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OUTLINE OF GEOLOGY OF THE
U12K AND U12K.01 TUNNELS ,
AREA 12 , NEVADA TEST SITE

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By Fred N. Houser

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OUTLINE OF GEOLOGY OF THE U12K AND U12K.01
TUNNELS, AREA 12, NEVADA TEST SITE*

By

Fred N. Houser

1962

Report TEI-817

*Prepared on behalf of the
U.S. Atomic Energy Commission

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OUTLINE OF GEOLOGY OF THE U12k AND U12k.01 TUNNELS,
AREA 12, NEVADA TEST SITE

By F. N. Houser

Descriptive data for the U12k tunnel system are summarized in table 1.

The U12k and U12k.01 tunnels were driven in predominantly air-fall tuffs of the Grouse Canyon and Survey Butte Members of the Oak Spring Formation of Miocene(?) or younger age. The base of the Grouse Canyon Member is exposed in the road cut 500 to 700 feet east of, and at the same approximate elevation as, the portal U12k tunnel. The contact of the Grouse Canyon Member with the younger Survey Butte Member is at 5+63R and 5+56L in U12k.01L (Personnel tunnel) and at 7+08R and 7+03L in U12k.01R (Line of sight tunnel). A total of 165 feet of tuff of the Grouse Canyon Member is exposed in and near the tunnel, but only 74 feet of the Survey Butte Member is exposed in the U12k tunnel system.

The tuffs of the Grouse Canyon and Survey Butte Members are friable, moderately well bedded to structureless, fine to lapilli, vitric, and crystal vitric tuffs that show pronounced cyclic repetitions of texture, structure, color, and composition. The thicknesses of the individual cyclic sets may vary as much as 25 percent within distances of 100 feet along bedding.

Table 1.--Descriptive data for U12k tunnel system, Nevada Test Site

	U12k tunnel	U12k.01 tunnel
Portal of tunnel		
Nevada State coordinates:		
North-----	899,105 (est.)	899,310 (est.)
East-----	648,098 (est.)	648,098 (est.)
Elevation (feet)-----	5,635	5,637 (est.)
Proposed working point		
Nevada State coordinates:		
North-----	899,542	900,192
East-----	648,072	648,268
Working point (feet)-----	5,640 (est.)	5,650
Vertical cover (feet)-----	293	625
Minimum cover (feet)-----	245	545
Length (feet) (from U12k portal)-----	452	1,125 (Personnel tunnel)
Bearing (predominant)-----	North	N. 5° E,

The major cyclic sets occur throughout the Grouse Canyon Member except for the middle part of the member and range from 2 to 19 feet in thickness. (See stratigraphic section, table 2.) The typical set consists of a light yellowish-gray to yellow-gray, thick-bedded to structureless, pumiceous, lapilli, vitric tuff, that grades upward into a brown-gray to red-brown, fine to coarse, vitric tuffs. The lower lapilli tuffs comprise most of each set. The lower contacts of the set are sharp; some are irregular.

The typical cyclic set of the Survey Butte Member ranges from 2 to 18 feet in thickness and consists of coarse white to light-gray, well-bedded to well-laminated, vitric and crystal tuffs in the lower part of each set that grade upward into fine to coarse, brown-gray, indistinctly bedded to structureless, vitric and crystal tuffs. In the thicker sets, the brown-gray tuffs are most abundant. The lower contacts of the sets are sharp and commonly slightly irregular; rounded inclusions of vitric tuffs are common.

The attitudes of the beds are fairly consistent throughout the tunnel, but significant variations occur. The beds of the Grouse Canyon Member from portal to 2+00 in the U12k tunnel strike generally N. 30° E., and dip 12° to 16° NW. From 2+00 to the U12k chamber and throughout the Grouse Canyon Member exposures in U12k.01 tunnel, the beds strike N. 55° E. and dip 13° NW. The beds in the overlying Survey Butte Member strike N. 50° E. and dip 18° NW. The 5° greater dip in the tuffs of the Survey Butte Member suggests a local unconformity between the two members.

Faults are rare throughout the tunnel system except near the portal where they are related to the nearby eroded slope; they strike generally N. 45° E. to east-west and dip 73° to 87° either northerly or southerly. Joints are not common nor well developed; most are high angle. One set parallels the strikes of the beds and another parallels the dip direction.

The major lithologic and mineralogic components of tuffs in the vicinity of the U12k.01 chamber were determined from X-ray diffraction analyses (table 3). The chemical composition of these tuffs is given in tables 4 and 5; porosity, density, and water content are given in table 6. Both the rapid rock analyses and the physical properties have been averaged by weighing the results for the thickness of rock the sample is considered to represent.

Table 2.--Stratigraphic section measured in and near U12k tunnel

By F. N. Houser, W. L. Emerick, and V. R. Wilmarth

[Base of section is in road cut 500 feet east of U12k tunnel portal.
Within tunnel system, section was measured along U12k to 2+05 and
along U12k.01L.]

Unit	Description (all percentages are approximate)	Thickness (feet)
------	--	---------------------

Oak Spring Formation (incomplete):

Survey Butte Member (incomplete):

Top of strata exposed in U12k tunnel system.

K29 Tuff, vitric, crystal, coarse, pumiceous, white to light-gray and interbedded brown glass--coarse to lapilli white pumice (30 to 60 percent), and coarse to lapilli black obsidian (1 to 5 percent); crystals (10 to 20 percent)--quartz and feldspar(?) lithic fragments (5 to 10 percent)--coarse, dark-gray, brown and black; lower contact is sharp and slightly irregular (0.05 foot) at 0+13R and 0+32L in short drift from 8+26 in hook of U12k.01L.

Light-tan lapilli, pumiceous, vitric, tuff, 1.5 feet thick, is based 3.8 feet above base of unit and grades upward to coarse pumiceous tuff. Lower contact of 1.5-foot bed is sharp and straight; upper contact is moderately gradational.

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
	Upper 1.7 feet of unit shows many beds truncated at slight to moderate angles. Light-tan lapilli pumiceous tuff exposed for 1.0 foot at top of unit in the end of short drift should probably be included in this unit-----	minimum 10.6
K28	Tuff, crystal, fine, light-brown; crystals--quartz and feldspar; very little vitric groundmass; fine to coarse, brown and black lithic fragments (2 percent); indistinct bedding; beds 0.1 to 0.5 foot thick; lower contact sharp at 7+63R and 7+61L in U12k.01L tunnel.	
	Lower 2 to 4 feet is a very light gray, coarse, lithic, vitric, crystal tuff that contains coarse pumice (5 to 10 percent), fresh shard groundmass (40 percent) and coarse black lithic fragments (5 to 20 percent); well-bedded; beds 0.05 to 0.3 foot thick; grades upward by interbedding-----	18.0

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
K27	Tuff, vitric, crystal, coarse, light-gray in lower part; glass--fresh shards and white pumice; crystals (40 percent)--quartz and feldspar; lithic fragments (5 to 15 percent)--gray and brown; well-sorted; well-bedded; beds 0.07 to 1.0 foot thick; grades to light brown-gray tuff of similar composition and laminated with very light gray tuff in upper 4.0 feet, laminae (0.01 to 0.1 foot thick), less distinctly bedded in upper 0.5 to 1.0 foot; lower contact sharp at 7+22R and 7+11L in U12k.01L and 8+78R and 8+70L in U12k.01R tunnels-----	14.0
K26	Tuff, crystal and crystal-vitric, coarse, white and medium brown; well bedded; beds are 0.03 to 0.2 foot thick; coarse lithic fragments range from .1 to 20 percent; coarse and fine lapilli white pumice (10 to 30 percent); and crystals (10 to 30 percent) quartz and feldspar (base not mapped). At 1.5 feet from base, unit grades to structureless light-brown, fine to coarse, pumiceous, vitric tuff, 3.9 feet thick-----	5.4

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
K25	<p>Tuff, vitric, coarse, pumiceous, light-gray; glass--fresh shards and coarse white pumice (20 percent); coarse brown lithic fragments (10 percent); crystals (2 percent)--quartz and feldspar; moderately well to well bedded; beds 0.2 to 1.2 feet thick; lower contact sharp at 6+83R and 6+73L in U12k.01L and 8+38R and 8+23L in U12k.01R tunnels-----</p>	2.3
K24	<p>Tuff, vitric, fine (becomes coarser upward), white to light-gray; glass-shards; and fine to coarse white pumice; crystals--fine quartz and feldspar (2 percent) and bronze-colored biotite (1 percent).</p> <p>Grades upward at 2.5 feet from base to: tuff, crystal, coarse, pumiceous, light- to medium- brown; crystals--coarse quartz and feldspar (60 percent) and biotite (<1 percent); glass-- coarse white pumice (25 percent); lithic fragments (10 to 15 percent)--coarse gray and brown; indistinctly bedded; beds 0.5 to 5.0 feet thick.</p>	

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
	Some beds in upper part are white crystal tuffs with rounded inclusions up to 0.5 foot across of pumiceous tuff, and up to 25 percent lithic fragments and glass. White pumiceous tuff 0.5 to 1.0 foot thick is based 1.0 to 3.0 feet from top.	
	Lower contact sharp at 5+76R and 5+63L in U12k.01L and 7+15R and 7+10L in U12k.01R tunnels-----	21.5
K23	Tuff, vitric, coarse, pumiceous, white to very light gray; contains 10 percent fine lithic fragments.	
	Grades upward to pumiceous vitric tuff, 1.0 foot thick, that is light gray and coarse at base grading to brown and fine at top and that contains rounded 0.1- to 0.25-foot inclusions. Lower contact is moderately sharp to sharp at 5+63R and 5+56L in U12k.01L and 7+08R and 7+03L in U12k.01R tunnels-----	2.0
	Total Survey Butte Member (incomplete)	73.8

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
Grouse Canyon Member:		
K22	<p>Tuff, like unit K20 except light gray, and some lapilli pumice up to 2 cm.</p> <p>At 15 feet from base, grades to tuff, vitric, coarse, pumiceous, light-brown; glass--fresh shards, fine lapilli pumice (5 to 10 percent), and black to dark-gray coarse to lapilli, obsidian (2 to 5 percent); crystals (15 percent)--quartz and feldspar; coarse lithic fragments (5 percent); structureless to moderately well bedded; lower contact sharp but irregular through 0.5-foot interval that contains common reworked(?) blue-gray lapilli pumice like that in lower part; lower contact at 4+83R and 4+71L in U12k.01L, and 6+30R in U12k.01R tunnel-----</p>	19.0
K21	<p>Tuff, like unit K20 but lapilli pumice (75 to 80 percent, decreasing upward), obsidian fragments (2 percent) are coarse; crystals (2 percent); tuff with coarse black obsidian grades upward to brown; lower contact moderately sharp to gradational at 4+02 and 3+94 in U12k.01L and 5+40R and 5+34L in U12k.01R tunnels.</p>	

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
	Common pink opalized lenticular masses. Rounded inclusions (several inches across) of coarse brown tuff-----	13.0
K20	Tuff, vitric, lapilli, pumiceous, light-gray; glass--fine shards, lapilli light-gray pumice (70 percent) and coarse to lapilli black obsidian fragments (5 to 10 percent); crystals (5 percent)--quartz and feldspar; coarse brown and black lithic fragments (10 percent); moderately well bedded; beds 0.2 to 3.0 feet thick; lower contact sharp at 3+14R and 3+00L in U12k.01L, and 4+63R and 4+52L in U12k.01R tunnels. Some coarse well-bedded tuffs especially in upper part; some show scour-and-fill structures. Upper 1.0 foot is brown-----	18.0

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
K19	<p>Tuff, like unit K9 except lapilli pumice (10 percent), lapilli obsidian (3 percent), and contains pink opalized irregular lenticular masses; upper 2.0 feet is coarse tuff; lower contact sharp at 2+62R and 2+55L in U12k.01L, and 4+02R and 3+93L in U12k.01R tunnels.</p> <p>Grades, at 3.2 feet from base, to tuff, vitric, pumiceous, fine, light-brown; glass--fine shards, light-gray lapilli pumice (10 to 20 percent), and black obsidian fragments (3 percent); crystals (5 percent)--quartz and feldspar.</p> <p>Upper 1.0 foot is light brownish-gray tuff, coarse at base to fine at top, fine lapilli pumice (30 percent at base to none at top); lithic fragments absent in upper 0.3 foot; well-sorted in upper part; pink opalized irregular lenses, partly vuggy where >0.05 foot thick, average 0.3 X 0.2 foot-----</p>	7.0

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
K18	<p>Tuff, vitric, coarse, pumiceous, light-gray, grades to tan in upper 0.2 foot; glass shards, coarse pumice (40 percent), and obsidian (3 percent); lithic fragments (5 percent); lower contact moderately sharp at 4+51R and 4+52L and approximately 2.5 feet above floor at 4+56 in U12k tunnel (base not mapped in U12k.01 tunnel.)</p> <p>Tuff like unit K9 is based 0.4 foot from base and is 1.8 feet thick-----</p>	3.2
K17	<p>Tuff, vitric, fine pumiceous, light-gray; glass--fresh fine shards, coarse white pumice (10 percent increases upward to 30 percent), and black perlitic obsidian; crystals (5 to 10 percent)--quartz and feldspar; lithic fragments (5 percent), average less than .1 mm brown and black; moderately well bedded; beds 0.1 to 0.7 foot thick; lower contact moderately sharp at 4+29L and 4+27R in U12k, 2+03R and 1+97L in U12k.01L, and 3+60R and 3+41L in U12k.01R tunnels.</p>	

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
	Grades through 0.1- to 0.2-foot interval at 0.5 foot from top to: tuff, vitric, pumiceous, coarse, light-brown; glass--fresh fine shards, less than 1 percent fine to coarser black perlitic obsidian fragments, and fine white lapilli pumice (20 percent); lithic fragments (5 percent) coarse and dark-brown-----	4.0
K16	Lower part is 1.0 foot thick and consists of: tuff vitric, lithic, coarse to lapilli, light- gray and brown-gray; glass, fine shards, fine to lapilli pumice (5 to 10 percent), and black obsidian (5 percent), 1 to 7 mm, average 2 mm; crystals (10 percent)--quartz and feldspar; lithic fragments (5 to 10 percent)--red and brown, 1 mm to 2 cm, decrease in abundance upward; grades to: Middle part is 2.1 feet thick and consists of light-brown coarse tuff with more pumice than lower part and sparse lithic fragments.	

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
	<p>Upper part is 1.5 feet thick and consists of tan, fine tuff moderately well bedded that contains no crystals, lithic fragments, pumice, or black obsidian in lower half and only 2 to 3 percent crystals and 3 percent lithic fragments in upper half.</p> <p>Lower contact is sharp at 1+85R and 1+77L in U12k.01L, 3+25R and 3+17L in U12k.01R, and 4+07R and 3+99L in U12k tunnels-----</p>	4.6
K15	<p>Tuff, interbeds and interlaminae of tuff 0.02 to 4.0 feet thick like that of units K9 and K11, subunit K12a, and top subunit of K13 in sequence from top to bottom and with exceptions as noted below; lower contact sharp at 2+82R and 2+71L in U12k, 0+66R and 0+52L in U12k.01L, and 2+14R and 2+02L in U12k.01R tunnels.</p>	

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
Like unit or subunit	Exceptions	Thickness of bed or laminae (feet)
K9	Pink, irregular, lenticular (0.02 X 0.2 foot) masses, probably opalized; moderately well bedded.	4.0
K9	Fine lapilli pumice.	2.9
K11		.1
K9	Fine lapilli pumice, coarse pumice in 0.3-foot interval; moderately well bedded.	1.25
K12a	Very fine gray tuff is at base.	.05
K9	Obsidian, 10 percent; moderately well bedded.	2.3
	Coarse pumiceous vitric tuff.	.1
K9	Fine and medium lapilli pumice.	.2
K12a		.2
K9	Fine and medium lapilli pumice.	.3
K11	Moderately sharp contact.	.05
K9	Fine lapilli pumice.	1.1
K11	Gradational contact.	.15

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
Like unit or subunit	Exceptions	Thickness of bed or laminae (feet)
K9	Fine lapilli pumice.	2.7
K11		.1
K9	Obsidian comprises 10 percent; fine lapilli pumice; moderately well bedded.	1.3
K11	Sharp upper contact.	.02
K9	Obsidian less common.	.6
K11		.1
K9	Fine lapilli pumice.	.25
K11		.1
Like top of subunit K13.		.15
Total of unit K15 (rounded)-----		<u>18.0</u>

Table 2, --Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
K14	Tuff, interbeds and interlaminae of tuff 0.03 to 3.7 foot thick like that of unit K9 and subunit K12a, in sequence from top to bottom and with exceptions as noted below; lower contact sharp (not mapped).	
Like unit or subunit	Exceptions	Thickness of bed or laminae (feet)
K9	Aggregate of laminae.	.9
K9	Fine lapilli; obsidian averages 1 mm and 5 to 10 percent; aggregate of laminae and beds 0.1 to 3.0 feet thick.	3.6
K12a		.03
K9	Obsidian fragments average 2 to 5 percent and are up to 1 cm across.	3.7
Total of unit K14 (rounded)-----		8.2

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
K13	Tuff, interbeds and interlaminae of tuff, 0.05 to 1.5 foot thick, that are like the tuffs of units K9 and K11, and subunit K12a in sequence from top to bottom and with exceptions as noted below; well bedded and laminated; lower contact at 1+42R and 1+30L in U12k tunnel.	
Like unit or subunit	Exceptions	Thickness of bed or laminae (feet)
K9	Coarse.	.2
K11		1.5
K9	Aggregate of very thin laminae.	.75
K12a		.12
K9	Coarse.	.75
K12a		.05
K9		1.3
K9	Fine (4 mm to 8 mm) lapilli; obsidian averages 5 percent, but 15 to 20 percent at top.	.9

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
Like unit or subunit	Exceptions	Thickness of bed or laminae (feet)
K9	Coarse, with .03 foot thick tuff like unit K11, .05 foot from base.	.15
K9		.75
K11		.05
K9		.5
K11		.05
K9	Somewhat smaller lapilli.	.2
K9	Lapilli tuff at base grades to coarse tuff at top; obsidian >50 percent at top.	.4
K9	Obsidian fragments are 30 percent and become finer upward.	.7
K9	Fine to coarse pumice average 2 mm. Well-bedded, fine, light-gray tuff.	1.0 .43
Total of unit K13-----		9.8

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
K12	Tuff, like unit K9; dark-gray obsidian fragments comprise 2 percent; structureless except for two thin laminated tuff beds; lower contact sharp at 1+31R and 0+92L in U12k tunnel (not mapped).	
K12b.	Dark-gray, coarse to lapilli vitric tuff 0.3 foot thick, 3.9 feet from base of unit has light-gray, very fine, well-sorted tuffs about 0.01 foot thick at top and bottom.	
K12a.	Friable dark-gray coarse vitric tuff 0.1 to 0.12 foot thick; 0.9 foot from base of unit; contains a light-gray, very fine, well-sorted tuff 0.01 to 0.07 foot thick.	
	Total of unit K12-----	4.7
K11	Tuff, vitric, coarse, black to dark gray; glass-- coarse, dark-gray to black, perlitic obsidian fragments; well-laminated, 3 mm to 1 cm thick; friable; lower contact very sharp at 1+30R and 0+91L in U12k tunnel.	

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
	K11a. Gray, very fine layer of tuff 5 mm thick about 0.1 foot from base has very sharp and slightly undulatory contacts.	
	Total of unit K11-----	0.7
K10	Tuff, vitric, lapilli, pumiceous, light yellowish- gray; glass--fine light-gray shards, and pale- yellow and gray lapilli pumice, lapilli generally larger at base, black obsidian fragments, common in 1 cm thick laminae, are 2 mm across and perlite (up to 5 percent of upper 2.5 feet); crystals and lithic fragments sparse; well to moderately well bedded; lower contact sharp at 0+49R and 0+36L in U12k tunnel.	
	Thin (2 cm) layer of laminated dark gray to black, fine to coarse, crystal vitric tuff 3.5 feet above base; crystals--quartz, feldspar; glass-- fine to coarse, black-----	6.0

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
K9	Tuff, vitric, lapilli, pumiceous, light yellowish-gray; glass--fine, fresh, light-gray groundmass shards, and pale-yellow and gray lapilli pumice (3 mm to 1 cm, average 8 mm); the gray pumice is fresh, the pale yellow is slightly zeolitized; fragments of perlitic black and dark-gray obsidian (2 to 8 mm) are progressively more abundant upward and comprise up to 15 percent in upper few inches (average 5 percent in upper one-third); crystals and lithic fragments sparse; structureless in lower half, moderately well bedded in upper half; beds 0.3 to 1.5 feet thick; lower contact sharp; base of unit at minus 0+04 at track level at U12k portal-----	9.2
K8	Tuff, like unit K2, except: pumice is coarse (75 percent); coarse, dark-green to black, perlitic obsidian fragments are common (10 percent); lithic fragments comprise 1 percent; and crystals are rare. Lower 0.6 foot is lapilli pumiceous tuff. Upper 0.4 foot grades to reddish brown-gray tuff-----	2.2

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
K7	Tuff, like unit K2, except lithic fragments are brown and gray, fine to lapilli, and abundant (5 to 30 percent) in upper 0.5 foot; and lithic fragments (3 percent) in basal 2 feet are angular, 3 mm to 1 cm, average 5 mm. Upper part concealed-----	5.5
K6	Tuff, like unit K3, except beds 1.0 to 2.0 feet thick-----	3.5
K5	Tuff, vitric, interbedded coarse and fine lapilli, pumiceous, light yellowish gray to pale greenish yellow; composition like unit K2 except lithic content variable vertically (1 to 5 percent); moderately well to indistinctly bedded, beds 1 to 5 feet thick; upper contact moderately sharp. Grades to reddish brown-gray tuff in upper 0.7 foot-----	13.0
K4	Tuff, interbeds, 0.5 to 2.5 feet thick, of tuff like units K2 and K3; upper contact gradational. Grades to pumiceous, coarse, reddish-brown tuff in upper 0.6 foot-----	5.6

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
K3	Tuff, like unit K2, except lapilli pumice are finer, average about 6 mm; consists of one bed; lower contact sharp. Grades to pumiceous, coarse, reddish brown-gray tuff in upper 0.7 foot-----	4.4
K2	Tuff, vitric, lapilli, pumiceous, light yellowish-gray to pale greenish-yellow; glass (90 to 95 percent)--fine light-gray shards and pumice, lapilli (4 to 12 mm, average 8 mm), gray and pale yellow, gray pumice is vitric, pale-yellow pumice is slightly zeolitized; crystals sparse (<5 percent)--quartz and feldspar(?); lithic fragments sparse (<5 percent)--brown and black; consists of one bed; lower contact sharp. Grades to pumiceous, coarse, reddish-brown tuff of same composition in upper 0.8 foot except much less lapilli pumice-----	about 5.0
Total Grouse Canyon Member		163.7

Table 2.--Stratigraphic section measured in and near U12k tunnel--
Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
Lower member (incomplete):		
K1	Tuff, vitric, coarse, pumiceous, light-gray, grades to light brownish-gray in upper half; glass (75 to 90 percent)--fine to coarse, pale yellow to whitish gray; fine (4 to 8 mm) lapilli; crystals (5 to 15 percent)-- quartz feldspar, and biotite; lithic fragments (5 to 10 percent)--reddish-brown, brown, and black; consists of one bed-----	1.7

Table 3. --X-ray diffractometer analyses of six samples from the
vicinity of the U12k.01 chamber, Nevada Test Site

[Analyst: Theodore Botinelly. Analyses are approximate and are reported in five groups: <10, 10 to 25, 25 to 50, 50 to 75, and >75 percent. For predominant clay, M = montmorillonite and I = illite. 0 = not detected. Asterisk (*) indicates samples from chamber.]

Sample number U12k.01-	Glass	Quartz	Feldspar	Clays	Cristobalite
820SF	>75	0	<10	<10I	0
855L+4	50-75	<10	<10	<10(?) I	<10(?)
923L+5*	>75	<10	<10	0	0
927L+4*	25-50	<10	<10	25-75M	0
934LF*	50-75	<10	<10	<10I	0
750R+5	50-75	<10(?)	0	10-25M	0
Average---	50-75	<10	<10	25	0

Table 4.--Chemical analyses of six samples from the vicinity of U12k.01 chamber, Nevada Test Site

[Analyzed by methods similar to those described in USGS Bulletin 1036-C, Rapid analysis of silicate rocks, by Shapiro and Brannock, 1956. Analysts: P. L. D. Elmore, S. D. Botts, and G. W. Chloee.]

Sample number-----	U12k.01- 750R+5	U12k.01- 934LF	U12k.01- 927L+4	U12k.01- 923L+5	U12k.01- 855L+4	U12k.01- 820SF	Average weighted for thicknesses represented
Thickness represented in feet-----	4.0	4.0	3.8	3.2	7.8	8.1	
SiO ₂	73.0	72.9	73.3	72.6	72.8	71.5	72.5
Al ₂ O ₃	11.9	12.3	12.0	12.2	12.4	12.7	12.3
Fe ₂ O ₃	.71	.84	.74	.84	.66	.94	.79
FeO	.28	.26	.26	.26	.34	.46	.34
MgO	.55	.30	.45	.35	.41	.36	.40
CaO	.63	.62	.68	.55	.62	.68	.64
Na ₂ O	2.3	2.3	2.2	2.2	2.3	2.6	2.36
K ₂ O	4.8	5.0	4.4	5.0	4.6	4.8	4.74
H ₂ O	5.4	5.1	5.6	5.9	5.4	5.5	5.46
TiO ₂	.08	.10	.08	.08	.11	.16	.11
P ₂ O ₅	.01	.01	.01	.01	.01	.02	.01
MnO	.08	.08	.08	.08	.08	.09	.08
CO ₂	<.05	<.05	<.05	<.05	<.05	<.05	<.05
Sum-----	100	100	100	100	100	100	

Table 5.--Semiquantitative spectrographic analyses of samples from the U12k.01 chamber, Nevada Test Site

[Analyst: J. C. Hamilton. Results are reported in percent to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, and 0.1, etc, which represent approximate midpoints of group data on a geometric scale. The assigned group for semiquantitative results will include the quantitative value about 30 percent of the time.

Looked for but not detected: Ag, As, Au, B, Bi, Cd, Co, Ge, Hf, Hg, In, Li, Mo, Ni, Pd, Pt, Re, Sb, Sc, Sn, Ta, Te, Th, Tl, U, V, W, and Zn.]

Sample number--	U12k.01-750R+5	U12k.01-934LF	U12k.01-927L+4	U12k.01-923L+5	U12k.01-855L+4	U12k.01-820SF
Ba	.007	.01	.007	.005	.007	.015
Be	.0003	.0003	.0003	.0002	.0002	.00015
Ce	.015	1/ 0	0	0	0	.015
Cr	0	.00015	.00015	.00015	.00015	.00015
Cu	.001	.0015	.0005	.0007	.003	.001
Ga	.002	.002	.002	.002	.002	.002
La	.007	0	0	.005	0	.007
Nb	.0015	.0015	.0015	.0015	.002	.002
Pb	.002	.002	.003	.002	.002	.002
Sr	.003	.005	.003	.003	.005	.005
Y	.003	.002	.002	.002	.002	.002
Yb	.0003	.0002	.0002	.0002	.0002	.0002
Zr	.007	.007	.007	.007	.007	.015
Pr ^{2/}	0			0		0
Nd ^{2/}	0			0		0
Sm ^{2/}	0			0		0
Eu ^{2/}	0			0		0

1/ Looked for but not detected.

2/ Looked for only when La or Ce found.

Table 6.--Density, porosity, water content, and magnetic susceptibility determinations on samples
from the vicinity of the U12k.01 chamber, Nevada Test Site

[Analysts: D. R. Cunningham, John Moreland, and E. F. Monk.]

Sample number U12k.01-	Thickness represented (feet)	Dry bulk density (mercury method) (g/cc)	Grain density (powder method) (g/cc)	Porosity (percent)	Water content (percent by weight)	Water content by volume (g/cc)	Natural state bulk density (g/cc)	Magnetic susceptibility (air-dried chips) (cgs units X 10 ⁻⁶)
820SF	8.1	Sample incoherent.						65.8
855L+4	7.8	1.53	2.25	31.8	11.7	.203	1.74	112.0
923L+5	3.2	1.27	2.18	41.8	14.2	.210	1.48	71.5
927L+4	3.8	1.46	2.19	33.2	10.3	.168	1.63	52.4
934LF	4.0	Sample incoherent.						70.0
750R+5	4.0	1.56	2.32	32.6	7.2	.121	1.68	73.9
Average weighted for thicknesses represented (see table 2)-----		1.48	2.24	34.0	10.9	.180	1.66	78.0

Base map from Holmes and Narver Inc.

Geology by F.N. Houser, W.L. Merick
and V.R. Wilmarth, October-December 1961

GEOLOGIC MAP AND CROSS SECTION OF THE U12k & U12k.01 TUNNELS

EXPLANATION

All units in Oak Spring Formation

K29

Set consisting of bedded white to light-gray and interbedded brown pumiceous coarse crystal vitric tuff; top not exposed; minimum of 10.6 feet thick

K28

Set consisting of well-bedded very light gray coarse vitric crystal tuff that grades upward into indistinctly to structureless light-brown crystal tuff; 18 feet thick

K27

K26

K25

K24

K23

Sets similar to unit K28

K22

Set consisting of light-gray pumiceous lapilli vitric tuff that grades upward to light-brown coarse vitric tuff; 19 feet thick

K21

K20

K19

Sets similar to unit K22

K18

K17

K16

K15

K14

K13

K12

K11

Sets of gray, dark-gray, light yellowish-gray, and black well-bedded to moderately well bedded and laminated, partly pumiceous, fine to lapilli vitric tuffs. One layer, the lower foot of K16, is correlated with an agglomerate that is common elsewhere in the Whiterock Spring quadrangle and marks the approximate base of the upper part of the Grouse Canyon Member

K10

Set consisting of light yellowish-gray pumiceous lapilli vitric tuff; sharp contacts at top and bottom; 6 feet thick

K9

Set similar to unit K10

Contact

Dashed where inferred

Fault, showing dip

Dashed where inferred

Strike and dip of beds

Joint

Survey station

Sample location