UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Major and trace element analyses of drill cores from thermal areas in Yellowstone National Park, Wyoming

by

Melvin H. Beeson[1] and Keith E. Bargar[1]

Open-file Report 84-373

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards.

[1]Menlo Park, CA

1984

INTRODUCTION

In 1967 and 1968, the U.S. Geological Survey drilled 13 research diamond drill holes in several of the major thermal areas of Yellowstone National Park, Wyoming (Fig. 1). The holes were completed for the purpose of obtaining

Figure 1 near here

detailed physical and chemical data on the shallow part of a high temperature geothermal system (White and others, 1975). Two earlier drill holes (C-I and C-II), drilled by the Carnegie Institution of Washington in 1929, are described by Fenner (1936). Depths of the 15 drill holes ranged from 65 to 330 m and averaged about 150 m; maximum temperatures encountered in the drill holes varied from 143.1°C to 237.5°C (White and others, 1975).

Nearly continuous drill core was recovered from each of the drill holes. Typically the drill holes penetrated one or more of the following rock units: (1) thin layers of surficial opaline sinter (or travertine) deposited by hot-spring runoff, (2) a mantling of glacial sediments deposited during Pinedale glaciation (about 45,000-14,000 years B.P.; Pierce and others, 1976), and (3) rhyolitic lava flows and pyroclastic rocks of middle and late Pleistocene age (Christiansen and Blank, 1972).

Approximately 20-30% of each of the 13 U. S. Geological Survey drill cores was selected for detailed laboratory study, and similar "skeleton" cores from C-I and C-II were obtained from the Carnegie Institution of Washington. These 15 "skeleton" cores were selected as being representative of a drilling interval or contained features of specific interest such as veins, vugs, well-developed secondary mineral relationships, or unusual secondary minerals.

Cores from the 13 modern drill holes were studied to identify the hydrothermal alteration mineral phases present. Details of these hydrothermal studies previously were reported for drill holes Y-1 (Honda and Muffler, 1970; Honda and Sasaki, 1977), Y-2 (Bargar and Beeson, 1981), Y-3 (Muffler and others, 1971; Bargar and others, 1973), Y-5 (Keith and Muffler, 1978), Y-6 (Bargar and Beeson, in press), Y-7 and Y-8 (Keith and others, 1978b), Y-11 (Muffler and Bargar, 1974; Bargar and Muffler, 1982), and Y-13 (Keith and others, 1978a). Additional reports are planned for drill cores Y-3, Y-4, Y-9, Y-12, and Y-13, and the two Carnegie drill cores. We do not intend to report on the Y-10 drill core, mostly a travertine drill core from Mammoth Hot Springs, although some information on this drill core is given in White and others (1975) and Bargar (1978).

The bulk of the 13 drill cores and the "skeleton" cores from drill holes Y-2, Y-5, Y-6, and Y-11 have been placed in a core library operated by the U.S. Geological Survey, Federal Center, Denver, CO, 80225. The remainder of the 1967-1968 "skeleton" drill cores also will be stored at this location upon completion of a few topical studies. The two Carnegie drill cores will be returned to the Carnegie Institution of Washington.

EXPLANATION OF CHEMICAL ANALYSES TABLES

Tables 1 through 4 list major and trace element analyses, as well as normative minerals, salic and femic percentages, differentiation index (D.I.), alumina/silica ratio, and ferric iron/ferrous iron ratio for selected core samples from drill holes in Upper Geyser Basin (Table 1), Lower Geyser Basin (Table 2), Norris Geyser Basin (Table 3), and the Mud Volcano Area (Table 4)

Tables 1, 2, 3, and 4 near here

(see Fig. 1 for drill hole locations). For the 13 U. S. Geological Survey drill holes, sample numbers (such as Y1-19.0), given at the top of each analysis column, consist of a prefix (ie. Y1) corresponding to the drill hole number as shown in Fig. 1 and a suffix (ie. 19.0) indicating depth in feet within the designated drill hole. The Carnegie drill holes C-I and C-II have a prefix YP and assigned numbers which are in sequence down the drill holes but have no relation to the depth. Except for two drill holes (C-I and C-II which have sample numbers begining with *YP in Tables 1 and 3) reported by Fenner (1936), the major element oxides listed in the tables are rapid rock analyses (Shapiro, 1967). These analyses were made in several batches between 1975 and 1979 by H. Smith, N. Skinner, or L. Artis, all of the U. S. Geological Survey. Dashed lines in the tables indicate that the oxide in question was not detected in a particular sample; n.d. means that the element was not determined for the sample. The symbol (1, 2, X, etc.) just below the sample number of each analysis is a plotting symbol used in the graphic normative analysis program (GNAP) (Bowen, 1971). Normative minerals calculated by this computer program are listed below the major oxide analyses.

Trace element analyses by emission spectroscopy also were performed on the samples between 1975 and 1979 in multiple batches by the following analysts: J. L. Harris, L. Mei, J. Kent, M. Retzloff, or N. Rait of the U. S. Geological Survey. In addition, separate emission spectrographic analyses were obtained for Li, Cs, and Rb by R. Mays or J. Kent (U. S. Geological Survey) for several drill core samples (Keith and others, 1983). Dashed lines indicate that the element sought was not detected; n.d. means that the element was not determined. Limits of detection for a given element vary somewhat in the tables because of slightly different methods of analysis. Elements looked for but not found at the limit of detectibility for a given method in the semiquantitative spectrographic analyses of all samples include: As, Au, Bi, Cd, Ge, Hf, Ho, Ir, Lu, Pd, Pt, Re, Rh, Ru, Ta, Tb, Te, Tm, and U. Elements which were detected in only a few of the analyzed samples and were not listed in Tables 1-4 include: Dy (22 ppm in Y8-160.5, and 36 ppm in Y12-706.6), In (7.2 ppm in Y7-157.5, and 7.1 ppm in Y13-112.4), Pr (71 ppm in Y13-112.4), Sm (77 ppm in Y12-706.6), Th (63 ppm in Y9-617.5, 26 ppm in Y12-706.6, and 22-41 ppm in several samples from drill core Y13), Tl (24 ppm in Y2-24, 4.7 ppm in Y13-149.9, and 70 ppm in YP 654), and W (210 ppm in Y2-24, 100 ppm in Y12-706.6, and 190 ppm in Y13-8).

REFERENCES

Bargar, K.E., 1978, Geology and thermal history of Mammoth Hot Springs, Yellowstone National Park, Wyoming: U.S. Geological Survey Bulletin 1444, 55p.

Bargar, K.E., and Beeson, M.H., 1981, Hydrothermal alteration in research drill hole Y-2, Lower Geyser Basin, Yellowstone National Park, Wyoming: American Mineralogist, v. 66, p. 473-490.

Bargar, K.E., and Beeson, M.H., in press, Hydrothermal alteration in research drill hole Y-6, Upper Firehole River, Yellowstone National Park, Wyoming: U.S. Geological Survey Professional Paper 1054-B.

Bargar, K.E., and Muffler, L.J.P., 1982, Hydrothermal alteration in research drill hole Y-11 from a vapor-dominated geothermal system at Mud Volcano, Yellowstone National Park, Wyoming: Thirty-third annual field conference Wyoming Geological Association Guidebook, p. 139-152.

Bargar, K.E., Beeson, M.H., Fournier, R.O., and Muffler, L.J.P., 1973, Present-day deposition of lepidolite from thermal waters in Yellowstone National Park: American Mineralogist, v. 58, p. 901-904.

Bowen, R.W., 1971, Graphic normative analysis program: U.S. Geological Survey Computer Contribution Number 13 (unpub.), 80p.

Christiansen, R.L., and Blank, H.R., Jr., 1972, Volcanic stratigraphy of the Quaternary rhyolite-plateau in Yellowstone National Park: U.S. Geological Survey Professional Paper 729-B, 18p.

Fenner, C.N., 1936, Bore-hole investigations in Yellowstone Park: Journal of Geology, v. 44, p. 225-315.

Honda, Sakuro, and Muffler, L.J.P., 1970, Hydrothermal alteration in core from research drill hole Y-1, Upper Geyser Basin, Yellowstone National Park, Wyoming: American Mineralogist, v. 55, p. 1714-1737.

Honda, Sakuro, and Sasaki, Kyoji, 1977, Scanning electron micrographs of zeolites produced by hydrothermal alteration - - an example in core from research drill hole Y-1, Yellowstone National Park, U.S.A.: Ahido University Mineralogy Publication, v. 44, 16p.

Keith, T.E.C., and Muffler, L.J.P., 1978, Minerals produced during cooling and hydrothermal alteration of ash-flow tuff from Yellowstone drill hole Y-5: Journal of Volcanology and Geothermal Research, v. 3, p. 373-402.

Keith, T.E.C., Beeson, M.H., and White, D.E., 1978a, Hydrothermal minerals in U.S. Geological Survey research drill hole Y-13, Yellowstone National Park, Wyoming: Geological Society of America Abstacts with Programs, v. 10, p. 432-433.

Keith, T.E.C., White, D.E., and Beeson, M.H., 1978b, Hydrothermal alteration and self-sealing in Y-7 and Y-8 drill holes in northern part of Upper Geyser Basin, Yellowstone National Park, Wyoming: U.S. Geological Survey Professional Paper 1054-A, 26p.

Keith, T.E.C., Thompson, J.M., and Mays, R.E., 1983, Selective concentration of cesium in analcime during hydrothermal alteration, Yellowstone National Park, Wyoming: Geochimica et Cosmochimica Acta, v 47, p. 795-804.

Muffler, L.J.P., and Bargar, K.E., 1974, Hydrothermal alteration of rhyolitic ash-flow tuff in the vapor-dominated geothermal system at Mud Volcano, Yellowstone National Park, U.S.A. (abs.): International Symposium on Water-Rock Interaction, Prague, Czechoslovakia, Abstract Volume, p. 52.

Muffler, L.J.P., White, D.E., and Truesdell, A.H., 1971, Hydrothermal explosion craters in Yellowstone National Park: Geological Society of America Bulletin, v. 82, p. 723-740.

Pierce, K.L., Obradovich, J.D., and Friedman, I., 1976, Obsidian hydration dating and correlation of Bull Lake and Pinedale Glaciations near West Yellowstone, Montana: Geological Society of America Bulletin, v. 87, p. 703-710.

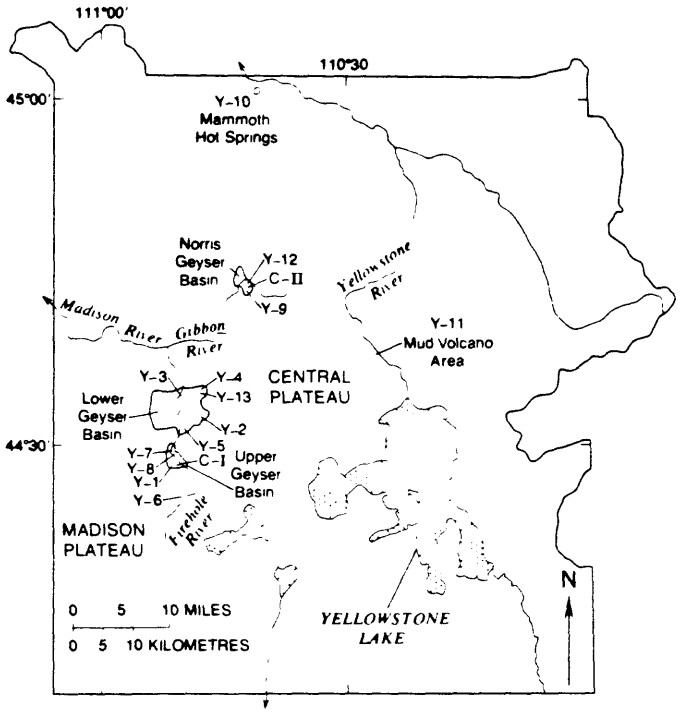
Shapiro, Leonard, 1967, Rapid analysis of rocks and minerals by a single-solution method: U.S. Geological Survey Professional Paper 575-B, B187-B191.

White, D.E., Fournier, R.O., Muffler, L.J.P., and Truesdell, A.H., 1975, Physical results of research drilling in thermal areas of Yellowstone National Park, Wyoming: U.S. Geological Survey Professional Paper, 892, 70p.

FIGURE CAPTIONS

Figure 1. Map of Yellowstone National Park showing location of U. S. Geological Survey drill holes Y-1 through Y-13, and the Carnegie Institute of Washington drill holes CI, and CII.

Figure 1


111°00'
110°30
45°00'
44°30'
Y-10
Mammoth
Hot Springs
Norris
Geyser
Basin
Y-12
C-II
Y-9
Yellowstone
River
Madison River
Gibbon
River
Y-11
Mud Volcano
Area
Y-3
Y-4
Y-13
CENTRAL
PLATEAU
Lower
Geyser
Basin
Y-2
Y-5
Y-7
Y-8
C-I
Upper
Geyser
Basin
Y-1
Y-6
Firehole
River
MADISON
PLATEAU
0 5 10 MILES
0 5 10 KILOMETRES
YELLOWSTONE
LAKE
N

TABLES 1-4

Table 1. -- Major and trace element chemical analyses of Upper Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y1-19.0	Y1-42.0	Y1-79.0	Y1-120.5	Y1-202.9	Y1-210.4	Y1-211.3	Y1-214.7	Y6-82.2	Y6-97.3	Y6-103.7	Y6-141.0
Symbol	1	1	1	1	1	1	1	1	6	6	6	6
SiO_2	79.40	74.20	70.00	76.50	73.70	74.40	72.20	72.10	72.00	68.80	76.80	69.80
Al_2O_3	8.40	11.20	10.90	11.70	12.10	11.60	13.70	13.10	14.60	14.40	12.40	15.10
Fe_2O_3	0.75	1.40	1.80	1.00	1.10	2.40	2.50	2.30	1.20	1.10	0.94	1.50
FeO	0.44	0.20	0.28	0.25	0.28	0.48	0.64	0.84	0.28	0.08	0.12	0.16
MgO	0.05	0.15	0.22	0.07	0.20	0.15	0.06	0.06	0.15	0.23	0.07	0.22
CaO	0.95	0.55	1.40	0.22	0.61	0.96	1.20	1.20	0.82	1.60	0.46	0.52
Na_2O	2.30	2.30	2.90	4.10	4.40	2.90	3.70	3.70	1.10	2.20	2.60	3.00
K_2O	3.10	2.50	4.00	3.80	4.30	4.10	4.90	4.60	4.70	2.00	5.50	6.50
H_2O	3.04	6.70	7.60	3.16	2.47	1.71	0.39	0.53	4.30	8.30	0.88	1.72
TiO_2	0.13	0.11	0.13	0.10	0.21	0.35	0.45	0.49	0.27	0.28	0.24	0.30
P_2O_5	0.08	0.10	0.06	0.04	0.10	0.09	0.13	0.19	0.08	0.04	0.04	0.04
MnO	0.06	0.03	0.09	0.02	0.03	0.04	0.06	0.05	0.01	0.02	---	0.02
CO_2	0.01	0.01	0.01	0.01	0.03	0.02	0.01	0.01	0.02	0.06	0.01	0.06
Total(-O)	98.71	99.45	99.39	100.97	99.53	99.21	99.94	99.17	99.53	99.11	100.06	98.94
Normative minerals												
q	53.095	50.439	35.249	37.312	30.904	40.187	29.678	31.136	46.132	45.258	39.655	26.592
c		3.995		0.556		0.915	0.463	0.333	6.481	5.995	1.452	2.445
or	18.558	14.855	23.782	22.240	25.530	24.421	28.973	27.410	27.905	11.925	32.482	38.822
ab	19.716	19.570	24.690	34.360	37.407	24.734	31.327	31.570	9.352	18.783	21.987	25.657
an	3.486	2.023	4.941	0.760	0.569	4.080	5.044	4.688	3.435	7.363	1.956	1.960
wo	0.290		0.663		0.678							
en	0.126	0.376	0.551	0.173	0.500	0.377	0.150	0.151	0.375	0.578	0.174	0.554
mt	0.086											
hm	1.102	0.426	0.824	0.576	0.394	0.668	0.955	1.462	0.153			
il		1.114	1.242	0.593	0.834	1.958	1.843	1.311	1.100	1.110	0.939	1.516
il	0.250	0.210	0.248	0.188	0.401	0.670	0.855	0.938	0.515	0.214	0.253	0.385
ru										0.170	0.106	0.101
ap	0.192	0.238	0.143	0.094	0.238	0.215	0.308	0.454	0.190	0.096	0.095	0.096
cc	0.023	0.023	0.023	0.023	0.069	0.046	0.023	0.023	0.046	0.138	0.023	0.138
Total	96.925	93.269	92.358	96.873	97.524	98.271	99.617	99.476	95.684	91.628	99.123	98.264
Salic	94.856	90.882	88.662	95.227	94.410	94.338	95.484	95.137	93.304	89.323	97.532	95.475
Femic	2.070	2.387	3.696	1.646	3.113	3.934	4.133	4.339	2.380	2.305	1.591	2.789
D.I.	91.370	84.864	83.721	93.911	93.842	89.342	89.978	90.116	83.388	75.965	94.124	91.070
Al_2O_3/SiO_2	0.106	0.151	0.156	0.153	0.164	0.156	0.190	0.182	0.203	0.209	0.161	0.216
FeO/Fe_2O_3	0.587	0.143	0.156	0.250	0.255	0.200	0.256	0.365	0.233	0.073	0.128	0.107

Table 1. (cont'd)-- Major and trace element chemical analyses of Upper Geyser Basin drill core, Yellowstone National Park, Wyoming

Trace elements (ppm)

	Y1-19.0	Y1-42.0	Y1-79.0	Y1-120.5	Y1-202.9	Y1-210.4	Y1-211.3	Y1-214.7	Y6-82.2	Y6-97.3	Y6-103.7	Y6-141.0
Symbol	1	1	1	1	1	1	1	1	6	6	6	6
Ag	<0.7	<0.7	0.14	0.13	<0.7	<0.1	<0.1	<0.7	0.11	<0.1	<0.1	0.12
B	20.	10.	<3.2	27.	15.	3.5	3.2	3.	4.7	<3.2	3.8	4.5
Ba	300.	150.	420.	430.	700.	760.	1100.	1000.	810.	910.	920.	1400.
Be	5.	7.	4.2	7.6	7.	6.8	5.1	7.	6.1	3.9	5.9	4.6
Ce	150.	200.	130.	140.	200.	150.	170.	<50.	150.	190.	130.	170.
Co	<1.	<1.	2.1	2.2	<1.	3.6	4.1	<1.	2.3	1.9	2.2	2.9
Cr	2.	3.	4.2	5.7	7.	6.6	6.5	7.	3.9	2.4	2.9	3.2
Cs	30.	20.	180.	300.	2000.	45.	n.d.	20.	n.d.	n.d.	n.d.	n.d.
Cu	3.	5.	4.5	4.1	5.	6.2	7.1	7.	6.3	3.6	4.	4.6
Er	---	---	<10.	11.	---	<10.	<10.	---	<10	<10.	<10.	<10.
Eu	<1.	<1.	<1.5	<1.5	<1.	<1.5	2.2	3.	2.1	<1.5	<1.5	2.4
Ga	20.	20.	20.	28.	20.	21.	32.	30.	27.	22.	21.	33.
Gd	---	---	<6.8	7.	---	12.	9.8	---	<6.8	7.3	<6.8	<6.8
La	100.	100.	68.	85.	150.	96.	94.	70.	87.	97.	83.	99.
Li	50.	50.	58.	95.	200.	160.	<68.	50.	<68.	<68.	160.	<68.
Mo	7.	5.	<2.2	<2.2	5.	2.3	2.7	5.	4.2	<2.2	4.1	<2.2
Nb	30.	70.	25.	39.	50.	34.	41.	20.	43.	34.	25.	31.
Nd	<20.	<20.	59.	63.	<20.	120.	98.	<20.	89.	100.	82.	110.
Ni	5.	5.	<4.6	6.6	7.	5.4	6.4	5.	5.5	<4.6	<4.6	<4.6
Pb	30.	30.	28.	33.	70.	27.	31.	50.	30.	35.	28.	46.
Rb	150.	100.	140.	120.	250.	94.	n.d.	200.	n.d.	n.d.	n.d.	n.d.
Sc	3.	3.	2.6	2.6	5.	8.1	10.	7.	4.6	5.3	4.2	4.5
Sn	7.	10.	<6.8	9.4	10.	9.8	9.1	7.	<6.8	<6.8	<6.8	<6.8
Sr	20.	15.	52.	23.	30.	89.	120.	150.	56.	67.	45.	52.
V	<1.	<1.	5.	3.6	3.	13.	15.	10.	8.1	7.1	5.7	8.1
Y	50.	70.	39.	50.	70.	60.	59.	30.	55.	51.	33.	50.
Yb	7.	10.	4.7	8.3	10.	6.2	8.	10.	7.5	6.8	5.1	7.4
Zn	50.	70.	48.	<22.	50.	33.	44.	70.	31.	<22.	<22.	<22.
Zr	200.	500.	180.	210.	200.	350.	480.	300.	310.	280.	230.	210.

Table 1. (cont'd)-- Major and trace element chemical analyses of Upper Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y6-151.3	Y6-314.0	Y6-494.0	Y7-21.0	Y7-43.3	Y7-77.3	Y7-100.5	Y7-129.0	Y7-142.0	Y7-148.7	Y7-157.5	Y7-173.0
Symbol	6	6	6	7	7	7	7	7	7	7	7	7
SiO_2	74.90	73.00	74.70	78.90	71.80	70.50	69.30	70.20	74.60	71.10	68.40	69.40
Al_2O_3	13.30	13.90	13.00	9.80	11.50	11.80	12.20	11.90	12.20	11.10	12.50	13.00
Fe_2O_3	1.10	1.20	0.52	0.50	0.59	0.76	0.72	0.63	1.00	0.76	1.20	2.00
FeO	0.24	0.20	0.60	0.64	0.36	0.40	0.44	0.52	0.36	0.40	0.32	0.88
MgO	0.12	0.10	0.09	---	0.03	0.07	0.03	0.02	---	0.03	0.06	0.21
CaO	0.56	0.67	0.57	0.35	0.56	0.55	0.53	0.50	0.26	0.73	0.67	0.98
Na_2O	3.10	3.20	3.10	2.80	3.20	3.50	3.50	3.60	3.80	3.80	3.80	3.60
K_2O	5.40	5.50	5.10	4.00	3.70	4.20	3.90	3.80	5.30	3.60	3.90	3.90
H_2O	0.67	0.76	0.77	2.71	9.20	9.10	9.00	9.40	0.78	8.30	8.20	6.00
TiO_2	0.24	0.26	0.25	0.12	0.16	0.17	0.16	0.16	0.12	0.18	0.18	0.40
P_2O_5	0.05	0.05	0.04	0.04	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.09
MnO	0.01	0.01	0.01	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.04	0.05
CO_2	0.03	0.05	0.06	0.03	0.02	0.02	0.02	0.02	0.03	0.03	0.04	0.08
Total(-O)	99.72	98.90	98.81	99.92	101.20	101.16	99.88	100.83	98.52	100.11	99.36	100.59
Normative minerals												
q	35.146	32.388	36.379	46.505	37.528	32.631	33.070	33.432	32.402	33.906	30.291	31.409
c	1.531	1.719	1.598	0.394	1.363	0.678	1.425	1.112			1.028	1.467
or	32.	32.862	30.500	23.656	21.605	24.534	23.074	22.270	31.790	21.250	23.195	22.911
ab	26.305	27.379	26.547	23.712	26.756	29.276	29.652	30.211	32.638	32.119	32.362	30.284
an	2.268	2.711	2.213	1.286	2.297	2.185	2.179	2.011	0.588	2.595	2.762	3.746
wo									0.082	0.212		
en	0.300	0.252	0.227		0.074	0.172	0.075	0.049		0.075	0.150	0.520
fs			0.281	0.620			0.005	0.224				
mt	0.111		0.763	0.726	0.785	0.884	1.045	0.906	0.891	0.864	0.644	1.829
hm	1.027	1.213			0.042	0.142			0.401	0.163	0.763	0.727
il	0.457	0.449	0.481	0.228	0.300	0.319	0.304	0.301	0.231	0.341	0.344	0.755
ru		0.027										
ap	0.119	0.120	0.096	0.095	0.117	0.140	0.119	0.117	0.120	0.118	0.119	0.212
cc	0.068	0.115	0.138	0.068	0.045	0.045	0.046	0.045	0.069	0.068	0.092	0.181
Total	99.331	99.234	99.223	97.290	90.912	91.008	90.992	90.680	99.211	91.712	91.750	94.040
Salic	97.249	97.059	97.237	95.553	89.549	89.305	89.399	89.037	97.416	89.871	89.637	89.817
Femic	2.081	2.175	1.986	1.737	1.363	1.703	1.593	1.643	1.795	1.841	2.113	4.224
D.I.	93.450	92.629	93.426	93.873	85.889	86.442	85.795	85.914	96.829	87.275	85.847	84.604
Al_2O_3/SiO_2	0.178	0.190	0.174	0.124	0.160	0.167	0.176	0.170	0.164	0.156	0.183	0.187
FeO/Fe_2O_3	0.218	0.167	1.154	1.280	0.610	0.526	0.611	0.825	0.360	0.526	0.267	0.440

Table 1. (cont'd)-- Major and trace element chemical analyses of Upper Geyser Basin drill core, Yellowstone National Park, Wyoming

Trace elements (ppm)

	Y6-151.3	Y6-314.0	Y6-494.0	Y7-21.0	Y7-43.3	Y7-77.3	Y7-100.5	Y7-129.0	Y7-142.0	Y7-148.7	Y7-157.5	Y7-173.0
Symbol	6	6	6	7	7	7	7	7	7	7	7	7
Ag	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
B	6.3	5.7	4.	11.	5.	4.7	<4.6	<4.6	5.2	<4.6	<4.6	5.9
Ba	1500.	1100.	850.	260.	560.	590.	440.	510.	200.	410.	390.	740.
Be	6.5	5.2	4.2	5.2	2.4	5.3	3.5	2.6	4.4	2.2	2.7	5.3
Ce	130.	170.	180.	160.	190.	150.	180.	190.	180.	180.	210.	190.
Co	2.6	2.2	2.4	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	2.3
Cr	2.7	4.1	2.4	3.	3.3	3.2	2.2	11.	1.3	1.5	<1.	6.4
Cs	n.d.	n.d.	n.d.	<20.	50.	<20.	20.	20.	<20.	50.	20.	<20.
Cu	4.4	5.1	5.1	1.7	2.2	3.3	1.9	3.6	1.8	2.	1.6	11.
Er	<10.	<10.	>10.	>10.	>10.	>10.	>10.	>10.	>10.	>10.	>10.	12.
Eu	2.5	2.	<1.5	<1.5	<1.5	<1.5	<1.5	2.	<1.5	<1.5	<1.5	2.
Ga	33.	29.	23.	28.	19.	27.	21.	20.	39.	25.	23.	30.
Gd	<6.8	<6.8	8.4	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.
La	77.	110.	100.	80.	110.	84.	94.	95.	80.	97.	110.	100.
Li	87.	<68.	<68.	20.	20.	20.	20.	20.	10.	20.	20.	20.
Mo	<2.2	2.5	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
Nb	28.	33.	33.	39.	45.	41.	31.	31.	52.	26.	47.	35.
Nd	84.	120.	110.	92.	110.	110.	98.	95.	89.	120.	120.	120.
Ni	<4.6	4.9	<4.6	2.2	1.9	2.	2.2	47.	2.4	<1.5	2.1	4.3
Pb	32.	32.	25.	26.	27.	40.	31.	29.	36.	29.	28.	38.
Rb	n.d.	n.d.	n.d.	100.	150.	150.	100.	100.	150.	100.	100.	150.
Sc	4.8	5.	3.1	2.5	2.8	2.1	2.5	3.1	1.8	2.4	2.9	6.6
Sn	<6.8	<6.8	<6.8	4.	5.6	7.1	5.8	6.1	7.4	5.7	7.	7.7
Sr	59.	66.	48.	15.	55.	55.	34.	31.	11.	26.	25.	140.
V	6.2	8.5	6.4	2.1	4.4	4.2	3.	2.2	1.2	3.	4.1	14.
Y	45.	62.	64.	52.	65.	60.	54.	55.	51.	59.	62.	69.
Yb	10.	7.3	7.5	6.	8.	11.	6.8	6.5	9.8	7.8	6.7	7.7
Zn	<22.	<22.	<22.	46.	21.	44.	45.	45.	48.	46.	36.	69.
Zr	180.	240.	370.	200.	210.	220.	160.	240.	270.	150.	320.	380.

Table 1. (cont'd)-- Major and trace element chemical analyses of Upper Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y7-190.0	Y7-196.0	Y7-211.0	Y7-233.6	Y7-238.3	Y8-14.7	Y8-21.0	Y8-24.0	Y8-32.5	Y8-43.0	Y8-71.5	Y8-110.3
Symbol	7	7	7	7	7	8	8	8	8	8	8	8
SiO_2	66.90	67.60	66.70	65.40	64.80	78.60	69.30	68.30	64.70	68.90	68.40	71.20
Al_2O_3	13.30	13.30	13.00	12.30	13.00	8.60	11.50	12.20	16.70	11.70	14.80	11.10
Fe_2O_3	1.90	1.10	1.70	1.70	1.70	0.53	0.85	0.86	0.91	0.96	0.72	0.91
FeO	1.60	1.90	1.80	1.20	1.60	0.52	0.32	0.40	0.36	0.40	0.44	0.36
MgO	0.30	0.30	0.34	0.27	0.29	---	0.01	0.05	0.07	0.06	0.08	0.07
CaO	1.40	1.40	1.40	1.40	1.40	0.32	0.44	0.63	0.26	0.47	0.29	0.50
Na_2O	3.50	3.60	3.50	3.40	3.60	2.90	4.30	5.10	8.60	5.20	7.00	5.20
K_2O	3.70	4.40	4.20	4.20	4.30	3.30	3.80	3.70	2.90	3.20	3.70	2.80
H_2O	6.60	5.79	6.90	9.70	7.80	3.80	9.10	9.50	5.70	9.90	4.65	8.60
TiO_2	0.54	0.44	0.44	0.42	0.46	0.10	0.14	0.15	0.16	0.18	0.16	0.17
P_2O_5	0.15	0.13	0.14	0.13	0.15	0.06	0.06	0.08	0.07	0.08	0.08	0.07
MnO	0.08	0.07	0.08	0.06	0.06	0.02	0.04	0.03	0.04	0.04	0.04	0.03
CO_2	0.05	0.02	0.04	0.02	0.02	0.02	0.07	0.03	0.02	0.02	0.02	0.02
Total(-O)	100.02	100.05	100.24	100.20	99.18	98.77	99.93	101.03	100.49	101.11	100.38	101.03
Normative minerals												
q	29.204	25.880	26.600	26.434	24.246	49.148	29.276	23.826	3.790	25.982	14.208	29.846
c	1.467	0.427	0.577		0.286							
or	21.860	25.988	24.760	24.769	25.620	19.743	22.471	21.641	17.053	18.702	21.782	16.377
ab	29.610	30.447	29.545	28.712	30.714	24.845	36.411	41.724	69.413	41.900	55.317	41.083
an	5.648	5.967	5.764	5.884	5.887	0.711	0.855					
ac								0.873	2.620	1.425	2.075	2.176
ns									0.007		0.311	
wo				0.031		0.155	0.206	0.997	0.293	0.695	0.328	0.784
en	0.747	0.747	0.845	0.671	0.728		0.025	0.123	0.173	0.148	0.198	0.173
fs	0.625	1.983	1.320	0.217	0.893	0.394		0.083	0.469	0.129	0.616	0.309
mt	2.754	1.594	2.459	2.460	2.485	0.778	0.757	0.797		0.662		0.216
hm							0.329					
il	1.025	0.835	0.834	0.796	0.881	0.192	0.266	0.282	0.302	0.338	0.303	0.320
ap	0.355	0.308	0.331	0.307	0.358	0.144	0.142	0.188	0.165	0.187	0.189	0.164
cc	0.114	0.045	0.091	0.045	0.046	0.046	0.159	0.068	0.045	0.045	0.045	0.045
Total	93.410	94.220	93.125	90.327	92.144	96.156	90.897	90.601	94.332	90.213	95.372	91.492
Salic	87.789	88.708	87.246	85.800	86.753	94.447	89.013	87.191	90.257	86.584	91.307	87.306
Femic	5.621	5.512	5.879	4.527	5.391	1.709	1.884	3.411	4.075	3.629	4.066	4.185
D.I.	80.674	82.314	80.904	79.915	80.580	93.736	88.158	87.191	90.257	86.584	91.307	87.306
Al_2O_3/SiO_2	0.199	0.197	0.195	0.188	0.201	0.109	0.166	0.179	0.258	0.170	0.216	0.156
FeO/Fe_2O_3	0.842	1.727	1.059	0.706	0.941	0.981	0.376	0.465	0.396	0.417	0.611	0.396

Table 1. (cont'd)-- Major and trace element chemical analyses of Upper Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y7-190.0	Y7-196.0	Y7-211.0	Y7-233.6	Y7-238.3	Y8-14.7	Y8-21.0	Y8-24.0	Y8-32.5	Y8-43.0	Y8-71.5	Y8-110.3
Symbol	7	7	7	7	7	8	8	8	8	8	8	8
Trace elements (ppm)												
Ag	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
B	<4.6	5.9	<4.6	<4.6	<4.6	30.	<4.6	4.8	<4.6	<4.6	<4.6	5.6
Ba	1200.	1400.	890.	950.	1300.	310.	280.	520.	420.	460.	420.	490.
Be	3.8	4.8	4.3	3.6	4.4	4.4	6.9	8.3	39.	3.9	5.3	5.2
Ce	180.	190.	180.	170.	180.	200.	130.	180.	170.	160.	170.	160.
Co	2.7	2.3	2.5	2.4	2.3	<1.	<1.	<1.	<1.	<1.	<1.	<1.
Cr	7.2	20.	6.2	5.7	8.6	<1.	<1.	4.6	2.6	7.7	3.4	1.
Cs	<20.	<20.	<20.	<20.	<20.	30.	150.	90.	3000.	50.	1000.	50.
Cu	7.8	9.7	7.4	7.7	6.6	1.8	2.3	3.8	3.9	3.2	2.3	2.8
Er	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Eu	2.3	2.9	2.1	2.2	2.7	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	1.9
Ga	23.	31.	27.	23.	26.	28.	27.	25.	28.	23.	24.	26.
Gd	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.
La	100.	100.	95.	90.	92.	130.	74.	94.	88.	99.	96.	100.
Li	50.	10.	20.	20.	20.	50.	100.	50.	20.	50.	100.	20.
Mo	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
Nb	26.	26.	26.	19.	20.	30.	25.	32.	29.	29.	29.	30.
Nd	81.	73.	77.	120.	65.	120.	72.	110.	82.	91.	96.	100.
Ni	4.5	3.5	3.1	2.2	2.9	1.6	<1.5	<1.5	<1.5	<1.5	1.7	<1.5
Pb	28.	41.	31.	27.	34.	31.	27.	39.	41.	31.	34.	30.
Rb	100.	150.	100.	100.	100.	100.	150.	150.	100.	100.	200.	100.
Sc	9.3	9.9	7.9	7.9	8.5	2.5	1.9	<1.	2.4	2.4	<1.	2.6
Sn	6.4	8.4	5.7	3.7	2.2	5.1	5.7	6.4	4.9	13.	6.4	4.9
Sr	210.	200.	210.	200.	240.	21.	18.	41.	32.	34.	34.	38.
V	12.	11.	10.	10.	12.	1.2	1.8	2.6	2.1	3.1	3.8	2.7
Y	64.	61.	61.	58.	54.	67.	45.	58.	59.	57.	55.	62.
Yb	7.8	11.	7.4	6.5	9.1	9.7	8.3	8.2	8.3	7.6	7.5	8.2
Zn	50.	58.	55.	42.	55.	49.	48.	50.	17.	19.	17.	23.
Zr	470.	420.	410.	450.	350.	240.	210.	210.	210.	200.	280.	280.

Table 1. (cont'd)-- Major and trace element chemical analyses of Upper Geyser Basin drill core, Yellowstone National Park, Wyoming

Symbol	Y8-159.8 8	Y8-160.5 8	Y8-180.2 8	Y8-181.9 8	Y8-185.3 8	Y8-194.5 8	Y8-202.0 8	Y8-207.0 8	Y8-304.0 8	Y8-410.0 8	Y8-502.0 8	*YP-215 y
SiO_2	76.70	72.20	71.30	85.80	62.00	66.40	66.20	62.70	67.20	62.30	64.40	70.07
Al_2O_3	10.40	11.10	11.60	6.00	14.00	12.60	12.60	15.40	12.50	15.30	14.10	12.13
Fe_2O_3	0.81	1.10	0.63	0.79	2.20	1.70	1.80	3.70	2.10	2.10	1.90	0.81
FeO	0.36	0.44	0.52	0.56	1.00	1.50	1.00	1.40	1.20	1.70	1.10	0.62
MgO	0.04	0.07	0.10	0.10	0.21	0.30	0.20	0.48	0.38	0.58	0.31	0.12
CaO	0.62	2.50	1.40	0.47	2.80	1.50	1.80	1.80	1.70	1.80	1.70	1.24
Na_2O	4.90	3.90	4.40	2.10	5.20	5.80	4.90	4.00	4.70	4.50	4.90	2.96
K_2O	3.10	5.20	3.10	3.60	1.60	1.80	2.40	5.80	2.90	4.50	3.60	3.14
H_2O	2.51	1.63	7.60	0.93	11.10	8.70	9.20	4.80	6.90	7.20	8.30	8.40
TiO_2	0.16	0.19	0.14	0.25	0.50	0.45	0.45	0.59	0.47	0.56	0.48	0.16
P_2O_5	0.06	0.06	0.05	0.09	0.16	0.15	0.14	0.17	0.14	0.16	0.15	0.05
MnO	0.03	0.04	0.03	0.03	0.04	0.07	0.05	0.08	0.05	0.06	0.05	
CO_2	0.17	1.60	0.02	0.01	0.02	0.02	0.02	0.04	0.02	0.04	0.02	0.20
Total(-O)	99.86	100.03	100.89	100.73	100.83	100.99	100.76	100.96	100.26	100.80	101.01	99.90
Normative minerals												
q	37.855	30.373	31.303	61.630	20.214	22.745	25.177	13.263	25.574	14.367	18.626	38.633
c										0.228		2.193
or	18.344	30.719	18.157	21.119	9.377	10.532	14.075	33.948	17.092	26.381	21.061	18.574
ab	36.286	28.136	36.903	10.741	43.639	48.597	41.150	33.525	39.667	37.776	41.048	25.072
an			2.722		10.050	3.	5.257	6.870	4.434	7.571	5.788	4.565
ac	2.347	3.181		2.269								
ns	0.598	0.289		1.006								
wo	0.673	0.791	1.551	0.697	1.071	1.367	1.074	0.261	1.227		0.612	
en	0.100	0.174	0.247	0.247	0.519	0.740	0.494	1.184	0.944	1.433	0.764	0.299
fs	0.453	0.568	0.257	0.666		0.730				0.569		0.205
mt			0.905		1.889	2.441	2.066	3.034	2.661	3.021	2.294	1.176
hm					0.879		0.361	1.572	0.259		0.299	
il	0.304	0.361	0.264	0.471	0.942	0.846	0.848	1.110	0.890	1.055	0.903	0.304
ap	0.142	0.142	0.117	0.212	0.376	0.352	0.329	0.399	0.331	0.376	0.352	0.119
cc	0.387	3.638	0.045	0.023	0.045	0.045	0.045	0.090	0.045	0.090	0.045	0.455
Total	97.490	98.374	92.470	99.082	89.	91.394	90.877	95.255	93.126	92.866	91.791	91.594
Salic	92.485	89.229	89.084	93.491	83.280	84.874	85.659	87.606	86.768	86.322	86.523	89.036
Femic	5.005	9.146	3.386	5.591	5.720	6.520	5.218	7.650	6.358	6.544	5.269	2.558
D.I.	92.485	89.229	86.363	93.491	73.230	81.874	80.402	80.735	82.334	78.523	80.735	82.278
Al_2O_3/SiO_2	0.136	0.154	0.163	0.070	0.226	0.190	0.190	0.246	0.186	0.246	0.219	0.173
FeO/Fe_2O_3	0.444	0.400	0.825	0.709	0.455	0.882	0.556	0.378	0.571	0.810	0.579	0.765

Table 1. (cont'd)-- Major and trace element chemical analyses of Upper Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y8-159.8	Y8-160.5	Y8-180.2	Y8-181.9	Y8-185.3	Y8-194.5	Y8-202.0	Y8-207.0	Y8-304.0	Y8-410.0	Y8-502.0	*YP-215
Symbol	8	8	8	8	8	8	8	8	8	8	8	y
Trace elements (ppm)												
Ag	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	
B	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	
Ba	360.	550.	620.	500.	1400.	490.	850.	1300.	1000.	1200.	1200.	
Be	72.	24.	5.2	27.	4.4	5.3	4.8	7.	6.1	7.1	5.7	
Ce	150.	210.	160.	82.	190.	170.	160.	180.	210.	220.	220.	
Co	<1.	<1.	<1.	1.9	2.5	1.8	1.9	4.	2.8	3.3	2.3	
Cr	1.7	3.9	<1.	3.2	12.	5.	6.3	13.	9.9	12.	6.9	
Cs	750.	450.	200.	10.	250.	200.	250.	150.	150.	250.	<20.	
Cu	2.6	2.1	3.4	3.7	9.	5.5	9.4	12.	10.	12.	9.8	
Er	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	
Eu	<1.5	<1.5	<1.5	<1.5	2.8	2.3	2.3	4.6	3.9	3.	3.1	
Ga	14.	23.	18.	15.	28.	22.	22.	47.	31.	44.	30.	
Gd	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	
La	97.	130.	95.	42.	100.	92.	88.	99.	110.	110.	120.	
Li	250.	200.	50.	200.	50.	100.	100.	150.	50.	100.	50.	
Mo	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	
Nb	35.	42.	27.	19.	30.	27.	27.	31.	32.	48.	37.	
Nd	92.	90.	63.	51.	70.	110.	53.	69.	93.	90.	92.	
Ni	<1.5	2.5	1.6	2.	3.5	1.7	2.9	6.1	3.5	3.7	3.	
Pb	28.	48.	34.	15.	42.	24.	23.	39.	43.	54.	32.	
Rb	50.	100.	50.	50.	100.	100.	150.	300.	150.	200.	150.	
Sc	2.2	3.1	2.6	3.5	9.7	7.4	6.5	13.	10.	10.	10.	
Sn	5.7	7.4	4.7	2.7	6.6	4.2	4.3	2.6	3.6	3.8	8.	
Sr	27.	58.	72.	87.	380.	150.	200.	260.	240.	260.	260.	
V	2.3	3.	2.9	12.	15.	11.	20.	23.	15.	18.	14.	
Y	55.	71.	58.	31.	64.	62.	53.	62.	70.	73.	75.	
Yb	8.1	12.	9.1	4.4	8.3	6.2	6.7	9.8	8.9	9.2	9.3	
Zn	59.	47.	28.	18.	69.	61.	61.	90.	73.	86.	56.	
Zr	250.	220.	270.	220.	390.	430.	390.	290.	420.	530.	600.	

Table 1. (cont'd)-- Major and trace element chemical analyses of Upper Geyser Basin drill core, Yellowstone National Park, Wyoming

	YP-222	*YP-227	YP-234	*YP-261	*YP-267	*YP-273	*YP-279	YP-307	*YP-325	*YP-334
Symbol	Y	y	Y	y	y	y	y	Y	y	y
SiO_2	81.10	75.36	80.90	67.18	66.65	66.51	67.09	80.40	77.36	78.35
Al_2O_3	8.90	12.02	9.40	15.26	13.07	12.93	13.08	9.00	10.73	9.97
Fe_2O_3	0.85	0.83	0.91	2.13	1.68	2.08	1.60	1.40	1.18	1.44
FeO	0.24	0.46	0.20	1.20	1.88	1.22	1.94	0.72	0.88	0.95
MgO	0.04	0.06	0.04	0.62	0.59	0.43	0.53	0.26	0.42	0.33
CaO	0.21	0.80	0.17	1.45	1.92	2.62	1.89	0.83	1.09	1.19
Na_2O	2.20	0.98	0.60	1.52	3.38	2.58	3.97	0.71	1.02	0.96
K_2O	3.40	8.72	6.40	9.68	3.59	3.26	2.75	4.90	6.16	5.68
H_2O	1.85	0.43	0.70	0.89	6.25	7.90	6.31	0.76	0.83	0.71
TiO_2	0.17	0.15	0.18	0.42	0.47	0.44	0.47	0.38	0.32	0.35
P_2O_5	0.04	0.04	0.03	0.13	---	---	0.08	0.06	0.06	0.05
MnO	0.01	0.02	0.01	0.05	---	---	0.05	0.03	0.04	0.01
ZrO_2	n.d.	n.d.	n.d.	n.d.	0.06	n.d.	0.02	n.d.	n.d.	n.d.
CO_2	0.05	0.40	0.03	0.05	0.08	0.07	0.01	0.02	0.50	0.04
Total(-O)	99.06	100.27	99.57	100.58	99.62	100.04	99.79	99.47	100.59	100.03
Normative minerals										
q	55.554	35.594	52.888	17.664	27.966	32.950	28.227	55.872	46.069	48.223
c	1.444	0.536	1.324	0.073	0.320	0.556	0.352	1.216	1.695	0.292
q					0.090		0.030			
or	20.282	51.390	37.983	56.872	21.295	19.257	16.285	29.110	36.188	33.555
ab	18.792	8.270	5.099	12.788	28.710	21.823	33.664	6.040	8.580	8.121
an	0.469	1.176	0.460	5.993	9.054	12.550	8.809	3.618	1.844	5.322
en	0.101	0.149	0.100	1.535	1.475	1.070	1.323	0.651	1.040	0.822
fs					1.293		1.561		0.186	
mt	0.316	1.110	0.156	2.797	2.445	2.656	2.325	1.324	1.701	2.079
hm	0.640	0.062	0.806	0.189		0.248		0.494		0.005
il	0.326	0.284	0.343	0.793	0.896	0.835	0.895	0.726	0.604	0.665
ap	0.096	0.094	0.071	0.306			0.190	0.143	0.141	0.118
cc	0.115	0.907	0.069	0.113	0.183	0.159	0.023	0.046	1.130	0.091
Total	98.135	99.573	99.299	99.122	93.726	92.103	93.681	99.239	99.178	99.293
Salic	96.541	96.966	97.753	93.389	87.434	87.135	87.366	95.856	94.376	95.513
Femic	1.593	2.607	1.546	5.733	6.292	4.968	6.315	3.383	4.803	3.780
D.I.	94.628	95.254	95.969	87.323	77.971	74.029	78.176	91.022	90.837	89.899
Al_2O_3/SiO_2	0.110	0.160	0.116	0.227	0.196	0.194	0.195	0.112	0.139	0.127
FeO/Fe_2O_3	0.282	0.554	0.220	0.563	1.119	0.587	1.213	0.514	0.746	0.660

Table 1. (cont'd)-- Major and trace element chemical analyses of Upper Geyser Basin drill core, Yellowstone National Park, Wyoming

	YP-222	*YP-227	YP-234	*YP-261	*YP-267	*YP-273	*YP-279	YP-307	*YP-325	*YP-334
Symbol	Y	y	Y	y	y	y	y	Y	y	y
Trace elements (ppm)										
Ag	<0.1		<0.1					<0.1		
B	88.		<3.2					<3.2		
Ba	280.		310.					460.		
Be	3.		28.					2.8		
Ce	120.		120.					92.		
Co	1.4		1.4					2.		
Cr	2.8		3.1					5.8		
Cs	270.		22.					n.d.		
Cu	2.9		3.5					3.9		
Er	<10.		<10.					<10.		
Eu	<1.5		<1.5					<1.5		
Ga	15.		20.					13.		
Gd	<6.8		<6.8					<6.8		
La	76.		61.					55.		
Li	307.		273.					210.		
Mo	<2.2		<2.2					<2.2		
Nb	6.2		5.9					4.9		
Nd	52.		<46.					53.		
Ni	<4.6		<4.6					<4.6		
Pb	14.		<10.					15.		
Rb	126.		290.					n.d.		
Sc	2.4		2.2					5.5		
Sn	<6.8		<6.8					<6.8		
Sr	15.		22.					35.		
V	4.4		5.					8.6		
Y	33.		30.					31.		
Yb	4.		3.7					3.		
Zn	<22.		<22.					<22.		
Zr	120.		160.					230.		

Table 2. — Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y2-24.0	Y2-42.0	Y2-68.0	Y2-104.0	Y2-106.5	Y2.178.0	Y2-217.0	Y2-248.0	Y2-355.5	Y2-357.0	Y2-375.8	Y2-380.5
Symbol	2	2	2	2	2	2	2	2	2	2	2	2
SiO_2	71.20	65.70	66.50	68.40	72.10	75.70	72.90	75.70	71.60	76.70	77.70	79.80
Al_2O_3	9.00	12.30	16.00	12.40	9.30	12.00	12.30	11.90	11.70	11.60	11.20	9.20
Fe_2O_3	1.00*	0.82	1.80	1.90	5.90*	1.10	0.90	1.10	0.85	0.92	0.28	3.50
FeO	---	0.40	0.16	0.12	---	0.60	0.52	0.44	0.48	0.36	0.68	0.56
MgO	0.26	0.06	0.07	0.09	0.28	0.02	0.05	0.02	---	0.02	0.23	0.41
CaO	2.70	3.60	1.40	1.50	0.93	1.00	0.50	0.23	1.00	0.30	0.73	0.51
Na_2O	0.78	0.95	1.70	2.30	1.10	2.40	1.00	1.70	3.10	3.00	1.80	1.30
K_2O	1.70	2.30	2.10	2.50	2.60	4.20	6.50	5.60	2.60	4.60	2.60	3.00
H_2O	9.80	12.40	10.10	9.80	6.30	2.90	3.70	1.71	7.00	1.93	2.17	1.93
TiO_2	0.13	0.15	0.29	0.24	0.28	0.16	0.15	0.17	0.15	0.14	0.41	0.33
P_2O_5	0.03	0.04	0.04	0.04	0.06	0.03	0.03	0.04	0.03	0.04	0.06	0.07
MnO	2.90	0.09	0.09	0.17	1.50	0.02	0.03	0.02	0.03	0.02	0.03	0.04
CO_2	0.02	0.01	0.09	0.02	0.01	0.02	0.01	0.02	0.01	0.01	0.03	0.02
Total(-O)	99.52	98.82	100.34	99.48	100.36	100.15	98.59	98.65	98.55	99.64	97.92	100.67
Normative minerals												
q	52.392	44.231	45.674	42.494	53.346	43.568	41.754	44.628	42.199	41.262	56.622	58.911
c	1.091	1.843	8.660	3.343	3.141	1.803	2.846	2.804	2.093	1.264	4.402	3.080
or	10.094	13.754	12.367	14.850	15.309	24.782	38.960	33.545	15.590	27.281	15.690	17.610
ab	6.632	8.135	14.336	19.564	9.275	20.278	8.583	14.582	26.617	25.477	15.555	10.927
an	13.135	17.744	6.094	7.091	4.144	4.632	2.253	0.764	4.771	1.168	3.104	1.933
en	0.651	0.151	0.174	0.225	0.695	0.050	0.126	0.050		0.050	0.585	1.014
fs	4.374						0.020				0.405	
mt	1.457	1.162		0.247	4.070	1.533	1.324	1.004	1.228	0.823	0.415	0.972
hm		0.028	1.794	1.739	3.072	0.041		0.422	0.016	0.356		2.806
il	0.248	0.288	0.529	0.458	0.530	0.303	0.289	0.327	0.289	0.267	0.795	0.623
ru			0.011									
ap	0.071	0.096	0.094	0.095	0.142	0.071	0.072	0.096	0.072	0.095	0.145	0.165
cc	0.046	0.023	0.204	0.046	0.023	0.045	0.023	0.046	0.023	0.023	0.070	0.045
Total	90.192	87.455	89.937	90.153	93.745	97.106	96.249	98.269	92.899	98.065	97.787	98.087
Salic	83.345	85.706	87.132	87.342	85.214	95.063	94.395	96.322	91.271	96.452	95.373	92.462
Femic	6.846	1.749	2.805	2.811	8.531	2.044	1.854	1.947	1.628	1.613	2.414	5.625
D.I.	69.119	66.119	72.378	76.909	77.930	88.628	89.297	92.755	84.407	94.020	87.867	87.448
Al_2O_3/SiO_2	0.126	0.187	0.241	0.181	0.129	0.159	0.169	0.157	0.163	0.151	0.144	0.115
FeO/Fe_2O_3		0.488	0.089	0.063		0.545	0.578	0.400	0.565	0.391	2.429	0.160

* total iron as Fe_2O_3

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y2-24.0	Y2-42.0	Y2-68.0	Y2-104.0	Y2-106.5	Y2.178.0	Y2-217.0	Y2-248.0	Y2-355.5	Y2-357.0	Y2-375.8	Y2-380.5
Symbol	2	2	2	2	2	2	2	2	2	2	2	2
Trace elements (ppm)												
Ag	0.77	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
B	<3.2	<3.2	<3.2	<3.2	16.	<3.2	<3.2	<3.2	<3.2	<3.2	5.1	14.
Ba	880.	280.	380.	260.	210.	370.	170.	190.	210.	180.	340.	420.
Be	39.	14.	3.4	3.7	13.	2.5	4.3	3.9	3.	3.3	5.5	4.
Ce	54.	120.	220.	130.	110.	140.	130.	190.	110.	94.	45.	50.
Co	1.9	1.5	1.8	2.2	9.1	1.6	1.6	1.6	1.4	1.5	3.8	6.9
Cr	1.2	<1.	1.4	2.2	17.	<1.	<1.	<1.	<1.	<1.	8.5	23.
Cs	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Cu	3.8	3.4	3.8	3.7	6.4	3.5	3.4	3.4	2.9	2.6	5.1	10.
Er	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Eu	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	2.1	<1.5	<1.5	<1.5	<1.5	<1.5
Ga	3.8	7.7	18.	13.	13.	16.	15.	17.	12.	13.	19.	12.
Gd	<6.8	8.6	9.2	<6.8	<6.8	13.	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8
La	41.	67.	120.	78.	49.	75.	75.	81.	63.	60.	38.	41.
Li	<68.	<68.	<68.	<68.	<68.	<68.	<68.	<68.	<68.	<68.	<68.	<68.
Mo	<2.2	<2.2	4.5	<2.2	<2.2	9.3	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
Nb	14.	26.	56.	41.	18.	49.	39.	57.	34.	26.	26.	11.
Nd	53.	<46.	92.	82.	61.	73.	76.	77.	<46.	<46.	<46.	<46.
Ni	<4.6	<4.6	<4.6	53.	8.1	<4.6	<4.6	<4.6	<4.6	<4.6	22.	16.
Pb	20.	24.	21.	20.	13.	22.	21.	37.	19.	18.	26.	28.
Rb	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Sc	<1.	2.8	3.9	2.2	4.7	2.3	2.5	1.3	2.	<1.	5.8	6.2
Sn	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8
Sr	280.	69.	21.	24.	46.	25.	9.3	11.	11.	9.2	70.	69.
V	6.3	<3.2	4.	4.6	14.	<3.2	<3.2	<3.2	<3.2	<3.2	9.6	18.
Y	44.	35.	80.	43.	47.	50.	56.	71.	45.	34.	33.	50.
Yb	4.4	7.7	9.2	6.7	5.	5.5	6.3	6.7	5.	4.	7.1	5.1
Zn	<22.	59.	48.	71.	140.	42.	48.	41.	38.	41.	85.	54.
Zr	130.	240.	450.	220.	220.	240.	260.	230.	220.	170.	190.	110.

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y2-455.5	Y2-492.2	Y2-499.1	Y2-515.9	Y3-5.5	Y3-40.6	Y3-50.3	Y3-89.1	Y3-146.4	Y3-165.6	Y3-216.8	Y3-230.0
Symbol	2	2	2	2	3	3	3	3	3	3	3	3
SiO_2	75.70	72.50	85.00	74.80	73.40	73.80	72.10	75.00	72.90	78.20	77.20	78.80
Al_2O_3	12.30	13.80	6.00	12.50	11.20	11.60	12.50	11.60	14.10	11.40	11.80	10.90
Fe_2O_3	2.30	1.80	1.60	1.80	0.64	1.80	1.70	1.10	1.30	1.00	1.10	0.98
FeO	0.72	0.60	0.64	0.16	0.32	0.32	0.20	0.16	0.60	0.20	0.16	0.28
MgO	0.06	0.01	0.05	0.02	0.05	0.40	0.28	0.10	0.05	---	0.04	0.05
CaO	0.43	0.92	0.74	0.36	0.29	1.00	0.81	1.10	0.24	0.28	0.31	0.14
Na_2O	3.00	3.00	1.20	3.30	0.88	2.00	2.10	4.10	3.00	2.50	3.00	1.10
K_2O	4.70	5.70	2.00	5.40	3.20	4.00	3.50	4.70	6.00	4.70	4.90	6.10
H_2O	1.02	1.00	0.92	0.61	5.60	3.80	5.50	0.94	1.00	0.63	0.41	0.80
TiO_2	0.23	0.24	0.13	0.24	0.20	0.32	0.30	0.21	0.26	0.21	0.22	0.20
P_2O_5	0.04	0.04	0.03	0.03	0.04	0.07	0.06	0.04	0.04	0.03	0.03	0.03
MnO	0.05	0.04	0.03	0.01	0.01	0.03	0.01	0.02	0.01	0.01	0.02	0.03
CO_2	0.03	0.04	0.16	0.10	0.01	0.01	0.01	0.07	0.01	0.01	0.04	0.01
Total(-O)	100.58	99.69	98.50	99.33	95.84	99.15	99.07	99.14	99.51	99.17	99.23	99.42
Normative minerals												
q	39.220	31.570	70.282	34.729	57.888	44.725	44.952	32.543	32.198	45.562	40.782	49.080
c	1.652	1.215	0.973	0.881	6.136	2.373	3.988		2.365	1.801	1.171	2.342
or	27.613	33.788	11.999	32.125	19.730	23.840	20.877	28.015	35.630	28.006	29.180	36.257
ab	25.239	25.464	10.309	28.112	7.770	17.069	17.936	33.791	25.510	21.331	25.582	9.362
an	1.673	4.063	2.501	0.964	1.163	4.479	3.597		0.870	1.139	1.098	0.438
ac								1.060				
wo								1.988				
en	0.149	0.025	0.126	0.050	0.130	1.005	0.704	0.251	0.125		0.100	0.125
mt	1.807	1.373	1.811		0.505	0.204			1.219	0.069		0.423
hm	1.041	0.859	0.375	1.812	0.319	1.675	1.716	0.743	0.466	0.961	1.109	0.694
il	0.434	0.457	0.251	0.362	0.396	0.613	0.448	0.384	0.496	0.402	0.384	0.382
tn								0.024				
ru				0.051			0.067				0.020	
ap	0.094	0.095	0.072	0.072	0.099	0.167	0.143	0.096	0.095	0.072	0.072	0.071
cc	0.068	0.091	0.369	0.229	0.024	0.023	0.023	0.161	0.023	0.023	0.092	0.023
Total	98.989	98.999	99.068	99.388	94.159	96.171	94.452	99.054	98.997	99.366	99.589	99.197
Salic	95.396	96.099	96.063	96.812	92.686	92.485	91.350	94.348	96.573	97.840	97.813	97.479
Femic	3.592	2.900	3.005	2.576	1.473	3.686	3.101	4.706	2.424	1.527	1.776	1.719
D.I.	92.072	90.822	92.589	94.966	85.388	85.633	83.766	94.348	93.338	94.899	95.544	94.699
Al_2O_3/SiO_2	0.162	0.190	0.071	0.167	0.153	0.157	0.173	0.155	0.193	0.146	0.153	0.138
FeO/Fe_2O_3	0.313	0.333	0.400	0.089	0.500	0.178	0.118	0.145	0.462	0.200	0.145	0.286

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y2-455.5	Y2-492.2	Y2-499.1	Y2-515.9	Y3-5.5	Y3-40.6	Y3-50.3	Y3-89.1	Y3-146.4	Y3-165.6	Y3-216.8	Y3-230.0
Symbol	2	2	2	2	3	3	3	3	3	3	3	3
Trace elements (ppm)												
Ag	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
B	<3.2	<3.2	<3.2	<3.2	3.9	7.9	9.3	11.	3.5	3.2	<3.2	<3.2
Ba	840.	700.	200.	740.	370.	390.	230.	210.	230.	310.	260.	320.
Be	3.8	3.5	3.1	2.6	2.5	4.9	3.3	3.2	2.9	3.3	3.6	3.6
Ce	230.	160.	180.	120.	63.	100.	100.	91.	83.	450.	120.	130.
Co	2.3	1.6	1.9	1.6	<1.	3.4	3.2	1.7	<1.	1.8	<1.	<1.
Cr	1.2	1.4	<1.	1.1	<1.	18.	14.	2.	17.	<1.	<1.	<1.
Cs	n.d.	n.d.	n.d.	n.d.	9.	48.	46.	48.	14.	13.	n.d.	n.d.
Cu	4.8	4.9	4.1	2.9	5.4	5.3	5.7	2.8	3.9	2.9	2.2	2.5
Er	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Eu	<1.5	<1.5	<1.5	1.8	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Ga	21.	15.	6.7	20.	11.	14.	14.	15.	18.	16.	17.	9.2
Gd	11.	<6.8	9.9	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	9.4	<6.8	<6.8
La	170.	86.	120.	72.	59.	60.	60.	62.	58.	300.	81.	83.
Li	<68.	<68.	<68.	<68.	20.	53.	77.	98.	55.	78.	<68.	<68.
Mo	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	47.	<2.2	<2.2	<2.2	<2.2	<2.2
Nb	23.	36.	32.	26.	29.	27.	29.	27.	31.	23.	25.	30.
Nd	150.	73.	100.	62.	47.	65.	62.	66.	<46.	240.	67.	71.
Ni	<4.6	<4.6	<4.6	<4.6	<4.6	7.4	6.1	<4.6	<4.6	<4.6	<4.6	<4.6
Pb	58.	48.	28.	23.	21.	22.	24.	19.	26.	19.	19.	17.
Rb	n.d.	n.d.	n.d.	n.d.	94.	109.	119.	117.	137.	102.	n.d.	n.d.
Sc	4.4	<1.	2.2	1.7	<1.	2.4	2.8	1.8	1.6	<1.	1.2	1.4
Sn	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8
Sr	30.	34.	14.	28.	19.	140.	52.	25.	14.	18.	14.	11.
V	<3.2	<3.2	<3.2	<3.2	3.6	13.	12.	<3.2	<3.2	<3.2	3.2	<3.2
Y	66.	34.	68.	41.	34.	39.	44.	35.	24.	43.	34.	41.
Yb	8.5	4.6	8.	5.6	3.5	4.5	4.9	4.4	3.9	5.3	4.6	4.1
Zn	79.	51.	59.	<22.	26.	<22.	26.	25.	34.	36.	32.	27.
Zr	240.	240.	190.	240.	220.	230.	230.	180.	180.	120.	170.	150.

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y3-240.0	Y3-257.6	Y3-262.7	Y3-264.3	Y3-283.6	Y3-339.3	Y3-400.8	Y3-486.3	Y4-6.0	Y4-20.0	Y4-158.7	Y4-185.0
Symbol	3	3	3	3	3	3	3	3	4	4	4	4
SiO_2	65.70	74.80	78.80	80.40	77.20	77.70	78.80	76.70	76.20	77.10	75.60	75.60
Al_2O_3	18.50	13.70	10.70	10.40	11.60	11.20	10.80	11.60	11.60	11.70	12.40	12.20
Fe_2O_3	1.60	1.50	0.73	0.66	0.99	0.88	1.00	1.00	1.20	1.30	0.95	1.20
FeO	0.32	0.12	0.48	0.52	0.36	0.36	0.48	0.56	0.16	0.16	0.32	0.08
MgO	0.08	0.03	0.03	0.03	0.02	0.07	0.06	0.06	---	---	---	---
CaO	0.55	0.31	0.21	0.24	0.22	0.42	0.21	0.59	0.26	0.26	0.37	0.43
Na_2O	1.70	2.30	1.60	1.40	2.70	1.90	2.20	2.30	3.20	3.20	3.30	3.30
K_2O	8.60	5.70	5.10	4.90	4.90	4.90	4.60	4.70	5.20	5.20	5.30	5.30
H_2O	2.40	1.20	0.82	0.79	0.42	1.02	0.87	0.90	0.70	0.70	0.68	0.84
TiO_2	0.30	0.26	0.20	0.19	0.22	0.20	0.19	1.50	0.14	0.14	0.14	0.15
P_2O_5	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.05	0.07	0.03	0.04
MnO	0.04	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.04	0.04	0.02	0.02
CO_2	0.03	0.01	0.01	0.01	0.01	0.08	0.05	0.06	0.02	0.04	0.03	0.02
Total(-O)	99.85	99.98	98.72	99.58	98.68	98.77	99.29	100.02	98.77	99.91	99.14	99.18
Normative minerals												
q	21.802	39.019	50.236	53.229	42.920	47.783	48.397	44.221	37.790	38.371	35.804	35.661
c	5.545	3.279	2.290	2.462	1.570	2.293	1.998	1.867	0.406	0.596	0.709	0.398
or	50.896	33.690	30.528	29.078	29.343	29.316	27.377	27.768	31.111	30.756	31.591	31.578
ab	14.407	19.466	13.714	11.896	23.152	16.277	18.749	19.458	27.415	27.102	28.166	28.155
an	2.346	1.279	0.793	0.935	0.843	1.399	0.599	2.351	0.847	0.580	1.463	1.760
en	0.200	0.075	0.076	0.075	0.050	0.177	0.150	0.149				
fs				0.115								
mt	0.293		1.013	0.961	0.563	0.621	1.036		0.243	0.241	0.697	
hm	1.400	1.500	0.041		0.615	0.463	0.292	1.	1.047	1.135	0.478	1.210
il	0.571	0.296	0.385	0.362	0.423	0.385	0.363	1.225	0.269	0.266	0.268	0.213
ru		0.104						0.855				0.039
ap	0.071	0.071	0.072	0.071	0.072	0.072	0.048	0.071	0.120	0.166	0.072	0.096
cc	0.068	0.023	0.023	0.023	0.023	0.184	0.115	0.136	0.046	0.091	0.069	0.046
Total	97.598	98.802	99.171	99.208	99.576	98.969	99.125	99.102	99.294	99.303	99.316	99.155
Salic	94.996	96.732	97.562	97.601	97.829	97.068	97.120	95.665	97.569	97.404	97.733	97.552
Femic	2.603	2.069	1.609	1.608	1.747	1.901	2.005	3.437	1.726	1.899	1.583	1.604
D.I.	87.104	92.175	94.479	94.203	95.415	93.376	94.523	91.447	96.316	96.229	95.561	95.394
Al_2O_3/SiO_2	0.282	0.183	0.136	0.129	0.150	0.144	0.137	0.151	0.152	0.152	0.164	0.161
FeO/Fe_2O_3	0.200	0.080	0.658	0.788	0.364	0.409	0.480	0.560	0.133	0.123	0.337	0.067

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y3-240.0	Y3-257.6	Y3-262.7	Y3-264.3	Y3-283.6	Y3-339.3	Y3-400.8	Y3-486.3	Y4-6.0	Y4-20.0	Y4-158.7	Y4-185.0
Symbol	3	3	3	3	3	3	3	3	4	4	4	4
Trace elements (ppm)												
Ag	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
B	<3.2	<3.2	<3.2	<3.2	3.8	<3.2	<3.2	3.5	7.	9.8	5.4	6.8
Ba	420.	240.	210.	180.	270.	190.	200.	230.	460.	390.	350.	450.
Be	4.8	3.1	2.8	4.	3.9	3.3	3.	4.8	4.8	3.4	4.3	5.
Ce	180.	130.	58.	58.	110.	64.	98.	120.	230.	190.	190.	260.
Co	1.4	1.5	<1.	1.4	1.3	1.5	1.4	1.8	<1.	<1.	<1.	<1.
Cr	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.
Cs	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	<20.	<20.	<20.	20.
Cu	2.5	2.5	2.4	3.7	2.4	2.4	2.5	3.5	1.9	2.2	1.7	2.1
Er	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	12.
Eu	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Ga	30.	22.	10.	9.7	17.	13.	15.	17.	26.	31.	23.	32.
Gd	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<15.	<15.	<15.	19.
La	130.	77.	45.	42.	73.	45.	57.	71.	120.	91.	110.	180.
Li	<68.	<68.	<68.	69.	91.	<68.	<68.	<68.	20.	10.	10.	10.
Mo	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	3.1
Nb	43.	31.	26.	26.	27.	23.	33.	38.	38.	59.	46.	42.
Nd	110.	68.	<46.	<46.	71.	<46.	59.	70.	120.	92.	100.	190.
Ni	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	5.6	8.4	1.6	1.9	<1.5	<1.5
Pb	37.	23.	18.	16.	21.	19.	17.	20.	47.	48.	33.	31.
Rb	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	200.	150.	200.	200.
Sc	1.8	1.4	<1.	<1.	1.2	1.2	1.1	1.8	3.4	2.3	2.6	3.2
Sn	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	<6.8	3.7	5.3	6.1	1.8
Sr	20.	16.	13.	15.	15.	13.	9.6	16.	29.	22.	18.	25.
V	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<1.	1.1	<1.	1.4
Y	75.	42.	62.	33.	34.	27.	37.	55.	69.	50.	67.	110.
Yb	7.6	4.6	7.9	4.8	4.8	3.7	5.2	6.1	9.1	7.2	8.7	12.
Zn	<22.	36.	31.	26.	27.	37.	31.	<22.	20.	26.	45.	21.
Zr	270.	190.	140.	100.	170.	140.	160.	240.	190.	230.	240.	190.

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y4-243.2	Y4-286.7	Y4-387.4	Y4-458.0	Y4-510.0	Y4-528.5	Y4-593.7	Y4-690.7	Y5-81.5	Y5-115.5	Y5-119.6	Y5-121.0
Symbol	4	4	4	4	4	4	4	4	5	5	5	5
SiO_2	75.80	76.10	76.30	75.30	76.30	77.30	76.00	76.10	75.70	79.30	75.70	74.30
Al_2O_3	12.50	12.40	12.30	12.20	12.50	12.20	12.40	12.70	12.50	10.90	12.60	13.00
Fe_2O_3	0.75	0.62	0.56	1.10	0.67	1.30	0.25	0.98	1.70	1.60	2.00	2.20
FeO	0.32	0.12	0.32	0.12	0.16	0.04	0.48	0.20	0.04	0.04	0.04	0.04
MgO	---	---	---	---	---	0.02	---	---	0.03	0.02	0.01	0.05
CaO	0.43	0.43	0.42	0.46	0.41	0.35	0.42	0.42	0.30	0.34	0.31	0.34
Na_2O	3.40	3.20	3.40	3.30	3.50	3.10	3.40	3.40	2.60	2.50	2.90	3.20
K_2O	5.30	5.30	5.30	5.20	5.40	5.20	5.30	5.40	5.30	4.40	5.10	5.30
H_2O	0.58	0.73	0.64	0.82	0.51	0.52	0.48	0.77	0.67	0.37	1.07	0.96
TiO_2	0.14	0.14	0.15	0.15	0.15	0.13	0.14	0.14	0.20	0.19	0.22	0.24
P_2O_5	0.04	0.05	0.06	0.04	0.05	0.05	0.03	0.04	0.04	0.05	0.06	0.07
MnO	0.03	0.02	0.03	0.01	0.02	0.11	0.02	0.02	0.02	0.03	0.02	0.02
CO_2	0.02	0.02	0.03	0.02	0.04	0.02	0.02	0.03	0.01	0.04	0.01	0.01
Total(-O)	99.31	99.13	99.51	98.72	99.71	100.34	98.94	100.20	99.11	99.78	100.04	99.73
Normative minerals												
q	35.230	36.799	35.767	35.846	34.749		35.336	34.883	40.104	47.516	38.816	34.920
c	0.534	0.790	0.422	0.455	0.365		0.429	0.662	2.078	1.623	1.912	1.576
or	31.537	31.594	31.473	31.127	32.003		31.655	31.846	31.600	26.058	30.125	31.404
ab	28.970	27.315	28.912	28.286	29.702		29.078	28.712	22.198	21.201	24.529	27.151
an	1.758	1.695	1.509	1.919	1.459		1.780	1.629	1.174	1.110	1.082	1.169
en									0.075	0.050	0.025	0.125
fs							0.486					
mt	0.728	0.047	0.698		0.147		0.366	0.304				
hm	0.253	0.593	0.081	1.114	0.571			0.769	1.715	1.604	1.999	2.206
il	0.268	0.268	0.286	0.278	0.286		0.269	0.265	0.128	0.149	0.127	0.128
ru				0.005					0.134	0.112	0.153	0.173
ap	0.095	0.119	0.143	0.096	0.119		0.072	0.095	0.096	0.119	0.142	0.166
cc	0.046	0.046	0.069	0.046	0.091		0.046	0.068	0.023	0.091	0.023	0.023
Total	99.418	99.266	99.360	99.172	99.491		99.517	99.234	99.326	99.632	98.934	99.041
Salic	98.028	98.193	98.083	97.632	98.278		98.278	97.734	97.155	97.508	96.465	96.220
Femic	1.390	1.074	1.277	1.540	1.213		1.239	1.500	2.172	2.124	2.469	2.821
D.I.	95.736	95.708	96.152	95.258	96.454		96.068	95.442	93.902	94.776	93.471	93.475
Al_2O_3/SiO_2	0.165	0.163	0.161	0.162	0.164		0.163	0.167	0.165	0.137	0.166	0.175
FeO/Fe_2O_3	0.427	0.194	0.571	0.109	0.239		1.920	0.204	0.024	0.025	0.020	0.018

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y4-243.2	Y4-286.7	Y4-387.4	Y4-458.0	Y4-510.0	Y4-528.5	Y4-593.7	Y4-690.7	Y5-81.5	Y5-115.5	Y5-119.6	Y5-121.0
Symbol	4	4	4	4	4	4	4	4	5	5	5	5
Trace elements (ppm)												
Ag	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
B	6.9	7.	6.4	5.	4.6	3.4	4.6	5.7	<3.2	<3.2	<3.2	<3.2
Ba	400.	450.	500.	380.	410.	410.	380.	440.	500.	460.	550.	630.
Be	4.4	5.2	3.5	4.	3.5	6.2	5.	3.5	2.4	2.6	2.4	2.
Ce	190.	220.	200.	240.	220.	240.	200.	220.	200.	140.	400.	280.
Co	<1.	<1.	<1.	<1.	<1.	2.	<1.	<1.	<1.	<1.	<1.	1.3
Cr	5.1	<1.	<1.	14.	<1.	1.4	<1.	<1.	1.7	<1.	1.8	3.
Cs	<20.	<20.	<20.	<20.	<20.	n.d.	<20.	<20.	n.d.	n.d.	n.d.	n.d.
Cu	3.	1.7	1.6	2.4	1.7	3.9	2.4	4.4	3.6	2.4	2.9	3.7
Er	<10.	10.	<10.	<10.	<10.	<10.	<10.	11.	<10.	<10.	<10.	<10.
Eu	<1.5	<1.5	<1.5	<1.5	1.8	1.8	<1.5	<1.5	<1.5	<1.5	<1.5	1.7
Ga	30.	33.	32.	26.	24.	26.	29.	29.	24.	13.	21.	21.
Gd	<15.	<15.	<15.	<15.	<15.	13.	<15.	<15.	<6.8	<6.8	<10.	8.6
La	110.	120.	120.	120.	120.	130.	100.	110.	100.	80.	230.	170.
Li	20.	10.	10.	10.	5.	70.	50.	20.	<68.	84.	<68.	<68.
Mo	<2.2	2.4	<2.2	<2.2	<2.2	6.3	<2.2	<2.2	<2.2	<2.2	2.6	2.7
Nb	44.	42.	42.	48.	41.	48.	49.	46.	12.	7.8	20.	13.
Nd	100.	140.	120.	120.	130.	130.	120.	100.	110.	72.	230.	180.
Ni	<1.5	>1.5	<1.5	<1.5	1.7	<4.6	<1.5	>1.5	<4.6	<4.6	<4.6	<4.6
Pb	41.	35.	44.	35.	34.	40.	33.	38.	32.	<10.	13.	13.
Rb	150.	200.	150.	150.	150.	n.d.	200.	200.	n.d.	n.d.	n.d.	n.d.
Sc	2.5	2.5	2.3	3.1	3.1	2.7	3.1	2.8	2.5	1.3	4.3	5.4
Sn	8.7	4.1	7.1	4.8	5.3	<6.8	4.8	6.1	<6.8	<6.8	<6.8	<6.8
Sr	23.	25.	29.	20.	20.	18.	24.	24.	26.	24.	28.	29.
V	<1.	<1.	1.1	<1.	<1.	<3.2	1.5	<1.	4.2	<3.2	<3.2	<3.2
Y	70.	86.	57.	80.	69.	110.	62.	79.	52.	26.	50.	26.
Yb	10.	12.	9.8	9.4	7.1	10.	9.6	11.	6.9	4.	6.3	3.7
Zn	35.	<10.	17.	15.	<10.	<22.	17.	28.	<22.	<22.	26.	<22.
Zr	230.	200.	220.	240.	210.	380.	280.	220.	140.	150.	350.	240.

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y5-139.0	Y5-265.3	Y5-525.5	Y13-8.0	Y13-43.4	Y13-47.2	Y13-54.6	Y13-64.0	Y13-70.9	13-84.3	Y13-86.0	Y13-90.6
Symbol	5	5	X	X	X	X	X	X	X	X	X	X
SiO_2	76.70	73.80	74.30	73.10	73.60	68.80	77.00	79.50	73.30	59.30	70.10	73.70
Al_2O_3	11.60	13.00	13.90	11.90	10.70	14.70	10.40	9.90	14.90	19.00	15.60	11.90
Fe_2O_3	1.80	2.00	0.94	0.50	1.10	1.00	1.90	0.91	0.33	2.10	1.30	0.72
FeO	0.04	0.16	0.12	0.40	0.44	0.16	0.12	0.36	0.08	0.92	0.16	0.44
MgO	0.05	0.05	0.05	0.07	0.19	0.18	0.04	0.15	0.27	0.22	0.06	0.01
CaO	0.28	0.39	0.59	0.35	1.10	1.50	0.15	0.10	0.83	1.10	0.54	1.00
Na_2O	2.50	3.10	3.40	3.80	3.80	4.10	3.10	2.50	0.43	0.91	1.80	2.60
K_2O	4.90	5.10	5.50	4.00	2.80	3.80	5.80	3.70	0.34	0.42	5.30	3.50
H_2O	0.68	0.67	0.35	4.47	6.60	6.60	0.74	2.00	9.30	12.90	4.30	4.90
TiO_2	0.19	0.26	0.24	0.19	0.15	0.22	0.12	0.16	0.21	0.27	0.21	0.14
P_2O_5	0.05	0.04	0.06	0.09	0.06	0.07	0.07	0.06	0.06	0.06	0.05	0.05
MnO	0.02	0.01	0.01	0.02	0.04	0.02	0.07	0.04	0.03	0.03	0.02	0.03
CO_2	0.01	0.01	0.01	0.02	0.08	0.02	0.02	0.02	0.02	0.19	0.02	0.02
Total(-O)	98.82	98.59	99.47	98.91	100.66	101.17	99.53	99.40	100.10	97.42	99.46	99.01
Normative minerals												
q	43.413	35.989	32.505	35.510	38.424	26.865	38.009	50.885	67.473	51.737	38.504	43.635
c	1.839	1.816	1.456	0.955		1.314		1.793	12.493	16.046	6.120	2.204
or	29.301	30.568	32.674	23.898	16.437	22.196	34.436	21.996	2.007	2.548	31.489	20.889
ab	21.407	26.606	28.923	32.509	31.944	34.292	21.304	21.282	3.635	7.904	15.314	22.220
an	1.011	1.633	2.485	1.033	3.844	6.778			3.596	3.966	2.238	4.553
ac							4.450					
wo					0.286		0.067					
en	0.126	0.126	0.125	0.176	0.470	0.443	0.100	0.368	0.672	0.562	0.150	0.025
fs				0.045								0.038
mt				0.733	1.107		0.269	0.832		2.341		1.054
hm	1.821	2.029	0.945		0.330	0.988	0.186	0.342	0.330	0.541	1.307	
il	0.129	0.364	0.276	0.365	0.283	0.376	0.229	0.306	0.233	0.526	0.383	0.269
ru	0.124	0.072	0.096			0.019			0.087		0.010	
ap	0.120	0.096	0.143	0.216	0.141	0.164	0.167	0.143	0.142	0.146	0.119	0.120
cc	0.023	0.023	0.023	0.046	0.181	0.045	0.046	0.038	0.045	0.444	0.046	0.046
mg								0.007				
Total	99.315	99.323	99.651	95.486	93.447	93.480	99.261	97.992	90.713	86.762	95.679	95.054
Salic	96.971	96.612	98.043	93.905	90.649	91.444	93.748	95.957	89.204	82.202	93.665	93.502
Femic	2.344	2.710	1.608	1.581	2.797	2.036	5.513	2.035	1.509	4.560	2.014	1.552
D.I.	94.121	93.163	94.103	91.916	86.805	83.352	93.748	94.164	73.115	62.189	85.307	86.745
Al_2O_3/SiO_2	0.151	0.176	0.187	0.163	0.145	0.214	0.135	0.125	0.203	0.320	0.223	0.161
FeO/Fe_2O_3	0.022	0.080	0.128	0.800	0.400	0.160	0.063	0.396	0.242	0.438	0.123	0.611

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y5-139.0	Y5-265.3	Y5-525.5	Y13-8.0	Y13-43.4	Y13-47.2	Y13-54.6	Y13-64.0	Y13-70.9	Y13-84.3	Y13-86.0	Y13-90.6
Symbol	5	5	5	X	X	X	X	X	X	X	X	X
Trace elements (ppm)												
Ag	<0.1	<0.1	<0.1	0.11	<0.1	0.14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
B	<3.2	3.9	<3.2	18.	<4.6	<4.6	4.9	<4.6	<4.6	<4.6	<4.6	<4.6
Ba	380.	810.	1300.	450.	310.	570.	520.	410.	16.	50.	620.	430.
Be	2.	2.8	2.2	3.5	6.9	4.6	4.9	2.3	2.1	4.2	4.8	4.6
Ce	140.	220.	220.	200.	190.	210.	210.	290.	100.	140.	250.	250.
Co	1.3	1.4	1.3	<1.	<1.	1.5	1.2	<1.	<1.	<1.	<1.	<1.
Cr	<1.	2.1	<1.	11.	4.3	13	2.1	<1.	<1.	<1.	<1.	<1.
Cs	n.d	n.d.	n.d.	250.	350.	1500.	<20.	550.	50.	20.	20.	200.
Cu	2.3	3.1	3.8	3.3	4.2	4.2	2.7	2.4	4.	3.8	6.4	2.1
Er	<10.	<10.	<10.	<10.	<10.	<10.	<10.	11.	<10.	<10.	<10.	<10.
Eu	<1.5	1.8	2.9	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Ga	14.	27.	26.	89.	27.	31.	29.	21.	34.	66.	42.	24.
Gd	<6.8	<6.8	<6.8	<15.	<15.	<15.	<15.	<15.	<15.	<15.	16.	<15.
La	87.	130.	130.	120.	96.	110.	110.	210.	34.	48.	150.	140.
Li	<68.	<68.	<68.	20.	50.	50.	50.	150.	750.	50.	50.	20.
Mo	<2.2	2.3	<2.2	7.9	<2.2	<2.2	<2.2	<2.2	13.	12.	<2.2	<2.2
Nb	11.	9.2	7.9	38.	45.	46.	39.	31.	32.	76.	63.	49.
Nd	64.	130.	150.	110.	110.	80.	120.	200.	69.	100.	160.	140.
Ni	<4.6	<4.6	<4.6	1.6	3.3	6.7	2.5	<1.5	<1.5	1.7	<1.5	2.
Pb	13.	19.	21.	51.	39.	49.	34.	29.	30.	70.	51.	33.
Rb	n.d.	n.d.	n.d.	150.	150.	400.	150.	150.	50.	50.	100.	100.
Sc	1.4	2.8	2.6	3.1	2.9	3.9	3.7	3.7	3.8	5.3	3.8	3.7
Sn	<6.8	<6.8	<6.8	8.4	7.	7.8	7.	5.3	7.9	13.	33.	6.2
Sr	21.	39.	<22.	140.	89.	260.	26.	27.	15.	31.	54.	110.
V	<3.2	<3.2	3.2	4.9	2.5	11.	1.4	2.	2.	<1.	<1.	<1.
Y	50.	42.	35.	45.	59.	69.	75.	66.	38.	87.	72.	70.
Yb	5.2	7.	6.5	5.2	7.2	9.1	11.	7.3	4.9	9.	12.	8.1
Zn	<22.	<22.	<22.	<10.	42.	43.	22.	16.	<10.	91.	41.	32.
Zr	170.	310.	170.	280.	330.	310.	270.	250.	260.	580.	410.	310.

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	13-112.4	13-119.8	13-149.9	Y13-155.	Y13-165.	13-169.7	13-185.4	Y13-206.	13-215.5	Y13-249.	Y13-294.	Y13-350.
Symbol	X	X	X	X	X	X	X	X	X	X	X	X
SiO_2	70.10	72.30	67.10	77.90	83.10	84.30	81.80	74.50	85.20	75.80	76.80	70.70
Al_2O_3	12.30	14.00	16.40	10.90	8.00	8.10	9.60	13.30	7.70	12.50	12.50	14.70
Fe_2O_3	0.95	0.81	1.40	1.30	0.65	0.51	0.62	1.00	0.41	0.59	1.00	0.68
FeO	0.32	0.36	0.12	0.16	0.20	0.32	0.28	0.20	0.36	0.56	0.28	0.84
MgO	---	0.07	---	---	---	---	---	---	---	---	---	---
CaO	2.30	0.74	0.31	0.32	0.19	0.22	0.19	0.21	0.16	0.38	0.17	0.37
Na_2O	2.90	2.50	4.70	0.78	3.90	1.60	2.10	3.20	0.93	3.40	4.00	4.30
K_2O	1.90	7.70	8.20	6.50	3.90	3.90	4.70	6.80	4.30	5.70	5.40	6.50
H_2O	8.90	0.84	0.76	1.40	0.76	0.67	0.61	0.61	0.73	0.74	0.82	0.75
TiO_2	0.16	0.17	0.19	0.14	0.09	0.08	0.12	0.16	0.09	0.16	0.15	0.19
P_2O_5	0.08	0.07	0.06	0.05	0.06	0.04	0.06	0.06	0.07	0.07	0.06	0.07
MnO	0.03	0.06	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03
CO_2	0.02	0.22	0.02	0.02	0.03	0.04	0.02	0.07	0.02	0.02	0.02	0.03
Total(-O)	99.96	99.84	99.28	99.49	100.90	99.80	100.13	100.14	100.00	99.95	101.23	99.16
Normative minerals												
q	41.329	27.443	8.466	48.244	51.865	59.906	51.349	29.733	63.140	33.513	32.356	20.140
c	1.529	0.886		2.177		1.037	0.902	0.599	1.439	0.260		0.157
or	11.232	45.574	48.807	38.607	22.841	23.092	27.738	40.127	25.410	33.700	31.522	38.736
ab	24.549	21.188	38.985	6.634	19.263	13.566	17.747	27.040	7.869	28.784	33.436	36.694
an	10.766	1.826		1.140		0.578	0.424	0.207	0.210	1.302	0.202	1.199
ac			0.946		1.864							
ns					2.636							
wo			0.379		0.149						0.050	
en		0.175										
fs					0.254	0.072			0.230	0.333		0.729
mt	0.666	0.865		0.176		0.741	0.652	0.278	0.594	0.856	0.559	0.994
hm	0.491	0.215	1.083	1.185			0.170	0.807			0.603	
il	0.304	0.323	0.298	0.267	0.169	0.152	0.228	0.303	0.171	0.304	0.281	0.364
tn			0.084									
ap	0.190	0.166	0.143	0.119	0.141	0.095	0.142	0.142	0.166	0.166	0.140	0.167
cc	0.046	0.501	0.046	0.046	0.068	0.091	0.045	0.159	0.045	0.046	0.045	0.069
Total	91.101	99.163	99.238	98.596	99.250	99.331	99.394	99.394	99.274	99.264	99.193	99.248
Salic	89.405	96.918	96.258	96.802	93.969	98.180	98.158	97.705	98.068	97.560	97.516	96.925
Femic	1.696	2.245	2.979	1.793	5.2 1	1.151	1.236	1.689	1.206	1.704	1.678	2.323
D.I.	77.110	94.206	96.258	93.485	93.969	96.565	96.833	96.899	96.419	95.997	97.314	95.569
Al_2O_3/SiO_2	0.175	0.194	0.244	0.140	0.096	0.096	0.117	0.179	0.090	0.165	0.163	0.208
FeO/Fe_2O_3	0.337	0.444	0.086	0.123	0.308	0.627	0.452	0.200	0.878	0.949	0.280	1.235

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

	13-112.4	13-119.8	13-149.9	Y13-155.	13-165.	13-169.7	13-185.4	Y13-206.	13-215.5	Y13-249.	Y13-294.	Y13-350.
Symbol	X	X	X	X	X	X	X	X	X	X	X	X
Trace elements (ppm)												
Ag	<0.1	0.7	0.15	0.41	0.34	0.16	0.23	0.3	0.39	<0.1	<0.1	<0.1
B	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	<4.6	5.1	<4.6
Ba	490.	480.	1100.	440.	270.	330.	350.	380.	350.	520.	360.	550.
Be	4.3	33.	5.1	5.8	4.8	2.4	5.3	8.6	3.2	4.2	2.8	3.9
Ce	230	230.	170.	150.	170.	140.	160.	160.	150.	210.	110.	220.
Co	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.
Cr	14.	14.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.
Cs	200.	<20.	---	<20.	<20.	<20.	<20.	---	<20.	---	---	---
Cu	4.	5.2	4.2	4.4	2.2	2.9	3.	3.9	2.4	4.9	11.	2.1
Er	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.	<10.
Eu	1.7	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	1.8	1.7	<1.5
Ga	22.	41.	36.	13.	13.	15.	17.	32.	12.	30.	45.	32.
Gd	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.	<15.
La	120.	130.	89.	70.	88.	87.	110.	93.	86.	130.	80.	110.
Li	50.	100.	150.	50.	150.	150.	100.	50.	200.	100.	10.	100.
Mo	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2	<2.2
Nb	32.	36.	38.	34.	25.	21.	25.	22.	28.	36.	36.	45.
Nd	91.	110.	93.	93.	110.	100.	120.	100.	91.	130.	78.	110.
Ni	<1.5	3.1	<1.5	1.7	<1.5	<1.5	<1.5	2.2	<1.5	<1.5	<1.5	2.9
Pb	36.	74.	58	34	20.	27.	24.	43.	39.	35.	34.	44.
Rb	50.	400.	400.	300.	150.	150.	200.	300.	200.	250.	150.	400.
Sc	3.8	3.3	1.9	2.3	1.8	1.9	2.1	1.9	2.1	3.1	2.1	2.5
Sn	4.4	4.8	7.7	7.8	4.9	1.7	6.8	12.	6.4	5.7	5.6	7.9
Sr	190.	41.	33.	23.	17.	25.	17.	22.	21.	<15.	13.	<15.
V	1.7	<1.	1.3	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.	<1.
Y	72.	60.	41.	54.	49.	47.	41.	47.	42.	68.	35.	48.
Yb	8.8	8.9	7.9	8.6	5.7	6.8	5.	8.2	6.3	10.	8.8	12.
Zn	20.	53.	29.	56.	36.	34.	35.	45.	41.	21.	41.	30.
Zr	310.	180.	140.	170.	180.	130.	160.	170.	190.	210.	140.	190.

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

Symbol	13-361.7 X	13-418.6 X	Y13-463. X
SiO_2	75.80	73.10	77.10
Al_2O_3	12.80	13.70	12.00
Fe_2O_3	0.71	0.74	0.60
FeO	0.72	0.20	0.64
MgO	---	---	---
CaO	0.31	0.45	0.42
Na_2O	3.40	4.80	3.40
K_2O	5.50	4.90	5.30
H_2O	0.66	2.77	0.30
TiO_2	0.15	0.16	0.16
P_2O_5	0.05	0.07	0.06
MnO	0.03	---	0.02
CO_2	0.02	0.02	0.06
Total(-O)	100.15	100.91	100.06
Normative minerals			
q	34.208	25.545	36.246
c	0.855		0.189
or	32.452	28.694	31.300
ab	28.727	40.250	28.753
an	1.083	1.352	1.312
wo		0.118	
fs	0.543		0.452
mt	1.028	0.179	0.869
hm		0.610	
il	0.284	0.301	0.304
ap	0.118	0.164	0.142
cc	0.045	0.045	0.136
Total	99.344	97.259	99.704
Salic	97.325	95.841	97.800
Femic	2.019	1.417	1.904
D.I.	95.387	94.489	96.299
Al_2O_3/SiO_2	0.169	0.187	0.156
FeO/Fe_2O_3	1.014	0.270	1.067

Table 2. (cont'd)-- Major and trace element chemical analyses of Lower Geyser Basin drill core, Yellowstone National Park, Wyoming

Symbol	13-361.7 X	13-418.6 X	Y13-463. X
Trace elements (ppm)			
Ag	<0.1	0.13	0.12
B	<4.6	<4.6	<4.6
Ba	490.	410.	480
Be	6.4	5.3	5.6
Ce	220	150.	210.
Co	<1.	<1.	<1.
Cr	<1.	<1.	<1.
Cs	---	<20.	<20
Cu	2.2	2.4	4.5
Er	13.	<10.	<10.
Eu	<1.5	<1.5	<1.5
Ga	32.	30.	26.
Gd	<15.	<15.	<15.
La	150.	84.	120.
Li	100.	100.	50.
Mo	<2.2	<2.2	<2.2
Nb	37.	29.	31.
Nd	140.	99.	120.
Ni	<1.5	<1.5	2.2
Pb	35.	34.	33
Rb	200.	200.	200.
Sc	3.1	2.5	3.6
Sn	6.3	4.3	5.2
Sr	<15.	<15.	27.
V	<1.	<1.	<1.
Y	80.	43.	77.
Yb	14	6.6	11.
Zn	12.	<10.	17.
Zr	230.	190.	230.

Table 3. -- Major and trace element chemical analyses of Norris Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y9-7.0	Y9-10.0	Y9-82.0	Y9-124.0	Y9-129.0	Y9-397.5	Y9-617.5	Y9-807.5	Y12-52.9	Y12-90.4	12-163.3	12-182.4
Symbol	9	9	9	9	9	9	9	9	W	W	W	W
SiO_2	76.40	77.30	77.00	77.00	75.70	76.00	76.70	76.80	79.70	76.40	76.10	77.80
Al_2O_3	12.00	12.20	12.30	12.90	13.00	12.80	11.30	12.10	12.70	13.40	12.80	11.30
Fe_2O_3	1.00	0.21	0.91	1.20	1.60	0.29	3.60	0.79	---	0.80	1.20	0.62
FeO	0.08	0.04	0.07	0.15	0.06	0.04	---	0.04	0.04	0.04	0.18	0.04
MgO	0.03	0.02	0.04	0.05	0.02	0.02	0.03	0.04	0.01	---	---	0.19
CaO	0.33	0.25	0.25	0.21	0.23	0.36	0.31	0.21	0.05	0.10	0.21	0.36
Na_2O	3.40	3.10	3.00	3.00	3.10	3.30	2.70	3.10	0.86	1.50	3.00	2.70
K_2O	4.70	5.00	5.10	5.10	5.30	5.30	4.70	5.00	1.70	3.40	5.20	4.30
H_2O	0.91	0.84	1.01	1.22	1.21	0.71	1.27	0.69	4.43	3.15	1.08	1.14
TiO_2	0.14	0.07	0.07	0.07	0.10	0.09	0.06	0.08	0.08	0.09	0.12	0.15
P_2O_5	0.09	0.05	0.05	0.03	0.02	0.03	0.02	0.03	0.06	0.04	0.07	0.10
MnO	0.01	0.01	0.01	0.02	0.02	0.01	0.11	0.01	---	---	---	0.03
CO_2	0.01	0.02	0.02	0.01	0.03	0.02	0.02	0.02	0.01	0.04	0.02	0.01
Total(-O)	99.10	99.11	99.83	100.96	100.39	98.97	100.82	98.91	99.64	98.96	99.98	98.74
Normative minerals												
q	38.513	40.121	39.701	39.244	36.858	36.234	42.066	39.696	68.437	55.238	38.560	45.467
c	0.967	1.413	1.559	2.137	1.856	1.110	1.291	1.339	9.479	7.329	2.069	1.835
or	28.026	29.812	30.189	29.851	31.197	31.645	27.548	29.872	10.082	20.303	30.734	25.734
ab	29.031	26.467	25.428	25.144	26.129	28.214	22.661	26.520	7.303	12.826	25.390	23.138
an	0.995	0.794	0.788	0.775	0.818	1.479	1.270	0.727			0.458	1.083
en	0.075	0.050	0.100	0.123	0.050	0.050	0.074	0.101	0.002			0.479
mt			0.055	0.343			0.184				0.232	
hm	1.009	0.212	0.873	0.952	1.594	0.293	3.444	0.799		0.808	1.040	0.628
il	0.192	0.107	0.133	0.132	0.169	0.107	0.113	0.107	0.085	0.085	0.228	0.151
ru	0.040	0.014			0.011	0.035		0.025	0.036	0.046		0.073
ap	0.215	0.119	0.119	0.070	0.047	0.072	0.047	0.072	0.090	0.096	0.166	0.240
cc	0.023	0.046	0.046	0.023	0.068	0.046	0.045	0.046		0.085	0.045	0.023
mg									0.019			
Total	99.087	99.155	98.991	98.793	98.796	99.284	98.743	99.304	95.534	96.816	98.923	98.851
Salic	97.532	98.606	97.665	97.151	96.858	98.682	94.836	98.155	95.302	95.695	97.212	97.258
Femic	1.555	0.549	1.326	1.643	1.938	0.603	3.907	1.149	0.232	1.121	1.712	1.593
D.I.	95.570	96.400	95.318	94.238	94.185	96.093	92.274	96.089	85.822	88.367	94.685	94.339
Al_2O_3/SiO_2	0.157	0.158	0.160	0.168	0.172	0.168	0.147	0.158	0.159	0.175	0.168	0.145
FeO/Fe_2O_3	0.080	0.190	0.077	0.125	0.038	0.138		0.051		0.050	0.150	0.065

Table 3. (cont'd) -- Major and trace element chemical analyses of Norris Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y9-7.0	Y9-10.0	Y9-82.0	Y9-124.0	Y9-129.0	Y9-397.5	Y9-617.5	Y9-807.5	Y12-52.9	Y12-90.4	12-163.3	12-182.4
Symbol	9	9	9	9	9	9	9	9	W	W	W	W
Trace elements (ppm)												
Ag	<0.7	0.14	0.12	<0.1	0.17	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.7
B	10.	6.7	7.5	9.5	10.	7.	12.	9.6	<3.2	5.8	7.8	10.
Ba	150.	91.	230.	48.	330.	630.	470.	110.	95.	140.	590.	300.
Be	7.	4.8	4.9	6.3	5.	3.3	7.8	5.1	<0.68	2.3	5.	5.
Ce	<50.	55.	59.	66.	89.	300.	1800.	140.	<29.	48.	300.	70.
Co	<1.	1.9	1.4	<1.	1.7	1.9	2.1	2.	<1.	2.1	1.9	<1.
Cr	5.	21.	1.8	1.3	<1.	<1.	1.7	1.2	<1.	5.2	5.7	1.
Cs	<20.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	<20.
Cu	5.	7.6	4.6	4.3	4.1	3.4	6.3	4.	3.7	4.	4.2	7.
Er	---	<10.	<10.	<10.	<10.	12.	23.	11.	<10.	<10.	12.	n.d.
Eu	<1.	1.5	1.8	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	2.4	<1.
Ga	20.	25.	25.	33.	31.	26.	28.	27.	18.	27.	31.	20.
Gd	---	<6.8	<6.8	<6.8	<6.8	24.	12.	14.	<6.8	<6.8	10.	n.d.
La	50.	30.	45.	44.	57.	450.	38.	120.	14.	17.	210.	50.
Li	20.	<68.	<68.	94.	<68.	<68.	130.	<68.	<68.	73.	<68.	10.
Mo	5.	2.8	3.2	3.8	3.8	<2.2	35.	4.1	<2.2	4.3	3.4	3.
Nb	50.	78.	48.	77.	66.	42.	48.	60.	41.	53.	47.	70.
Nd	<20.	<46.	<46.	<46.	48.	250.	<46.	110.	<46.	<46.	170.	<20.
Ni	5.	12.	<4.6	<4.6	<4.6	<4.6	6.3	5.2	<4.6	7.1	7.1	3.
Pb	30.	25.	29.	32.	26.	22.	63.	26.	13.	28.	25.	30.
Rb	200.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	100.
Sc	<0.7	1.4	2.3	2.2	2.1	1.3	3.7	2.	1.4	1.9	1.5	3.
Sn	7.	<6.8	<6.8	10.	8.8	<6.8	9.6	8.7	<6.8	<6.8	<6.8	10.
Sr	15.	9.5	14.	6.3	14.	24.	11.	8.9	6.	8.2	22.	15.
V	<1.	3.3	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	3.7	<3.2	<1.
Y	30.	38.	27.	27.	34.	130.	140.	71.	14.	20.	120.	50.
Yb	7.	4.9	4.7	5.5	5.1	9.8	16.	7.	2.	3.8	12.	7.
Zn	50.	<22.	30.	25.	36.	38.	77.	47.	<22.	<22.	<22.	<15.
Zr	150.	310.	180.	240.	330.	180.	210.	170.	130.	220.	220.	200.

Table 3.(cont'd) -- Major and trace element chemical analyses of Norris Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y12-188.	Y12-219.	Y12-298.	12-481.2	12-706.6	12-901.6	Y12-919.	Y12-1081	YP-654	*YP-654	YP-662	*YP-669
Symbol	W	W	W	W	W	W	W	W	Z	z	Z	z
SiO_2	76.60	76.10	76.10	76.10	77.80	76.90	78.40	76.90	80.90	82.65	77.70	77.98
Al_2O_3	13.80	12.50	14.30	13.00	12.20	12.20	12.20	12.20	11.50	10.68	11.70	11.60
Fe_2O_3	0.47	1.20	1.40	0.36	0.59	0.82	0.25	0.59	0.18	0.18	0.97	0.92
FeO	---	0.08	0.08	---	0.12	0.24	0.37	0.15	0.08	0.08	0.08	0.10
MgO	0.05	0.01	0.02	0.02	0.04	0.05	0.03	0.13	0.02	0.05	0.29	0.06
CaO	0.21	0.20	0.15	0.27	0.21	0.17	0.10	0.74	0.07	0.08	0.30	0.29
Na_2O	2.20	2.60	1.80	2.90	2.90	3.00	2.20	1.10	0.23	0.22	2.60	2.56
K_2O	4.20	4.90	3.10	4.90	4.90	4.80	4.70	5.20	0.44	0.32	4.60	4.94
H_2O	2.45	1.29	3.37	1.47	0.80	0.91	1.29	1.71	5.06	5.07	1.36	1.15
TiO_2	0.10	0.08	0.09	0.10	0.07	0.07	0.06	0.06	0.12	0.14	0.12	0.11
P_2O_5	0.04	0.05	0.07	0.05	0.05	0.05	0.06	0.06	0.09	0.07	0.09	0.13
MnO	---	---	---	---	---	---	---	0.02	0.15	---	0.03	---
ZrO_2	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.03	n.d.	0.03
CO_2	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.42	0.01	n.d.	0.01	---
Total(-O)	100.13	99.02	100.49	99.18	99.69	99.24	99.67	99.28	98.85	99.57	99.85	99.87
Normative minerals												
q	47.285	42.365	53.379	40.371	41.969	41.178	47.541	50.502	78.732	80.402	44.245	43.883
c	5.365	2.725	7.863	2.599	1.893	1.964	3.490	4.566	10.769	10.015	2.140	1.828
z										0.045		0.045
or	24.787	29.242	18.229	29.195	29.045	28.582	27.866	30.951	2.630	1.899	27.223	29.230
ab	18.592	22.218	15.157	24.742	24.615	25.580	18.677	9.375	1.969	1.870	22.034	21.690
an	0.716	0.608	0.223	0.957	0.654	0.330	0.041	0.629			0.838	0.590
en	0.124	0.025	0.050	0.050	0.100	0.125	0.075	0.326	0.027	0.125	0.723	0.150
fs							0.375		0.080			
mt		0.026			0.184	0.575	0.364	0.378	0.264		0.008	0.004
hm	0.469	1.194	1.393	0.363	0.465	0.430		0.334		0.181	0.966	0.919
il		0.153	0.168		0.133	0.134	0.114	0.115	0.231	0.170	0.228	0.209
ru	0.100		0.001	0.101						0.051		
ap	0.095	0.120	0.165	0.119	0.119	0.119	0.143	0.143	0.127	0.145	0.213	0.308
cc	0.023	0.023	0.023	0.023	0.023	0.069	0.023	0.962			0.023	
mg									0.019			
Total	97.555	98.700	96.650	98.520	99.200	99.086	98.709	98.281	94.849	94.902	98.643	98.855
Salic	96.744	97.159	94.850	97.864	98.176	97.633	97.615	96.023	94.100	94.231	96.481	97.266
Femic	0.811	1.541	1.800	0.656	1.024	1.452	1.093	2.258	0.749	0.671	2.162	1.589
D.I.	90.663	93.825	86.765	94.308	95.630	95.339	94.084	90.828	83.331	84.171	93.502	94.803
Al_2O_3/SiO_2	0.180	0.164	0.188	0.171	0.157	0.159	0.156	0.159	0.142	0.129	0.151	0.149
FeO/Fe_2O_3		0.067	0.057		0.203	0.293	1.480	0.254	0.444	0.444	0.082	0.109

Table 3. (cont'd) -- Major and trace element chemical analyses of Norris Geyser Basin drill core, Yellowstone National Park, Wyoming

	Y12-188.	Y12-219.	Y12-298.	12-481.2	12-706.6	12-901.6	Y12-919.	Y12-1081	YP-654	*YP-654	YP-662	*YP-669
Symbol	W	W	W	W	W	W	W	W	Z	z	Z	z
Trace elements (ppm)												
Ag	<0.1	<0.1	<0.1	0.12	<0.1	<0.1	<0.1	<0.1	<0.7		<0.7	
B	4.4	8.1	4.8	6.6	10.	11.	6.7	4.3	10.		7.	
Ba	440.	440.	380.	450.	220.	160.	110.	130.	15.		200.	
Be	3.6	5.6	3.	3.2	5.	4.6	5.1	5.6	<0.7		5.	
Ce	67.	70.	44.	61.	700.	110.	61.	95.	<50.		<50.	
Co	2.3	<1.	<1.	1.8	1.7	1.5	1.6	1.6	<1.		<1.	
Cr	1.2	<1.	3.	1.4	<1.	<1.	<1.	1.2	1.		2.	
Cs	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	<20.		<20.	
Cu	8.5	3.5	3.3	3.6	3.6	5.	4.6	4.4	3.		3.	
Er	<10.	<10.	<10.	<10.	17.	<10.	<10.	<10.	---		---	
Eu	<1.5	<1.5	1.5	<1.5	1.7	2.3	<1.5	1.5	<1.		<1.	
Ga	25.	31.	36.	27.	26.	35.	27.	23.	15.		30.	
Gd	22.	10.	<6.8	<6.8	46.	7.6	6.8	7.7	---		---	
La	49.	64.	37.	19.	440.	77.	48.	81.	<7.		50.	
Li	<68.	<68.	<68.	<68.	<68.	<68.	<68.	<68.	5.		20.	
Mo	<2.2	2.3	<2.2	<2.2	3.4	2.5	23.	<2.2	5.		5.	
Nb	37.	47.	51.	50.	42.	33.	43.	61.	50.		70.	
Nd	46.	57.	<46.	<46.	420.	74.	<46.	74.	<20.		<20.	
Ni	<4.6	<4.6	5.4	<4.6	<4.6	<4.6	<4.6	<4.6	3.		5.	
Pb	26.	27.	26.	21.	38.	37.	37.	38.	20.		50.	
Rb	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	<5.		150.	
Sc	2.3	2.4	2.7	1.5	1.9	1.7	2.	1.9	<0.7		3.	
Sn	<6.8	<6.8	<6.8	<6.8	<6.8	11.	9.	<6.8	5.		7.	
Sr	19.	18.	18.	17.	9.7	15.	8.9	13.	1.5		15.	
V	3.6	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<3.2	<1.		<1.	
Y	28.	69.	21.	51.	140.	63.	49.	79.	<7.		20.	
Yb	3.1	7.5	3.3	6.	12.	12.	6.3	9.9	1.		5.	
Zn	<22.	<22.	<22.	<22.	43.	61.	50.	55.	<15.		<15.	
Zr	180.	330.	190.	210.	190.	110.	190.	250.	200.		200.	

Table 3. (cont'd) -- Major and trace element chemical analyses of Norris Geyser Basin drill core, Yellowstone National Park, Wyoming

	YP-692	*YP-709	YP-717	YP-722	YP-728	*YP-750	YP-768	*YP-776
Symbol	Z	z	Z	Z	Z	z	Z	z
SiO_2	76.50	77.61	77.20	76.90	75.40	76.95	76.20	75.96
Al_2O_3	12.30	11.74	11.70	12.10	12.10	12.18	12.00	12.21
Fe_2O_3	0.53	1.13	0.58	1.10	1.60	1.07	1.40	1.65
FeO	0.20	0.21	0.16	0.24	0.24	0.26	0.32	0.36
MgO	0.05	0.14	0.04	0.03	0.04	0.12	0.04	0.01
CaO	0.29	0.35	0.32	0.39	0.32	0.28	0.34	0.44
Na_2O	3.20	2.85	3.00	2.80	3.10	2.98	3.10	2.90
K_2O	5.20	4.91	5.10	5.10	5.10	5.50	4.90	5.12
H_2O	1.00	0.80	0.96	1.04	0.87	0.30	0.87	1.05
TiO_2	0.13	0.11	0.09	0.12	0.13	0.13	0.14	0.14
P_2O_5	0.10	0.04	0.09	0.09	0.09	0.07	0.10	0.11
MnO	0.04	---	0.03	0.04	0.04	0.01	0.03	0.01
ZrO_2	n.d.	n.d.	n.d.	n.d.	n.d.	0.03	n.d.	n.d.
CO_2	0.01	---	0.01	0.02	0.01	0.04	0.01	0.01
Total(-O)	99.55	99.89	99.28	99.97	99.04	99.92	99.55	99.97
Normative minerals								
q	37.770	41.442	40.057	40.536	37.749	38.112	39.114	38.890
c	1.148	1.198	0.908	1.527	1.148	1.077	1.247	1.385
z						0.045		
or	30.867	29.046	30.356	30.146	30.429	32.527	29.086	30.265
ab	27.200	24.142	25.569	23.700	26.486	25.236	26.350	24.546
an	0.725	1.477	0.943	1.221	0.945	0.679	0.975	1.401
en	0.125	0.349	0.100	0.075	0.101	0.299	0.100	0.025
mt	0.400	0.358	0.355	0.556	0.532	0.494	0.727	0.787
hm	0.256	0.884	0.339	0.717	1.248	0.730	0.905	1.107
il	0.248	0.209	0.172	0.228	0.249	0.247	0.267	0.266
ap	0.238	0.095	0.215	0.213	0.215	0.166	0.238	0.261
cc	0.023		0.023	0.045	0.023	0.091	0.023	0.023
Total	99.001	99.201	99.038	98.965	99.127	99.703	99.031	98.955
Salic	97.711	97.306	97.833	97.130	96.758	97.676	96.771	96.486
Femic	1.290	1.896	1.205	1.834	2.369	2.027	2.260	2.469
D.I.	95.837	94.631	95.982	94.383	94.664	95.875	94.550	93.700
Al_2O_3/SiO_2	0.161	0.151	0.152	0.157	0.160	0.158	0.157	0.161
FeO/Fe_2O_3	0.377	0.186	0.276	0.218	0.150	0.243	0.229	0.218

Table 3. (cont'd) -- Major and trace element chemical analyses of Norris Geyser Basin drill core, Yellowstone National Park, Wyoming

	YP-692	*YP-709	YP-717	YP-722	YP-728	*YP-750	YP-768	*YP-776
Symbol	Z	z	Z	Z	Z	z	Z	z
Trace elements (ppm)								
Ag	<0.7		<0.7	<0.7	<0.7		<0.7	
B	7.		5.	10.	5.		5.	
Ba	500.		300.	500.	500.		700.	
Be	5.		5.	5.	7.		5.	
Ce	<50.		<50.	<50.	200.		70.	
Co	<1.		<1.	<1.	<1.		<1.	
Cr	2.		1.	2.	1.		<0.7	
Cs	<20.		<20.	<20.	<20.		<20.	
Cu	1.5		1.5	5.	5.		5.	
Er	---		---	---	---		---	
Eu	<1.		<1.	<1.	<1.		<1.	
Ga	30.		30.	30.	30.		30.	
Gd	---		---	---	---		---	
La	70.		70.	70.	150.		70.	
Li	10.		10.	10.	10.		20.	
Mo	5.		5.	5.	5.		5.	
Nb	50.		50.	30.	30.		30.	
Nd	<20.		<20.	<20.	<20.		<20.	
Ni	5.		5.	5.	5.		5.	
Pb	30.		30.	30.	50.		30.	
Rb	150.		150.	200.	200.		200.	
Sc	3.		<0.7	3.	5.		3.	
Sn	7.		7.	7.	7.		5.	
Sr	20.		15.	15.	20.		30.	
V	<1.		<1.	<1.	<1.		<1.	
Y	50.		30.	50.	100.		50.	
Yb	10.		7.	10.	15.		10.	
Zn	20.		30.	100.	50.		70.	
Zr	150.		200.	150.	150.		150.	

Table 4.-- Major and trace element chemical analyses of Mud Volcano area drill core, Yellowstone National Park, Wyoming

	Y11-21.0	Y11-54.0	Y11-64.1	Y11-75.6	Y11-98.1	Y11-118.2	Y11-154.4	Y11-248.3	Y11-343.5
Symbol	V	V	V	V	V	V	V	V	V
SiO_2	73.90	58.50	84.40	76.80	75.00	74.80	73.20	66.80	69.00
Al_2O_3	10.90	21.10	7.60	11.10	11.80	12.10	12.90	17.10	9.20
Fe_2O_3	0.62	4.20	0.73	1.10	2.10	1.70	2.00	1.80	6.00
FeO	0.52	0.12	0.02	0.04	0.12	0.16	0.12	0.04	6.00
MgO	0.06	0.53	0.14	0.27	0.10	0.06	0.07	0.15	0.74
CaO	0.49	0.92	0.35	0.48	0.38	0.48	0.46	0.57	0.31
Na_2O	0.45	1.20	0.67	2.10	3.10	3.00	3.40	3.70	0.16
K_2O	3.30	2.40	1.90	4.80	5.30	5.10	5.40	6.50	1.10
H_2O	7.70	9.10	2.60	1.68	0.85	0.88	0.70	1.65	4.20
TiO_2	0.15	0.31	0.08	0.16	0.16	0.14	0.21	0.26	0.16
P_2O_5	0.05	0.04	0.01	0.03	0.04	0.03	0.03	0.04	0.05
MnO	0.03	0.04	0.02	0.01	0.01	0.01	0.03	0.02	0.23
CO_2	0.02	0.06	0.01	0.02	0.02	0.02	0.02	0.01	0.01
Total(-O)	98.19	98.52	98.53	98.59	98.98	98.48	98.54	98.64	97.16
Normative minerals									
q	58.657	40.449	73.408	45.567	36.260	37.423	32.279	19.362	61.163
c	5.971	15.317	3.910	1.720	0.419	0.904	0.755	3.103	7.540
or	19.860	14.395	11.395	28.770	31.642	30.602	32.383	38.940	6.690
ab	3.878	10.307	5.754	18.024	26.502	25.777	29.196	31.740	1.393
an	2.014	3.982	1.632	2.088	1.513	2.091	1.989	2.538	1.182
en	0.152	1.340	0.354	0.682	0.252	0.152	0.177	0.379	1.897
fs	0.255								6.406
mt	0.916					0.145			8.954
hm		4.263	0.741	1.116	2.122	1.626	2.030	1.825	
il	0.290	0.344	0.086	0.107	0.278	0.270	0.322	0.129	0.313
ru		0.133	0.036	0.106	0.015		0.043	0.196	
ap	0.121	0.096	0.024	0.072	0.096	0.072	0.072	0.096	0.122
cc	0.046	0.139	0.023	0.046	0.046	0.046	0.046	0.023	0.023
Total	92.161	90.766	97.362	98.298	99.143	99.108	99.292	98.330	95.683
Salic	90.381	84.451	96.098	96.169	96.335	96.797	96.601	95.682	77.968
Femic	1.780	6.315	1.264	2.129	2.808	2.311	2.691	2.647	17.715
D.I.	82.395	65.151	90.557	92.361	94.403	93.802	93.858	90.042	69.247
Al_2O_3/SiO_2	0.147	0.361	0.090	0.145	0.157	0.162	0.176	0.256	0.133
FeO/Fe_2O_3	.839	0.029	0.027	0.036	0.057	0.094	0.060	0.022	1.000

Table 4.--(cont'd) Major and trace element chemical analyses of Mud Volcano area drill core, Yellowstone National Park, Wyoming

Trace elements (ppm)

	Y11-21.0	Y11-54.0	Y11-64.1	Y11-75.6	Y11-98.1	Y11-118.2	Y11-154.4	Y11-248.3	Y11-343.5
Symbol	V	V	V	V	V	V	V	V	V
Ag	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
B	15.	<2.	70.	5.	7.	7.	5.	3.	<2.
Ba	1000.	700.	500.	1000.	500.	500.	1500.	1500.	150.
Be	50.	70.	70.	30.	70.	70.	50.	50.	10.
Ce	300.	200.	<50.	300.	200.	150.	200.	300.	<50.
Co	<1.	3.	2.	<1.	<1.	<1.	<1.	5.	5.
Cr	10.	10.	3.	7.	1.	<0.7	2.	2.	5.
Cs	20.	200.	20.	20.	<20.	<20.	<20.	<20.	<20.
Cu	5.	10.	7.	7.	5.	5.	5.	5.	15.
Eu	<1.	<1.	<1.	<1.	<1.	<1.	5.	5.	<1.
Ga	20.	30.	15.	20.	20.	30.	30.	30.	15.
La	150.	100.	50.	150.	150.	70.	100.	150.	70.
Li	<5.	20.	10.	10.	<5.	<5.	10.	10.	50.
Mo	7.	<2.	3.	5.	5.	7.	5.	5.	<2.
Nb	50.	50.	50.	50.	50.	50.	20.	30.	20.
Nd	<20.	<20.	<20.	<20.	<20.	<20.	<20.	<20.	<20.
Ni	5.	15.	5.	7.	3.	5.	3.	7.	10.
Pb	100.	70.	30.	50.	50.	50.	50.	50.	70.
Rb	50.	50.	20.	150.	150.	150.	150.	200.	50.
Sc	3.	5.	2.	3.	2.	3.	3.	5.	5.
Sn	10.	20.	15.	7.	7.	10.	7.	7.	50.
Sr	200.	70.	50.	50.	20.	20.	70.	70.	30.
V	5.	20.	5.	5.	<1.	<1.	<1.	3.	5.
Y	70.	100.	20.	70.	70.	50.	20.	70.	70.
Yb	7.	10.	3.	10.	10.	7.	7.	15.	15.
Zn	50.	100.	50.	70.	150.	100.	100.	100.	150.
Zr	300.	300.	300.	300.	300.	300.	300.	300.	300.