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OUTLINE OF GEOLOGY OF THE
U12j AND U12j.01 TUNNELS,
NEVADA TEST SITE

By W. H. Laraway and F. N. Houser

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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W. H. Laraway and F. N. Houser

September 1962

Report TEI-828

This report is preliminary and
has not been edited for conformity
with Geological Survey format.

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OUTLINE OF GEOLOGY OF THE U12j AND U12j.01 TUNNELS,
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By

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Descriptive data for the U12j tunnel system are summarized in table 1.

The U12j tunnel system was driven entirely in the Survey Butte Member of the Piapi Canyon Formation of Pliocene or younger age (fig. 1). The base of the Survey Butte Member is exposed in the road cut approximately 600 to 700 feet east of the U12j tunnel portal. At least 70 feet of the member is exposed in the tunnel, where it is composed entirely of light-gray to brown, well-bedded to structureless, fine to lapilli, vitric and crystal vitric, friable, air-fall tuffs (fig. 2). The lower units (J1-J7) exposed in the U12j tunnel system show a marked cyclic repetition of texture, color, and composition. Each cycle is characterized by a light-gray, coarse to lapilli, well-bedded, pumiceous tuff in the lower part and brown-gray, fine to coarse, structureless tuff in the upper part. Units J8 and J9, in which most of the U12j tunnel system is driven, are markedly homogeneous, brown-gray, vitric tuffs (fig. 2, and table 2).

The attitudes of the beds are fairly consistent and only one major variation in strike occurs. From the portal to approximately 0+00 in the L.O.S. tunnel the beds strike from N. 15° to 25° E.;

Table 1.--Descriptive data for U12j tunnel system, Nevada Test Site

	U12j tunnel	U12j.01 tunnel
Portal of tunnel		
Nevada State coordinates (rounded):		
North-----	899,063	899,440
East-----	647,063	647,258
Elevation (feet)-----	5,635	*5,639
Proposed working point		
Nevada State coordinates (rounded):		
North-----	899,560	900,260
East-----	647,232	646,900
Working point elevation (feet)-----	*5,640	*5,649
Vertical cover (feet)-----	298	655
Minimum cover (feet)-----	230	610
Length (feet) from U12j portal-----	512	1,385 (L.O.S. tunnel)
Bearing (predominant)-----	North	N. 10°47'45" W. (L.O.S. tunnel)

* Estimate.

in the vicinity of 0+00 L.O.S. they strike approximately N. 55° E. Although minor variations occur, the beds generally dip 5°-10° NW.

Minor faulting occurs in two places in the tunnel--near the portal, between stations 0+00 and 1+00, and in the Personnel tunnel between 0+00 and 2+00.

Near the portal there are nine faults of very small displacement. They are filled with brown clay and are probably related to the nearby eroded slope. This group of faults strikes generally eastward and dips steeply south.

The faults between 0+00 and 2+00 in the Personnel tunnel strike N. 75°-85° E. and with one exception, dip 70°-86° SE. The displacement, although not discernible, is believed to be small. Few of the faults are traceable eastward into the L.O.S. tunnel. Several faults are filled, in thicknesses of from 0.02 to 0.1 foot, with brown clay like that in the faults near the portal, suggesting that they too may be related to the eroded surface.

Physical properties of samples from the U12j tunnel system are shown in table 3. Chemical analyses and semiquantitative spectrographic analyses of two samples from the U12j.01 chamber are given in tables 4 and 5, respectively. Locations of samples are shown on the geologic map (fig. 1).

Table 2.--Stratigraphic section measured in U12j tunnel

By F. N. Houser and W. H. Laraway

Unit	Description (all percentages are approximate)	Thickness (feet)
J9	Tuff, crystal, fine and coarse, gray and brown; a few beds are lapilli tuffs in U12j.01R; glass (20 to 40 percent)--shards and gray obsidian (<5 percent); crystals (40 to 75 percent)--quartz, feldspar, magnetite, and hornblende(?) (common to abundant); lithic fragments (5 to 20 percent)--brown and gray; well-laminated and bedded (0.01 to 0.3 foot thick); flat, some lenticular; at 4+87 in U12j.01L beds strike N. 55° E. and dip 5° SE.; bedded sequence is minimum of 6 feet thick; bottom contact highly irregular (up to 6 feet of relief)-----	7.0
J8	Tuff, vitric, crystal, fine to coarse, brown; glass (50 to 60 percent)--very fine shards and coarse white pumice (2 to 3 percent); crystals (35 percent)--quartz, feldspar, magnetite(?); lithic fragments (5 to 10 percent) red-brown, brown and dark-gray; structureless, except locally where moderately well-bedded; beds (0.1 to 0.4 foot thick) grade out laterally or are cut by erosional surface; neither top of unit nor full vertical extent of unit are observable in tunnel; unit is abnormally thin in places due to a scour contact at top. Minimum thickness probably-----	20.0
J7	Tuff, like the lower 4.5 feet of J2 except crystals comprise 40 to 50 percent and lithic grains 5 to 10 percent; at 2.5 feet above base grades to brown-gray fine vitric crystal structureless tuff that is 60 to 70 percent fine crystals; 5 percent lithic grains; lithic grains become more abundant and larger upward; some 0.1- to 0.5-foot beds and laminae in upper part. Estimated thickness-----	20.0

Table 2.--Stratigraphic section measured in U12j tunnel--Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
J6	<p>Tuff, vitric, crystal, coarse, white; glass (70 to 80 percent) crystals (20 to 30 percent) are same as lower 4.5 feet of J2; lithics (5 percent); moderately well bedded and laminated 0.02 to 0.3 foot thick; at 0.9 foot from base grades to brown-gray tuff like J1 except contains 30 to 60 percent crystals.</p> <p>Contains some rounded brown inclusions in basal 0.5 foot and common angular and rounded inclusions of tuff 0.3 to 0.6 foot in diameter in upper few feet.</p> <p>Very dark brown, nonpersistent layer, 0.5 foot thick is 4.5 feet below top.</p> <p>White coarse tuffs, 0.1 to 0.3 foot thick, one with abundant lithic grains, are about 4.0 feet from top.</p> <p>Top contact is sharp at 0+55L in U12j.01 L.O.S. tunnel and 1+48R in access tunnel, but elsewhere the contact is obscure or impossible to recognize because overlying white tuff is locally absent.</p> <p>Total thickness-----</p>	9.5
J5	<p>Tuff, lower part like lower 4.5 feet of J2 except 20 to 30 percent crystals and 2 to 5 percent lithic fragments; has 0.3-foot white pumiceous lapilli tuff at base; at 0.8 foot above base grades to brown-gray tuff like J1 except crystals comprise 10 to 40 percent and contains rounded inclusions of light-gray tuff 0.3 to 0.5 foot in diameter.</p> <p>Base of white to light tan-gray coarse tuff is 1.4 to 1.7 feet above base of J5 and marks a bottom of separate cyclic set.</p>	

Table 2.--Stratigraphic section measured in U12j tunnel--Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
	Top contact is at 0+68R and 0+68L in U12j.01 tunnel-----	5.6
J4	Tuff like lower part of J3 except has white pumiceous coarse to fine lapilli tuff 0.3 foot thick at base; at 2.8 feet above base grades into brown-gray tuff like upper part of J1 except contains 40 to 50 percent crystals; top contact sharp and slightly irregular to gradational through 0.2 foot stratigraphically and cuts tunnel at 4+57R-----	6.8
J3	Tuff like lower 4.5 feet of J2 except 20 to 30 percent crystals and 2 to 5 percent lithic fragments; beds are from 0.8 to 1.5 feet thick and differ slightly in lithology; at 2.8 to 4.4 feet above base grades upward to brown-gray tuff similar to J1 except contains 40 to 50 percent crystals; top contact sharp at 3+30L and 3+76R-----	5.5
J2	Tuff, vitric, coarse, very light gray to white; glass (85 percent)--fine shards, coarse to fine lapilli white pumice, and coarse, green-gray and gray obsidian fragments; crystals (5 percent)--feldspar, coarse, lithic fragments (5 to 10 percent) coarse, gray to dark-gray, well-bedded; at 4.5 feet above base grades to brown-gray structureless tuff similar to J1, except contains 3 percent lithic grains and 10 to 20 percent crystals; about 0.2 and 1.0 foot below top contains opal nodules with white to pink rinds; top contact sharp at 2+73R and 2+29L-----	9.2

Table 2.--Stratigraphic section measured in U12j tunnel--Continued

Unit	Description (all percentages are approximate)	Thickness (feet)
J1	<p>Tuff, vitric, crystal, fine to coarse, brown-gray; glass (70 percent); fine shards partly altered to clay near portal, coarse pumice partly altered to clay near portal, upper 3.5 feet contains a few but prominent lapilli of white pumice; crystals (30 percent), feldspar, quartz(?) and trace of bronze biotite, all coarse; lithic grains (<1 percent); friable; base of tuff below tunnel floor.</p> <p>Bed 1.0 foot thick, and based 3.5 feet below top, contains coarse to lapilli pumice, 10 percent coarse lithic and obsidian fragments, and rounded tuff inclusions 0.4 foot in diameter; contacts are gradational. Unit is very light gray to brown gray near portal. Top contact is sharp at 1+17R and 0+96L.</p> <p>Minimum thickness-----</p>	6.5

Table 3.--Density, porosity, water content, and magnetic susceptibility determinations on samples from the U12j and U12j.01 tunnels, Nevada Test Site

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

Sample No.	Saturated bulk density	Dry bulk density (Hg. method) (g/cc)	Grain density (powder method) (g/cc)	Porosity (percent)	Water content (percent by weight)	Water content (percent by volume) (g/cc)	Natural state bulk density (g/cc)	Magnetic susceptibility (chips powder) (cgs units X 10^{-6})
*U12jC1	1.96	1.62	2.45	34.0	11.3	0.206	1.82	1,001.5
*U12jC2	1.98	1.68	2.40	30.1	9.0	.165	1.85	767.3
J4-1	1.73	1.28	2.34	45.5	-----	-----	-----	36.4
J4-2	1.80	1.39	2.38	41.6	-----	-----	-----	423.4
J4-3	1.85	1.45	2.41	39.9	-----	-----	-----	304.9
J4-4	1.77	1.34	2.35	42.9	-----	-----	-----	472.5
J4-5	1.80	1.41	2.31	39.0	-----	-----	-----	281.1
J4-6	1.90	1.56	2.37	33.9	-----	-----	-----	271.6
J5-1	1.60	1.08	2.24	51.9	-----	-----	-----	37.8
J5-2	1.76	1.41	2.23	36.9	-----	-----	-----	99.2

* From U12j.01 chamber.

Table 4.--Chemical analyses of two samples from the U12j.01 chamber,
Nevada Test Site

[Samples analyzed by methods described in USGS Bulletin 1144-A (in press). Analysts: P. L. D. Elmore, S. D. Botts, and G. W. Chloë]

Sample No.-----	U12j-C-1	U12j-C-2
SiO ₂	69.0	66.8
Al ₂ O ₃	14.3	14.4
Fe ₂ O ₃	2.0	2.5
FeO	.43	.55
MgO	.55	.75
CaO	1.2	1.7
Na ₂ O	2.7	2.7
K ₂ O	4.3	4.1
H ₂ O-	1.9	2.1
H ₂ O+	3.5	3.5
TiO ₂	.38	.49
P ₂ O ₅	.03	.07
MnO	.08	.09
CO ₂	<.05	<.05
Sum-----	100	100
Powder density by air pycnometer---	2.45	2.46

Table 5.--Semiquantitative spectrographic analyses of two samples from the U12j.01 chamber, Nevada Test Site

[Analyst: Nancy M. Conklin. 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: P, Ag, As, Au, B, Bi, Cd, Ce, Ge, Hf, Hg, In, Li, Mo, Pd, Pt, Re, Sb, Sn, Ta, Te, Th, Tl, U, W, Zn, Gd, Td, Dy, Ho, Er, Tm, Lu]

	U12j-C-1	U12j-C-2
Ba	0.07	0.07
Be	.0003	.0003
Co	.0007	.0007
Cr	.002	.001
Cu	.0015	.001
Ga	.003	.003
La	.007	.007
Nb	.0015	.0015
Ni	.0007	.0003
Pb	.002	.002
Sc	.001	.0005
Sr	.05	.05
V	.005	.002
Y	.005	.005
Yb	.0005	.0005
Zr	.02	.02
Pr*	0	0
Nd*	0	0
Sm*	0	0
Eu*	0	0

* Looked for only when La or Ce found.

FIGURE 1.- GEOLOGIC MAP AND CROSS SECTION OF THE UI2j AND UI2j.01 TUNNELS, NEVADA TEST SITE, NYE COUNTY, NEVADA

FIGURE 2.- STRATIGRAPHIC SECTION MEASURED IN U12j. TUNNEL, NEVADA TEST SITE

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STATE	NEVADA	TUNNEL	U 12 j
COUNTY	NYE	TOTAL DEPTH	
AREA	NTS Area 12	GROUND EL. (Portal)	5,635 feet
Portal COORDINATES	N 899,063 E 647,063	DIAMETER	
SCALE	1 inch equals 10 feet	CASING RECORD	

GENERAL PUMICEOUS WELDED- PARTLY WELDED VITRIC	
DEVITRIFIED	
ZEOLITIZED	
CLAYEY	
VITROPHYRE	

LITHOLOGY SYMBOLS - TUFF

BEDDING

STRUCTURELESS
VERY THICK BEDDED
THICK BEDDED
THIN BEDDED
VERY THIN BEDDED
LAMINATED

SHARDS
PUMICE
LITHIC GRAINS
PHENOCRYSTS

MODAL ANALYSES

K-FELDSPAR
PLAGIOCLASE
QUARTZ
MAFIC GRAINS

ZEOLITIZED TUFF	WELDED TUFF	PARTLY WELDED TUFF	FELDSPAR	QUARTZ	LITHIC GRAINS	MAFIC GRAINS	GLASS (INCLUDES PUMICE)	PHENOCRYSTS

PERCENT OF TOTAL ROCK

PERCENT OF PHENOCRYSTS

LITHOLOGY

REMARKS

BEDDING VISUAL ESTIMATE (PERCENT)