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CHEMICAL ANALYSES OF SELECTED TERTIARY AND QUATERNARY VOLCANIC ROCKS, CASCADE RANGE, WASHINGTON

By

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The chemical analyses reported here are from selected samples of Tertiary and Quaternary volcanic rocks from the Cascade Range, Washington, collected between 1975 and 1979. We selected the freshest samples from our office reference collection for chemical analysis with the exception of the samples from Mount Adams which were collected especially for analysis. Analyses were done in the U.S. Geological Survey analytical laboratories in Menlo Park, California and Lakewood, Colorado. Rock type, sample location, and method of analysis are given in Table 1. Table 2 lists chemical analyses and normative mineral compositions. Brief descriptions of the sampled units are given below.

Silver Pass Volcanic Member of the Swauk Formation

The early Eocene Silver Pass Volcanic Member of the Swauk Formation (Tabor and others, 1982c) ranges in composition from basalt to rhyolite but is mostly andesitic to dacitic pyroclastic volcanic rocks and flows. The unit overlies and is in part interbedded with sandstones of the Swauk Formation (Gresens and others, 1977; Tabor and others, in press). Analysed samples were all collected from the type area near Silver Pass, east of Lake Kachess.

Taneum Formation

The Taneum Formation, formerly called the Taneum andesite by Smith (1904, p. 7) and renamed the Taneum Formation by Tabor and others (in press), is a sequence of andesitic to dacitic lavas and pyroclastic rocks cropping out in the headwaters of Taneum Creek. It appears to be early Eocene in age and correlative with the Silver Pass Volcanic Member of the Swauk Formation (Tabor and others, in press).

Teanaway Formation and Basalt of Frost Mountain

The middle Eocene Teanaway Formation (formerly called the Teanaway Basalt by Smith, 1904, p.5-6) but renamed by Tabor and others (in press) consists of basaltic to rhyolitic flows, tuff, and breccia with very minor feldspathic sedimentary interbeds. The Teanaway crops out mainly in the drainage of the Teanaway River. Its correlative, the basalt of Frost Mountain, (Tabor and others, in press), crops out mainly in the upper reaches of the Manastash River. Samples analysed were selected because they looked representative of the typical volcanic rocks in the unit.

Naches Formation

The late Eocene to early Oligocene(?) Naches Formation consists of interbedded feldspathic sandstone, siltstone and shale, rhyolite, basaltic to andesitic flows, tuff, and breccia (Foster 1960, p. 115-117, 1967, p. 33-35; Tabor and others, in press). The unit crops out in a belt stretching from the Little Naches River to the Cascade Crest northeast of Snoqualmie Pass.

Probable correlatives are the Barlow Pass volcanics of Vance (1957b) and the rhyolite near the town of Oso (this report).

Barlow Pass volcanics of Vance (1957b)

The Barlow Pass volcanics of Vance are predominantly basalt and rhyolite with minor andesite. Flows are abundant but interbedded tuff, breccia and tuffaceous to feldspathic sandstone and argillite are conspicuous. The rocks are mostly highly altered, and many have been recrystallized by thermal metamorphism reaching pyroxene hornfels facies adjacent to Tertiary plutons. The Barlow Pass volcanics crop out north of Barlow Pass where they form steep faces on Mount Dickerman, Twin Peaks, and Mount Forgotten, and in the Monte Cristo area to the south. The Barlow Pass appears to be late Eocene to early Oligocene based on correlation with the Naches Formation (Vance 1957a, p. 286-287; Tabor and others, in press).

Rhyolite near Lake Cavanaugh

The late Eocene rhyolite near Lake Cavanaugh consists of rhyolitic flows and ash-flow tuffs. The unit appears to be interbedded with feldspathic sedimentary rocks probably correlative with the Eocene Chuckanut Formation (Johnson, 1982) northwest of the sample locality (Dethier and others, 1980; see also Lovseth, 1975).

Rhyolite near Oso

The rhyolite near Oso is part of a sequence of slightly altered mainly dacitic volcanic rocks (Jones, 1959) which are interbedded with feldspathic sedimentary rocks and are probably correlative with the Barlow Pass volcanics of Vance (1957a) and the Naches Formation (Vance, written communication, 1978; Tabor and others, in press).

Round Lake volcanic breccias of Vance (1958)

The Round Lake volcanic breccias of Vance (1958) consists almost exclusively of andesitic tuff and breccia with minor basalt and crops out just northeast of the junction of the north and south forks of the Sauk River in the vicinity of Round Lake. Vance (1957a) interpreted the tuff to be a volcanic pipe, possibly a feeder for the Miocene breccia above Monte Cristo (see breccia of Kyes Peak in Tabor and others, 1982b).

Eagle Tuff of Yeats (1977)

The probable Miocene Eagle Tuff of Yeats (1977) consists of rhyolitic to dacitic tuff, ashflow tuff, and breccia locally with fragments of pre-Tertiary country rock near the base (Yeats, 1958, p. 174-175; Tabor and others, 1982b). The Eagle Tuff is mostly exposed west of the Beckler River near Eagle Creek and on Eagle Rock.

Sauk ring dike

Analyses of volcanic dikes and irregular bodies in the upper Sauk Formation are from selected samples of a dike complex near Monte Cristo referred to as the Sauk ring dike by J. A. Vance (writ. comm., 1978). The

andesite and dacite porphyry dikes intruded the Barlow Pass volcanics of Vance (1957b) in the middle to late Tertiary (Heath 1971, p. 150). Descriptions of the dikes are in Heath (1971, p. 150) and Tabor and others (1982b).

Columbia River Basalt

The analyses of the Miocene Columbia River Basalt were made on selected specimens of the Grande Ronde Basalt collected from the margin of the basalt northwest of Ellensburg. The Grande Ronde is mostly nonporphyritic tholeiitic basalt (Swanson and Wright, 1978, p. 42-43; Tabor and others, 1982c).

Volcanic rocks of Mount Adams

The Quaternary volcanic rocks of Mount Adams are undeformed and include pyroxene andesite lavas from Mount Adams and olivine basalt flows from numerous peripheral vents (Hopkins 1976, p. 10). Analyses are of selected samples from the south, west and north slopes of the volcano.

Volcanic rocks of Simcoe Mountains

The late Pliocene and younger volcanic rocks of Simcoe Mountains comprise flows of olivine basalt, rhyolite, porphyritic andesite, and flow banded dacite (Sheppard, 1960). The Simcoe volcanics analysed here crop out north of Goldendale near the headwaters of Mill Creek, Devils Canyon, and West Prong Creek.

Table 1
Sample Information. [Rapid rock analyses by method of Shapiro (1975)]

Sample Number	Collector	Formation	Rock Type	Location Lat.	Location Long.	Method of Analysis	Analysts	Quad.Map
RWT-487-77	R.W. Tabor	Silver Pass Volcanic Member of Swauk Formation	pyroxene basalt	47° 19' 48"	121° 11' 42"	Rapid Rock	K. Coats, N.Skinner, H. Smith, F.Brown (project leader)	Easton (15')
RWT-488-77	"	"	pyroxene dacite	47° 19' 48"	121° 11' 42"	"	"	Easton (15')
RWT-489-77	"	"	dacite ash flow tuff	47° 19' 48"	121° 11' 54"	"	"	"
RWT-346-76	"	Teanaway Formation & Basalt of Frost Mtn.	pyroxene basalt	47° 24' 18"	120° 31' 54"	"	"	Liberty (15')
RWT-490-77	"	"	andesite	47° 17' 00"	121° 09' 42"	"	"	Easton (15')
RWT-143-78	"	"	olivine pyroxene andesite	47° 13' 18"	120° 41' 48"	"	"	Thorp (15')
RWT-140-75	"	"	pyroxene dacite	47° 16' 18"	121° 10' 24"	"	"	Easton (15')
RWT-497-75	"	"	"	47° 08' 48"	120° 54' 18"	"	"	Cle Elum (15')
RWT-250-77	"	"	olivine basalt	47° 05' 00"	121° 02' 12"	"	"	Easton (15')
RWT-435-76	"	"	pyroxene dacite	47° 03' 30"	120° 59' 42"	"	"	Cle Elum (15')
RWT-306-77	"	Taneum Formation	"	47° 06' 30"	121° 00' 48"	"	"	Easton (15')
RWT-431-76	"	"	dacite	47° 03' 48"	120° 59' 12"	"	"	Cle Elum (15')
RWT-477-76	"	"	rhyolite tuff	47° 21' 42"	121° 19' 48"	"	"	Snoqualmie Pass (15')
RWT-427-76	"	"	rhyolite	47° 08' 00"	121° 06' 30"	"	"	Easton (15')
RWT-492-76	"	Naches Formation	diabasic augite basalt	47° 15' 42"	121° 17' 42"	"	"	Snoqualmie Pass (15')
RWT-436-77	"	"	olivine-clinopyroxene basalt	47° 07' 06"	121° 12' 36"	"	"	Stray Gulch (7.5')
RWT-275-77	"	"	pyroxene basalt	47° 03' 18'	121° 04' 42"	"	"	Easton (15')
RWT-336-77	"	"	olivine-clinopyroxene basalt	47° 10' 42"	121° 10' 48"	"	"	Easton (15')
M-84B-77	K. Marcus	"	two pyroxene basalt	47° 03' 48"	121° 05' 12"	"	"	Easton (15')
BG-209-77	W. Gaum	"	pyroxene andesite	47° 06' 12"	121° 09' 6"	"	"	Easton (15')
RWT-477-77	R. W. Tabor	"	dacite	47° 21' 42"	121° 19' 48"	"	"	Snoqualmie Pasa (15')
RWT-339-77	"	"	clinopyroxene andesite	47° 10' 42"	121° 10' 42"	"	"	Easton (15')
RWT-482-77	"	"	"	47° 21' 42"	121° 18' 30"	"	"	Snoqualmie Pass (15')
RWT-368-77	"	"	rhyolite tuff	47° 17' 18"	121° 14' 42"	"	"	Kachess Lake (15')
M77-162	K. Marcus	"	rhyolite	47° 10' 42"	121° 11' 12"	"	"	Easton (15')
M77-166	"	"	"	47° 08' 36"	121° 11' 30"	"	"	Easton (15')
JV-43	J.A. Vance	Barlow Pass volcanics	rhyolite	48° 03' 12"	121° 28' 54"	"	K. Coates, H. Smith, F. Brown (project leader)	Bedal (7.5')
JV-55	"	of Vance	"	48° 08' 18"	121° 28' 18"	"		
JV-1554	"	"	"	48° 03' 36"	121° 29' 24"	"		White Chuck Mtn. (7.5')
JV-1517	"	"	tuff	48° 02' 36"	121° 27' 12"	"	"	Bedal (7.5')
JV-24	"	Rhyolite near Lake Cavanaugh	ash flow tuff	47° 19' 30"	122° 02' 06"	"	"	Clear Lake (15')
JV-48	"	Rhyolite near Oso	"	48° 21' 24"	121° 45' 12"	"	"	Oso (15')
JV-49	"	"	"	48° 21' 30"	121° 45' 12"	"	"	Oso (15')
JV-52	"		"	48° 20' 54"	121° 47' 36"	"	"	Oso (15')
JV-951	"	Round Lake volcanic	tuff	48° 08' 18"	121° 19' 6"	"	"	Pugh Mtn (7.5')
JV-952	"	breccias of Vance	"	48° 08' 24"	121° 19' 24"	"	"	Pugh Mtn (7.5')
JV-18	"	Eagle Tuff	ash flow tuff	47° 46' 48"	121° 19' 48"	"	"	Evergreen Mtn (7.5')
JV-1549	"	"Sauk Ring Dike"	andesite porphyry	48° 05' 42"	121° 26' 48"	"	"	Bedal (7.5')
JV-1583	"	"	"	48° 02' 12"	121° 26' 36"	"	"	Bedal (7.5')
RWT-333-75	R.W. Tabor	Columbia River Basalt	basalt	47° 10' 12"	120° 35' 51"	X-ray Fluorescence (XRF)	M. Villarreal, Larry Espos, J.H. Christie (acting project leader)	Thorp (15')
RWT-334-75	"	"	"	47° 10' 12"	120° 35' 51"	"	"	Thorp (15')
RWT-337-75	"	"	"	47° 11' 11"	120° 35' 06"	"	"	Thorp (15')
RWT 378-75	"	"	"	47° 11' 29"	120° 41' 15"	"	"	Thorp (15')
RWT-383-75	"	"	"	47° 10' 12"	120° 43' 39"	"	"	Thorp (15')
RWT-382-75	"	"	"	47° 10' 12"	120° 43' 39"	"	"	Thorp (15')
RWT-380-75	"	"	"	47° 10' 30"	120° 43' 39"	"	"	Thorp (15')
RWT-491-75	"	"	"	47° 10' 43"	120° 46' 30"	"	"	Cle Elum (15')
RWT-490-75	"	"	"	47° 10' 43"	120° 46' 30"	"	"	Cle Elum (15')
RWT-496-75	"	"	"	47° 08' 17"	120° 54' 27"	"	"	Cle Elum (15')
RWT-347-75	"	"	"	47° 08' 31"	120° 51' 45"	"	"	Cle Elum (15')
RWT-381-75	"	"	"	47° 10' 12"	120° 43' 39"	"	"	Cle Elum (15')

Table 1 (cont.)

Sample Number	Collector	Formation	Rock Type	Location Lat.	Location Long.	Method of Analysis	Analysts	Quad. Map
RBW-75.52A	R.B. Waitt,Jr.	Columbia River Basalt	basalt	47° 18' 42"	120° 33' 54"	"	M. Villareal, Larry Espos, J. H.Christie acting project leader	Liberty (15')
RBW-75.52C	"	"	"	47° 18' 42"	120° 33' 54"	"	"	Liberty (15')
RBW-75.202-2	"	"	"	47° 10' 43"	120° 47' 24"	"	"	Cle Elum (15')
RBW-75.203F	"	"	"	47° 10' 30"	120° 47' 24"	"	"	Cle Elum (15')
RBW-75.299	"	"	"	47° 11' 00"	120° 41' 54"	"	"	Thorp (15')
RBW-75.521	"	"	"	47° 01' 27"	120° 41' 33"	"	"	Thorp (15')
RBW-75.525	"	"	"	42° 01' 57"	120° 42' 09"	"	"	Thorp (15')
RBW-75.570	"	"	"	47° 07' 30"	120° 34' 48"	"	"	Thorp (15')
RBW-75.51-2	"	"	"	47° 18' 28"	120° 34' 39"	"	"	Liberty (15')
VF-79-755	V.A. Frizzell,Jr.	Mt. Adams volcanic rocks	andesite flow	46° 10' 48"	121° 29' 34"	"	L. Espos, B. Lai project leaders: J.M. Baldwin, V.G. Mossotti	Mt. Adams East (7.5')
VF-79-756	"	"	"	46° 10' 48"	121° 29' 34"	"	"	Mt. Adams East (7.5')
VF-79-757	"	"	"	46° 10' 48"	121° 29' 34"	"	"	Mt. Adams East (7.5')
VF-79-758	"	"	"	46° 13' 38"	121° 33' 45"	"	"	Mt. Adams West (7.5')
VF-79-759	"	"	"	46° 14' 32"	121° 32' 56"	"	"	Mt. Adams West (7.5')
VF-79-760	"	"	"	46° 14' 48"	121° 27' 36"	"	"	Mt Adams East (7.5')
VF-79-761	"	"	"	46° 14' 50"	121° 27' 45"	"	"	Mt Adams East (7.5')
RWT-651-79	R.W. Tabor	"	"	46° 09' 39"	121° 28' 45"	"	"	Mt. Adams East (7.5')
RWT-652-79	"	"	"	46° 08' 25"	121° 28' 4"	"	"	Mt. Adams East (7.5')
RWT-653-79	"	"	"	46° 14' 45"	121° 27' 50"	"	"	Mt. Adams East (7.5')
RWT-654-79	"	"	"	46° 03' 25"	121° 29' 56"	"	"	King Mtn (7.5')
RWT-655-79	"	"	"	46° 03' 28"	121° 29' 56"	"	"	King Mtn (7.5')
RWT-656-79	"	"	"	46° 03' 25"	121° 29' 56"	"	"	King Mtn (7.5')
RWT-657-79	"	"	"	46° 31' 25"	121° 29' 56"	"	"	Glaciate Butte (7.5')
RWT-658-79	"	"	"	46° 08' 27"	121° 29' 50"	"	" (7.5')	Mt Adams East
D-150A	K.F. Fox, Jr.	Simcoe volcanic rocks	olivine basalt	49° 59'	120° 51'	XRF	J. Taggart, J. Baker, J. Riviello, B. Lai project leaders: J.S. Wahlberg and J.M. Baldwin	Goldendale (15')
D-150B	"	"	"	46° 00'	120° 51'	"	"	"
D-151A	"	"	"	45° 59'	120° 49'	"	"	"
D-151B	"	"	basalt	48° 59"	120° 49"	"	"	"
D-151C	"	"	"	48° 59'	120° 49'	"	"	"
D-152	"	"	rhyolite	45° 58'	120° 50'	"	"	"
D-153	"	"	basalt	45° 56"	120° 50'	"	"	"
D-154	"	"	hornblende dacite	45° 58'	120° 50'	"	"	"
D-155A	"	"	rhyolite	45° 58'	120° 50'	"	"	"
D-156	"	"	"	45° 58'	120° 51'	"	"	"
D-157	"	"	"	45° 58'	120° 48'	"	"	"
D-158	"	"	andesite	45° 58'	120° 48'	"	"	"

Table 2

Chemical analyses of Tertiary and Quaternary volcanic rocks from the Cascade Range, Washington. [Normative mineral calculations are based on normalized values of chemical analyses with water removed; Normative mineral symbols are standard symbols of CIPW norm as presented by Cross and others (1902); tr = trace].

Formation	Silver Pass Volcanic Member			Teanaway Formation					Basalt of Frost Mountain		Taneum Formation			
Sample--Number	RWT 487-77	RWT 488-77	RWT 489-77	RWT 346-76	RWT 490-77	RWT 143-78	RWT 140-75	RWT 497-75	RWT 250-77	RWT 435-76	RWT 306-77	RWT 431-76	RWT 477-76	RWT 427-76
SiO_2 ----	46.6	61.4	71.9	50.1	53.8	54.5	56.7	59.7	48.6	62.2	60.1	60.7	71.3	72.1
Al_2O_3----	14.9	15.6	14.1	14.6	13.0	13.8	13.9	12.8	14.5	13.3	17.3	17.2	14.2	12.2
Fe_2O_3----	2.3	2.3	1.5	5.4	2.0	4.7	3.3	4.7	2.3	2.3	3.7	3.7	1.8	3.7
FeO ----	4.8	2.8	1.4	7.2	11.9	8.1	7.3	6.9	9.5	6.7	.52	1.5	.06	1.2
MgO ----	3.2	2.1	.72	5.3	2.5	3.1	2.8	1.5	8.0	.56	2.7	1.7	.08	.45
CaO ----	15.4	7.0	1.1	8.2	7.4	7.0	6.8	4.8	10.9	4.3	5.2	4.3	1.1	.77
Na_2O ----	2.1	3.3	4.3	2.2	3.0	2.9	2.9	3.3	2.4	3.7	4.2	4.9	3.1	2.7
K_2O ----	.00	1.4	3.4	.21	.77	1.1	1.1	1.8	.27	1.8	2.1	2.0	4.2	4.7
TiO_2 ----	1.0	.95	.40	1.2	2.1	2.0	1.4	1.5	1.6	.74	.54	1.2	.25	.41
P_2O_5 ----	.18	.19	.10	.19	.72	.46	.21	.37	.35	.27	.18	.30	.08	.06
MnO ----	.13	.12	.06	.15	.22	.17	.16	.18	.21	.18	.08	.08	.04	.08
H_2O+ ----	2.1	1.7	1.6	3.2	1.3	1.1	1.4	.95	.99	2.4	2.1	1.9	1.7	1.5
H_2O- ----	.73	.67	.68	1.7	0.59	.71	.56	.82	.55	.66	1.7	.66	1.1	.67
CO_2 ----	8.0	2.2	.03	0.82	.01	.03	.87	.01	.01	.01	.03	.01	.01	.01
TOTAL	101.00	101.00	101.00	100.00	99.00	100.00	99.00	99.00	100.00	99.00	100.00	100.00	99.00	100.00
Normative Minerals (CIPW)														
Q ----	16.99	24.56	30.76	12.19	10.99	14.02	17.47	21.06	1.62	22.18	14.02	14.07	36.34	36.88
C ----	2.80	1.49	1.67	---	---	---	---	---	--	---	---	---	2.88	1.46
or ----	---	8.33	20.29	1.30	4.67	6.64	6.67	10.90	--	11.07	12.84	12.11	25.80	28.23
ab ----	18.01	28.09	36.73	19.47	26.05	25.06	25.17	28.61	20.58	32.58	36.76	42.47	27.25	23.21
an ----	24.03	19.69	4.66	30.69	20.24	21.85	22.22	15.16	28.37	14.95	22.90	19.49	5.06	3.42
mt ----	3.38	3.36	2.20	8.19	2.98	6.96	4.91	6.98	3.38	3.47	.39	1.66	--	2.99
il ----	1.64	1.82	.77	2.38	4.09	3.88	2.73	2.92	3.08	1.46	1.06	2.33	.22	.79
ap ----	.77	.45	.24	.47	1.75	1.11	.51	.90	.84	.67	.44	.73	.20	.14
cc ----	18.46	5.04	.07	1.95	.02	.07	2.03	.02	.02	.02	.07	.02	.02	.02
di ----	--	--	--	4.17	10.72	8.58	4.45	5.65	19.64	4.67	1.84	.22	--	--
hy ----	13.93	7.18	2.60	19.19	18.52	11.82	13.84	7.80	18.11	8.93	6.11	4.24	.21	1.14
fo ----	--	--	--	--	--	--	--	--	2.52	--	--	--	--	--
fa ----	--	--	--	--	--	--	--	--	1.85	--	--	--	--	--
hm ----	--	--	--	--	--	--	--	--	--	--	3.56	2.65	1.87	--
ru ----	--	--	--	--	--	--	--	--	--	--	--	--	.14	--
TOTAL	100.00	99.99	99.99	100.00	100.03	100.01	100.00	100.00	100.00	100.00	99.98	99.99	99.99	99.99

Table 2 (cont.)

Formation --	Naches Formation											
Sample Number	RWT 492-76	RWT 436-77	RWT 275-77	RWT 336-77	M-84B-77	BG-209-77	RWT 477-77	RWT 339-77	RWT 482-77	RWT 368-77	M-77-162	M-77-166
SiO_2 -----	45.5	50.0	51.0	51.4	51.8	54.2	56.3	56.7	57.1	72.0	75.2	78.9
Al_2O_3 ----	16.5	16.3	15.3	16.0	15.5	13.5	16.0	16.6	16.8	13.2	13.0	11.9
Fe_2O_3 ----	5.2	3.7	3.7	2.5	2.7	2.5	1.3	2.6	3.9	1.2	1.3	.20
FeO ----	6.0	5.0	6.8	7.2	6.8	9.2	5.7	4.0	4.3	2.0	.56	.16
MgO ----	5.0	6.4	6.0	7.6	6.1	2.8	1.1	3.8	4.2	.52	.37	.01
CaO ----	8.9	8.2	10.3	9.7	10.7	7.3	6.5	7.5	4.9	2.0	.54	.15
Na_2O ----	3.1	2.9	2.2	2.8	2.2	3.0	2.8	3.2	4.8	3.1	3.5	3.1
K_2O ----	.68	1.1	.33	.30	.28	.73	.63	1.4	.16	3.1	4.2	4.2
TiO_2 ----	3.2	2.3	1.0	1.6	1.1	2.2	.85	.96	1.3	.39	.33	.18
P_2O_5 ----	.65	.50	.16	.28	.17	.39	.32	.22	.26	.09	.05	.07
MnO ----	.24	.16	.24	.14	.21	.19	.13	.12	.16	.02	.00	.01
H_2O+ ----	3.1	2.1	1.5	.98	1.2	1.2	3.0	1.2	2.4	1.8	.98	.85
H_2O- ----	2.0	1.8	.97	.96	.80	.65	1.7	.72	.76	.52	.50	.41
CO_2 ----	.02	.06	.63	.02	.14	2.1	3.6	.03	.55	1.1	.02	.01
TOTAL	100.00	101.00	100.00	101.00	100.00	100.00	100.00	99.00	101.00	101.00	100.00	100.00
Normative Minerals (CIPW)												
Q ----	1.76	4.43	7.81	2.15	7.12	16.01	30.47	12.19	12.96	39.87	37.60	43.40
C ----	--	--	--	--	--	.31	8.41		1.75	3.92	1.90	2.16
or ----	4.23	6.75	2.00	1.78	1.69	4.40	3.91	8.52	.96	18.56	25.05	24.74
ab ----	27.60	25.47	19.05	23.79	19.05	25.86	24.87	27.87	41.25	26.56	29.88	26.13
an ----	30.62	28.42	31.62	30.33	32.32	20.77	7.75	27.57	19.43	2.41	2.25	.22
mt ----	7.94	5.57	5.49	3.64	4.01	3.69	1.98	3.88	5.74	1.76	.86	.29
il ----	6.40	--	1.94	3.05	2.14	4.26	1.69	1.87	2.51	.75	.63	.34
ap ----	1.62	1.23	.39	.67	.41	.94	.80	.54	.63	.22	.12	.17
cc ----	.05	.14	1.47	.05	.33	4.87	8.60	.07	1.27	2.53	.05	.02
di ----	8.88	7.92	12.61	12.95	16.22	--	--	7.28	--	--	--	--
hy ----	10.92	15.55	17.61	21.59	16.71	18.89	11.53	10.20	13.51	3.42	.93	2.51
fo ----	--	--	--	--	--	--	--	--	--	--	--	--
fa ----	--	--	--	--	--	--	--	--	--	--	--	--
hm ----	--	--	--	--	--	--	--	--	--	--	.72	--
ru ----	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL	100.01	100.01	99.99	100.00	99.99	100.01	100.01	99.99	99.99	99.99	99.99	99.99

Table 2 (cont.)

Formation	Barlow Pass volcanics of Vance (1957b)				Rhyolite near Lake Cavanaugh	Rhyolite near Oso			Round Lake volcanic breccias of Vance (1958)		Eagle Tuff of Yeats (1977)
Sample Number —	JV-43	JV-55	JV-1554	JV-1517	JV-24	JV-48	JV-49	JV-52	JV-951	JV-952	JV-18
SiO_2 ----	75.4	78.0	76.2	54.8	81.4	78.1	79.0	78.1	63.3	68.0	74.6
Al_2O_3----	12.5	13.2	13.7	15.6	9.5	12.6	11.8	10.8	15.6	14.6	13.2
Fe_2O_3----	0.88	0.79	0.38	2.7	0.82	0.58	1.6	0.45	3.3	3.4	1.6
FeO ----	1.8	0.20	1.0	5.4	0.44	1.0	0.36	1.7	3.0	2.1	0.84
MgO ----	0.26	0.09	0.19	4.2	0.26	0.16	0.04	0.18	1.8	0.87	0.57
CaO ----	0.00	0.00	0.08	6.8	0.21	0.01	0.00	1.4	6.0	1.8	1.4
Na_2O ----	4.4	1.5	4.5	3.6	1.9	2.8	5.5	0.56	3.8	6.3	3.7
K_2O ----	3.2	5.5	3.8	0.91	3.2	2.8	0.39	3.2	0.96	1.2	2.4
TiO_2 ----	0.26	0.39	0.22	1.7	0.23	0.26	0.23	0.28	0.91	0.80	0.31
P_2O_5 ----	0.06	0.07	0.04	0.38	0.06	0.05	0.05	0.03	0.19	0.20	0.08
MnO ----	0.04	0.01	0.00	0.12	0.01	0.00	0.01	0.01	0.07	0.10	0.06
H_2O+ ----	1.1	1.2	0.68	3.1	1.3	1.5	0.86	1.4	1.9	1.0	1.2
H_2O- ----	0.23	0.40	0.30	0.51	0.65	0.73	0.87	0.76	0.46	0.41	0.61
CO_2 ----	0.01	0.01	0.01	1.3	0.01	0.01	0.01	1.2	0.01	0.01	0.01
TOTAL	100.1	101.4	101.1	101.1	100	100.6	100.7	100.1	101.3	100.8	100.6
Normative Minerals (CIPW)											
Q ----	36.63	48.25	34.50	12.14	58.6	51.30	45.96	62.8	23.40	22.34	40.80
C ----	1.82	4.79	2.06	0.26	2.75	5.05	2.35	6.55	--	0.17	2.21
or ----	19.15	32.60	22.44	5.52	19.3	16.83	2.33	19.3	5.73	7.14	14.36
ab ----	37.68	12.73	38.03	31.23	16.4	24.08	47.02	4.84	32.49	53.62	31.68
an ----	--	0.79	0.33	23.61	0.60	--	--	--	22.90	7.60	6.44
mt ----	1.29	--	0.55	4.01	0.80	0.86	0.53	0.67	4.83	4.81	2.03
il ----	0.50	0.45	0.42	3.31	0.45	0.50	0.44	0.54	1.75	1.53	0.60
ap ----	--	--	--	0.92	0.15	--	--	0.07	0.46	0.48	0.19
cc ----	--	--	0.02	3.03	0.02	0.02	--	2.48	0.02	0.02	.02
di ----	--	--	--	--	--	--	--	--	4.68	--	--
hy ----	2.89	0.20	1.63	15.97	0.66	1.35	0.08	2.51	3.72	2.18	1.44
hm ----	--	--	--	--	0.28	--	1.25	--	--	0.10	0.22
ru ----	--	0.16	--	--	--	--	--	--	--	--	--
mg ----	0.02	0.02	--	--	--	tr	0.02	0.26	--	--	--
TOTAL	100.02	100.01	99.91	100.01	100.01	99.98	100	100.02	99.98	99.99	99.96

Table 2 (cont.)

Formation	Sauk Ring Dike		Columbia River Basalt											
Sample Number —	JV-1549	JV-1583	RWT 333-75	RWT 334-75	RWT 337-75	RWT 378-75	RWT 383-75	RWT 382-75	RWT 380-75	RWT 491-75	RWT 490-75	RWT 496-75	RWT 347-75	RWT 381-75	RBW-75.52A
SiO_2 ----	63.3	64.7	53.02	53.91	54.05	52.77	53.19	52.66	53.58	54.23	54.75	52.68	54.50	54.73	54.42
Al_2O_3----	16.8	15.9	14.23	13.98	14.17	14.42	14.62	14.27	14.05	14.21	14.34	14.30	14.24	14.03	14.68
Fe_2O_3----	0.94	1.8	13.36	12.89	12.66	12.32	11.92	12.76	13.08	12.20	12.10	12.79	12.45	12.62	11.37
FeO ----	3.6	2.6	--	--	--	--	--	--	--	--	--	--	--	--	--
MgO ----	3.0	2.5	4.73	4.00	4.04	5.17	4.98	4.76	3.56	3.82	3.75	5.01	4.22	3.36	4.48
CaO ----	5.3	4.2	8.45	7.57	7.63	8.97	9.22	8.61	7.43	7.74	7.71	8.92	7.79	6.91	8.72
Na_2O ----	3.7	4.6	3.11	3.17	3.28	3.00	2.92	2.96	3.17	3.10	3.17	3.03	3.13	3.14	3.14
K_2O ----	1.3	1.4	1.11	1.53	1.53	1.09	1.12	1.18	1.62	1.64	1.65	1.06	1.54	1.71	1.27
TiO_2 ----	0.64	0.67	1.85	1.85	1.81	1.70	1.71	1.83	2.12	1.80	1.85	1.69	1.78	1.89	1.85
P_2O_5 ----	0.13	0.13	0.27	0.31	0.31	0.25	0.25	0.26	0.38	0.32	0.32	0.26	0.28	0.34	0.28
MnO ----	0.07	0.07	0.20	0.18	0.18	0.19	0.20	0.19	0.18	0.18	0.19	0.19	0.18	0.18	0.18
H_2O+ ----	1.8	1.8	--	--	--	--	--	--	--	--	--	--	--	--	--
H_2O- ----	0.54	0.63	--	--	--	--	--	--	--	--	--	--	--	--	--
CO_2 ----	0.01	0.01	--	--	--	--	--	--	--	--	--	--	--	--	--
TOTAL	101.1	101	100.33	99.4	99.7	99.9	100.1	99.5	99.2	99.2	99.8	99.9	100.1	98.9	100.4
Normative Minerals (CIPW)															
Q ----	19.37	19.77	10.26	11.86	11.20	9.30	9.89	10.24	12.14	12.16	12.29	9.53	11.77	14.01	10.83
C ----	tr	--	--	--	--	--	--	--	--	--	--	--	--	--	--
or ----	7.78	8.39	6.54	9.10	9.07	6.45	6.61	7.01	9.65	9.77	9.77	6.27	9.09	10.22	7.48
ab ----	31.60	39.47	26.22	26.98	27.84	25.41	24.67	25.17	27.04	26.42	26.86	25.64	26.45	26.85	26.45
an ----	25.68	18.86	21.51	19.51	19.48	22.67	23.44	22.27	19.47	20.16	20.05	22.29	20.22	19.34	22.11
mt ----	1.38	2.65	--	--	--	--	--	--	--	--	--	--	--	--	--
il ----	1.23	1.29	0.42	0.39	0.38	0.40	0.42	0.41	0.39	0.39	0.40	0.42	0.38	0.38	0.39
ap ----	0.31	0.31	0.64	0.74	0.74	0.59	0.59	0.62	0.91	0.76	0.76	0.62	.66	0.81	0.66
cc ----	0.02	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--
di ----	--	1.08	10.01	8.14	8.43	11.70	12.00	10.3	6.58	8.42	8.12	11.79	8.59	5.53	10.46
hy ----	12.54	8.15	7.12	6.25	6.19	7.47	6.83	7.12	5.89	5.68	5.59	7.02	6.52	5.90	6.27
hm ----	--	--	13.32	13.00	12.70	12.33	11.91	12.83	13.19	12.29	12.12	12.80	12.44	12.76	11.33
tn ----	--	--	3.98	4.07	3.96	3.66	3.65	3.98	4.74	3.94	4.03	3.61	3.88	4.20	4.02
TOTAL	100.00	100.10	100.00	100.08	99.97	99.97	99.99	99.94	100.00	100.00	99.99	100.00	100.00	100.00	100.00

Table 2 (cont.)

Formation	Columbia River Basalt								Volcanic rocks of Mount Adams						
Sample Number —	RBW-75.52C	RBW-75.202-2	RBW-75.203F	RBW-75.299	RBW-75.521	RBW-75-525	RBW-75-570	RBW-75.51-2	VF 79-755	VF 79-756	VF 79-757	VF 79-758	VF 79-759	VF 79-760	VF 79-761
SiO_2 ----	54.68	53.49	53.79	52.82	53.23	53.42	53.48	53.94	60.77	57.27	57.59	59.03	57.45	50.03	59.82
Al_2O_3----	14.48	14.33	14.01	14.59	14.22	14.21	14.38	14.14	16.47	17.60	17.07	16.43	17.35	15.98	16.20
Fe_2O_3----	11.56	12.81	12.87	11.75	12.56	12.46	12.18	13.02	1.41	1.78	2.59	1.44	2.68	1.83	1.58
FeO ----	--	--	--	--	--	--	--	--	4.65	5.04	4.24	5.22	4.25	7.14	4.95
MgO ----	3.36	4.06	4.19	4.96	4.73	4.86	4.77	3.94	2.67	3.54	3.46	2.98	3.42	6.92	3.06
CaO ----	7.68	7.69	7.59	9.14	8.27	8.19	8.43	7.55	5.19	6.57	6.56	5.61	6.53	9.26	5.62
Na_2O ----	3.08	3.16	3.11	2.82	3.07	3.08	3.06	3.16	4.36	4.22	4.09	4.32	4.23	3.80	4.33
K_2O ----	1.66	1.42	1.57	0.94	1.31	1.32	1.34	1.49	2.43	1.35	1.67	2.35	1.36	1.20	2.30
TiO_2 ----	1.89	1.86	1.83	1.72	1.74	1.73	1.71	1.89	1.08	1.08	1.06	1.19	1.09	1.65	1.15
P_2O_5 ----	0.31	0.31	0.29	0.26	0.34	0.34	0.33	0.32	0.26	0.24	0.24	0.29	0.24	0.37	0.29
MnO ----	0.17	0.19	0.18	0.18	0.19	0.19	0.19	0.18	0.09	0.11	0.10	0.09	0.10	0.14	0.10
H_2O+ ----	--	--	--	--	--	--	--	--	0.12	0.26	0.47	0.09	0.23	0.39	0.15
H_2O- ----	--	--	--	--	--	--	--	--	0.12	0.14	0.23	0.19	0.19	0.22	0.23
CO_2 ----	--	--	--	--	--	--	--	--	0.0	0.05	0.04	0.05	0.09	0.41	0.23
ZrO_2 ----	--	--	--	--	--	--	--	--	0.04	0.03	0.03	0.04	0.03	0.03	0.42
Cr_2O_3----	--	--	--	--	--	--	--	--	tr	0.01	0.01	tr	0.01	0.04	tr
NiO ----	--	--	--	--	--	--	--	--	tr	tr	tr	tr	tr	0.02	tr
BaO ----	--	--	--	--	--	--	--	--	0.05	0.03	0.03	0.05	0.03	0.02	0.05
SrO ----	--	--	--	--	--	--	--	--	0.04	0.07	0.07	0.05	0.07	0.06	0.05
TOTAL	98.9	99.32	99.4	99.2	99.7	99.8	99.9	99.6	99.8	99.4	99.8	99.4			
Normative Minerals (CIPW)															
Q ----	13.27	11.42	11.55	10.82	10.39	10.39	10.24	12.07	10.46	7.45	8.64	7.96	9.01	--	9.03
Z ----	--	--	--	--	--	--	--	--	0.06	0.04	0.47	0.07	0.05	0.04	0.62
or ----	9.92	8.45	9.33	5.60	7.77	7.82	7.93	8.84	14.43	8.07	9.96	14.01	8.13	7.18	13.58
ab ----	26.35	26.91	26.45	24.05	26.05	26.10	25.92	26.83	37.05	36.08	34.92	36.87	36.19	32.52	36.60
an ----	21.01	20.85	19.73	24.57	21.21	21.08	21.56	20.06	18.27	25.35	23.49	18.66	24.60	23.26	17.95
mt ----	--	--	--	--	--	--	--	--	2.05	2.61	3.79	2.11	3.93	2.68	2.29
cm ----	--	--	--	--	--	--	--	--	tr	tr	0.01	0.01	0.01	0.060	tr
il ----	0.37	0.398	0.40	0.38	0.41	0.40	0.41	0.39	2.06	2.07	2.03	2.28	2.09	3.17	2.18
ap ----	0.74	0.740	0.69	0.62	0.81	0.81	0.78	0.76	0.62	0.58	0.57	0.69	0.58	0.89	0.59
cc ----	--	--	--	--	--	--	--	--	0.11	0.12	0.09	0.12	0.21	0.94	0.52
di ----	7.39	7.56	8.20	10.96	9.64	9.41	10.06	7.42	4.66	4.69	6.12	5.99	4.89	14.74	5.67
hy ----	5.04	6.68	6.70	7.38	7.35	7.77	7.23	6.41	10.18	12.90	9.87	11.21	10.29	1.22	10.91
fo ----	--	--	--	--	--	--	--	--	--	--	--	--	--	8.39	--
fa ----	--	--	--	--	--	--	--	--	--	--	--	--	--	4.90	--
hm ----	11.69	12.90	12.94	11.85	12.60	12.49	12.20	13.07	--	--	--	--	--	--	--
tn ----	4.21	4.08	4.01	3.76	3.75	3.73	3.68	4.15	--	--	--	--	--	--	--
TOTAL	100.00	99.99	100.00	99.99	99.98	100.00	100.01	100.00	99.96	99.96	99.96	99.97	99.96	99.99	99.95

Table 2 (cont.)

Formation	Volcanic rocks of Mount Adams								Volcanic rocks of the Simcoe Mountains						
Sample Number —	RWT 651-79	RWT 652-79	RWT 653-79	RWT 654-79	RWT 655-79	RWT 656-79	RWT 657-79	RWT 658-79	D-150A	D-150B	D-151A	D-151B	D-151C	D-152	D-153
SiO_2 ----	56.58	58.45	59.43	58.71	58.71	58.41	58.21	58.68	47.5	48.5	46.0	49.9	46.1	73.8	51.8
Al_2O_3----	16.74	16.88	16.52	16.95	16.51	16.65	16.89	16.72	16.1	16.3	14.2	16.0	14.8	13.2	15.9
Fe_2O_3----	3.31	1.54	1.49	2.55	2.99	2.95	2.10	1.97	4.30	2.91	1.61	3.10	3.24	1.58	2.9
FeO ----	4.08	5.20	5.05	4.31	4.04	3.99	4.61	4.86	7.27	9.33	10.67	7.45	8.31	0.20	7.99
MgO ----	4.04	3.10	2.93	3.52	3.45	3.46	3.31	3.41	5.91	5.31	9.01	6.16	8.64	tr	5.09
CaO ----	7.01	5.91	5.55	6.07	5.92	5.89	6.03	5.93	9.57	7.43	9.36	8.88	9.22	0.25	7.86
Na_2O ----	3.85	4.30	4.22	4.14	4.17	4.18	4.39	4.48	3.20	3.70	2.78	2.84	2.68	4.34	3.38
K_2O ----	1.31	2.20	2.32	2.16	2.22	2.22	2.18	2.25	1.36	1.86	1.31	1.10	1.28	4.80	1.47
TiO_2 ----	1.15	1.21	1.16	1.16	1.21	1.17	1.15	1.18	2.86	2.45	2.87	2.23	2.66	0.08	2.08
P_2O_5 ----	0.27	0.29	0.28	0.27	0.28	0.25	0.26	0.26	0.64	0.88	0.59	0.47	0.76	0.05	0.36
MnO ----	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.17	0.18	0.19	0.16	0.18	tr	0.15
H_2O+ ----	0.56	0.06	0.17	0.09	0.86	tr	0.03	0.01	2.31	0.43	0.16	0.53	0.61	0.27	0.21
H_2O- ----	0.24	0.15	0.16	0.19	0.19	0.25	0.21	0.13	0.43	0.35	0.33	0.47	0.97	0.19	0.43
CO_2 ----	0.10	0.07	0.11	0.09	0.07	0.06	0.06	0.08	0.10	0.20	0.22	0.44	0.05	0.07	0.05
ZrO_2 ----	0.03	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.03	0.04	0.03	0.02
Cr_2O_3----	0.01	tr	tr	0.01	tr	0.01	tr	tr	0.02	0.01	0.03	0.02	0.03	tr	0.01
NiO ----	0.01	tr	tr	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	tr	0.01
BaO ----	0.04	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.04	0.04	0.05	0.01	0.04
SrO ----	0.06	0.05	0.04	0.04	0.04	0.04	0.05	0.04	0.07	0.07	0.06	0.06	0.10	tr	0.05
Cl ----	--	--	--	--	--	--	--	--	0.01	0.02	0.03	0.02	tr	0.08	0.01
F ----	--	--	--	--	--	--	--	--	0.06	0.06	0.05	0.05	0.06	0.02	0.05
Total S ----	--	--	--	--	--	--	--	--	0.01	0.02	0.01	0.03	0.01	tr	0.01
TOTAL	99.5	99.6	99.6	100.5	100.9	99.7	99.7	100.2	102	100.1	99.6	100	99.8	99.1	99.9
Normative Minerals (CIPW)															
Q ----	9.56	7.25	9.22	8.61	9.24	8.80	6.79	6.41	--	--	--	2.38	--	30.70	2.03
C ----	--	--	--	--	--	--	--	--	--	--	--	--	--	.86	--
Z ----	.04	.06	.06	.06	.07	.06	.06	.06	.045	.05	.03	.05	.06	.05	.030
or ----	7.85	13.09	13.81	12.75	13.15	13.20	12.96	13.29	8.11	11.07	7.82	6.57	7.71	28.76	8.76
ab ----	33.01	36.61	35.96	34.97	35.35	35.56	37.36	37.88	27.26	31.36	21.94	24.10	23.07	36.58	28.43
an ----	24.85	20.38	19.41	21.25	19.81	20.22	20.05	18.85	25.78	22.62	22.71	28.04	25.04	.38	24.28
hl ----	--	--	--	--	--	--	--	--	tr	tr	tr	tr	tr	tr	tr
mt ----	4.86	2.25	2.18	3.69	4.34	4.30	3.06	2.86	6.29	4.25	2.36	4.54	4.79	.49	4.24
cm ----	.01	tr	tr	.01	.01	.01	.01	.01	.03	.02	.05	.03	.05	.01	.02
il ----	2.21	2.31	2.22	2.20	2.30	2.23	2.20	2.24	5.48	4.69	5.50	4.28	5.15	.15	3.98
ap ----	.65	.69	.67	.64	.67	.60	.62	.62	1.53	2.10	1.41	1.13	1.83	.12	.86
fr ----	--	--	--	--	--	--	--	--	.01	--	--	.02	--	.03	.04
pr ----	--	--	--	--	--	--	--	--	.01	.03	.02	.06	.02	tr	.03
cc ----	.23	.16	.25	.20	.16	.14	.14	.18	.23	.46	.51	1.01	.12	.16	.12
di ----	6.42	5.64	4.82	5.30	5.96	5.79	6.53	6.87	13.88	6.20	15.43	8.56	13.08	--	10.06
hy ----	10.25	11.53	11.35	10.28	8.92	9.06	10.18	10.69	5.27	5.17	--	19.13	5.26	.25	17.05
fo ----	--	--	--	--	--	--	--	--	4.28	6.19	12.63	--	9.57	--	--
fa ----	--	--	--	--	--	--	--	--	1.73	5.68	8.61	--	4.18	--	--
ne ----	--	--	--	--	--	--	--	--	--	--	.88	--	--	--	--
hm ----	--	--	--	--	--	--	--	--	--	--	--	--	--	1.26	--
TOTAL	99.95	99.97	99.96	99.97	99.97	99.96	99.95	99.96	99.93	99.88	99.88	99.89	99.93	99.7	99.91

Table 2 (cont.)

Formation	Volcanic rocks of the Simcoe Mountains				
Sample Number —	D-154	D-155A	D-156	D-157	D-158
SiO_2 ----	68.9	74.2	64.6	64.7	50.6
Al_2O_3----	14.1	14.1	15.3	15.3	18.2
Fe_2O_3----	2.88	0.98	4.41	2.81	2.99
FeO ----	1.09	0.06	1.05	1.99	6.83
MgO ----	0.21	tr	0.63	0.98	5.47
CaO ----	2.09	0.58	2.64	2.64	9.24
Na_2O ----	4.45	2.82	3.81	3.71	3.11
K_2O ----	3.06	4.80	3.63	3.97	0.58
TiO_2 ----	0.29	0.20	0.81	0.74	1.63
P_2O_5 ----	tr	tr	0.24	0.23	0.18
MnO ----	0.06	tr	0.02	0.04	0.15
H_2O+ ----	0.53	1.03	0.65	0.96	0.49
H_2O- ----	1.59	0.41	1.78	1.45	0.45
CO_2 ----	0.05	0.06	0.05	0.06	0.05
ZrO_2 ----	0.05	0.01	0.05	0.05	0.02
Cr_2O_3----	tr	tr	tr	tr	0.01
NiO ----	tr	tr	tr	tr	tr
BaO ----	0.08	0.05	0.08	0.09	0.01
SrO ----	0.02	0.01	0.02	0.03	0.08
Cl ----	tr	tr	tr	0.01	tr
F ----	0.05	0.02	0.05	0.06	0.02
Total S ----	tr	0.02	tr	tr	tr
TOTAL	99.6	99.5	99.8	99.8	100.1
Normative Minerals (CIPW)					
Q ----	27.58	39.10	23.39	22.17	1.75
C ----	--	3.55	1.05	0.86	--
Z ----	0.08	0.02	0.08	0.08	0.03
or ----	18.56	28.92	22.03	24.09	3.46
ab ----	38.63	24.31	33.08	32.18	26.51
an ----	9.71	2.19	11.44	11.38	34.30
hl ----	tr	tr	tr	tr	tr
mt ----	2.95	--	1.14	4.18	4.37
cm ----	0.01	0.01	0.01	0.01	0.02
il ----	0.57	0.14	1.58	1.44	3.12
ap ----	0.12	0.12	0.58	0.56	0.43
fr ----	0.10	0.03	.06	.08	0.01
pr ----	tr	0.03	tr	tr	tr
cc ----	0.12	0.14	0.12	0.14	0.12
di ----	.06	--	--	2.70	8.47
hy ----	0.51	0.25	1.61	--	17.37
hm ----	0.92	1.00	3.74	--	--
ru ----	--	0.13	--	--	--
TOTAL	99.91	99.89	99.91	99.87	99.95

REFERENCES CITED

Cross, W., Iddings, J. P., Pirsson, L. V., and Washington, H.S., 1902, A quantitative chemico-mineralogical classification and nomenclature of igneous rocks: Journal of Geology, v. 10, p. 555-690.

Dethier, D. P., Whetten, J. T., Carroll, P. R., 1980, Preliminary geologic map of the Clear Lake SE quadrangle, Skagit County, Washington: U. S. Geological Survey, Open-File Report 80-303, p. 11.

Foster, R. J., 1960, Tertiary Geology of a portion of the Central Cascade Mountains, Washington: Geological Society of America Bulletin, v.71, p. 99-126.

-----, 1967, Geology of the Rampart Ridge-Keechelus Ridge area, Central Cascade Mountains, Washington: Northwest Science, v. 41, no. 1, p. 32-41.

Frizzell, V. A., Jr., Tabor, R. W., Gaum, William, Hetherington, M. J., 1979, Ages and stratigraphic relationships of selected Paleogene nonmarine rocks, central Cascades and western foothills, Washington: Geological Society of America Abstracts with Programs, v. 11, no. 7, p. 428.

Gresens, R. L., Whetten, J. T., Tabor, R. W., Frizzell, V. A., Jr., 1977, Tertiary stratigraphy of the central Cascades Mountains, Washington State, in Brown, E. H., and Ellis, R. C., eds., Geological Excursions in the Pacific Northwest: Geological Society of America field guide, annual meeting, Seattle, p. 84-126.

Heath, M. T., 1971, Bedrock geology of the Monte Cristo area, north Cascades, Washington: Seattle, University of Washington Ph.D. thesis, 164 p.

Hopkins, K. D., 1976, Geology of the south and east slopes of Mount Adams Volcano, Cascade Range, Washington: Seattle, University of Washington, Ph.D. thesis, 143 p.

Johnson, S. Y., 1982, Stratigraphy, sedimentology, and tectonic setting of the Eocene Chuckanut Formation, northwest Washington: Seattle, University of Washington, Ph.D. thesis, 221 p.

Lovseth, T. P., 1975, The Devils Mountain fault zone, northwestern Washington: Seattle, University of Washington, Ph.D. thesis, 29 p.

Shapiro, L., 1975, Rapid analysis of silicate, carbonate, and phosphate rocks-revised edition: U.S. Geological Survey Bulletin 1401, 76 p.

Sheppard, R. A., 1960, Petrology of the Simcoe Mountains area, Washington: Baltimore, John Hopkins University Ph.D. thesis, 153 p., Plate 1, 1:125,000.

Smith, G. O., 1904, Description of the Mount Stuart quadrangle, Washington: U.S. Geological Survey, Geologic Atlas Mount Stuart, Folio 106, 10 p.

-----, 1906, Description of the Snoqualmie quadrangle, Washington: U.S. Geological Survey, Geologic Atlas Snoqualmie, Folio 139, 14 p.

Swanson, D. A., Wright, T. L., 1978, Bedrock geology of the northern Columbia Plateau and adjacent Areas, in Baker, V. R., and Nummedal, D., eds., The Channeled Scabland, N.A.S.A., Office of Space Science, Washington, D.C., 186 p.

Tabor, R. W., Frizzell, V. A., Jr., Whetten, J. T., Swanson, D. A., Byerly, G. R., Booth, D. B., Hetherington, M. J., Waitt, R. B., Jr., 1980, Preliminary geologic map of the Chelan 1:100,000 quadrangle, Washington: U.S. Geological Survey Open-File Map 80-841, 43 p.

Tabor, R. W., Frizzell, V. A., Jr., Booth, D. B., Whetten, J. T., Waitt, R. B., Jr., 1982a, Preliminary geologic map of the Skykomish River 1:100,000 quadrangle, Washington: U.S. Geologic Survey Open-File map no. 82-747, 31 p.

Tabor, R. W., Frizzell, V. A., Jr., Yeats, R. S., and Whetten, J. T., 1982b, Geologic map of the Eagle Rocks-Glacier Peak Roadless Areas (U.S.F.S. RARE II nos. 6031 and 6054) U.S. Geological Survey MF-1380-A.

Tabor, R. W., Waitt, R. B., Jr., Frizzell, V. A., Jr., Swanson, D. A., and Byerly, G. R., 1982c, Geologic map of the Wenatchee 1:100,000 quadrangle, Washington: U.S. Geological Survey M. I. Map. no. I-1311.

Tabor, R. W., Frizzell, V. A., Jr., Vance, J. A., and Naeser, C. W., in press, Ages and stratigraphy of lower and middle Tertiary sedimentary and volcanic rocks of the Central Cascades, Washington: applications to the tectonic history of the Straight Creek fault: Geological Society of American Bulletin.

Vance, J. A., 1957a, The geology of the Sauk River area in the northern Cascades of Washington: Seattle, University of Washington, Ph. D. thesis, 312 p.

-----, 1957b, The geology of the Sauk River area in the northern Cascades of Washington: Dissertation Abstracts, vol. 17, no. 9, p. 1984

-----, 1982, Cenozoic stratigraphy and tectonics of the Washington Cascades (abstract): Geological Society of America Abstracts with Programs, v. 14, no. 4, p. 241.

Yeats, R. S., 1958, Geology of the Skykomish area in the Cascade Mountains of Washington: Seattle, University of Washington, Ph.D. thesis, 249 p.

-----, 1977, Structure, stratigraphy, plutonism and volcanism of the central Cascades, Washington, Part I, General geologic setting of the Skykomish Valley, in Brown, E. H., and Ellis, R. C., eds., Geological Excursions in the Pacific Northwest, Geological Society of America field guide, annual meeting, Seattle, p. 265-275.