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GROUND-WATER LEVEL DATA AND PRELIMINARY POTENTIOMETRIC-SURFACE MAPS, YUCCA MOUNTAIN AND VICINITY, NYE COUNTY, NEVADA

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 84-4197

Prepared in cooperation with the
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UNITED STATES DEPARTMENT OF THE INTERIOR

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GEOLOGICAL SURVEY

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CONTENTS

ILLUSTRATIONS

TABLE

CONVERSION TABLE

Multiply	*By*	*To obtain*
kilometer (km)	0.6214	mile (mi)
meter (m)	3.281	foot (ft)

National Geodetic Vertical Datum of 1929: A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Mean Sea Level; it is referred to as sea level in this report.

GROUND-WATER LEVEL DATA AND PRELIMINARY POTENTIOMETRIC-SURFACE MAPS, YUCCA MOUNTAIN AND VICINITY, NYE COUNTY, NEVADA

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ABSTRACT

This report contains data on ground-water levels and preliminary maps of the potentiometric surface beneath Yucca Mountain and adjacent areas, Nye County, Nevada. The information was obtained in cooperation with the U.S. Department of Energy to help evaluate the suitability of the area for storing high-level nuclear waste.

The water-level surface shown on the maps generally represents water-table (unconfined) conditions. The water table in the Yucca Mountain area occurs in ash-flow and air-fall tuffs of Tertiary age.

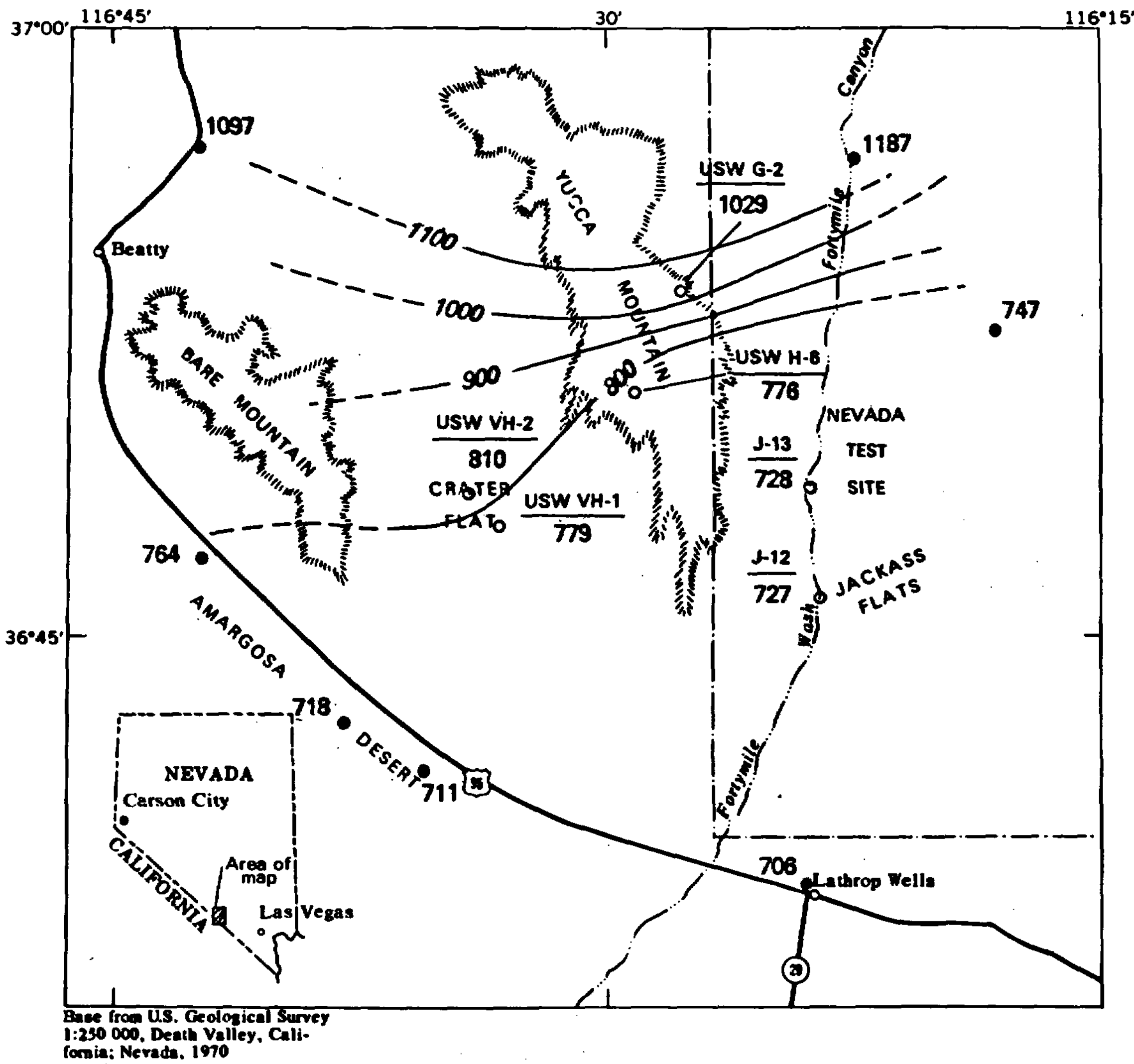
West of the crest of Yucca Mountain, water-level altitudes are about 775 meters above sea level. Along the eastern edge and southern end of Yucca Mountain, the potentiometric surface generally is nearly flat, is about 728 to 730 meters above sea level, and has a southeastward slope.

INTRODUCTION

This report contains a table of water-level data from wells and test holes in the Yucca Mountain area, Nye County, Nevada, and two preliminary potentiometric-surface maps based on the water-level data. The information was obtained as part of the Nevada Nuclear Waste Storage Investigations being made in part by the U.S. Geological Survey in cooperation with the U.S. Department of Energy under Interagency Agreement DE-AI08-78ET44802. The purpose of the investigations is to evaluate the suitability of the area for storing high-level nuclear wastes in a mined underground repository.

GEOHYDROLOGIC SETTING

The Yucca Mountain area (fig. 1) is within a large silicic volcanic field of southwestern Nevada. The area is underlain principally by a series of Tertiary ash-flow and bedded tuffs and lavas that range in age from about 11 to 15 million years (Carr and others, 1984). Sources of these volcanic rocks are caldera complexes north of Yucca Mountain. The volcanic plateau is gently tilted eastward at 6° to 13° and is broken into structural blocks. Faults are generally north-striking basin-and-range types and northwest-striking strike-slip types.



0 5 10 15 KILOMETERS

0 5 MILES

EXPLANATION

USW VH-1 / 779 ○ WELL--Upper number is well number assigned by U.S. Department of Energy; lower number is altitude of water level measured during this study (table 1), in meters above sea level

764 ● WELL--Number is altitude of water level reported in Waddell (1982), in meters above sea level

—800— POTENTIOMETRIC CONTOUR--Shows altitude of potentiometric surface 1982-83. Contour interval 100 meters. Datum is sea level

Figure 1.--Preliminary potentiometric-surface map, Yucca Mountain and vicinity.

The tuffs are generally of two types: densely welded tuff that is extremely fractured with relatively little matrix permeability but with significant bulk permeability; and nonwelded tuff that is relatively unfractured and very porous with relatively little permeability. Hydraulic characteristics of the rocks depend on the occurrence and nature of structural features and on the physical properties of individual units; these properties do not necessarily correspond with the formal stratigraphy of the rocks.

Yucca Mountain lies within the Alkali Flat-Furnace Creek Ranch ground-water basin (Waddell, 1982). Principal recharge areas (to the north) and discharge areas (to the south) are beyond the area shown in figure 1.

WATER LEVELS

Water levels beneath Yucca Mountain and the surrounding area range in altitude from about 1,100 to 700 m above sea level; selected values are shown in figure 1. The water levels generally represent water-table, or unconfined conditions; potentiometric levels show little variation with depth in the upper part of the saturated zone. In the Yucca Mountain area, the potentiometric surface occurs principally in members of the Miocene Paintbrush Tuff and underlying Crater Flat Tuff. Slope of the potentiometric surface beneath Yucca Mountain, based on gradients indicated by the contours, is south to southeast, similar to the regional slope. The gradient in the north is relatively steep compared to that in the south.

Water-level altitudes beneath Yucca Mountain are shown in greater detail in figure 2. Water-level altitudes in figure 2 are highest to the north at test wells USW G-2 and UE-25 WT#6; however, no data exist to indicate whether the southward slope toward test well USW H-1 is uniform, or if the potentiometric surface is mainly flat with one or more abrupt flections.

West of the crest of Yucca Mountain, in test wells USW H-6, USW WT-7, and USW WT-10, and also in test well USW H-5 on the crest, the water levels all are about 775 m above sea level. Water levels are as much as 45 m lower at test well USW G-3 and USW H-3, 1 km east of USW WT-7.

From the eastern edge and southern end of Yucca Mountain to western Jackass Flats, the potentiometric surface generally is flat, typically ranging from about 728 to 730 m in altitude with a general southeastward slope.

The potentiometric surface needs to be measured at enough locations and with sufficient accuracy and precision to define direction and magnitude of the hydraulic gradient in order for the maps or table to be useful for determination of velocity and probable flow paths of ground water. Permeability of rocks near Yucca Mountain is not isotropic; therefore, flow paths locally or in detail may not be parallel to hydraulic gradients.

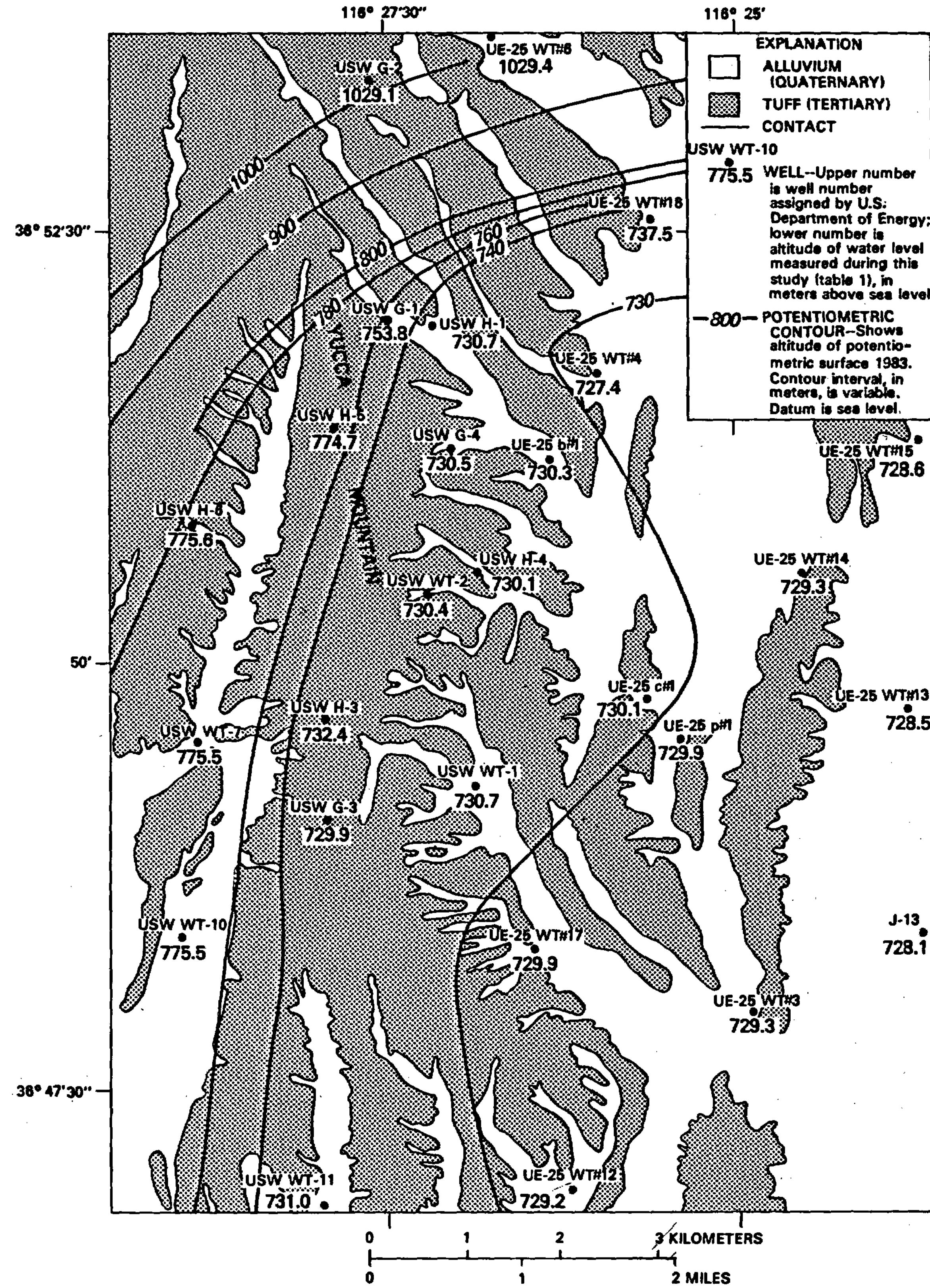


Figure 2.--Preliminary potentiometric-surface map, Yucca Mountain.

The potentiometric contours on the maps are considered approximate and preliminary; some revision may be necessary as more water-level data are obtained after the completion of additional wells. The contours are based on assumptions of areally-uniform variation of water levels between data points. Further refinements or changes may be warranted as more data are obtained and concepts of geohydrological controls of local ground-water movement are developed; for example, abrupt changes of gradient might occur across faults that have very low permeability.

DATA ACCURACY AND PRECISION

Because the range of altitudes of the water table in much of the eastern part of Yucca Mountain area is only about 2 m, magnitudes and directions of gradients are defined by very small differences of water-level altitude. Thus, the following factors need to be considered when evaluating the significance of water levels:

1. Altitudes of measuring points of wells need to be reliable and accurate.

2. Measured or apparent depths of water levels need to be reliable and precise.

3. Corrections need to be made to convert apparent depths or altitudes to true values for holes that are not vertical.

4. Measured water levels need to represent closely the hydraulic heads in the zone of interest, such as the water table or zones likely to transmit fluid.

5. Measured water levels need to be in hydraulic equilibrium with the formation, unaffected by such disturbances as recent drilling or pumping, in order to represent natural conditions.

6. Long-term, seasonal, or other natural fluctuations are small, and these fluctuations need to be accounted for by only comparing water-level measurements that are approximately contemporaneous or by comparing annual averages of water levels.

Land-surface altitudes used in this report are those reported by Holmes and Narver, Inc., contractor to the U.S. Department of Energy. Some values were reported to the nearest foot and others were reported more precisely; in this report the values have been converted to meters, and are rounded to the nearest tenth.

Most of the water levels in table 1 are based on measurements by the U.S. Geological Survey using calibrated steel cables with electrical or mechanical water-level sensors or using pressure transducers. Water levels in the Yucca Mountain area are extremely deep, as much as 750 m below land surface;

Table 1.--Ground-water levels, Yucca Mountain area

Hole or well number: Designation assigned by U.S. Department of Energy.
Location: Nevada State Coordinate System Central Zone (feet).
Hole Depth: Total depth drilled.
Land-surface altitude: Altitude above National Geodetic Vertical Datum of 1929 at well, reported by Holmes & Narver, Inc., contractor to U.S. Department of Energy.
Depth correction: Correction needed to adjust measured depth or altitude to true value because of hole deviation from vertical. The correction is computed for a depth approximately equal to the depth of the measured water level; this correction is obtained from a down-hole gyroscopic survey.
Date measured: Date of a water-level measurement.

Interval: Depth interval of the hole represented by the water-level measurement. Composite levels represent mixed hydraulic heads of the entire interval between the water table or lower end of the casing and the bottom of the hole. Where a specific interval is indicated, the zone was isolated, using inflatable packers for the straddled interval during permeability testing, or using a single packer installed to determine hydraulic head differences above and below the packer.
Depth to water: Depth based on direct measurements of water levels using down-hole wireline equipment, adjusted for depth correction (where available), except where noted.
Altitude: Computed altitude of water level above National Geodetic Vertical Datum of 1929, based on land-surface altitude and measured depth to water (corrected).

Hole or well number	Location (feet) North	Location (feet) East	Hole depth (meters)	Land-surface altitude (meters)	Depth correction (meters)	Date measured	Water level (corrected)[1] Interval (meters)	Water level (corrected)[1] Depth to water (meters)	Water level (corrected)[1] Altitude (meters)
UE-25b#1	765,243	566,416	1220	1200.6	0.25	12/03/83	Composite	470.6	730.8
						08/01/83	471-1199	470.3	730.3
						do.	1199-1220	472.2	728.4
UE-25c#1	757,095	569,680	914	1130.4	.06	11/07/83	Composite	400.3	730.1
UE-25p#1	756,171	571,485	1805	1114	.02	Feb. 1983	383- 500	383.9	729.9
						do.	500- 550	383.5	730.4
						do.	739- 789	383.3	730.6
						do.	764- 834	383.1	730.8
						do.	834- 904	381.1	732.7
						do.	904- 974	382.2	731.7
						do.	974-1044	380.9	733.0
						do.	1044-1114	379.4	734.5
						do.	1110-1180	361.7	[2]752.2
						do.	1117-1301	360.5	[2]753.4
						do.	1180-1301	355.0	[2]758.9
						May 1983	1297-1308	362.0	751.9
						do.	1297-1338	362.3	751.6
						do.	1341-1381	362.3	751.6
						do.	1381-1420	362.4	751.5
						do.	1423-1463	362.5	751.4
						do.	1463-1509	362.4	751.5
						do.	1509-1585	362.5	751.4
						do.	1597-1643	362.7	751.2
						do.	1643-1689	360.0	750.9
						do.	1734-1780	363.1	750.8
						do.	1780-1805	363.0	750.9
						11/07/83	1297-1805	364.7	[3]749.2

Table 1.--*Ground-water levels, Yucca Mountain area*--Continued

Hole or well number	Location (feet) North	Location (feet) East	Hole depth (meters)	Land-surface altitude (meters)	Depth correction (meters)	Date measured	Water level (corrected)[1] Interval (meters)	Water level (corrected)[1] Depth to--water (meters)	Water level (corrected)[1] Altitude (meters)
USW G-1	770,500	561,000	1829	1325.5	0.67	03/23/82	Composite	571.7	753.8
USW-G-2	778,824	560,504	1831	1554.0	.16	09/17/82	Composite	524.9	1029.1
USW G-3	752,780	558,483	1533	1480.2	.57	11/30/83	Composite	750.3	729.9
USW G-4	765,807	563,082	915	1269.6	1.53	04/27/83	Composite	539.5	730.1
USW H-1	770,254	562,388	1829	1302.8	.19	02/25/82	Composite	572.1	730.7
						11/01/83	572- 673	572.4	730.5
						do.	716- 765	572.4	730.5
						do.	1097-1123	571.7	731.2
						do.	1783-1814	518.2	784.7
USW H-3	756,542	558,452	1219	1483.3	.08	11/19/82	Composite	750.8	732.5
						11/03/83	751-1190	750.9	732.4
						do.	1190-1219	729.0	754.1
USW H-4	761,643	563,911	1219	1248.6	.45	12/30/82	Composite	518.7	730.1
						06/16/83	518-1181	518.2	730.8
						do.	1181-1219	518.1	730.9
USW H-5	766,634	558,909	1219	1478.5	0.08	12/22/83	Composite	704.2	774.3
						11/07/83	704-1091	703.8	774.7
						do.	1091-1219	703.8	774.7
USW H-6	763,299	554,075	1220	1301.7	.05	12/15/82	Composite	526.6	775.1
						10/24/83	526-1187	526.1	775.6
						do.	1187-1220	524.7	777.0
USW WT-1	753,941	563,739	515	1201.7	.33	10/31/83	Composite	471.0	730.7
USW WT-2	760,661	561,924	628	1301.4	.53	11/01/83	Composite	571.0	730.4
UE-25 WT#3	745,995	573,384	348	1029.8	.27	10/31/83	Composite	300.5	729.3
UE-25 WT#4	768,512	568,040	482	1167.1	.46	11/01/83	Composite	438.9	728.2
UE-25 WT#6	780,576	567,524	383	1312.9	.24	10/31/83	Composite	283.9	1029.4
USW WT-7	755,570	553,891	491	1197.0	.03	10/24/83	Composite	421.2	775.9
USW WT-10	748,771	553,302	430	1123.2	.03	10/24/83	Composite	347.7	775.5
USW WT-11	739,070	558,377	441	1094.4	.12	10/24/83	Composite	363.9	730.5
UE-25 WT#12	739,726	567,011	399	1074.6	.20	10/31/83	Composite	345.4	729.2
UE-25 WT#13	756,884	578,843	352	1031.8	.01	10/31/83	Composite	303.3	728.5
UE-25 WT#14	761,651	575,210	399	1076.1	.09	11/07/83	Composite	346.2	729.9
UE-25 WT#15	766,116	579,806	415	1082.8	.19	12/01/83	Composite	354.2	728.6
UE-25 WT#16	774,420	570,395	519	1210.5	.06	12/01/83	Composite	472.7	737.8
UE-25 WT#17	748,420	566,212	443	1124.5	.48	11/07/83	Composite	394.6	729.9
J-11	740,968	611,764	405	1050	--	03/22/73	Composite	317.4	732.6
J-12	733,509	581,011	347	953.5	--	12/05/83	Composite	226.2	727.3
J-13	749,209	579,651	1063	1011.3	--	10/31/83	Composite	283.2	728.1
USW VH-1	743,356	533,626	762	963.5	--	02/12/81	Composite	184.2	779.3
USW VH-2	748,320	526,264	1219	974.4	--	04/23/83	Composite	164.0	[4]810.4

[1]Where more than one water-level altitude is reported for a well, the value shown on the map is underscored in the table.
[2]Water level probably not stabilized.
[3]Composite of interval open to rocks of Paleozoic age.
[4]Water level estimated from geophysical logs.

therefore, even a small-percentage error can be significant because gradients are defined by only small differences in water-level altitudes. However, accuracy probably is within several tenths of 1 m, and precision (repeatability of individual measurements) is within 0.1 m.

For those wells in which gyroscopic surveys for hole deviation were made, measured water-level depths and altitudes in table 1 were corrected to obtain true values. These corrections ranged from 0.01 to 1.53 m.

Most water levels in the table and on the maps represent composite hydraulic heads of the entire saturated thicknesses open to the wells. For some wells, water levels shown are for depth intervals considered most representative, usually for the shallowest permeable zones.

For most holes, a succession of unchanging water-level measurements was made, indicating the absence of drilling or pumping disturbances. Complete equilibrium is not assured for well J-13 because this well frequently is pumped to supply drilling water for test holes in the area.

Most measurements were made in 1983; therefore, any long-term trends are not yet evident. In 1983, a program of periodic or continuous water-level monitoring began that will indicate any seasonal fluctuations; preliminary indications are that seasonal ranges of levels are several tenths of a meter or more.

REFERENCES CITED

Carr, W. J., Byers, F. M., Jr., and Orkild, P. P., 1984, Stratigraphic and volcano-tectonic relations of Crater Flat Tuff and some older volcanic units, Nye County, Nevada: U.S. Geological Survey Open-File Report 84-114, 42 p.

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