UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Chemical, spectrographic, and modal analyses of syenitic rocks, thorium veins, and carbonatite in the Powderhorn district, Gunnison County, Colorado

by D. C. Hedlund and J. C. Olson

Open-File Report 80-233

1980

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Introduction

This report is a tabulation of analytical data on 53 samples of thorium veins, 56 samples of syenitic and related rocks, 12 samples of carbonatite dikes and intrusive bodies, and one sample each of magnetite-perovskite-apatite rock and a quartz diabase dike. These data have been tabulated for reference in relation to geologic reports and maps published on the Powderhorn district, (see reference list) as well as work currently being done.

Each sample is described briefly and its locality is given by quarter-section and by latitude and longitude. The locations of thorium veins that have been sampled and analyzed are shown on the geologic maps of the Carpenter Ridge, Powerderhorn, Gateview, and Rudolph Hill quadrangle maps (Hedlund and Olson, 1973, 1975; Olson and Hedlund, 1973; and Olson, 1974, respectively. The syenitic and related rocks that have been analyzed and tabulated herein (excluding diabase and magnetite-perovskite rock) are thought to be about 1,400 m.y. in age, based upon age determinations of samples from four of the intrusive bodies. The age determinations of these four rocks (P7406, C9803, 2G3200, and G3730N) have been reported and discussed previously (Olson and others, 1977).

Spectrographic analyses were made by P. R. Barnett, L. A. Bradley, N. M. Conklin, J. C. Hamilton, J. L. Harris, R. G. Havens, and M. J. Malcolm. Chemical analyses by rapid rock methods were made by L. Artis, I. H. Barlow, S. D. Botts, G. Chloe, P. L. D. Elmore, J. Glenn, J. Kelsey, M. D. Mack, N. Skinner, H. Smith, and H. H. Thomas. In the partial chemical analyses, MgO and P_2O_5 were determined by H. H. Lipp, F by W. D. Goss, CO_2 and total S by I. C. Frost, CaO by W. Mountjoy, and total Fe by D. L. Skinner. Radiochemical analyses were by J. N. Rosholt and W. Mountjoy. Radiometric analyses were by C. G. Angelo, L. M. Lee, and W. W. Niles. Fluorimetric analyses for U were by E. J. Fennelly, D. L. Ferguson, and J. P. Schuch. Gamma-ray spectrometry was by C. M. Bunker and C. A. Bush, all of the U.S. Geological Survey.

Description of samples and analytical data for Tables 1A, 1B, and 1C, Carpenter Ridge quadrangle, Colorado

C5130 Thorium vein, Mary Ann claim, in fault zone 1.5 m wide.

C5511 Thorium-bearing breccia zone in granite, in saddle on ridge west of Cebolla Creek.

C930 Thorite vein in fractures in quartz-biotite schist.

C5327 Intrusive breccia, composed of fragments of Precambrian rock in dolomitic matrix; south side of Blue Mesa Reservoir.

C63 Intrusive breccia, composed of fragments of Precambrian rock in dolomitic matrix; east rim of Cebolla Creek Canyon.

C64 Intrusive breccia, composed of fragments of Precambrian rocks in dolomitic matrix; east rim of Cebolla Creek Canyon.

C64M Dolomitic matrix of intrusive breccia C64.

C9800 Granite dike cutting eastern part of syenitic pluton of Wolf Creek.

C972 Augite syenite; biotite and augite phenocrysts in fine-grained matrix; north side of Wolf Creek at 8,220-foot altitude.

C3245 Syenite from central part of composite shonkinite-syenite body 150 m wide, north side of Wildcat Gulch.

C3245a Shonkinite (melasyenite) from northeastern mafic border zone of composite shonkinite-syenite body, north side of Wildcat Gulch.

C3254 Biotite shonkinite (melasyenite) near south edge of composite shonkinite-syenite body on south side of Wildcat Gulch.

Table 1A.--Spectrographic and radiometric analyses of 3 samples from thorium veins, Carpenter Ridge quadrangle, Colorado

[Leaders (---) indicate not determined.]

Loc. No.--------	C5130	C5511	C930
Ser. No.--------	269436	281244	269439
Lat.----------	38°23'57"	38°24'39"	38°24'13"
Long.----------	107°44'28"	107°10'26"	107°8'5"
Sec.----------	NW 1/4 20	SE 1/4 14	NE 1/4 19
TWP----------	48 N	48 N	48 N
Range----------	3 W	3 W	2 W
eU----------	0.008	0.005	0.09
U----------	0.001	<0.001	0.001
$eThO_2$----------	0.035	0.025	0.51
Major element--	Fe	Si	Si
In percent			
7	Si	AlK	----
3	----	Fe	AlFe
1.5	----	----	K
0.7	----	----	NaTh
0.3	----	----	CaV
0.15	MnPb	Na	Ti
In parts per million			
700	BaCaCeZn	CaMnTi	BaCeCuMgNd
300	AlLaNd	Mg	LaMnSmY
150	Mg	BaV	DyGdSr
70	MoNi	CuY	ErPbZr
30	CrYZr	LaNbNdSrZr	CrNbYb
15	CoCuBiSc	CrSc	NiSc
7	Ti	MoNiYb	----
3	BeGaSrYb	----	----
1.5	----	Be	Be

Table 1B.—Spectrographic and radiometric analyses of 9 samples of syenitic and related rocks, Carpenter Ridge quadrangle, Colorado

[Leaders (---) indicate not determined.]

Locality	C5327	C63	C64	C64M	C9800	C972	C3245	C3245a	C3254
Serial no.	277765	281243	277766	W173600	W173593	156272	269452	269451	269447
Latitude	38°27′44"	38°26′11"	38°25′25"	38°25′25"	38°23′39"	38°23′39"	38°22′44"	38°22′46"	38°22′3
Longitude	107°7′42"	107°9"52"	107°9"48"	107°9′48"	107°8′8"	107°8′6"	107°8′54"	107°8′51"	107°9′1
Section	SW1/4 36	SW1/4 1	SW1/4 12	SW1/4 12	SW1/4 19	SW1/4 19	SW1/4 30	SW1/4 30	SE1/4 2.
Township	49N	48N	48N	48N	48N	48N	48N	48N	48N
Range	3W	3W	3W	3W	2W	2W	2W	2W	3W
eU	0.001	0.002	0.003	---	---	---	0.004	0.004	0.004
U	---	---	0.00022	---	---	---	<0.001	<0.001	<0.001
Th	---	---	0.0038	---	---	---	0.001	0.002	0.001
Major element	FeSi	Si	FeSi	---	---	---	AlSi	Si	Si
In percent									
7	AlCaNa	AlCa	AlCaNa	---	---	---	FeK	AlK	AlFMg
3	KMg	FeKMgNa	Mg	---	---	---	CaNa	CaFeMg	CaFe
2	---	---	K(1.82)	---	---	---	---	---	---
1.5	Ti	---	---	---	---	---	Mg	Na	Na
0.7	---	---	Ti	---	---	---	BaTi	Ba	BaTi
0.3	---	Ti	---	---	---	Ba	---	Ti	---
0.15	BaMnSr	BaMnSr	MnSr	---	---	Sr	Sr	Sr	MnSr
0.1	---	---	---	Ba	Ba	---	---	---	---
In parts per million									
700	Zr	---	BaZr	CeSr	---	---	Mn	Mn	---
300	CeV	CeZr	CeNdV	---	---	Zr	CeZr	Ce	CeVZr
200	---	---	---	LaNdZr	Ga	---	---	---	---
150	LaNdNi	CrLaNdV	CrLaNiY	Cr	Sr	CeCrCuV	LaV	CrLaVZr	CrLaNd
100	---	---	---	NiV	CeLaZr	---	---	---	---
70	CrCuNbY	Nb	CuNb	Y	---	LaNd	PbY	CuPb	CuPb
50	---	---	---	---	Pb	---	---	---	---
30	CoPbSc	CuNiY	CoPbSc	CoNbSc	---	BNiPbScY	CrCuSc	NiScY	CoNiScY
15	Ga	PbSc	Ga	Ga	NbV	Co	CoGaNb	Co	NbSn
10	---	---	---	Cu	CrY	---	---	---	---
7	Yb	BeCo	BeYb	Yb	Cu	BeGaNb	BeNi	Ga	GaMo
3	Be	GaYb	---	Mo	Sc	Yb	MoYb	BeMoYb	BeYb
1.5	---	---	---	Be	---	---	---	---	---
1	---	---	---	---	Yb	---	---	---	---

Table 1C.--Chemical and normative analyses of 3 samples of syenitic and related rocks, Carpenter Ridge quadrangle, Colorado

[Leaders (---) indicate not determined.]

Loc. No.-----	C64M	C9800	C972
Ser. No.-----	W173600	W173593	156272
Lat.--------	38°25'25"	38°23'39"	38°23'39"
Long.-------	107°9'48"	107°8'8"	107°8'6"
Sec.--------	SW1/4 12	SW1/4 19	SW1/4 19
Twp---------	48N	48N	48N
Range-------	3W	2W	2W
Chemical Analyses			
SiO_2	40.0	73.7	56.0
Al_2O_8	9.3	14.2	12.8
Fe_2O_3	1.0	.92	3.6
FeO	8.3	.44	4.2
MgO	6.2	.32	5.7
CaO	9.1	.66	5.0
Na_2O	4.0	3.8	2.6
K_2O	2.3	5.0	7.2
TiO_2	1.1	.33	1.0
P_2O_5	.75	.06	.84
MnO	.24	.00	.13
H_2O+	.32	.60	.62
H_2O-	.10	---	---
CO_2	17.2	<.05	<.05
Sum-------	100	100	100
Sp.G.-----	---	---	2.82

Table 1C.--Chemical and normative analyses of 3 samples of syenitic and related rocks, Carpenter Ridge quadrangle, Colorado--Continued

		Norms	
Q	---	30.6	0
or	---	29.5	42.7
ab	---	32.1	22.1
an	---	3.1	2.0
C	---	1.4	---
fa	---	---	0.7
fo	---	---	2.6
en	---	0.8	10.6
fs	---	---	2.5
wo	---	---	7.3
mt	---	0.5	5.2
ilm	---	0.6	1.9
ap	---	0.1	2.0
cc	---	---	---
mg	---	---	---
hm	---	0.6	---
Total-----	---	99.3	99.6

Description of samples and analytical data for Table 2, Carpenter Ridge quadrangle, Colorado

C5169 Fine to medium-grained porphyritic lamprophyre (melasyenite), small dike about 6 by 20 m; biotite phenocrysts in matrix of K-feldspar and hornblende.

C5172 Dark gray medium-grained lamprophyre, composed mostly of hornblende and biotite grains with interstitial pink oligoclase, in small plug about 10 x 30 m.

C5328a Fine-grained hornblende syenite, with scattered hornblende phenocrysts, from small dike near body of intrusive breccia on south side of Blue Mesa Reservoir.

C5328b Medium-grained hornblende syenite from small dike near body of intrusive breccia on south side of Blue Mesa Reservoir.

C979 Medium- to coarse grained melasyenite, near south end of melasyenite body in the composite intrusive 900 m northeast of mouth of Wolf Creek.

C980 Fine-grained porphyritic hornblende-biotite melasyenite.

C981 Pyroxene-rich shonkinite (melasyenite); olivine present as phenocrysts.

C952 Fine-grained, gray porphyritic syenite near east edge of composite intrusive body 900 m northeast of mouth of Wolf Creek.

C951c Hornblende syenite from small (20 x 45m) composite shonkinite-syenite body on north side of Wolf Creek.

C995B Coarse-grained biotite syenite, southern part of puton 200 x 550 m in area.

C976 Black, fine-grained, porphyritic melasyenite, northern part of syenite pluton of Wolf Creek.

C990 Dark gray, fine-grained, porphyritic mafic syenite, central part of syenite pluton of Wolf Creek.

C972 Same as described in Table 1B.

Table 2.--Modal analyses of 13 samples of syenitic and related rocks,

Carpenter Ridge quadrangle, Colorado

[Tr., trace - Leaders (---) indicate not determined.]

Loc. No.----	C5169	C5172	C5328a	C5328b	C979	C980	C981	C952	C951C	C995B	C976	C990	C972
Lat.--------	38°28'19"	38°28'9"	38°27'44"	38°27'44"	38°24'38"	38°24'42"	38°24'43"	38°24'41"	38°24'9"	38°23'28"	38°23'58"	38°23'43"	38°23'39"
Long.-------	107°13'21"	107°13'18"	107°7'48"	107°7'48"	107°9'43"	107°9'42"	107°9'36"	107°9'27"	107°9'7"	107°9'8"	107°8'15"	107°8'14"	107°8'6"
Sec.--------	SE 1/4 30	NE 1/4 31	SE 1/4 36	SE 1/4 36	SW 1/4 13	SE 1/4 13	SW 1/4 13	SE 1/4 13	NE 1/4 24	SE 1/4 24	NE 1/4 19	SE 1/4 19	SE 1/4 19
Twp---------	49N	49N	49N	49N	48N	48N	48N	48N	48N	48N	48N	48N	48N
Range-------	3W	3W	3W	3W	3W	3W	3W	3W	3W	3W	2W	2W	2W
						MODE							
Quartz	---	1.9	1.6	1.1	---	Tr.	---	---	1.3	6.4	---	---	---
K-feldspar	30.6	---	40.5	48.9	25.3	50.7	42.8	---	79.7	58.4	58.8	60.6	68.5
Plagioclase	---	40.1	---	0.5	---	---	---	---	1.1	12.9	---	---	---
Biotite	15.2	25.0	17.6	2.2	48.8	17.0	8.1	2.6	---	14.7	3.2	8.5	13.0
Hornblende	18.7	24.1	29.9	26.3	0.1	28.4	---	14.6	12.3	4.9	30.7	20.2	---
Pyroxene	---	---	---	---	24.4	1.5	20.8	---	---	---	1.2	2/	15.7
Opaque	1.2	0.5	0.2	---	---	1.2	2.3	---	2.2	0.9	5.5	2.4	2.1
Apatite	0.3	0.1	Tr.	---	1.3	0.1	---	Tr.	0.1	0.1	---	Tr.	---
Calcite	---	0.6	0.4	---	---	---	---	---	---	---	---	---	---
Chlorite	17.0	7.5	8.3	19.6	0.1	1.0	---	1.8	2.4	1.1	0.5	8.3	0.7
Sphene	0.5	0.2	0.3	1.0	---	Tr.	---	---	0.9	0.5	---	---	---
Epidote	13.4	---	---	0.4	---	---	---	---	---	Tr.	---	---	---
Clinozoisite	2.9	---	---	---	---	---	---	---	---	---	---	---	---
Groundmass	---	---	---	---	---	---	---	1/81.	---	---	---	---	---
Olivine	---	---	---	---	---	---	26.0	---	---	---	---	---	---

1/ Fine-grained felsic minerals, opaques, hornblende.

2/ Present but largely replaced by hornblende.

Description of samples and analytical data for Table 3, Gateview quadrangle, Colorado

G1222 Thorium vein, fine-grained, reddish-brown; associated with carbonate vein and blue amphibole rock.

G1223 Thorium-bearing quartz-carbonate-feldspar vein 30 to 60 cm thick.

G2LP Quartz-hematite-thorite vein, Lone Peak Lode.

G2-3569 Thorite vein, Ten Mile claims, containing quartz, barite, jasper, red feldspar, specular hematite.

G2-3571 do.

10-M2 do.

G221 Thorite-bearing quartz-hematite vein, 1.8 m thick, containing K-feldspar, limonite, barite; Atomic Queen.

G292 Thorite vein, Sand Rock No. 5 Lode, containing carbonate, limonite, hematite, quartz, barite, jasper.

G291 Thorite vein containing jasper, K-feldspar, carbonate mineral, barite, limonite, quartz, 30-60 cm thick.

G2623 Thorium-bearing limonitic jasper-bearing quartz-barite vein.

G2108 do.

G2630 Carbonate-rich thorium vein (carbonatite) containing disseminated pink K-feldspar and minor pyrite.

G2105 Thorium-bearing vein 60 cm thick composed of K-feldspar, calcite, goethite, hematite, barite.

G22 Thorite vein composed of quartz, K-feldspar, hematite, limonite, minor barite; Cassie Lode.

G26 Thorium-bearing quartz-hematite vein 0.6-2.5 m thick.

G542A Jasper-bearing quartz-hematite vein 2.5 m thick.

G542B Jasper-bearing quartz-hematite vein 4.5 m thick.

G518 Thorium-bearing quartz vein 0.5-1.5 m thick.

G56 Thorium-bearing limonitic quartz-carbonate vein 1 m thick.

G55 Thorite-bearing limonitic quartz-hematite vein.

G538a Thorium-bearing barite-specularite vein 1.5 m thick.

G538b do.

G319 Thorium vein 2 m thick composed of barite, calcite, quartz, pyrite, limonite, blue amphibole.

G347 Thorium-bearing vein 0.5 m thick containing quartz, hematite, limonite, barite.

Table 3. Spectrographic (24) and radiometric (22) analyses of thorium veins, Gateview quadrangle, Colorado

[Leaders (---) indicate not determined.)

Locality---	G1222	G1223	G2LP	G2-3569	G2-3571	10-M2	G221	G292	G291	G2623	G2108	G2630
Ser. No.---	263967	269438	253060	261713	261716	261714	253058	261708	269434	269435	277770	281242
Latitude---	38°10'23"	38°10'21"	38°22'17"	38°22'27"	38°22'27"	38°22'27"	38°21'48"	38°21'28"	38°21'20"	38°21'26"	38°21'28"	38°21'2"
Long.------	107°13'5"	107°13'12"	107°12'14"	107°11'36"	107°11'36"	107°11'36"	107°11'23"	107°11'11"	107°11'3"	107°10'30"	107°10'35"	107°10'36"
Section----	NW 1/4 9	SW 1/4 9	NW 1/4 34	NE 1/4 34	NE 1/4 34	NE 1/4 34	SE 1/4 34	NW 1/4 2	NW 1/4 2	NE 1/4 2	NE 1/4 2	SE 1/4 2
Twp--------	47N	47N	48N	48N	48N	48N	48N	47N	47N	47N	47N	47N
Range------	3W	3W	3W	3W	3W	3W	3W	3W	3W	3W	3W	3W
eU---------	---	.007	.007	.18	.023	.039	.048	.093	.53	.017	.053	.002
U----------	---	<.001	.001	.001	<.001	.001	.002	<.001	.001	<.001	---	---
$eThO_2$------	---	.035	.03	1	0.1	0.2	0.26	0.6	3	.097	.265	$.010_2$
ThO_2-------	---	---	.02	---	---	---	-.21	---	---	---	---	---
Major element	CaSi	CaSi	Si	BaSi	BaSi	Si	BaFeSi	BaCa	Ca	BaSi	BaSi	Ca
						In Percent						
7	---	Fe	AlK	---	---	AlFeK	---	Si	---	K	Ca	---
5	---	---	---	---	---	---	---	---	---	---	---	---
3	FeMgNa	BaMg	Fe	Fe	Fe	---	Ca	---	Th	AlFePb	AlFeK	Na
2	---	---	---	---	---	---	---	---	---	---	---	---
1.5	---	AlK	---	Th	AlK	---	---	FeK	NdSiBaFe	---	Na	FeSi
1	---	---	---	---	---	---	---	---	---	---	---	---
0.7	KTi	---	Na	---	---	---	P	AlTh	AlSm	Na	P	Al
0.5	---	---	---	---	---	---	---	---	---	---	---	---
0.3	Al	MnPb	Ti	Ca	CaTh	MnThBaCa	AlCeNd	---	---	---	---	---
0.2	---	---	---	---	---	---	---	---	---	---	---	---
0.15	Mn	---	BaCa	AlCeMn	NaMn	CeNa	SnSrThLaMn	MnNaPb	PbPrCdMn	MgMnSr	Mn	MgNdBaCeSmSr
0.1	---	---	---	---	---	---	---	---	---	---	---	---

In parts per million												
700	Cr	SrTiCeNa	Mn	SmSrLaNd	SrTi	LaNdTi	NaPbGdMgPrY	NdSmSr	SrYEuLa	ThTiCeNd	CePbY	MnTi
300	SrZrCeNi	NdZnEuLa	Mg	TiVY	CeNd	CuMgV	---	MgTiYCeEu	Dy	VZnLaSm	LaNdDyGdSmV	GdLa
200	---	---	---	---	---	---	DyEuVZn	---	---	---	---	---
150	NbNdBaLaVY	Cr	NbSr	EuGdDyErPb	VYLaMg	YZrNbPb	ErTi	GdLaDyErV	Ti	CuGdY	Nb	CuY
70	---	BiV	CuVZr	CuZr	ErGdCuDyZr	DyErSr	MoYbCrCu	Cu	---	DyNbBiCrSc	ErScCrCuYbZr	V
30	CoCu	NiNbCoCuSc	PbYCrLa	Mg	Pb	MoSc	ScZrNiNb	Bi	CuYb	Sn	Ni	Pb
15	BeScYb	Y	---	BiScYb	BiNiNb	NiYbBiCr	Bi	ScYbCrNi	---	CoNiZr	Co	CrSc
10	---	---	---	---	---	---	---	---	---	---	---	---
7	---	---	CoMoNi	CoNi	GaScYb	CoGa	---	Co	---	Yb	---	Co
5	---	---	---	---	---	---	---	---	---	---	---	---
3	---	Ag	GaYb	Cr	CoCr	Be	Be	---	---	---	Ga	Yb
1.5	---	---	---	---	---	---	---	---	---	---	---	Be

Table 3.-- Spectrographic (24) and radiometric (22)

analyses of thorium veins, Gateview quadrangle, Colorado--Continued

Locality---	G2105	G22	G26	G542A	G542B	G518	G56	G55	G538a	G538b	G319	G347
Ser. No.---	261709	253061	269437	---	---	D190395	D190394	D190393	253059	---	261706	277769
Latitude---	38°20'47"	38°20'9"	38°20'a"	38°19'22"	38°19'22"	38°19'52"	38°19'40"	38°19'31"	38°19'33"	38°19'33"	38°20'48"	38°21'2"
Long.------	107°10'37"	107°11'38"	107°12'11"	107°11'41"	107°11'41"	107°12'8"	107°12'5"	107°11'56"	107°11'7"	107°11'7"	107°9'32"	107°8'38"
Section----	SE 1/4 2	SE 1/4 10	SW 1/4 10	SE 1/4 15	SE 1/4 15	NW 1/4 15	NW 1/4 15	NW 1/4 15	NW 1/4 14	NW 1/4 14	S 1/2 1	SW 1/4 6
Twp--------	47N	47N	47N	47N	47N	47N	47N	47N	47N	47N	47N	47N
Range------	3W	3W	3W	3W	3W	3W	3W	3W	3W	3W	3W	2W
eU---------	.007	.021	.069	---	---	---	---	---	.06	---	.001	.083
U----------	<.001	.001	<.001	1/<.0002	1/<.0001	1/.0005	1/.00025	1/.0017	.001	---	<.001	---
$eThO_2$------	.04	.11	.39	---	---	---	---	---	.34	---	---	.415
ThO_2-------	---	.04	---	.021Th	.046Th	.029Th	.011Th	.018Th	.33	---	---	---
Major element--	Si	FeSi	Ca	Si	FeSi	FeSi	Ca	Ca	Si	Si	SiZn	KSi
						In Percent						
7	AlCaK	---	BaFe	Fe	---	Ca	FeSi	Fe	BaFeK	---	CaFeKPb	AlFe
5	---	---	---	---	---	---	---	Si	---	Fe	---	---
3	Fe	K	Si	---	---	---	K(3.2)	---	AlCa	K	AlMg	Ca
2	---	---	---	---	---	---	Al	---	---	Al	---	---
1.5	Mg	Ba	---	---	---	---	---	AlMg	---	BaCa	---	P
1	---	---	---	---	---	---	Mg	K(.84)	---	PTi	---	---
0.7	BaNa	---	AlCeNd	AlBaF(.76)	---	---	---	---	Na	---	Mn	Na
0.5	---	---	---	---	Ba	AlMn	MnNa	---	----	---	---	---
0.3	Ti	CaMn	MnSnLaMgTh	---	Mn	MgZn	---	MnNa	Ti	Th	Ba	MnPbTh
0.2	---	---	---	---	Zn	CeF(.2)	---	---	---	---	---	---
0.15	Mn	NaTiZnAlMg	PrZn	Na	Ti	Ba	Ti	Ba	CeTh	---	Ti	MgNdSrCeLaTiZn
0.1	---	---	---	---	FAlMgPb	LaNdPb	Ba	Zn	---	---	---	---

In Parts Per Million												
700	Sr	NdPbCeLaTh	GdSr	PbZnCaMn	CaCeLaNaNdTh	Na	---	CePbTi	NdSmLaMgSr	MgNa	CuSrTh	BaGdSmVY
500	---	---	---	Ti	---	---	---	---	---	MnSr	---	---
300	CeLaNd	SmSr	---	Mg	---	PrSmTi	CePbSrZn	LaNdSr	GdMnV	CeCuPbNbNd	CdNd	DyPrZr
200	---	---	---	Ce	---	---	Nd	---	---	VY	---	---
150	NbZr	CuGdV	DyScY	CuNd	---	NiSr	La	---	EuNbCuDyPbY	EuGdLa	---	EuNbCrCu
100	---	---	---	La	EuNiSrV	Cr	V	---	---	---	---	---
70	Y	NiNbCrDyY	PbTiCrNiV	CrSrV	CrY	CoCuV	CrNbNiY	VYCrNi	CrZr	CrDyZr	MoNbCoCrNiZr	NiScAgEr
50	---	---	---	Ni	Cu	Y	Cu	Nb	---	Er	---	---
30	CuPbScV	CoMoScZr	CuMo	NbY	NbSc	---	CoSc	CuSc	NiSc	NiSc	LaScVY	CoMo
20	---	---	---	ScZr	Co	NbZr	---	---	---	Ho	---	---
15	CrNi	---	CoNbZr	---	BiMoZr	Sc	Zr	Co	BiMoYb	---	AgBi	GaYb
10	---	---	---	---	---	AgBiMo	---	---	---	CoYb	---	---
7	CoMoYb	Yb	Yb	Mo	---	---	Ga	Yb	---	Ga	---	Be
5	---	---	---	BeCo	Be	---	---	---	---	---	---	---
3	Ga	Be	---	---	---	Be	Yb	Mo	Be	BeMo	Yb	---
1.5	---	---	---	---	---	---	---	---	---	---	---	---

1/ RaeU

Description of samples and analytical data for Table 4, Gateview quadrangle, Colorado

G2742 Hornblende melasyenite, forms darker border unit near west end of composite syenite body east of confluence of Goose Creek and Cebolla Creek.

G3200 Porphyritic hornblende syenite; dark phenocrysts of uralitic hornblende, biotite, and chlorite in a fine grained, light pinkish-gray groundmass; typical of main mass of small pluton 60 m wide.

4G3200 Porphyritic hornblende syenite from small pluton 60 m wide.

G3068 Quartz syenite, small intrusive body on east rim of Cebolla Canyon.

G3069 Medium-grained, porphyritic biotite syenite; biotite is poikilitically enclosed in light pink microcline crystals up to 1.5 cm in diameter. Small intrusive body on east rim of Cebolla Canyon.

G3730N Biotite-calcite-feldspar (minette) dike.

G334 Black, fine-grained, biotite-rich lamprophyre (minette) dike, north side of draw east of Cebolla Creek.

G2715 Biotite melasyenite, small intrusive body 900 m east of upper Goose Creek.

G528 Black, fine-grained augite syenite, containing sporadic phenocrysts of augite and poikilitic biotite plates in matrix of euhedral microcline laths; augite grains are zonally altered to uralitic hornblende, chlorite, and biotite. Occurs near margin of Goose Creek syenite body.

G5800 Fine-grained augite syenite.

Table 4.--Spectrographic (10) and radiometric (3) analyses of svenitic and related rocks, Gateview quadrangle, Colorado

[Leaders (---) indicate not determined.]

Loc. No.-	G2742	G3200	4G3200	G3068	G3069	G3730N	G334	G2715	G528	G5800
Sec. No.-	269449	263969	W173595	269450	263968	W173594	263965	269448	263966	W173596
Lat.-----	38°22'9"	38°21'32"	38°21'32"	38°20'42"	38°20'46"	38°20'45"	38°20'34"	38°19'26"	38°19'51"	38°19'46
Long.----	107°9'39	107°7'40"	107°7'40"	107°7'43"	107°7'42"	107°8'15"	107°8'37"	107°9'30"	107°11'11"	107°11'8
Sec.-----	NW 1/4 36	NW 1/4 5	NW 1/4 5	NW 1/4 8	NW 1/4 8	NE 1/4 7	NW 1/4 7	SW 1/4 13	NW 1/4 14	NW 1/4 14
Twp------	48N	47N	47N	47N	47N	47N	47N	47N	47N	47N
Range----	3W	2W	2W	2W	2W	2W	2W	3W	3W	3W
eU-------	.003	---	---	.003	---	---	---	.004	---	---
U--------	<.001	---	---	<.001	---	---	---	.001	---	---
Th-------	.002	---	---	.002	---	---	---	.001	---	---
Major element-	AlSi	AlSi	---	AlSi	AlSi	---	AlSi	Si	AlSi	---
				In Percent						
7	FeKMg	CaKFeMg	---	CaFeNa	FeK	---	CaK	AlFeKMg	CaFeKMg	---
3	Ca	---	---	---	CaMgNa	---	FeMgNa	CaNa	Na	---
1.5	Na	Na	---	Mg	---	---	---	---	---	---
0.7	---	BaPTi	---	Ba	---	---	---	Ti	Ti	---
0.3	Ti	---	Ba	Ti	BaTi	---	BaTi	Ba	Ba	---
0.2	---	---	---	---	---	Ba	---	---	---	Ba
0.15	BaSr	MnSr	---	Sr	MnSr	---	Sr	---	MnSr	Sr
0.1	---	---	Sr	---	---	Sr	---	---	---	---
				In parts per million						
700	CrMn	---	---	Mn	---	---	Mn	MnSr	---	---
500	---	---	Ce	---	---	---	---	---	---	Ce
300	NiV	Ce	---	Zr	---	CeCrZr	Zr	CrV	CeCrZr	Zr
200	---	---	NdZCrLa	---	---	---	---	---	---	Cr
150	NdZr	NdNiCrLaVZr	---	V	NdZr	---	NdVCrCu	NdZr	NiVLaNd	CuLaNi
100	---	---	V	---	---	LaV	---	---	---	V
70	CuLa	CoY	CuNi	La	CuLaPb	Ni	LaNi	La	CuPb	---
50	---	---	Y	---	---	Cu	---	---	---	PbY
30	PbScBCo	CuSc	Co	Y	CoScY	CoPbScY	ScYCoPb	NiScCoCuY	ScYBCo	Co
20	---	---	Sc	---	---	---	---	---	---	Sc
15	Y	GaPb	GaPb	PbScGaNb	GaNi	Ga	GaNb	GaPb	GaNb	Ga
10	---	---	---	---	---	Nb	---	---	---	---
7	Ga	Yb	Nb	BeCoCrCu	Yb	---	---	Mo	MoYb	Nb
5	---	---	BeYb	---	---	Be	---	---	---	ReMoYb
3	BeMo	Be	Mo	Yb	Be	MoYb	BeYb	BeYb	Be	---
1.5	Yb	---	---	---	Cr	---	---	---	---	---

Description of samples and analytical data for Tables 5A and 5B, Gateview quadrangle, Colorado

G2406 Hornblende-biotite syenite, Goose Creek syenite body, west side of draw; similar to G528.

G2415 Medium- to coarse-grained biotite syenite that forms a discontinuous marginal unit along west side of Goose Creek augite syenite body. Thin section is 2.4 percent holes, so does not total 100 percent.

G528 Fine-grained augite syenite; description in Table 4.

G5800 Fine-grained augite syenite.

G3200 Porphyritic hornblende syenite; description in Table 4.

G3730N Biotite-calcite-feldspar (minette) dike.

G334 Fine-grained, biotite-rich minette; description in Table 4.

G4501 Quartz diabase dike, bottom of Lake Fork Canyon.

Table 5A.—Chemical and normative analyses of 7 samples of syenitic rocks and chemical analysis of one diabase sample, Gateview quadrangle, Colorado

[Leaders (——) indicate not determined.]

Loc. No.	G2406	G2415	G528	G5800	G3200	G3730N	G334	G4501
Ser. No.	——	——	——	W173596	W173595	W173594	152855	W199472
Lat.	38°20'5"	38°20'3"	38°19'51"	38°19'46"	38°21'32"	38°20'45"	38°20'34"	38°20'9"
Long.	107°11'11"	107°10'58"	107°11'11"	107°11'8"	107°7'40"	107°8'15"	107°8'37"	107°13'49
Sec.	SW 1/4 11	SW 1/4 11	NW 1/4 14	NW 1/4 14	NW 1/4 5	NE 1/4 7	NW 1/4 7	NE 1/4 8
Twp	47N	47N	47N	47N	47N	47N	47N	47N
Range	3W	3W	3W	3W	2W	2W	2W	3W
				In Percent				
SiO_2	53.8	44.7	48.5	55.3	55.8	52.5	52.7	52.3
Al_2O_3	11.9	9.2	10.4	13.3	13.2	13.0	12.8	14.1
Fe_2O_3	3.0	2.1	4.6	3.6	2.6	1.0	1.6	1.4
FeO	4.7	6.3	3.3	4.4	4.8	5.7	5.4	10.3
MgO	9.2	13.3	10.9	6.3	5.4	5.2	5.3	5.1
CaO	6.6	9.8	7.2	5.6	5.3	6.6	6.2	7.9
Na_2O	2.2	1.0	1.3	2.5	3.4	2.5	2.2	2.7
K_2O	5.8	4.8	8.4	6.3	6.5	5.0	5.2	1.2
TiO_2	.82	1.5	.81	1.0	1.1	1.1	.90	2.1
P_2O_5	.66	1.7	1.3	.80	.89	.82	.74	0.26
MnO	.14	0.13	.14	.12	.15	.15	.16	0.17
H_2O+	.56	1.4	.71	.68	.52	1.3	1.3	0.70
H_2O-	——	——	——	.05	.12	.05	——	.28
CO_2	.16	1.8	.68	.08	.08	4.4	4.6	.08
Total——	99.54	97.73	98.24	100	100	99	99	99
Sp.G.——	——	——	——	——	——	——	2.78	——
				NORMS				
Q	——	——	——	——	——	7.4	9.3	——
or	34.3	28.4	49.6	37.1	38.3	29.7	30.9	——
ab	18.39	8.46	.85	21.1	26.8	21.2	18.7	——
an	5.42	6.26	——	6.4	1.6	——	——	——
C	——	——	.9	——	——	3.5	3.6	——
fa	3.68	5.66	.7	0.3	2.4	——	——	——
fo	7.35	19.6	19.1	1.3	5.7	——	——	——
en	12.5.	5.24	——	13.7	5.3	13.0	12.3	——
fs	——	——	——	3.2	2.0	8.1	7.4	——
wo	9.33	8.71	9.94	6.7	7.9	——	——	——
ac	4.35	3.04	6.58	5.2	3.8	1.5	2.3	——
ilm	1.54	2.82	1.52	1.9	2.1	2.1	1.7	——
ap	1.44	3.72	2.84	1.9	2.1	2.0	1.8	——
cc	0.35	4.09	1.55	0.2	0.2	10.0	9.6	——
mg	——	——	5.5	——	——	——	0.8	——
ne	——	——	——	——	1.1	——	——	——
Total——	98.85	96.0	98.2	99.0	99.3	98.5	98.4	——

Table 5B.--Modes of 4 syenitic rocks, Gateview quadrangle, Colorado

[Leaders (---) indicate not determined.]

Loc. No.	G2415	G528	G3200	G334
Lat.	38°20′3"	38°19′51"	38°21′32"	38°20′34"
Long.	107°10′58"	107°11′11"	107°7′40"	107°8′37"
Sec.	SW 1/4 11	NW 1/4 14	NW 1/4 5	NW 1/4 7
Twp	47N	47N	47N	47N
Range	3W	3W	2W	2W
Quartz	0.3	0.4	2.2	17.1
Microcline	14.4	53.5	69.8	35.9
Biotite	50.2	13.0	5.7	39.5
Muscovite	---	---	---	0.1
Hornblende	22.6	22.8	10.2	---
Pyroxene	---	3.6	---	---
Opaque	0.1	2.1	1.0	---
Apatite	2.8	---	0.2	0.1
Calcite	2.0	---	---	7.2
Sphene	0.3	---	---	---
Chlorite	4.6	4.5	10.6	---

Description of samples and analytical data for Table 6, Gateview quadrangle, Colorado

G1206a Hornblende-biotite-calcite lamprophyre from small dike.

G4130 Biotite-hornblende minette from small (7.5 x 35 m) dike. Thin section has 3.7 percent holes, so mode does not total 100 percent.

G417 Biotite-rich minette, small intrusive body 45 m wide.

G2406b Very coarse-grained hornblende-biotite syenite, Goose Creek syenite body.

G2406c Hornblende-quartz syenite; hornblende phenocrysts in very fine grained feldspar-quartz matrix; Goose Creek syenite body.

G2407 Augite-rich melasyenite; marginal facies of Goose Creek syenite body.

G528a Hornblende syenite from Goose Creek syenite body.

G424a Biotite-quartz syenite from small syenite body on east side of Lake Fork valley. Thin section has 1.8 percent holes, so mode does not total 100 percent.

G3218 Biotite-hornblende melasyenite in small plug about 45 m long.

G3200a Biotite syenite, part of small pluton 60 m wide.

G3068 Quartz syenite; small intrusive body on east rim of Cebolla Canyon.

G3069 Porphyritic biotite syenite; description in Table 4.

G2715 Biotite melasyenite, small intrusive body 900 m east of upper Goose Creek.

Table 6.--Modes of 13 samples of syenitic and related rocks, Gateview quadrangle, Colorado

[Tr., trace - Leaders (---) indicate not determined]

Loc. No.	G1206a	G4130	G417	G2406b	G2406c	G2407	G528a	G424a	G3218	G3200a	G3068	G3069	G2715
Lat.	38°20'14"	38°19'50"	38°19'53"	38°20'5"	38°20'5"	38°20'8"	38°19'51"	38°19'12"	38°22'24"	38°21'32"	38°20'42"	38°20'46"	38°19'26"
Long.	107°12'44"	107°13'30"	107°13'6"	107°11'11"	107°11'11"	107°11'9"	107°11'11"	107°13'12"	107°9'24"	107°7'40"	107°7'43"	107°7'42"	107°9'30"
Sec.	SW 1/4 9	NW 1/4 16	NW 1/4 16	SW 1/4 11	SW 1/4 11	SW 1/4 11	NW 1/4 14	SW 1/4 16	NE 1/4 36	NW 1/4 5	NW 1/4 8	NW 1/4 8	SW 1/413
Twp	47N	47N	47N	47N	47N	47N	47N	47N	48N	47N	47N	47N	47N
Range	3W	3W	3W	3W	3W	3W	3W	3W	3W	2W	2W	2W	3W
Quartz	---	1.5	6.8	---	18.	0.4	---	17.6	0.6	6.7	11.8	14.4	5.4
K-feldspar	43.5	42.2	33.5	---	---	---	---	45.9	33.9	---	---	---	---
Microcline	---	---	---	58.2	24	17.7	40	---	---	21.5	72.1	48.6	50.5
Plagioclase	---	---	---	---	---	Tr.	Tr.	---	---	---	---	---	---
Biotite	9.3	27.8	47.1	11.7	35	7.3	33	28.2	31.4	44.2	9.0	29.0	22.1
Muscovite	---	---	---	---	---	---	Tr.	---	---	---	Tr.	0.3	---
Hornblende	23.9	12.1	5.8	5.9	15	1.6	2	---	31.4	19.2	---	---	6.0
Pyroxene	---	---	---	11.8	---	61.4	22	---	---	---	---	---	---
Chlorite	---	6.7	0.6	8.6	6.6	3.6	2	4.4	0.2	---	---	---	9.9
Opaque	1.6	0.2	---	2.5	1.6	---	0.5	2.2	0.5	---	1.6	2.7	2.7
Apatite	---	0.2	0.3	---	---	1.0	Tr.	0.1	---	6.0	0.1	0.3	Tr.
Calcite	21.6	5.1	6.2	---	0.5	---	Tr.	---	1.6	---	Tr.	4.5	Tr.
Sphene	---	0.3	---	---	---	---	---	---	0.2	---	---	---	---
Epidote	---	---	Tr.	---	---	---	---	---	---	---	---	---	---

Description of samples and analytical data for Table 7, Powderhorn quadrangle, Colorado

P4-2992 K-feldspar-barite-limonite-thorite vein 1 m thick in feldspathized felsite and amphibolite.

P4-2993 Thorite-bearing barite-limonite vein 1 to 4 m thick in breccia zone along fault in feldspathized felsite and amphibolite. Same vein system as P4-2992.

P4-7358 Thorite-bearing quartz-K-feldspar veins in jointed zone 1 m wide in feldspathized granite.

P4-9546 Thorium vein about 30 cm thick in granite; Marian No. 1 claim.

P4-7411 Small thorium vein, about 15-30 cm thick, in granite.

P4LJ K-feldspar-quartz-barite-carbonate-goethite-thorite vein about 0.15-1.5 m thick; Little Johnnie claims.

P51A Feldspar-quartz-goethite-thorite vein about 2 m thick in sheared and feldspathized felsite.

P51B do.

P5-7872 Thorite-rich feldspathized zone 1-4 m thick in sheared granite, Whitney claim.

P1-3274 Thorite-bearing breccia vein, east side of Wildcat Gulch at 8,800-ft. altitude.

P1-3754 Thorite-bearing K-feldspar-quartz-hematite vein in granite.

P1-3754a Calcitic thorium vein near P1-3754.

P1-3701 Thorium-bearing carbonate-quartz-hematite vein.

P1-3702 Limonitic carbonate-quartz vein 30-60 cm thick.

P2700 Quartz-hematite-pyrite-goethite-carbonate vein in brecciated granite and red syenite zone in hornblende shist, Red Rock claim.

P4-7371 Limonitic thorium vein in fault zone in felsite.

Table 7.--Spectrographic and radiometric analyses of 19 samples of thorium veins, Powderhorn quadrangle, Colorado

[Leaders (---) indicate not determined]

Loc. No.----------	P4-2992	P4-2992	P4-2993	P4-2993	P4-7358	P4-9546	P4-7411	P4LJ	P4LJ	P51A
Ser. No.----------	261710	---	261711	---	285439	285444	285440	273254	273253	D190399
Lat.----------	38°19'6"	38°19'6"	38°19'00"	38°19'00"	38°19'54"	38°19'37"	38°19'33"	38°19'18"	38°19'18"	38°19'22"
Long.----------	107°6'56"	107°6'56"	107°7'00"	107°7'00"	107°5'23"	107°5'12"	107°5'6"	107°5'12"	107°5'12"	107°4'39"
Sec.----------	NE 1/4 20	NE 1/4 20	NE 1/4 20	NE 1/4 20	NW 1/4 15	SW 1/4 15	SW 1/4 15	SW 1/4 15	SW 1/4 15	SE 1/4 15
Twp----------	47N	47N	47N	47N	47N	47N	47N	47N	47N	47N
Range----------	2W	2W	2W	2W	2W	2W	2W	2W	2W	2W
eU----------	.012	---	.018	---	.008	.02	.009	---	---	---
U----------	<.001	.001	.002	---	<.001	.003	<.001	---	---	---
$eThO_2$----------	.07	.031Th	.09	---	.04	.10	.05	---	---	---
ThO_2----------	---	.031Th	---	.05(Th)	.02	.06	.02	---	---	.574(Th)
Major element-----	Ba	AlSi	Ba	Ba	Si	Si	Si	Si	Si	Si
In Percent										
7	Fe	K(9.27)	---	Si	Fe	FeCa	AlK	AlFFe	Fe	Al
5	---	---	---	---	---	---	---	---	---	K(5)
3	Si	CaFe	KPbSi	AlK(2.9)	AlF	---	Na	BaCa	AlBaK	FeNa
2	---	---	---	Fe	---	---	---	---	---	---
1.5	K	---	AlCaFe	---	---	P	Fe	Na	NaTh	Ba
1	---	---	---	---	---	---	---	---	---	---
0.7	Al	Na	Nd	Na	---	BaMn	---	Ti	Ti	Th
0.5	---	---	---	Th(.05)	---	---	---	---	---	---
0.3	PbTi	TiZr	CeSm	CaPb	BaNaTi	AlCe	---	Mg	CaMgY	CaTi
0.2	---	Ba	---	---	---	---	---	---	---	P
0.15	MnNaCaCeNdSr	Mn	MnNaLaMoSrTh	NdTiCeMn	CaMn	LaNd	CaTi	Mn	GdPbDyEu	---
0.1	---	Mg	---	Sr	---	---	---	---	---	Mg

Parts Per Million										
700	LaThZn	---	EuPr	LaZr	Mg	NaSrMgThTi	CeMg	NdPbSrEuNbThVY	LaLuMnNbCeErHoNdSmScV	PbYZr
500	---	Y	---	Zn	---	---	---	---	---	---
300	SmZrMgNb	GaNb	TiYZnDyGd	MoPrGaMgSmTh	NbThMoZnZr	VYZn	LaNdTh	CeDyGdSm	Tm	SrVNdMnNb
200	---	---	---	Y	---	---	---	---	---	CeGd
150	VYMoPr	PbSrV	ErMg	NbV	NdPbSrV	NbSmDyGd	MbSrVBaMn	CrFrLaZr	CrZr	---
100	---	---	---	Eu	---	---	---	---	---	Dy
70	CuDyEr	GdMoDyErSnYb	YbZr	Sn	CrGdLaNiY	PbScCuNi	YZr	---	Cu	LaEr
50	---	---	---	---	---	---	---	---	---	---
30	---	CrHoSc	CuNbV	---	BiCu	BiYbZr	CuPb	MoNiCoCuSc	ScSn	CrHoYb
20	---	Ni	---	Cu	---	---	---	---	---	CuNi
15	BiSc	Cu	BiGaSc	CrNiScYb	CoSc	CoMo	CrNiSc	GaSn	GaNi	CoGaSc
10	---	---	---	---	---	---	---	---	---	Mo
7	GaNiCoCrYb	---	CoNi	---	GaYb	Cr	CoGaMo	---	---	---
5	---	Co	---	---	---	---	---	---	---	---
3	---	Be	BeCr	Be	---	Be	Yb	---	---	Be
2	---	---	---	---	---	---	---	---	---	---
1.5	---	---	---	---	Be	---	Be	---	---	---
1	---	---	---	Ag	---	---	---	---	---	---

1/ Parts per million

Table 7.--Spectrographic and radiometric analyses of 19 samples of thorium veins, Powderhorn quadrangle--Continued

[Leaders (---) indicate not determined]

Loc. No.----------	P51B	P5-7872	P1-3274	P1-3754	P1-3754a	P1-3701	P1-3702	P2700	P4-7371
Ser. No.----------	D190400	285445	269440	277767	277768	D190401	D190402	285441	D190405
Lat.----------	38°19'22"	38°19'38"	38°21'47"	38°20'36'	38°20'36"	38°20'43"	38°20'46"	38°20'2"	38°19'25"
Long.----------	107°4'39"	107°3'49"	107°7'27"	107°7'29"	107°7'29"	107°7'8"	107°7'3"	107°4'49"	107°6'36"
Sec.----------	SE 1/4 15	NE 1/4 14	NW 1/4 5	NW 1/4 8	NW 1/4 8	NE 1/4 8	NE 1/4 8	NW 1/4 11	SW 1/4 16
Twp----------	47N	47N	47N	47N	47N	47N	47N	47N	47N
Range----------	2W	2W	2W	2W	2W	2W	2W	2W	2W
eU----------	---	.06	.002	.069	.005	1/4.98	1/4.98	.03	1/2.2
U----------	.00011	.002	<.001	---	---	---	---	.001	---
$eThO_2$----------	---	.33	<.04	.345	.025	---	---	.17	---
ThO_2----------	.0255(Th)	.27	---	---	---	1/116.5(Th)	1/325.8(Th)	.13	1/75.0(Th)
				In Percent					
Major element-----	Si	SiAl	Si	CaFeSi	CaSi	Ca	Ca	AlKSi	AlSi
7	CaAl	FeK	AlFeK	P	K	---	---	---	K(9.3)
5	K(3.73)	---	---	---	---	Fe	FeSi	---	---
3	Na	CaNa	Ti	---	AlFe	Si	---	Fe	Fe
2	Fe	---	---	---	---	K(1.62)	K(1.83)	---	---
1.5	---	---	V	---	Ti	AlMg	AlMgNaP	---	---
1	---	---	---	---	---	Ti	---	---	---
0.7	---	PTi	---	AlSr	---	Na	Ti	Ba	Na
0.5	Mg	---	---	---	---	P	---	---	---
0.3	PTi	ThY	---	Na	MgMnNa	---	---	Na	---
0.2	Ba	---	---	---	---	Mn	---	---	---
0.15	---	MgSrV	Na	ThTi	---	---	BaMn	Ti	Ti
0.1	Mn	---	---	---	---	---	Sr	---	---

Parts Per Million									
700	Sr	LaNbNdBaCe	CaMgMn	NdYGdMg	Ba	BaCe	Ce	CaTh	BaCa
500	---	---	---	---	Sr	---	---	---	---
300	Ce	MnCrDyGdZr	BaCrNb	DyLaBaCeMnSm	CrSr	LaNdZr	NdZr	Sr	MgNb
200	Nd	---	---	---	---	Cr	La	---	Zr
150	LaNbZr	ErPbSmYb	ScZr	ErEuPbV	NdVLaNb	NbV	CrCuNbVY	MgV	Mn
100	---	---	---	---	---	Y	---	---	CuGa
70	VY	CuHoNi	---	CrCuYbZr	NiY	CuNi	Ni	MnNbCrLaPbZr	MoSrV
50	---	---	---	---	---	---	Pb	---	---
30	Cr	GaMoSc	SnSr	NbNi	Sc	Sc	---	GaY	CrPb
20	Sc	---	---	---	---	CoPb	CoSc	---	Y
15	CuGaNiPb	---	MoNiBeCuPbY	MoSc	CoZr	---	Ga	---	Ni
10	---	---	---	---	---	Ga	---	---	---
7	---	Co	CoGa	BeCo	CuGa	Yb	Yb	CoCuNi	---
5	---	---	---	---	---	---	Be	---	---
3	Yb	Be	---	---	BeYb	BeMo	---	Mo	---
2	Be	---	---	---	---	---	---	---	Yb
1.5	---	---	---	---	---	---	---	Yb	Ag
1	---	---	---	---	---	---	---	---	---

Description of samples and analytical data for Tables 8A and 8B, Powderhorn quadrangle, Colorado

P7-4702 Light brown, foliated dolomitic carbonatite plug in felsite about 450 m northwest of Powderhorn P. O.; contains minor amounts of apatite and pyrite.

IH-1 Light brown, medium grained dolomitic carbonatite at north end of Little Iron Hill; contains minor amounts of apatite and pyrite.

IH-91 Light brown, medium grained dolomitic carbonatite on west side of Iron Hill on north side of a major draw; contains several percent apatite and trace amounts of pyrite.

IH-100 Light brown, medium-grained dolomitic carbonatite in southwest part of Iron Hill carbonatite body; contains minor amounts of apatite and pyrite.

IH-107 Light brown, strongly foliated, dolomitic carbonatite in gully on south side of Iron Hill; contains minor amounts of phlogopite, apatite, and pyrite.

IH-110 Light brown, foliated, dolomitic carbonatite on south side of Iron Hill; contains minor amounts of apatite and pyrite.

P8702 Carbonatite dike 2 m thick; small shaft 430 m east of main Iron Hill carbonatite body; layered structure with sideritic layers alternating with dolomitic; contains abundant pyrite, chlorite, barite, and phlogopite.

P9-9023 Sideritic and dolomitic carbonatite from small shaft in dike 0.5 m thick on north side of North Beaver Creek; contains pyrite and barite.

P8-9044 Thin veins of carbonate mineral and sodic amphiboles in fenitized granite, Huntsman Gulch.

PC-15 Carbonatite near top of Little Iron Hill.

PC-104 Carbonatite, south side of Iron Hill.

PC-111 Main carbonatite body, north side of Road Beaver Creek.

NJX-1 Magnetite-perovskite-apatite rock, New Jersey Zinc Co. adit.

Table 8A.—Partial chemical analyses of 8 samples of carbonatite dikes and carbonate veins, Powderhorn quadrangle, Colorado

[Tr., trace, Leaders (---) indicate not determined]

Loc. No.	P7-4702	IH-1	IH-91	IH-100	IH-107	IH-110	P8702	P9-9023
Ser. No.	298833	298825	298826	298827	298828	298829	298830	B368
Lat.	38°17'12"	38°16'7"	38°15'18"	38°14'56"	38°14'52"	38°14'51"	38°15'5"	38°15'10"
Long.	107°7'40"	107°4'42"	107°4'8"	107°3'47"	107°3'27"	107°3'21"	107°2'31"	107°1'33"
Sec.	NW 1/4 32	SE1/4 3	W 1/2 11	SE 1/4 11	NE 1/4 14	NE 1/4 14	SE 1/4 12	SW 1/4 12
Twp	47N	46N	46N	46N	46N	46N	46N	46N
Range	2W	2W	2W	2W	2W	2W	2W	1 1/2W
CaO	28.6	30.2	30.6	29.6	27.8	30.0	20.3	10.4
MgO	16.0	18.4	17.3	18.1	18.4	18.2	9.01	4.68
Fe_2O_3[1/]	4.74	2.89	2.30	3.09	4.60	2.69	21.12	36.86
P_2O_5	0.97	1.03	4.34	0.36	0.13	0.94	0.74	0.48
CO_2	42.1	43.7	41.3	46.3	43.8	45.2	35.5	30.6
S	.03	<0.01	.01	<0.01	.13	0.71	.37	.94
F	.017	.016	.033	.005	.013	.012	.007	.024
$CaCO_3$	49.1	51.8	45.5	52.0	49.5	51.4	34.5	17.5
$MgCO_3$	33.5	38.5	36.2	37.9	38.5	38.1	18.8	9.8
$FeCO_3$	7.9	2.1	6.3	9.5	5.0	7.1	27.6	46.9
$Ca_3(PO_4)_2F$	2.1	2.3	9.5	0.8	0.3	2.1	1.6	1.0
FeS_2	0.1	Tr.	Tr.	Tr.	0.2	1.3	---	---
$BaSO_4$	---	---	---	---	---	---	5.0	5.1
Total[2/]	92.7	94.7	97.5	100.2	93.5	100.0	87.5	80.3

[1/] Total Fe as Fe_2O_3

[2/] Total of previous 6 items

Table 8B.--Spectrographic (14) and radiometric (6) analyses of carbonatite dikes and carbonate veins, and one spectrographic analysis of magnetite-perovskite rock, Powderhorn quadrangle, Colorado

[Leaders (---) indicate not determined]

Loc. No.-	P7-4702	IH-1	IH-91	IH-100	IH-107	IH-110	P8702	P8702	P9-9023	P9-9023	P9-9044	PC-15	PC-104	PC-111	NJX-1
Ser. No.-	298833	---	---	---	---	---	---	281237	285442	---	285443	281234	281235	281236	281241
Lat.-----	38°17'12"	38°16'7"	38°15'18"	38°19'56"	38°14'52"	38°14'51"	38°15'5"	38°15'5"	38°15'10"	38°15'10"	38°16'34"	38°15'55"	38°14'52"	38°14'51"	38°16'31"
Long.----	107°7'40"	107°4'42"	107°4'8"	107°3'47"	107°3'27"	107°3'21"	107°2'31"	107°2'31"	107°1'33"	107°1'33"	107°3'55"	107°4'19"	107°6'7"	107°5'46"	107°5'27"
Sec.-----	NW 1/4 32	SE 1/4 3	W 1/2 11	SE 1/4 11	NE 1/4 14	NE 1/4 14	SE 1/4 12	SE 1/4 12	SW 1/4 12	SW 1/4 12	NW 1/4 2	SW 1/4 2	NE 1/4 14	NW 1/4 13	NW 1/4 3
Twp------	47N	46N	46N	46N	46N	46N	46N	46N	46N	46N	46N	46N	46N	46N	46N
Range----	2W	2W	2W	2W	2W	2W	2W	2W	1 1/2W	2W	2W	2W	2W	2W	2W
eU-------	---	---	---	---	---	---	---	.009	.087	---	.03	<.001	.003	.002	.008
U--------	---	---	---	---	---	---	---	<.001	.002	---	.005	---	---	---	.003
$eThO_2$----	---	---	---	---	---	---	---	---	.48	---	.14	---	---	---	.025
ThO_2-----	---	---	---	---	---	---	---	.03	.32	---	.12	---	---	---	---
Major element-	---	---	---	---	---	---	---	Fe	Fe	---	CaFe	BaCa	Ca	Ca	CaFeTi
								In percent							
7	---	---	---	---	---	---	---	Ca	BaCaKSi	---	Si	---	KMgSi	Mg	---
5	---	---	---	---	---	---	Ba(4.9)	---	---	Ba(4.2)	---	---	---	---	---
3	---	---	---	---	---	---	---	Mg	Al	---	P	Mg	Fe	---	---
1.5	Si	---	---	---	---	---	---	BaMn	---	Si	MgMnNaAlK	Fe	AlP	FeK	AlMgP
0.7	Mn	---	---	---	---	---	CeKMn	---	MnNdTi	NdZnKMn	Ti	Sr	NaSrTi	BaSi	Si
0.5	---	---	---	---	MnBa(.0540)	---	---	---	---	Ce	---	---	---	---	---
0.3	---	Mn	Mn	Mn	Si	---	NdSiTi	---	CeNaPrTh	---	BaNdSr	MnNaNb	Mn	AlNaPMnSr	CeNdSr
0.2	---	---	---	---	---	Mn	La	---	---	---	---	---	---	---	---
0.15	---	Si	Si	---	---	---	---	AlCeNdSiSr	MgLaSrSmZn	AlSm	CeTh	Si	Ce	---	LaMn
0.1	Na	---	NaNb	---	Na	Ba(.088)	Zn	---	---	---	---	---	---	---	---

	In parts per million														
700	Ba(830)	Na	AlBa(720)	Na	Al	NaSi	AlNaPrSm	LaNaTi	Pb	LaNa	LaSmY	CeTi	BaNd	CeTi	NbV
500	---	---	---	---	---	Nb	---	---	---	---	---	---	---	---	---
300	Al	AlBa(370)	Nd	SiBa(370)	---	Al	---	Zn	GdV	---	VZnCrGd	Al	CrLa	LaNbNd	Ba
200	---	---	Sr	---	---	---	MoSr	---	---	Sr	---	---	---	---	---
150	NbNd	LaNd	La	AlSr	---	Sr	---	---	MoNb	EuMo	NbNiCuDyPbZr	LaNd	---	Cr	Y
100	La	Sr	Ti	---	Ti	---	---	---	---	---	---	---	---	---	---
70	Sr	Nb	---	---	NbSr	Ti	---	---	CrYZr	---	Co	---	CuNbNi	---	NiZrCoCu
50	---	---	---	Nb	La	La	CrNb	---	---	Nb	---	---	---	---	---
30	Ti	---	Zr	---	Cr	---	---	NbPbCrMo	GaNi	Cu	GaMoScYb	Cr	VY	CuNi	---
20	Sc	Ti	Y	---	---	---	Ni	---	---	CrV	---	---	---	---	---
15	VY	CrV	V	Cr	---	Cr	---	Ni	CoCu	Ni	---	CuS	CoGa	VYZrPbSc	GaSc
10	---	---	Cr	V	CuV	CuV	Cu	---	---	---	--	---	---	---	---
7	CrCu	CuNiSc	CuSc	Cu	Ni	Sc	---	Cu	---	---	Be	Ni	---	---	CrYb
5	---	---	---	Ni	---	Ni	---	---	---	---	---	---	---	---	---
3	---	---	---	---	---	---	---	Co	Yb	---	---	Co	---	CoMo	---
2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
1.5	Yb	---	Yb	---	---	---	---	---	---	Be	---	---	---	Be	---

1/ RaeU (ppm)

Description of samples and analytical data for Tables 9A and 9B, Powderhorn quadrangle, Colorado

P7301 Dark gray to black, fine-grained hornblende syenite near Spencer; phenocrysts of uralitic hornblende and biotite in matrix of microcline laths.

P7406 Coarse-grained biotite syenite, Lot mine; large euhedral to subhedral phenocrysts of microcline poikilitically enclose biotite and pale bluish-green hornblende.

IH-71 Gray, gneissic, medium-grained fenite composed chiefly of perthitic microcline and elongate, aligned aggregates of aegirine-augite grains; mode is average of 5 thin sections.

P3266 Dark pinkish-gray, fine-grained melasyenite near Spencer; small phenocrysts of uralitic hornblende in fine-grained matrix of microcline laths.

P3267 do.

P7432 Foliated black shonkinite (melasyenite) near Spencer.

P7430 do.

P7429 Medium-grained porphyritic shonkinite (melasyenite) near Spencer; phenocrysts of biotite.

P3709 Hornblende-biotite lamprophyre; phenocrysts of hornblende and biotite in fine-grained gray matrix; occupies 7.5 x 60 m area in northwest corner of quadrangle.

P7406 Coarse-grained biotite syenite, Lot mine; large euhedral to subhedral phenocrysts of microcline poikilitically enclose biotite and pale bluish-green hornblende.

P7406a Shonkinite at Lot mine, near contact with felsite.

P7406d Shonkinite at Lot mine, 15 m south of Lucky Day prospect pit.

PR-9 Mafic biotite syenite near Lot mine; coarse microcline grains 1-3 cm long poikilitically enclose biotite.

P8021 Chloritic syenite, Willow Creek syenite body.

Table 9A.—Chemical, normative, and spectrographic analyses of 3 samples of syenitic and related rocks, Powderhorn quadrangle, Colorado

[Leaders indicate not determined]

Chemical Analyses			
Loc. No.-	P7301	P7406	IH-71
Ser. No.-	156273	156274	---
Lat.------	38°21'34"	38°19'14"	38°15'33"
Long.-----	107°6'53"	107°5'38"	107°1'12"
Sec.------	NE 1/4 5	SW 1/4 15	NE 1/4 12
Twp-------	47N	47N	46N
Range-----	2W	2W	1 1/2W
SiO_2	52.3	55.2	62.55
Al_2O_3	12.3	10.0	15.07
Fe_2O_3	2.4	2.5	2.42
FeO	5.6	4.1	2.03
MgO	8.0	10.0	1.33
CaO	7.2	6.7	4.09
Na_2O	2.3	2.5	5.80
K_2O	5.6	5.0	5.68
TiO_2	.86	.60	.15
P_2O_5	1.0	.86	.14
MnO	.14	.14	.29
H_2O+	1.1	1.2	.13
H_2O-	---	---	.05
CO_2	.66	1.4	.03
Sum-------	99.46	100	99.80
Sp.G.-----	2.82	2.78	---
NORMS			
Q	---	0.1	0.75
or	33.3	29.5	33.6
ab	19.6	21.1	41.1
an	6.7	1.3	2.36
C	---	---	---
fa	3.3	---	ac7.00
fo	8.4	---	hy3.49
en	8.1	24.9	3.33
fs	2.9	4.7	---
wo	7.7	7.3	7.05
mt	3.5	3.6	---
ilm	1.6	1.1	0.28
ap	2.4	2.0	0.31
cc	1.5	3.2	0.07
Total-----	99.0	98.8	99.34

Spectrographic Analyses			
Loc. No.—	P7301	P7406	IH-71
Ser. No.—	156273	156274	---
Lat.------	38°21'34"	38°19'14"	38°15'33"
Long.-----	107°6'53"	107°5'38"	107°1'12"
Sec.------	NE 1/4 5	SW 1/4 15	NE 1/4 12
Twp-------	47N	47N	46N
Range-----	2W	2W	1 1/2W
In percent			
0.3	BaSr	Ba	---
0.2	---	---	Sr
0.15	---	---	Ba
Parts per million			
700	Cr	CrSr	---
300	YZr	Ni	---
150	CeCuNi	CeYZr	V
100	---	---	Zr
70	ScLaNd	CuLaNd	---
30	CoPbY	ScYCoPb	Ga
15	B	B	---
10	---	---	Cu
7	GaNb	BeGaNb	---
5	---	-----	ScYCoCr
3	YbBe	Yb	---
2	---	---	Ni
1.5	---	---	Be
1	---	---	Yb

Table 9B.--Modes of 13 samples of syenitic and related rocks,

Powderhorn quadrangle, Colorado

[Tr., trace - Leaders (---) indicate not determined]

Loc. No.	P3266	P3267	P7432	P7430	P7301	P7429	P3709	P7406	P7406a	P7406d	PR-9	P8021	IN-71
Lat.	38°21'30"	38°21'33"	38°21'31"	38°21'39"	38°21'34"	38°21'31"	38°20'57"	38°19'14"	38°19'14"	38°19'14"	38°19'18"	38°18'44"	38°15'33"
Long.	107°7'12"	107°7'1"	107°7'7"	107°6'57"	107°6'53"	107°6'44"	107°6'37"	107°5'38"	107°5'38"	107°5'38"	107°5'36"	107°2'38"	107°1'12"
Sec.	NE 1/4 5	NE 1/4 5	NE 1/4 5	NE 1/4 5	NE 1/4 5	NW 1/4 4	NW 1/4 9	SW 1/4 15	SW 1/4 15	SW 1/4 15	SW 1/4 15	SE 1/4 24	NE 1/4 12
Twp	47N	47N	47N	47N	47N	47N	47N	47N	47N	47N	47N	47N	46N
Range	2W	2W	2W	2W	2W	2W	2W	2W	2W	2W	2W	2W	1 1/2W
Quartz	---	---	---	0.3	Tr.	---	---	7	10	8.8	6.9	1	Tr.
Microcline	60.3	59.4	70.0	50.0	63.0	66.7	---	44	40	41.8	46.3	72	[1]/57-93
K-feldspar	---	---	---	---	---	---	76.7	---	---	---	---	---	---
Plagioclase	---	---	---	---	---	---	---	1	4	2.9	0.7	Tr.	Tr.
Biotite	9.1	8.4	[1]/	6.8	5	7.9	---	35	34	34.6	19.4	0.6	---
Muscovite	---	---	---	---	---	---	---	0.4	---	0.2	0.7	---	---
Hornblende	18.1	17.2	17.2	34.0	21	12.5	4.4	6	5	5.2	11.8	---	---
Pyroxene	1.4	0.7	3 3	---	2.0	3.8	12.5	---	---	---	---	---	[4]/6-42
Opaque	1.4	1.3	1.6	0.6	1	1.0	1.4	Tr.	Tr.	0.1	0.7	0.2	Tr.
Chlorite	9.2	12.4	7.3	8.3	8	7.6	---	---	0.6	0.3	12.0	[2]/25	---
Apatite	0.4	0.6	0.6	---	Tr.	0.1	0.7	---	---	---	1.5	1	Tr.
Calcite	---	---	---	---	---	---	3.5	6	6	6	---	---	Tr.
Sphene	---	---	---	---	---	---	0.6	---	---	---	---	---	Tr.
Epidote	---	---	Tr.	Tr.	Tr.	---	[3]/	---	---	0.1	---	---	---

1/ Included with chlorite.

2/ Includes some fine amphibole.

3/ 0.1 percent fluorite present.

4/ Range of 5 thin sections.

Description of samples and analytical data for Tables 10A and 10B Rudolph Hill quadrangle, Colorado

J349 Thorium-bearing limonitic vein or dike 1-2 m thick in pyroxenite.

J352 Thorium-bearing vein or pod in nepheline syenite dike; contains limonite, carbonate, fluorite.

J120, 120A, 120B Thorium-bearing limonitic feldspar-carbonate vein in felsite; Elk No. 2 claim area.

J337 Limonitic veinlets in radioactive fine-to medium-grained granite.

J326 Narrow thorium-bearing veinlets in limonitic and hematitic altered zone in fine-grained quartz diorite.

Table 10A.--Spectrographic (7) and radiometric (3) analyses of thorium veins, Rudolph Hill quadrangle, Colorado

[Leaders (---) indicate not determined]

Loc. No.	J120	J120A	J120B	J349	J352	J337	J326
Ser.No.	269441	273251	273252	W175004	W175003	285447	285446
Lat.	38°14'58"	38°14'58"	38°14'58"	38°14'54"	38°14'37"	38°13'26"	38°12'54"
Long.	107°5'26"	107°5'26"	107°5'26"	107°0'38"	107°0'29"	107°1'57"	107°2'15"
Sec.	SW 1/4 10	SW 1/4 10	SW 1/4 10	NW 1/4 18	NW 1/4 18	SW 1/4 24	NE 1/4 25
Twp	46N	46N	46N	46N	46N	46N	46N
Range	2W	2W	2W	1W	1W	1 1/2W	2W
eU	.013	---	---	---	---	.02	.04
U	.001	---	---	---	---	.001	.005
$eThO_2$	.07	---	---	---	---	---	---
ThO_2	---	---	---	---	---	.08	.17
Major Element-	AlFSi	FeSi	Si	---	---	Si	CaFe
7	---	K	FeK	---	---	AlF	Si
3	Fe	BaAl	Al	---	---	CaFeMgNa	BaP
2	---	---	---	Ba	Ba	---	---
1.5	Ba	Ca	---	---	---	---	---
0.7	Ca	Mn	CaTi	---	---	BaCeLaMnP	---
0.3	Ti	CeNdMgThTi	MgNd	---	---	NdSr	AlMnNaSrTh
0.2	---	---	---	Sr	---	---	---
0.15	MgNa	EuNa	MnNaBaCeSm	---	---	---	Ti
0.1	---	PrSmS	---	---	Sr	---	---
700	NdSr	---	EuPrTh	Ce	CeNb	PrThTi	NdCeMgZrY
500	---	---	---	NdZr	Nd	---	---
300	CeLaSmTh	GdV	GdSrV	V	CrV	GdSmY	GdLaSmV
200	---	---	---	CuLa	LaPbY	---	---
150	MnV	CrDyErLaNbPbScY	DyErLaNbYCrCu	NbY	---	NbPbV	Dy
70	CrNbPbSnZr	CoCuMoNiZr	PbNiScZr	---	CuNi	DyZr	CrNbPbSc
50	---	---	---	---	Sc	---	---
30	GaNiCuScY	Sn	CoSn	CoCrSc	MoZr	CuNiSc	Ni
20	---	---	---	MoPb	Yb	---	---
15	Mo	Ga	GaMo	GaNiYb	Co	GaMoCoCr	CoCuYb
7	Co	BeYb	Yb	---	Ga	Yb	---
3	Be	---	Be	---	Be	Be	Be
1.5	Yb	---	---	---	---	---	---
1	---	---	---	Be	---	---	---

Table 10B.--Chemical analyses of two samples of thorium veins, Rudolph Hill quadrangle, Colorado

Loc. No.----------	J349	J352
Ser. No.----------	W175004	W175003
Lat.----------	38°14'54"	38°14'37"
Long.----------	107°0'38"	107°0'29"
Sec.----------	NW 1/4 18	NW 1/4 18
Twp----------	46N	46N
Range----------	1W	1W
SiO_2	47.6	62.0
Al_2O_3	8.5	6.5
Fe_2O_3	15.9	13.5
FeO	.12	.0
MgO	.22	.28
CaO	6.7	2.1
Na_2O	.06	.03
K_2O	6.3	4.8
TiO_2	2.5	3.1
P_2O_5	.89	.86
MnO	.14	.12
H_2O+	2.7	2.9
H_2O-	.50	1.2
CO_2	3.8	.06
Total----------	96	97

Description of samples and analytical data for Table 11, Rudolph Hill quadrangle, Colorado

J2500	Fenitized fine-grained granite; south end of Powderhorn Valley.
J311G1	Thorium-mineralized, fenitized, coarse-grained Powderhorn Granite.
J311G2	do.
J311G3	do.
J3121	Red- and yellow-stained, fenitized, fine-grained granite.
J3122	do.
J3123	Fine-grained granite.
J3124	do.
	Spectrographic analysis of Carbonate-rich fenite.
J257S	Carbonate-rich fenite associated with carbonatite dike 10 m thick.

References

Olson, J. C., and Hedlund, D. C., 1973, Geologic map and sections of the Gateview quadrangle, Gunnison County, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ-1071, scale 1:24,000.

Hedlund, D. C. and Olson, J. C., 1975, Geologic map of the Powderhorn quadrangle, Gunnison County, Colorado: U.S. Geological Survey Geologic Quadrangle Map GQ 1178, scale 1:24,000.

Hedlund, D. C. and Olson, J. C., 1973, Geologic map and sections of the Carpenter Ridge quadrangle, Gunnison County, Colorado: U.S. Geological Survey Quadrangle Map GQ-1070, scale 1:24,000.

Olson, J. C., 1974, Geologic map of the Rudolph Hill quadrangle, Gunnison, Hinsdale, and Saguache Counties, Colorado: U.S. Geologic Survey Quadrangle Map GQ-1177, scale 1:24,000.

Olson, J. C., Marvin, R. F., Parker, R. L., and Mehnert, H. H., 1977, Age and tectonic setting of Lower Paleozoic alkalic and mafic rocks, carbonatites, and thorium veins in south-central Colorado: U.S. Geological Survey, Journal of Research, v. 5, no. 6, p. 673-687.