UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Analytical Data from Host Rocks and Ores, Schwartzwalder Uranium Deposit, Front Range, Colorado

By

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Open-File Report 83-364
1983

Introduction

The Schwartzwalder uranium deposit is located in the foothills of the Front Range northwest of Golden, Colo., and is one of more than 20 uranium mines and prospects in the foothills (fig. 1). It is currently the largest known vein-type uranium deposit in the United States. This report provides the analytical data from host rocks and ores that have been (Wallace, 1983) and will be used in reports discussing the genesis of the deposit. Previous analytical data were presented by Young (1979).

The deposit is in a complex fracture system that cuts a mixed metasedimentary and metavolcanic terrane of Proterozoic age (Sheridan and others, 1967). The lithologies include regionally extensive mica schist and hornblende gneiss units with an intervening transition zone of garnet-biotite gneiss and quartzite (fig. 2). The protoliths for the units were probably mafic volcanic rocks with associated carbonate muds (hornblende gneiss), chert (quartzite), silicate iron formation (garnet-biotite gneiss), and iron-rich shale (mica schist) (Wallace, 1983). All rocks were metamorphosed to amphibolite grade during Proterozoic time.

The major controlling fault system for fractures at the deposit is the Rogers fault, a northwest-trending system that, at the deposit, has two parallel segments, about 1,000 m apart, that dip steeply to the east. The Illinois fault forms a north-trending, cymoid-type fracture between the two segments. Tension or horsetail fractures (the 17-1, Titan, RB, and other fractures of fig. 3) developed in the hanging wall of the Illinois fault in response to movement along the latter structure.

Ascending hydrothermal fluids invaded the entire fracture system 70.6 m.y. ago (K. R. Ludwig, written commun., 1982). The fluids altered the wall rocks and produced successive assemblages of carbonate-sericite and hematite-adularia. Major reductions in the confining pressure during repeated fault movement initiated the deposition of pitchblende, carbonates, adularia, and various sulfides during several stages of mineralization. Clastic dikes composed of remobilized fault gouge were injected into the fractures at several intervals.

Numerous samples were collected from unaltered and altered wall rocks, from clastic dikes, and from veins in the three major fracture systems; all samples were grab samples from the faces, ribs, and backs of the stopes. The samples were analyzed for major and trace elements by emission spectroscopy, X-ray fluorescence, neutron activation, and optical spectroscopy. The results are listed in tables 1, 3, 4, 6-9, and 11-13. Tables 2 and 5 provide data from microprobe analyses of the major minerals in the hornblende and garnet-biotite gneisses. Table 10 is a summary of the average compositions of altered and unaltered hornblende gneiss and garnet-biotite gneiss, the two major host rocks for the ores. Table 14 summarizes the trace-element data for the three vein systems; correlation coefficients for selected elements are presented in table 15.

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References

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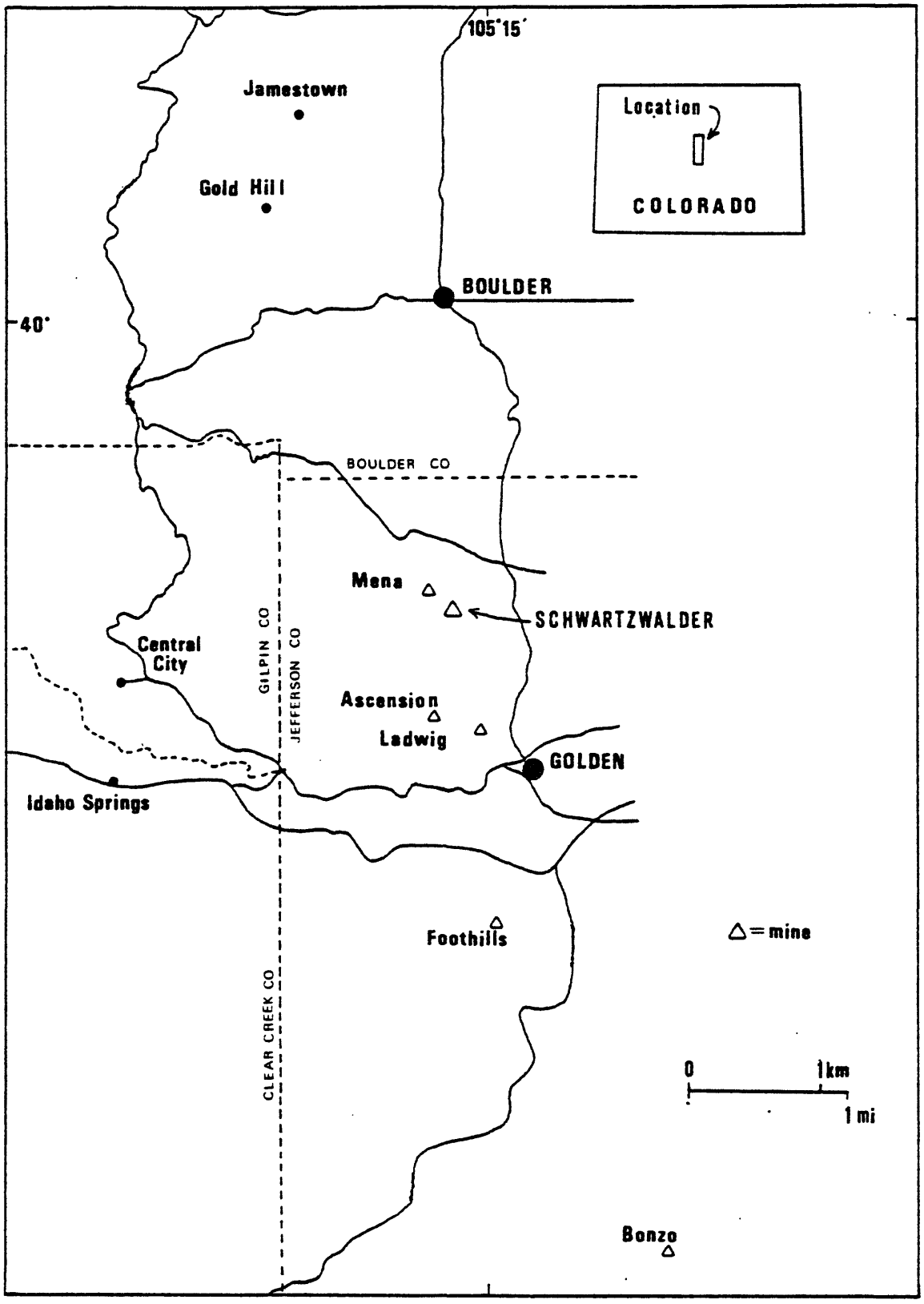

Figure 1. Location of the Schwartzwalder uranium deposit and other mines and prospects in the east-central Front Range.

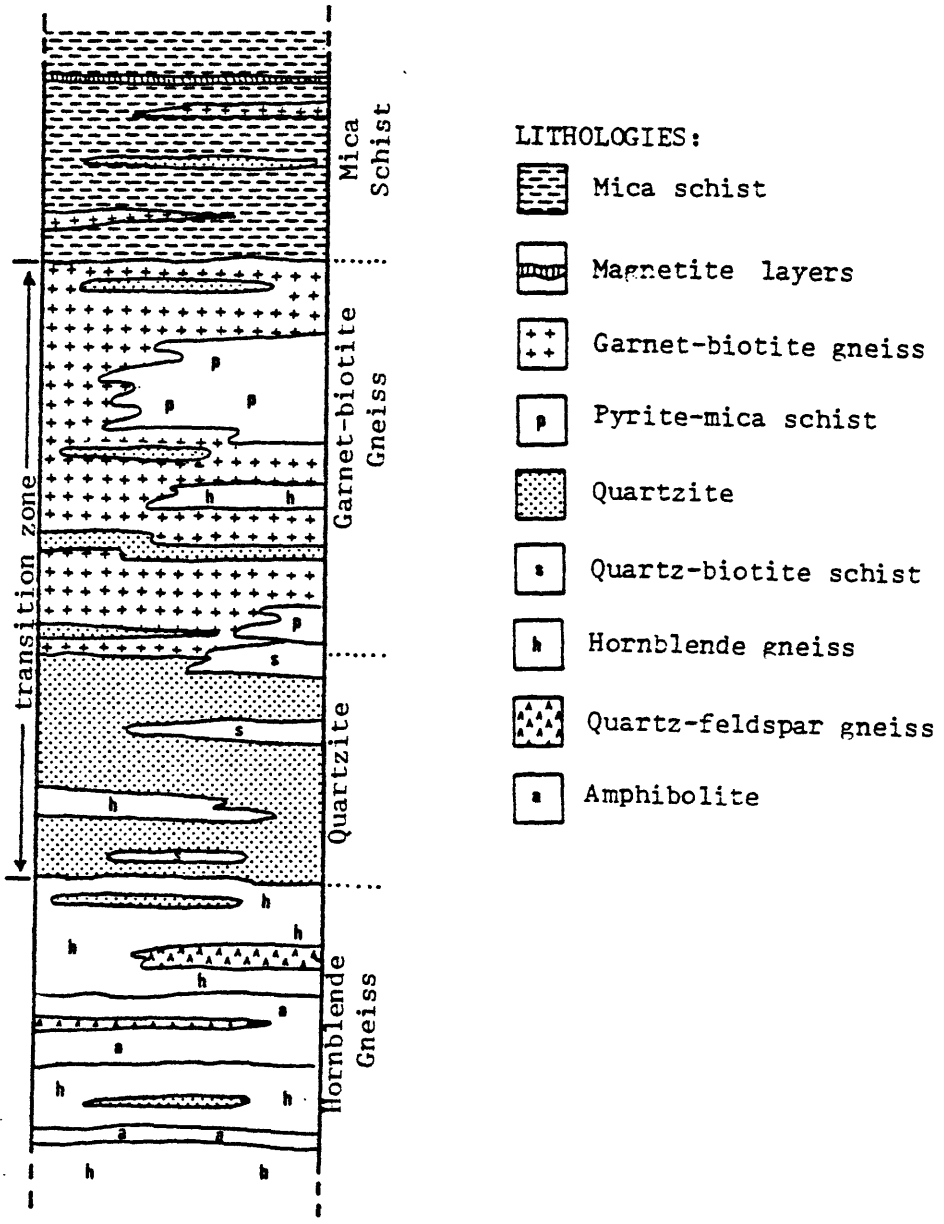

Figure 2. Schematic stratigraphic column for the major rock units at the Schwartzwalder deposit.

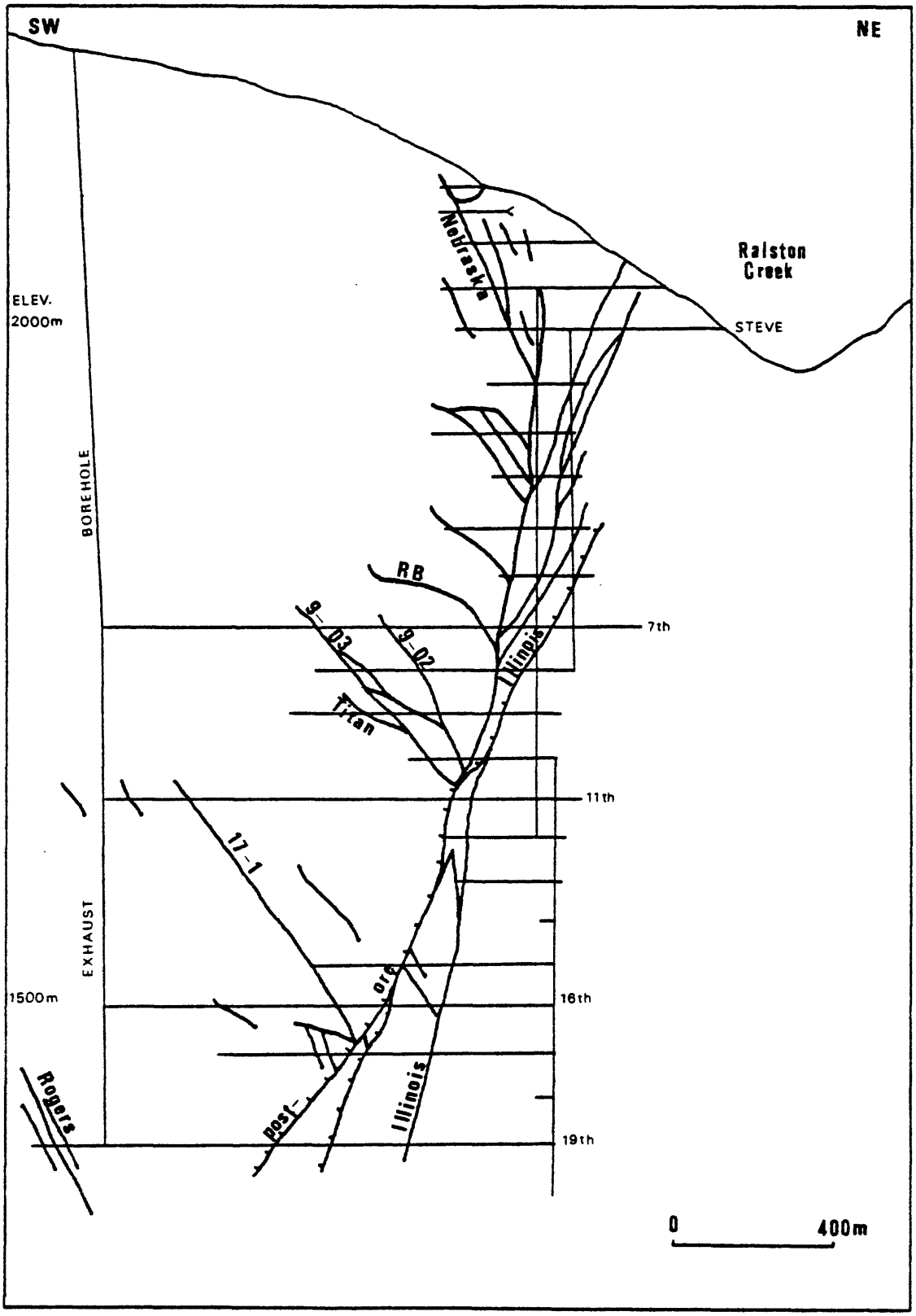

Figure 3. Cross-section of the Schwartzwalder uranium mine, showing the mine workings (thin vertical and horizontal lines) and veins (heavier oblique lines). Post-ore Illinois vein hatchured for clarity.

Table 1. Chemical analyses of hornblende gneiss unit.

	79S28	79S31	80S8	80S15	80S28	80S31	80S35	80S40	80S67	80S81	80S90	80S124
SiO_2 (%)	40.70	45.70	33.10	42.00	50.00	45.70	44.50	46.20	48.10	30.30	44.00	49.60
Al_2O_3	4.80	13.00	12.60	14.30	15.00	15.80	16.10	15.30	14.20	16.80	15.80	13.70
Fe (total)	7.36	13.00	9.32	9.92	9.24	14.40	12.90	9.93	9.97	13.20	9.98	10.60
FeO	5.95	10.70	7.69	7.93	7.46	11.50	10.40	7.94	—	—	8.38	7.54
Fe_2O_3	1.57	2.55	1.63	2.20	1.98	3.22	2.78	2.21	—	—	1.78	3.40
MgO	2.30	5.48	5.89	3.80	3.60	5.56	4.60	4.50	4.70	4.20	3.70	3.70
CaO	26.90	9.31	21.50	9.42	10.20	8.15	10.30	13.00	11.30	11.40	5.47	8.53
Na_2O	0.20	<0.20	0.30	2.40	4.40	2.80	3.10	4.10	3.30	<0.20	0.30	3.10
K_2O	0.39	4.39	3.03	3.83	0.77	1.51	2.01	0.62	1.80	5.93	4.99	1.86
TiO_2	0.51	1.27	0.79	1.75	0.87	1.93	1.87	0.95	1.25	1.64	1.49	1.93
P_2O_5	<0.10	0.40	0.20	0.20	0.20	0.30	0.20	0.20	0.20	0.40	0.40	0.62
MnO	0.27	0.08	0.13	0.18	0.16	0.20	0.13	0.11	0.70	0.16	0.10	0.13
LOI	16.66	6.78	13.10	11.32	4.45	1.85	3.74	4.41	4.38	14.68	14.10	5.34
C (total)	4.38	1.71	3.07	3.05	1.04	0.34	0.84	1.04	1.2	3.49	—	—
C (org.)	0.05	0.39	0.28	0.53	0.15	0.13	0.01	0.01	0.40	0.21	--	—
C (carb.)	4.33	1.32	2.79	2.52	0.89	0.21	0.83	1.02	0.80	3.28	--	—
S	0.01	0.05	0.06	0.02	0.03	0.16	0.02	0.04	0.02	0.07	—	—
Hg (ppm)	0.01	<0.01	<0.01	0.01	<0.01	<0.01	0.01	0.01	<0.01	0.01	0.03	0.04
Ag	<5	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5
As	<1	5	<1	30	10	7	1	1	<1	50	100	10
B	N	N	N	L	N	N	N	N	N	N	30	N
Ba	100	500	500	150	150	300	150	100	300	200	150	1500
Be	N	L	N	70	N	N	N	N	N	L	10	2
Bi	<0.20	0.50	0.20	1.50	<0.20	<0.20	0.50	<0.20	<0.20	<0.20	<0.20	0.70
Cd	1	0.30	0.20	2	0.20	0.50	0.50	0.20	0.20	0.30	0.30	0.20
Co	3	22	23	37	23	37	41	30	26	26	77	23
Cr	150	300	100	150	150	70	200	200	200	150	300	100
Cu	2	150	30	5	100	70	30	20	70	100	150	100
F	300	1500	500	1000	300	700	900	400	800	1400	3100	1200
Ga	7	20	20	20	15	20	30	20	20	20	20	20
La	N	N	N	N	N	N	N	N	N	N	N	70
Mo	2	<2	25	16	3	2	<5	<5	7.40	5.40	14	42
Ni	15	77	36	65	46	38	67	62	48	77	120	41
Pb	10	N	N	20	N	10	N	N	10	10	50	N
Sb	<1	50	<1	15	<1	2	<1	<1	<1	3	3	3
Sc	10	30	20	30	20	30	30	30	30	20	30	20
Sr	150	150	70	200	N	150	150	150	150	150	150	1500
Th	<2.80	<3.20	<2.30	<15	<2.90	<2.10	<2.40	2.64	<2.50	<3.20	<2.50	<11
Tl	<1	<1	<1	<1	<1	<1	<1	<1	<1	2	<1	<1
U	1.80	2.66	1.08	52	1.74	0.74	<2.10	2.03	2.97	3.75	3.46	37.50
V	70	300	70	300	150	200	300	150	300	100	300	150
Y	20	30	15	20	15	20	30	15	30	15	20	30
Yb	2	3	1.50	3	1.50	2	3	1.50	3	1.50	3	3
Zn	30	70	50	20	70	70	150	100	50	100	100	200
Zr	30	70	30	70	70	50	70	70	100	30	100	100
density (g/cm^3)	2.77	2.90	2.95	2.71	2.77	2.87	2.82	2.77	2.89	2.87	2.63	2.54

Analyzed for but not detected in any sample: Au, Ce, Eu, Ge, Hf, In, Li, Nb. Nd, Pd, Pr, Pt, Re, Se, Sm, Sn, Ta, Te, W. N: not detected; L: detected but below accurate detection limit; (-): not analyzed for.

Table 2. Microprobe analyses of minerals from hornblende gneiss unit.

Mineral	Biotite	Biotite	Pyroxene
Sample	80S59	79S31	79S31
# spots anal.	3	4	2
SiO_2%	36.3	36.3	51.0
Al_2O_3	15.5	16.8	0.31
FeO	23.2	22.2	15.7
MgO	9.9	9.75	9.51
CaO	0.01	0.04	23.8
Na_2O	0.34	0.12	0.05
K_2O	9.03	9.58	0.02
TiO_2	2.16	1.76	0.02
MnO	0.12	0.13	0.36
Total	96.58	96.68	100.70

Numbers of ions on basis of 24 O (6 O for pyroxene)

Si	6.073	8.000	6.034	8.000	Si	1.96	2.00
Al	1.927		1.966		Al	0.01	
Al	1.118	1.384	1.320	1.539	Ti	0.00	2.02
Ti	0.271		0.219		Fe	0.03	
Fe	3.237	5.726	3.085	5.518	Fe	0.48	
Mn	0.017		0.019		Mg	0.55	
Mg	2.472		2.414		Mn	0.01	
Ca	0.001	2.036	0.007	2.077	Ca	0.98	
Na	0.109		0.038		Na	0.00	
K	1.926		2.032		K	0.00	

* *

Mineral	Amphibole	Amphibole	Amphibole
Sample	80S59	79S31	79S31
# spots anal.	4	1	1
SiO_2%	43.12	49.40	46.20
Al_2O_3	10.89	1.99	6.46
FeO	20.38	19.00	20.00
MgO	8.45	12.20	10.60
CaO	11.08	12.50	12.30
Na_2O	2.07	0.29	0.65
K_2O	0.58	0.15	0.67
TiO_2	0.86	0.04	0.39
MnO	0.44	0.20	0.21
Total	97.87	95.78	97.49

Numbers of ions on basis of 24 O

Si	6.852	8.00	7.879	8.00		7.322	8.00
Al	1.148		0.121			0.678	
Al	0.891	5.00	2.901	5.00		0.529	5.000
Ti	0.102		0.004			0.046	
Mg	2.001		2.901			2.507	
Fe	2.006		1.840			1.918	
Mn	—		—			—	
Fe	0.702	2.00	0.703	2.990		0.735	3.197
Mn	0.059		0.028			0.029	
Ca	1.239		2.140			2.096	
Na	0.637	1.402	0.088			0.201	
Ca	0.648		—			—	
K	0.117		0.31			0.136	

Table 3. Chemical analyses of quartzite unit.

	79S30	80S91
SiO_2 (%)	92.00	97.40
Al_2O_3	0.87	0.70
Fe (total)	4.03	0.37
FeO	3.12	0.25
Fe_2O_3	1.01	0.13
MgO	0.74	0.20
CaO	0.90	0.25
Na_2O	<0.20	<0.20
K_2O	0.15	0.09
TiO_2	0.05	<0.02
P_2O_5	<0.10	<0.10
MnO	<0.02	<0.02
LOI	1.09	0.31
C (total)	0.31	—
C (org.)	<0.01	—
C (carb.)	0.31	—
S	0.27	—
Hg (ppm)	0.01	0.11
Ag	<5	<5
As	1	50
B	N	N
Ba	50	50
Be	N	N
Bi	<0.20	<0.20
Cd	0.20	<0.20
Co	<2	<2
Cr	2	2
Cu	50	3
F	100	100
Ga	N	N
La	N	N
Mo	2	11
Ni	6	<5
Pb	N	N
Sb	1	<1
Sc	N	N
Sr	10	N
Th	<2.60	<6.90
Tl	<1	<1
U	1.73	26.8
V	15	7
Y	N	N
Yb	N	N
Zn	20	10
Zr	N	N
density (g/cm^3)	2.83	2.70

Analyzed for but not detected in any sample: Au, Ce, Eu, Ge, Hf, In, Li, Nb, Nd, Pd, Pr, Pt, Re, Se, Sm, Sn, Ta, Te, W.
N: not detected; L: detected but below accurate detection limit; (-): not analyzed for

Table 4. Chemical analyses of garnet-biotite gneiss unit.

	79S19	80S19	80S25	80S48	80S71	80S77	80S84	80S87	80S97	80S107	80S117	79S24
SiO_2 (%)	59.50	39.10	58.70	53.70	55.40	47.30	59.60	51.90	57.00	54.10	58.60	52.30
Al_2O_3	11.70	13.50	10.90	9.93	11.10	10.60	13.70	12.90	15.00	13.30	12.60	13.50
Fe (total)	17.00	19.10	14.10	19.30	21.10	20.70	15.70	22.70	18.30	20.40	14.90	22.00
FeO	13.00	15.40	10.50	15.30	20.50	17.10	—	18.60	15.50	17.40	12.30	19.10
Fe_2O_3	4.40	4.11	4.00	4.44	0.56	3.60	—	4.55	3.11	3.30	2.90	3.22
MgO	3.00	5.99	2.40	3.40	3.30	3.40	3.00	2.00	3.10	3.20	2.70	3.40
CaO	1.56	2.60	1.80	4.12	1.61	1.22	0.48	1.00	0.98	0.70	0.85	1.12
Na_2O	0.20	0.90	0.30	0.40	<0.20	0.30	0.50	<0.20	<0.20	< 0.20	0.70	<0.20
K_2O	3.18	3.75	3.71	1.59	2.85	3.69	4.11	2.44	3.54	3.40	3.23	4.88
TiO_2	0.48	3.90	0.30	0.38	0.49	0.45	0.56	0.53	0.62	0.62	0.49	0.59
P_2O_5	0.40	0.65	0.20	0.20	0.30	0.40	0.10	<0.10	0.10	0.20	0.20	0.20
MnO	0.48	1.06	0.66	1.05	1.03	1.18	0.21	0.48	0.47	0.37	0.35	0.58
LOI	3.35	8.31	7.15	4.92	3.02	10.49	1.86	5.35	1.50	4.02	5.55	1.88
C (total)	0.53	2.25	2.41	1.34	1.02	2.33	0.28	—	—	—	—	0.35
C (org.)	0.14	0.26	1.32	0.30	0.98	1.12	0.22	—	—	—	—	<0.01
C (carb.)	0.39	1.99	1.07	1.04	0.04	1.21	0.06	—	—	—	—	0.35
S	1.74	0.59	1.66	0.53	1.98	4.77	<0.01	—	—	—	—	0.03
Hg (ppm)	0.01	<0.01	0.02	0.02	<0.01	0.04	<0.01	0.09	0.02	0.01	0.02	<0.01
Ag (ppm)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
As	10	20	30	15	1	50	3	20	<1	2	20	<1
B	N	N	20	N	N	L	N	100	200	300	30	N
Ba	300	500	200	200	300	300	200	150	700	500	300	700
Be	N	L	5	N	L	L	N	1.50	2	2	2	1.50
Bi	1.50	1	2	1.50	1	<.20	0.70	<0.20	<0.20	<0.20	<0.20	<0.20
Cd	0.50	2	5	2	1	10	0.20	0.20	0.70	0.30	<0.20	0.70
Co	35	22	20	25	13	8	17	18	17	18	15	16
Cr	50	70	20	30	50	50	50	70	70	70	70	70
Cu	200	30	300	100	150	150	3	70	1	2	100	2
F	1300	1700	900	600	900	1200	1300	1400	1300	1300	1100	800
Ga	20	20	20	15	—	20	15	20	20	30	20	20
La	L	N	N	N	L	50	L	N	50	50	50	L
Mo	5	5	7	5	5	5	35	86	12	5.50	<5	7
Ni	47	49	75	40	25	30	32	32	41	38	29	36
Pb	50	70	150	50	50	70	30	100	70	30	50	30
Sb	3	<1	5	1	<1	7	1	10	<1	<1	<1	2
Sc	10	20	10	7	10	7	15	10	15	15	15	15
Sr	30	150	70	150	15	50	30	30	50	100	70	70
Th	<9.10	<4.10	<11	<8.93	<12.90	<7.70	<11	<17	<17.80	<16.80	<13.20	<8.20
Tl	<1	<1	3	<1	<1	<1	2	<1	<1	<1	<1	<1
U	6.21	5.34	9.37	6.32	7.36	23.30	40.20	88	6.52	4.58	4.73	18.40
V	150	200	700	70	150	150	70	150	150	200	150	150
Y	20	50	30	15	30	20	30	10	15	10	15	15
Yb	2	—	—	2	—	3	2	—	—	—	3	—
Zn	100	30	200	150	100	100	150	200	200	200	150	150
Zr	100	100	150	70	70	70	100	70	100	100	70	150
density (g/cm^3)	3.02	3.10	2.88	2.90	3.02	3.03	2.95	3.07	2.95	3.05	3.00	3.25

Analyzed for but not detected in any sample: Au, Ce, Eu, Ge, Hf, In, Li, Nb, Nd, Pd, Pt, Re, Se, Sm, Sn, Ta, Te, W. N: not detected; L: detected by below accurate detection limit; (-): not analyzed for.

Table 5. Microprobe analyses of garnet and biotite in the garnet-biotite gneiss unit.

Mineral	Garnet	Garnet	Garnet Rim	Garnet Middle	Garnet Core
Sample	79S24	79S18	79S21	79S21	79S21
#spots anal.	8	4	1	1	1
SiO_2%	39.40	39.70	36.70	35.80	36.50
Al_2O_3	20.90	21.50	21.40	20.90	21.60
FeO	31.70	31.70	31.60	28.60	26.30
MgO	1.26	2.33	1.25	0.88	0.82
CaO	1.97	1.92	3.75	3.83	3.82
Na_2O	0.02	0.01	0.00	0.00	0.10
K_2O	0.01	0.01	0.01	0.02	0.00
TiO_2	0.03	0.07	0.14	0.03	0.04
MnO	3.11	1.41	4.43	9.08	10.1
Total	98.41	98.65	99.27	98.15	99.28

Numbers of ions on basis of 24 O

Si	6.000	6.000	6.318	6.318	5.973	6.000	5.935	6.000	5.953	6.000
Al	—		—		0.027		0.065		0.047	
Al	3.963	3.967	4.040	4.048	4.078	4.096	4.020	4.024	4.096	4.101
Ti	0.004		0.0078		0.018		0.004		0.005	
Mg	4.272		0.5513		0.303		0.218		0.199	
Fe	0.303	5.338	4.2180	5.286	4.294	5.861	3.960	5.994	3.587	5.853
Mn	0.340		0.1900		0.611		1.136		1.399	
Ca	0.423		0.3270		0.653		0.680		0.668	
Almandine	80.00%		79.80%		73.30%		66.10%		61.30%	
Andradite	0.07		0.15		0.44		0.10		0.12	
Grossular	6.30		6.06		10.70		11.20		11.30	
Pyrope	5.68		10.40		5.17		3.64		3.40	
Spessartine	7.92		3.59		10.40		19.00		23.90	

* *

Mineral	Green biotite	Brown biotite	Brown biotite
Sample	79S24	79S18	79S21
# spots anal.	9	4	2
SiO_2%	36.60	35.70	33.90
Al_2O_3	19.60	20.70	18.20
FeO	26.40	17.60	25.50
MgO	6.35	9.03	6.17
CaO	0.04	0.04	0.01
Na_2	0.14	0.27	0.09
K_2O	8.12	7.61	9.58
TiO_2	0.98	1.34	1.37
MnO	0.13	0.03	0.10
Total	98.36	92.32	94.84

Numbers of ions on basis of 24 O

Si	6.01	8.000	5.976	8.000	5.862	8.000
Al	1.99		2.024		2.138	
Al	1.77		2.066		1.573	
Ti	0.12		0.170		0.179	
Fe	3.62	7.080	2.457	6.953	3.682	7.035
Mn	0.02		0.004		0.015	
Mg	1.55		2.256		1.586	
Ca	0.01		0.007		0.001	
Na	0.04	1.750	0.078	1.711	0.029	2.144
K	1.70		1.626		2.114	

Table 6. Chemical analyses of mica schist unit.

	79S21	79S22	79S25	80S95	80S103
SiO_2%	60.90	62.40	53.10	62.30	57.10
Al_2O_3	13.70	13.70	12.70	11.20	14.30
Fe (total)	13.40	13.10	18.40	11.20	12.30
FeO	4.28	4.07	15.80	6.34	7.36
Fe_2O_3	10.00	10.00	2.89	5.39	5.48
MgO	2.00	2.40	3.20	2.10	2.60
CaO	1.20	1.16	0.67	1.50	1.18
Na_2O	2.80	1.70	<0.20	1.60	1.50
K_2O	2.71	4.08	4.38	2.87	3.72
TiO_2	0.54	0.51	0.54	0.47	0.58
P_2O_5	0.10	0.10	0.10	<0.10	0.20
MnO	0.31	0.25	0.62	0.27	0.71
LOI	1.55	1.94	6.99	6.44	5.44
C (total)	0.34	0.36	1.73	—	—
C (org.)	0.09	0.04	0.27	—	—
C (carb.)	0.25	0.35	1.46	—	—
S	0.01	0.01	0.01	—	—
Hg (ppm)	<0.01	<0.01	0.01	<0.01	0.03
Ag	<5	<5	<5	<5	<5
As	1	1	5	1	1
B	N	N	20	70	30
Ba	150	300	300	150	700
Be	N	L	3	2	5
Bi	0.70	1.50	0.70	<0.20	<0.20
Cd	0.70	0.20	0.50	<0.20	<0.20
Co	16	23	18	13	14
Cr	20	70	50	70	70
Cu	1000	3	1.50	5	70
F	1100	1400	1700	1100	1600
Ga	20	20	20	20	20
La	N	70	L	N	L
Mo	<2	2	4	<5	<5
Ni	24	29	36	20	24
Pb	20	50	30	30	20
Sb	<1	<1	<1	<1	<1
Sc	5	10	15	10	20
Sr	200	150	150	150	200
Th	<15.00	<16.70	<13.50	<7.92	<9.13
Tl	<1	<1	<1	<1	<1
U	3.13	2.27	5.79	3.58	5.46
V	50	70	100	70	100
Y	10	20	20	20	30
Yb	2	3	2	2	—
Zn	70	70	70	200	150
Zr	30	100	100	100	150
density (g/cm^3)	3.05	2.93	3.05	2.57	2.78

Analyzed for but not detected in any sample: Au, Ce, Eu, Ge, Hf, In, Li, Nb, Nd, Pd, Pr, Pt, Re, Se, Sm, Sn, Ta, Te, W. N: not detected; L: detected but below accurate detection limit; (-): not analyzed for

Table 7. Trace-element data for gray, light-colored, and pink clastic dikes.

	Gray	Light				Pink	
	80S20	80S21	80S50	80S94	80S100	80S111	80S113
Ag (ppm)	2	<5	<5	<5	<5	<5	<5
As	30	7	70	10	20	<1	1
B	N	N	N	N	N	N	N
Ba	150	150	100	150	70	500	30
Be	N	N	L	L	N	L	L
Bi	0.70	5	<.20	<.20	<.20	<.20	<.20
Cd	1.50	1	.70	.20	.50	.50	.30
Co	14	8	20	16	13	7.90	12
Cr	15	50	70	50	70	30	70
Cu	50	10	10	5	100	20	7
F	100	100	200	200	100	100	<100
Ga	7	7	5	15	10	10	10
Hg	0.20	0.03	.02	.03	.06	.05	.03
La	N	N	L	N	N	N	N
Mo	384	35	6	<5	110	69	6.60
Nb	N	N	N	L	N	L	L
Ni	20	16	35	16	48	11	16
Pb	100	30	20	N	70	70	N
Sb	15	1.50	7	2	20	50	1
Sc	5	10	20	10	10	10	15
Sr	70	100	70	150	200	300	200
Th	<470	<4.80	<2.60	<6.40	<6.20	<26	<7.20
Tl	7	<1	<1	<1	<1	<1	<1
U	1560	6.50	3.40	5.31	22.20	114	21.20
V	100	100	150	150	300	150	200
Y	10	15	15	20	15	15	20
Yb	1.50	1.50	1.50	2	2	2	2
Zn	50	50	50	50	100	70	50
Zr	30	20	50	70	30	30	70
W	N	N	N	N	N	N	N
S%	0.05	0.02	0.30	NA	NA	NA	NA
C inorg. %	6.25	7.46	5.07	NA	NA	NA	NA
C org. %	0.32	.18	.17	NA	NA	NA	NA

N: not detected
L: present but below detection limits
NA: not analyzed for

Table 8. Chemical analyses of altered hornblende gneiss.

	80S7	80S14	80S27	80S30	80S34	80S41	80S66	80S79	80S80*	80S65*
SiO_2 (%)	30.90	38.40	42.50	40.90	37.50	39.60	35.80	30.70	35.40	39.30
Al_2O_3	12.20	13.80	13.90	13.70	13.50	11.90	13.50	18.10	12.50	12.90
Fe (total)	9.76	12.30	8.14	9.97	8.96	8.68	7.99	10.80	7.42	8.04
FeO	8.59	10.20	7.07	8.32	7.74	7.87	7.56	—	—	7.52
Fe_2O_3	1.17	2.33	1.19	1.83	1.35	0.90	0.48	—	—	0.58
MgO	5.39	4.00	5.36	4.30	4.20	4.70	4.60	4.40	4.90	3.60
CaO	13.00	5.97	6.53	8.12	10.50	7.82	11.90	8.81	11.00	9.64
Na_2O	<0.20	2.10	3.30	2.90	3.50	0.50	3.00	<0.20	0.40	2.10
K_2O	5.94	4.22	4.18	2.72	3.18	9.62	2.43	6.52	7.95	6.37
TiO_2	0.80	3.78	0.82	1.72	1.42	0.79	1.14	1.85	1.31	1.08
P_2O_5	0.20	0.57	0.20	0.50	0.20	0.10	0.20	0.40	0.30	0.20
MnO	0.22	0.38	0.20	0.19	0.19	0.21	0.21	0.20	0.22	0.16
LOI	21.36	14.58	14.25	13.65	16.38	14.98	17.46	16.89	16.34	14.58
C (total)	5.46	3.76	3.82	3.67	4.38	4.26	4.77	4.23	4.67	4.28
C (org.)	0.16	0.41	0.24	0.51	1.45	0.02	0.55	0.22	0.15	0.42
C (carb.)	5.30	3.35	5.58	3.16	2.93	4.21	4.22	4.01	4.52	3.86
S	0.03	0.03	0.02	0.32	<0.01	<0.01	<0.01	<0.01	0.03	0.06
Hg (ppm)	<0.01	<0.01	0.02	<0.01	0.02	0.01	0.04	0.48	0.12	0.03
Ag	<5	<5	<5	<5	<5	6	<5	6	6	6
As	15	50	15	20	30	30	30	100	100	50
B	L	L	N	N	L	N	N	50	N	N
Ba	500	150	150	300	150	300	70	150	300	300
Be	2	5	10	2	2	1.50	N	15	L	L
Bi	<0.20	0.70	5	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.70
Cd	0.50	0.30	<0.20	0.30	0.70	0.30	2	0.70	0.70	10
Co	26	31	23	26	22	27	24	39	26	16
Cr	100	200	200	300	150	150	70	300	150	70
Cu	15	5	5	70	300	10	7	70	20	70
F	1500	1000	1200	1000	800	100	800	2900	700	400
Ga	20	20	15	20	30	15	20	30	10	15
La	N	N	N	L	N	N	N	N	N	N
Mo	69	67	4	2	<5	<5	16	260	160	48
Ni	44	12	39	108	38	43	45	96	71	22
Pb	20	50	N	15	20	N	30	150	50	70
Sb	2	15	3	3	30	3	2	20	10	10
Sc	20	15	20	20	50	30	10	30	15	15
Sr	70	500	300	500	150	150	150	200	200	300
Th	<2.70	<5.50	<5.50	<4.40	<61	<3.50	<7.20	<18	<240	<230
Tl	<1	<1	2	<1	<1	<1	<1	3	7	2
U	1.59	7.38	9.52	4.96	298	6.38	18.40	67.20	936	906
V	100	300	200	200	300	200	70	300	300	150
Y	15	30	20	20	30	15	L	15	15	10
Yb	2	3	2	2	3	2	L	2	2	2
Zn	70	150	50	50	100	100	30	50	70	50
Zr	50	150	70	70	100	70	30	70	70	50
density (g/cm^3)	2.75	2.76	2.80	2.76	2.68	2.71	2.73	2.76	2.69	2.70

Analyzed for but not detected in any sample: Au, Ce, Eu, Ge, Hf, In, Li, Nb, Nd, Pd, Pt, Re, Se, Sm, Sn, Ta, Te, W. N: not detected; L: detected but below accurate detection limit; (-): not analyzed for

*Hematite adularia zone

Table 9. Chemical analyses of altered garnet-biotite gneiss.

	79S17	80S18	80S24	80S49	80S70	80S76	80S83	80S86	80S99	80S108	80S118
SiO_2 (%)	53.90	48.10	37.80	36.60	37.80	45.80	34.70	51.60	51.60	50.10	55.20
Al_2O_3	12.80	10.60	13.40	10.90	10.90	7.07	12.70	9.61	9.98	10.30	12.40
Fe (total)	11.10	17.20	8.44	15.00	14.90	18.40	30.10	13.50	14.80	16.60	11.30
FeO	9.85	13.20	7.37	13.20	—	—	—	10.60	12.90	14.50	9.23
Fe_2O_3	1.39	4.44	1.19	2.00	—	—	—	3.22	2.11	2.33	2.30
MgO	3.10	3.50	4.80	5.55	4.50	4.50	2.60	3.10	3.00	3.20	2.60
CaO	1.59	1.93	10.20	4.78	6.09	2.04	7.13	3.25	2.70	3.92	1.38
Na_2O	<0.20	<0.20	2.20	2.50	2.00	<0.20	<0.20	<0.30	<0.20	<0.20	1.30
K_2O	5.86	3.18	4.49	3.14	4.19	2.56	0.11	4.02	5.13	2.36	5.05
TiO_2	0.54	0.47	1.15	3.6	2.75	0.41	0.49	0.45	0.46	0.56	0.48
P_2O_5	0.30	0.20	0.20	0.52	0.40	0.30	0.77	0.30	0.10	0.10	0.10
MnO	0.20	1.24	0.26	0.51	0.51	0.52	2.96	0.53	0.29	1.01	0.28
LOI	10.18	13.40	16.60	16.45	15.58	15.14	7.08	10.40	11.70	11.00	9.26
C (total)	2.61	3.87	4.38	4.49	4.69	4.76	2.32	—	—	—	—
C (org.)	0.20	1.49	0.51	0.17	0.38	2.13	0.37	—	—	—	—
C (carb.)	2.41	2.38	3.87	4.32	4.31	2.63	1.95	—	—	—	—
S	0.02	1.58	0.02	0.15	0.04	2.47	1.88	—	—	—	—
Hg (ppm)	<0.01	<0.01	0.01	0.02	0.01	0.81	0.03	0.28	0.08	0.02	0.02
Ag	<5	<5	<5	<5	<5	6	6	8	<5	<5	<5
As	30	30	30	70	30	50	20	20	<1	20	10
B	50	50	L	L	N	20	N	300	20	100	30
Ba	150	100	200	70	150	30	15	300	50	100	300
Be	15	7	7	5	5	7	N	10	7	5	3
Bi	0.20	1.50	<0.20	2	<0.20	1	<0.20	<0.20	<0.20	<0.20	<0.20
Cd	<0.20	2	0.50	2	0.50	7	1.50	0.50	0.70	0.70	<0.20
Co	11	25	26	31	15	22	5.20	18	6.40	4.60	13
Cr	70	50	150	10	70	30	50	70	70	50	70
Cu	3	100	3	70	3	200	100	200	3	70	70
F	2600	2500	1100	1200	1100	1900	700	1500	1600	1500	1000
Ga	30	15	20	20	20	20	—	20	70	20	20
La	N	N	N	N	N	N	N	L	N	N	50
Mo	4	28	12	<5	24	560	<5	760	25	71	<5
Ni	32	39	47	46	38	42	10	33	24	18	20
Pb	30	150	20	200	70	500	50	2000	20	7000	10
Sb	<1	15	1.50	15	7	100	2	20	2	20	<1
Sc	10	7	30	15	15	5	10	10	7	7	15
Sr	200	70	300	150	300	50	30	150	150	150	150
Th	<7.20	<27	<11	<2.20	<4.70	<370	<16	<290	<17.60	<7.10	<3.70
Tl	<1	<1	2	<1	<1	<1	<1	<1	<1	<1	<1
U	12.00	115	25.80	1.89	8.89	1550	67.80	1760	17.00	20.90	5.47
V	150	100	300	200	200	150	150	200	150	150	150
Y	20	20	20	30	20	10	20	10	10	L	20
Yb	2	2	3	3	3	1.50	3	—	—	—	2
Zn	70	20	100	500	30	700	150	200	300	200	200
Zr	70	70	70	100	70	70	70	70	50	70	100
density (g/cm^3)	2.83	2.87	2.76	2.80	2.81	2.86	3.47	2.80	2.81	2.75	2.80

Analyzed for but not detected in any sample: Au, Ce, Eu, Ge, Hf, In, Li, Nb, Nd, Pd, Prd, Pt, Re, Se, Sm, Sn, Ta, Te, W. N: not detected; L: detected but below accurate detection limit.

Table 10. Average compositions of unaltered garnet-biotite gneiss (GBG) and hornblende gneiss, (HG), and of altered equivalents in carbonate-sericite zone.

	Fresh GBG	S.D.	Alt GBG	S.D.	Fresh HG	S.D.	Alt HG	S.D.
SiO_2 (%)	53.90	6.00	45.70	7.60	43.30	6.10	37.00	4.40
Al_2O_3	12.40	1.50	11.00	1.80	14.00	3.20	13.80	1.90
Fe (total)	18.80	2.80	15.60	5.60	10.80	2.10	9.60	1.40
FeO	15.80	3	11.40	2.50	8.60	1.70	8.20	1.00
Fe_2O_3	3.50	1.10	2.40	1.00	2.30	.64	1.32	.61
MgO	3.30	.90	3.67	1.00	4.30	1.00	4.62	.52
CaO	1.50	1.00	4.09	2.76	12.10	6.10	9.10	2.50
Na_2O	.36	.23	.87	.94	2.03	1.70	1.96	1.40
K_2O	3.40	.83	3.64	1.60	2.59	1.80	4.85	2.40
TiO_2	.78	.99	1.03	1.10	1.37	.50	1.84	1.00
P_2O_5	.25	.16	.30	.20	.29	.14	.30	.17
MnO	.66	.33	.76	.80	.50	.05	.23	.06
LOI	4.80	2.80	12.40	3.20	7.88	5.30	16.20	2.50
C(total)	1.31	.91	3.87	1.00	2.02	1.40	4.30	.60
C (org.)	.60	.50	.75	.76	.22	.18	.45	.44
C (carb.)	.77	.68	3.12	1.00	1.80	1.30	4.10	.96
S	1.40	1.60	.88	1.10	0.50	0.40	0.60	.10
Hg (ppm)	0.02	.02	.12	.24	.01	0	.08	.16
Ag	<5	0	<5	—	<5	—	<5.10	.40
As	14.40	14.90	28.30	18.70	18	30	38.80	28
B	66	92	59	84	N	—	L	—
Ba	363	192	133	99	341	391	221	138
Be	1.90	1	6.90	3.20	N	—	20.10	38
Bi	<.70	.60	<.60	.64	<.20	—	<.87	1.70
Cd	1.90	2.90	1.40	2.00	.49	.53	.63	.60
Co	18.70	6.60	16.10	9.10	31	17	27.30	5.50
Cr	57	17	63	35	173	73	184	84
Cu	92	95	75	73	69	52	60	101
F	1150	303	1518	606	1008	774	1163	809
Ga	20	4	26	16	19	5	21	5.80
La	<50	—	<50	—	<50	—	<50	—
Mo	15.20	24	136	263	10.70	12	53.50	88
Ni	40	13	32	13	58	27	53.10	32
Pb	63	34	914	2101	<10	—	38.10	47
Sb	2.80	3	16.80	29	<7	14	9.75	10.70
Sc	12	4	12	7	25	7	24.40	12.40
Sr	68	45	155	88	270	409	253	166
Th	<11.50	<4.20	<69	<131	<4.40	<4.13	<13.50	<20
Tl	<1	—	<1	—	<1	—	<1	—
U	18.30	24	326	660	9.32	17	71.40	106
V	191	165	176	52	199	96	209	90
Y	21.70	12	17.30	6.50	22	6.50	21	6.70
Yb	2.40	.50	2.44	.62	2.30	.70	2.10	.60
Zn	144	54	225	208	84	51	75	39
Zr	96	29	74	14.30	66	26	76.30	35.80
density (g/cm^3)	3.02	—	2.87	—	2.79	—	2.75	—

Analyzed for but not detected in any sample: Au, Ce, Eu, Ge, Hf, In, Li, Nb, Nd, Pd, Pr, Pt, Re, Se, Sm, Sn, Ta, Te, W. N: not detected; L: detected but below accurate detection limit; (-): not analyzed for.

Table 11. Trace-element data for samples from Illinois vein system.

	80S12	80S17	80S23	80S26	80S29	80S33	80S43	80S57	80S60
Ag (ppm)	<5	13	<5	<5	<5	14	<5	<5	<5
As	50	70	30	70	30	150	30	N	N
B	N	N	N	N	N	N	N	N	N
Ba	300	150	150	150	150	50	150	150	70
Be	L	2	1.50	1.50	1.50	1.50	5	1.50	1.50
Bi	5	1.50	1	7	10	2	1.50	N	N
Cd	1	2	1.50	3	1.50	3	3	N	N
Co	15	18	23	123	30	18	26	14	15
Cr	70	30	70	70	150	70	30	15	100
Cu	150	300	100	100	150	3000	30	50	7
F	100	200	100	100	200	500	800	200	200
Ga	15	10	10	10	15	15	15	10	15
Hg	0.64	0.33	0.59	0.75	0.04	0.09	0.07	0.16	0.04
La	N	N	N	N	N	N	N	N	N
Mo	707	2370	574	848	5	<5	260	440	38
Nb	L	15	N	N	L	10	L	N	N
Ni	30	44	31	36	83	26	52	43	38
Pb	1000	3000	200	1000	30	150	200	70	15
Sb	70	150	50	50	30	300	50	N	N
Sc	20	10	20	15	15	15	15	7	20
Sr	200	100	150	150	150	70	70	150	300
Th	<38	<2400	<450	<290	<5	<1600	<430	NA	<2.80
Tl	3	15	5	10	2	<1	10	N	N
U	169	7100	1440	880	7.40	5830	1800	NA	3.44
V	500	500	500	150	200	300	150	70	150
Y	20	30	15	15	20	20	15	20	20
Yb	3	N	2	1.50	2	3	1.50	2	2
Zn	70	500	70	70	70	150	200	700	N
Zr	30	150	30	50	70	150	70	70	30
S%	0.11	0.87	0.14	0.97	0.23	.44	.15	NA	NA
C carb. %	5.41	4.73	5.75	5.89	4.14	5.62	4.05	NA	NA
C org. %	0.27	0.66	0.63	0.52	0.71	.29	.20	NA	NA
W	N	N	N	N	N	N	N	N	N

N: not detected
L: present but below detection limits
NA: not analyzed for

Table 12. Trace-element data for samples from the horsetail fracture system.

	79S16	79S23	79S26	80S1	80S2	80S3	80S6	80S64	80S69	80S72	80S75	80S78	80S82
Ag(ppm)	<5	8	13	105	<5	21	15	27	12	18	6	79	27
As	50	50	100	300	50	70	70	100	50	100	70	300	300
B	N	N	N	N	N	N	N	N	N	L	N	N	N
Ba	150	150	30	150	30	50	150	100	100	100	150	200	150
Be	1.50	L	N	1.50	N	N	1.50	N	5	1.50	1.50	1.50	5
Bi	1	2	0.70	1	0.70	0.70	10	0.20	0.20	0.20	0.30	0.20	2
Cd	1.50	0.70	5	2	1.50	0.70	1	0.50	1	5	7	2	5
Co	14	17	18	188	6	14	49	43	33	6.5	9	160	34
Cr	50	15	30	10	15	20	50	20	100	30	50	100	30
Cu	50	150	100	3000	50	150	100	300	150	100	70	1500	700
F	200	200	<100	200	200	100	100	200	400	200	200	300	400
Ga	15	N	N	L	5	5	10	5	15	5	15	10	10
Hg	0.17	1.70	0.95	11	6.70	0.57	0.64	6	0.60	0.14	0.20	20	9
La	N	N	N	N	N	N	N	N	N	N	N	N	N
Mo	550	2710	2890	9810	5210	3210	2940	1800	1800	910	350	7500	8000
Nb	N	L	N	10	N	N	L	N	L	L	L	20	20
Ni	20	47	60	212	28	70	74	32	58	21	23	130	65
Pb	2000	1500	700	7000	5000	2000	500	1000	1500	7000	500	7000	20000
Sb	30	150	70	500	200	100	50	70	70	50	70	300	500
Sc	7	L	N	N	5	7	15	10	15	5	7	10	N
Sr	150	150	50	100	150	70	150	70	300	100	200	150	300
Th	<560	<3100	<1300	<5800	<4600	<780	<680	<1600	<160	<1200	<1000	<4700	<34000
Tl	20	30	30	50	50	15	15	50	10	7	10	20	50
U	1850	9380	4430	18000	14,400	2680	2300	5550	586	4090	3270	18100	28000
V	300	300	150	100	700	300	500	100	300	300	200	300	700
Y	10	20	L	30	20	L	20	30	30	15	20	20	70
Yb	N	N	N	N	N	1.50	2	3	3	N	2	3	N
Zn	70	30	50	100	70	70	50	15	30	2000	70	50	500
Zr	50	70	30	100	70	30	30	50	70	70	70	150	300
S%	0.50	0.74	0.60	2.34	1.09	0.52	0.32	0.60	0.24	2.12	0.84	1.02	3.84
carb C%	5.31	6.50	1.44	1.24	0.26	4.58	5.74	8.62	3.57	4.56	3.20	3.48	3.72
org C%	0.36	0.34	2.55	0.23	0.08	0.26	0.23	0.04	1.19	1.17	1.24	0.49	0.34
W	N	N	N	N	N	N	N	N	N	N	N	N	200

N: not detected
L: present but below detection limit
NA: not analyzed for.

Table 13. Trace-element data for samples from Rogers vein system.

	80S85	80S86	80S88	80S92	80S93	80S98	80S104	80S110	80S120
Ag (ppm)	24	8	14	<5	<5	16	29	8	<5
As	100	20	100	30	10	50	20	50	20
B	N	300	N	N	N	N	N	N	N
Ba	150	300	30	50	300	200	200	100	1000
Be	5	10	N	N	N	2	2	L	L
Bi	0.50	0.50	0.30	0.30	0.20	0.20	0.20	0.20	0.20
Cd	15	0.50	0.30	0.30	1.50	2	1	3	0.20
Co	26	18	36	13	8.90	16	55	17	10
Cr	30	70	5	5	50	50	30	30	30
Cu	300	200	100	100	50	150	150	150	20
F	700	1500	100	100	100	200	100	400	200
Ga	5	20	N	N	15	10	5	10	10
Hg	0.80	0.28	1.08	1.21	0.25	0.64	0.79	0.36	2.01
La	L	L	N	N	N	N	N	N	N
Mo	3400	760	760	800	270	3500	2200	2500	28
Nb	10	10	N	10	L	20	15	N	10
Ni	100	33	46	20	13	48	73	38	9.60
Pb	5000	2000	1000	500	200	3000	3000	3000	70
Sb	200	20	70	50	15	150	30	150	10
Sc	5	10	10	N	10	10	10	7	10
Sr	150	150	30	30	200	150	500	500	300
Th	<1500	<290	<510	<300	<260	<1400	<3100	<640	<1000
Tl	5	<1	3	5	2	10	7	5	<1
U	5520	1760	1910	1820	1550	6070	14,100	2530	4550
V	300	200	150	70	700	500	500	500	150
Y	30	10	10	N	15	20	30	15	30
Yb	N	N	N	N	N	N	N	N	3
Zn	2000	200	50	50	200	300	150	300	50
Zr	70	70	30	30	100	100	150	70	100
S%	NA	NA	NA	NA	NA	NA	NA	NA	NA
C carb. %	NA	NA	NA	NA	NA	NA	NA	NA	NA
C org. %	NA	NA	NA	NA	NA	NA	NA	NA	NA
W	N	N	N	N	N	N	N	N	N

N: not detected
L: present but below detection limits
NA: not analyzed for

Table 14. Summary of trace-element concentrations for horsetail, Illinois, and Rogers veins.

	Horsetail Veins		Illinois Vein		Rogers Vein	
No. samples	13		9		9	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Ag (ppm)	26.30	30.60	*6.50	4.20	*12.70	8.90
As	124	102	61.40	43	44.40	34.30
B	N	—	N	—	N	—
Ba	116	53	147	70	259	294
Be	*1.80	1.40	1.94	1.16	*2.94	2.88
Bi	1.50	2.60	*3.22	3.36	0.29	0.13
Cd	2.54	2.20	*1.82	0.93	2.64	4.73
Co	45.50	58.90	20.20	5.60	22.20	14.90
Cr	40.00	29.90	67.20	41.00	33.30	21.10
Cu	494	855	432	967	147	76
F	215	99	267	235	378	466
Ga	*8.46	4.30	12.80	2.60	*9.44	5.27
Hg	4.43	6.00	0.30	0.29	0.82	0.56
La	N	—	N	—	N	—
Mo	3668	3043	583	739	1580	1337
Nb	L	—	*10.60	1.67	*11.70	3.50
Ni	64.60	53.60	42.60	17.20	42.30	29.30
Pb	4285	5383	629	971	1974	1666
Sb	166	166	*78.40	93.80	69.40	75.60
Sc	*7.77	3.68	15.20	4.50	8.56	2.24
Sr	149	79	149	71	223	177
Th	*4575	9030	*652	878	*1000	917
Tl	27.50	17.00	*5.33	5.12	*4.33	2.99
U	8664	8412	2154	2762	4547	4079
V	327	196	280	176	341	216
Y	*23.50	15.70	19.40	4.64	18.90	10
Yb	*1.65	0.85	2.00	0.66	N	—
Zn	239	543	237	226	367	620
Zr	83.80	72.60	72.20	47.40	80	37.70
W	N	—	N	—	N	—
S%	1.14	1.03	0.42	0.36	NA	—
C% inorg.	4.17	2.41	5.08	0.77	NA	—
C% org.	0.66	0.70	0.47	0.21	NA	—

*Maximum value only: samples with concentations below detection limits were calculated on basis of value of detection limit.

N: not detected
L: detected but at concentrations below accurate detection limit
NA: not analyzed for.

Horsetail vein (n=13)

	U	Mo	As	Ag	Co	Ni	F	Bi	Cd	Sb	Tl	Hg
U	1.000											
Mo	0.873	1.000										
As	0.847	0.856	1.000									
Ag	0.516	0.766	0.816	1.000								
Co	0.463	0.739	0.767	0.970	1.000							
Ni	0.446	0.790	0.722	0.933	0.934	1.000						
F	0.466	0.271	0.413	0.083	0.110	0.032	1.000					
Bi	-0.138	-0.008	-0.123	-0.146	-0.017	0.062	-0.373	1.000				
Cd	0.188	-0.141	-0.160	-0.165	-0.234	-0.264	0.312	-0.203	1.000			
Sb	0.929	0.943	0.894	0.689	0.627	0.688	0.415	-0.128	0.124	1.000		
Tl	0.685	0.624	0.433	0.325	0.273	0.270	0.145	-0.120	-0.205	0.648	1.000	
Hg	0.761	0.790	0.820	0.755	0.772	0.606	0.346	-0.220	-0.129	0.699	0.474	1.000

Illinois vein (n=9)

	U	Mo	As	Ag	Co	Ni	F	Bi	Cd	Sb	Tl	Hg
U	1.000											
Mo	0.574	1.000										
As	0.595	-0.023	1.000									
Ag	0.949	0.414	0.778	1.000								
Co	-0.304	-0.281	-0.310	-0.301	1.000							
Ni	-0.191	-0.079	-0.341	-0.156	0.836	1.000						
F	0.277	-0.266	0.208	0.243	0.310	0.207	1.000					
Bi	-0.367	-0.112	-0.140	-0.242	0.528	0.657	-0.227	1.000				
Cd	0.460	0.071	0.400	0.392	0.245	0.024	0.609	0.081	1.000			
Sb	0.809	0.151	0.865	0.914	-0.260	-0.227	0.346	-0.143	0.512	1.000		
Tl	0.446	0.806	-0.224	0.184	-0.030	0.014	0.085	-0.143	0.417	-0.042	1.000	
Hg	-0.128	0.435	-0.120	-0.193	-0.199	-0.345	-0.539	0.212	0.039	-0.102	0.287	1.000

Rogers vein (n=9)

	U	Mo	As	Ag	Co	Ni	F	Bi	Cd	Sb	Tl	Hg
U	1.000											
Mo	0.574	1.000										
As	0.167	0.510	1.000									
Ag	0.882	0.705	0.406	1.000								
Co	0.557	0.428	0.175	0.687	1.000							
Ni	0.663	0.816	0.573	0.896	0.675	1.000						
F	0.096	0.620	0.453	0.305	0.153	0.643	1.000					
Bi	-0.143	-0.089	0.085	-0.189	-0.274	-0.153	-0.108	1.000				
Cd	0.316	0.626	0.611	0.546	0.097	0.759	0.858	0.045	1.000			
Sb	0.279	0.909	0.690	0.488	0.228	0.730	0.772	-0.014	0.735	1.000		
Tl	0.666	0.857	0.331	0.665	0.356	0.604	0.166	0.074	0.287	0.662	1.000	
Hg	0.760	0.468	0.311	0.770	0.709	0.620	-0.080	0.241	0.147	0.251	0.650	1.000

Table 15. Correlation coefficients for trace-element data from the Rogers, Illinois, and horsetail vein systems.