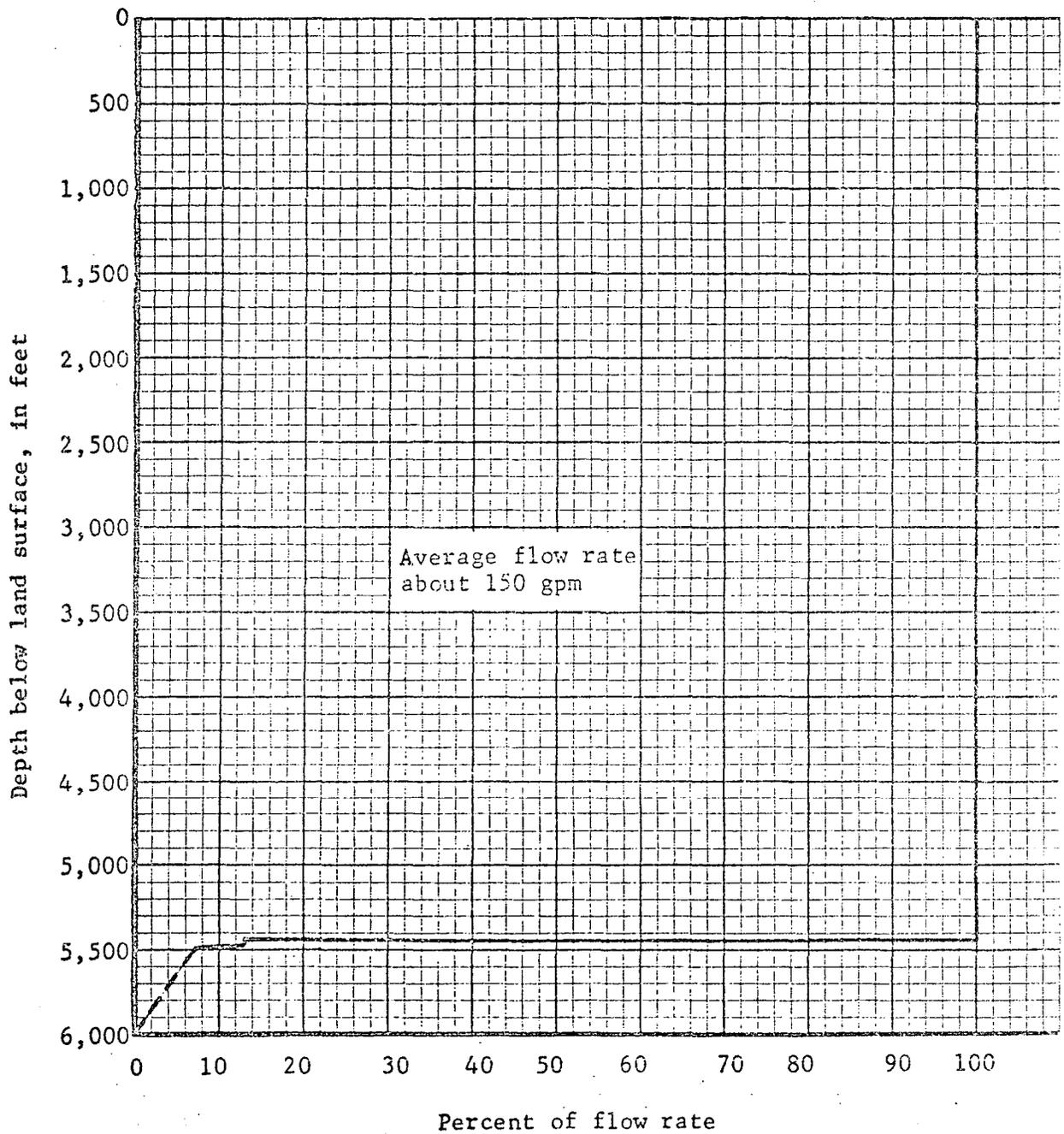


Figure 43.--Tracejectory survey of hole UCe-20, Hot Creek Valley, Nevada, while jetting.

06

Depth to water below measuring point, in feet

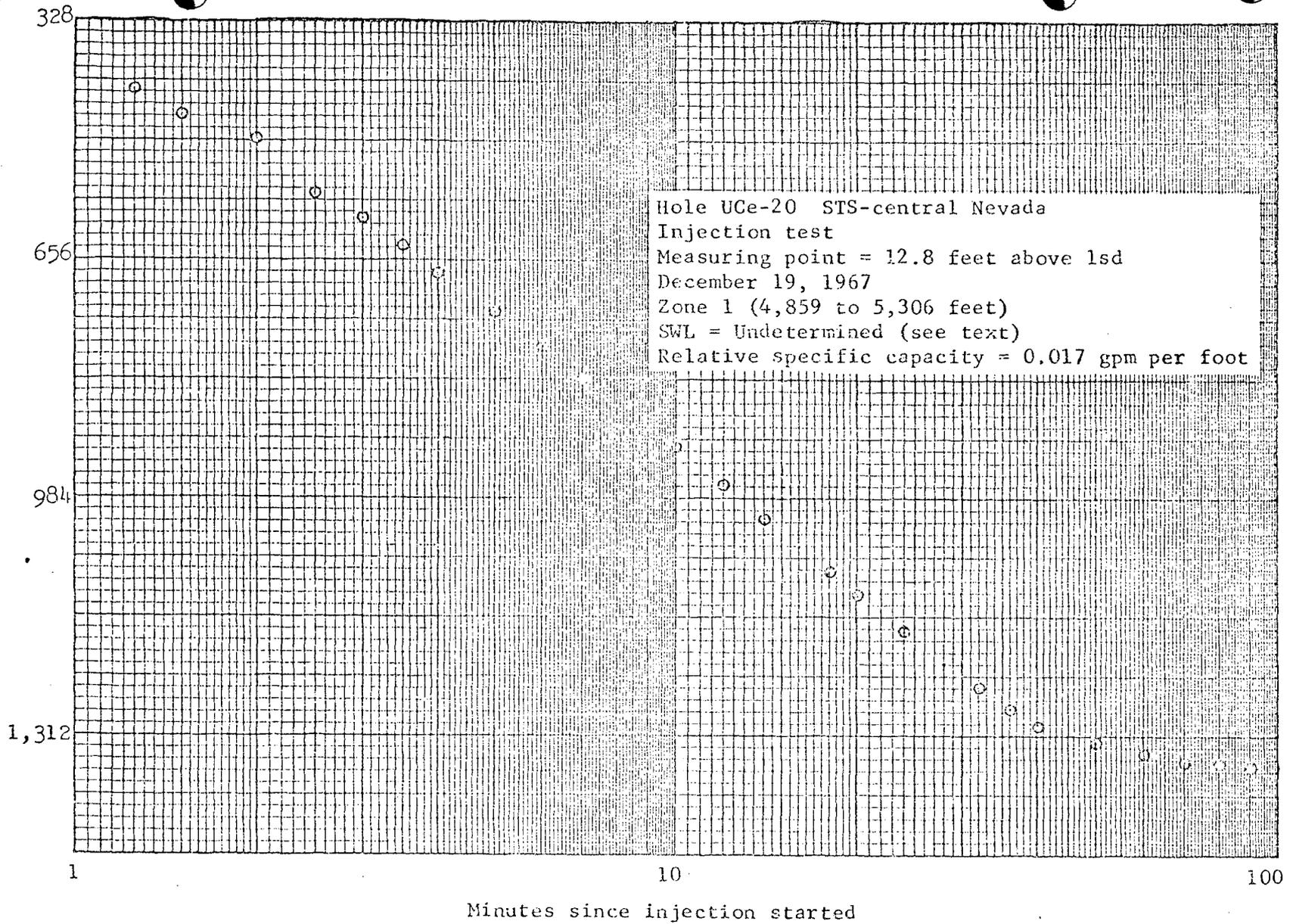


Figure 44.--Injection test of zone 1 (4,859 to 5,306 feet), hole UCe-20, STS-central Nevada, December 19, 1967.

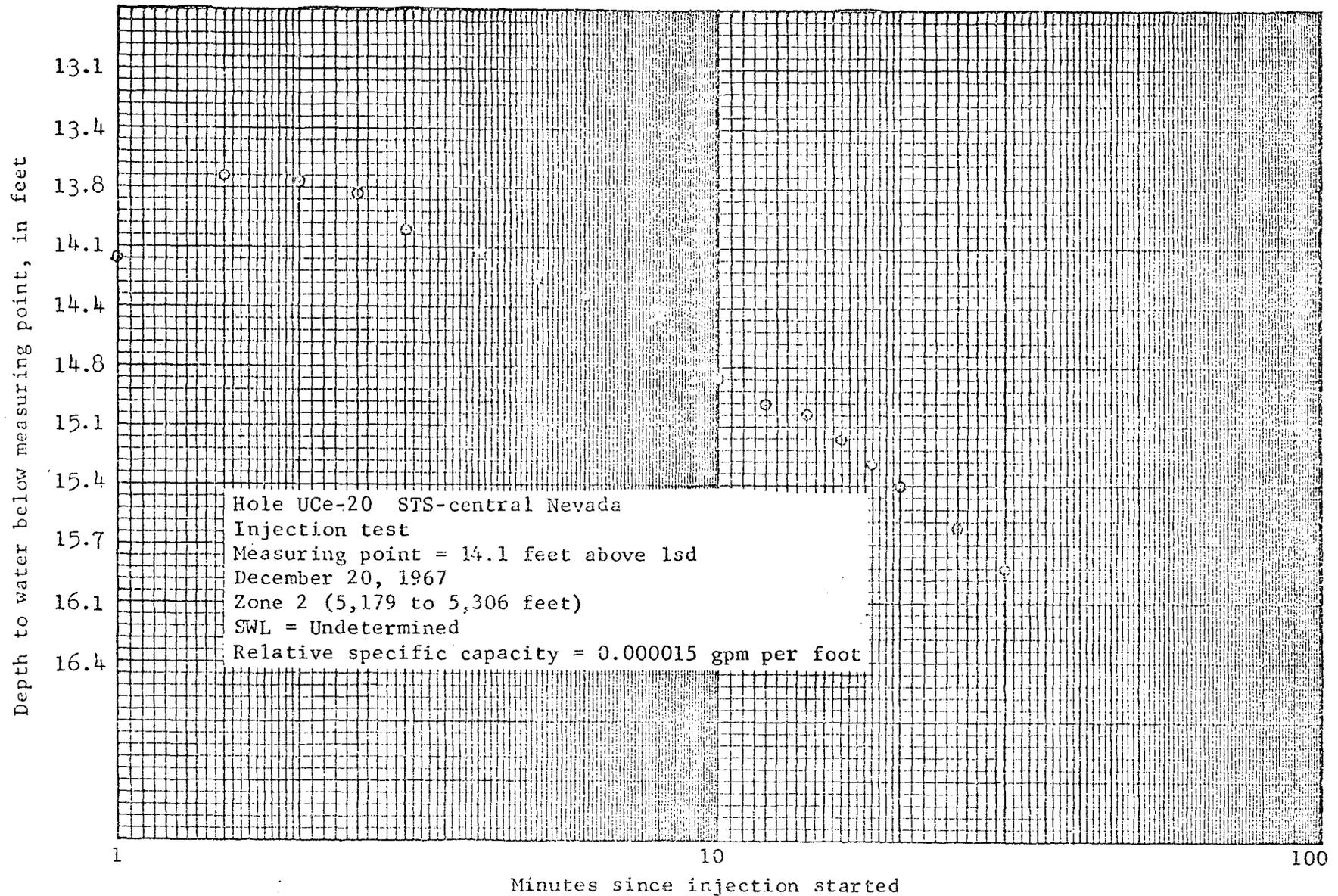


Figure 45.--Injection test of zone 2 (5,179 to 5,306 feet), hole UCe-20, STS-central Nevada, December 20, 1967.

Zone 3, 5,050 to 5,306 feet

Static water level was not measured because of the extremely long time involved in waiting for the level to become static. For calculating relative specific capacity, the water-level decline after injection was projected to about 1,100 feet below lsd.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection-test data (fig. 46) follows:

$$\text{Head loss} = 482.55 - 429.68 = 52.87 \text{ feet per minute}$$

$$Q = (0.162)(52.87) = 8.6 \text{ gallons per minute}$$

$$\text{Drawdown} = 1,100 - 458.35 = 641.65 \text{ feet}$$

$$\text{Relative specific capacity} = 8.6/641.65 = 0.013 \text{ gpm per foot}$$

Zone 4, 4,928 to 5,046 feet

Static water level was not measured because of the extremely long time involved in waiting for the level to become static. For calculating relative specific capacity, the static level was assumed to be about 1,356 feet below lsd.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection-test data (fig. 47) follows:

$$\text{Head loss} = 29.65 - 25.42 = 4.23 \text{ feet per minute}$$

$$Q = (0.162)(4.23) = 0.69 \text{ gallons per minute}$$

$$\text{Drawdown} = 1,356 - 15.54 = 1,340.5 \text{ feet}$$

$$\text{Relative specific capacity} = 0.69/1,340.5 = 0.0005 \text{ gpm per foot}$$

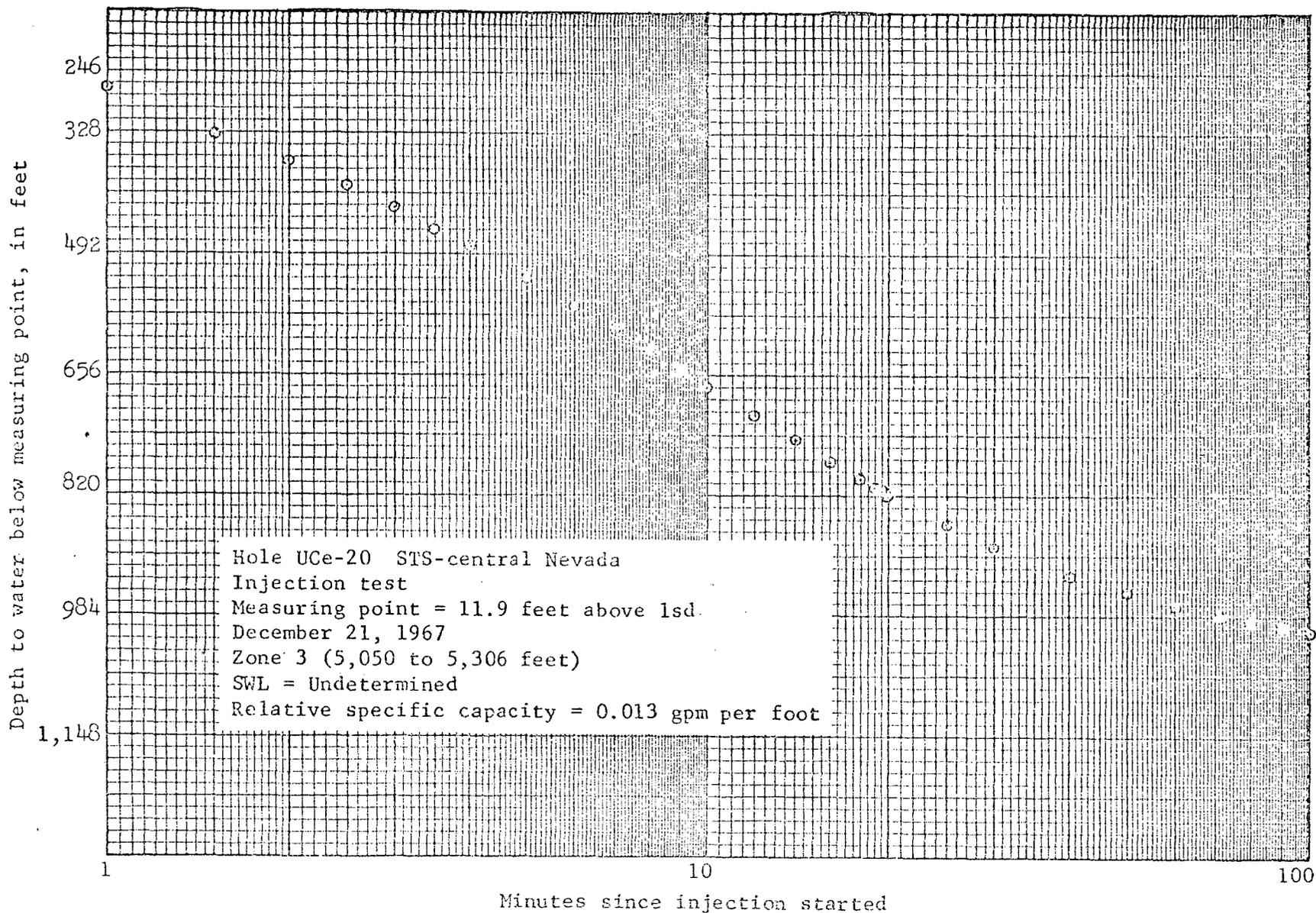


Figure 46.--Injection test of zone 3 (5,050 to 5,306 feet), hole UCe-20, STS-central Nevada, December 21, 1967.

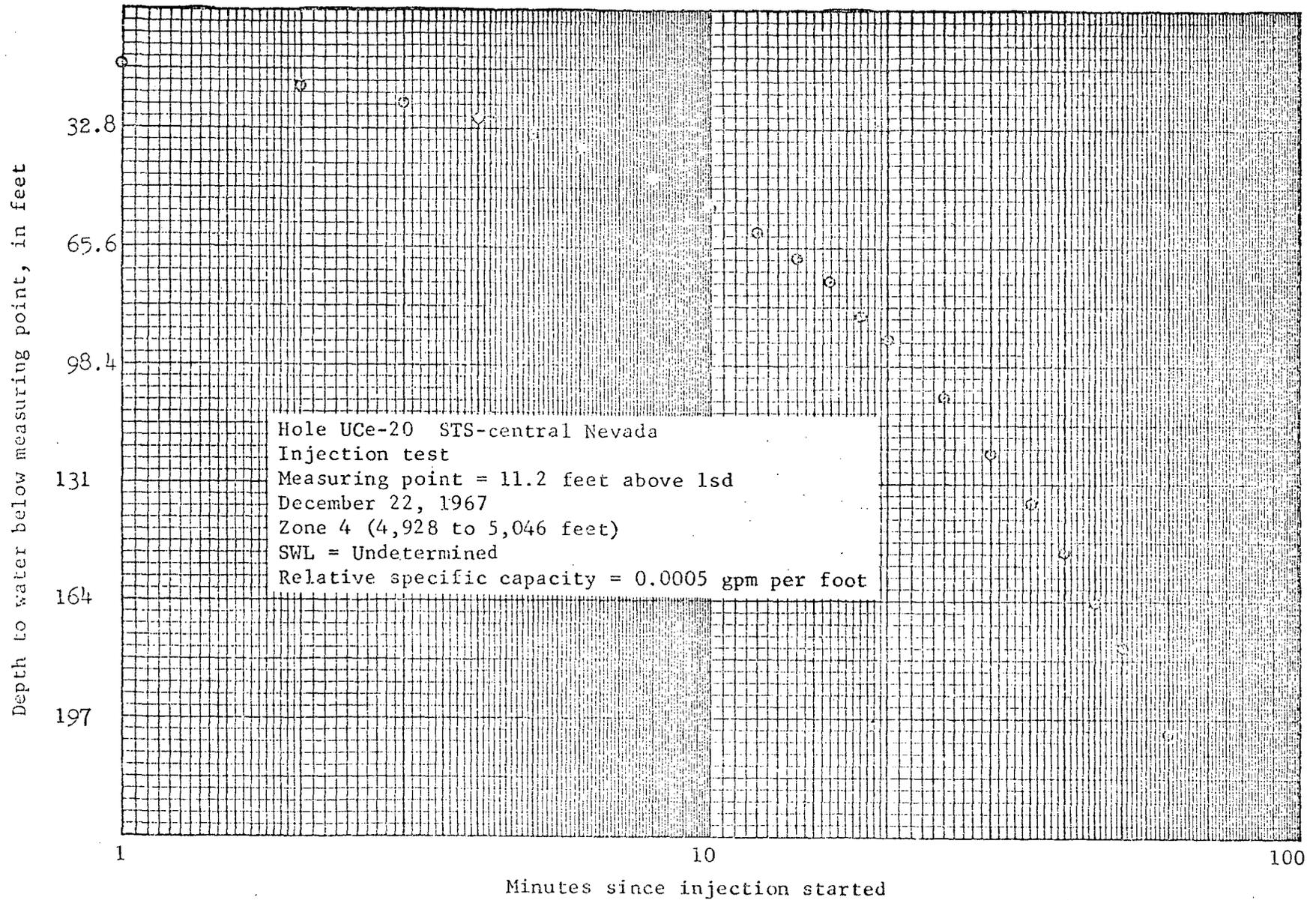


Figure 47.--Injection test of zone 4 (4,928 to 5,046 feet), hole UCe-20, STS-central Nevada, December 22, 1967.

Zone 5, 4,859 to 4,928 feet

Static water level was not measured and water sample was not obtained because of the extremely long time involved. Relative specific capacity was computed from injection data and an assumed static level of 1,356 feet below lsd.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection-test data (fig. 48) follows:

$$\text{Head loss} = 12.40 - 11.48 = 0.92 \text{ foot per minute}$$

$$Q = (0.162)(0.92) = 0.15 \text{ gallons per minute}$$

$$\text{Drawdown} = 1,356 - 0.20 = 1,355.8 \text{ feet}$$

$$\text{Relative specific capacity} = 0.15/1,355.8 = 0.0001 \text{ gpm per foot}$$

Zone 6, 5,330 to 6,000 feet

A seal in the packer leaked during the test of this zone (5,330 to 6,000 feet); therefore, the data are not valid. This interval was successfully retested later as zone 9.

Zone 7, 5,900 to 6,000 feet

Static water level was not measured and water sample was not obtained because of the extremely long time involved. Relative specific capacity was computed from injection data and an assumed static level of 277 feet below lsd.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection-test data (fig. 49) follows:

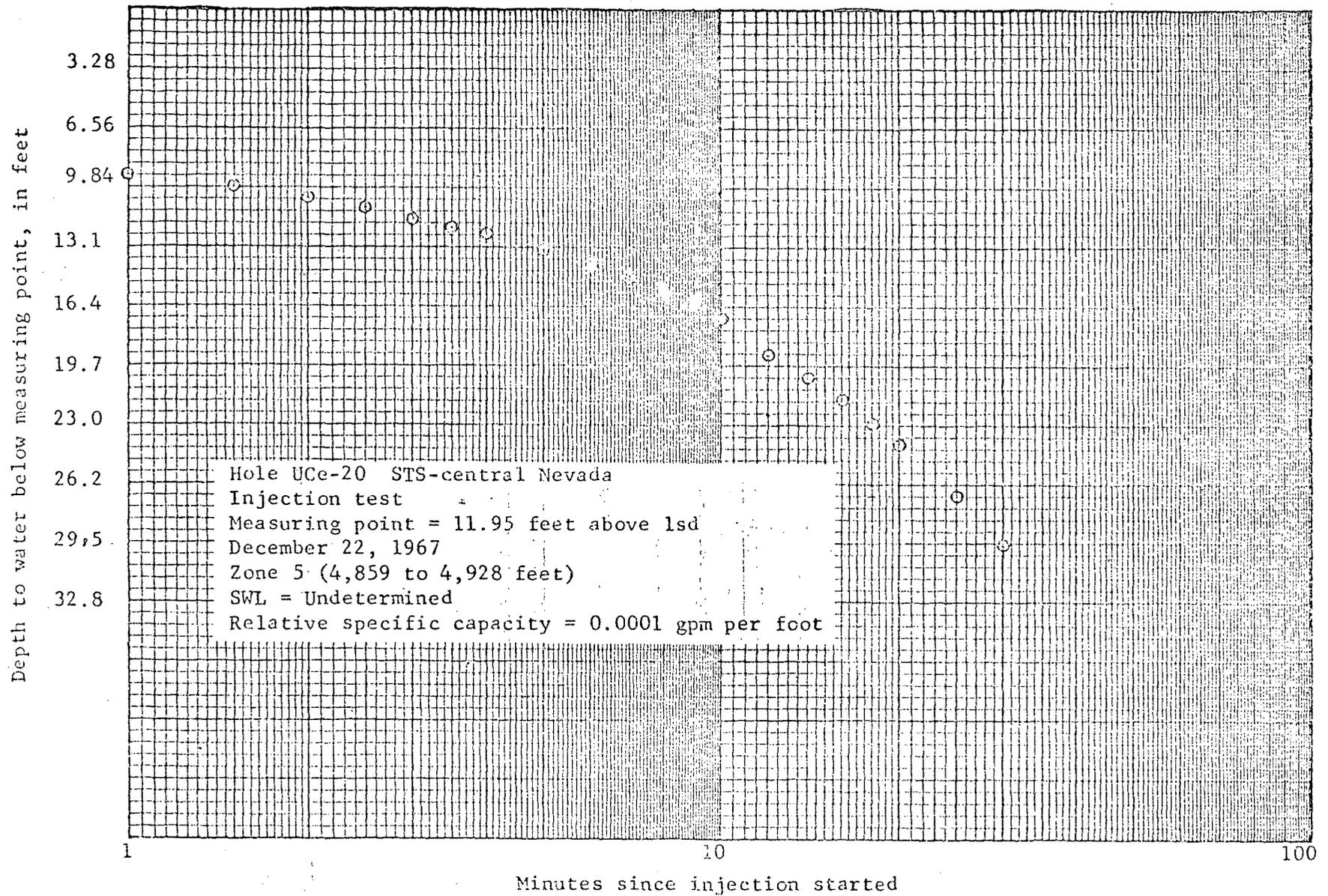


Figure 48.--Injection test of zone 5 (4,859 to 4,928 feet), hole UCe-20, STS-central Nevada, December 22, 1967.

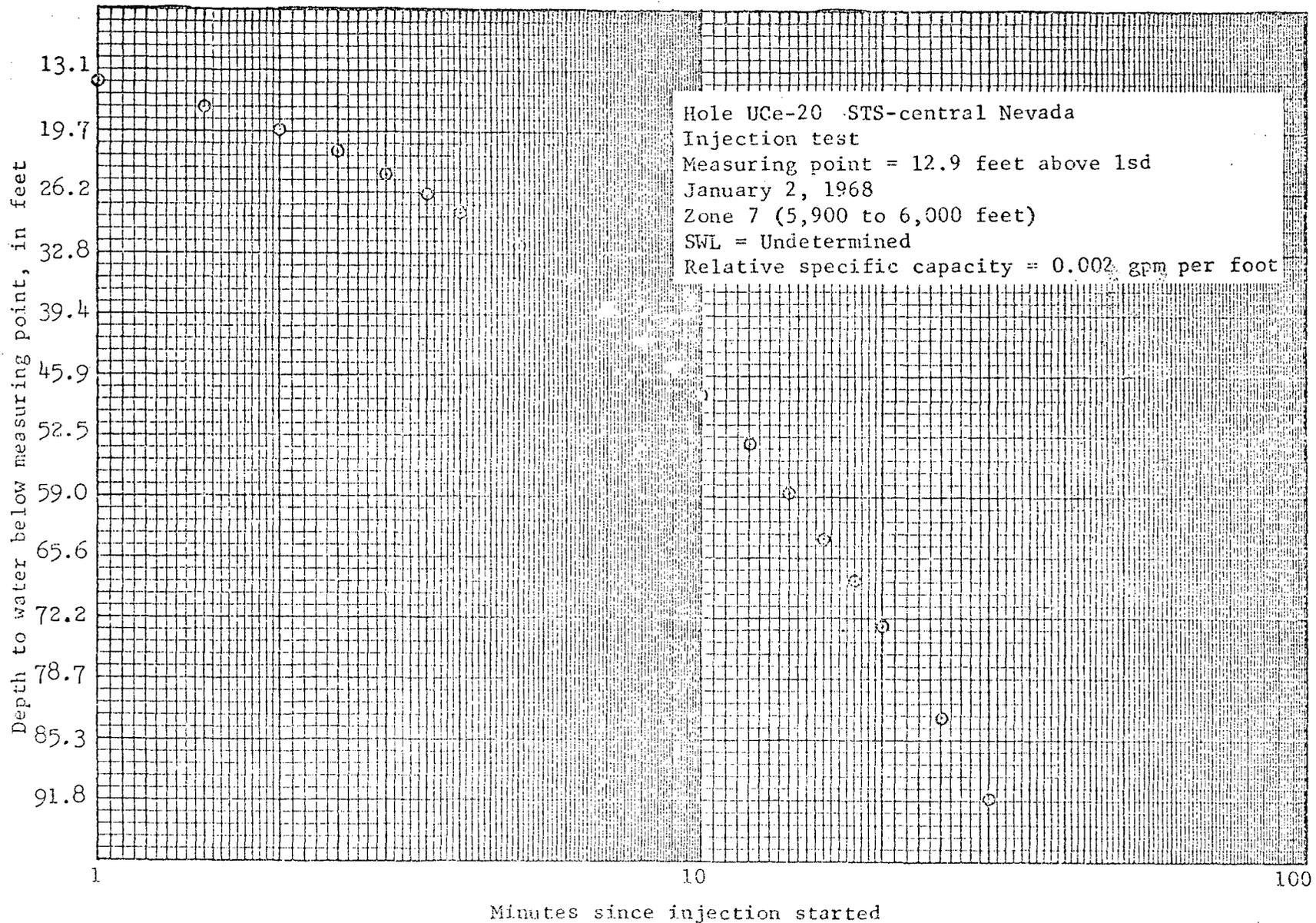


Figure 49.--Injection test of zone 7 (5,900 to 6,000 feet), hole UCe-20, STS-central Nevada, January 2, 1968.

Head loss = $28.2 - 24.3 = 3.9$ feet per minute

$Q = (0.162)(3.9) = 0.63$ gallons per minute

Drawdown = $277 - 18.3 = 258.7$ feet

Relative specific capacity = $0.63/258.7 = 0.002$ gpm per foot

Zone 8, 5,510 to 6,000 feet

The static water level after injection was 277 feet below lsd and after recovery from swabbing was 272 feet below lsd. The difference in measured static levels may be due to a difference in water temperatures because cold water was injected and warm water was swabbed. Relative specific capacity was computed from recovery data.

Relative specific capacity calculated using the time interval from the 8th to the 9th minute of the recovery-test data (fig. 50) follows:

Head loss = $1,059.8 - 1,024 = 35.8$ feet per minute

$Q = (0.162)(35.8) = 5.8$ gallons per minute

Drawdown = $1,027.1 - 272 = 755.1$ feet

Relative specific capacity = $5.8/755.1 = 0.008$ gpm per foot

Zone 9, 5,330 to 6,000 feet

The static water level after injection was 271 feet below lsd and after recovery from swabbing was 262 feet below lsd. The difference in measured static levels may be due to a difference in water temperatures because cold water was injected and warm water was swabbed. Relative specific capacity was computed from injection data.

Relative specific capacity calculated using the time interval from $\frac{1}{2}$ -minute to $1\frac{1}{2}$ -minutes of the injection-test data (fig. 51) follows:

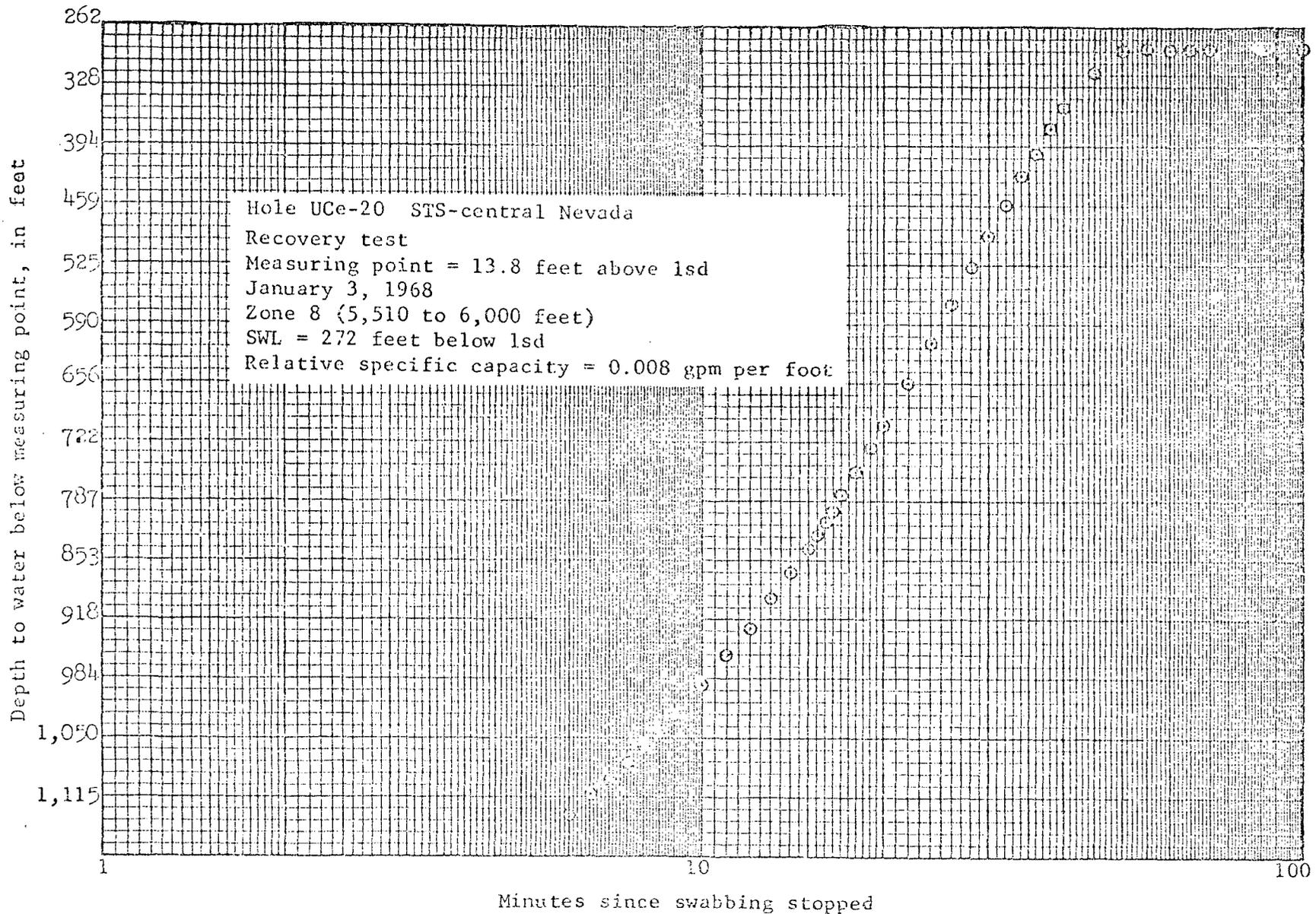
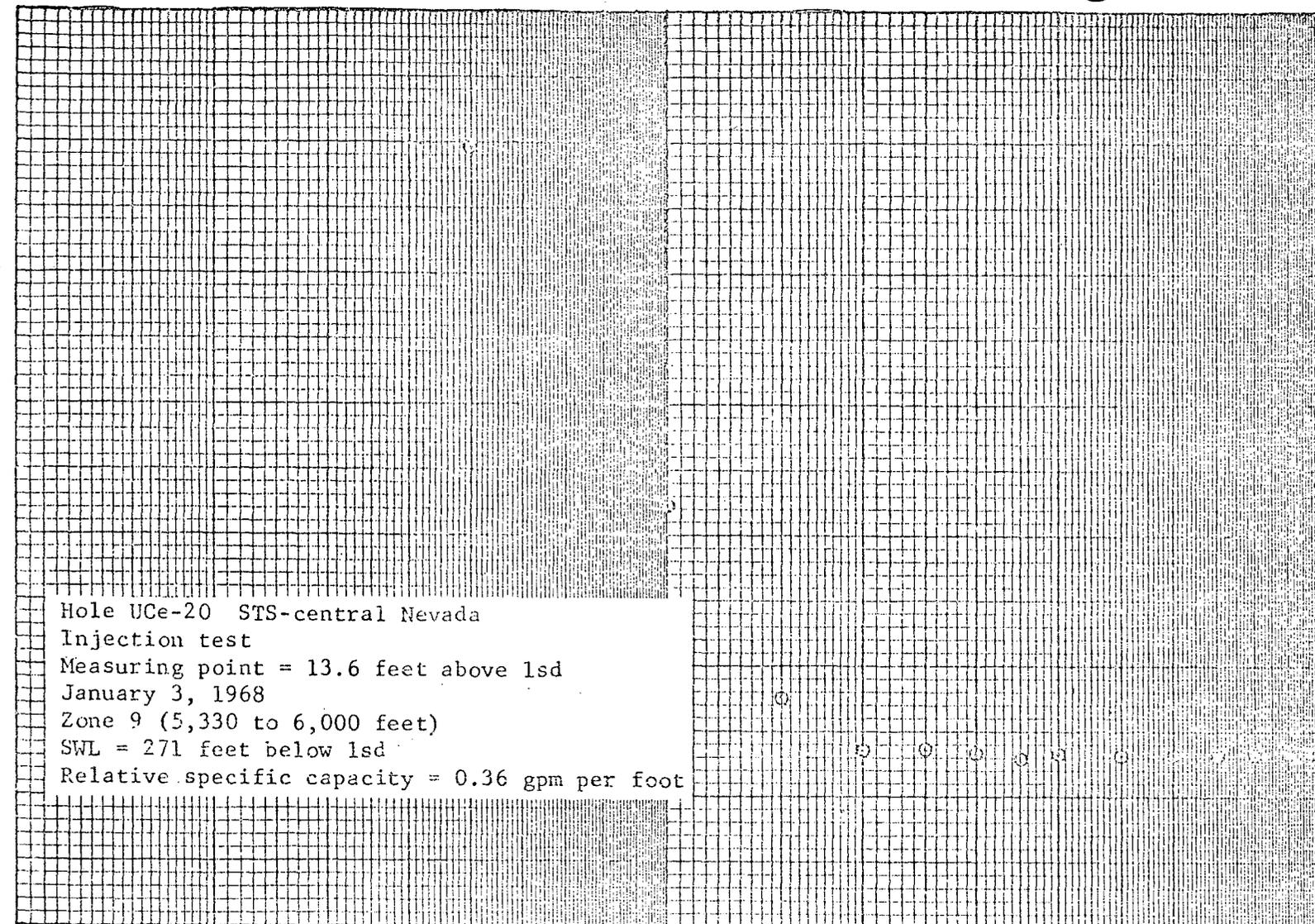


Figure 50.--Swab test of zone 8 (5,510 to 6,000 feet), hole UCe-20, STS-central Nevada, January 3, 1968.

001

Depth to water below measuring point, in feet

131
164
197
230
262
295



0.1

1

10

Minutes since injection started

Figure 51.--Injection test of zone 9 (5,330 to 6,000 feet), hole UCe-20, STS-central Nevada, January 3, 1968.

Head loss = $270.3 - 132.0 = 138.3$ feet per minute

$Q = (0.162)(138.3) = 22.4$ gallons per minute

Drawdown = $271 - 209.1 = 61.9$ feet

Relative specific capacity = $22.4/61.9 = 0.36$ gpm per foot

Zone 10, 4,990 to 5,050 feet

Static water level was not measured and water sample was not obtained because of the extremely long time involved. Relative specific capacity was computed from injection data and an assumed static level of 228 feet below lsd.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection-test data (fig. 52) follows:

Head loss = $3.97 - 3.51 = 0.46$ feet per minute

$Q = (0.162)(0.46) = 0.075$ gallons per minute

Drawdown = $228 + 8.26 = 236.26$ feet

Relative specific capacity = $0.075/236.26 = 0.0003$ gpm per foot

Zone 11, 5,050 to 5,110 feet

The static water level after injection was 228 feet below lsd and after recovery from swabbing was 219 feet below lsd. The difference in measured static levels may be due to a difference in water temperatures because cold water was injected and warm water was swabbed. Relative specific capacity was computed from both injection and recovery data.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection-test data (fig. 53) follows:

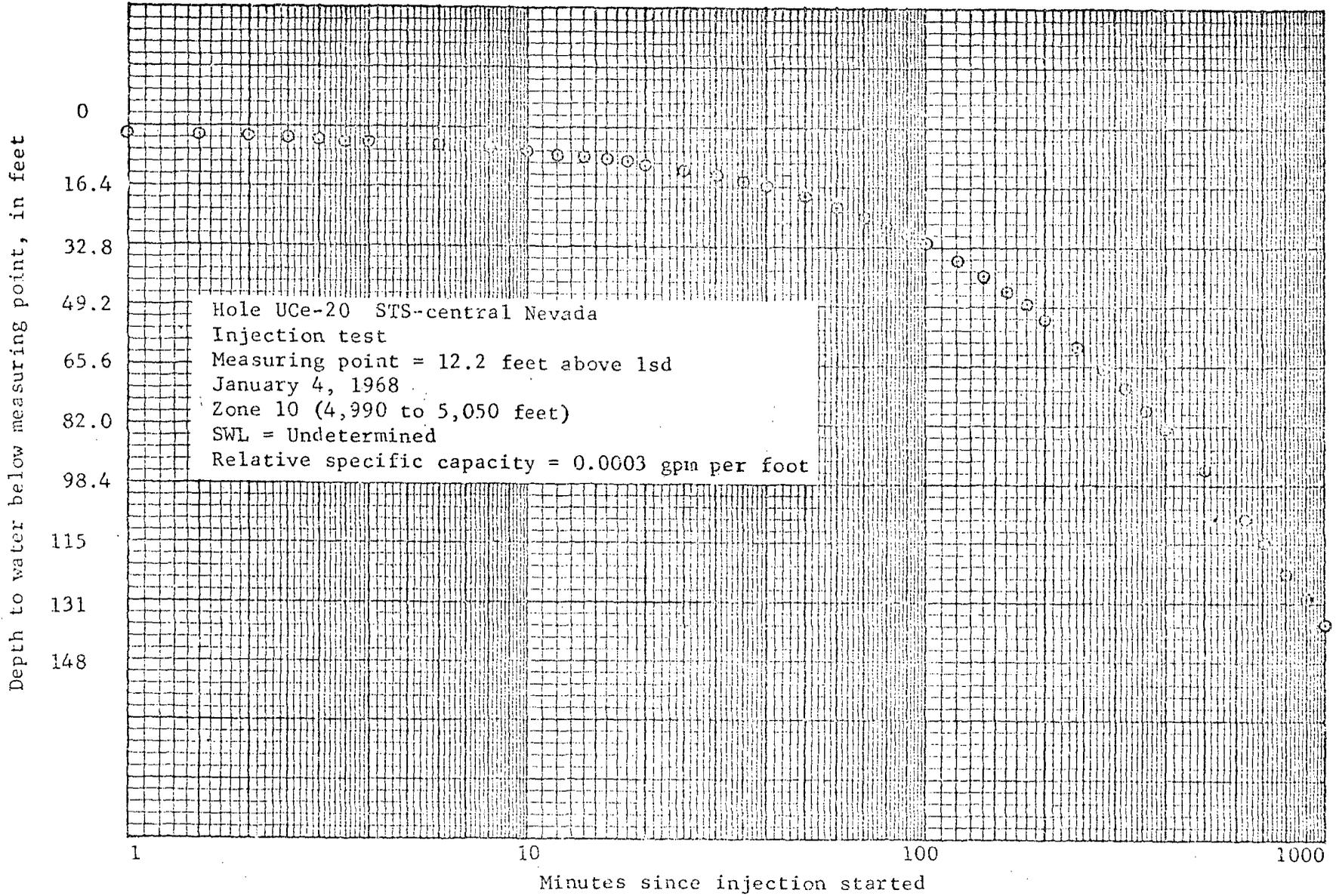


Figure 52.--Injection test of zone 10 (4,990 to 5,050 feet), hole UCe-20, STS-central Nevada, January 4, 1968.

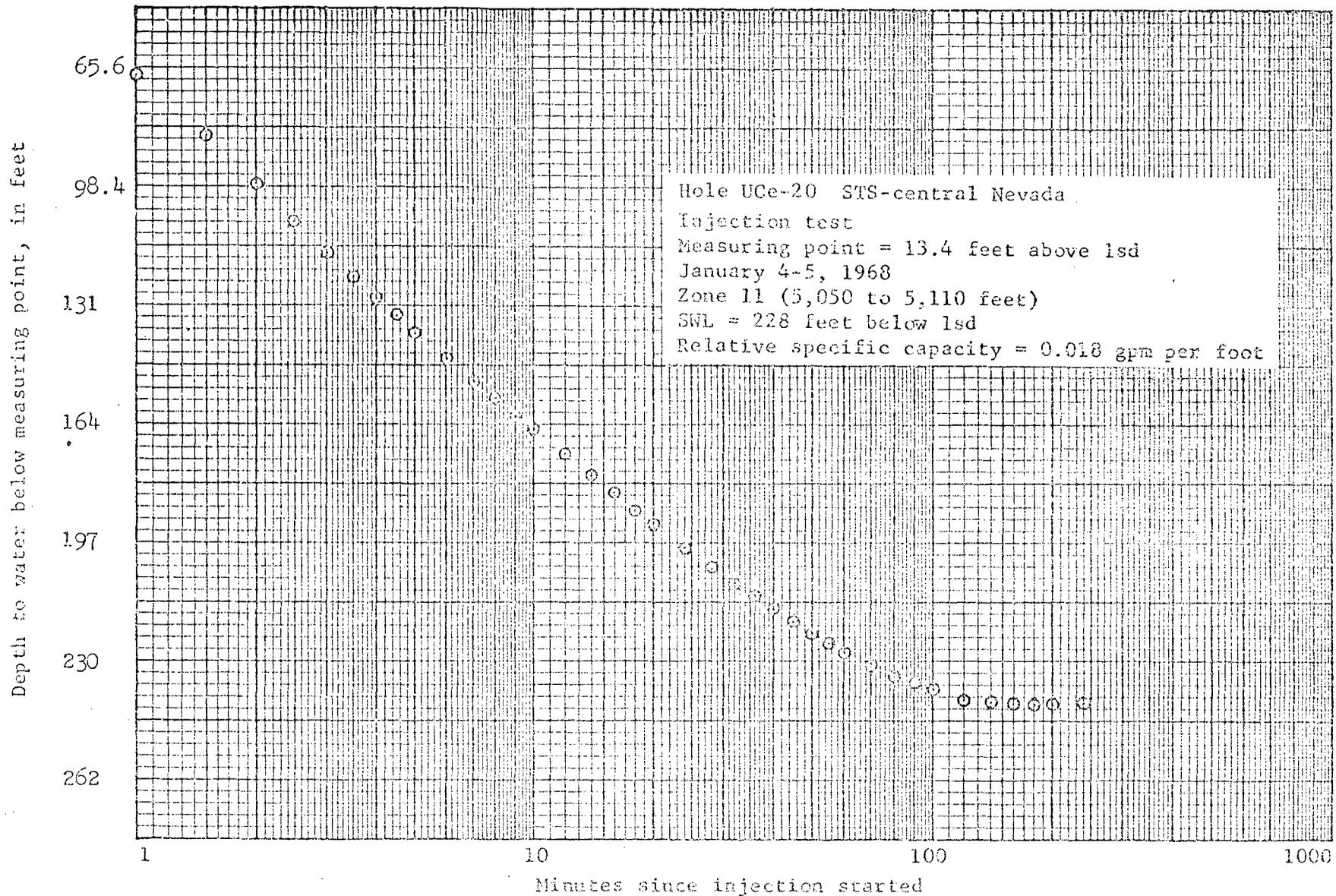


Figure 53.--Injection test of zone 11 (5,050 to 5,110 feet), hole UCe-20, STS-central Nevada, January 4-5, 1968.

Head loss = $129.3 - 116.6 = 12.7$ feet per minute

$Q = (0.162)(12.7) = 2.1$ gallons per minute

Drawdown = $228 - 110.3 = 117.7$ feet

Relative specific capacity = $2.1/117.7 = 0.018$ gpm per foot

Relative specific capacity calculated using the time interval from the 6th to the 7th minute of the recovery-test data (fig. 54) follows:

Head loss = $679.0 - 622.1 = 56.9$ feet per minute

$Q = (0.162)(56.9) = 9.2$ gallons per minute

Drawdown = $634.7 - 219 = 415.7$ feet

Relative specific capacity = $9.2/415.7 = 0.022$ gpm per foot

Zone 12, 5,420 to 5,480 feet

The static water level after both injection and recovery was 215 feet below lsd. Permeability of this part of the formation probably is due to fractures in welded tuff. The only water sample obtained from UCe-20 was obtained from this zone. Relative specific capacity could not be computed for this zone and is reported only as high, probably greater than 0.5 gpm per foot.

Zone 13, 700 to 720 feet

Static water level was not measured and water sample was not obtained because of the extremely long time involved. However, the static level, determined by extending the curve of the injection data points on figure 55, is about 340 feet below lsd. Relative specific capacity was computed from injection data.

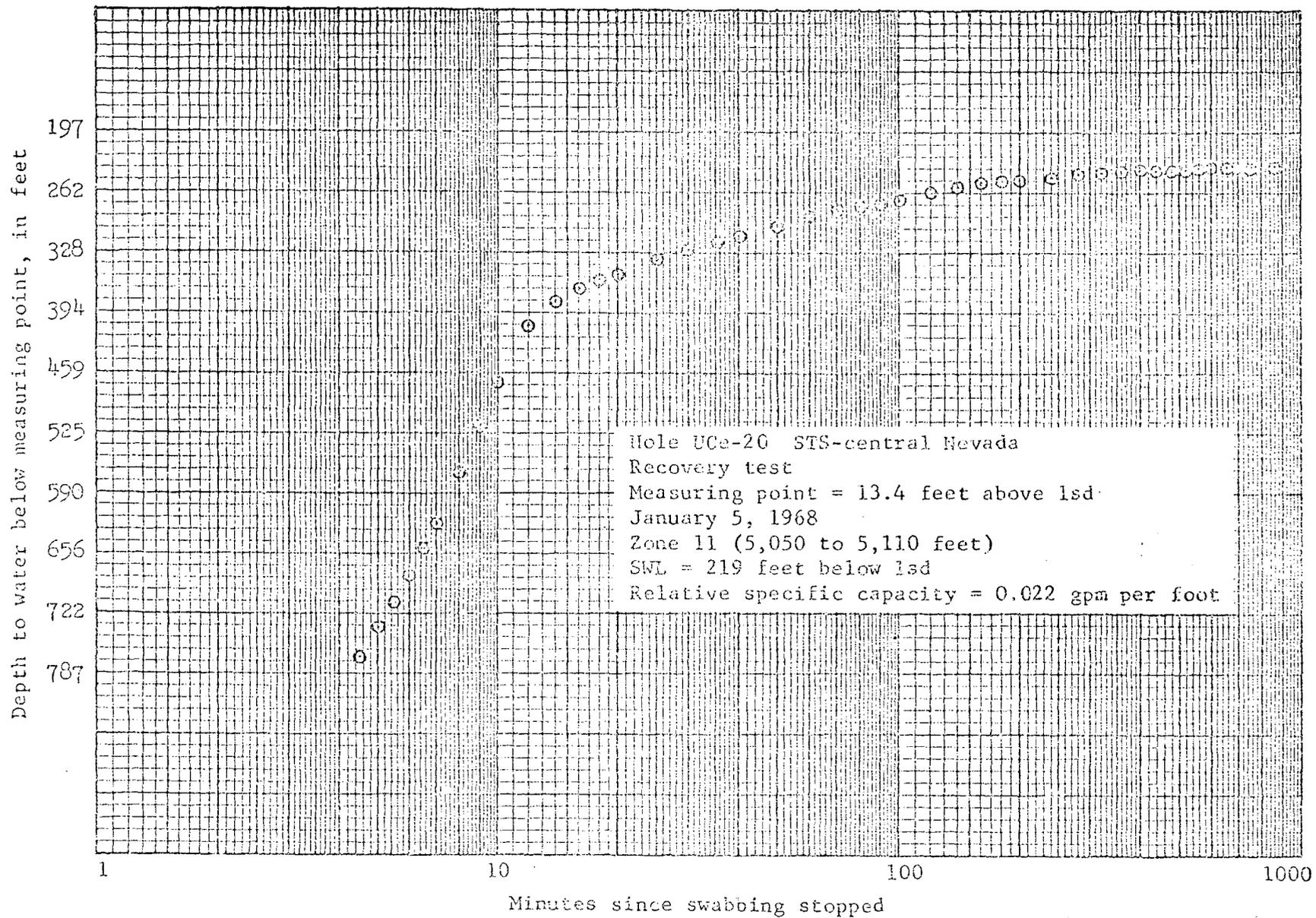


Figure 54.--Swab test of zone 11 (5,050 to 5,110 feet), hole UCe-20, STS-central Nevada, January 5, 1968.

Depth to water below measuring point, in feet

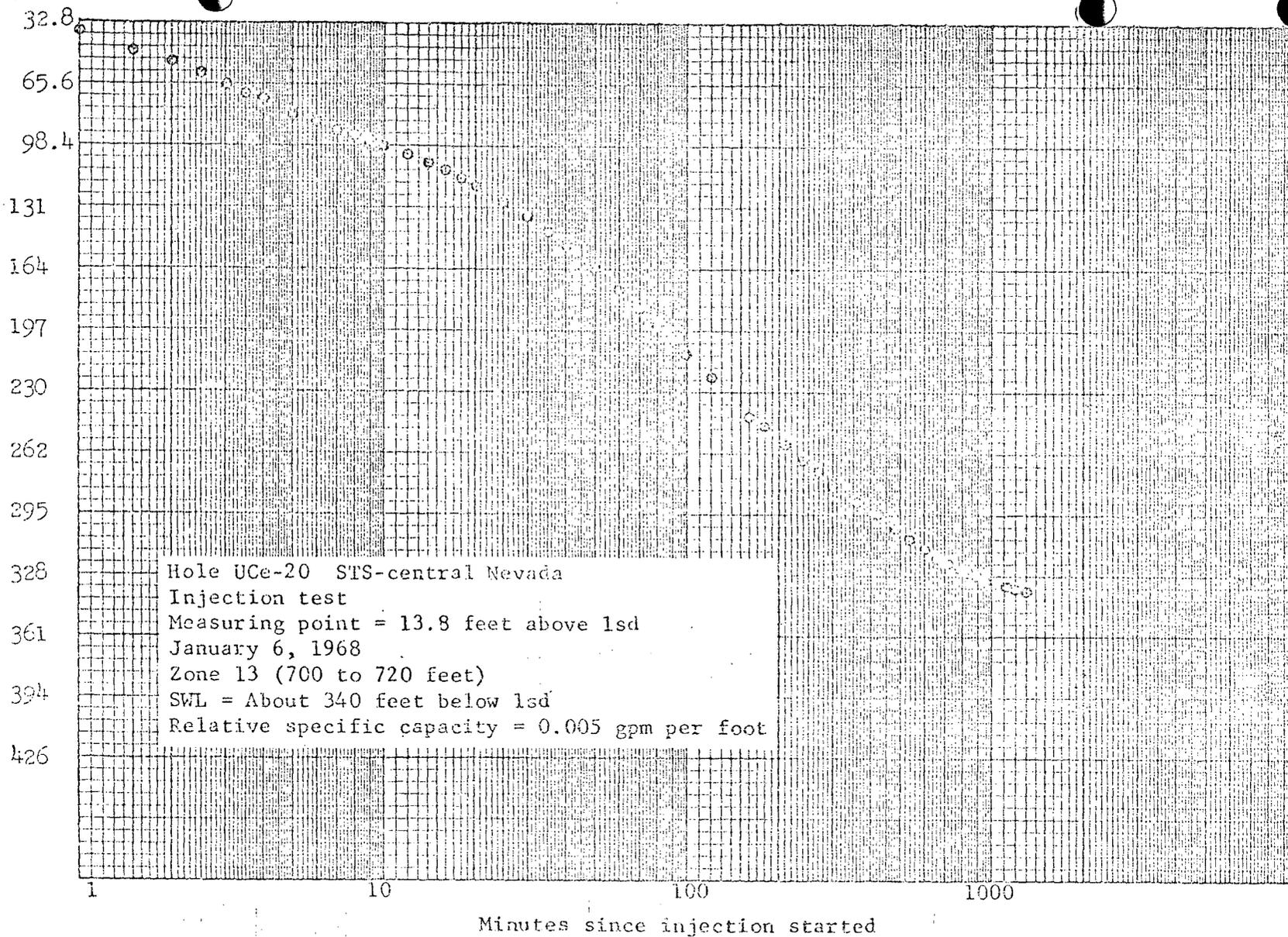


Figure 55.--Injection test of zone 13 (700 to 720 feet), hole UCe-20, STS-central Nevada, January 6, 1968.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection-test data (fig. 55) follows:

$$\text{Head loss} = 74.3 - 65.7 = 8.6 \text{ feet per minute}$$

$$Q = (0.162)(8.6) = 1.4 \text{ gallons per minute}$$

$$\text{Drawdown} = 340 + 56.6 = 283.6 \text{ feet}$$

$$\text{Relative specific capacity} = 1.4/283.6 = 0.005 \text{ gpm per foot}$$

Zone 14, 2,200 to 2,220 feet

Static water level was not measured and water sample was not obtained because of the extremely long time involved. Relative specific capacity was computed from injection data and an assumed static level of 340 feet below lsd.

Relative specific capacity calculated using the time interval from the 3rd to the 4th minute of the injection test data (fig. 56) follows:

$$\text{Head loss} = 1.21 - 1.12 = 0.09 \text{ feet per minute}$$

$$Q = (0.162)(0.09) = 0.015 \text{ gallons per minute}$$

$$\text{Drawdown} = 340 + 11.42 = 351.4 \text{ feet}$$

$$\text{Relative specific capacity} = 0.015/351.4 = 0.00004 \text{ gpm per foot}$$

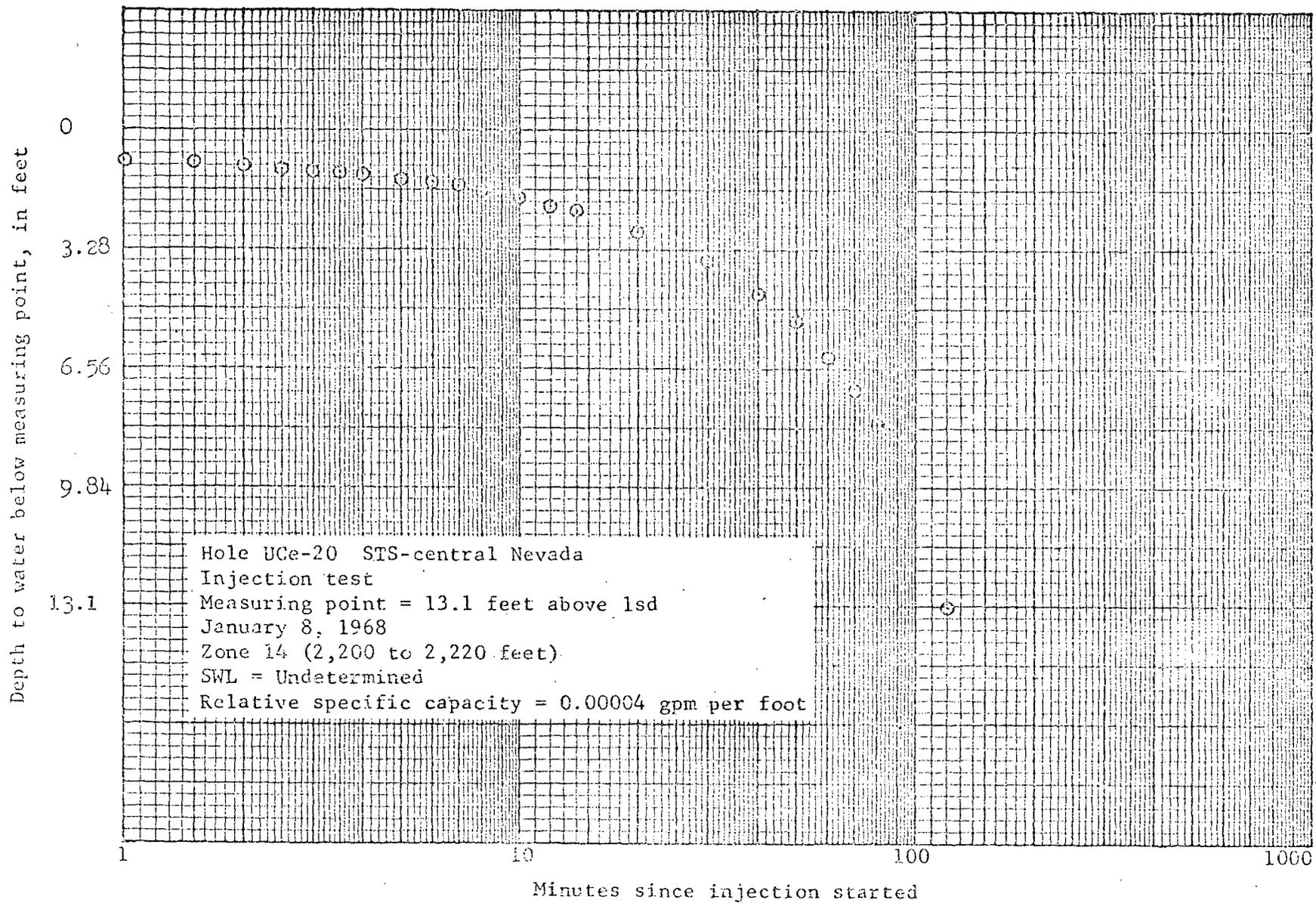


Figure 56.--Injection test of zone 14 (2,200 to 2,220 feet), hole UCe-20, STS-central Nevada, January 8, 1968.

Table 5.--Summary of hydraulic tests in hole UCe-20
(e Estimated because of estimated static water level.)

Zone	1	2	3	4	5	7	8	8	9	9	10	11	11	12	12	13	14	Units
Tested interval	4,859 to 5,306	5,179 to 5,306	5,050 to 5,306	4,928 to 5,046	4,859 to 4,928	5,900 to 6,000	5,510 to 6,000	5,510 to 6,000	5,330 to 6,000	5,330 to 6,000	4,990 to 5,050	5,050 to 5,110	5,050 to 5,110	5,420 to 5,480	5,480 to 5,480	700 to 720	2,200 to 2,220	Feet
	Injec.						277		271			228		215		2340#		Feet below land-surface datum
Relative specific capacity	0.071 0.032	.000015 .000024	.013 .01	.0005 .0008	.0001 .0003	.002 .005			.36 .12		.0003 .001	.018 .029		High		.005 .02	.00004 .0001	Gpm per foot of drawdown
	Recov.							.008 .003					.022 .074		High			

1/ Swabbed 9,000 gallons (34°C; 800 micromhos per cm at 25°C). Only water sample taken.

2/ Composite water level = 215 feet below lsd.

Notes: The greatest hydraulic potential was measured in zone 12, and the hydraulic potential decreases above and below this zone.

In "relative specific capacity" line, the upper figure is for interval tested, and the lower figure is for comparable 200-foot section.

SELECTED REFERENCES

Blankennagel, R. K., 1967, Hydraulic testing techniques of deep
drill holes at Pahute Mesa, Nevada Test Site. U.S. Geol.
Survey Open-file Report, 50 p.