TEI-772

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

INTERIM REPORT ON GEOLOGIC INVESTIGATIONS OF THE U12e TUNNEL SYSTEM, NEVADA TEST SITE, NYE COUNTY, NEVADA*

By

F. A. McKeown and D. D. Dickey

September 1960

Trace Elements Investigations Report 772

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

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

CONTENTS

Page

Introduction---------- 4

Geology---------- 4

References Cited---------- 16

ILLUSTRATIONS

Figure 1. Geologic map of the U12e tunnel system, Nevada Test Site, Nye County, Nev.---------- in pocket

2. Cross sections through the right wall of the U12e tunnel, Nevada Test Site, Nye County, Nev.---------- in pocket

3. Geologic map and cross sections of the right wall of the U12e tunnel from station 0+24 to station 28+00, Nevada Test Site, Nye County, Nev.---------- in pocket

4. Geologic map and cross sections of the right wall of the U12e tunnel from station 28+00 to station 57+00, Nevada Test Site, Nye County, Nev.---------- in pocket

5. Geologic map of the U12e.01 tunnel, Nevada Test Site, Nye County, Nev.---------- in pocket

6. Geologic map of the U12e.03 tunnel, Nevada Test Site, Nye County, Nev.---------- in pocket

7. Geologic map of the U12e.04 tunnel, Nevada Test Site, Nye County, Nev.---------- in pocket

8. Explanation for figures 3 through 7---------- in pocket

TABLES

		Page
Table 1.	Description of samples taken from the U12e tunnel system, Nevada Test Site, Nye County, Nev.	7
2.	Chemical analyses (percent by weight) of tuff from U12e tunnel, Nevada Test Site, Nye County, Nev.	9
3.	Chemical analyses (percent by weight) of tuff from U12e.03 tunnel, Nevada Test Site, Nye County, Nev.	10
4.	Chemical analyses (percent by weight) of tuff from U12e.04 tunnel, Nevada Test Site, Nye County, Nev.	11
5.	Semiquantitative spectrographic analyses of tuff from U12e.03 tunnel, Nevada Test Site, Nye County, Nev.	12
6.	Semiquantitative spectrographic analyses of tuff from U12e.04 tunnel, Nevada Test Site, Nye County, Nev.	14

INTERIM REPORT ON GEOLOGIC INVESTIGATIONS OF THE U12e TUNNEL SYSTEM, NEVADA TEST SITE, NYE COUNTY, NEVADA

By F. A. McKeown and D. D. Dickey

INTRODUCTION

The maps and tables comprising this report are being transmitted at this time to provide interested users with a summary of the geology of the U12e tunnel system. The system was constructed to provide access to underground test sites. This report contains part of the geologic information obtained from investigations conducted by the U. S. Geological Survey to determine the geologic environment of the underground test sites. Results of geophysical and radiometric surveys, and physical properties are being studied. This work was done on behalf of the U. S. Atomic Energy Commission.

The parts of the U12e tunnel system described in this report consist of a 5,700-foot main tunnel, U12e, and five lateral tunnels, U12e.01, U12e.02, U12e.03, U12e.04, and U12e.05, totalling about 8,900 feet. The portal of the main tunnel is at an altitude of 6,115 feet above sea level on the east side of Rainier Mesa, a prominent topographic feature in the northwestern part of the Nevada Test Site. The U12e.02 and U12e.05 tunnels were the sites of the nuclear tests code named Logan and Blanca that were conducted in October 1958; the geology of these sites has been described by Houser and McKeown (1958, written communication) and by Houser and Dickey (1959).

GEOLOGY

The U12e tunnel system penetrates tuffaceous rocks in the lower 800 feet of the Oak Spring formation of Miocene(?) or younger age. The Oak Spring formation ranges from about 1,900 feet to possibly as much as 2,500

feet (Gibbons and Wilmarth, 1959, written communication) in thickness in Rainier Mesa. It rests disconformably on a surface of moderate relief cut in carbonate rocks of early Paleozoic age.

As the result of detailed regional geologic mapping in the vicinity of Rainier Mesa, the Oak Spring formation was divided into eight lithologic units, listed in ascending order Tos_1 through Tos_8 (Hansen and Lemke, 1957); this nomenclature was used in the earlier reports on the U12e.02 and U12e.05 tunnels (Houser and McKeown, 1958, written communication, and Houser and Dickey, 1959). In this report the rock units mapped in the U12e tunnel system are in the lower 4 units (Tos_1 through Tos_4) of Hansen and Lemke. The symbols used to designate these units however are changed to tr1, tr2, etc. Capital letters are added to these symbols to identify subunits mapped in the tunnels.

The most significant structural element mapped in the U12e tunnel system since the U12e.02 and U12e.05 tunnels were completed in 1958 is a broad syncline that plunges about 2° SW. The axial plane of the syncline was intersected in the main U12e tunnel at station 46+70 and the U12e.03 personnel tunnel at 4+10 (fig. 1). The axis of the syncline has been traced on the surface by Gibbons and others (1960, fig. 2) for several thousand feet northeastward and as much as 1 mile southwestward from the vicinity of the U12e tunnel. Minor anticlines and synclines with amplitudes of 10 to 30 feet occur on the limbs of the broad syncline. The maximum dip of the beds is 14°.

The joint diagrams shown on figure 1 were compiled from the data shown on figures 3 through 7. The diagrams graphically summarize the attitudes of all joints in selected parts of the tunnel system. The part of the tunnel represented in a diagram was selected variously on the basis of lithology

and structural or geographic position. An average strike and dip and the relative abundance of joints in each dominant joint set may be obtained by inspection of the diagrams. From the post-shot geologic studies of the Logan and Blanca underground nuclear explosions, these data were found to be extremely useful in the evaluation and prediction of tunnel damage caused by explosions (McKeown and Dickey, 1960).

The description of samples collected for other than physical property determinations from the U12e tunnel system, exclusive of the U12e.02 and U12e.05 tunnels, is given in table 1 and the results of analyses of the samples are given in tables 2 through 6. The analytical data indicate that the variation in oxide and minor element content of the tuff exposed in the U12e tunnel system is small, and without much detailed petrographic and mineralogic study in conjunction with further analytical work, the significance of the small variations is unknown. Detailed physical property data for samples taken throughout the U12e tunnel system are being studied.

Table 1.--Description of samples taken from the U12e tunnel system, Nevada Test Site, Nye County, Nev.

Sample number 1/	Lithologic unit	Description
E200L	tr1B	Tuff, brick-red, fine; contains coarse to lapilli pumice 2/.
E220R	tr1C	Tuff, greenish-white mottled with purple; contains abundant biotite.
E330R	tr1E	Tuff, light brownish-red to purple, fine to coarse; contains locally abundant biotite.
E380R	tr1F	Tuff, light brownish-red; contains biotite and soft white opal-like silica.
E605L	tr1H	Tuff, brick-red, fine.
E800L	tr1J	Tuff, purplish-red, some mottling, fine.
E885R	tr1J	Tuff, light greenish-white with fine purple mottling, coarse; contains biotite.
E3-35R	tr2D	Tuff, light greenish-gray with dark-green clayey seams.
E3-85R	tr2E	Tuff, light greenish-gray and pink.
E3-478PB	tr4A(?)	Tuff, white, coarse, pumiceous.
E3-590PR	tr3D	Tuff, red, coarse, pumiceous.
E3-1178PL	tr3D	Tuff, purplish-red, coarse, pumiceous.
E3-1406PF	tr3D	Tuff, red, coarse to lapilli, very pumiceous.
E4-966Ra	tr4F	Tuff, white, fine with coarse pumice.
E4-966Rb	tr4F	Tuff, red, fine with coarse pumice.

Table 1.--Description of samples taken from the U12e tunnel system, Nevada Test Site, Nye County, Nev.--Continued

Sample number 1/	Lithologic unit	Description
E4-1673Ca	tr4F	Tuff, pink and white, fine to coarse.
E4-1673Cb	tr4F	Tuff, light greenish-white, fine to coarse.
E4-1673Cc	tr4E	Tuff, light greenish-white; contains fine to coarse common lithic fragments.

1/ Sample number is coded as follows:

Tunnel system	Tunnel number (if no number, sample is from main tunnel)	-	Footage	Coded letters
E	3	-	590	PR

The code for the letters following the tunnel footage is:

P - Personnel or pipe tunnel.
R - Right wall of tunnel.
L - Left wall of tunnel.
B - Back of tunnel.
F - Face of tunnel.
C - Chamber.
a - Lower case letters indicate separate samples from the same location in tunnel.

2/ All "pumice" as used in this report is altered predominantly to zeolite, cristobalite and clay.

Table 2.--Chemical analyses (percent by weight) of tuff from U12e tunnel, Nevada Test Site, Nye County, Nev. 1/

Sample number 2/	E200L	E220R	E330R	E380R	E605L	E800L	E885R	E5665
Laboratory number	155402	155403	155404	155405	155408	155406	155407	155409
SiO_2	74.0	66.6	69.4	67.8	60.9	73.6	71.0	66.0
Al_2O_3	12.7	16.4	14.4	16.4	18.4	12.7	14.2	14.0
Fe_2O_3	2.3	2.3	2.2	3.2	4.4	2.1	1.9	1.3
FeO	< .05	< .05	< .05	.15	.16	.21	.12	< .05
MgO	.30	.52	.51	.42	.51	.38	.46	.33
CaO	.93	2.5	1.7	1.9	2.0	.93	1.4	1.9
Na_2O	1.3	2.8	2.1	2.7	2.8	3.0	2.6	1.7
K_2O	5.0	3.0	4.0	3.0	3.7	4.1	4.7	5.4
H_2O	3.1	5.4	5.2	4.0	5.5	2.6	3.0	9.1
TiO_2	.31	.30	.28	.42	.59	.26	.23	.20
P_2O_5	.04	.08	.08	.08	.04	.08	.22	.02
MnO	.03	.04	.10	.06	.06	.08	.09	.11
CO_2	< .05	< .05	< .05	< .05	< .05	< .05	< .05	< .05
Sum	100	100	100	100	99	100	100	100

1/ Analysts: Paul L. D. Elmore, Samuel D. Botts, Ivan H. Barlow, and Gillison Chloe.

2/ See table 1 for descriptions of samples.

Table 3.--Chemical analyses (percent by weight) of tuff from U12e.03 tunnel, Nevada Test Site, Nye County, Nev. 1/

Sample number 2/	E3-35R	E3-85R	E3-478PB	E3-590PR	E3-1178PL	E3-1406PF
Laboratory number	155410	155411	274776	274777	274778	274779
SiO_2	71.2	67.8	68.5	69.5	66.8	69.0
Al_2O_3	12.8	13.9	12.9	13.5	13.7	12.0
Fe_2O_3	2.4	3.5	1.5	1.9	1.9	1.3
FeO	< .05	< .05	.00	.00	.18	.00
MgO	.19	.26	.27	.15	.27	.12
CaO	.50	.70	.73	.65	.75	.55
Na_2O	2.4	2.1	3.2	2.7	3.4	3.5
K_2O	3.1	2.7	3.2	5.0	4.0	3.0
H_2O	6.9	8.5	9.6	6.4	9.1	9.9
TiO_2	.16	.18	.12	.24	.31	.18
P_2O_5	.02	.04	.02	.02	.02	.02
MnO	.07	.06	.10	.14	.05	.10
CO_2	< .05	< .05	< .05	< .05	< .05	< .05
Sum	100	100	100	100	100	100

1/ Analysts: Paul L. D. Elmore, Samuel D. Botts, Ivan H. Barlow, and Gillison Chloe.

2/ See table 1 for descriptions of samples.

Table 4.--Chemical analyses (percent by weight) of tuff from U12e.04 tunnel, Nevada Test Site, Nye County, Nev. 1/

Sample number 2/	E4-966Ra	E4-966Rb	E4-1673Ca	E4-1673Cb	E4-1673Cc
Laboratory number	154645	154646	154642	154643	154644
SiO_2	70.1	69.9	67.2	69.3	69.6
Al_2O_3	11.5	11.7	13.4	12.2	12.1
Fe_2O_3	1.2	1.2	1.2	1.0	1.1
FeO	< .1	< .1	< .1	< .1	< .1
MgO	.08	.10	.21	.10	.09
CaO	.70	.75	.70	.69	.56
Na_2O	3.4	3.3	3.3	3.4	3.4
K_2O	3.3	3.5	4.8	3.8	3.8
H_2O	9.2	8.7	8.9	9.0	8.9
TiO_2	.10	.12	.11	.09	.10
P_2O_5	.00	.00	.00	.00	.00
MnO	.01	.02	.01	.02	.03
CO_2	< .05	< .05	< .05	< .05	< .05
Sum	100	99	100	100	100

1/ Analysts: Paul L. D. Elmore, Ivan H. Barlow, and Samuel D. Botts.

2/ See table 1 for descriptions of samples.

Table 5.--Semiquantitative spectrographic analyses of tuff from U12e.03 tunnel, Nevada Test Site, Nye County, Nev. 1/

Sample number 2/	E3-478PB	E3-590PR	E3-1178PL	E3-1406PF	Standard spectrographic sensitivity
Laboratory number	274776	274777	274778	274779	
Ba	0.007	0.015	0.007	0.03	0.0002
Be	.0003	0	.0003	.00015	.0001
Ce	0	0	0	0	.02
Co	0	0	0	0	.0005
Cr	.00015	.0007	.00015	.0003	.0001
Cu	.00015	.0003	.00015	.00015	.0001
Ga	.0015	.0015	.0015	.0007	.0002
La	.003	.003	0	.003	.002
Nb	.003	.0015	.0015	0	.001
Nd	0	0	0	0	.01
Ni	0	0	0	0	.0003
Pb	.0015	.0015	.0015	.0015	.001
Sc	0	0	0	0	.0005
Sn	0	0	0	0	.001
Sr	.003	.007	.003	.015	.0002
V	.0015	0	0	.0015	.001
Y	.0015	.0015	.0015	.0015	.001
Yb	.0003	.00015	.00015	.00015	.0005
Zr	.015	.015	.007	.015	.001

Table 5.--Semiquantitative spectrographic analyses of tuff from U12e.03 tunnel, Nevada Test Site, Nye County, Nev.--Continued

1/ Analyst: John C. Hamilton.

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

The number 0 also indicates looked for but not found.

Figures are reported to the nearest number in the series 7, 3, 1.5, 0.7, 0.3, 0.15, etc., in percent. These numbers represent midpoints of group data on a geometric scale. Comparisons of this type of semiquantitative result with data obtained by quantitative methods, either chemical or spectrographic, show that 60 percent of the quantitative values fall within the assigned semiquantitative groups.

2/ See table 1 for descriptions of samples.

Table 6.--Semiquantitative spectrographic analyses of tuff from U12e.04 tunnel, Nevada Test Site, Nye County, Nev. 1/

Sample number 2/	E4-966Ra	E4-966Rb	E4-1673Ca	E4-1673Cb	E4-1673Cc	Standard spectro-graphic sensitivity
Laboratory number	273056	273057	273053	273054	273055	
Ba	0.015	0.03	0.015	0.007	0.007	0.0002
Be	.0003	.0003	.0003	.0003	.0003	.0001
Ce	0	0	0	0	0	.02
Co	0	0	0	0	0	.0005
Cr	.00015	.0003	.0003	0	.0007	.0001
Cu	.0003	.0003	.0007	.003	.00015	.0001
Ga	.0015	.0015	.0015	.0007	.0015	.0002
La	.003	.003	.003	0	.003	.002
Nb	.0015	.0015	.0015	.0015	.0015	.001
Nd	0	0	0	0	0	.01
Ni	0	0	0	0	0	.0003
Pb	.0015	.0015	.003	.0015	.0015	.001
Sc	0	0	0	0	0	.0005
Sn	0	0	0	0	0	.001
Sr	.003	.007	.007	.003	.003	.0002
V	0	0	0	0	0	.001
Y	.0015	.0015	.0015	.003	.0015	.001
Yb	.00015	.00015	.00015	.0003	.00015	.0005
Zr	.007	.007	.007	.007	.007	.001

Table 6.--Semiquantitative spectrographic analyses of tuff from U12e.04 tunnel, Nevada Test Site, Nye County, Nev.--Continued

1/ Analyst: John C. Hamilton.

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

The number 0 also indicates looked for but not found.

Figures are reported to the nearest number in the series 7, 3, 1.5, 0.7, 0.3, 0.15, etc., in percent. These numbers represent midpoints of group data on a geometric scale. Comparisons of this type of semiquantitative result with data obtained by quantitative methods, either chemical or spectrographic, show that 60 percent of the quantitative values fall within the assigned semiquantitative groups.

2/ See table 1 for descriptions of samples.

REFERENCES CITED

Gibbons, A. B., and others, 1960, Preliminary geologic map of the Tippipah Spring NW quadrangle, Nye County, Nevada: U. S. Geol. Survey TEI-754, open-file report.

Hansen, W. R., and Lemke, R. W., 1957, Geology of the USGS and Rainier tunnel areas, Nevada Test Site: U. S. Geol. Survey TEI-716, open-file report.

Houser, F. N., and Dickey, D. D., 1959, Part II, Stratigraphy and structure, in Diment, W. H., and others, Geological Survey investigations in the U12e.05 tunnel, Nevada Test Site: U. S. Geol. Survey TEM-997, open-file report.

McKeown, F. A., and Dickey, D. D., 1960, Some relations between geology and effects of underground nuclear explosions at Nevada Test Site, Nye County, Nevada, in Short papers in the geological sciences: U. S. Geol. Survey Prof. Paper 400B, p. B415-B417.

UNPUBLISHED REPORTS

Gibbons, A. B., and Wilmarth, V. R., 1959, Engineering geology of potential test sites, Nevada Test Site, Nye County, Nevada: U. S. Geol. Survey TEI-643 (Confidential report).

Houser, F. N., and McKeown, F. A., 1958, Part II, Geology, in Diment, W. H., and others, Geological Survey investigations in the U12e.02 tunnel, Nevada Test Site: U. S. Geol. Survey TEM-728 (preliminary draft).