TEI-834

INTERIM GEOLOGICAL INVESTIGATIONS IN THE U12e.07 TUNNEL, NEVADA TEST SITE, NYE COUNTY, NEVADA

By J. W. Hasler

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

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ABSTRACT

The U12e.07 tunnel is a part of the U12e tunnel system beneath Rainier Mesa in the northern part of the Nevada Test Site. The tunnel was driven in nonwelded tuff of the lower member of the Indian Trail Formation of late Miocene or early Pliocene age. Vertical cover over the face of the tunnel to the surface of Rainier Mesa is about 1,267 feet.

The tuffs in the tunnel strike northwest and northeast and dip 4°-26° southwest and northwest. The principal structural features of the tuffs are a minor northeast-trending syncline and a southwest-trending anticline. These minor structures are superimposed upon the east limb of a major southwest-trending syncline west and northwest of the U12e.07 tunnel.

The tuffs in subunits E, F, G, and H of Tunnel Bed 4 of the lower member of the Indian Trail Formation are generally well bedded, fine grained, alternating gray and red, and contain moderate amounts of lapilli pumice, lithic fragments, and phenocrysts.

The tuffs in the U12e.07 tunnel are similar chemically and physically to other tuffs in the Indian Trail Formation at the Nevada Test Site.

INTRODUCTION

The U12e.07 tunnel is a part of the U12e tunnel system, which has been driven southwestward, in Area 12, beneath Rainier Mesa, a prominent topographic feature within the Whiterock Spring quadrangle in the northern part of the Nevada Test Site (figs. 1 and 2). The geologic studies in the U12e.07 tunnel were conducted by the U.S. Geological Survey on behalf of the U.S. Atomic Energy Commission for the purpose of determining the structural features, lithologic character, chemical composition, and physical properties of the tuff exposed in the tunnel.

The U12e.07 tunnel trends N. 23°03'59" W. for 2,618 feet from station 56+00 feet in the main U12e tunnel. Cross section of the tunnel averages 11 by 12 feet. The tunnel is supported by steel sets spaced at intervals ranging from 4 to 6 feet and lagged with wood planking between the sets (table 1).

GEOLOGY

General

The U12e.07 tunnel was driven in zeolitic bedded tuffs in the upper part of Tunnel Bed 4 of the lower member of the Indian Trail Formation of late Miocene or early Pliocene age (fig. 3). Tunnel Bed 4 is the youngest of the four units that make up the lower member. Tunnel Beds 1 through 4, as described by Hinrichs and Orkild (1961), are equivalent to map units Tos1 through Tos4 of Hansen and Lemke

(1957) and Trl through Trr of McKeown and Dickey (1961). Mappable subunits of Tunnel Bed 4 are designated by capital letters following the unit designation.

In the U12e.07 tunnel area, the lower member rests upon an erosional surface of dolomite of early(?) Paleozoic age (fig. 4). The contact of the tuff with the Paleozoic dolomite as projected from cross sections and drill holes elsewhere in the U12e tunnel system is estimated to be about 800± feet below the face of the U12e.07 tunnel. In the U12e.06 tunnel, about 1,900 feet to the southeast, the contact between the tuff and the Paleozoic dolomite was determined to be 971.5 feet in drill hole U12e.06a, and 959 feet below the floor of the U12e.06 tunnel in drill hole U12e.06b. The two drill holes are 1,700 feet apart (Emerick and Bunker, 1962). Core hole U12e-M1, drilled in an alcove off the main U12e tunnel at about 46+75 feet, penetrated the contact of the tuff and dolomite at 974 feet below the tunnel floor. The U12e-M1 hole is 927 feet from the portal of the U12e.07 tunnel, and 1,040 and 2,400 feet from drill holes U12e.06a and U12e.06b respectively.

The tuffaceous rocks in the tunnel strike N. 40° E. to N. 82° W. and dip 4°-26° NW. This structure is modified slightly by one northwest-trending reverse fault and several northeast-trending normal faults of small displacement that cut across the tunnel. Two faults displace subunits E and G about 20 feet, and E and F as much as 33 feet. Locally the tuffs between 22+28 and 22+83 feet are strongly fractured. The principal structural features in the U12e.07

tunnel are a northeast-trending syncline and southwest-trending anticline. The axis of the syncline, where it crosses the tunnel at about 4+00 feet, strikes about S. 30° W. and plunges 9° SW. The anticlinal axis, where it crosses the tunnel at about 19+90 feet, strikes about S. 18° W. and plunges 3° SW.

Joints are common in the tuffs cut by the U12e.07 tunnel. A total of 481 joints was observed in the first 2,570 feet of the U12e.07 tunnel; of these 56 percent trend northeast, 38 percent trend northwest, and the remaining 6 percent have random orientation. The northeast-trending joints have three predominant dips: vertical, average 85° SE., and 80° NW. The northwest-trending joints are generally vertical; some dip about 85° SW., others about 75° NE.

Rocks

Stratigraphic position

The U12e.07 tunnel was driven principally in subunits E, F, G, and H of Tunnel Bed 4 of the lower member of the Indian Trail Formation (figs. 3 and 4). These four mappable subunits are in the upper part of Tunnel Bed 4.

Modal and X-ray analyses, chemical analyses, semiquantitative spectrographic analyses, and physical property determinations of the rocks of the subunits are shown in tables 2, 3, 4, and 5.

Subunit E

Subunit E is a thick- to very thick-bedded, red to light-gray tuff with coarse to lapilli pumice. Most of the red and gray layers are in the lower 15 feet; the upper 15 feet is mottled and crudely banded with red. The lower contact is gradational. The subunit is about 30 feet thick.

Subunit F

Subunit F is a fine to coarse, thin- to thick-bedded, white tuff with a few red interbeds 1 foot to 2 feet thick. Coarse lithic fragments are conspicuous in the lower 5 feet, but in the upper 25 feet, 5 to 10 percent of the rock consists of lithic fragments. A conspicuous bright orange-red tuff bed about 2 feet thick occurs near the middle of the subunit; porcelaneous layers as much as 0.5 foot thick and light-red layers 0.1 to 0.3 foot thick are common in the upper 10 feet. A thickness of about 30 feet of subunit F is exposed in the U12e.07 tunnel.

Subunit G

Subunit G is a red and white, relatively hard, pumiceous, generally coarse-grained tuff. Beds in this subunit are generally irregular and are 15 feet or more thick; thin beds and laminae are rare (McKeown and Dickey, 1961). A thickness of 80(?) feet is exposed in the U12e.07 tunnel between 735 and 1,378 feet from the main U12e tunnel. In the main U12e tunnel to the southeast the subunit is about 45 feet thick. Elsewhere in the U12e tunnel system the thickness of the subunit has been estimated to be more than 50 feet (McKeown and Dickey, 1961).

Subunit H

Subunit H is a white, red, and gray, massive to bedded, fine- to coarse-grained, pumiceous tuff. The lower part of the subunit consists of bedded white tuff with abundant dark lithic fragments, which are principally quartzite or other metamorphic and volcanic rock. Locally the lower part has red streaks and wider red bands. The white tuff grades upward into massive and indistinctly bedded, soft, greenish- to yellowish-gray zeolitized tuff with mottled and banded red zones at top and bottom. Lithic fragments are sparse in this yellowish-gray zone. The total thickness of subunit H is not exposed in the U12e.07 tunnel or elsewhere in the U12e tunnel system, but the subunit is estimated to be more than 100 feet thick. A thickness of about 45 feet is exposed in the U12e.07 tunnel.

PETROGRAPHY

The mineral constituents of the tuffs in each of the subunits were determined by a point-count method under the microscope on slab specimens that have been etched with hydrofluoric acid and stained with cobaltinitrite. Relative proportions of minerals in the submicroscopic matrix were determined by X-ray diffractometer methods on powdered samples of the matrix. The results of these analyses are shown in table 2.

The tuff of subunit E consists of 66 to 83 percent matrix material (including coarse to lapilli pumice), 4 to 13 percent lithic fragments, largely quartzite, and 13 to 21 percent phenocrysts of potassium feldspar and quartz.

In the tuff of subunit F, the fine-grained matrix and the fine to lapilli pumice comprise 80 to 90 percent of the rock, lithic fragments 4 to 8 percent, and phenocrysts of potassium feldspar and quartz 6 to 16 percent.

Subunit G consists of tuff containing 68 to 81 percent fine-grained matrix and fine to lapilli pumice, 7 to 13 percent lithic fragments, and 8 to 22 percent phenocrysts of potassium feldspar, quartz, and magnetite, listed in decreasing order of abundance. The lithic fragments of subunit G consist principally of quartzite and other metamorphic and volcanic rocks.

The tuff of subunit H contains 85 to 93 percent of fine-grained matrix and fine to lapilli pumice, 4 to 5 percent lithic fragments, and 3 to 10 percent phenocrysts of potassium feldspar and quartz.

The modal analyses indicate that a few significant general differences may exist among subunits in their relative proportions of matrix and phenocrysts and in the relative proportions of mineral types in the phenocrysts, although the modal analysis of a single sample from any one of the subunits might not bear out such differences.

In general it appears that subunit E has the highest average relative proportion of phenocrysts to matrix, and subunit H the lowest, and, on this basis of comparison, subunit G more nearly resembles subunit E, whereas subunit F is more similar to subunit H.

The phenocrysts of all the subunits--E, F, G, and H--consist largely of potassium feldspar and quartz, but there seems to be differences in the relative proportions of these minerals. Both analyses of subunit E (table 2) show somewhat more potassium feldspar than quartz. In subunits F, G, and H, individual samples show different relations between the two minerals, but the averages suggest that subunits G and H may have greater average proportions of feldspar to quartz than subunits E and F.

Magnetite seems to be characteristically present in minor amounts in subunit G and absent in subunits E, F, and H.

X-ray analyses, the results of which are shown in table 2, show that the original glassy matrix of the tuffs in the four subunits has been largely altered to a zeolitelike[1/] mineral and

---

1/ The zeolite corresponds in X-ray pattern to heulandite but is stable above 260°C. Recent work of Shepard (1961) has shown that this thermal stability indicates that the mineral may be clinoptilolite or a heulanditelike mineral. Special heat treatment is necessary to differentiate heulandite from the heulanditelike mineral.

cristobalite. The presence of quartz and feldspar in the X-ray analyses may be products of devitrification of the original glass or it may be due to incomplete separation of small phenocrysts of quartz and feldspar from the matrix sample.

CHEMICAL COMPOSITION

The chemical composition of the tuffs of subunits E, F, G, and H is indicated by chemical and semiquantitative spectrographic analyses shown in tables 3 and 4. The compositions of these subunits are not significantly different from those elsewhere in the U12e tunnel complex. There are, however, some significant differences among the chemical compositions of some of the subunits in the U12e.07 tunnel. Subunits E and F contain less CaO and MgO than do subunits G and H. Subunit F contains less K_2O than do the other subunits. Subunits E and F contain considerably more Na_2O than do subunits G and H. Subunits G and H show a little more Ba than subunits E and F.

PHYSICAL PROPERTIES

Values for porosity, bulk density, grain density, hardness, and unconfined compressive strength, as well as those for elastic, sonic, and magnetic properties were determined in the laboratory on samples from each of the subunits. These values are shown and also are summarized as subunit averages in table 5.

The laboratory procedures used to determine porosity, bulk density, and grain density have been described by Diment and others (1959, p. 51-53). Those for the determination of hardness and unconfined compressive strength have been described by Emerick and Dickey (1962, p. 23). The elastic moduli and velocity data given in table 5 were calculated from the flexural and torsional resonant frequencies of oven-dried core. This method as applied to concrete specimens is described by American Society for Testing Materials (1952, p. 1072-1075).

From table 5 it can be seen that the tuffs from the four subunits exposed in the U12e.07 tunnel embrace a rather broad range of physical properties. The inhomogeneity of the tuff in the tunnel is shown both by individual samples and the average values for each subunit.

The averages show that in general subunit G is the most dense and least porous, subunit H is the least dense and most porous, and subunits E and F are intermediate between the two extremes. In the averages for elastic moduli and velocities, it can be seen that an expectable trend exists, with the average values for subunit G being greater than those of the other subunits. Decreasing values for elastic and velocity values between subunits probably are within the range of laboratory error with the techniques used at the present time.

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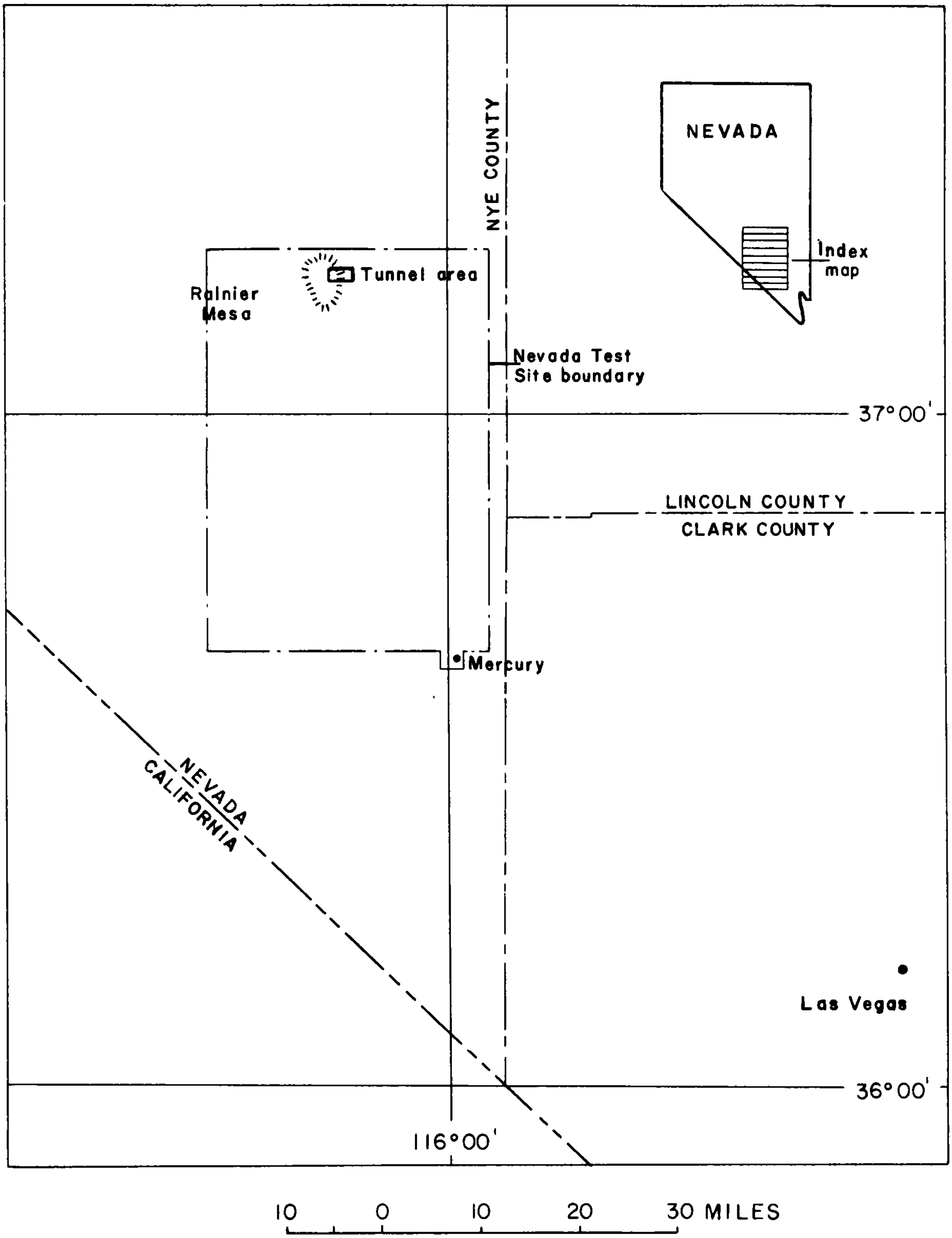

Figure 1.--Index map showing the tunnel area, Nevada Test Site, Nye County, Nevada.

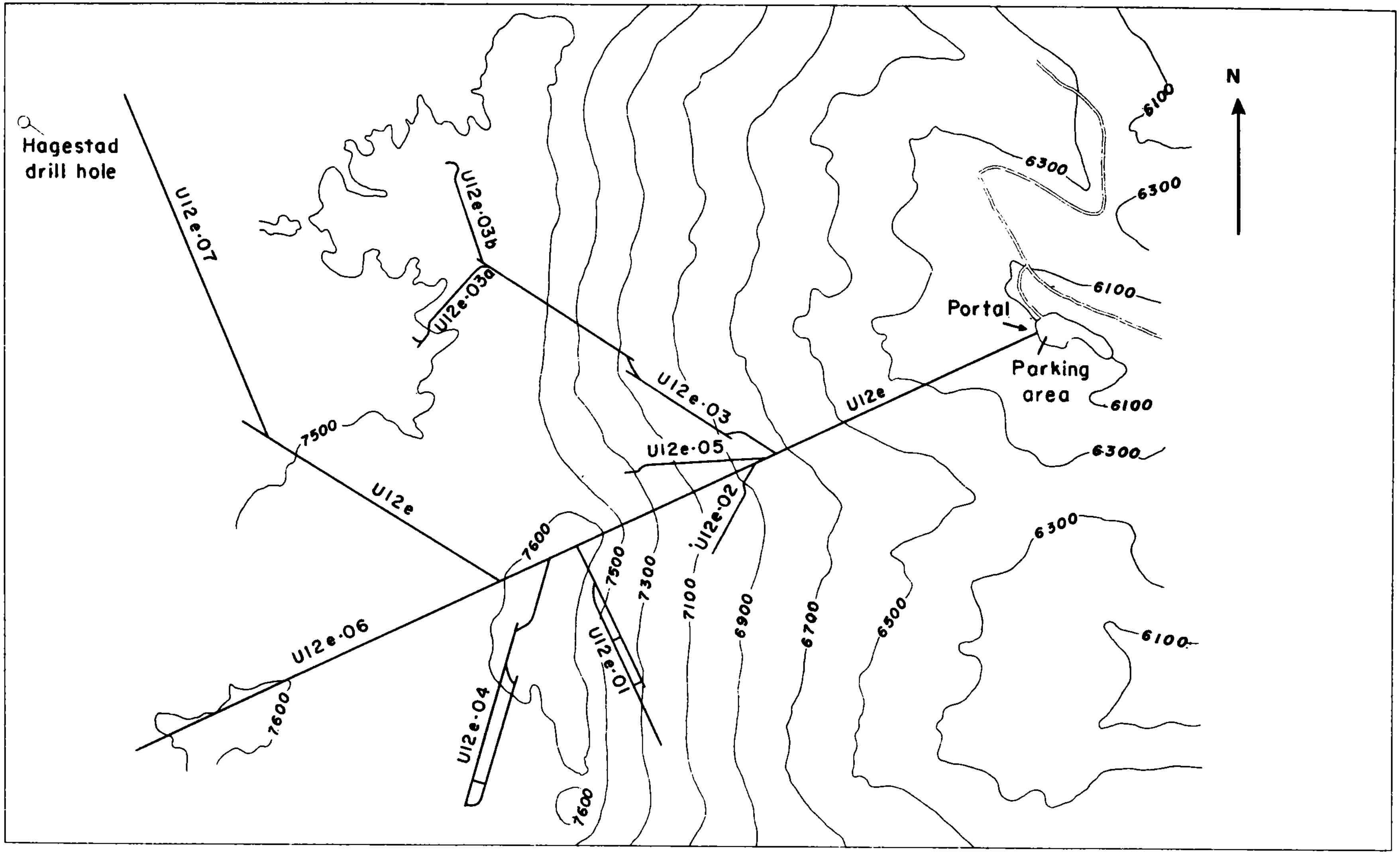

Figure 2.--Index map showing the U12e tunnel system, Rainier Mesa, Nevada Test Site, Nye County, Nevada.

1000 0 1000 FEET

Contour interval 100 feet

Table 1.--Descriptive data for U12e.07 tunnel, Nevada Test Site, Nye County, Nev.

Nevada State coordinates:	
Portal or beginning of tunnel (Station 56+00 of U12e tunnel)----------------------------	N. 887,110 E. 632,735
Elevation (feet above sea level):	
Portal or beginning of tunnel----------------	6,167
Length (feet)--------------------------------------	2,618
Bearing--	N. 23°03'59" W.
Cross section dimensions (feet)------------------	11 by 12
Vertical cover (at collar of U12e.07 shaft (feet)-	1,267

Table 2.--Modal and X-ray analyses, in percent, of tuff from U12e.07 tunnel, Nevada Test Site, Nye County, Nev.

[Modal analyses by J. W. Hasler; X-ray analyses by Theodore Botinelly. Location of samples are shown on figure 3.

The sample number indicates the tunnel system (E), secondary tunnel driven from main U12e tunnel (7), a numeral indicating footage from tunnel entrance referred to Holmes and Narver, Inc., survey, followed by R or L indicating sample was taken from right or left wall, plus a numeral indicating height above track level from which sample was taken]

Sample No. (E7-)--------	1847L+4	2155R+3.5	1437R+6.5	2155R+6.5	2362R+4.5	130L+3	1000L+7	2555R+3.5	180R+4	680R+4	Mean
Lithologic subunits of Tunnel Bed 4----------	E	E	F	F	F	G	G	G	H	H	
Matrix 1/---------------	83	66	80	86	90	79	68	81	85	93	81
Lithic fragments--------	4	13	4	8	4	13	10	7	5	4	7
Phenocrysts:											
Potassium feldspar----	7	12	11	3	2	2	20	5	5	3	7
Quartz---------------	6	9	5	3	4	6	2	7	5	<1	5
Magnetite------------	-------	-------	-------	-------	-------	<1	-------	<1	-------	-------	----
Total phenocrysts-------	13	21	16	6	6	8	22	12	10	3	12
Total-------------	100	100	100	100	100	100	100	100	100	100	----
Area measured (mm²)-----	500	500	500	500	500	500	500	500	500	500	----
Zeolite 2/-------------	1	2	1	1	1	1	1	2	1	1	
Feldspar 2/------------	3-4	3	---------	5	---------	4	4	4-5	4	-------	
Quartz 2/--------------	5	5	---------	5	---------	Trace	-------	5	Trace	5	
Cristobalite 2/---------	5	5	---------	4	5	5	4	4	-------	5	
Clay minerals 2/--------	-------	---------	3-4	---------	---------	Trace	-------	---------	-------	-------	

1/ The matrix includes the fine and lapilli pumice.

2/ The amounts of the constituents are estimated on the intensity of X-ray diffractometer pattern and are at best only rough approximations: 1 = >75 percent, 2 = 50-75 percent, 3 = 25-50 percent, 4 = 10-25 percent, and 5 = <10 percent.

Table 3.--Chemical analyses, in percent, of tuff from the U12e.07 tunnel, Nevada Test Site, Nye County, Nev.

[Analyses by Paul L. D. Elmore, Samuel D. Botts, Gillison Chloe, and H. Smith, by methods similar to those described by Shapiro and Brannock (1956).

For sample locations see headnote table 2]

Sample No. (E7-)------	1847L+4	2155R+3.5	2155R+6.5	2362R+4.5	1437R+6.5	130L+3	1000L+7	2555R+3.5	180R+4	680R+4	Average chemical composition of each subunit			
Lithologic subunits of Tunnel Bed 4------	E	E	F	F	F	G	G	G	H	H	E	F	G	H
SiO_2---------	70.5	68.7	73.2	69.6	66.2	66.8	70.0	71.6	66.4	68.5	69.6	69.7	69.5	67.5
Al_2O_3--------	11.8	13.5	10.9	11.1	13.8	12.6	12.1	11.6	12.9	11.3	12.7	11.9	12.1	12.1
Fe_2O_3--------	1.8	2.7	1.1	1.1	1.2	1.3	1.3	1.7	1.3	2.2	2.3	1.1	1.4	1.8
FeO----------	.06	.06	.12	.10	.08	.04	.06	.08	.04	.08	.06	.10	.06	.06
MgO----------	.10	.16	.16	.14	.16	.33	.26	.36	.57	.32	.13	.15	.32	.45
CaO----------	.31	.68	.64	1.0	.73	1.9	.74	1.3	1.9	1.3	.50	.86	1.3	1.6
Na_2O---------	3.0	2.5	2.6	2.3	3.0	1.4	2.7	1.6	1.3	1.3	2.8	2.6	1.9	1.3
K_2O----------	4.8	6.4	3.9	3.8	3.5	4.6	4.3	4.6	4.9	4.6	5.6	3.7	4.5	4.8
H_2O----------	7.8	5.3	6.1	11.0	11.6	10.8	8.1	6.8	10.6	10.1	6.6	9.7	8.6	10.4
TiO_2---------	.13	.30	.10	.10	.10	.18	.19	.22	.20	.11	.22	.10	.20	.16
P_2O_5---------	.02	.02	.02	.01	.01	.02	.02	.02	.02	.02	.02	.01	.02	.02
MnO----------	.03	.04	.05	.04	.04	.08	.06	.04	.09	.05	.04	.04	.06	.07
CO_2----------	$<.05$	$<.05$	$<.05$	$<.05$	$<.05$	$<.05$	$<.05$	$<.05$	$<.05$	$<.05$	$<.05$	$<.05$	$<.05$	$<.05$
Sum----------	100	100	99	100	100	100	100	100	100	100	------	-----	-----	-----

Table 4.--Semiquantitative spectrographic analyses of tuff from U12e.07 tunnel, Nevada Test Site, Nye County, Nev.

[Analyses by N. M. Conklin, USGS. Figures are reported to the nearest number in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, etc. in percent. These points represent midpoints of group data on geometric scale. The assigned group for semiquantitative results will include the quantitative value about 30 percent of the time.

Looked for but not found: P, Ag, As, Au, B, Bi, Cd, Ce, Co, Ge, Hf, Hg, In, Li, Mo, Ni, Pd, Pt, Re, Sb, Sc, Ta, Te, Th, Tl, U, W, Zn, Pr, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Lu.

0 = looked for but not detected. For sample locations see headnote table 2]

Sample No. (E7-)---	1847L+4	2155R+3.5	2155R+6.5	2362R+4.5	1437R+6.5	130L+3	1000L+7	2555R+3.5	180R+4	680R+4	Standard spectrographic sensitivity
Laboratory No.-----	298937	298938	298939	298940	298936	298932	298935	298941	298933	298934	
Lithologic subunits of Tunnel Bed 4--	E	E	F	F	F	G	G	G	H	H	
Ba-----------------	0.02	0.07	0.02	0.015	0.015	0.05	0.1	0.07	0.07	0.02	0.0002
Be-----------------	.0002	.0003	.0002	.0003	.0002	.0002	.0002	.0002	.0002	.0007	.0001
Ce-----------------	0	0	0	0	0	0	0	0	0	0	.02
Cr-----------------	.00015	.0003	0	0	0	0	0	.0002	0	0	.0001
Cu-----------------	.0002	.0002	0	0	.0005	0	0	.0001	0	.0002	.0001
Ga-----------------	.003	.003	.003	.002	.003	.002	.003	.003	.002	.005	.0002
La-----------------	.007	.01	.005	.005	.01	.005	.005	.007	0	.007	.002
Nb-----------------	.0015	.002	.002	.002	.002	.0015	.002	.002	.0015	.005	.001
Nd-----------------	0	.01	0	0	.01	0	0	0	0	.01	.01
Pb-----------------	.0015	.0015	.0015	.0015	.0015	.0015	.0015	.001	.0015	.003	.001
Sn-----------------	0	0	0	0	0	0	0	0	0	.001	.001
Sr-----------------	.005	.05	.005	.003	.005	.007	.015	.02	.007	.007	.0002
V------------------	.0007	.0015	.0007	0	.0007	0	0	.0015	0	0	.001
Y------------------	.005	.005	.005	.003	.015	.003	.003	.003	.002	.01	.001
Yb-----------------	.0005	.0005	.0005	.0003	.0015	.0003	.0003	.0003	.0002	.001	.0005
Zr-----------------	.015	.02	.015	.015	.01	.015	.015	.02	.01	.07	.001

Table 5.--Physical properties of tuffs from U12e.07 tunnel, Nevada Test Site, Nye County, Nev.

[Analyses of physical properties for shore hardness and unconfined compressive strength by J. C. Thomas; other analyses by D. R. Cunningham, John Moreland, and E. J. Monk. For sample locations see headnote table 2]

Sample No. (E7-)	Laboratory No. (P2-)	Rock subunit of Tunnel Bed 4	Porosity (percent)	Dry bulk denisty (g/cc)	Saturated bulk density (g/cc)	Grain density (g/cc)	Shore hardness	Unconfined compressive strength (psi)	Young's modulus (10^6 lb/in^2) 1/	Modulus rigidity (10^6 lb/in^2) 1/	Poisson's ratio	Longitudinal velocity (ft/sec)	Transverse velocity (ft/sec)	Magnetic susceptibility (10^{-6} cgs units)
1847L+4	764(2-692)	E	36.5	1.47	1.84	2.32	29	4,600	No core	--------	--------	--------	--------	147.1
2155R+3.5	765(2-698)	E	32.6	1.61	1.94	2.39	20	2,800	0.91	0.42	0.0843	6,515	4,390	300.9
1437R+6.5	763(2-696)	F	31.4	1.50	1.81	2.18	39	3,600	.91	.38	.2016	7,171	4,384	100.7
2155R+6.5	766(2-699)	F	34.8	1.47	1.82	2.25	27	No core	No core	--------	--------	--------	--------	230.7
2362R+4.5	767(2-700)	F	22.4	1.64	1.86	2.11	32	4,100	.69	.27	.2778	6,677	3,704	11.5
130L+3	759(2-692)	G	28.7	1.57	1.86	2.21	17	----------	1.10	.44	.2443	8,096	4,709	155.8
1000L+7	762(2-695)	G	19.2	1.83	2.02	2.26	21	2,600	No core	--------	--------	--------	--------	148.2
2555R+3.5	768(2-701)	G	21.3	1.81	2.02	2.30	28	6,800	1.62	.69	.1688	8,509	5,371	423.4
180R+4	760(2-693)	H	38.2	1.35	1.73	2.19	16	1,500	.60	.25	.2085	6,155	3,735	204.5
680R+4	761(2-694)	H	42.4	1.30	1.72	2.25	25	3,900	1.32	.56	.1850	8,431	5,242	38.8
		Avg E--	34.5	1.54	1.89	2.35	24	3,700	.91	.42	.0843	6,515	4,390	224.0
		Avg F--	29.5	1.53	1.83	2.18	32	3,850	.80	.32	.2397	6,924	4,044	114.3
		Avg G--	23.0	1.80	1.96	2.25	22	3,137	1.36	.56	.2065	8,302	5,040	242.4
		Avg H--	40.3	1.32	1.72	2.22	20	2,700	.95	.40	.1967	7,293	4,488	121.6

1/ Resonant Bar method.

FIGURE.-3. GEOLOGIC MAP AND CROSS SECTION OF THE RIGHT WALL OF THE U12e.07 TUNNEL, NEVADA TEST SITE, NYE COUNTY, NEVADA

Geology by D.D. Dickey, F.A. McKeown, F.N. Houser, V.R. Wilmarth, F.G. Poole, and R. Johnson. August and October 1960.
J.W. Hasler, W.L. Emerick, R.P. Snyder, W.H. Laraway, D. Hoover, W. Bowers, 1962.

DEPARTMENT OF THE INTERIOR
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TEI-834

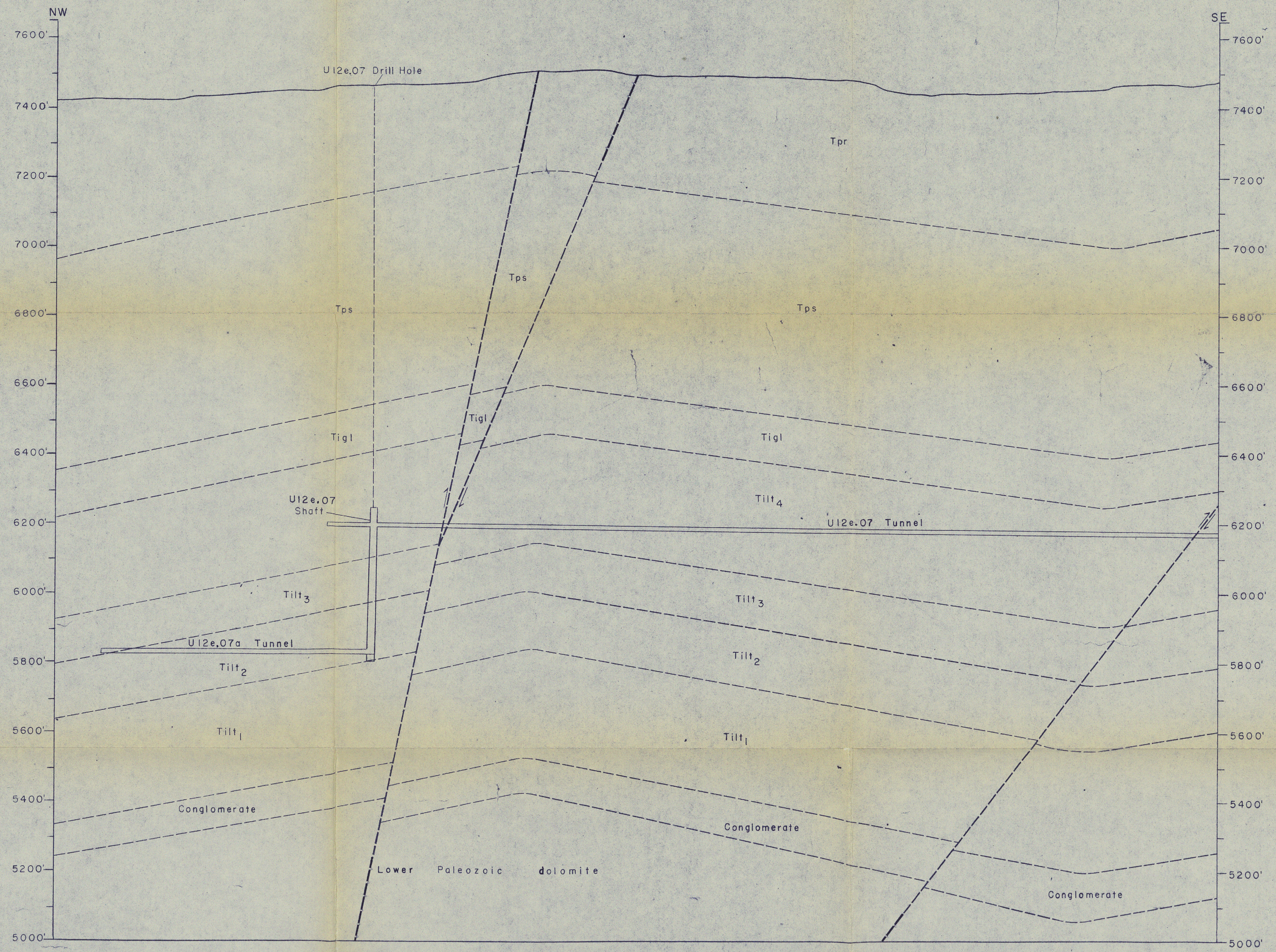
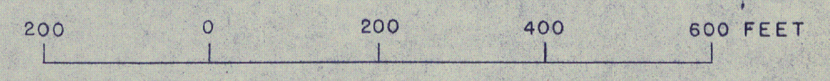


FIGURE 4.--GEOLOGIC CROSS SECTION S.23°03'59"E. THROUGH U12e07 TUNNEL AND SHAFT AND U12e.07a TUNNEL, RAINIER MESA, NEVADA TEST SITE, NYE COUNTY, NEVADA



EXPLANATION

Pliocene or younger — Piapi Canyon Formation
- Tpr, Rainier Mesa Member
- Tps, Survey Butte Member

Miocene or Pliocene — Indian Trail Formation
- Tigl, lower part of the Grouse Canyon Member
- $Tilt_4$, Tunnel Bed 4 of the lower member
- $Tilt_3$, Tunnel Bed 3 of the lower member
- $Tilt_2$, Tunnel Bed 2 of the lower member
- $Tilt_1$, Tunnel Bed 1 of the lower member
- Conglomerate

Inferred contact

Fault
Showing direction of relative movement