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PROGRESS REPORT

GRANT NO. DE-FG02-85ER13321.A000.

DRILLING INVESTIGATION OF A YOUNG MAGMATIC INTRUSION

BENEATH INYO DOME

LONG VALLEY CALDERA, CALIFORNIA

DOE/ER/13321--1

DE86 001134

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HIGHLIGHTS

****The conduit and lava flow at Obsidian Dome consist of two magma types.

****The more mafic magma occurs at the base of Obsidian Dome and at the margins of the conduit and was emplaced first.

****The more silicic magma occurs in the center of the conduit and in the dike. The more mafic magma does not occur in the dike.

MASTER

****The ilmentite-magnetite and orthopyroxene-augite geothermometers have not reequilibrated in the conduit or dike.

Jsw

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****The more mafic magma's emplacement temperature was 974°C compared to the silicic magma's 951°C.

****Trace elements such as Ba, Zr, Sr, and Rb are characteristic of each magma type

During this budget period we have obtained samples from both the conduit and dike holes. Forty three samples of the conduit hole and twenty one samples from the dike hole have been analyzed for major elements and selected traced elements. In addition, detailed microprobe analyses of ilmenite, magnetite, orthopyroxene and clinopyroxene have been completed on selected samples.

We have presented two papers at the American Geophysical Union Meetings in May and we have submitted a third paper for the Fall AGU meeting. These papers are attached as part of this progress report.

The major and selected trace element data for the conduit hole are shown in Table 1 through 3. The major element data are presented as weight percent and the trace element data are presented as part per million. Also shown in Table 2 is the temperature in degrees centigrade, and log of the oxygen fugacity calculated from the composition of ilmenite and magnetite. Depths on all the tables and figures are in feet and are slant depths.

Figures 1 through 7 show some of these variables plot against slant depth for the conduit hole. It is clear from examining these figures that the margins of the conduit hole are chemically different than the interior of the conduit. Furthermore, these are characterized by different phenocryst assemblages (see fall 1985 AGU abstract).

Tables 5 and 6 and Figures 8 through 11 show the major and trace element data that we have obtained. The analyses of the dike hole samples are very similar to the interior of the conduit (see fall 1985 AGU abstract).

Using a simple Student's T test it can be shown that the samples from the conduit margins and the base of the lavas at Obsidian Dome are similiar; whereas the samples from the conduit interior, the dike, and in those from Obsidian Dome, except in those from the base, are nearly identical.

The temperatures of the margins of the conduit, based on the ilmenite - magnetite geothermometer using thirteen sample is 974° with a standard deviation of 16.4° C. In contrast, the interior of the conduit has a temperature using 10 samples of 951° with a standard deviation of 23.2° C. There is no data that could be interpreted as indicating that these minerals have reequilibrated in the conduit.

COLUMN COUNT ROW	SAMPLE 43	DEPTH 43	SI02 43	AL203 43	FEOT 43
1	1.0000	34.60	73.0200	14.0500	1.45600
2	2.0000	79.70	71.5900	14.1700	1.98400
3	3.0000	119.70	71.6200	14.8700	1.80300
4	4.0000	139.70	69.7300	15.6700	2.06600
5	6.0000	1591.70	70.8100	14.9300	1.94900
6	8.0000	1594.50	70.5100	15.0000	1.78900
7	-9.0000	1595.70	69.6000	14.9300	2.55000
8	10.0000	1596.40	69.9900	15.1100	2.35700
9	-11.0000	1597.10	70.3300	14.7100	2.24000
10	-12.0000	1597.60	69.7900	14.7200	2.42000
11	-14.0000	1599.10	70.1200	14.9900	2.22000
12	-15.0000	1599.80	69.8700	14.8700	2.12000
13	-16.0000	1601.40	69.7500	14.9000	2.00000
14	17.0000	1602.80	69.6100	15.0800	2.18000
15	18.0000	1604.10	70.6000	14.9700	1.72000
16	19.0000	1605.10	70.9200	15.2500	2.06200
17	-20.1000	1609.30	72.0400	14.0400	1.72000
18	20.0000	1609.30	72.1400	14.2200	1.54200
19	21.0000	1613.40	73.1400	14.1900	1.44500
20	22.0000	1622.40	72.7900	14.0700	1.35200
21	23.0000	1630.30	73.3700	14.1300	1.29800
22	24.0000	1639.70	72.7400	14.0700	1.58100
23	25.0000	1647.70	72.9900	14.5300	1.56100
24	26.0000	1655.80	72.8600	14.1000	1.46800
25	27.0000	1664.50	72.5500	13.9100	1.34300
26	28.0000	1672.40	72.8800	13.9900	1.53700
27	29.0000	1680.20	72.4100	14.1000	1.65600
28	30.0000	1688.30	72.8200	14.0500	1.33200
29	32.0000	1705.40	72.6800	14.0900	1.42500
30	33.0000	1713.50	72.8900	14.1900	1.58600
31	34.0000	1721.70	73.0400	14.0900	1.35100
32	36.0000	1738.20	73.2200	14.0400	1.42500
33	38.0000	1748.50	73.3900	14.4000	1.57700
34	40.0000	1765.60	72.2800	14.3600	1.49300
35	41.0000	1774.70	72.5600	14.2600	1.45300
36	42.0000	1782.80	73.2100	14.0000	1.42100
37	44.0000	1800.30	72.6000	14.1000	1.48200
38	45.0000	1809.50	71.7100	14.6100	2.02400
39	46.0000	1818.70	69.6400	15.1900	2.63600
40	47.0000	1826.40	69.7000	15.4300	2.23300
41	48.0000	1835.20	70.8800	14.8500	2.43400
42	48.2000	1835.30	71.1500	14.5900	1.80000
43	57.0000	1847.90	70.2600	15.5900	2.16100

TABLE 1. Major element analysis. Conduit hole, depth in slant feet

COLUMN COUNT ROW	MGO 43	CAD 43	NA2O 43	K2O 43	TIO2 43
1	.145300	.91620	4.04300	5.13800	.145400
2	.113700	.87040	3.99500	5.13900	.151000
3	.255700	1.07100	4.38700	5.05900	.214200
4	.431500	1.45400	4.66200	4.75700	.367400
5	.365100	1.31000	4.37000	4.83100	.304000
6	.290900	1.24800	4.15900	4.92000	.297900
7	.320000	1.33000	4.03000	4.88000	.340000
8	.317500	1.41400	4.29800	4.82900	.324100
9	.230000	1.16000	2.95000	4.99000	.250000
10	.280000	1.21000	3.99000	4.92000	.280000
11	.300000	1.27000	4.01000	4.91000	.290000
12	.290000	1.24000	4.01000	4.30000	.290000
13	.320000	1.31000	3.96000	4.94000	.290000
14	.403100	1.43800	4.21700	4.83700	.337900
15	.279200	1.29400	4.18800	4.96600	.294500
16	.308900	1.30100	4.48200	4.94900	.289500
17	.160000	.90000	3.74000	5.11000	.180000
18	.172800	.94890	3.93500	5.10900	.183800
19	.164500	.91760	3.86200	5.14600	.147300
20	.115500	.89510	3.89500	5.15600	.144500
21	.067500	.83910	3.95600	5.18000	.143400
22	.109200	.85240	3.95900	5.19560	.147500
23	.137400	.93850	4.34600	5.20900	.151600
24	.085100	.78750	3.88900	5.16700	.143500
25	.083000	.77930	3.84300	5.10200	.142400
26	.111600	.80030	3.90300	5.13200	.145400
27	.110400	.83350	3.98500	5.17700	.141700
28	.089800	.78800	3.87300	5.16800	.141100
29	.076500	.80730	3.92200	5.21400	.145600
30	.122300	.91020	4.18100	5.19500	.149200
31	.084000	.79430	3.88600	5.22900	.143400
32	.093900	.78690	3.83700	5.18700	.142600
33	.137200	.89890	4.32800	5.19600	.151000
34	.115000	.92020	3.99100	5.30600	.148900
35	.137800	.90990	4.16100	5.17100	.145500
36	.106700	.85290	3.89000	5.16800	.152700
37	.108300	.87720	3.90400	5.16000	.161000
38	.202800	1.07800	4.25800	5.05700	.225600
39	.331500	1.37500	4.39900	4.85500	.340900
40	.389400	1.48700	4.63000	4.83800	.366000
41	.257400	1.19300	4.48200	5.00600	.267500
42	.210000	1.10000	3.89000	5.03000	.240000
43	.385500	1.49300	4.45700	4.88300	.364500

TABLE 1. (continued)

COLUMN COUNT	P205 43	MNO 43	TOTAL 43
ROW			
1	.0248000	.0600000	98.999
2	.0267000	.0616000	98.101
3	.0528000	.0670000	99.400
4	.0925000	.0663000	99.297
5	.0734000	.0593000	99.002
6	.0707000	.0479000	98.333
7	.0800000	.0600000	98.000
8	.0818000	.0580000	98.779
9	.0500000	.0600000	97.980
10	.0600000	.0600000	97.730
11	.0600000	.0500000	98.250
12	.0600000	.0600000	97.740
13	.0700000	.0400000	97.600
14	.0821000	.0542000	98.239
15	.0682500	.0441000	98.424
16	.0760000	.0546000	99.693
17	.0300000	.0400000	97.990
18	.0341000	.0396000	98.325
19	.0259000	.0441000	99.082
20	.0230000	.0447000	98.486
21	.0243000	.0212000	99.029
22	.0269000	.0541000	98.736
23	.0286000	.0668000	99.959
24	.0249000	.0499000	98.575
25	.0236000	.0426000	97.819
26	.0236000	.0565000	98.579
27	.0258000	.0623000	98.502
28	.0228000	.0441000	98.329
29	.0220000	.0515000	98.434
30	.0307000	.0677000	99.322
31	.0218000	.0496000	98.689
32	.0249000	.0252000	98.782
33	.0288000	.0661000	100.173
34	.0244000	.0607000	98.699
35	.0290000	.0562000	98.883
36	.0235000	.0610000	98.886
37	.0268000	.0603000	98.480
38	.0533000	.0641000	99.283
39	.0804000	.0642000	98.912
40	.0943000	.0694000	99.237
41	.0641000	.0750000	99.509
42	.0500000	.0600000	98.140
43	.0972000	.0578000	99.749

TABLE 1. (continued)

TABLE 2. Conduit hole. Trace elements, temperatures, Log FO₂

--print,c1-c5					
COLUMN	ID	DEPTH	LA	BA	SR
COUNT	41	41	41	41	41
ROW					
1	1.0000	34.60	87.	340.00	52.
2	2.0000	79.70	82.	500.00	62.
3	3.0000	119.70	73.	681.00	97.
4	4.0000	139.70	61.	1045.00	196.
5	6.0000	1591.70	60.	787.00	163.
6	8.0000	1594.50	61.	860.00	164.
7	9.0000	1595.80	68.	931.00	172.
8	10.0000	1596.40	63.	958.00	186.
9	11.0000	1597.10	69.	837.00	133.
10	12.0000	1597.60	69.	869.00	144.
11	14.0000	1599.10	74.	910.00	166.
12	15.0000	1599.80	61.	888.00	156.
13	16.0000	1601.40	59.	968.00	163.
14	17.0000	1602.80	55.	1092.00	199.
15	18.0000	1604.10	63.	936.00	171.
16	19.0000	1605.10	56.	903.00	157.
17	20.0000	1609.30	79.	482.00	85.
18	20.1000	1609.30	77.	501.00	72.
19	21.0000	1613.40	80.	424.00	75.
20	22.0000	1622.40	75.	374.00	56.
21	23.0000	1630.30	88.	391.00	51.
22	24.0000	1639.70	86.	358.00	50.
23	25.0000	1647.70	73.	354.00	52.
24	26.0000	1655.80	85.	366.00	46.
25	27.0000	1664.50	90.	354.00	54.
26	28.0000	1672.40	82.	377.00	52.
27	29.0000	1680.20	82.	410.00	53.
28	30.0000	1688.30	81.	375.00	56.
29	32.0000	1705.40	82.	394.00	48.
30	34.0000	1721.70	83.	365.00	44.
31	36.0000	1738.20	90.	402.00	53.
32	38.0000	1748.50	79.	350.00	47.
33	41.0000	1774.70	77.	361.00	46.
34	44.0000	1800.30	88.	406.00	58.
35	45.0000	1809.50	71.	738.00	111.
36	46.0000	1818.70	62.	935.00	189.
37	47.0000	1826.40	59.	1002.00	201.
38	48.0000	1835.20	65.	729.00	141.
39	48.1000	1835.21	56.	961.00	202.
40	48.2000	1835.22	68.	699.00	117.
41	57.0000	1847.90	52.	912.00	192.

TABLE 2. (continued)

COLUMN COUNT ROW	RB 41	ZR 41	CB 41	TEMP 41	LOGF02 41
1	166.	234.	1.0000	9999.0	9999.0
2	158.	248.	2.0000	9999.0	9999.0
3	147.	287.	3.0000	9999.0	9999.0
4	132.	368.	4.0000	967.0	-10.6
5	131.	323.	6.0000	971.0	-10.2
6	142.	328.	8.0000	956.0	-10.7
7	134.	338.	9.0000	1008.0	-9.8
8	131.	332.	10.0000	964.0	-10.6
9	141.	306.	11.0000	983.0	-10.2
10	131.	310.	12.0000	1004.0	-9.9
11	136.	325.	14.0000	9999.0	9999.0
12	133.	314.	15.0000	9999.0	9999.0
13	137.	323.	16.0000	9999.0	9999.0
14	134.	353.	17.0000	975.0	-10.4
15	137.	335.	18.0000	964.0	-10.6
16	135.	318.	19.0000	966.0	-10.6
17	159.	258.	20.1000	9999.0	9999.0
18	155.	240.	20.0000	946.0	-11.0
19	161.	227.	21.0000	971.0	-10.6
20	160.	227.	22.0000	936.0	-11.2
21	166.	231.	23.0000	1002.0	-10.3
22	167.	235.	24.0000	9999.0	9999.0
23	159.	222.	25.0000	9999.0	9999.0
24	157.	213.	26.0000	949.0	-10.8
25	161.	224.	27.0000	926.0	-11.0
26	163.	232.	28.0000	964.0	-10.5
27	167.	232.	29.0000	9999.0	9999.0
28	163.	226.	30.0000	948.0	-10.7
29	167.	241.	32.0000	960.0	-10.5
30	164.	228.	33.0000	9999.0	9999.0
31	166.	226.	34.0000	9999.0	9999.0
32	162.	225.	36.0000	924.0	-11.5
33	150.	204.	38.0000	942.0	-11.0
34	166.	248.	41.0000	927.0	-11.2
35	146.	286.	44.0000	9999.0	9999.0
36	135.	346.	45.0000	9999.0	9999.0
37	132.	345.	46.0000	9999.0	9999.0
38	140.	304.	47.0000	983.0	-10.2
39	133.	343.	48.1000	959.0	-10.4
40	145.	300.	48.2000	962.0	-10.7
41	139.	324.	57.0000	9999.0	9999.0

--note 9999 is a dummy variable

TABLE 3. Conduit hole, oxidation state of iron

COLUMN COUNT ROW	DEPTH 35	FEOT 35	FEO 35	FE203 35	FERATIO 35
1	34.60	1.45600	1.38000	.11000	12.5455
2	79.70	1.98400	1.09000	.99000	1.1010
3	119.70	1.80300	1.18000	.69000	1.7100
4	139.70	2.06600	1.76000	.34000	5.1765
5	1591.70	1.94900	1.49000	.51000	2.9216
6	1594.50	1.78900	1.24000	.61000	2.0328
7	1596.40	2.35700	1.36000	1.11000	1.2252
8	1602.80	2.18000	1.28000	1.00000	1.2800
9	1604.10	1.72000	1.24000	.54000	2.2963
10	1605.10	2.06200	*****	*****	*****
11	1609.30	1.54200	*****	*****	*****
12	1613.40	1.44500	*****	*****	*****
13	1622.40	1.35200	*****	*****	*****
14	1630.30	1.29800	*****	*****	*****
15	1639.70	1.58100	*****	*****	*****
16	1647.70	1.56100	*****	*****	*****
17	1655.80	1.46800	*****	*****	*****
18	1664.50	1.34300	*****	*****	*****
19	1672.40	1.53700	*****	*****	*****
20	1680.20	1.65600	*****	*****	*****
21	1688.30	1.33200	.91000	.47000	1.9362
22	1705.40	1.42500	1.09000	.37000	2.9459
23	1713.50	1.58600	1.01000	.63000	1.6032
24	1721.70	1.35100	.94000	.46000	2.0435
25	1738.20	1.42500	*****	*****	*****
26	1748.50	1.57700	*****	*****	*****
27	1765.60	1.49300	*****	*****	*****
28	1774.70	1.45300	*****	*****	*****
29	1782.80	1.42100	*****	*****	*****
30	1800.30	1.48200	*****	*****	*****
31	1809.50	2.02400	1.17000	.95000	1.2316
32	1818.70	2.63600	1.34000	1.44000	.9306
33	1826.40	2.23300	1.52000	.79000	1.9241
34	1835.20	2.43400	1.44000	1.10000	1.3091
35	1847.90	2.16100	1.39000	.86000	1.6163

FeO/Fe₂O₃

LAVAS

margin

Condu. + Center

margin

FIGURE 1a,1b Conduit hole, Temperatures vs. depth

--plotplot,c19,900,1050,c2,1575,1875

1 POINTS OUT OF BOUNDS
16 MISSING OBSERVATIONS

--plot,c19,1900,1050,c2,1590,1640

12 POINTS OUT OF BOUNDS
16 MISSING OBSERVATIONS

FIGURE 2. FEO vs depth

--plot,c100,1.2,2.6,c102,1550,1850

FIGURE 3. BA vs. depth

4 POINTS OUT OF BOUNDS

FIGURE 4. Conduit hole, TiO_2 vs depth

--plot, z10, .1, .4, z102, 1550, 1850

TiO2

.40+

.30+

.20+

.10+

1550.

1610.

1670.

1730.

1790.

1850.

DEPTH

FIGURE 5. Conduit hole, SiO_2 vs. depth

--plot, z107, .45, .74, z102, 1550, 1850

SiO2

.74+

.65+

.55+

.45+

1550.

1610.

1670.

1730.

1790.

1850.

DEPTH

A FEW SET OF POINTS.

FIGURE 6. Conduit hole, Rb vs. depth

4 POINTS OUT OF BOUNDS

23 POINTS OUT OF BOUNDS

FIGURE 7. Sr and Zr vs depth • Conduit hole

4 POINTS OUT OF BOUNDS

COLUMN COUNT ROW	ID 21	DEPTH 21	SI02 21	AL203 21	FE0(T) 21
1	1.	2263.65	71.7100	14.4800	1.64000
2	2.	2263.83	73.2100	13.8800	1.64000
3	3.	2264.50	72.6300	14.0000	1.65000
4	4.	2264.75	72.5800	14.0000	1.71000
5	5.	2265.60	73.1700	14.0500	1.68000
6	6.	2267.00	72.4800	14.1100	1.42000
7	7.	2270.00	73.0200	14.0200	1.44000
8	8.	2272.70	72.6900	14.0600	1.31000
9	9.	2278.90	72.7800	13.9400	1.40000
10	10.	2288.10	72.7300	13.9900	1.44000
11	11.	2301.50	73.0200	13.9300	1.44000
12	12.	2316.70	72.5200	14.0100	1.58000
13	13.	2324.65	72.6700	13.9900	1.49000
14	14.	2331.00	72.4400	14.0400	1.58000
15	15.	2338.70	72.7500	14.0700	1.39000
16	16.	2341.90	72.8400	14.0200	1.59000
17	20.	2346.10	72.7900	13.9500	1.60000
18	21.	2346.50	70.4400	13.6400	1.54000
19	22.	2347.00	70.1100	13.4700	1.74000
20	23.	2347.10	69.6000	13.4100	1.38000
21	24.	2347.58	69.7300	13.3900	1.58000

COLUMN COUNT ROW	MGO 21	CAO 21	NA2O 21	K2O 21	TIO2 21
1	.120000	.92000	3.44000	5.59000	.150000
2	.080000	.78000	3.69000	5.17000	.140000
3	.100000	.78000	3.74000	5.23000	.150000
4	.100000	.79000	3.69000	5.21000	.140000
5	.100000	.80000	3.78000	5.20000	.140000
6	.170000	.88000	3.74000	5.17000	.150000
7	.100000	.82000	3.68000	5.23000	.150000
8	.080000	.81000	3.85000	5.22000	.140000
9	.120000	.81000	3.81000	5.18000	.150000
10	.100000	.81000	3.75000	5.20000	.140000
11	.180000	.79000	3.69000	5.23000	.140000
12	.080000	.80000	3.76000	5.26000	.140000
13	.090000	.80000	3.72000	5.20000	.140000
14	.080000	.81000	3.76000	5.24000	.150000
15	.090000	.80000	3.77000	5.22000	.140000
16	.070000	.79000	3.74000	5.24000	.140000
17	.100000	.80000	3.67000	5.22000	.160000
18	.100000	.80000	3.57000	5.09000	.140000
19	.110000	1.01000	3.55000	4.89000	.150000
20	.090000	1.03000	3.50000	4.87000	.140000
21	.100000	.98000	3.50000	4.77000	.140000

COLUMN COUNT ROW	P2O5 21	MNO 21	TOTAL 21
1	.0200000	.0600000	98.1300
2	.0200000	.0600000	98.6900
3	.0200000	.0600000	98.3600
4	.0200000	.0600000	98.3100
5	.0200000	.0600000	98.9900
6	.0200000	.0600000	98.2100
7	.0200000	.0600000	98.5700
8	.0200000	.0600000	98.2400
9	.0200000	.0600000	98.3200
10	.0200000	.0600000	98.2400
11	.0200000	.0600000	98.4100
12	.0200000	.0600000	98.2200
13	.0200000	.0600000	98.2000
14	.0200000	.0600000	98.1900
15	.0200000	.0600000	98.3100
16	.0200000	.0500000	98.5100
17	.0200000	.0600000	98.4700
18	.0200000	.0600000	95.4100
19	.0200000	.0600000	95.1200
20	.0200000	.0600000	94.1000
21	.0200000	.0600000	94.2600

TABLE 4. Dike hole, Major elements

COLUMN COUNT ROW	DEPTH 21	LA 21	BA 21	SR 21
1	2263.65	83.	313.	71.
2	2263.83	81.	297.	39.
3	2264.50	78.	325.	40.
4	2264.75	77.	338.	45.
5	2265.60	86.	321.	43.
6	2267.00	82.	337.	48.
7	2270.00	80.	318.	42.
8	2272.70	87.	267.	41.
9	2278.90	84.	294.	40.
10	2288.10	79.	274.	40.
11	2301.50	76.	327.	42.
12	2316.70	83.	367.	40.
13	2324.65	76.	353.	52.
14	2331.00	75.	333.	41.
15	2338.70	79.	329.	41.
16	2341.90	86.	343.	40.
17	2346.10	81.	388.	50.
18	2346.50	80.	337.	40.
19	2347.00	76.	369.	62.
20	2347.10	76.	319.	55.
21	2347.58	67.	273.	51.

COLUMN COUNT ROW	RB 21	ZR 21
1	124.	230.
2	151.	203.
3	159.	221.
4	156.	221.
5	163.	242.
6	163.	235.
7	164.	219.
8	167.	226.
9	167.	232.
10	165.	232.
11	167.	227.
12	168.	228.
13	163.	218.
14	168.	230.
15	169.	237.
16	163.	230.
17	156.	237.
18	169.	232.
19	153.	233.
20	153.	218.
21	171.	217.

TABLE 7. Dike hole, trace elements

FIGURE 8, Dike hole FeO, TiO₂ vs depth
 plot, c5, 1.2, 2.6, c2, 2260, 2360 2

--plot, c10, c2

FIGURE 9. Dike hole, Zr and Total vs. depth. Low totals show hydrated glassy samples.

--plot,c18,c2

--plot,c13,c2

FIGURE 10. Dike hole. Sr and Rb vs. depth

--plot,c16,c2

--plot,c17,c2

FIGURE 11. Ba and La vs. depth

--plot,c14,0,100,c2,2260,2360

Conference abstracts removed.