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CHEMICAL ANALYSES OF TUFFS AND SOME LAVA FLOWS IN PALEOGENE FORMATIONS IN WESTERN WASHINGTON AND NORTHWESTERN OREGON

by

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INTRODUCTION

This report presents major-element and trace-element whole-rock analyses of 290 samples of mainly tuffs and minor lava flows interstratified in chiefly middle to upper Eocene sedimentary formations in western Washington and northwestern Oregon. Additional samples of tuffs from the southern Cascade Range, Washington, and Mazama ash, in northwestern Oregon, were analyzed for comparisons. The analyses, consisting of X-ray fluoresence (XRF) and instrumental neutron activation (INA), were performed at laboratories of the U.S. Geological Survey and the Oregon State University Radiation Center in Corvallis, Oregon.

Geologic Setting

Tuff beds (deposits of volcanic ash) are locally common within the middle to upper Eocene sedimentary formations of western Washington and Oregon. These formations consist chiefly of micaceous quartz-feldspar sandstone, siltstone and mudstone, local coal beds, and a few conglomerates, ranging in thickness from 200 m to more than 2 km, and over an age span of about 38 to 48 Ma. They were deposited in continental, transitional and marine environments, grading east to west, and transported from eastern sediment sources. Geographically, they mainly lie within the Coast Range (Cascade forearc) and the Cascade Range (volcanic arc). Stratigraphically, they interfinger with and overlie lava flows and volcaniclastic deposits composing the basement of the Coast Range, and underlie and interstratify with volcanic strata of the Cascade Range. Areal distributions of these formations are shown in Figure 1.

Purpose

Because the sedimentary formations are similar lithologically over a broad area, have variable thickness, and were deposited in diverse environments, attempts at defining biostratigraphic zones applicable to the entire area lack resolution and have been only partly successful (Armentrout, 1981). Recognition of coccolith zones has been especially helpful in correlating to the Narizian and lower Refugian Foraminiferal Stages, which span the age of most marine deposits. Attempts to extend these stratigraphic boundaries eastward into nonmarine rocks have met with limited success. Megafloral zones can not be traced laterally because of lack of good fossil preservation, extensive forest cover, and structural complications. However, radiometric age dating of random volcanic beds within the sedimentary formations has aided in establishing chronology between marine and continental sections (Niem and Niem, 1992).

The purpose in sampling and analyzing tuffs is to correlate beds between outcrops and drill holes and to trace beds between formations based on their geochemistry. Distribution and thickness of beds also provides information on sedimentary depositional patterns. For example,

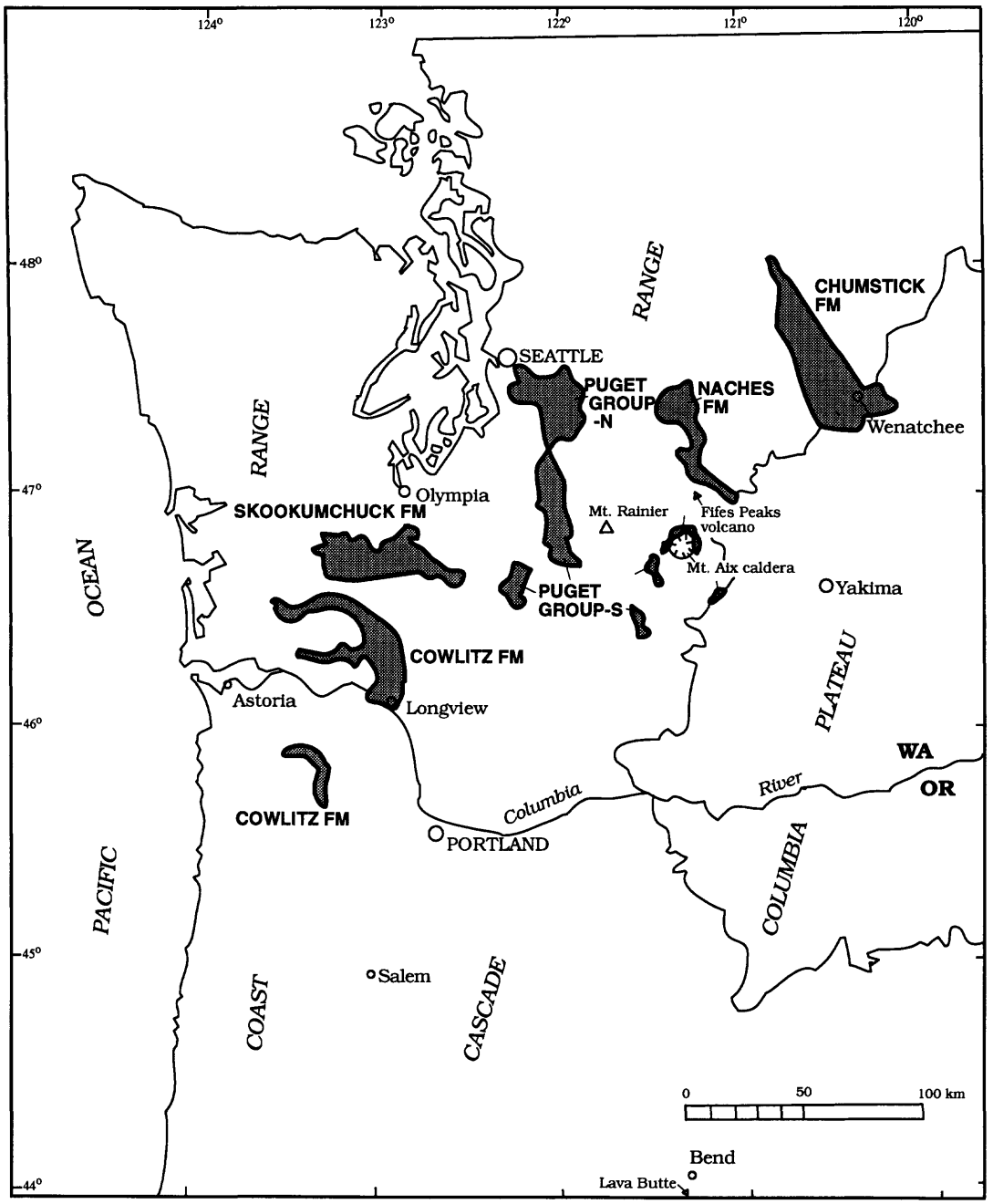

Figure 1 Areal distribution of middle to upper Eocene sedimentary formations sampled for tuffs in northwestern Oregon and western Washington (Base map from King and Beikman, 1974, with additions from Niem and Niem, 1985; Walsh and others, 1987; and P.E. Hammond, unpub. mapping, 1995)

tuff beds in the Cowlitz Formation, of northwestern Oregon and southwestern Washington, are variable in thickness and discontinuous; most are probably lenses which were deposited in eddies of streams or in swales on the continental shelf. In contrast, tuff beds in the Chumstick Formation of central Washington were deposited on extensive floodplains and are nearly uniform in thickness and traceable for kilometers (McClincy, 1986). The study also reveals the composition and type of volcanic activity that was concurrent with sedimentation. Some tuff beds listed here can be radiometrically dated, thus establishing better age control on the depositional interval of the sedimentary formation and correlation between formations. Many beds, because of their high clay content, can give information on diagenetic processes during burial. Some samples are tuffs collected from coal beds, and are tonsteins (Bohor and Triplehorn, 1993). They are generally extensively altered to clay.

Tables

Analyses of tuffs, and some lava flows, are listed in Tables 1 to 8. Tables 1 to 7 correspond to the major sedimentary formations sampled, arranged in sequence geographically from southwest to northeast as shown in figure 1. Table 1 lists samples from the Cowlitz Formation of northwestern Oregon. Additional samples in Table 1 are from the Tillamook volcanic rocks, the Sunset Highway member of the Hamlet Formation of Niem and Niem (1985), Grays River volcanic rocks, Goble volcanic rocks, and Keasey Formation. Table 2 shows analyses of samples from the Cowlitz Formation of southwestern Washington and three from the underlying McIntosh Formation. Table 3 is samples from the Skookumchuck Formation in southwestern Washington (Flores and Johnson, 1995). Table 4 lists samples from the Puget Group-south of southwestern Washington. Puget Group-south comprises those formations south of latitude 47°15' and west of the crest of the Cascade Range, including the Carbonado (Johnson and Stanley, 1995) and Spiketon Formations, and the Chambers Creek beds (Winters, 1984). Three analyses in Table 4 are from the overlying Ohanapecosh Formation. Table 5 lists samples from Puget Group-north, of northwestern Washington, which includes the Tiger Mountain and Renton Formations. Additionally two analyses in Table 5 are from the underlying Raging River Formation (Johnson and O'Connor, 1994). Table 6 shows samples from the Naches Formation, chiefly in the upper Naches River drainage, although a few samples are from the upper Yakima River drainage. The Naches Formation here includes all stratigraphic units of micaceous-feldspathic beds east of the crest of the Cascade Range which have previously been referred to as Puget Group. Units included are the Puget Group in the Bumping Lake area (Abbott, 1953), and Spencer Creek beds (Swanson, 1966, 1978). Three analyses in Table 6 are from the overlying Wildcat Creek beds (Swanson, 1966, 1978). Table 7 shows analyses of samples from the Chumstick Formation of northwestern Washington. Table 8 lists analyses of miscellaneous samples taken from volcanic strata in the southern Cascade Range of Washington and Mazama ash in northwestern Oregon. Five samples of Mazama ash were recovered from drill cuttings in the Columbia River floodplain between Portland, Oregon, and Longview, Washington (K.C. Robbins, personal communication, 1990). Two samples of airfall Mazama ash were collected below basaltic ash of Lava Butte which is located south of Bend, Oregon.

Most stratigraphic units referred to in the tables are generally well known, widely recognized, and appear in name in regional geologic maps such as the Geologic Map of Oregon

(Walker and MacLeod, 1991) and the Southwest Quadrant Map of Washington (Walsh and others, 1987). Three informally named stratigraphic units are referenced above. In Table 8 several informally named tuff units are mentioned. The Bumping River, McDaniel Lake, and Cash Prairie tuffs are briefly described in Hammond and others (1994). Fifes Peaks tuff is an informal name applied to andesitic tuffs interstratified with lava flows of the Fifes Peaks Formation. The Burnt Mountain tuff was recognized and mapped by Swanson (1966, 1978). Stevens Ridge tuff is a pyroclastic-flow unit within the Stevens Ridge Formation, first mapped in Mount Rainier National Park (Fiske and others, 1963).

Samples are arranged in each table in approximate ascending stratigraphic order.

Sample Information

Brief information on each sample is shown in one column. It gives sample number, with prefix denoting quadrant in the state, analysis number, batch (group sent to U.S. Geological Survey for analysis), lithology, thickness of bed, host stratigraphic unit and approximate stratigraphic position within that formation, section or road where sample was collected, and location by section, township, and range, based on Willamette Meridian and Baseline, longitude north and latitude west, and elevation. This information is followed below by XRF analyzed values, normalized values at 100% recalculated volatile free with total iron oxides converted to FeO*, and XRF and INA analyses for trace elements. Key to abbreviations in the tables is listed in the pages preceding the tables. Key to abbreviations to stratigraphic units is summarized at end of this list.

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KEY TO ABBREVIATIONS IN LISTS OF ANALYSES OF TUFFS AND LAVA FLOWS

Note that abbreviations run together in some descriptions

Am	American
A	andesite
ab	above base, lower contact
ag	augite
B	basalt
BA	basaltic or mafic andesite
bas	basalt, basaltic
bd	bed
blo	below
BMT	Burnt Mountain tuff (informal unit described in Swanson 1966, 1978; see also Hammond and others, 1994)
brc	breccia
brdg	bridge
brn	brown
BRT	Bumping River tuff (informal unit described in Hammond and others, 1994)
bt	below top contact
But	Butte
carb	carbon, carbonaceous
C&W	Clark and Wilson sand in the Cowlitz Formation of northwestern Oregon
CB	Carbonado Formation (lower part of Puget Group-south)
CC	Chambers Creek beds (informal unit in upper part of Puget Group-south, Winters, 1984)
CCH	Christopher C. Humphrey, sampler
cgl	conglomerate
Champlin P.	Champlin Oil Company, Puckett well 13-36-85
chan	channel
cl	clay, clayey
clt	clast
clst	claystone
cm	centimeters
co	core
colbrc	collapse breccia (in Mount Aix caldera, described in Hammond and others, 1994)
CPT	Cash Prairie tuff (informal unit described in Hammond and others, 1994)
Cr	Creek
cs	coarse, coarse-grained
CS	Chumstick Formation
cu	cuttings
CWL	Cowlitz Formation
Cyn	Canyon

D	dacite
dep	depth
DH	drill hole
E	east
ERx	Edgar Rock volcano (described in Carkin, 1988; location and brief description in Hammond and others, 1994)
Fe0*	total iron oxides as FeO
fm	ferromagnesian mineral, femic
Fm	Formation
fn	fine, fine-grained
FPk	Fifes Peaks volcano (location and description in Hammond and others, 1994)
fs	feldspar
FS	Forest Service (pertaining to roads)
ft	feet
GRV	Grays River volcanic rocks
gry	gray
HS	Hot Springs
hycl	hyaloclastic, hyaloclastite
KCR	Kenneth C. Robbins, sampler
Kelly	The top of a rotary drill string at approximate top of drilling platform, about 40 ft above ground level.
lac	lacustrine
lam	laminated
Lk	lake
lap	lapilli
lapst	lapillistone
lf	lava flow
lo	lower
LOI	lost on ignition
Longv	Longview, Washington
lth	lithic
MA	mafic or basaltic andesite
MAC	Mount Aix caldera (described in Hammond and others, 1994)
mdst	mudstone
mid	middle
MJM	Matthew J. McClincy, sampler
Mt. Cath R	Mt. Catherine Rhyolite
mtx	matrix
Mult	Multnomah
N	north
na	not analyzed
nd	not determined
nr	not reported, or near

NWEC	Nehama Weagant Energy Company
NWO	northwestern Oregon
NWW	northwestern Washington
oc	outcrop
OH	Ohanapecosh Formation
pc	plagioclase
Pen	Penitentiary coal seam (in the Skookumchuck Formation, Centralia coal field, southwestern Washington, Snavely and others, 1958; Flores and Johnson, 1995)
pm	pumice, pumiceous
pt	part
q, Q	quartz
qry	quarry
R	rhyolite
RAJ	Robert A. Jensen, sampler
rc	roadcut
RCE	Russell C. Evarts, sampler
rd	road
RD	rhyodacite
Rdg, rdg	ridge
RDS	Rodney D. Swanson, sampler
RN	Renton Formation (upper part of Puget Group-north)
RR	Raging River Formation (Johnson, 1995)
rw	reworked
rx	rock
S	south
sdy	sandy
scor	scoria, scoriaceous
si	siliceous, silicified
SJ	Samuel Y. Johnson, sampler
SK	Skookumchuck Formation
SLK	Steven L. Kenitz, sampler
Snoq Pass	Snoqualmie Pass
SPK	Spiketon Formation (upper part of Puget Group-south)
SRT	tuff in Stevens Ridge Formation (Fiske and others, 1963; see also Hammond and others, 1994)
STR	section-township-range
Suns Hwy ss	Sunset Highway sandstone (member of Hamlet Formation of Niem and Niem (1985)
SW	southwestern Washington
SWW	southwestern Washington
tf	tuff
tf-brc	tuff-breccia

TM	Tiger Mountain Formation (upper part of Puget Group-north)
TVR	Tillamook volcanic rocks
TWM	Timberwolf Mountain (volcano described by Shultz, 1988; see also Hammond and others, 1994)
up	upper
vit	vitric
volc	volcanic, volcano
W	west
WC	Wildcat Creek beds (Swanson, 1966, 1978; see also Hammond and others, 1994)
wd	welded (tuff)
wh	white
w/o	without
xl	crystal

Roman number in Field no. represents month, e.g., VI=June, etc.
#183 is number of analysis at Oregon State University Radiation Center, Corvallis, Oregon.
W. Summit Creek lies in Mineral 7.5' quadrangle; E. Summit Creek drains Cascade Range crest and lies in White Pass and Ohanapecosh Hot Springs 7.5' quadrangles.

ABBREVIATIONS TO STRATIGRAPHIC UNITS

BMT	Burnt Mountain tuff (informal unit described in Swanson, 1966, 1978; see also Hammond and others, 1994)
BRT	Bumping River tuff (informal unit described in Hammond and others, 1994)
C&W	Clark and Wilson sandstone member in the Cowlitz Formation of NWO
CB	Carbonado Formation (lower part of Puget Group-south)
CC	Chambers Creek beds (informal unit in upper part of Puget Group-south, Winters, 1984)
CPT	Cash Prairie tuff (informal unit described in Hammond and others, 1994)
CS	Chumstick Formation
CWL	Cowlitz Formation
FPk	Fifes Peaks volcano (location and description in Hammond and others, 1994)
GRV	Grays River volcanic rocks
OH	Ohanapecosh Formation
Pen	Penitentiary coal seam (in the Skookumchuck Formation, Centralia coal field, southwestern Washington, Snavely and others, 1958; Flores and Johnson, 1995)
RN	Renton Formation (upper part of Puget Group-north)
RR	Raging River Formation (Johnson, 1995)
SK	Skookumchuck Formation
SPK	Spiketon Formation (upper part of Puget Group-south)
SRT	tuff in Stevens Ridge Formation (see Hammond and others, 1994)
Suns Hwy ss	Sunset Highway sandstone member of Hamlet Formation (Niem and Niem, 1985)
TM	Tiger Mountain Formation (lower part of Puget Group-north)
TVR	Tillamook volcanic rocks
WC	Wildcat Creek beds (in formal unit described in Swanson, 1966, 1978; see also Hammond and others, 1994)

Table 1. Analyses of tuff and lava flow samples from Cowlitz Formation of northwestern Oregon

[Other formations sampled: Tillamook volcanic rocks, Sunset Highway sandstone member of Hamlet Formation, Grays River volcanic rocks, Goble volcanic rocks, and Keasey. Analyses listed in approximate stratigraphic order]

Sample no.	NWO93017	NWO93016	NWO93015	NWO93014	NWO93018	NWO93001	NWO93013	NWO93021	NWO93012	NWO93020	NWO93011	NWO93002
Lab no.	D-546947	D-546946	D-546945	D-546944	D-546948	D-546931	D-546943	D-546951	D-546942	D-546950	D-546941	D-546932
Analysis	VS23	VS23	VS23	VS23	VS23	VS23	VS23	VS23	VS23	VS23	VS23	VS23
Batch	D	D	D	D	D	D	D	D	D	D	D	D
Field no.	SLK 93017	SLK 93016	SLK 93015	SLK 93014	SLK 93018	SLK 93001	SLK 93013	SLK 93021	SLK 93012	SLK 93020	SLK 93011	SLK 93002
Lithology	bas lava flow	lithic tuff	lithic tuff	basaltic tuff	tuff	bas tf-brc	tuff-breccia	bas lava flow	basaltic tuff	basaltic tuff	basaltic tuff	bas tf-brc
Source/tk,cm	cu/640	cu/1585	cu/793	cu/732	cu/1128	co/76	cu/457	cu/1100	cu/1950	cu/1675	cu/1495	co/1160
Strat position	mid TVR	mid TVR	top TVR	top TVR	top TVR	top TVR	Suns Hwy ss	Suns Hwy ss	Suns Hwy ss	Suns Hwy ss	Suns Hwy ss	Suns Hwy ss
Section/Well	ARCO	ARCO	ARCO	ARCO	Reichhold	Texaco	ARCO	ARCO	ARCO	ARCO	ARCO	Texaco
	31-27-65	31-27-65	31-27-65	31-27-65	32-10-65	Clatskanie #1	31-27-65	44-21-65	31-27-65	44-21-65	31-27-65	Clatskanie #1
1/4,1/4,1/4	NWNE	NWNE	NWNE	NWNE	SWNE	SWNE	NWNE	SESE	NWNE	SESE	NWNE	SWNE
STR	27-6N-5W	27-6N-5W	27-6N-5W	27-6N-5W	10-6N-5W	36-7N-4W	27-6N-5W	21-6N-5W	27-6N-5W	21-6N-5W	27-6N-5W	36-7N-4W
7.5' quad	Birkenfield	Birkenfield	Birkenfield	Birkenfield	Marshland	Delena	Birkenfield	Birkenfield	Birkenfield	Birkenfield	Birkenfield	Delena
Lat N	45°58'51"	45°58'51"	45°58'51"	45°58'51"	46°01'14"	46°03'00"	45°58'51"	45°59'02"	45°58'51"	45°59'02"	45°58'51"	46°03'00"
Long W	123°17'02"	123°17'02"	123°17'02"	123°17'02"	123°17'02"	123°07'05"	123°17'02"	123°18'00"	123°17'02"	123°18'00"	123°17'02"	123°07'05"
Kelly/elev,ft	758	758	758	758	762	271	758	880	758	880	758	271
Sample dep,ft	-4628	-4562	-3692	-3662	-4290	-5634	-3272	-3600	-2522	-3020	-2297	-4064
Major Elements (XRF, analyzed values, waight%)												
SiO_2	47.10	na	47.70	48.80	51.30	30.70	na	47.40	47.80	na	44.90	44.20
Al_2O_3	13.70	- - -	14.20	14.50	16.20	12.60	- - -	14.10	12.10	- - -	12.90	12.90
TiO_2	3.16	- - -	3.08	3.28	2.55	2.52	- - -	3.22	2.79	- - -	3.08	2.62
$FeTO_3$	13.50	- - -	13.10	13.00	10.80	7.84	- - -	13.20	13.00	- - -	13.00	12.00
MnO	0.18	- - -	0.19	0.20	0.20	0.34	- - -	0.23	0.19	- - -	0.21	0.16
CaO	9.74	- - -	7.18	7.39	5.93	19.90	- - -	8.51	9.95	- - -	10.40	8.04
MgO	5.14	- - -	4.46	4.28	2.80	1.43	- - -	4.15	4.28	- - -	4.90	5.46
K_2O	0.76	- - -	0.92	0.99	1.71	0.26	- - -	1.18	0.81	- - -	0.59	1.14
Na_2O	2.65	- - -	3.33	3.64	4.59	1.20	- - -	3.13	2.58	- - -	2.78	2.34
P_2O_5	0.41	- - -	0.49	0.55	0.50	0.49	- - -	0.65	0.48	- - -	0.46	0.51
LOI @ 925°C	3.06	- - -	4.62	2.69	2.64	19.30	- - -	3.65	4.52	- - -	5.99	9.93
Total	99.40	- - -	99.27	99.32	99.22	96.58	- - -	99.42	98.50	- - -	99.21	99.30
FeO*	12.15	- - -	11.79	11.70	9.72	7.05	- - -	11.88	11.70	- - -	11.70	10.80
Total w/o LOI	94.99	- - -	93.34	95.33	95.50	76.49	- - -	94.45	92.68	- - -	91.92	88.17
Major Elements (XRF, normalized values, waight%)												
SiO_2	49.59	- - -	51.10	51.19	53.72	40.13	- - -	50.19	51.58	- - -	48.85	50.13
Al_2O_3	14.42	- - -	15.21	15.21	16.96	16.47	- - -	14.93	13.06	- - -	14.03	14.63
TiO_2	3.33	- - -	3.30	3.44	2.67	3.29	- - -	3.41	3.01	- - -	3.35	2.97
FeO*	12.79	- - -	12.63	12.27	10.18	9.22	- - -	12.58	12.62	- - -	12.73	12.25
MnO	0.19	- - -	0.20	0.21	0.21	0.44	- - -	0.24	0.21	- - -	0.23	0.18
CaO	10.25	- - -	7.69	7.75	6.21	26.01	- - -	9.01	10.74	- - -	11.31	9.12
MgO	5.41	- - -	4.78	4.49	2.93	1.87	- - -	4.39	4.62	- - -	5.33	6.19
K_2O	0.60	- - -	0.99	1.04	1.79	0.34	- - -	1.25	0.87	- - -	0.64	1.29
Na_2O	2.79	- - -	3.57	3.82	4.81	1.57	- - -	3.31	2.78	- - -	3.02	2.65
P_2O_5	0.43	- - -	0.52	0.58	0.52	0.64	- - -	0.69	0.52	- - -	0.50	0.58
Total	100.00	- - -	100.00	100.00	100.00	100.00	- - -	100.00	100.00		100.00	100.00
Trace Elements (XRF, ppm)												
Ni	52	70	50	36	<10	172	30	25	nd	48	nd	45
Cr	88	112	90	75	<20	335	44	34	nd	60	nd	53
Ba	320	325	680	315	435	104	465	410	nd	680	nd	170
Rb	14	21	23	21	33	<10.	24	30	16	34	12	27
Sr	410	390	365	370	405	280	450	385	400	325	395	255
Zr	225	240	280	305	405	182	290	275	240	305	260	230
Y	33	33	36	41	43	38	38	42	31	34	33	31
Nb	33	37	42	51	60	30	46	45	40	47	40	35
Cu	73	70	46	44	26	72	45	52	nd	60	nd	48
Zn	94	102	120	116	104	94	108	118	nd	108	nd	106
La	40	34	44	30	50	30	54	<30	nd	41	nd	30
Ce	57	60	92	79	106	70	86	80	nd	75	nd	60
Trace Elements (INAA, ppm, except Fe, Na, K, Ce, and Tl in weight%)												
Lab no.	na	na	na	na	na	na	na	na	na	na	na	W-258643
Analysis	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	CK32
Fe	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	8.85
Na	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	1.87
K	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	1.24
Ca	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	5.96
Tl	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	1.68
Sc	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	22.62
Cr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	63.00
Co	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	34.00
Ni	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	51.00
Zn	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	99.10
As	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	1.46
Se	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	<0.8
Br	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	nd
Rb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	25.50
Sr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	280.00
Mo	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	2.00
Sb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	0.184
Au	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	<0.005
Ce	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	0.57
Ba	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	159.00
La	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	32.30
Ce	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	65.80
Nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	35.10
Sm	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	8.67
Eu	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	2.42
Gd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	nd
Tb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	1.14
Ho	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	nd
Tm	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	nd
Yb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	2.88
Lu	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	0.374
Zr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	213.00
Hf	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	5.49
Ta	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	2.69
W	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	nd
Th	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	3.52
U	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	0.98

Table 1. Analyses of tuff and lava flow samples from Cowlitz Formation of northwestern Oregon (continued)

[Other formations sampled: Tillamook volcanic rocks, Sunset Highway sandstone member of Hamlet Formation, Grays River volcanic rocks, Goble volcanic rocks, and Keasey. Analyses listed in approximate stratigraphic order]

Sample no.	NWO93029	NWO93028	NWO93027	NWO93032	NWO93031	NWO93030	NWO93003	NWO93004	NWO93005	NWO93019	NWO85204	NWO85205
Lab no.	D-546959	D-546958	D-546957	D-546962	D-546961	D-546960	D-546933	D-546934	D-546935	D-546949	D-501250	D-501251
Analysis	VS23	VS23	VS23	VS23	VS23	VS23	VS23	VS23	VS23	VS23	UX21	UX21
Batch	D	D	D	D	D	D	D	D	D	D	A	A
Field no.	SLK 93029	SLK 93028	SLK 93027	SLK 93032	SLK 93031	SLK 93030	SLK 93003	SLK 93004	SLK 93005	SLK 93019	2A1.24VIIIS	2A2.24VIIIS
Lithology	silty tuff	silty tuff	silty tuff	bas lava flow	bas lava flow	bas lava flow	bas lava flow?	basaltic tuff	basaltic tuff	basaltic tuff	ss70cmbelotf	ss35cmbelotf
Source/tk,cm	cu/365	cu/152	cu/1680	cu/1550	cu/2100	cu/1600	co/1036	co/305	co/305	cu/640	oc/-	oc/-
Strat position	Suns Hwy ss	Suns Hwy ss	Suns Hwy ss	GRV	GRV	GRV	GRV	GRV	GRV	GRV	lo Cowlitz	lo Cowlitz
Section/Well	NWEC	NWEC	NWEC	NWEC	NWEC	NWEC	Texaco	Texaco	Texaco	ARCO	Beaver Cr II	Beaver Cr II
	12-35-65	12-35-65	12-35-65	31-36-65	31-36-65	31-36-65	Clatskanie #1	Clatskanie #1	Clatskanie #1	44-21-65		
1/4,1/4,1/4	SWNW	SWNW	SWNW	NWNE	NWNE	NWNE	SWNE	SWNE	SWNE	SESE	SWNESW	SWNESW
STR	35-6N-5W	36-6N-5W	36-6N-5W	36-6N-5W	36-6N-5W	36-8N-5W	36-7N-4W	36-7N-4W	36-7N-4W	21-6N-5W	10-2N-5W	10-2N-5W
7.5' quad	Birkenfield	Birkenfield	Birkenfield	Pittsburg	Pittsburg	Pittsburg	Delena	Delena	Delena	Marshland	Clear Creek	Clear Creek
Lat N	45°57'50"	45°57'50"	45°57'50"	45°57'53"	45°57'53"	45°57'53"	46°03'00"	46°03'00"	46°03'00"	45°59'02"	45°40'07"	45°40'07"
Long W	123°16'33"	123°16'33"	123°16'33"	123°14'41"	123°14'41"	123°14'41"	123°07'05"	123°07'05"	123°07'05"	123°18'00"	123°17'27"	123°17'27"
Kelly/elev,ft	622	822	822	772	772	772	271	271	271	880	575	575
Sample dep,ft	-2346	-2288	-2248	-2662	-2209	-2003	-3124	-2872	-2861	-2060		
Major Elements (XRF, analyzed values, weight%)												
SiO_2	56.00	50.50	52.40	47.50	49.10	48.00	43.00	35.30	45.10	46.00	60.70	61.00
Al_2O_3	15.40	14.40	15.20	14.40	13.40	13.40	13.90	12.10	13.60	13.10	13.90	14.70
TiO_2	1.45	1.19	1.40	2.97	2.93	3.22	2.51	2.35	2.62	2.17	0.86	0.92
$FeTO_3$	5.05	7.95	7.97	12.00	13.00	14.00	11.90	11.00	12.70	9.21	7.86	6.58
MnO	0.06	0.13	0.09	0.17	0.18	0.18	0.16	0.23	0.15	0.13	0.03	0.03
CaO	4.62	7.34	5.35	8.35	9.21	9.44	7.49	16.20	5.71	5.52	1.83	2.10
MgO	0.74	1.91	2.34	4.08	4.95	4.56	6.04	3.86	5.45	4.91	1.36	1.24
K_2O	3.38	1.65	1.61	0.96	0.94	0.65	0.45	0.44	0.88	1.25	2.38	2.03
Na_2O	3.25	2.20	2.29	2.71	2.87	2.61	3.46	2.11	4.06	4.27	1.72	1.92
P_2O_5	0.31	0.29	0.27	0.52	0.48	0.54	0.34	0.44	0.33	0.37	0.10	0.09
LOI @ 925°C	6.45	9.18	9.33	5.42	2.49	2.90	10.20	15.20	9.10	9.58	8.72	8.72
Total	96.71	96.74	98.25	99.08	99.55	99.50	99.45	99.23	99.70	96.51	99.46	99.33
FeO*	4.54	7.15	7.17	10.80	11.70	12.60	10.71	9.90	11.43	8.29	7.07	5.92
Total w/o LOI	89.75	86.76	88.12	92.46	95.76	95.20	86.06	82.93	89.33	86.01	89.95	89.95
Major Elements (XRF, normalized values, weight%)												
SiO_2	62.39	58.20	59.46	51.37	51.28	50.42	46.83	42.57	50.49	53.48	67.48	67.81
Al_2O_3	17.16	16.60	17.25	15.57	13.99	14.08	15.79	14.59	15.22	15.23	15.45	16.34
TiO_2	1.62	1.37	1.59	3.21	3.06	3.38	2.85	2.83	2.93	2.52	0.96	1.02
FeO*	5.06	8.24	8.14	11.68	12.22	13.23	12.16	11.94	12.79	9.64	7.66	6.56
MnO	0.07	0.15	0.10	0.18	0.19	0.19	0.18	0.28	0.17	0.15	0.03	0.03
CaO	5.15	8.46	6.07	9.03	9.62	9.92	8.51	19.54	6.39	6.42	2.03	2.33
MgO	0.82	2.20	2.66	4.41	5.17	4.79	6.86	4.65	6.10	5.71	1.51	1.38
K_2O	3.77	1.90	1.83	1.04	0.96	0.68	0.51	0.53	0.99	1.45	2.65	2.26
Na_2O	3.62	2.54	2.60	2.93	3.00	2.74	3.93	2.54	4.55	4.96	1.91	2.13
P_2O_5	0.35	0.33	0.31	0.56	0.50	0.57	0.39	0.53	0.37	0.43	0.11	0.10
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	10	32	33	36	44	32	84	47	102	84	17	20
Cr	<20	67	74	38	54	50	116	62	134	nd	100	67
Ba	1150	455	470	280	280	235	198	102	194	>5000	710	750
Rb	90	53	58	22	21	16	20	25	28	27	18	19
Sr	1950	410	410	445	430	415	240	275	168	152	89	72
Zr	500	215	230	280	255	240	176	178	194	200	250	260
Y	48	33	28	32	32	37	28	27	28	24	240	250
Nb	68	23	21	44	44	36	30	28	33	31	51	59
Cu	25	30	38	48	80	60	87	61	102	57	19	23
Zn	126	82	93	98	93	110	94	86	92	92	108	114
La	69	<30	50	37	<30	<30	<30	<30	30	<30	68	49
Ce	114	58	67	80	70	43	39	34	50	64	93	76
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Tl in weight%)												
Lab no.	na	W-256652	W-258651	na	na	na	na	W-256644	W-258645	na	OSU A18304	OSU A18305
Analysis	- - -	CK32	CK32	- - -	- - -	- - -	- - -	CK32	CK32	- - -	#183	#183
Fe	- - -	6.10	6.76	- - -	- - -	- - -	- - -	8.11	9.50	- - -	7.49	5.95
Na	- - -	1.64	1.88	- - -	- - -	- - -	- - -	1.62	3.09	- - -	1.57	1.91
K	- - -	1.47	1.32	- - -	- - -	- - -	- - -	0.49	<1	- - -	1.90	1.20
Ca	- - -	5.71	4.60	- - -	- - -	- - -	- - -	10.90	4.90	- - -	nd	nd
Tl	- - -	<1.0	1.40	- - -	- - -	- - -	- - -	1.93	1.66	- - -	nd	nd
Sc	- - -	15.56	18.00	- - -	- - -	- - -	- - -	21.90	27.20	- - -	20.60	19.20
Cr	- - -	64.60	75.30	- - -	- - -	- - -	- - -	66.30	132.00	- - -	91.00	94.00
Co	- - -	17.00	20.30	- - -	- - -	- - -	- - -	34.40	48.10	- - -	5.00	5.00
Ni	- - -	34.00	39.00	- - -	- - -	- - -	- - -	53.00	102.00	- - -	58.00	54.00
Zn	- - -	77.00	81.60	- - -	- - -	- - -	- - -	79.00	93.00	- - -	110.00	100.00
As	- - -	12.10	10.00	- - -	- - -	- - -	- - -	0.60	<2	- - -	16.50	13.60
Se	- - -	nd	nd	- - -	- - -	- - -	- - -	nd	nd	- - -	nd	nd
Br	- - -	nd	nd	- - -	- - -	- - -	- - -	nd	nd	- - -	<2.5	1.80
Rb	- - -	60.00	52.30	- - -	- - -	- - -	- - -	25.80	27.10	- - -	76.00	69.00
Sr	- - -	407.00	379.00	- - -	- - -	- - -	- - -	321.00	196.00	- - -	149.00	275.00
Mo	- - -	4.60	2.60	- - -	- - -	- - -	- - -	<2.0	<5.0	- - -	nd	nd
Sb	- - -	0.76	0.63	- - -	- - -	- - -	- - -	0.125	<0.1	- - -	0.60	0.70
Au	- - -	<0.004	<0.004	- - -	- - -	- - -	- - -	<0.004	<0.007	- - -	nd	nd
Cs	- - -	3.52	4.80	- - -	- - -	- - -	- - -	1.27	3.18	- - -	4.30	4.40
Ba	- - -	412.00	356.00	- - -	- - -	- - -	- - -	87.00	167.00	- - -	672.00	661.00
La	- - -	35.10	37.40	- - -	- - -	- - -	- - -	23.80	29.60	- - -	52.60	60.90
Ce	- - -	70.50	74.50	- - -	- - -	- - -	- - -	47.20	56.70	- - -	77.60	89.20
Nd	- - -	33.20	35.00	- - -	- - -	- - -	- - -	26.30	30.10	- - -	52.00	61.00
Sm	- - -	7.54	8.38	- - -	- - -	- - -	- - -	6.38	7.62	- - -	9.68	11.78
Eu	- - -	1.78	1.99	- - -	- - -	- - -	- - -	1.85	2.15	- - -	2.11	2.79
Gd	- - -	nd	nd	- - -	- - -	- - -	- - -	nd	nd	- - -	nd	nd
Tb	- - -	0.97	1.016	- - -	- - -	- - -	- - -	0.88	1.035	- - -	1.32	1.33
Ho	- - -	nd	nd	- - -	- - -	- - -	- - -	nd	nd	- - -	nd	nd
Tm	- - -	nd	nd	- - -	- - -	- - -	- - -	nd	nd	- - -	nd	nd
Yb	- - -	2.79	2.85	- - -	- - -	- - -	- - -	2.23	2.73	- - -	3.91	4.63
Lu	- - -	0.399	0.366	- - -	- - -	- - -	- - -	0.282	0.377	- - -	0.47	0.61
Zr	- - -	265.00	217.00	- - -	- - -	- - -	- - -	174.00	240.00	- - -	130.00	215.00
Hf	- - -	5.78	5.53	- - -	- - -	- - -	- - -	4.25	4.72	- - -	5.60	6.50
Ta	- - -	1.76	1.91	- - -	- - -	- - -	- - -	2.00	2.22	- - -	1.00	0.90
W	- - -	nd	nd	- - -	- - -	- - -	- - -	nd	nd	- - -	0.70	1.20
Th	- - -	7.08	6.72	- - -	- - -	- - -	- - -	2.60	2.90	- - -	7.10	7.60
U	- - -	2.05	2.00	- - -	- - -	- - -	- - -	0.74	0.53	- - -	2.40	2.90

Table 1. Analyses of tuff and lava flow samples from Cowlitz Formation of northwestern Oregon (continued)

[Other formations sampled: Tillamook volcanic rocks, Sunset Highway sandstone member of Hamlet Formation, Grays River volcanic rocks, Goble volcanic rocks, and Keasey. Analyses listed in approximate stratigraphic order]

Sample no.	NWO85206	NWO85207	NWO85200	NWO85208	NWO85209	NWO85210	MWO85211	NWO85212	NWO85224	NWO85226	NWO85228	NWO85229
Lab no.	D-501252	D-501253	D-501246	D-501254	D-501255	D-501256	D-501257	D-501258	D-501243			D-501244
Analysis	UX21	UX21	UX21	UX21	UX21	UX21	UX21	UX21	UX21			UX21
Batch	A	A	A	A	A	A	A	A	A	A	A	A
Field no.	2B.24VIII85S	2C.24VIII85S	2.18I85F	2D.24VIII85S	2E.24VIII85S	2F.24VIII85S	2G.24VIII85S	2H.24VIII85S	RDS 6.28VIII	RDS 2.8IX85	RDS 1.9X85	RDS 3A.9X85
Lithology	ss at contact	tf 6cm ab	tf 10cm ab	tf 15cm ab	tf 35cm ab	tf 45cm ab	sdytf 65cmab	ss 75cm ab	sandy tuff	sandy tuff	sandy tuff	sandy tuff
Source/tk,cm	oc/65	oc/65	oc/65	oc/65	oc/65	oc/85	oc/65	oc/65	oc/5	oc/3	oc/2	oc/20
Strat position	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	?lo Cowlitz	?lo Cowlitz	?lo Cowlitz	?lo Cowlitz
Section/Well	Beaver Cr II	Beaver Cr II	Beaver Cr II	Beaver Cr II	Beaver Cr II	Beaver Cr II	Beaver Cr II	Beaver Cr II	Wolf Cr	Wolf Cr	Nehalem R	Nehalem R
1/4,1/4,1/4	SWNESW	SWNESW	SWNESW	SWNESW	SWNESW	SWNESW	SWNESW	SWNESW	SENWNW	NESENW	NWNENW	NENENW
STR	10-2N-5W	10-2N-5W	10-2N-5W	10-2N-5W	10-2N-5W	10-2N-5W	10-2N-5W	10-2N-5W	5-3N-5W	5-3N-5W	15-3N-5W	15-3N-5W
7.5' quad	Clear Creek	Clear Creek	Clear Creek	Clear Creek	Clear Creek	Clear Creek	Clear Creek	Clear Creek	Clear Creek	Clear Creek	Timber	Timber
Lat N	45°40'07"	45°40'07"	45°40'07"	45°40'07"	45°40'07"	45°40'07"	45°40'07"	45°40'07"	45°46'42"	45°46'32"	45°45'02"	45°44'58"
Long W	123°17'27"	123°17'27"	123°17'27"	123°17'27"	123°17'27"	123°17'27"	123°17'27"	123°17'27"	123°20'10"	123°19'47"	123°17'27"	123°17'22"
Kelly/elev,ft	575	575	575	575	575	575	575	575	870	840	770	780
Sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	61.40	62.70	65.30	65.90	58.40	60.80	61.80	58.60	38.60	ns	na	42.80
Al_2O_3	13.90	16.70	14.80	14.30	18.10	16.10	15.90	17.80	17.90	- -	- -	14.50
TiO_2	0.83	0.30	0.29	0.29	0.83	0.62	0.58	0.73	3.04	- -	- -	1.12
$FeTO_3$	7.53	3.19	3.09	3.09	6.34	4.83	4.42	5.40	7.15	- -	- -	6.71
MnO	0.04	0.03	0.03	0.03	0.02	0.03	0.03	0.02	0.24	- -	- -	0.13
CaO	1.80	0.75	0.86	0.88	1.04	1.09	1.13	1.03	9.77	- -	- -	9.34
MgO	1.22	0.43	0.50	0.50	0.86	0.87	0.85	0.95	1.62	- -	- -	2.33
K_2O	2.24	2.82	3.19	3.25	1.72	2.31	2.38	1.82	0.89	- -	- -	0.21
Na_2O	1.85	1.75	1.68	1.79	1.35	1.67	1.88	1.50	1.76	- -	- -	1.14
P_2O_5	0.07	0.05	0.05	0.05	0.07	0.05	0.05	0.05	0.89	- -	- -	0.24
LOI @ 925°C	8.35	9.78	9.37	8.94	12.40	10.90	10.20	11.60	15.10	- -	- -	21.40
Total	99.23	98.50	99.16	99.02	99.13	99.27	99.20	99.50	96.96	- -	- -	99.72
FeO*	6.78	2.87	2.78	2.78	5.70	4.35	3.98	4.86	6.43	- -	- -	6.04
Total w/o LOI	90.13	88.40	89.48	89.77	86.09	87.89	88.56	87.36	81.14	- -	- -	77.65
Major Elements (XRF, normalized values, weight%)												
SiO_2	68.13	70.93	72.98	73.41	85.51	69.18	69.79	67.08	47.57	- -	- -	54.86
Al_2O_3	15.42	18.89	16.54	15.93	21.02	18.32	17.95	20.38	22.06	- -	- -	18.67
TiO_2	0.92	0.34	0.32	0.32	0.96	0.71	0.65	0.84	3.75	- -	- -	1.44
FeO*	7.52	3.25	3.11	3.10	6.63	4.95	4.49	5.56	7.93	- -	- -	7.78
MnO	0.04	0.03	0.03	0.03	0.02	0.03	0.03	0.02	0.30	- -	- -	0.17
CaO	2.00	0.85	0.96	0.98	1.21	1.24	1.28	1.18	12.04	- -	- -	12.03
MgO	1.35	0.49	0.56	0.58	1.00	0.99	0.96	1.09	2.00	- -	- -	3.00
K_2O	2.49	3.19	3.57	3.62	2.00	2.63	2.69	2.08	1.10	- -	- -	0.27
Na_2O	2.05	1.98	1.88	1.99	1.57	1.90	2.10	1.72	2.17	- -	- -	1.47
P_2O_5	0.08	0.06	0.06	0.06	0.06	0.06	0.06	0.06	1.10	- -	- -	0.31
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	- -	- -	100.00
Trace Elements (XRF, ppm)												
Ni	15	<10	12	20	<10	<10	15	11	158	ns	na	<10
Cr	104	<20	32	<20	<20	<20	85	32	<20	- - -	- - -	<20
Ba	720	910	900	99	750	960	500	445	305	- - -	- - -	960
Rb	19	108	90	<10	45	120	54	41	29	- - -	- - -	116
Sr	79	71	144	205	4100	91	220	79	215	- - -	- - -	89
Zr	250	285	245	550	405	240	270	305	375	- - -	- - -	220
Y	265	39	64	50	49	59	22	25	92	- - -	- - -	51
Nb	51	21	23	64	<10	18	18	22	73	- - -	- - -	12
Cu	23	15	34	26	17	13	35	29	48	- - -	- - -	16
Zn	110	82	108	138	53	86	118	83	420	- - -	- - -	91
La	53	<30	85	38	42	49	<30	33	86	- - -	- - -	59
Ce	77	65	88	91	59	<30	46	32	182	- - -	- - -	71
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)												
Lab no.	OSU A18306	OSU A18307	D-501758	OSU A18308	OSU A18309	OSU A18310	OSU A18311	OSU A18312	D-501763	D-501764	D-501765	D-501766
Analysis	#183	#183	UX44	#183	#183	#183	#183	#183	UX44	UX44	UX44	UX44
Fe	6.60	2.87	1.96	2.68	5.02	4.18	3.85	4.53	5.45	4.19	6.67	4.80
Na	1.85	1.91	1.45	1.95	1.47	1.71	1.97	1.55	1.42	3.31	1.03	1.03
K	1.70	2.10	2.98	2.70	1.50	1.90	3.00	1.60	0.957	0.702	1.31	0.00
Ca	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ti	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Sc	18.10	7.30	6.74	7.20	16.40	13.60	12.60	16.20	23.90	12.40	45.80	14.00
Cr	89.00	8.00	7.91	12.00	32.00	34.00	36.00	60.00	13.60	8.84	55.90	6.58
Co	5.00	2.00	2.51	2.00	3.00	5.00	6.00	8.00	65.70	3.34	9.22	8.35
Ni	44.00	<84	6.24	36.00	<96	<78	30.00	<78	154.00	3.09	35.70	19.50
Zn	101.00	66.00	69.10	71.00	88.00	89.00	93.00	100.00	383.00	54.20	88.20	119.00
As	10.50	9.50	11.40	9.10	7.70	7.80	8.80	7.70	7.77	3.48	18.80	1.90
Se	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Br	1.60	3.40	nd	3.40	2.60	2.20	1.50	1.30	nd	nd	nd	nd
Rb	80.00	83.00	127.00	81.00	69.00	77.00	69.00	87.00	30.90	17.60	23.00	5.08
Sr	370.00	<360	72.80	<285	179.00	547.00	229.00	<350	0.00	555.00	206.00	282.00
Mo	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Sb	0.70	1.10	1.08	1.10	1.00	1.10	1.10	0.90	0.373	0.684	1.13	0.225
Au	nd	nd	0.691	nd	nd	nd	nd	nd	0.615	3.39	0.00	0.356
Cs	5.70	7.00	8.39	7.80	5.20	6.80	6.20	4.90	1.08	0.215	0.256	0.136
Ba	662.00	896.00	1010.00	952.00	814.00	875.00	838.00	601.00	301.00	227.00	285.00	136.00
La	54.70	35.10	44.10	42.80	46.80	58.10	59.70	44.90	84.20	14.80	13.50	68.50
Ce	69.80	58.80	73.00	60.00	60.10	77.30	82.50	48.90	184.00	33.40	31.70	144.00
Nd	53.00	26.00	43.20	39.00	39.00	60.00	60.00	41.00	104.00	20.20	17.60	70.10
Sm	9.88	8.42	9.68	7.77	8.24	10.69	10.71	7.08	24.00	4.55	4.08	14.60
Eu	2.21	0.88	1.03	1.18	1.77	2.16	2.13	1.60	6.90	1.95	1.24	3.72
Gd	nd	nd	8.88	nd	nd	nd	nd	nd	23.70	4.39	3.42	13.10
Tb	1.38	1.13	1.29	1.13	1.32	1.19	1.38	1.07	3.33	0.812	0.548	1.92
Ho	nd	nd	1.74	nd	nd	nd	nd	nd	3.64	0.818	0.849	2.60
Tm	nd	nd	0.773	nd	nd	nd	nd	nd	1.29	0.297	0.00	0.956
Yb	3.88	3.86	4.72	4.15	3.83	4.44	4.51	3.43	7.82	1.86	2.32	8.08
Lu	0.52	0.55	0.662	0.60	0.51	0.60	57.00	0.50	1.05	0.246	0.329	0.879
Zr	160.00	324.00	240.00	170.00	258.00	227.00	190.00	247.00	502.00	188.00	295.00	575.00
Hf	6.00	7.50	6.82	6.10	6.70	6.40	6.30	7.20	10.10	5.19	8.63	13.20
Ta	0.80	1.50	1.86	1.40	1.20	1.20	1.10	1.30	4.89	1.99	4.15	4.78
W	1.40	1.10	2.12	0.70	0.90	0.70	1.00	0.70	1.45	2.60	2.15	0.391
Th	7.30	17.10	15.60	14.10	9.10	10.80	10.90	12.00	6.82	5.82	4.83	9.85
U	2.50	3.90	5.27	4.70	4.00	3.00	2.90	3.80	2.35	1.99	2.90	2.82

Table 1. Analyses of tuff and lava flow samples from Cowlitz Formation of northwestern Oregon (continued)

[Other formations sampled: Tillamook volcanic rocks, Sunset Highway sandstone member of Hamlet Formation, Grays River volcanic rocks, Goble volcanic rocks, and Keasey. Analyses listed in approximate stratigraphic order]

Sample no.	NWO85201	NWO85202	NWO85203	NWO85213	NWO85214	NWO85215	NWO85216	NWO85217	NWO85218	NWO85219	NWO92009	NWO92008
Lab no.	D-501247	D-501248	D-501249	D-501259	D-501260	D-501261	D-501262	D-501263	D-501264	D-501265	D-526530	D-526529
Analysis	UX21	UX21	UX21	UX21	UX21	UX21	UX21	UX21	UX21	UX21	VJ25	VJ25
Batch	A	A	A	A	A	A	A	A	A	A	C	C
Field no.	1A.24VIII85S	1B.24VIII85S	1C.24VIII85S	3A.24VIII85S	3B.24VIII85S	5A1.24VIIIS	5A2.24VIIIS	5B1.24VIIIS	5B2.24VIIIS	5C.24VIII85S	SLK 92009	SLK 92008
Lithology	ss 5cm belotf	tf 7 cm ab	ss 20cm ab	sdy tf 30cmab	sdytf 60cmab	cl lth tf	cl xl(fs) tf	cl xl(fs) tf	cl xl(q-fs) tf	white cl tuff	cl pm tuff	bas lava flow
Source/tk,cm	oc/-	oc/15	oc/-	oc/70	oc/70	oc/40	oc/65	oc/65	oc/65	oc/15	cu/1000	cu/>100
Strat position	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo Cowlitz	base C&W ss	top C&W ss
Section/Well	Beaver Cr I	Beaver Cr I	Beaver Cr I	Dober Rd I	Dober Rd I	Dober Rd II	Dober Rd II	Dober Rd II	Dober Rd II	Dober Rd II	NWEC 31-15-65	NWEC 11A-5-65
1/4,1/4,1/4	SWNESW	SWNESW	SWNESW	NESESE	NESESE	NESWSW	NESWSW	NESWSW	NESWSW	NESWSW	NWNE	NWNW
STR	10-2N-5W	10-2N-5W	10-2N-5W	9-2N-5W	9-2N-5W	10-2N-5W	10-2N-5W	10-2N-5W	10-2N-5W	10-2N-5W	15-6N-5W	5-6N-5W
7.5' quad	Timber	Timber	Timber	Timber	Timber	Timber	Timber	Timber	Timber	Timber	Marshland	Marshland
Lat N	45°40'07"	45°40'07"	45°40'07"	45°40'01"	45°40'01"	45°40'01"	45°40'01"	45°40'01"	45°40'01"	45°40'01"	46°00'37"	46°02'20"
Long W	123°17'27"	123°17'27"	123°17'27"	123°17'51"	123°17'51"	123°17'39"	123°17'39"	123°17'39"	123°17'39"	123°17'39"	123°17'03"	123°20'09"
Kelly/elev,ft	570	570	570	780	780	720	720	720	720	720	735	615
Sample dep,ft											-2508	-2740
Major Elements (XRF, analyzed values, weight%)												
SiO_2	58.70	52.50	56.60	49.00	48.60	58.70	54.30	50.20	54.50	49.90	61.20	47.70
Al_2O_3	17.80	23.80	18.10	23.00	20.40	12.30	19.00	23.00	20.20	23.50	14.70	15.70
TiO_2	0.99	0.63	0.89	1.74	1.84	0.93	0.79	1.29	1.05	1.38	1.15	3.56
$FeTO_3$	5.39	4.80	5.84	6.36	5.33	9.61	6.22	6.32	5.76	5.98	5.39	13.40
MnO	0.03	0.01	0.02	0.01	0.02	0.02	0.03	0.03	0.03	0.02	0.10	0.12
CaO	1.27	0.49	0.90	0.68	3.16	1.19	1.41	0.42	1.15	0.18	2.41	6.44
MgO	1.03	0.73	1.00	1.05	1.25	1.44	1.15	1.15	1.13	1.00	1.97	4.37
K_2O	1.57	1.14	1.53	0.47	0.51	2.58	0.92	1.17	1.49	0.88	4.48	0.98
Na_2O	1.50	0.73	1.18	0.68	0.90	0.89	1.09	0.48	1.15	0.45	2.54	3.75
P_2O_5	0.06	0.05	0.05	0.13	1.60	0.10	0.15	0.09	0.11	0.09	0.29	0.72
LOI @ 925°C	10.90	14.40	11.60	16.20	15.70	11.20	14.40	15.20	12.50	15.80	5.96	3.66
Total	99.24	99.28	97.91	99.32	99.11	98.96	99.48	99.35	99.07	99.18	100.19	100.40
FeO*	4.85	4.32	5.25	5.72	4.80	8.65	5.60	5.69	5.18	5.38	4.85	12.06
Total w/o LOI	87.80	84.40	85.52	82.48	82.88	86.80	84.44	83.52	85.99	82.78	93.69	95.40
Major Elements (XRF, normalized values, weight%)												
SiO_2	66.86	62.20	66.18	59.41	58.64	67.63	64.31	60.11	63.38	60.28	65.32	50.00
Al_2O_3	20.27	28.20	21.16	27.88	24.62	14.17	22.50	27.54	23.49	28.39	15.69	16.46
TiO_2	1.13	0.75	1.04	2.11	1.98	1.07	0.94	1.54	1.22	1.67	1.23	3.73
FeO*	5.52	5.12	6.14	6.94	5.79	9.96	6.63	6.81	6.03	6.50	5.18	12.64
MnO	0.03	0.01	0.02	0.01	0.02	0.02	0.04	0.04	0.03	0.02	0.11	0.13
CaO	1.45	0.58	1.05	0.82	3.81	1.37	1.67	0.50	1.34	0.22	2.57	8.75
MgO	1.17	0.86	1.17	1.27	1.51	1.86	1.36	1.38	1.31	1.21	2.10	4.58
K_2O	1.79	1.35	1.79	0.57	0.62	2.97	1.09	1.40	1.73	1.06	4.78	1.03
Na_2O	1.71	0.86	1.38	0.82	1.09	1.03	1.29	0.57	1.34	0.54	2.71	3.93
P_2O_5	0.07	0.06	0.06	0.18	1.93	0.12	0.18	0.11	0.13	0.11	0.31	0.75
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	10	12	16	42	38	18	<10	14	14	18	12	30
Cr	26	59	74	24	36	87	<20	29	<20	50	<20	<20
Ba	830	610	450	840	1900	2000	840	590	1800	360	485	320
Rb	86	64	53	22	31	93	28	82	54	37	97	16
Sr	148	144	152	99	275	225	192	83	180	56	275	435
Zr	240	270	295	230	305	196	265	415	325	335	650	350
Y	61	41	28	50	230	39	54	46	73	65	63	42
Nb	23	20	22	18	11	19	11	22	22	21	81	57
Cu	26	24	28	102	114	36	33	47	46	52	18	62
Zn	112	122	92	124	148	128	110	89	102	126	114	118
La	36	48	30	63	180	<30	<30	34	70	56	71	50
Ce	39	56	51	78	240	<30	<30	46	184	102	140	87
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Tl in weight%)												
Lab no.	OSU A18301	OSU A18302	OSU A18303	OSU A18313	OSU A18314	D-501759	OSU A18315	OSU A18316	OSU A18317	D-501760	D-527421	na
Analysis	#183	#183	#183	#183	#183	UX44	#183	#183	#183	UX44	VJ71	- - -
Fe	4.68	4.16	5.28	5.47	4.71	7.28	5.33	5.64	4.80	4.57	3.86	- - -
Na	1.60	0.73	0.37	0.66	0.95	0.678	1.12	0.43	1.14	0.381	1.98	- - -
K	1.20	0.70	0.30	0.40	0.50	2.47	0.80	0.80	1.80	0.85	3.67	- - -
Ca	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	2.19	- - -
Tl	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.97	- - -
Sc	20.80	15.90	19.80	37.40	59.80	23.40	21.40	24.00	21.50	28.10	10.01	- - -
Cr	94.00	33.00	93.00	30.00	27.00	96.50	26.00	32.00	34.00	48.30	9.10	- - -
Co	8.00	7.00	6.00	5.00	4.00	6.63	5.00	4.00	2.00	13.40	7.11	- - -
Ni	75.00	<93	72.00	120.00	130.00	13.40	45.00	80.00	47.00	35.80	17.00	- - -
Zn	111.00	71.00	80.00	124.00	150.00	133.00	98.00	87.00	91.00	119.00	131.90	- - -
As	7.60	11.90	5.20	5.70	4.20	24.40	8.70	3.20	4.50	6.56	4.40	- - -
Se	nd	nd	nd	nd	nd	nd	nd	nd	nd	1.90	<0.8	- - -
Br	1.00	1.90	1.30	0.90	1.80	nd	1.70	1.30	3.20	nd	nd	- - -
Rb	<26	51.00	63.00	<33	<48	115.00	<42	89.00	<42	41.30	95.10	- - -
Sr	421.00	<390	<390	408.00	<1050	273.00	402.00	<480	190.00	61.00	296.00	- - -
Mo	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	1.70	- - -
Sb	0.80	1.20	0.70	0.50	0.50	0.64	0.70	0.60	0.80	0.557	0.398	- - -
Au	nd	nd	nd	nd	nd	0.627	nd	nd	nd	0.513	<0.005	- - -
Cs	3.60	2.80	3.70	3.00	4.10	5.25	3.70	3.90	4.30	3.27	1.20	- - -
Ba	446.00	442.00	420.00	796.00	1846.00	2150.00	810.00	551.00	1519.00	394.00	487.00	- - -
La	25.80	16.50	15.20	36.60	50.40	24.80	28.50	25.40	52.70	48.60	82.20	- - -
Ce	50.70	28.20	42.50	94.50	188.60	34.60	42.40	54.90	159.70	117.00	162.00	- - -
Nd	25.00	16.00	23.00	39.00	51.00	26.80	33.00	46.00	85.00	70.70	71.50	- - -
Sm	4.53	2.99	2.87	8.20	9.63	5.07	5.80	9.49	17.59	16.20	15.19	- - -
Eu	1.19	0.71	1.10	2.03	2.46	1.16	1.52	2.18	3.92	3.23	3.55	- - -
Gd	nd	nd	nd	nd	nd	5.01	nd	nd	nd	14.10	nd	- - -
Tb	0.69	0.66	1.01	1.76	2.04	0.757	1.06	1.25	2.02	1.97	1.90	- - -
Ho	nd	nd	nd	nd	nd	1.01	nd	nd	nd	2.64	nd	- - -
Tm	nd	nd	nd	nd	nd	0.395	nd	nd	nd	1.13	nd	- - -
Yb	2.09	1.77	1.90	4.34	5.60	2.33	3.07	4.29	6.10	7.02	6.02	- - -
Lu	0.33	0.31	0.31	0.60	0.74	0.339	0.46	0.69	0.81	0.999	0.804	- - -
Zr	284.00	167.00	210.00	198.00	344.00	0.00	401.00	268.00	189.00	372.00	634.00	- - -
Hf	6.90	8.30	7.90	8.10	7.00	4.88	7.60	10.50	8.10	9.30	15.24	- - -
Ta	1.00	1.50	1.10	0.90	1.00	0.793	1.00	1.50	1.20	1.45	6.12	- - -
W	0.90	0.60	0.30	1.50	1.40	1.79	0.70	1.50	0.60	2.44	nd	- - -
Th	7.80	15.20	9.80	2.80	3.10	4.81	3.40	10.20	8.50	10.70	9.64	- - -
U	3.00	3.20	2.50	3.60	5.00	2.23	1.70	4.10	3.80	4.58	2.63	- - -

Table 1. Analyses of tuff and lava flow samples from Cowlitz Formation of northwestern Oregon (continued)

[Other formations sampled: Tillamook volcanic rocks, Sunset Highway sandstone member of Hamlet Formation, Grays River volcanic rocks, Goble volcanic rocks, and Keasey. Analyses listed in approximate stratigraphic order]

Sample no.	NWO93006	NWO86001	NWO86002	NWO93023	NWO93007	NWO93008	NWO93009	NWO93010	NWO93024	NWO93022	NWO93026	NWO93025
Lab no.	D-546936	D-501245	D-501266	D-546953	D-546937	D-546938	D-546939	D-546940	D-546954	D-546952	D-546956	D-546955
Analysis	VS23	UX21	UX22	VS23	VS23	VS23	VS23	VS23	VS23	VS23	VS23	VS23
Batch	D	A	A	D	D	D	D	D	D	D	D	D
Field no.	SLK 93006	1.17III86	2.17III66	SLK 93023	SLK 93077	SLK 93006	SLK 93009	SLK 93010	SLK 93024	SLK 93022	SLK 93026	SLK 93025
Lithology	basaltic tuff	clayey tuff	claystone tuff	bas lava flow	basaltic tuff	lithic tuff	bas lava flow	basaltic tuff	bas lava flow	bas lava flow	bas lava flow	vitric tuff
Source/tk,cm	co/122	oc/26	oc/10	cu/490	co/1525	co/183	co/122	co/1525	cu/520	cu/800	cu/6550	cu/1710
Strat position	top, C&W ss	?up Cowlitz	?up Cowlitz	GRV	GRV	GRV	GRV	GRV	GRV	GRV	Goble volc rx	Goble volc rx
Section/Well	Texaco Clatskanie #1	Rocky Point	Rocky Point	Champlin P. 13-36-85	Texaco Clatskanie #1	Texaco Clatskanie #1	Texaco Clatskanie #1	Texaco Clatskanie #1	Champlin P. 13-36-85	Champlin P. 13-36-85	Reichhold CZ2	Reichhold CZ4
1/4,1/4,1/4	SWNE	NESWSW	SWSWNW	NWSW	SWNE	SWNE	SWNE	SWNE	NWSW	NWSW	NWNWSW	SESENW
STR	5-6N-5W	15-4N-5W	15-4N-5W	36-8N-5W	36-7N-4W	36-7N-4W	36-7N-4W	36-7N-4W	36-8N-5W	36-8N-5W	8-4N-3W	36-5N-4W
7.5' quad	Delena	Clear Creek	Clear Creek	Oak Point	Delena	Delena	Delena	Delena	Oak Point	Oak Point	Bacona	Baker Point
Lat N	46°03'00"	45°49'30"	45°49'30"	46°07'48"	46°03'00"	46°03'00"	46°03'00"	46°03'00"	46°07'46"	46°07'46"	45°50'38"	45°52'34"
Long W	123°07'05"	123°17'45"	123°17'45"	123°14'54"	123°07'05"	123°07'05"	123°07'05"	123°07'05"	123°14'54"	123°14'54"	123°05'25"	123°07'28"
Kelly/elev,ft	271	1430	1550	13	271	271	271	271	13	13	689	622
Sample dep,ft	-2239			-4097	-489	-479	-469	-459	-2627	-1307	-2141	-1628
Major Elements (XRF, analyzed values, weight%)												
SiO_2	43.50	57.30	69.20	47.00	45.70	45.10	46.60	43.70	46.50	na	57.70	54.30
Al_2O_3	12.60	14.60	12.50	15.70	13.00	12.70	14.10	13.10	14.40	- - -	16.10	16.00
TiO_2	2.32	0.65	0.17	3.24	3.23	3.14	3.65	3.28	3.10	- - -	1.16	1.18
$FeTO_3$	10.70	1.91	1.28	13.10	14.50	14.20	14.10	13.00	12.60	- - -	6.28	8.39
MnO	0.18	0.02	0.02	0.19	0.19	0.20	0.53	0.11	0.16	- - -	0.11	0.10
CaO	9.12	5.16	3.16	7.21	6.16	5.17	9.43	6.61	8.30	- - -	5.99	6.76
MgO	2.85	1.22	0.47	3.16	4.77	5.60	4.75	6.06	4.11	- - -	2.42	4.02
K_2O	0.35	0.71	1.59	1.12	0.55	1.13	0.57	0.36	0.71	- - -	1.21	0.39
Na_2O	1.21	0.59	1.84	3.32	2.87	2.58	3.05	2.68	3.05	- - -	3.93	3.02
P_2O_5	0.67	0.63	0.05	0.62	0.52	0.46	0.60	0.66	0.47	- - -	0.25	0.20
LOI @ 925°C	15.60	16.30	8.41	4.49	5.67	8.91	1.91	8.73	3.92	- - -	1.55	2.73
Total	99.10	99.09	98.69	99.17	99.16	99.19	99.29	98.51	99.52	- - -	98.70	99.09
FeO*	9.63	1.72	1.15	11.79	13.05	12.78	12.69	11.70	11.52	- - -	7.45	7.55
Total w/o LOI	82.43	82.60	90.15	93.37	92.04	88.86	95.97	88.48	94.32	- - -	96.32	95.52
Major Elements (XRF, normalized values, weight%)												
SiO_2	52.77	69.37	76.76	50.34	49.65	50.76	48.56	49.39	51.42	- - -	59.90	56.85
Al_2O_3	15.29	17.68	13.87	16.82	14.12	14.29	14.69	14.81	15.27	- - -	16.72	16.75
TiO_2	2.81	0.79	0.19	3.47	3.51	3.53	3.80	3.71	3.29	- - -	1.20	1.24
FeO*	11.68	2.08	1.28	12.62	14.18	14.38	13.22	13.22	12.21	- - -	7.73	7.90
MnO	0.22	0.02	0.02	0.20	0.21	0.23	0.55	0.12	0.17	- - -	0.11	0.10
CaO	11.06	6.25	3.51	7.72	8.87	5.82	9.83	7.47	8.80	- - -	6.22	9.17
MgO	3.46	1.48	0.52	3.41	5.18	6.30	4.95	6.87	4.36	- - -	2.51	4.21
K_2O	0.42	0.86	1.76	1.20	0.60	1.27	0.59	0.41	0.75	- - -	1.26	0.41
Na_2O	1.47	0.71	2.04	3.56	3.12	2.90	3.18	3.26	3.23	- - -	4.08	3.16
P_2O_5	0.81	0.76	0.06	0.66	0.56	0.52	0.63	0.75	0.50	- - -	0.26	0.21
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	- - -	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	15	12	<10	18	19	19	21	20	39	27	<10	30
Cr	20	25	<20	<20	20	20	<20	25	46	<20	<20	99
Ba	126	820	570	380	215	415	250	2	300	650	325	1100
Rb	18	67	106	20	13	26	<10	11	16	24	27	<10
Sr	325	138	>5000	485	510	590	460	475	420	435	345	460
Zr	290	290	126	335	265	265	290	265	255	690	174	142
Y	44	52	<10	50	30	30	38	38	32	50	25	20
Nb	54	24	<10	55	40	40	44	41	41	102	10	<10
Cu	33	41	12	25	42	40	46	48	60	30	102	136
Zn	91	94	87	112	126	118	126	114	100	136	70	60
La	45	51	33	34	<30	45	31	34	<30	74	31	<30
Ce	88	64	56	93	69	62	78	94	58	164	43	41
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Tl in weight%)												
Lab no.	W258646	D-501767	na	na	W-258647	W-258648	na	W-258649	na	na	na	W-258650
Analysis	CK32	UX44	- - -	- - -	CK32	CK32	- - -	CK32	- - -	- - -	- - -	CK32
Fe	7.70	1.40	- - -	- - -	11.34	8.21	- - -	9.86	- - -	- - -	- - -	6.65
Na	0.957	0.473	- - -	- - -	2.12	2.35	- - -	1.98	- - -	- - -	- - -	2.56
K	0.42	0.735	- - -	- - -	0.50	0.86	- - -	<0.3	- - -	- - -	- - -	0.73
Ca	6.40	nd	- - -	- - -	6.00	6.20	- - -	5.20	- - -	- - -	- - -	6.00
Tl	1.30	nd	- - -	- - -	1.85	2.62	- - -	1.93	- - -	- - -	- - -	1.09
Sc	16.30	13.40	- - -	- - -	24.62	31.00	- - -	24.30	- - -	- - -	- - -	26.00
Cr	15.10	2.74	- - -	- - -	5.20	4.40	- - -	4.60	- - -	- - -	- - -	94.30
Co	21.60	0.415	- - -	- - -	41.70	37.40	- - -	40.40	- - -	- - -	- - -	26.60
Ni	<30	3.72	- - -	- - -	<40	<24	- - -	29.00	- - -	- - -	- - -	38.00
Zn	92.00	45.90	- - -	- - -	108.00	126.00	- - -	100.00	- - -	- - -	- - -	74.10
As	1.19	2.35	- - -	- - -	1.16	<0.7	- - -	0.81	- - -	- - -	- - -	<1
Se	nd	nd	- - -	- - -	nd	nd	- - -	nd	- - -	- - -	- - -	nd
Br	nd	nd	- - -	- - -	nd	nd	- - -	nd	- - -	- - -	- - -	nd
Rb	12.50	22.90	- - -	- - -	15.30	26.60	- - -	<5	- - -	- - -	- - -	8.20
Sr	372.00	4310.00	- - -	- - -	561.00	540.00	- - -	550.00	- - -	- - -	- - -	524.00
Mo	<7.0	nd	- - -	- - -	<3.0	<5.0	- - -	<5.0	- - -	- - -	- - -	<5.0
Sb	0.19	0.272	- - -	- - -	<0.3	<0.2	- - -	0.154	- - -	- - -	- - -	0.33
Au	<0.004	1.80	- - -	- - -	<0.005	<0.007	- - -	<0.005	- - -	- - -	- - -	<0.004
Cs	0.26	2.46	- - -	- - -	0.33	0.78	- - -	<0.2	- - -	- - -	- - -	0.17
Ba	126.00	753.00	- - -	- - -	184.00	216.00	- - -	190.00	- - -	- - -	- - -	960.00
La	47.60	61.60	- - -	- - -	34.50	46.50	- - -	33.70	- - -	- - -	- - -	19.90
Ce	95.40	101.00	- - -	- - -	70.40	96.40	- - -	69.40	- - -	- - -	- - -	41.90
Nd	48.50	74.30	- - -	- - -	38.00	51.00	- - -	36.70	- - -	- - -	- - -	21.90
Sm	11.90	18.80	- - -	- - -	9.17	12.42	- - -	8.82	- - -	- - -	- - -	5.40
Eu	3.15	3.40	- - -	- - -	2.58	3.58	- - -	2.50	- - -	- - -	- - -	1.54
Gd	nd	15.80	- - -	- - -	nd	nd	- - -	nd	- - -	- - -	- - -	nd
Tb	1.36	2.33	- - -	- - -	1.22	1.63	- - -	1.17	- - -	- - -	- - -	0.742
Ho	nd	3.04	- - -	- - -	nd	nd	- - -	nd	- - -	- - -	- - -	nd
Tm	nd	1.10	- - -	- - -	nd	nd	- - -	nd	- - -	- - -	- - -	nd
Yb	3.47	6.80	- - -	- - -	3.00	3.87	- - -	2.78	- - -	- - -	- - -	2.13
Lu	0.458	0.947	- - -	- - -	0.402	0.513	- - -	0.371	- - -	- - -	- - -	0.314
Zr	248.00	376.00	- - -	- - -	253.00	293.00	- - -	220.00	- - -	- - -	- - -	170.00
Hf	6.50	9.08	- - -	- - -	6.09	7.54	- - -	5.79	- - -	- - -	- - -	3.82
Ta	3.81	1.74	- - -	- - -	3.02	3.63	- - -	2.75	- - -	- - -	- - -	0.926
W	nd	0.29	- - -	- - -	nd	nd	- - -	nd	- - -	- - -	- - -	nd
Th	4.60	6.53	- - -	- - -	3.38	4.20	- - -	3.28	- - -	- - -	- - -	2.86
U	1.27	2.83	- - -	- - -	1.09	1.04	- - -	0.88	- - -	- - -	- - -	0.65

Table 1. Analyses of tuff and lava flow samples from Cowlitz Formation of northwestern Oregon (continued)

[Other formations sampled: Tillamook volcanic rocks, Sunset Highway sandstone member of Hamlet Formation, Grays River volcanic rocks, Goble volcanic rocks, and Keasey. Analyses listed in approximate stratigraphic order]

Sample no.	NWO85220	NWO85221
Lab no.	D-501215	D-501239
Analysis	UX20	UX21
Batch	A	A
Field no.	7A.24VIII85S	7B.24VIII85S
Lithology	ss	fn ss
Source/tk,cm	oc/>500	oc/>500
Strat position	lo Keasey	lo Keasey
Section/Well	hwy OR 6	hwy OR 6
1/4,1/4,1/4	NWSENE	NWSENE
STR	34-3N-5W	34-3N-5W
7.5' quad	Timber	Timber
Lat N	45°42'06"	45°42'06"
Long W	123°16'50"	123°16'50"
Kelly/elev,ft	820	830
Sample dep,ft		
	Major Elements (XRF, analyzed values, weight%)	
SiO_2	57.60	55.90
Al_2O_3	15.20	15.10
TiO_2	1.00	1.04
$FeTO_3$	7.04	6.96
MnO	0.04	0.03
CaO	3.41	3.24
MgO	1.92	1.82
K_2O	1.41	1.13
Na_2O	1.77	1.57
P_2O_5	0.12	0.17
LOI @ 925°C	9.96	12.50
Total	99.47	99.46
FeO*	6.33	6.26
Total w/o LOI	88.80	86.26
	Major Elements (XRF, normalized values, weight%)	
SiO_2	64.86	64.80
Al_2O_3	17.12	17.50
TiO_2	1.13	1.21
FeO*	7.13	7.26
MnO	0.05	0.03
CaO	3.84	3.76
MgO	2.16	2.11
K_2O	1.59	1.31
Na_2O	1.99	1.82
P_2O_5	0.14	0.20
Total	100.00	100.00
	Trace Elements (XRF, ppm)	
Ni	31	46
Cr	99	20
Ba	355	144
Rb	44	14
Sr	265	275
Zr	180	230
Y	22	39
Nb	10	35
Cu	27	22
Zn	98	77
La	30	83
Ce	30	148
	Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)	
Lab no.	D-501761	D-501762
Analysis	UX44	UX44
Fe	5.20	5.28
Na	1.51	1.31
K	1.36	0.956
Ca	nd	nd
Ti	nd	nd
Sc	20.10	21.60
Cr	116.00	73.30
Co	14.40	5.54
Ni	33.80	13.10
Zn	100.00	103.00
As	10.70	8.71
Se	nd	nd
Br	nd	nd
Rb	55.90	44.80
Sr	348.00	298.00
Mo	nd	nd
Sb	0.577	0.466
Au	0.074	2.05
Cs	3.16	2.87
Ba	413.00	373.00
La	23.80	21.90
Ce	52.10	45.30
Nd	28.50	29.80
Sm	6.62	7.23
Eu	1.51	1.64
Gd	6.02	7.24
Tb	0.864	1.01
Ho	1.14	1.38
Tm	0.451	0.565
Yb	2.76	3.44
Lu	0.406	0.475
Zr	199.00	236.00
Hf	5.45	5.63
Ta	0.86	1.04
W	0.694	0.00
Th	5.31	4.93
U	2.27	2.62

Table 2. Analyses of tuff and lava flow samples from Cowlitz Formation, southwestern Washington

[Other formation sampled: McIntosh. Analyses listed in approximate stratigraphic order]

Sample no.	SWW92002	SW92026A	SW92026B	SWW93063	SWW93064	SWW93071	SW92025A	SW92025B	SW92025C	SW92025D	SWW93070	SWW91007
Lab no.	D-526497	D-522636	D-522637	D-572948	D-572949	D-572953	D-522632	D-522633	D-522634	D-522635	D-572952	D-522609
Analysis	VJ24	VG51	VG51	WD16	WD18	WD16	VG51	VG51	VG51	VG51	WD18	VG51
Batch	C	B	B	F	F	F	B	B	B	B	F	B
Field no.	SJ-92-177	SLK 2A.12lVSn	SLK 2B.12lVSn	SJ-93-37	SJ-93-40	SJ-93-67	SLK 3A.12lVSn	SLK 3B.12lVSn	SLK 3C.12lVSn	SLK 3D.12lVSn	SJ-93-63	SJ-91-100
Lithology	cl xl(q-pc) tf	xl(pc) tuff	xl(pc) tuff	xl(fs) clst	pm lapst	pm lapst	?tuff in coal	sdy pm tuff	sdyxl(q-pc)tf	sdyxl(q-pc)tf	pm-scor ss	cl xl(q-fs) tf
Source/tk,cm	oc/10	rc/200	rc/200	oc/35	oc/85	oc/120	rc/10	rc/10	rc/15	rc/15	oc/25	co/?
Strat position	top McIntosh	lo Cowlitz or	lo Cowlitz or	lo Cowlitz	lo Cowlitz	lo Cowlitz	lo/mid Cowlitz	lo/mid Cowlitz	lo/mid Cowlitz	lo/mid Cowlitz	mid Cowlitz	mid Cowlitz
Section/Well		top McIntosh	top McIntosh	Olequa Cr	Olequa Cr	Olequa Cr					Olequa Cr	WK-42
1/4,1/4,1/4	SE	NWNWNW	NWNWNW	SWSENE	SESWNE	SENWNW	NENWSE	NENWSE	NENWSE	NENWSE	NWSWNW	NWNWNW
STR	5-12N-7W	23-11N-3W	23-11N-3W	32-11N-2W	32-11N-2W	29-11N-2W	24-11N-3W	24-11N-3W	24-11N-3W	24-11N-3W	20-11N-2W	6-12N-3W
7.5' quad	Lebam	Wildwood	Wildwood	Winlock	Winlock	Winlock	Winlock	Winlock	Winlock	Winlock	Winlock	Curtis
Lat N	46°32'33"	46°25'45"	46°25'45"	46°23'36"	46°23'43"	46°24'56"	46°25'24"	46°25'24"	46°25'24"	46°25'24"	46°25'33"	48°33'22"
Long W	123°34'00"	123°01'38"	123°01'38"	122°57'00"	122°57'09"	122°57'55"	122°59'40"	122°59'40"	122°59'40"	122°59'40"	122°57'51"	123°05'00"
Kelly/elev,ft	60	215	215	100	100	140	170	170	170	170	150	260
Sample dep,ft												-360
Major Elements (XRF, analyzed values, weight%)												
SiO_2	52.20	59.80	58.00	na	na	na	55.80	54.80	55.60	51.60	na	53.10
Al_2O_3	21.30	20.00	17.00	- - -	- - -	- - -	19.70	19.70	19.20	20.60	- - -	17.30
TiO_2	1.96	1.02	1.02	- - -	- - -	- - -	3.27	1.68	3.29	3.98	- - -	1.60
$FeTO_3$	4.90	3.70	6.33	- - -	- - -	- - -	3.38	4.47	3.94	4.70	- - -	10.20
MnO	0.02	0.01	0.01	- - -	- - -	- - -	0.10	0.07	0.02	0.02	- - -	0.11
CaO	3.88	0.59	1.07	- - -	- - -	- - -	1.04	1.23	0.79	0.85	- - -	1.45
MgO	1.03	1.03	1.54	- - -	- - -	- - -	1.43	1.60	1.54	1.75	- - -	2.26
K_2O	0.37	2.26	1.68	- - -	- - -	- - -	0.68	0.51	0.51	0.23	- - -	0.14
Na_2O	2.55	1.02	0.94	- - -	- - -	- - -	0.66	1.54	0.43	0.18	- - -	2.22
P_2O_5	0.20	0.08	0.20	- - -	- - -	- - -	0.29	0.09	0.11	0.12	- - -	0.18
LOI @ 925°C	10.80	9.63	11.80	- - -	- - -	- - -	12.60	13.20	13.30	14.90	- - -	10.70
Total	99.21	99.34	99.59	- - -	- - -	- - -	98.95	98.89	98.73	98.93	- - -	99.26
FeO*	4.41	3.33	5.70	- - -	- - -	- - -	3.04	4.02	3.55	4.23	- - -	9.18
Total w/o LOI	87.92	89.14	87.16	- - -	- - -	- - -	86.01	85.24	85.04	83.56	- - -	87.54
Major Elements (XRF, normalized values, weight%)												
SiO_2	59.37	67.09	66.55	- - -	- - -	- - -	64.87	64.29	65.38	61.75	- - -	60.66
Al_2O_3	24.23	22.44	19.51	- - -	- - -	- - -	22.90	23.11	22.58	24.65	- - -	19.76
TiO_2	2.23	1.14	1.17	- - -	- - -	- - -	3.54	4.72	4.17	5.06	- - -	1.83
FeO*	5.01	3.73	6.54	- - -	- - -	- - -	1.66	1.88	1.81	2.09	- - -	10.48
MnO	0.02	0.01	0.01	- - -	- - -	- - -	1.21	1.44	0.93	1.02	- - -	0.13
CaO	4.41	0.66	1.23	- - -	- - -	- - -	0.77	1.81	0.51	0.22	- - -	1.66
MgO	1.17	1.18	1.77	- - -	- - -	- - -	0.79	0.60	0.60	0.28	- - -	2.58
K_2O	0.42	2.54	1.93	- - -	- - -	- - -	3.80	1.97	3.87	4.76	- - -	0.16
Na_2O	2.90	1.14	1.08	- - -	- - -	- - -	0.34	0.11	0.13	0.14	- - -	2.54
P_2O_5	0.23	0.09	0.23	- - -	- - -	- - -	0.12	0.08	0.02	0.02	- - -	0.21
Total	100.00	100.00	100.00	- - -	- - -	- - -	100.00	100.00	100.00	100.00	- - -	100.00
Trace Elements (XRF, ppm)												
Ni	40	12	19	<10	19	22	15	23	25	43	<10	17
Cr	85	104	116	35	<20	27	20	20	91	215	<20	<20
Ba	160	580	550	96	490	425	580	370	260	196	186	93
Rb	<10	89	54	<10	32	42	19	15	13	11	<10	10
Sr	270	142	178	140	350	285	600	176	124	142	235	182
Zr	225	225	220	770	530	810	250	560	230	230	740	750
Y	31	38	21	33	47	45	65	81	97	114	28	37
Nb	19	25	19	94	77	79	71	78	50	49	106	118
Cu	240	35	37	54	22	23	20	26	29	79	15	22
Zn	156	76	114	176	146	148	102	93	114	170	176	128
La	<30	34	<30	<30	56	33	110	62	67	73	41	72
Ce	52	54	36	88	126	92	122	92	99	86	90	134
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)												
Lab no.	na	D-522661	D-522662	na	na	na	D-522657	D-522658	D-522659	D-522660	na	D-522675
Analysis	- - -	VG53	VG53	- - -	- - -	- - -	VG53	VG53	VG53	VG53	- - -	VG53
Fe	- - -	2.75	4.57	- - -	- - -	- - -	2.52	3.31	2.89	3.28	- - -	7.29
Na	- - -	0.786	0.754	- - -	- - -	- - -	0.567	1.123	0.389	0.171	- - -	1.78
K	- - -	2.02	1.34	- - -	- - -	- - -	0.68	0.54	0.49	<0.3	- - -	<0.8
Ca	- - -	<0.7	0.74	- - -	- - -	- - -	1.13	1.19	1.40	<2	- - -	<2
Ti	- - -	0.69	<0.6	- - -	- - -	- - -	2.07	1.24	1.65	2.68	- - -	<1
Sc	- - -	18.00	18.20	- - -	- - -	- - -	18.10	13.05	28.90	43.00	- - -	18.50
Cr	- - -	82.10	104.60	- - -	- - -	- - -	20.40	14.20	67.50	179.00	- - -	8.20
Co	- - -	4.75	8.14	- - -	- - -	- - -	43.80	38.10	13.86	36.50	- - -	10.46
Ni	- - -	22.00	28.00	- - -	- - -	- - -	<40	25.00	<50	51.00	- - -	25.00
Zn	- - -	51.30	82.00	- - -	- - -	- - -	73.00	67.00	83.00	110.00	- - -	109.00
As	- - -	2.72	8.30	- - -	- - -	- - -	4.90	1.88	3.39	2.20	- - -	1.00
Se	- - -	<0.07	<0.6	- - -	- - -	- - -	<0.9	<0.8	<1	<1	- - -	<0.9
Br	- - -	nd	nd	- - -	- - -	- - -	nd	nd	nd	nd	- - -	nd
Rb	- - -	93.30	66.50	- - -	- - -	- - -	23.70	17.70	19.00	14.00	- - -	7.90
Sr	- - -	163.00	216.00	- - -	- - -	- - -	650.00	192.00	151.00	156.00	- - -	205.00
Mo	- - -	<3.0	<3.0	- - -	- - -	- - -	4.10	2.00	2.90	4.20	- - -	<3.0
Sb	- - -	0.44	0.55	- - -	- - -	- - -	0.23	0.152	0.25	0.22	- - -	0.25
Au	- - -	<0.005	0 .004	- - -	- - -	- - -	<0.005	<0.004	<0.005	<0.004	- - -	<0.009
Ce	- - -	5.15	3.64	- - -	- - -	- - -	0.74	1.05	0.77	0.81	- - -	0.22
Ba	- - -	520.00	522.00	- - -	- - -	- - -	552.00	330.00	262.00	186.00	- - -	95.00
La	- - -	38.80	28.40	- - -	- - -	- - -	103.50	57.10	78.90	93.80	- - -	62.40
Ce	- - -	59.50	31.90	- - -	- - -	- - -	117.70	87.90	123.70	107.20	- - -	131.20
Nd	- - -	37.10	18.50	- - -	- - -	- - -	66.00	58.50	97.20	106.00	- - -	58.30
Sm	- - -	7.63	3.52	- - -	- - -	- - -	12.92	12.35	22.00	23.50	- - -	12.67
Eu	- - -	1.38	0.748	- - -	- - -	- - -	3.00	3.70	5.63	6.00	- - -	3.18
Gd	- - -	nd	nd	- - -	- - -	- - -	nd	nd	nd	nd	- - -	nd
Tb	- - -	0.914	0.484	- - -	- - -	- - -	1.84	1.92	3.11	3.35	- - -	1.51
Ho	- - -	nd	nd	- - -	- - -	- - -	nd	nd	nd	nd	- - -	nd
Tm	- - -	nd	nd	- - -	- - -	- - -	nd	nd	nd	nd	- - -	nd
Yb	- - -	2.66	1.69	- - -	- - -	- - -	4.85	5.83	7.55	8.58	- - -	4.09
Lu	- - -	0.362	0.236	- - -	- - -	- - -	0.651	0.787	1.006	1.17	- - -	0.562
Zr	- - -	211.00	258.00	- - -	- - -	- - -	244.00	570.00	280.00	210.00	- - -	703.00
Hf	- - -	5.84	6.58	- - -	- - -	- - -	7.01	18.00	6.65	7.26	- - -	19.60
Ta	- - -	1.83	1.25	- - -	- - -	- - -	3.21	6.65	3.38	3.69	- - -	8.13
W	- - -	nd	nd	- - -	- - -	- - -	nd	nd	nd	nd	- - -	nd
Th	- - -	13.20	8.30	- - -	- - -	- - -	5.53	11.10	5.48	4.97	- - -	12.60
U	- - -	3.53	2.85	- - -	- - -	- - -	2.52	2.44	1.84	1.59	- - -	3.01

Table 2. Analyses of tuff and lava flow samples from Cowlitz Formation, southwestern Washington (continued)

[Other formation sampled: McIntosh. Analyses listed in approximate stratigraphic order]

Sample no.	SWW91006	SWW91005	SW91004B	SWW91003	SWW91002	SWW92022	SWW92024	SWW93067	SWW93065	SWW85004	SWW85005	SWW85006
Lab no.	D-522608	D-522605	D-522618	D-522604	D-522603	D-522630	D-522631	D-572951	D-572950	D-501274	D-501275	D-501276
Analysis	VG51	VG51	VG51	VG51	VG51	VG51	VG51	WD16	WD16	UX22	UX22	UX22
Batch	B	B	B	B	B	B	B	F	F	A	A	A
Field no.	SJ-91-99	SJ-91-92B	SJ-91-91	SJ-91-90	SJ-91-89	2.4IV92S	4.4IV92S	SJ-93-58	SJ-93-54	3A.5IX85Th	3B.5IX85Th	4.5IX85Th
Lithology	claystone	clxl(fs)pm tf	clxl(fs)lth tf	clxl(fs)pm tf	cl lth tuff	hycl brc	xl(q-bi)lth tf	lapilli tuff	pum xl? tuff	clxl(fs)lth tf	clxl(fs)lth tf	clxl(fs)lth tf
Source/tk,cm	co/?	co/?	co/?	co/?	co/?	rc/3000	rc/10	oc/100	oc/10	rc/30	rc/15	rc/>70
Strat position	mid Cowlitz	mid Cowlitz	mid Cowlitz	mid Cowlitz	mid Cowlitz	mid Cowlitz	mid Cowlitz	mid Cowlitz	mid Cowlitz	mid? Cowlitz	mid? Cowlitz	mid? Cowlitz
Section/Well	WK-42	WK-110-0B	WK-110-0B	WK-110-0B	WK-110-0B	nr Coal Cr	nr Coal Cr	Olequa Cr	Olequa Cr	Allen Road	Allen Road	Delameter Rd
1/4,1/4,1/4	NWNWNW	SESE	SESE	SESE	SESE	SWSENW	NENENW	NESWSW	SWSENW	SESWSE	SESWSE	NESWNE
STR	6-12N-3W	9-12N-3W	9-12N-3W	9-12N-3W	9-12N-3W	13-8N-3W	25-10N-3W	17-11N-2W	17-11N-2W	30-8N-1W	30-8N-1W	17-9N-2W
7.5' quad	Curtis	Curtis	Curtis	Curtis	Curtis	Coal Creek	Castle Rock	Winlock	Winlock	Mt. Brynion	Mt. Brynion	Castle Rock
Lat N	46°33'22"	46°27'05"	46°27'05"	46°27'05"	46°27'05"	46°10'47"	46°19'40"	46°26'01"	46°26'15"	46°08'30"	46°08'30"	46°16'05"
Long W	123°05'00"	123°03'25"	123°03'25"	123°03'25"	123°03'25"	123°00'23"	122°59'56"	122°58'05"	122°57'54"	122°51'09"	122°51'09"	122°57'17"
Kelly/elev,ft	260	562	562	562	562	10	680	180	180	30	30	70
Sample dep,ft	-351	-326	-315	-302	-213							
Major Elements (XRF, analyzed values, weight%)												
SiO_2	57.10	54.80	55.70	53.90	48.20	45.50	60.30	na	na	59.10	63.90	56.90
Al_2O_3	19.30	14.40	15.00	16.50	26.90	12.70	17.60	- - -	- - -	15.50	15.90	18.00
TiO_2	1.97	2.00	2.53	1.38	1.73	2.74	1.73	- - -	- - -	0.72	0.81	1.20
$FeTO_3$	6.01	9.07	7.85	8.72	5.26	12.70	4.47	- - -	- - -	2.58	2.94	3.35
MnO	0.01	0.20	0.14	0.08	0.01	0.17	0.02	- - -	- - -	0.07	0.02	0.02
CaO	2.29	4.49	4.57	2.29	0.88	8.17	0.84	- - -	- - -	4.04	3.48	4.87
MgO	1.80	1.44	1.65	1.68	0.61	5.68	1.32	- - -	- - -	1.00	0.22	0.97
K_2O	0.23	1.60	1.54	0.67	0.81	0.86	1.79	- - -	- - -	1.15	1.38	0.63
Na_2O	2.94	3.11	3.15	2.23	0.48	2.54	1.21	- - -	- - -	1.71	4.05	2.66
P_2O_5	0.25	0.59	0.51	0.20	0.11	0.69	0.12	- - -	- - -	0.16	0.16	0.27
LOI @ 925°C	7.49	7.29	5.76	11.50	14.20	8.08	9.56	- - -	- - -	13.40	6.63	10.70
Total	99.39	98.99	98.40	99.15	99.19	99.83	98.96	- - -	- - -	99.43	99.49	99.57
FeO*	5.41	8.16	7.06	7.85	4.73	11.43	4.02	- - -	- - -	2.32	2.65	3.01
Total w/o LOI	91.30	90.79	91.85	86.78	84.46	90.48	88.95	- - -	- - -	85.77	92.57	88.53
Major Elements (XRF, normalized values, weight%)												
SiO_2	62.54	60.36	60.64	62.11	57.07	50.29	67.79	- - -	- - -	68.90	69.03	64.27
Al_2O_3	21.14	15.86	16.33	19.01	31.85	14.04	19.79	- - -	- - -	18.07	17.18	20.33
TiO_2	2.16	2.20	2.75	1.59	2.05	3.03	1.94	- - -	- - -	0.84	0.88	1.36
FeO*	5.92	8.99	7.69	9.04	5.60	12.63	4.52	- - -	- - -	2.71	2.86	3.40
MnO	0.01	0.22	0.15	0.09	0.01	0.19	0.02	- - -	- - -	0.08	0.02	0.02
CaO	2.51	4.95	4.98	2.64	1.04	9.03	0.94	- - -	- - -	4.71	3.76	5.50
MgO	1.97	1.59	1.80	1.94	0.72	6.28	1.48	- - -	- - -	1.17	0.24	1.10
K_2O	0.25	1.76	1.68	0.77	0.96	0.95	2.01	- - -	- - -	1.34	1.49	0.71
Na_2O	3.22	3.43	3.43	2.57	0.57	2.81	1.36	- - -	- - -	1.99	4.38	3.00
P_2O_5	0.27	0.65	0.56	0.23	0.13	0.76	0.13	- - -	- - -	0.19	0.17	0.30
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	- - -	- - -	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	18	17	34	25	26	81	41	<10	28	<10	<10	<10
Cr	<20	<20	<20	<20	45	64	78	<20	53	<20	<20	<20
Ba	154	550	520	250	110	205	590	425	680	690	290	420
Rb	10	35	37	23	22	20	56	33	<10	30	29	20
Sr	290	360	365	240	78	360	240	290	445	630	275	1000
Zr	660	600	600	650	360	265	210	550	410	370	260	192
Y	41	55	54	41	34	42	30	50	45	44	29	30
Nb	106	86	96	108	27	41	30	74	97	20	18	10
Cu	30	24	36	25	69	52	16	25	39	46	26	56
Zn	172	162	166	156	61	112	148	144	210	78	52	73
La	80	68	46	50	<30	<30	39	<30	32	42	<30	<30
Ce	160	156	110	116	166	70	73	91	100	50	44	<30
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Tl in weight%)												
Lab no.	D-522674	D-522673	D-522672	D-522671	D-522670	D-522655	D-522656	na	na	na	D-501770	na
Analysis	VG53	VG53	VG53	VG53	VG53	VG53	VG53	- - -	- - -	- - -	UX44	- - -
Fe	4.29	6.62	6.17	6.08	3.87	9.44	3.33	- - -	- - -	- - -	1.98	- - -
Na	2.28	2.47	2.45	1.72	0.378	1.97	0.935	- - -	- - -	- - -	3.15	- - -
K	<1	1.67	1.11	<0.8	0.67	<0.7	1.47	- - -	- - -	- - -	0.898	- - -
Ca	1.63	4.20	4.00	2.04	0.87	6.50	<1	- - -	- - -	- - -	nd	- - -
Tl	1.76	1.79	1.79	1.20	1.31	2.07	1.25	- - -	- - -	- - -	nd	- - -
Sc	15.90	15.90	17.90	13.63	23.80	25.40	20.00	- - -	- - -	- - -	15.30	- - -
Cr	16.60	12.60	25.90	32.90	49.10	130.00	65.10	- - -	- - -	- - -	15.00	- - -
Co	12.94	15.55	28.20	20.40	13.22	37.80	6.59	- - -	- - -	- - -	1.17	- - -
Ni	35.00	<30	31.00	46.00	35.00	91.00	46.00	- - -	- - -	- - -	12.10	- - -
Zn	152.00	144.00	150.00	150.00	39.80	107.00	115.00	- - -	- - -	- - -	36.20	- - -
As	1.90	3.30	4.70	4.17	1.67	1.30	4.16	- - -	- - -	- - -	3.30	- - -
Se	<0.7	<0.7	<0.8	<0.9	<0.8	<1	<0.8	- - -	- - -	- - -	nd	- - -
Br	nd	nd	nd	nd	nd	nd	nd	- - -	- - -	- - -	nd	- - -
Rb	6.30	44.20	42.40	21.20	19.10	18.90	67.50	- - -	- - -	- - -	33.80	- - -
Sr	316.00	432.00	436.00	289.00	103.00	380.00	263.00	- - -	- - -	- - -	308.00	- - -
Mo	<3.0	4.50	5.00	<3.0	<3.0	<2.0	<4.0	- - -	- - -	- - -	nd	- - -
Sb	0.34	0.346	0.45	0.33	0.80	0.163	0.317	- - -	- - -	- - -	0.276	- - -
Au	<0.005	<0.005	<0.005	<0.004	<0.004	<0.005	<0.004	- - -	- - -	- - -	1.47	- - -
Ce	0.20	0.77	0.70	0.86	1.08	0.43	1.97	- - -	- - -	- - -	2.07	- - -
Ba	137.00	543.00	512.00	240.00	115.00	202.00	576.00	- - -	- - -	- - -	259.00	- - -
La	64.60	70.40	64.40	45.20	30.80	34.70	35.90	- - -	- - -	- - -	13.60	- - -
Ce	136.00	145.50	133.30	97.70	167.00	73.80	60.90	- - -	- - -	- - -	26.40	- - -
Nd	66.40	69.40	63.80	44.50	42.00	43.10	37.50	- - -	- - -	- - -	18.10	- - -
Sm	14.35	15.32	14.42	9.65	10.64	10.32	8.20	- - -	- - -	- - -	3.96	- - -
Eu	3.62	3.89	3.74	2.52	2.40	2.89	1.86	- - -	- - -	- - -	1.34	- - -
Gd	nd	nd	nd	nd	nd	nd	nd	- - -	- - -	- - -	4.01	- - -
Tb	1.70	1.94	1.83	1.16	1.20	1.38	1.024	- - -	- - -	- - -	0.571	- - -
Ho	nd	nd	nd	nd	nd	nd	nd	- - -	- - -	- - -	0.877	- - -
Tm	nd	nd	nd	nd	nd	nd	nd	- - -	- - -	- - -	0.409	- - -
Yb	3.50	5.41	4.85	2.83	2.65	3.43	3.05	- - -	- - -	- - -	2.63	- - -
Lu	0.429	0.716	0.65	0.374	0.341	0.444	0.42	- - -	- - -	- - -	0.383	- - -
Zr	631.00	540.00	518.00	590.00	333.00	310.00	258.00	- - -	- - -	- - -	218.00	- - -
Hf	17.20	14.10	13.02	16.60	8.39	6.33	6.55	- - -	- - -	- - -	6.41	- - -
Ta	7.26	6.03	5.86	7.00	1.81	2.81	2.10	- - -	- - -	- - -	1.35	- - -
W	nd	nd	nd	nd	nd	nd	nd	- - -	- - -	- - -	0.98	- - -
Th	10.50	8.90	8.20	10.90	4.79	3.29	7.80	- - -	- - -	- - -	3.59	- - -
U	2.84	2.48	2.33	2.66	2.42	0.85	2.05	- - -	- - -	- - -	1.43	- - -

Table 2. Analyses of tuff and lava flow samples from Cowlitz Formation, southwestern Washington (continued)

[Other formation sampled: McIntosh. Analyses listed in approximate stratigraphic order]

Sample no.	SWW92001	SWW92002	SWW92003	SWW92004	SWW92005	SWW92007	SWW85001	SWW85009	SWW85007	SWW85008	SWW86012	SWW86013
Lab no.	D-522622	D-522623	D-522624	D-522625	D-522626	D-522627	D-501272	D-501186	D-501277	D-501278	D-501198	D-501199
Analysis	VG51	VG51	VG51	VG51	VG51	VG51	UX22	UX20	UX22	UX22	UX20	UX20
Batch	B	B	B	B	B	B	A	A	A	A	A	A
Field no.	SLK 92001	SL 92002K	SLK 92003	SLK 92004	SLK 92005	SLK 92007	1.5IX85Th	5C.5IX85Th	5B.5IX65Th	5A.5IX85Th	3A.14III66F	3B.14III86F
Lithology	bas lava flow	xl(pc-fm)tf	xl(fm)lth tf	xl(fm) lth tf	cl lth tf	hyaloclastite	clxl(fs)lth tf	clxl(fs)lth tf	clxl(fs)lth tf	clxl(fs)lth tf	clxl(fs)pm tf	clxl(fs)pm tf
Source/tk,cm	rc/200	rc/400	rc/400	rc/400	rc/30	rc/1000	rc/30	rc/4	rc/4	rc/4	rc/20	rc/20
Strat position	Goble volc rx	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up? Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz
Section/Well	Kalama R brdg	SE Longv Exit	SE Longv Exit	SE Longv Exit	SE Longv Exit	SE Longv Exit	Longv SE Exit	upper Coal Cr	upper Coal Cr	upper Coal Cr	Kelso Drive	Kelso Drive
1/4,1/4,1/4	NWSWNE	NESWNE	NESWNE	NESWNE	NESWNE	NESWNE	SESENW	NWNESW	NWNESW	NWNESW	SESENE	SESENE
STR	6-6N-1W	12-7N-2W	12-7N-2W	12-7N-2W	12-7N-2W	12-7N-2W	12-7N-2W	11-8N-3W	11-8N-3W	11-8N-3W	2-7N-2W	2-7N-2W
7.5' quad	Kalama	Rainier	Rainier	Rainier	Rainier	Rainier	Rainier	Coal Creek	Coal Creek	Coal Creek	Rainier	Rainier
Lat N	46°02'05"	46°06'26"	46°06'26"	46°06'26"	46°06'26"	46°06'26"	46°06'23"	46°11'29"	46°11'29"	46°11'29"	46°07'16"	46°07'18"
Long W	122°51'17"	122°52'35"	122°52'35"	122°52'35"	122°52'35"	122°52'35"	122°52'37"	123°01'27"	123°01'27"	123°01'27"	122°53'07"	122°53'07"
Kelly/elev,ft	30	100	100	100	100	100	30	100	100	100	100	100
Sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	52.10	58.30	57.60	59.80	49.30	40.60	32.50	49.00	50.10	49.40	57.60	58.70
Al_2O_3	17.20	15.50	15.30	16.40	14.40	11.70	11.30	19.50	18.20	17.50	13.40	13.80
TiO_2	1.38	0.97	1.05	1.44	0.40	2.58	0.88	4.26	1.32	3.95	0.82	0.92
$FeTO_3$	8.86	6.27	7.21	4.28	6.61	11.40	4.67	5.10	3.67	5.36	3.64	2.76
MnO	0.12	0.10	0.12	0.04	0.26	0.19	0.91	0.01	0.01	0.01	0.03	0.03
CaO	9.06	4.28	4.78	5.07	9.43	10.70	21.60	1.13	1.05	1.49	3.70	4.10
MgO	4.42	1.89	1.79	1.02	1.65	5.94	0.96	1.45	2.12	1.69	2.19	1.84
K_2O	0.55	0.70	0.79	0.34	0.20	0.72	0.13	0.91	0.48	0.64	0.82	0.91
Na_2O	3.10	2.10	2.27	2.45	1.09	1.26	0.79	1.33	1.28	1.36	0.58	0.80
P_2O_5	0.26	0.23	0.35	0.27	0.07	0.72	0.11	0.20	0.07	0.18	0.22	0.26
LOI @ 925°C	2.69	9.08	8.33	8.08	16.40	13.80	24.80	16.80	20.10	17.70	16.50	15.60
Total	99.74	99.42	99.59	99.19	99.81	99.61	98.65	99.69	96.40	99.28	99.50	99.72
FeO*	7.97	5.64	6.49	3.85	5.95	10.26	4.20	4.59	3.30	4.82	3.28	2.48
Total w/o LOI	96.16	89.71	90.54	90.68	82.75	84.67	73.38	82.38	77.93	81.04	82.64	83.84
Major Elements (XRF, normalized values, weight%)												
SiO_2	54.18	64.99	63.62	65.95	59.58	47.95	44.29	59.48	64.29	60.96	69.70	70.01
Al_2O_3	17.89	17.28	16.90	18.09	17.40	13.82	15.40	23.67	23.35	21.59	16.22	16.46
TiO_2	1.44	1.08	1.16	1.59	0.48	3.05	1.20	5.17	1.69	4.87	0.99	1.10
FeO*	8.29	6.29	7.17	4.25	7.19	12.12	5.73	5.57	4.24	5.95	3.96	2.96
MnO	0.12	0.11	0.13	0.04	0.31	0.22	1.24	0.01	0.01	0.01	0.04	0.04
CaO	9.42	4.77	5.28	5.59	11.40	12.64	29.43	1.37	1.35	1.84	4.46	4.89
MgO	4.60	2.11	1.98	1.12	1.99	7.02	1.31	1.76	2.72	2.09	2.65	2.19
K_2O	0.57	0.78	0.87	0.37	0.24	0.85	0.18	1.10	0.62	0.79	0.99	1.09
Na_2O	3.22	2.34	2.51	2.70	1.32	1.49	1.08	1.61	1.64	1.68	0.70	0.95
P_2O_5	0.27	0.26	0.39	0.30	0.08	0.85	0.15	0.24	0.09	0.22	0.27	0.31
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	55	11	13	<10	12	60	13	<10	<10	<10	<10	<10
Cr	95	<20	<20	<20	<20	42	<20	32	<20	25	<20	<20
Ba	134	205	225	146	85	94	37	250	168	245	540	550
Rb	11	24	20	10	10	16	10	24	10	13	26	25
Sr	455	215	230	300	112	230	106	176	134	225	770	900
Zr	172	265	245	205	580	210	184	385	590	345	295	270
Y	21	37	39	32	46	36	22	20	49	13	43	43
Nb	20	25	19	15	57	39	17	81	73	75	16	15
Cu	94	46	62	82	19	59	32	15	15	18	53	45
Zn	88	106	94	95	148	108	58	31	27	35	100	26
La	<30	<30	<30	33	32	<30	<30	<30	46	<30	31	<30
Ce	41	47	51	53	100	48	41	47	118	<30	65	41
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)												
Lab no.	na	D-522649	D-522650	D-522651	na	D-522652	D-501768	na	na	D-501771	D-501777	na
Analysis	- - -	VG53	VG53	VG53	- - -	VG53	UX44	- - -	- - -	UX44	UX44	- - -
Fe	- - -	4.62	5.34	3.16	- - -	8.59	3.42	- - -	- - -	4.17	2.42	- - -
Na	- - -	1.64	1.73	1.66	- - -	0.937	0.574	- - -	- - -	1.07	0.39	- - -
K	- - -	0.59	0.63	<5	- - -	0.65	0.00	- - -	- - -	0.681	0.506	- - -
Ca	- - -	3.01	3.10	3.60	- - -	7.21	nd	- - -	- - -	nd	nd	- - -
Ti	- - -	0.92	0.83	1.08	- - -	2.17	nd	- - -	- - -	nd	nd	- - -
Sc	- - -	18.50	20.40	24.40	- - -	25.60	16.00	- - -	- - -	22.80	17.00	- - -
Cr	- - -	14.00	16.20	19.50	- - -	84.50	10.90	- - -	- - -	30.70	3.19	- - -
Co	- - -	10.64	11.85	13.12	- - -	40.10	12.00	- - -	- - -	3.71	10.10	- - -
Ni	- - -	<40	<40	<23	- - -	59.00	12.60	- - -	- - -	9.88	3.85	- - -
Zn	- - -	76.30	72.80	74.60	- - -	87.00	67.70	- - -	- - -	34.00	87.50	- - -
As	- - -	1.96	1.40	4.50	- - -	0.94	1.50	- - -	- - -	6.37	4.07	- - -
Se	- - -	<0.8	<0.8	<0.9	- - -	<0.9	nd	- - -	- - -	nd	nd	- - -
Br	- - -	nd	nd	nd	- - -	nd	nd	- - -	- - -	nd	nd	- - -
Rb	- - -	21.60	27.40	9.20	- - -	19.50	1.30	- - -	- - -	15.70	23.00	- - -
Sr	- - -	249.00	259.00	353.00	- - -	261.00	102.00	- - -	- - -	254.00	961.00	- - -
Mo	- - -	<2.0	1.30	<0.7	- - -	3.40	nd	- - -	- - -	nd	nd	- - -
Sb	- - -	0.24	0.23	0.169	- - -	0.121	0.166	- - -	- - -	0.462	0.159	- - -
Au	- - -	<0.003	<0.007	<0.006	- - -	<0.004	0.883	- - -	- - -	1.77	1.78	- - -
Ce	- - -	1.04	1.12	0.41	- - -	0.79	0.083	- - -	- - -	0.651	2.17	- - -
Ba	- - -	179.00	210.00	130.00	- - -	115.00	56.00	- - -	- - -	267.00	603.00	- - -
La	- - -	22.50	25.10	21.50	- - -	28.50	25.80	- - -	- - -	12.40	23.40	- - -
Ce	- - -	48.60	53.60	42.60	- - -	60.70	47.40	- - -	- - -	26.00	59.70	- - -
Nd	- - -	26.00	28.80	22.00	- - -	33.10	25.20	- - -	- - -	16.60	37.10	- - -
Sm	- - -	6.60	7.21	5.54	- - -	7.90	5.55	- - -	- - -	4.45	9.57	- - -
Eu	- - -	1.67	1.73	1.48	- - -	2.33	1.43	- - -	- - -	1.49	2.16	- - -
Gd	- - -	nd	nd	nd	- - -	nd	5.47	- - -	- - -	4.01	9.39	- - -
Tb	- - -	0.959	1.06	0.803	- - -	1.08	0.766	- - -	- - -	0.476	1.34	- - -
Ho	- - -	nd	nd	nd	- - -	nd	1.08	- - -	- - -	0.663	1.76	- - -
Tm	- - -	nd	nd	nd	- - -	nd	0.439	- - -	- - -	0.00	0.821	- - -
Yb	- - -	3.10	3.68	2.65	- - -	2.58	2.74	- - -	- - -	1.90	4.67	- - -
Lu	- - -	0.439	0.509	0.357	- - -	0.339	0.404	- - -	- - -	0.285	0.656	- - -
Zr	- - -	230.00	220.00	198.00	- - -	182.00	163.00	- - -	- - -	333.00	312.00	- - -
Hf	- - -	6.21	5.90	5.07	- - -	4.87	4.33	- - -	- - -	9.52	7.77	- - -
Ta	- - -	1.30	1.23	1.15	- - -	2.37	0.935	- - -	- - -	5.73	1.48	- - -
W	- - -	nd	nd	nd	- - -	nd	0.00	- - -	- - -	2.04	0.00	- - -
Th	- - -	3.69	3.36	2.64	- - -	2.71	2.74	- - -	- - -	2.31	3.25	- - -
U	- - -	1.22	1.14	0.87	- - -	0.72	0.874	- - -	- - -	1.31	1.66	- - -

Table 2. Analyses of tuff and lava flow samples from Cowlitz Formation, southwestern Washington (continued)

[Other formation sampled: McIntosh. Analyses listed in approximate stratigraphic order]

Sample no.	SWW86014	SWW86022	SWW86015	SWW86016	SWW86017	SWW86018	SWW86019	SWW86020	SWW86021	SWW92027	SWW92028	SWW92029
Lab no.	D-501200	D-501217	D-501201	D-501202	D-501203	D-501204	D-501205	D-501206	D-501207	D-522638	D-522639	D-522640
Analysis	UX20	UX20	UX20	UX20	UX20	UX20	UX20	UX20	UX20	VG51	VG51	VG51
Batch	A	A	A	A	A	A	A	A	A	B	B	B
Field no.	3C.14III86F	7.26III86W	4.14III86F	4A.14III86F	4B.14III86F	4C.14III86F	2A.26III86W	2B.26III86W	2C.26III86W	2A1.21VII92T	2A2.21VII92T	2B.21VII92T
Lithology	clxl(q-fs) tf	bas lth vit ss	cl pm lth tf	clxl(fs-fm)tf	clxl(fs)pmtf	cl pm lth tf	cl pm lth tf	cl pm lth tf	clxl(fs)pm tf	xl(fs) lth tf	xl(fs)pmlthtf	xl(fs)pm tf
Source/tk,cm	rc/5	rc/3000	rc/800	rc/50	rc/75	rc/>30	rc/>600	rc/>600	rc/>500	rc/6	rc/>25	rc/30
Strat position	up Cowlitz	up? Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz
Section/Well	Kelso Drive	Rocky Point	N. Kelso	N. Kelso	N. Kelso	N. Kelso	Kelso Drive N	Kelso Drive N	Kelso Drive N	Powell Road	Powell Road	Powell Road
1/4,1/4,1/4	SESENE	SENWSW	NWNESW	NWNESW	NWNESW	NWNESW	SESENE	SESENE	SESENE	NWNWSW	NWNWSW	NWNWSW
STR	2-7N-2W	14-8N-2W	23-8N-2W	23-8N-2W	23-8N-2W	23-8N-2W	2-7N-2W	2-7N-2W	2-7N-2W	12-9N-2W	12-9N-2W	12-9N-2W
7.5' quad	Rainier	Kelso	Kelso	Kelso	Kelso	Kelso	Rainier	Rainier	Rainier	Castle Rock	Castle Rock	Castle Rock
Lat N	46°07'18"	46°10'32"	46°09'45"	46°09'45"	46°09'45"	46°09'45"	46°07'18"	48°07'18"	46°07'18"	46°16'32"	46°16'32"	46°16'32"
Long W	122°53'07"	122°54'10"	122°54'03"	122°54'03"	122°54'03"	122°54'03"	122°53'07"	122°53'07"	122°53'07"	122°52'58"	122°52'58"	122°52'58"
Kelly/elev,ft	100	110	100	100	100	100	100	100	100	350	350	350
Sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	58.80	42.00	56.60	46.80	46.20	47.30	57.00	58.20	50.90	46.30	45.00	47.00
Al_2O_3	14.20	13.20	13.40	20.00	21.60	16.90	16.70	15.60	20.00	17.00	18.90	14.00
TiO_2	0.94	1.31	0.76	1.92	1.95	1.44	1.71	1.51	1.75	3.77	4.25	2.86
$FeTO_3$	2.45	9.85	2.90	8.32	7.20	11.20	2.07	1.87	4.32	10.00	8.87	12.20
MnO	0.01	0.17	0.07	0.03	0.01	0.03	0.01	0.02	0.05	0.02	0.05	0.06
CaO	3.68	7.26	6.15	1.64	1.55	1.74	3.17	3.75	2.01	1.96	3.09	2.75
MgO	1.97	7.15	2.14	1.35	1.18	1.49	1.70	1.76	1.55	2.30	2.19	3.60
K_2O	0.85	0.39	0.58	0.74	0.31	0.67	1.10	1.04	0.54	0.33	0.34	0.37
Na_2O	0.57	2.19	0.55	0.49	0.21	0.28	0.91	1.11	0.39	0.39	0.62	0.63
P_2O_5	0.27	0.27	0.17	0.05	0.05	0.05	0.27	0.34	0.05	0.36	0.66	0.23
LOI @ 925°C	16.00	16.10	16.40	18.30	19.20	18.10	15.10	14.40	17.70	16.90	15.40	16.50
Total	99.74	99.89	99.72	99.84	99.46	99.20	99.74	99.60	99.26	99.33	99.37	99.20
FeO*	2.20	8.86	2.61	7.49	6.48	10.08	1.86	1.68	3.89	9.00	7.98	10.98
Total w/o LOI	83.49	82.80	83.03	80.51	79.54	79.98	84.43	85.01	81.13	81.43	83.08	82.48
Major Elements (XRF, normalized values, weight%)												
SiO_2	70.42	50.72	68.17	58.13	58.09	59.14	67.51	68.48	62.74	56.86	54.16	56.99
Al_2O_3	17.01	15.94	16.14	24.84	27.16	21.13	19.78	18.35	24.65	20.88	22.75	16.97
TiO_2	1.13	1.58	0.92	2.38	2.45	1.80	2.03	1.78	2.16	4.63	5.12	3.47
FeO*	2.64	10.70	3.14	9.30	8.15	12.60	2.21	1.98	4.79	11.05	9.61	13.31
MnO	0.01	0.21	0.08	0.04	0.01	0.04	0.01	0.02	0.06	0.02	0.06	0.07
CaO	4.41	8.77	7.41	2.04	1.95	2.18	3.75	4.41	2.48	2.41	3.72	3.33
MgO	2.36	8.63	2.58	1.68	1.48	1.86	2.01	2.07	1.91	2.82	2.64	4.36
K_2O	1.02	0.47	0.70	0.92	0.39	0.84	1.30	1.22	0.67	0.41	0.41	0.45
Na_2O	0.68	2.64	0.66	0.61	0.26	0.35	1.08	1.31	0.48	0.48	0.75	0.76
P_2O_5	0.32	0.33	0.20	0.06	0.06	0.06	0.32	0.40	0.06	0.44	0.79	0.26
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	21	240	<10	19	19	38	<10	<10	<10	47	70	74
Cr	<20	134	<20	54	20	28	<20	<20	<20	102	114	85
Ba	1500	138	510	76	48	36	230	265	1200	770	1000	720
Rb	21	12	20	19	13	25	29	32	17	12	11	10
Sr	810	770	840	68	51	45	580	570	475	360	475	390
Zr	290	126	190	350	325	245	194	180	255	330	340	235
Y	56	12	20	36	65	33	33	50	36	39	55	41
Nb	21	12	15	28	26	21	10	11	19	48	50	42
Cu	55	116	33	73	106	78	43	57	99	90	87	62
Zn	225	78	76	134	182	83	60	56	122	192	162	158
La	<30	<30	<30	<30	41	39	34	<30	<30	<30	<30	<30
Ce	72	<30	<30	51	104	74	<30	<30	<30	43	76	40
Trace Elements (INAA, ppm, except Fe, Na, K, Ce, and Tl in weight%)												
Lab no.	D-501778	D-501783	na	na	na	na	na	na	na	D-522663	D-522664	D-522665
Analysis	UX44	UX44	- - -	- - -	- - -	- - -	- - -	- - -	- - -	VG53	VG53	VG53
Fe	1.74	6.66	- - -	- - -	- - -	- - -	- - -	- - -	- - -	7.56	6.84	9.17
Na	0.398	1.81	- - -	- - -	- - -	- - -	- - -	- - -	- - -	0.309	0.563	0.498
K	0.667	0.466	- - -	- - -	- - -	- - -	- - -	- - -	- - -	0.28	<0.4	0.36
Ca	nd	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	2.00	3.20	2.30
Tl	nd	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	2.46	2.55	1.69
Sc	18.30	24.30	- - -	- - -	- - -	- - -	- - -	- - -	- - -	32.10	34.80	25.30
Cr	6.62	169.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	101.10	106.00	103.70
Co	13.00	45.40	- - -	- - -	- - -	- - -	- - -	- - -	- - -	22.00	61.40	29.10
Ni	17.70	209.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	62.00	73.00	63.00
Zn	179.00	63.10	- - -	- - -	- - -	- - -	- - -	- - -	- - -	145.00	133.00	125.00
As	0.135	0.519	- - -	- - -	- - -	- - -	- - -	- - -	- - -	3.50	3.80	3.26
Se	nd	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	<0.9	<1	<0.9
Br	nd	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	nd	nd	nd
Rb	20.40	8.26	- - -	- - -	- - -	- - -	- - -	- - -	- - -	9.00	10.00	15.60
Sr	849.00	879.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	366.00	540.00	435.00
Mo	nd	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	<2.0	<3.0	1.90
Sb	0.139	0.048	- - -	- - -	- - -	- - -	- - -	- - -	- - -	0.239	0.27	0.22
Au	0.125	0.166	- - -	- - -	- - -	- - -	- - -	- - -	- - -	<0.004	<0.005	<0.004
Ce	1.94	0.35	- - -	- - -	- - -	- - -	- - -	- - -	- - -	0.28	<0.2	0.38
Ba	1570.00	124.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	715.00	925.00	695.00
La	30.30	10.40	- - -	- - -	- - -	- - -	- - -	- - -	- - -	36.40	64.50	37.00
Ce	63.40	24.30	- - -	- - -	- - -	- - -	- - -	- - -	- - -	58.20	113.40	57.00
Nd	43.30	14.60	- - -	- - -	- - -	- - -	- - -	- - -	- - -	36.60	0.72	42.70
Sm	11.10	3.72	- - -	- - -	- - -	- - -	- - -	- - -	- - -	8.32	17.30	10.05
Eu	2.57	1.14	- - -	- - -	- - -	- - -	- - -	- - -	- - -	2.28	4.71	2.82
Gd	11.30	3.86	- - -	- - -	- - -	- - -	- - -	- - -	- - -	nd	nd	nd
Tb	1.62	0.531	- - -	- - -	- - -	- - -	- - -	- - -	- - -	1.172	2.38	1.33
Ho	1.96	0.691	- - -	- - -	- - -	- - -	- - -	- - -	- - -	nd	nd	nd
Tm	0.745	0.264	- - -	- - -	- - -	- - -	- - -	- - -	- - -	nd	nd	nd
Yb	4.28	1.57	- - -	- - -	- - -	- - -	- - -	- - -	- - -	3.28	5.78	3.66
Lu	0.593	0.226	- - -	- - -	- - -	- - -	- - -	- - -	- - -	0.429	0.735	0.488
Zr	275.00	109.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	304.00	350.00	182.00
Hf	7.06	2.71	- - -	- - -	- - -	- - -	- - -	- - -	- - -	8.42	8.65	6.02
Ta	1.32	0.657	- - -	- - -	- - -	- - -	- - -	- - -	- - -	3.79	3.98	2.65
W	0.00	0.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	nd	nd	nd
Th	2.91	0.937	- - -	- - -	- - -	- - -	- - -	- - -	- - -	4.69	4.54	3.76
U	1.38	0.293	- - -	- - -	- - -	- - -	- - -	- - -	- - -	3.27	1.64	0.83

Table 2. Analyses of tuff and lava flow samples from Cowlitz Formation, southwestern Washington (continued)

[Other formation sampled: McIntosh. Analyses listed in approximate stratigraphic order]

Sample no.	SWW92030	SWW92031	SWW92032	SWW92033	SWW86006	SWW86007	SWW86008	SWW86009	SWW86010	SWW88011	SWW92012	SWW92011
Lab no.	D-522641	D-522642	D-522643	D-522644	D-501192	D-501193	D-501194	D-501195	D-501196	D-501197	D-522629	D-522628
Analysis	VG52	VG52	VG52	VG52	UX20	UX20	UX20	UX20	UX20	UX20	VG51	VG51
Batch	B	B	B	B	A	A	A	A	A	A	B	B
Field no.	2C.21VII92T	2D.21VII92T	2E.21VII92T	2F.21VII92T	2A.14III86F	2B.14III86F	2C.14III86F	2D.14III86F	2E.14III86F	2F.14III86F	SLK	SLK
Lithology	cl xl(fs) tf	cl xl(fs) tf	cl xl(fs) tf	cl xl(fs) tf	cl pm lth tf	cl pm lth tf	clxl(qfsfm)tf	pm lth tf	cl lth pm tf	clxl(qfs)pmtf	cl xl pm lth tf	cl xl pm lth tf
Source/tk,cm	rc/8	rc/10	rc/50	rc/>50	rc/50	rc/50	rc/50	rc/15	rc/10	rc/>100	rc/250	rc/250
Strat position	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz	up Cowlitz
Section/Well	Powell Road	Powell Road	Powell Road	Powell Road	Carroll Road	Carroll Road	Carroll Road	Carroll Road	Carroll Road	Carroll Road	Carroll Road	Carroll Road
1/4,1/4,1/4	NWNWSW	NWNWSW	NWNWSW	NWNWSW	NWNWSW	NWNWSW	NWNWSW	NWNWSW	NWNWSW	NWNWSW	SWNWSW	SWNWSW
STR	12-9N-2W	12-9N-2W	12-9N-2W	12-9N-2W	1-7N-2W	1-7N-2W	1-7N-2W	1-7N-2W	1-7N-2W	1-7N-2W	1-7N-2W	1-7N-2W
7,5' quad	Castle Rock	Castle Rock	Castle Rock	Castle Rock	Rainier	Rainier	Rainier	Rainier	Rainier	Rainier	Rainier	Rainier
Lat N	46°16'32"	46°16'32"	46°16'32"	46°16'32"	46°07'09"	46°07'09"	46°07'09"	46°07'09"	46°07'09"	46°07'09"	46°06'57"	46°06'57"
Long W	122°52'58"	122°52'58"	122°52'58"	122°52'58"	122°53'13"	122°53'13"	122°53'13"	122°53'13"	122°53'13"	122°53'13"	122°52'59"	122°52'59"
Kelly/elev,ft	350	350	350	350	60	60	60	60	60	60	65	65
Sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	46.30	46.50	46.60	44.60	45.30	55.00	57.60	58.00	57.40	57.20	60.70	59.30
Al_2O_3	22.90	18.00	15.40	14.70	20.90	15.50	17.50	16.50	14.80	16.20	15.00	15.50
TiO_2	1.66	3.25	3.15	3.31	1.62	1.27	1.38	1.17	1.28	1.42	1.13	1.28
$FeTO_3$	6.80	10.20	11.40	13.70	10.90	5.26	2.96	1.64	2.99	1.67	2.49	2.85
MnO	0.03	0.03	0.07	0.23	0.05	0.03	0.01	0.01	0.01	0.01	0.01	0.01
CaO	1.27	1.54	3.24	2.52	1.05	2.72	2.77	2.91	3.36	3.93	3.22	3.35
MgO	1.91	2.56	2.96	3.12	2.06	1.81	1.03	1.35	1.73	1.51	1.49	1.57
K_2O	0.17	0.34	0.36	0.46	0.46	0.92	1.08	1.12	1.02	1.06	1.34	1.25
Na_2O	0.20	0.34	0.81	0.50	0.36	0.63	1.20	0.64	0.45	0.95	0.96	0.96
P_2O_5	0.12	0.25	0.57	0.81	0.07	0.05	0.05	0.05	0.05	0.45	0.07	0.08
LOI @ 925°C	17.80	16.60	14.80	15.60	16.80	16.20	13.70	15.90	16.40	14.70	12.70	13.00
Total	99.16	99.61	99.36	99.55	99.57	99.39	99.28	99.29	99.49	99.12	99.11	99.15
FeO*	6.12	9.18	10.26	12.33	9.81	4.73	2.66	1.48	2.69	1.50	2.24	2.56
Total w/o LOI	80.68	81.99	83.42	62.58	81.68	82.66	85.28	83.23	82.79	84.25	86.16	85.86
Major Elements (XRF, normalized values, weight%)												
SiO_2	57.39	56.72	55.86	54.01	55.46	66.54	67.54	69.69	69.33	67.89	70.45	69.06
Al_2O_3	28.38	21.95	18.46	17.80	25.59	18.75	20.52	19.83	17.88	19.23	17.41	18.05
TiO_2	2.06	3.96	3.78	4.01	1.98	1.54	1.62	1.41	1.55	1.69	1.31	1.49
FeO*	7.58	11.19	12.30	14.93	12.01	5.73	3.12	1.77	3.25	1.78	2.60	2.99
MnO	0.04	0.04	0.08	0.26	0.06	0.04	0.01	0.01	0.01	0.01	0.01	0.01
CaO	1.57	1.88	3.88	3.05	1.29	3.29	3.25	3.50	4.06	4.66	3.74	3.90
MgO	2.37	3.12	3.55	3.78	2.52	2.19	1.21	1.62	2.09	1.79	1.73	1.83
K_2O	0.21	0.41	0.43	0.56	0.56	1.11	1.27	1.35	1.23	1.28	1.56	1.46
Na_2O	0.25	0.41	0.97	0.61	0.44	0.76	1.41	0.77	0.54	1.13	1.11	1.12
P_2O_5	0.15	0.30	0.68	0.98	0.09	0.06	0.06	0.06	0.06	0.53	0.08	0.09
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	23	28	61	50	18	<10	<10	<10	<10	<10	<10	<10
Cr	32	80	90	80	<20	<20	<20	<20	<20	<20	<20	<20
Ba	375	485	910	780	220	1900	1500	1400	1000	2500	1100	610
Rb	10	12	13	11	26	23	19	27	31	25	39	29
Sr	198	250	305	240	99	920	780	930	1600	1300	1250	1400
Zr	126	335	280	250	285	245	370	315	285	210	265	275
Y	10	23	86	61	61	10	10	37	10	64	23	10
Nb	10	50	42	36	26	17	26	16	31	10	15	10
Cu	102	65	79	57	72	44	39	34	37	80	32	35
Zn	104	128	172	138	168	158	89	80	87	56	106	106
La	<30	32	83	39	38	<30	<30	<30	<30	<30	<30	<30
Ce	32	68	84	64	96	<30	<30	<30	35	36	49	<30
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Tl in weight%)												
Lab no.	D-522666	D-522667	D-522668	D-522669	D-501774	na	D-501775	na	D-501776	na	D-522654	D-522653
Analysis	VG53	VG53	VG53	VG53	UX44	- - -	UX44	- - -	UX44	- - -	VG53	VG53
Fe	4.96	7.42	8.42	9.96	8.41	- - -	2.24	- - -	2.25	- - -	1.93	2.07
Na	0.193	0.276	0.674	0.427	0.269	- - -	0.924	- - -	0.317	- - -	0.772	0.738
K	0.20	0.31	<0.5	0.47	0.405	- - -	0.993	- - -	0.858	- - -	1.15	1.05
Ca	0.82	1.42	3.20	2.60	nd	- - -	nd	- - -	nd	- - -	2.58	2.73
Tl	1.17	2.20	2.30	2.16	nd	- - -	nd	- - -	nd	- - -	0.64	0.74
Sc	38.30	25.50	26.13	27.80	31.30	- - -	22.20	- - -	19.60	- - -	17.30	20.03
Cr	4.90	75.40	82.40	73.00	17.30	- - -	25.10	- - -	26.30	- - -	26.10	23.90
Co	6.92	11.67	35.00	32.10	20.40	- - -	5.21	- - -	9.93	- - -	9.78	10.28
Ni	<40	<50	58.00	47.00	22.60	- - -	18.00	- - -	16.80	- - -	26.00	25.00
Zn	70.00	95.00	144.00	121.00	153.00	- - -	76.50	- - -	74.70	- - -	77.10	78.20
As	2.36	4.55	2.31	3.36	0.999	- - -	0.281	- - -	0.00	- - -	<0.8	<0.3
Se	<0.7	5.50	<1	<1	nd	- - -	nd	- - -	nd	- - -	<0.8	<0.7
Br	nd	nd	nd	nd	nd	- - -	nd	- - -	nd	- - -	nd	nd
Rb	5.60	13.80	16.00	15.90	25.60	- - -	17.70	- - -	19.60	- - -	31.90	25.40
Sr	220.00	300.00	352.00	272.00	117.00	- - -	866.00	- - -	1620.00	- - -	1410.00	1610.00
Mo	<2.0	2.60	3.00	2.20	nd	- - -	nd	- - -	nd	- - -	<2.0	<0.3
Sb	<0.2	0.27	0.22	0.174	0.282	- - -	0.259	- - -	0.157	- - -	0.122	0.103
Au	<0.005	<0.003	<0.004	<0.005	2.73	- - -	4.92	- - -	0.012	- - -	<0.006	<0.005
Ce	<0.2	0.41	0.40	0.63	1.67	- - -	0.85	- - -	0.923	- - -	1.53	1.11
Ba	377.00	506.00	963.00	805.00	229.00	- - -	1570.00	- - -	1110.00	- - -	10.27	769.00
La	10.60	25.50	95.30	65.70	48.60	- - -	7.35	- - -	2.37	- - -	23.80	6.00
Ce	20.90	66.50	112.50	79.10	67.40	- - -	13.90	- - -	5.24	- - -	55.10	10.50
Nd	10.20	26.40	108.00	70.00	68.10	- - -	7.82	- - -	2.68	- - -	26.40	4.30
Sm	2.37	5.80	26.30	16.20	17.60	- - -	1.97	- - -	0.694	- - -	6.48	1.26
Eu	0.681	1.51	7.06	4.35	4.41	- - -	1.14	- - -	0.524	- - -	1.55	0.798
Gd	nd	nd	nd	nd	16.30	- - -	1.81	- - -	0.63	- - -	nd	nd
Tb	0.351	0.738	3.56	2.32	2.36	- - -	0.263	- - -	0.087	- - -	0.923	0.198
Ho	nd	nd	nd	nd	3.07	- - -	0.506	- - -	0.168	- - -	nd	nd
Tm	nd	nd	nd	nd	1.21	- - -	0.225	- - -	0.101	- - -	nd	nd
Yb	1.49	2.06	8.11	5.56	7.28	- - -	1.80	- - -	0.676	- - -	2.62	1.08
Lu	0.196	0.275	1.049	0.728	1.03	- - -	0.27	- - -	0.099	- - -	0.354	0.157
Zr	240.00	359.00	270.00	273.00	324.00	- - -	327.00	- - -	229.00	- - -	258.00	251.00
Hf	3.46	9.06	7.29	6.69	7.29	- - -	9.36	- - -	6.90	- - -	6.06	6.13
Ta	0.729	4.27	3.24	2.99	1.51	- - -	2.00	- - -	1.39	- - -	1.19	1.248
W	nd	nd	nd	nd	2.23	- - -	0.00	- - -	1.28	- - -	nd	nd
Th	1.61	6.03	4.47	4.57	3.13	- - -	5.16	- - -	4.11	- - -	4.05	3.99
U	1.15	1.92	1.15	1.24	1.66	- - -	2.14	- - -	0.912	- - -	1.04	0.84

Table 2. Analyses of tuff and lava flow samples from Cowlitz Formation, southwestern Washington (continued)

[Other formation sampled: McIntosh. Analyses listed in approximate stratigraphic order]

Sample no.	SWW86001	SWW86002	SWW86003	SWW86004	SWW86005	SWW85002	SWW93076
Lab no.	D-501187	D-501188	D-501189	D-501190	D-501191	D-501273	D-572963
Analysis	UX20	UX20	UX20	UX20	UX20	UX22	WD16
Batch	A	A	A	A	A	A	F
Field no.	1A.14III86F	1B.14III86F	1C.14III86F	1D.14III86F	1E.14III86F	2.5IX85Th	90CG-V654E
Lithology	lt gray ss	clxl(fsfm) tf	clxl(fsfm) tf	clxl(fsfm) tf	clxl(fsfm) tf	cl xl(fs)lth tf	mdst
Source/tk,cm	rc/>500	rc/>800	rc/>800	rc/>800	rc/>800	rc/>800	rc/20
Strat position	top Cowlitz	top Cowlitz	top Cowlitz	top Cowlitz	top Cowlitz	top Cowlitz	top? Cowlitz?
Section/Well	Paxton Road	Paxton Road	Paxton Road	Paxton Road	Paxton Road	Paxton Road	upCoweeman R
1/4,1/4,1/4	SESWSW	SESWSW	SESWSW	SESWSW	SESWSW	NESWSW	SESWSE
STR	1-7N-2W	1-7N-2W	1-7N-2W	1-7N-2W	1-7N-2W	1-7N-2W	19-8N-3E
7.5' quad	Rainier	Rainier	Rainier	Rainier	Rainier	Rainier	Elk Mtn
Lat N	46°06'51"	46°06'51"	46°08'51"	46°06'51"	46°06'51"	46°06'51"	46°09'22"
Long W	122°52'55"	122°52'55"	122°52'55"	122°52'55"	122°52'55"	122°52'55"	122°28'41"
Kelly/elev,ft	70	70	70	70	70	70	2140
Sample dep,ft							
Major Elements (XRF, analyzed values, weight%)							
SiO_2	75.20	57.30	55.50	55.90	56.60	55.30	na
Al_2O_3	12.70	15.30	15.60	15.90	15.30	15.70	- - -
TiO_2	0.32	1.01	1.01	1.04	0.98	1.01	- - -
$FeTO_3$	1.04	6.29	6.53	6.92	6.62	6.60	- - -
MnO	0.02	0.08	0.08	0.10	0.11	0.08	- - -
CaO	1.42	4.46	4.79	5.09	4.42	4.64	- - -
MgO	0.26	3.01	3.14	3.24	2.92	3.17	- - -
K_2O	2.46	0.66	0.51	0.59	0.73	0.47	- - -
Na_2O	2.57	2.39	2.48	2.69	2.44	2.40	- - -
P_2O_5	0.05	0.21	0.21	0.22	0.21	0.21	- - -
LOI @ 925°C	3.34	9.26	9.65	8.11	9.69	10.30	- - -
Total	99.40	99.97	99.70	99.80	100.02	99.88	- - -
FeO*	0.94	5.66	5.88	6.23	5.96	5.94	- - -
Total w/o LOI	95.96	90.08	89.40	91.00	89.67	86.92	- - -
Major Elements (XRF, normalized values, weight%)							
SiO_2	78.37	63.61	62.08	61.43	63.12	62.19	- - -
Al_2O_3	13.24	16.98	17.67	17.47	17.06	17.66	- - -
TiO_2	0.33	1.12	1.13	1.14	1.09	1.14	- - -
FeO*	0.98	6.28	6.57	6.84	6.64	6.68	- - -
MnO	0.02	0.09	0.09	0.11	0.12	0.09	- - -
CaO	1.48	4.95	5.36	5.59	4.93	5.22	- - -
MgO	0.29	3.34	3.51	3.56	3.26	3.57	- - -
K_2O	2.56	0.73	0.57	0.65	0.81	0.53	- - -
Na_2O	2.68	2.65	2.77	2.96	2.72	2.70	- - -
P_2O_5	0.05	0.23	0.23	0.24	0.23	0.24	- - -
Total	100.00	100.00	100.00	100.00	100.00	100.00	- - -
Trace Elements (XRF, ppm)							
Ni	<10	12	16	19	18	13	42
Cr	<20	<20	<20	<20	<20	<20	152
Ba	920	178	146	146	156	150	158
Rb	63	29	14	14	20	14	15
Sr	405	260	265	285	260	260	490
Zr	78	240	240	240	245	245	520
Y	<10	34	32	40	32	30	57
Nb	<10	19	16	21	17	22	51
Cu	<10	70	69	67	64	70	89
Zn	25	77	82	82	73	98	166
La	<30	<30	<30	31	<30	<30	42
Ce	30	46	61	40	39	<30	106
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)							
Lab no.	D-501772	na	na	D-501773	na	D-501769	na
Analysis	UX44	- - -	- - -	UX44	- - -	UX44	- - -
Fe	0.767	- - -	- - -	5.13	- - -	4.96	- - -
Na	2.04	- - -	- - -	2.03	- - -	1.99	- - -
K	1.79	- - -	- - -	0.00	- - -	0.671	- - -
Ca	nd	- - -	- - -	nd	- - -	nd	- - -
Ti	nd	- - -	- - -	nd	- - -	nd	- - -
Sc	6.50	- - -	- - -	19.30	- - -	19.10	- - -
Cr	15.00	- - -	- - -	19.70	- - -	18.20	- - -
Co	3.76	- - -	- - -	16.20	- - -	14.40	- - -
Ni	7.02	- - -	- - -	5.92	- - -	7.93	- - -
Zn	22.80	- - -	- - -	106.00	- - -	94.40	- - -
As	0.601	- - -	- - -	3.04	- - -	2.14	- - -
Se	nd	- - -	- - -	nd	- - -	nd	- - -
Br	nd	- - -	- - -	nd	- - -	nd	- - -
Rb	68.10	- - -	- - -	18.40	- - -	17.00	- - -
Sr	439.00	- - -	- - -	350.00	- - -	291.00	- - -
Mo	nd	- - -	- - -	nd	- - -	nd	- - -
Sb	0.244	- - -	- - -	0.344	- - -	0.371	- - -
Au	0.276	- - -	- - -	0.861	- - -	2.09	- - -
Ce	1.49	- - -	- - -	1.32	- - -	1.37	- - -
Ba	863.00	- - -	- - -	175.00	- - -	157.00	- - -
La	9.90	- - -	- - -	19.90	- - -	18.50	- - -
Ce	20.10	- - -	- - -	43.50	- - -	41.20	- - -
Nd	10.80	- - -	- - -	27.00	- - -	25.70	- - -
Sm	2.10	- - -	- - -	6.53	- - -	6.07	- - -
Eu	0.717	- - -	- - -	1.67	- - -	1.56	- - -
Gd	1.82	- - -	- - -	6.26	- - -	5.54	- - -
Tb	0.25	- - -	- - -	0.935	- - -	0.857	- - -
Ho	0.318	- - -	- - -	1.24	- - -	1.15	- - -
Tm	0.133	- - -	- - -	0.534	- - -	0.478	- - -
Yb	0.80	- - -	- - -	3.30	- - -	3.07	- - -
Lu	0.119	- - -	- - -	0.486	- - -	0.473	- - -
Zr	85.70	- - -	- - -	232.00	- - -	246.00	- - -
Hf	2.25	- - -	- - -	6.22	- - -	6.32	- - -
Ta	0.394	- - -	- - -	1.23	- - -	1.25	- - -
W	0.593	- - -	- - -	1.81	- - -	0.699	- - -
Th	2.29	- - -	- - -	3.15	- - -	3.15	- - -
U	0.602	- - -	- - -	1.55	- - -	1.76	- - -

Table 3. Analyses of tuff samples from Skookumchuck Formation, southwestern Washington

[Analyses listed in approximate stratigraphic order]

Sample no.	SWW91015	SWW91013	SWW91014	SWW91016	SWW84002	SWW92036	SWW92037
Lab no.	D-522601	D-522619	D-522620	D-522621	D-501209	D-522645	D-522646
Analysis/Run	VG51	VG51	VG51	VG51	UX20	VG52	VG52
Batch	B	B	B	B	A	B	B
Field no.	SJ-91-167	SJ-91-165	SJ-91-166	SJ-91-215	4.17VII82/CT2	3.22VII92W	4.22VII92W
Lithology	clayey tuff	cl xl(fs) tf	cl xl(q-fs) tf	cl xl(q-fs) tf	cl pm tf	cl xl(fs) tf	cl xl(fs) tf
Source/tk,cm	rc/?	oc/15	rc/10	rc/2	rc/100	rc/50	rc/300
Strat position	Pen coal bed	Big Dirty bed	Big Dirty bed	lo Thomp bed	Lucas Creek	Lucas Creek	Lucas Creek
Section/Well	mid SK	mid SK	mid SK	mid SK	upper SK	upper SK	upper SK
1/4,1/4,1/4	NESWNE	SWSWNE	NENWNE	NENWNE	SWNWNE	NESWSW	SWNWNE
STR	32-15N-1W	33-15N-2W	32-15N-1W	32-15N-1W	32-14N-1E	29-14N-1E	32-14N-1E
7.5' quad	Logan Hill	Centralia	Logan Hill	Logan Hill	Onalaska NW	Onalaska NW	Onalaska NW
Lat N	46°44'35"	46°49'47"	46°44'30"	46°44'30"	46°39'36"	46°39'54"	46°39'38"
Long W	122°49'44"	122°56'16"	122°49'44"	122°49'44"	122°42'20"	122°42'49"	122°42'20"
Kelly/elev,ft	340	220	230	230	870	1030	940
Sample dep,ft							
Major Elements (XRF, analyzed values, weight%)							
SiO_2	37.30	53.80	60.00	50.10	48.50	66.60	56.10
Al_2O_3	16.90	19.20	16.90	21.90	19.60	13.60	20.20
TiO_2	1.93	3.74	0.56	2.68	1.30	0.54	1.54
$FeTO_3$	1.26	4.24	2.68	4.08	7.09	1.40	2.02
MnO	0.01	0.01	0.02	0.01	0.01	0.01	0.01
CaO	0.63	0.66	1.91	0.51	0.46	1.42	1.69
MgO	0.46	1.55	2.14	2.17	2.44	0.12	0.41
K_2O	1.25	0.51	0.36	0.03	0.59	4.67	4.45
Na_2O	0.37	0.71	1.48	0.15	0.26	0.58	1.25
P_2O_5	0.06	0.14	0.08	0.28	0.10	0.05	0.08
LOI @ 925°C	39.20	13.20	12.90	17.10	19.20	8.92	9.04
Total	99.39	97.96	99.03	99.21	99.55	98.31	98.79
FeO*	1.15	3.82	2.41	3.67	6.38	1.26	1.82
Total w/o LOI	60.06	84.34	65.86	61.70	79.64	89.25	69.55
Major Elements (XRF, normalized values, weight%)							
SiO_2	62.10	63.79	69.88	61.32	60.90	74.62	64.88
Al_2O_3	28.14	22.77	19.68	26.80	24.61	15.46	22.56
TiO_2	3.21	4.43	0.65	3.53	1.63	0.61	1.72
FeO*	1.92	4.52	2.81	4.49	8.01	1.41	2.03
MnO	0.02	0.01	0.02	0.01	0.01	0.01	0.01
CaO	1.05	1.02	2.22	0.62	0.56	1.59	1.89
MgO	0.77	1.84	2.49	2.66	3.06	0.13	0.46
K_2O	2.08	0.60	0.42	0.04	0.74	5.46	4.97
Na_2O	0.82	0.84	1.72	0.18	0.33	0.65	1.40
P_2O_5	0.10	0.17	0.09	0.34	0.13	0.06	0.09
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)							
Ni	10	14	10	10	21	10	15
Cr	20	23	20	20	76	20	75
Ba	245	300	320	340	150	930	330
Rb	25	14	10	<10	28	180	64
Sr	102	122	370	260	88	1300	1500
Zr	290	280	510	540	240	520	250
Y	17	22	94	68	18	31	10
Nb	21	59	104	128	22	19	10
Cu	112	30	25	27	58	16	71
Zn	24	55	186	18	126	28	126
La	30	30	112	100	30	71	35
Ce	38	41	230	152	30	104	78
Th	nd	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)							
Lab no.	na	na	na	na	D-501779	na	na
Analysis					UX44		
Fe	- - -	- - -	- - -	- - -	5.26	- - -	- - -
Na	- - -	- - -	- - -	- - -	0.192	- - -	- - -
K	- - -	- - -	- - -	- - -	0.379	- - -	- - -
Ca	- - -	- - -	- - -	- - -	nd	- - -	- - -
Ti	- - -	- - -	- - -	- - -	nd	- - -	- - -
Sc	- - -	- - -	- - -	- - -	28.00	- - -	- - -
Cr	- - -	- - -	- - -	- - -	71.40	- - -	- - -
Co	- - -	- - -	- - -	- - -	14.00	- - -	- - -
Ni	- - -	- - -	- - -	- - -	14.00	- - -	- - -
Zn	- - -	- - -	- - -	- - -	116.00	- - -	- - -
As	- - -	- - -	- - -	- - -	5.62	- - -	- - -
Se	- - -	- - -	- - -	- - -	nd	- - -	- - -
Br	- - -	- - -	- - -	- - -	nd	- - -	- - -
Rb	- - -	- - -	- - -	- - -	25.20	- - -	- - -
Sr	- - -	- - -	- - -	- - -	128.00	- - -	- - -
Mo	- - -	- - -	- - -	- - -	nd	- - -	- - -
Sb	- - -	- - -	- - -	- - -	0.332	- - -	- - -
Au	- - -	- - -	- - -	- - -	1.76	- - -	- - -
Ce	- - -	- - -	- - -	- - -	1.42	- - -	- - -
Ba	- - -	- - -	- - -	- - -	147.00	- - -	- - -
La	- - -	- - -	- - -	- - -	15.30	- - -	- - -
Ce	- - -	- - -	- - -	- - -	29.60	- - -	- - -
Nd	- - -	- - -	- - -	- - -	9.98	- - -	- - -
Sm	- - -	- - -	- - -	- - -	1.77	- - -	- - -
Eu	- - -	- - -	- - -	- - -	0.461	- - -	- - -
Gd	- - -	- - -	- - -	- - -	1.77	- - -	- - -
Tb	- - -	- - -	- - -	- - -	0.247	- - -	- - -
Ho	- - -	- - -	- - -	- - -	0.349	- - -	- - -
Tm	- - -	- - -	- - -	- - -	0.137	- - -	- - -
Yb	- - -	- - -	- - -	- - -	0.857	- - -	- - -
Lu	- - -	- - -	- - -	- - -	0.127	- - -	- - -
Zr	- - -	- - -	- - -	- - -	238.00	- - -	- - -
Hf	- - -	- - -	- - -	- - -	6.47	- - -	- - -
Ta	- - -	- - -	- - -	- - -	1.40	- - -	- - -
W	- - -	- - -	- - -	- - -	1.23	- - -	- - -
Th	- - -	- - -	- - -	- - -	4.85	- - -	- - -
U	- - -	- - -	- - -	- - -	1.97	- - -	- - -

Table 4. Analyses of tuff samples from Puget Group-south, southwestern Washington

[Puget Group-south includes Carbonado and Spiketon Formations and Chambers Creek beds. Other formstion sampled: Ohanapecosh. Analyses listed in approximate stratigraphic order]

Sample no.	NWW86015	NWW86010	NWW86014	NWW86013	NWW86009	NWW86008	NWW86012	NWW86011	NWW86007	SWW91009	SWW91008	SWW91010
Lab no.	D-501238	D-501233	D-501237	D-501236	D-501232	D-501231	D-501235	D-501234	D-501230	D-522614	D-522613	D-522615
Analysis/Run	UX21	UX21	UX21	UX21	UX21	UX21	UX21	UX21	UX21	VG51	VG51	VG51
Batch	A	A	A	A	A	A	A	A	A	B	B	B
Field no.	DH180623.2C	DH180615.1	DH180615.3	DH180615.3	DH180615.1	DH180615.1	DH180615.3	DH180615.2	DH180615.1	SJ-91-133	SJ-91-131	SJ-91-141
Lithology	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff
Source/tk,cm	co/8	co/60	co/30	co/15	co/60	co/60	co/30	co/30	co/60	co/135	co/30	co/3
Strat position	lo CB	lo CB	lo CB	lo CB	lo CB	lo CB	lo CB	lo CB	lo CB	mid CB	mid CB	mid CB
Section/Well	DH180623.2C	DH180615.1	DH180615.3	DH180615.3	DH180615.1	DH180615.1	DH180615.3	DH180615.2	DH180615.1	WC-83-5	WC-83-5	WC-83-5
1/4,1/4,1/4	NENENE	SENWSW	NESESW	NESESW	SENWSW	SENWSW	NESESW	SWNESE	SENWSW	SENWSW	SENWSW	SENWSW
STR	23-18N-6E	15-18N-6E	15-18N-6E	15-18N-6E	15-18N-6E	15-18N-6E	15-18N-6E	16-18N-6E	15-18N-6E	29-14N-5E	29-14N-5E	29-14N-5E
7.5' quad	Old Baldy Mtn.	Wilkeson	Wilkeson	Wilkeson	Wilkeson	Wilkeson	Wilkeson	Wilkeson	Wilkeson	Mineral	Mineral	Mineral
Lat N	47°02'23"	47°02'35"	47°02'30"	47°02'30"	47°02'35"	47°02'35"	47°02'30"	47°02'47"	47°02'35"	46°40'00"	46°40'00"	46°40'00"
Long W	121°59'39"	122°01'45"	122°01'27"	122°01'27"	122°01'45"	122°01'45"	122°01'27"	122°01'39"	122°01'45"	122°12'03"	122°12'03"	122°12'03"
Kelly/elev,ft	2320	1920	2220	2220	1920	1920	2220	1960	1920	1915	1915	1915
sample dep,ft	-358	-1242	-770	-768	-449	-424	-240	-364	-268	-1770	-824.5	-548.8
Major Elements (XRF, analyzed values, weight%)												
SiO_2	80.20	52.10	47.00	56.30	52.10	50.30	54.10	40.40	53.60	58.50	44.40	43.00
Al_2O_3	9.42	23.30	24.40	22.20	15.50	15.20	16.50	17.10	23.00	16.20	17.50	19.90
TiO_2	0.38	1.64	1.03	0.83	1.99	1.88	2.05	2.21	0.39	0.89	1.18	1.44
$FeTO_3$	2.19	5.22	3.04	3.05	8.46	8.82	8.73	9.02	3.54	4.31	9.43	8.31
MnO	0.08	0.02	0.11	0.06	0.13	0.11	0.11	0.11	0.08	0.07	0.07	0.10
CaO	0.36	0.44	4.41	1.42	2.43	2.93	6.35	7.18	0.88	4.11	2.56	4.07
MgO	0.28	3.24	1.39	1.55	2.53	2.88	3.27	3.39	2.20	1.42	1.50	2.21
K_2O	2.13	3.03	4.51	4.07	1.08	1.28	0.60	0.31	4.88	1.04	2.64	2.92
Na_2O	0.56	3.37	0.67	0.90	3.71	3.85	4.52	0.38	0.16	0.96	2.64	2.15
P_2O_5	0.08	0.25	0.22	0.17	0.21	0.21	0.24	0.22	0.06	0.19	0.16	0.30
LOI @ 925°C	3.45	6.31	11.70	8.53	10.80	11.60	2.87	18.80	10.80	9.67	15.90	12.00
Total	99.13	98.92	98.48	99.08	98.94	99.06	99.34	99.10	99.39	97.36	97.98	96.40
FeO*	1.97	4.70	2.74	2.74	7.61	7.94	7.86	8.12	3.19	3.88	8.49	7.48
Total w/o LOI	95.46	92.09	86.48	90.24	87.29	86.58	95.60	79.40	88.44	87.26	81.14	83.57
Major Elements (XRF, normalized values, weight%)												
SiO_2	84.01	56.58	54.35	62.39	59.68	58.10	56.59	50.88	60.61	67.04	54.72	51.46
Al_2O_3	9.87	25.30	28.22	24.60	17.76	17.56	17.26	21.54	26.01	18.57	21.57	23.81
TiO_2	0.40	1.78	1.19	0.92	2.28	2.17	2.14	2.78	0.44	1.02	1.45	1.72
FeO*	2.06	5.10	3.16	3.04	8.72	9.17	8.22	10.22	3.60	4.44	10.46	8.95
MnO	0.08	0.02	0.13	0.07	0.15	0.13	0.12	0.14	0.09	0.08	0.09	0.12
CaO	0.38	0.48	5.10	1.57	2.78	3.38	6.64	9.04	1.00	4.71	3.16	4.87
MgO	0.29	3.52	1.61	1.72	2.90	3.33	3.42	4.27	2.49	1.63	1.85	2.64
K_2O	2.23	3.29	5.22	4.51	1.24	1.48	0.63	0.39	5.52	1.19	3.25	3.49
Na_2O	0.59	3.66	0.77	1.00	4.25	4.45	4.73	0.45	0.18	1.10	3.25	2.57
P_2O_5	0.08	0.27	0.25	0.19	0.24	0.24	0.25	0.28	0.07	0.22	0.20	0.36
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	<10	28	14	17	46	48	58	55	17	<10	19	45
Cr	<20	<20	<20	<20	65	62	50	49	<20	<20	<20	52
Ba	400	2100	1200	1100	435	400	205	220	960	660	760	700
Rb	53	82	144	132	33	41	15	13	176	38	85	93
Sr	110	300	495	350	280	250	540	250	215	375	310	660
Zr	86	750	550	425	162	160	180	168	325	380	250	335
Y	16	108	63	58	19	21	24	23	61	34	28	45
Nb	<10	160	59	48	16	15	17	18	52	31	20	21
Cu	25	31	52	63	128	128	166	174	26	49	42	86
Zn	39	210	120	114	83	86	97	100	98	73	74	124
La	<30	122	91	74	<30	<30	<30	<30	75	32	<30	<30
Ce	<30	280	174	134	<30	34	<30	<30	170	85	<30	67
Th	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Tl in weight%)												
Lab no.	D-501802	D-501798	D-501801	D-501800	D501797	D-501796	D-501799	na	D-501795	na	na	na
Analysis	UX45	UX45	UX45	UX45	UX44	UX44	UX44	---	UX44	---	---	---
Fe	4.28	3.69	2.39	2.24	6.50	6.01	6.51	---	2.18	---	---	---
Na	0.25	2.45	0.488	0.684	3.04	2.86	3.61	---	0.824	---	---	---
K	2.34	2.73	3.87	2.96	0.937	0.758	0.349	---	4.35	---	---	---
Ca	nd	nd	nd	nd	nd	nd	nd	---	nd	---	---	---
Tl	nd	nd	nd	nd	nd	nd	nd	---	nd	---	---	---
Sc	11.20	13.10	12.70	13.80	14.90	15.20	16.20	---	6.32	---	---	---
Cr	42.70	1.23	14.40	33.80	68.10	65.50	76.30	---	13.70	---	---	---
Co	17.60	7.69	24.40	7.87	23.80	29.00	28.90	---	6.24	---	---	---
Ni	36.60	38.20	27.30	17.80	55.00	49.00	87.90	---	9.74	---	---	---
Zn	51.50	186.00	109.00	109.00	86.50	85.50	94.20	---	92.10	---	---	---
As	13.80	0.00	31.40	4.18	83.60	2.97	0.596	---	1.84	---	---	---
Se	nd	nd	nd	nd	nd	nd	nd	---	nd	---	---	---
Br	nd	nd	nd	nd	nd	nd	nd	---	nd	---	---	---
Rb	88.00	91.20	165.00	145.00	39.30	32.70	15.80	---	205.00	---	---	---
Sr	181.00	328.00	552.00	387.00	266.00	315.00	588.00	---	231.00	---	---	---
Mo	nd	nd	nd	nd	nd	nd	nd	---	nd	---	---	---
Sb	7.36	0.076	0.893	0.508	0.509	0.336	0.074	---	0.364	---	---	---
Au	7.88	8.21	0.943	2.42	4.02	1.19	2.61	---	0.846	---	---	---
Cs	3.90	3.89	7.29	7.14	1.04	0.93	0.329	---	18.00	---	---	---
Ba	527.00	2130.00	1220.00	1160.00	385.00	432.00	214.00	---	1030.00	---	---	---
La	22.80	145.00	59.30	59.90	12.30	10.70	11.70	---	68.90	---	---	---
Ce	43.70	294.00	132.00	134.00	29.60	26.50	29.80	---	137.00	---	---	---
Nd	22.70	130.00	65.00	64.00	20.10	18.30	22.50	---	58.80	---	---	---
Sm	4.62	25.50	14.20	13.00	5.13	4.90	5.65	---	12.70	---	---	---
Eu	0.89	4.84	1.83	1.61	1.25	1.35	1.68	---	1.29	---	---	---
Gd	3.37	20.10	11.20	10.60	4.68	5.04	5.10	---	10.10	---	---	---
Tb	0.52	3.04	1.80	1.46	0.645	0.603	0.696	---	1.66	---	---	---
Ho	0.701	3.73	2.43	2.13	0.761	0.679	0.808	---	2.31	---	---	---
Tm	0.321	1.52	1.05	0.928	0.24	0.23	0.259	---	1.02	---	---	---
Yb	2.04	9.59	6.31	5.47	1.41	1.35	1.56	---	6.60	---	---	---
Lu	0.302	1.34	0.881	0.775	0.192	0.189	0.218	---	0.91	---	---	---
Zr	125.00	713.00	565.00	421.00	168.00	154.00	163.00	---	357.00	---	---	---
Hf	3.62	23.50	16.00	13.20	4.04	3.84	4.42	---	11.20	---	---	---
Ta	0.879	10.70	4.53	4.00	0.929	0.918	1.02	---	6.20	---	---	---
W	2.32	3.20	1.54	1.92	1.11	0.00	0.00	---	0.00	---	---	---
Th	4.77	19.10	21.90	20.60	1.27	0.862	0.729	---	29.10	---	---	---
U	1.80	6.29	6.93	6.60	0.538	0.343	0.351	---	9.46	---	---	---

Table 4. Analyses of tuff samples from Puget Group-south, southwestern Washington (continued)

[Puget Group-south includes Carbonado and Spiketon Formations and Chambers Creek beds. Other formation sampled: Ohanapecosh. Analyses listed in approximate stratigraphic order]

Sample no.	SWW91011	SWW92068	SWW92069	SWW92070	SWW92071	SWW92072	SWW92073	SWW92074	SWW92075	SWW92076	SWW92077	SWW92078
Lab no.	D-522616	D-526485	D-526486	D-526487	D-526488	D-526489	D-526490	D-526491	D-526492	D-526493	D-526494	D-526495
Analysis/Run	VG51	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24
Batch	B	C	C	C	C	C	C	C	C	C	C	C
Field no.	SJ-91-143	SJ-92-28	SJ-92-61	SJ-92-66V	SJ-92-68	SJ-92-70	SJ-92-73	SJ-92-75	SJ-92-76	SJ-92-77	SJ-92-83	SJ-92-88
Lithology	cl tf	cl xl(pc) tf	xl(pc) tf	sdy xl(pc) tf	cl xl(fs) tf	cl xl(pc) tf	sdy xl(pc) tf	sdy xl(pc) tf	cl xl(fs) tf	cl xl(pc) tf	sdy xl(pc) tf	cl xl(fs) tf
Source/tk,cm	co/230	oc/400	oc/4	oc/15	oc/90	oc/320	oc/235	oc/70	oc/5	oc/70	oc/30	oc/20
Strat position	mid CB	up CB	up CB	up CB	up CB	up CB	up CB	up CB	up CB	up CB	up CB	up CB
Section/Well	WC-83-5	W. Summit Cr	W. Summit Cr	W. Summit Cr	W. Summit Cr	W. Summit Cr	W. Summit Cr	W. Summit Cr	W. Summit Cr	W. Summit Cr	W. Summit Cr	W. Summit Cr
1/4,1/4,1/4	SENWSW	SE	SW	NW	NW	NW	NW	NW	SW	SW	SE	SE
STR	29-14N-5E	28-14N-5E	29-14N-5E	29-14N-5E	29-14N-5E	29-14N-5E	29-14N-5E	29-14N-5E	20-14N-5E	20-14N-5E	19-14N-5E	19-14N-5E
7.5' quad	Mineral	Mineral	Mineral	Mineral	Minaral	Mineral	Mineral	Mineral	Mineral	Mineral	Mineral	Mineral
Lat N	46°40'00"	46°40'32"	46°40'38"	46°40'38"	46°40'38"	46°40'38"	46°40'38"	46°40'36"	46°40'35"	46°40'34"	46°40'39"	46°41'01"
Long W	122°12'03"	122°11'58"	122°12'14"	122°12'16"	122°12'19"	122°12'21"	122°12'23"	122°12'25"	122°12'27"	122°12'29"	122°12'43"	122°12'51"
Kelly/elev,ft	1915	2640	1980	2320	2340	2340	2360	2380	2440	2450	2450	2450
sample dep,ft	-522											
Major Elements (XRF, analyzed values, weight%)												
SiO_2	66.00	55.80	60.80	76.10	63.00	51.90	44.20	53.50	48.50	44.70	55.00	64.80
Al_2O_3	13.40	17.90	18.40	13.00	20.80	16.00	16.90	24.80	26.60	17.50	18.70	15.90
TiO_2	0.25	1.47	1.53	0.70	0.85	1.22	1.11	1.80	2.17	1.29	1.02	0.98
$FeTO_5$	3.02	13.90	4.84	1.65	3.05	6.87	7.63	2.19	4.02	8.32	6.16	4.18
MnO	0.10	0.05	0.02	0.03	0.01	0.10	0.12	0.01	0.01	0.29	0.02	0.02
CaO	2.47	0.04	0.94	0.13	0.04	5.08	8.16	0.21	0.17	9.71	1.82	1.90
MgO	1.96	0.10	0.75	0.34	0.46	2.07	3.44	0.67	1.38	1.94	1.27	0.79
K_2O	2.71	0.29	0.82	2.32	2.48	1.28	0.51	0.58	4.09	0.68	1.19	1.84
Na_2O	0.89	0.15	5.92	0.75	0.78	0.33	3.04	0.66	0.17	2.81	1.18	2.65
P_2O_5	0.05	0.21	0.23	0.10	0.10	0.28	0.19	0.38	0.08	0.22	0.20	0.17
LOI @ 925°C	7.85	9.63	5.00	4.49	8.16	14.10	14.10	14.50	12.40	11.70	13.00	6.10
Total	98.70	99.54	99.25	99.61	99.73	99.23	99.40	99.30	99.57	99.16	99.56	99.33
FeO*	2.72	12.51	4.36	1.48	2.74	6.18	6.87	1.97	3.62	7.49	5.54	3.76
Total w/o LOI	90.55	88.52	93.77	94.95	91.26	84.44	84.54	84.58	86.77	86.63	85.94	92.81
Major Elements (XRF, normalized values, weight%)												
SiO_2	72.89	63.04	64.84	80.14	69.03	61.46	52.29	63.25	55.90	51.60	64.00	69.82
Al_2O_3	14.80	20.22	19.62	13.69	22.79	18.95	19.99	29.32	30.66	20.20	21.76	17.13
TiO_2	0.28	1.66	1.63	0.74	0.93	1.44	1.31	2.13	2.50	1.49	1.19	1.06
FeO*	3.00	14.13	4.64	1.56	3.01	7.32	8.12	2.33	4.17	8.64	6.45	4.05
MnO	0.11	0.06	0.02	0.03	0.01	0.12	0.14	0.01	0.01	0.33	0.02	0.02
CaO	2.73	0.05	1.00	0.14	0.04	6.02	9.65	0.25	0.20	11.21	2.12	2.05
MgO	2.16	0.11	0.80	0.36	0.50	2.45	4.07	0.79	1.57	2.24	1.48	0.85
K_2O	2.99	0.33	0.87	2.44	2.72	1.52	0.60	0.69	4.71	0.78	1.38	1.98
Na_2O	0.98	0.17	6.31	0.79	0.85	0.39	3.60	0.78	0.20	3.24	1.37	2.86
P_2O_5	0.06	0.24	0.25	0.11	0.11	0.33	0.22	0.45	0.09	0.25	0.23	0.18
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	<10	49	<10	11	24	25	120	19	28	24	<10	<10
Cr	<20	86	73	66	85	46	200	36	100	44	24	34
Ba	425	220	275	530	660	550	300	184	164	260	194	345
Rb	86	15	27	80	96	41	29	24	136	13	41	30
Sr	158	890	355	118	200	370	425	255	19	345	166	420
Zr	146	182	250	270	205	240	110	385	285	122	395	260
Y	25	20	28	29	26	27	10	30	42	19	36	19
Nb	11	11	18	17	14	16	11	26	22	10	23	15
Cu	17	160	49	30	41	84	102	63	182	118	63	40
Zn	46	104	<10	50	85	71	72	81	74	52	61	32
La	<30	<30	<30	36	<30	<30	<30	<30	34	<30	36	<30
Ce	49	30	38	65	50	41	<30	56	90	37	64	44
Th	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)												
Lab no.	na	na	na	na	na	na	na	na	na	na	na	na
Analysis	---	---	---	---	---	---	---	---	---	---	---	---
Fe	---	---	---	---	---	---	---	---	---	---	---	---
Na	---	---	---	---	---	---	---	---	---	---	---	---
K	---	---	---	---	---	---	---	---	---	---	---	---
Ca	---	---	---	---	---	---	---	---	---	---	---	---
Ti	---	---	---	---	---	---	---	---	---	---	---	---
Sc	---	---	---	---	---	---	---	---	---	---	---	---
Cr	---	---	---	---	---	---	---	---	---	---	---	---
Co	---	---	---	---	---	---	---	---	---	---	---	---
Ni	---	---	---	---	---	---	---	---	---	---	---	---
Zn	---	---	---	---	---	---	---	---	---	---	---	---
As	---	---	---	---	---	---	---	---	---	---	---	---
Se	---	---	---	---	---	---	---	---	---	---	---	---
Br	---	---	---	---	---	---	---	---	---	---	---	---
Rb	---	---	---	---	---	---	---	---	---	---	---	---
Sr	---	---	---	---	---	---	---	---	---	---	---	---
Mo	---	---	---	---	---	---	---	---	---	---	---	---
Sb	---	---	---	---	---	---	---	---	---	---	---	---
Au	---	---	---	---	---	---	---	---	---	---	---	---
Cs	---	---	---	---	---	---	---	---	---	---	---	---
Ba	---	---	---	---	---	---	---	---	---	---	---	---
La	---	---	---	---	---	---	---	---	---	---	---	---
Ce	---	---	---	---	---	---	---	---	---	---	---	---
Nd	---	---	---	---	---	---	---	---	---	---	---	---
Sm	---	---	---	---	---	---	---	---	---	---	---	---
Eu	---	---	---	---	---	---	---	---	---	---	---	---
Gd	---	---	---	---	---	---	---	---	---	---	---	---
Tb	---	---	---	---	---	---	---	---	---	---	---	---
Ho	---	---	---	---	---	---	---	---	---	---	---	---
Tm	---	---	---	---	---	---	---	---	---	---	---	---
Yb	---	---	---	---	---	---	---	---	---	---	---	---
Lu	---	---	---	---	---	---	---	---	---	---	---	---
Zr	---	---	---	---	---	---	---	---	---	---	---	---
Hf	---	---	---	---	---	---	---	---	---	---	---	---
Ta	---	---	---	---	---	---	---	---	---	---	---	---
W	---	---	---	---	---	---	---	---	---	---	---	---
Th	---	---	---	---	---	---	---	---	---	---	---	---
U	---	---	---	---	---	---	---	---	---	---	---	---

Table 4. Analyses of tuff samples from Puget Group-south, southwestern Washington (continued)

[Puget Group-south includes Carbonado and Spiketon Formations and Chambers Creek beds. Other formation sampled: Ohanapecosh. Analyses listed in approximate stratigraphic order]

Sample no.	SWW91001	SWW92047	SWW92048	SWW92049	SWW92050	SWW92051	SWW92052	SWW92053	SWW92054	SWW92055	SWW92056	SWW92057
Lab no.	D-522602	D-526499	D-526500	D-526501	D-526502	D-526503	D-526504	D-525505	D-526506	D-526507	D-526508	D-526509
Analysis/Run	VG51	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24
Batch	B	C	C	C	C	C	C	C	C	C	C	C
Field no.	SJ-91-76	4.3VIII92M	5A.3VIII92M	5B.3VIII92M	5C.3VIII92M	5D.3VIII92M	5E.3VIII92M	5F.3VIII92M	5G.3VIII92M	5H.3VIII92M	5I.3VIII92M	6.3VIII92M
Lithology	clayey tuff	cl xl(q-fs?) tf	clayey carb tf	clayey tuff	clayey tuff	cl xl(q-fs) tf	cl xl(q-fs) tf	cl xl(fs) tf	cl xl(fs) tf	cl xl(fs) tf	lam clayey tf	wh cl xl(fs) tf
Source/tk,cm	rc/25	rc/25	rc/30	rc/30	rc/30	rc/30	rc/30	rc/3	rc/3	rc/10	rc/30	rc/20
Strat position	up CB	mid SPK	mid SPK	mid SPK	mid SPK	mid SPK	mid SPK	mid SPK	mid SPK	mid SPK	mid SPK	up SPK
Section/Well	Bear Canyon	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd
1/4,1/4,1/4	SW	NWSESW	NWSWSE	NWSWSE	NWSWSE	NWSWSE	NWSWSE	NWSWSE	NWSWSE	NWSWSE	NWSWSE	SESESE
STR	8-13N-3E	13-17N-6E	13-17N-6E	13-17N-6E	13-17N-6E	13-17N-6E	13-17N-6E	13-17N-6E	13-17N-6E	13-17N-6E	13-17N-6E	19-17N-6E
7.5' quad	Mossyrock	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes
Lat N	46°37'17"	46°57'17"	46°57'13"	46°57'13"	46°57'13"	46°57'13"	46°57'13"	46°57'13"	46°57'13"	46°57'13"	46°57'13"	46°56'15"
Long W	122°27'59"	121°59'34"	121°59'16"	121°59'16"	121°59'16"	121°59'16"	121°59'16"	121°59'16"	121°59'16"	121°59'16"	121°59'16"	121°57'34"
Kelly/elev,ft	1715	3270	3355	3355	3355	3355	3355	3355	3355	3355	3355	3430
sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	66.40	59.10	62.00	48.60	65.30	68.30	55.50	53.40	52.20	52.50	66.20	42.60
Al_2O_3	18.00	24.90	22.40	29.00	18.60	18.50	23.60	27.30	27.80	27.00	19.80	16.70
TiO_2	1.02	1.11	0.97	2.42	0.61	0.58	0.85	1.68	1.51	2.71	0.97	1.31
$FeTO_3$	1.50	1.45	1.66	2.49	3.20	0.96	5.17	1.92	1.49	1.11	0.80	9.95
MnO	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.19
CaO	0.24	0.19	0.07	0.07	0.16	0.15	0.23	0.06	0.07	0.13	0.10	5.54
MgO	1.43	0.58	0.82	0.39	0.36	0.44	0.37	0.26	0.28	0.59	0.43	3.45
K_2O	3.75	3.21	3.13	1.67	1.10	1.33	0.99	0.51	0.68	1.10	1.32	1.99
Na_2O	0.70	0.34	0.44	0.15	0.59	0.58	0.54	0.39	0.44	0.44	0.63	2.44
P_2O_5	0.06	0.08	0.05	0.14	0.22	0.08	0.25	0.07	0.09	0.08	0.05	0.25
LOI @ 925°C	6.13	8.53	7.98	14.30	9.10	8.54	12.00	13.90	14.60	13.40	9.01	13.20
Total	99.24	99.50	99.53	99.24	99.25	99.47	99.51	99.50	99.17	99.07	99.32	97.62
FeO*	1.35	1.30	1.49	2.24	2.88	0.86	4.65	1.73	1.34	1.00	0.72	8.95
Total w/o LOI	92.96	90.82	91.38	84.69	89.83	90.83	86.99	85.41	84.42	85.56	90.23	83.42
Major Elements (XRF, normalized values, weight%)												
SiO_2	71.43	65.07	67.85	57.39	72.69	75.19	63.80	62.52	61.83	61.36	73.37	51.07
Al_2O_3	19.36	27.42	24.51	34.24	20.71	20.37	27.13	31.96	32.93	31.56	21.94	20.02
TiO_2	1.10	1.22	1.06	2.86	0.68	0.64	0.98	1.97	1.79	3.17	1.08	1.57
FeO*	1.45	1.44	1.63	2.65	3.21	0.95	5.35	2.02	1.59	1.17	0.80	10.73
MnO	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.23
CaO	0.26	0.21	0.08	0.08	0.18	0.17	0.26	0.07	0.08	0.15	0.11	6.64
MgO	1.54	0.64	0.90	0.46	0.40	0.48	0.43	0.30	0.33	0.69	0.48	4.14
K_2O	4.03	3.53	3.43	1.97	1.22	1.46	1.14	0.60	0.81	1.29	1.46	2.39
Na_2O	0.75	0.37	0.48	0.18	0.66	0.64	0.62	0.46	0.52	0.51	0.70	2.92
P_2O_5	0.06	0.09	0.05	0.17	0.24	0.09	0.29	0.08	0.11	0.09	0.08	0.30
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	<10	10	11	13	<10	<10	11	16	12	<10	<10	76
Cr	110	104	112	63	28	46	22	79	150	48	23	130
Ba	680	520	520	390	310	335	315	400	380	390	240	870
Rb	144	142	132	58	45	49	41	24	30	47	40	57
Sr	100	158	82	72	86	146	85	68	75	104	89	600
Zr	250	225	154	182	230	230	300	178	126	245	455	118
Y	23	35	33	41	20	31	25	20	14	24	39	18
Nb	22	20	18	31	18	20	41	21	15	28	29	<10
Cu	19	23	36	89	32	25	34	42	55	31	21	81
Zn	14	26	69	46	32	22	37	33	32	41	<10	86
La	<30	<30	36	58	30	42	<30	41	<30	<30	83	<30
Ce	<30	70	60	108	52	90	55	69	45	38	110	<30
Th	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Tl in weight%)												
Lab no.	na	na	na	na	na	na	na	na	na	na	na	na
Analysis	---	---	---	---	---	---	---	---	---	---	---	---
Fe	---	---	---	---	---	---	---	---	---	---	---	---
Na	---	---	---	---	---	---	---	---	---	---	---	---
K	---	---	---	---	---	---	---	---	---	---	---	---
Ca	---	---	---	---	---	---	---	---	---	---	---	---
Tl	---	---	---	---	---	---	---	---	---	---	---	---
Sc	---	---	---	---	---	---	---	---	---	---	---	---
Cr	---	---	---	---	---	---	---	---	---	---	---	---
Co	---	---	---	---	---	---	---	---	---	---	---	---
Ni	---	---	---	---	---	---	---	---	---	---	---	---
Zn	---	---	---	---	---	---	---	---	---	---	---	---
As	---	---	---	---	---	---	---	---	---	---	---	---
Se	---	---	---	---	---	---	---	---	---	---	---	---
Br	---	---	---	---	---	---	---	---	---	---	---	---
Rb	---	---	---	---	---	---	---	---	---	---	---	---
Sr	---	---	---	---	---	---	---	---	---	---	---	---
Mo	---	---	---	---	---	---	---	---	---	---	---	---
Sb	---	---	---	---	---	---	---	---	---	---	---	---
Au	---	---	---	---	---	---	---	---	---	---	---	---
Cs	---	---	---	---	---	---	---	---	---	---	---	---
Ba	---	---	---	---	---	---	---	---	---	---	---	---
La	---	---	---	---	---	---	---	---	---	---	---	---
Ce	---	---	---	---	---	---	---	---	---	---	---	---
Nd	---	---	---	---	---	---	---	---	---	---	---	---
Sm	---	---	---	---	---	---	---	---	---	---	---	---
Eu	---	---	---	---	---	---	---	---	---	---	---	---
Gd	---	---	---	---	---	---	---	---	---	---	---	---
Tb	---	---	---	---	---	---	---	---	---	---	---	---
Ho	---	---	---	---	---	---	---	---	---	---	---	---
Tm	---	---	---	---	---	---	---	---	---	---	---	---
Yb	---	---	---	---	---	---	---	---	---	---	---	---
Lu	---	---	---	---	---	---	---	---	---	---	---	---
Zr	---	---	---	---	---	---	---	---	---	---	---	---
Hf	---	---	---	---	---	---	---	---	---	---	---	---
Ta	---	---	---	---	---	---	---	---	---	---	---	---
W	---	---	---	---	---	---	---	---	---	---	---	---
Th	---	---	---	---	---	---	---	---	---	---	---	---
U	---	---	---	---	---	---	---	---	---	---	---	---

Table 4. Analyses of tuff samples from Puget Group-south, southwestern Washington (continued)

[Puget Group-south includes Carbonado and Spiketon Formations and Chambers Creek beds. Other formation sampled: Ohanapecosh. Analyses listed in approximate stratigraphic order]

Sample no.	SWW92058	SWW92059	SWW92060A	SWW92060B	SWW92061	SWW92062	SWW92063	SWW92064	SWW92065	SWW92066	SWW92067	SWW91012
Lab no.	D-526510	D-526511	D-526512	D-526513	D-526514	D-526515	D-526516	D-526517	D-526518	D-526519	D-526520	D-522617
Analysis/Run	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VJ24	VG51
Batch	C	C	C	C	C	C	C	C	C	C	C	B
Field no.	1.4VIII92T	2A.4VIII92T	2B1.4VIII92T	2B2.4VIII92T	2C.4VIII92T	2D.4VIII92T	2E.4VIII92T	2F.4VIII92T	2G.4VIII92T	2H.4VIII92T	2I.4VIII92T	SJ-91-146
Lithology	wh xl(q-fs) tf	pm xl(pc) tf	xl(pc) tf	xl(fs) tf	cl xl(fs) tf	cl tf	claystone	xl(fs) tf	cl vit tf	cl xl(fs) tf	cl xl(q-fs) tf	cl tf
Source/tk,cm	rc/10	rc/5	rc/150	rc/150	rc/5	rc/50	rc/150	rc/40	rc/30	rc/4	rc/35	rc/10
Strat position	up SPK	top SPK	top SPK	top SPK	top SPK	top SPK	top SPK	top SPK	top SPK	top SPK	top SPK	top SPK
Section/Well	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Mowich L rd	Evans Cr rd
1/4,1/4,1/4	SENESW	SESESE	SESESE	SESESE	SESESE	SESESE	SESESE	SESESE	SESESE	SESESE	SESESE	NENWNW
STR	19-17N-6E	19-17N-6E	19-17N-6E	19-17N-6E	19-17N-6E	19-17N-6E	19-17N-6E	19-17N-6E	19-17N-6E	19-17N-6E	19-17N-6E	29-17N-7E
7.5' quad	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes	Golden Lakes
Lat N	46°56'28"	46°56'12"	46°56'12"	46°56'12"	46°56'12"	46°56'12"	46°56'12"	46°56'12"	46°56'12"	46°56'12"	46°56'12"	46°56'10"
Long W	121°58'04"	121°57'28"	121°57'28"	121°57'28"	121°57'28"	121°57'26"	121°57'28"	121°57'28"	121°57'28"	121°57'28"	121°57'28"	121°57'23"
Kelly/elev,ft	3350	3270	3270	3270	3270	3270	3270	3270	3270	3270	3270	3200
sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	57.70	60.60	59.10	60.40	49.00	64.80	60.30	57.00	74.20	56.00	55.80	59.60
Al_2O_3	12.90	22.00	20.30	20.90	27.40	20.10	18.80	21.30	16.20	26.60	21.60	22.90
TiO_2	1.26	1.29	1.19	1.18	1.77	0.67	0.62	1.45	0.44	0.94	1.34	1.74
$FeTO_3$	9.92	3.31	5.81	4.20	3.90	3.31	8.13	5.52	0.64	1.76	6.39	2.13
MnO	0.20	0.05	0.02	0.04	0.03	0.03	0.11	0.04	0.02	0.01	0.04	0.01
CaO	1.33	0.17	0.53	0.33	1.67	0.24	0.30	0.36	0.26	0.32	0.21	0.13
MgO	1.85	1.40	1.83	2.19	1.60	1.02	1.41	2.76	0.30	0.48	2.66	0.27
K_2O	0.81	0.65	0.73	0.48	2.38	2.84	2.69	0.40	1.76	1.40	1.33	2.62
Na_2O	3.41	2.32	3.46	3.65	1.73	1.00	0.91	1.57	0.90	0.43	2.15	4.07
P_2O_5	0.61	0.20	0.21	0.20	1.03	0.10	0.33	0.10	0.06	0.06	0.05	0.19
LOI @ 925°C	9.18	7.80	6.41	6.06	8.92	5.33	5.96	9.15	4.72	11.20	7.99	5.17
Total	99.17	99.79	99.59	99.63	99.43	99.64	99.76	99.65	99.50	99.20	99.56	98.83
FeO*	8.93	2.98	5.23	3.78	3.51	2.98	7.32	4.97	0.58	1.58	5.75	1.92
Total w/o LOI	89.00	91.66	92.60	93.15	90.12	93.98	92.99	89.95	94.72	87.82	90.93	93.45
Major Elements (XRF, normalized values, weight%)												
SiO_2	64.83	66.12	63.82	64.64	54.37	68.95	64.85	63.37	78.34	63.76	61.37	63.78
Al_2O_3	14.50	24.00	21.92	22.44	30.40	21.39	20.22	23.68	17.10	30.29	23.75	24.51
TiO_2	1.42	1.41	1.29	1.27	1.96	0.93	0.88	1.61	0.46	1.07	1.47	1.86
FeO*	10.03	3.25	5.65	4.06	3.89	3.17	7.87	5.52	0.61	1.80	6.32	2.05
MnO	0.22	0.05	0.02	0.04	0.03	0.03	0.12	0.04	0.02	0.01	0.04	0.01
CaO	1.49	0.19	0.57	0.35	1.85	0.26	0.32	0.40	0.27	0.36	0.23	0.14
MgO	2.08	1.53	1.98	2.35	1.78	1.09	1.52	3.07	0.32	0.55	2.93	0.29
K_2O	0.91	0.71	0.79	0.52	2.64	3.02	2.69	0.44	1.86	1.59	1.46	2.80
Na_2O	3.83	2.53	3.74	3.92	1.92	1.06	0.98	1.75	0.95	0.49	2.36	4.36
P_2O_5	0.69	0.22	0.23	0.21	1.14	0.11	0.35	0.11	0.06	0.07	0.05	0.20
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	<10	<10	<10	11	33	25	16	<10	<10	11	16	28
Cr	<20	22	28	22	60	90	74	42	<20	<20	36	97
Ba	445	142	425	192	1100	710	690	162	310	340	300	1200
Rb	25	24	17	19	69	110	102	13	67	45	40	70
Sr	138	200	260	330	230	96	75	102	47	69	126	450
Zr	168	200	188	194	235	220	205	198	360	550	186	178
Y	36	18	14	15	48	33	39	14	58	63	20	18
Nb	<10	11	12	13	20	20	17	15	22	22	15	11
Cu	17	50	46	160	64	47	31	80	21	108	106	31
Zn	106	49	17	54	100	110	26	36	24	57	136	21
La	<30	<30	<30	<30	69	<30	<30	<30	46	59	37	<30
Ce	31	<30	<30	38	140	62	74	<30	92	102	52	36
Th	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Tl in weight%)												
Lab no.	na	na	na	na	na	na	na	na	na	na	na	na
Analysis	---	---	---	---	---	---	---	---	---	---	---	---
Fe	---	---	---	---	---	---	---	---	---	---	---	---
Na	---	---	---	---	---	---	---	---	---	---	---	---
K	---	---	---	---	---	---	---	---	---	---	---	---
Ca	---	---	---	---	---	---	---	---	---	---	---	---
Tl	---	---	---	---	---	---	---	---	---	---	---	---
Sc	---	---	---	---	---	---	---	---	---	---	---	---
Cr	---	---	---	---	---	---	---	---	---	---	---	---
Co	---	---	---	---	---	---	---	---	---	---	---	---
Ni	---	---	---	---	---	---	---	---	---	---	---	---
Zn	---	---	---	---	---	---	---	---	---	---	---	---
As	---	---	---	---	---	---	---	---	---	---	---	---
Se	---	---	---	---	---	---	---	---	---	---	---	---
Br	---	---	---	---	---	---	---	---	---	---	---	---
Rb	---	---	---	---	---	---	---	---	---	---	---	---
Sr	---	---	---	---	---	---	---	---	---	---	---	---
Mo	---	---	---	---	---	---	---	---	---	---	---	---
Sb	---	---	---	---	---	---	---	---	---	---	---	---
Au	---	---	---	---	---	---	---	---	---	---	---	---
Cs	---	---	---	---	---	---	---	---	---	---	---	---
Ba	---	---	---	---	---	---	---	---	---	---	---	---
La	---	---	---	---	---	---	---	---	---	---	---	---
Ce	---	---	---	---	---	---	---	---	---	---	---	---
Nd	---	---	---	---	---	---	---	---	---	---	---	---
Sm	---	---	---	---	---	---	---	---	---	---	---	---
Eu	---	---	---	---	---	---	---	---	---	---	---	---
Gd	---	---	---	---	---	---	---	---	---	---	---	---
Tb	---	---	---	---	---	---	---	---	---	---	---	---
Ho	---	---	---	---	---	---	---	---	---	---	---	---
Tm	---	---	---	---	---	---	---	---	---	---	---	---
Yb	---	---	---	---	---	---	---	---	---	---	---	---
Lu	---	---	---	---	---	---	---	---	---	---	---	---
Zr	---	---	---	---	---	---	---	---	---	---	---	---
Hf	---	---	---	---	---	---	---	---	---	---	---	---
Ta	---	---	---	---	---	---	---	---	---	---	---	---
W	---	---	---	---	---	---	---	---	---	---	---	---
Th	---	---	---	---	---	---	---	---	---	---	---	---
U	---	---	---	---	---	---	---	---	---	---	---	---

Table 4. Analyses of tuff samples from Puget Group-south, southwestern Washington (continued)

[Puget Group-south includes Carbonado and Spiketon Formations and Chambers Creek beds. Other formation sampled: Ohanapecosh. Analyses listed in approximate stratigraphic order]

Sample no.	SWW93055	SWW93057	SWW84008	SWW92038	SWW92039
Lab no.	D-546924	D-546925	D-501214	D-522647	D-522648
Analysis/Run	VS22	VS22	UX20	VG52	VG52
Batch	E	E	A	B	B
Field no.	2A.5IX93Sn	2C.5IX93Sn	CT-8	1.23VII92Th	2.23VII92Th
Lithology	siltstone	xl(pc-fm) tf	volcanic ss	cl xl(pc-ag)tf	cl xl(pc-ag)tf
Source/tk,cm	rc/40	rc/10	rc/10	rc/>2000	rc/100
Strat position	up CC	up CC	up OH	lo OH	lo OH
Section/Well	road FS 22	road FS 22	Coal Creek	road FS 2120	road FS 2120
1/4,1/4,1/4	NENENW	NENENW	NWSESW	NWSENE	SWNENW
STR	22-11N-10E	22-11N-10E	6-14N-10E	t8-12N-10E	20-12N-10E
7.5' quad	Hamilton	Butta Hamilton	Butte Ohanapecosh	Packwood Lake	Packwood Lake
Lat N	46°25'54"	46°25'38"	46°38'29"	46°31'25"	46°31'07"
Long W	121°32'57"	121°33'12"	121°36'05"	121°35'57"	121°35'35"
Kelly/elev,ft	4110	4110	1600	2850	2640
sample dep,ft					
Major Elements (XRF, analyzed values, weight%)					
SiO_2	63.30	66.00	60.20	58.30	62.50
Al_2O_3	18.70	17.40	17.40	15.40	15.00
TiO_2	1.11	1.31	0.81	1.34	1.24
$FeTO_3$	4.87	3.89	4.10	9.31	7.67
MnO	0.03	0.06	0.04	0.18	0.12
CaO	0.86	2.65	2.19	3.91	3.36
MgO	t.62	0.78	1.47	t.88	1.16
K_2O	2.83	0.85	1.32	t.06	1.03
Na_2O	1.60	2.51	0.88	3.56	2.44
P_2O_5	0.06	0.17	0.13	0.25	0.26
LOI @ 925°C	4.34	3.82	11.00	3.93	4.45
Total	99.32	99.44	99.54	99.12	99.23
FeO*	4.38	3.50	3.69	8.38	6.90
Total w/o LOI	94.49	95.23	88.13	94.26	94.01
Major Elements (XRF, normalized values, weight%)					
SiO_2	66.99	69.31	68.31	61.85	66.48
Al_2O_3	19.79	18.27	19.74	16.34	15.96
TiO_2	1.17	1.38	0.92	1.42	1.32
FeO*	4.64	3.68	4.19	8.89	7.34
MnO	0.03	0.06	0.05	0.19	0.13
CaO	0.91	2.78	2.48	4.15	3.57
MgO	1.71	0.82	1.67	1.99	1.23
K_2O	2.99	0.89	1.50	1.12	1.10
Na_2O	1.69	2.64	1.00	3.78	2.60
P_2O_5	0.06	0.18	0.15	0.27	0.28
Total	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)					
Ni	22	12	<10	12	11
Cr	70	44	<20	20	20
Ba	670	330	440	310	265
Rb	88	24	49	3t	55
Sr	180	265	108	260	126
Zr	215	128	355	240	260
Y	23	26	37	47	53
Nb	19	<10	20	10	15
Cu	<10	52	42	37	37
Zn	90	77	110	t06	99
La	<30	<30	<30	<30	49
Ce	52	<30	58	36	84
Th	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)					
Lab no.	na	na	na	na	na
Analysis	---	---	---	---	---
Fe	---	---	---	---	---
Na	---	---	---	---	---
K	---	---	---	---	---
Ce	---	---	---	---	---
Tl	---	---	---	---	---
Sc	---	---	---	---	---
Cr	---	---	---	---	---
Co	---	---	---	---	---
Ni	---	---	---	---	---
Zn	---	---	---	---	---
As	---	---	---	---	---
Se	---	---	---	---	---
Br	---	---	---	---	---
Rb	---	---	---	---	---
Sr	---	---	---	---	---
Mo	---	---	---	---	---
Sb	---	---	---	---	---
Au	---	---	---	---	---
Cs	---	---	---	---	---
Ba	---	---	---	---	---
La	---	---	---	---	---
Ce	---	---	---	---	---
Nd	---	---	---	---	---
Sm	---	---	---	---	---
Eu	---	---	---	---	---
Gd	---	---	---	---	---
Tb	---	---	---	---	---
Ho	---	---	---	---	---
Tm	---	---	---	---	---
Yb	---	---	---	---	---
Lu	---	---	---	---	---
Zr	---	---	---	---	---
Hf	---	---	---	---	---
Ta	---	---	---	---	---
W	---	---	---	---	---
Th	---	---	---	---	---
U	---	---	---	---	---

Table 5. Analyses of tuff samples from Puget Group-north, northwestern Washington

[Puget Group-north includes Tiger Mountain, Tukwila, and Renton Formations. Other formation sampled: Raging River. Analyses listed in approximate stratigraphic order]

Sample no.	NWW91001	NWW92001	NWW91002	NWW91003	NW91004A	NWW91005	NWW91006	NWW91007	NWW91008	NWW92003	NWW92004	NWW92005
Lab no.	D-501240	D-526496	D-501241	D-501242	D-522606	D-522607	D-522610	D-522611	D-522612	D-526525	D-526526	D-526527
Analysis/Run	UX21	VJ24	UX21	UX21	VG51	VG51	VG51	VG51	VG51	VJ25	VJ25	VJ25
Batch	A	C	A	A	B	B	B	B	B	C	C	C
Field no.	SJ-91-32	SJ-92-130	SJ-91-33	SJ-91-35	SJ-91-94	SJ-91-95	SJ-91-101	SJ-91-102	SJ-91-106	1B.14XI92S	1C.14XI92S	1.15XI92Sn
Lithology	tf clt in cgl	cl xl(fs) tf	lo clayey tuff	up clayey tuff	tuff	tuff	tuff/mdst	tuff	tuff/mdst	xl(fs-fm) tf	clayey tuff	claystone
Source/tk,cm	rc/5	oc/10	rc/15	rc/5	co/8	co/3	co/200	co/50	co/66	oc/35	oc/35	rc/5
Strat position	mid RR	mid RR	TM, coal seam	TM, coal seam	up TM?	up TM?	up TM?	up TM?	up TM?	lo RN	lo RN	lo RN
Section/Well			Franklin #8	Franklin #8	AMOCO WC-83-17	AMOCO WC-83-17	AMOCO WC-83-17	AMOCO WC-83-17	AMOCO WC-83-17	Jones Creek	Jones Creek	Jones Creek
1/4,1/4,1/4	NW	NW	SENWNW	SENWNW	SW	SW	SW	SW	SW	SESWSE	SESWSE	SESWSE
STR	15-23N-7E	15-23N-7E	12-21N-6E	12-21N-6E	13-22N-6E	13-22N-6E	13-22N-6E	13-22N-6E	13-22N-6E	32-24N-6E	32-24N-6E	32-24N-6E
7.5' quad	Hobart	Hobart	Cumberland	Cumberland	Hobart	Hobart	Hobart	Hobart	Hobart	Issaquah	Issaquah	Issaquah
Lat N	47°28'37"	47°28'37"	47°19'39"	47°19'39"	47°23'27"	47°23'27"	47°23'27"	47°23'27"	47°23'27"	47°30'59"	47°30'59"	47°31'09"
Long W	121°53'31"	121°53'31"	121°59'24"	121°59'24"	121°59'24"	121°59'24"	121°59'24"	121°59'24"	121°59'24"	122°03'45"	122°03'45"	122°03'52"
Kelly/elev,ft	1230	1230	?	?	645	645	645	645	645	800	800	640
Sample dep,ft					-1053.8	-1051.3	-1043	-1034	-890			
Major Elements (XRF, analyzed values, weight%)												
SiO_2	57.60	57.30	69.80	53.90	55.00	54.80	63.80	49.90	62.70	52.50	56.70	51.00
Al_2O_3	24.70	20.60	16.70	22.80	20.90	21.00	18.10	18.60	18.20	30.20	27.90	20.50
TiO_2	0.42	1.82	0.43	1.33	1.12	1.32	0.71	0.37	0.72	0.86	0.86	1.90
$FeTO_3$	1.96	7.45	1.20	5.50	4.60	4.72	3.18	6.79	3.26	1.84	1.59	2.56
MnO	0.01	0.08	0.01	0.06	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01
CaO	0.49	0.18	0.28	0.18	1.80	1.87	0.53	1.83	0.50	0.09	0.06	1.21
MgO	1.45	0.62	1.17	1.74	1.93	1.93	1.59	2.02	1.58	0.10	0.10	2.56
K_2O	0.32	1.08	0.09	0.23	0.21	0.16	2.79	0.14	3.06	0.04	0.04	0.23
Na_2O	0.15	0.62	0.15	5.89	0.42	0.39	1.25	0.94	1.11	0.15	0.15	0.61
P_2O_5	0.08	0.06	0.12	0.10	0.20	0.24	0.08	0.09	0.08	0.05	0.05	0.12
LOI @ 925°C	12.10	9.52	9.13	7.23	12.80	12.80	7.30	18.60	7.63	13.70	12.60	19.40
Total	99.28	99.33	99.06	98.96	98.99	99.24	99.35	99.29	98.86	99.54	100.06	100.10
FeO*	1.76	5.70	1.08	4.95	4.14	4.25	2.86	6.11	2.93	1.66	1.43	2.30
Total w/o LOI	86.98	89.06	89.81	91.18	85.73	85.97	91.73	80.01	90.90	85.66	87.30	80.44
Major Elements (XRF, normalized values, weight%)												
SiO_2	66.22	64.34	77.72	59.11	64.16	63.75	69.55	62.37	68.97	61.29	64.95	63.40
Al_2O_3	28.40	23.13	18.59	25.01	24.38	24.43	19.73	23.25	20.02	35.26	31.96	25.48
TiO_2	0.48	2.04	0.48	1.46	1.31	1.54	0.77	0.46	0.79	1.00	0.99	2.36
FeO*	2.03	7.53	1.20	5.43	4.83	4.94	3.12	7.64	3.23	1.93	1.64	2.86
MnO	0.01	0.09	0.01	0.07	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01
CaO	0.56	0.20	0.29	0.20	2.10	2.18	0.58	2.29	0.55	0.11	0.07	1.50
MgO	1.67	0.70	1.30	1.91	2.25	2.25	1.73	2.52	1.74	0.12	0.11	3.18
K_2O	0.37	1.21	0.10	0.25	0.24	0.19	3.04	0.17	3.37	0.05	0.05	0.29
Na_2O	0.17	0.70	0.17	6.46	0.49	0.45	1.36	1.17	1.22	0.18	0.17	0.76
P_2O_5	0.09	0.07	0.13	0.11	0.23	0.26	0.09	0.11	0.09	0.06	0.06	0.15
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	19	90	<10	76	23	50	22	<10	16	21	20	<10
Cr	63	205	<20	29	<20	<20	72	<20	83	70	57	<20
Ba	345	205	425	350	110	112	700	69	730	42	32	360
Rb	45	36	<10	<10	14	<10	112	<10	132	<10	<10	<10
Sr	245	72	270	245	270	265	162	225	152	14	17	310
Zr	210	255	450	325	285	295	188	355	215	168	160	88
Y	36	29	74	20	39	48	43	31	44	12	<10	<10
Nb	19	21	102	22	30	39	23	<10	24	15	15	23
Cu	34	99	22	78	76	54	27	34	29	39	57	20
Zn	106	86	138	71	170	170	102	91	96	52	32	27
La	<30	<30	120	<30	<30	<30	<30	33	35	<30	<30	33
Ce	<30	<30	255	<30	63	74	76	55	92	48	<30	65
Th	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Tl in weight%)												
Lab no.	D-501803	na	D-501804	D-501805	na	na	na	na	na	na	na	na
Analysis	UX45	- - -	UX45	UX45	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Fe	5.32	- - -	1.37	0.829	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Na	3.86	- - -	0.088	0.051	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
K	1.02	- - -	0.328	0.499	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ca	nd	- - -	nd	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tl	nd	- - -	nd	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sc	28.00	- - -	7.87	2.24	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Cr	70.20	- - -	16.90	1.91	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Co	26.80	- - -	16.10	2.56	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ni	93.00	- - -	55.50	19.40	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zn	67.10	- - -	104.00	157.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
As	7.39	- - -	45.80	7.46	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Se	nd	- - -	nd	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Br	nd	- - -	nd	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Rb	5.69	- - -	14.60	3.52	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sr	231.00	- - -	314.00	306.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mo	nd	- - -	nd	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sb	0.994	- - -	0.904	0.341	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Au	2.85	- - -	0.696	2.68	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ce	0.896	- - -	0.951	0.181	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ba	293.00	- - -	148.00	433.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
La	13.00	- - -	73.20	123.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ce	19.50	- - -	144.00	260.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Nd	13.40	- - -	62.50	118.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sm	3.46	- - -	11.50	20.90	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Eu	0.962	- - -	0.981	1.91	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Gd	3.87	- - -	8.90	16.80	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tb	0.659	- - -	1.19	2.40	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ho	1.05	- - -	1.76	3.18	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tm	0.532	- - -	0.00	0.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Yb	3.61	- - -	4.90	7.09	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lu	0.536	- - -	0.667	0.936	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zr	220.00	- - -	229.00	449.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Hf	5.27	- - -	8.78	16.50	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ta	3.17	- - -	5.91	10.90	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
W	0.00	- - -	0.37	1.18	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Th	6.21	- - -	28.90	15.90	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
U	1.78	- - -	10.20	5.15	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Table 5. Analyses of tuff samples from Puget Group-north, northwestern Washington (continued)

[Puget Group-north includes Tiger Mountain, Tukwila, and Renton Formations. Other formation sampled: Raging River. Analyses listed in approximate stratigraphic order]

Sample no.	**NWW92006**
Lab no.	D-526526
Analysis/Run	VJ25
Batch	C
Field no.	2A.15XI92Sn
Lithology	clayey tuff
Source/tk,cm	rc/15
Strat position	lo RN
Section/Well	Jones Creek
1/4,1/4,1/4	SESWSE
STR	32-24N-6E
7.5' quad	Issaquah
Lat N	47°31'03"
Long W	122°03'52"
Kelly/elev,ft	620
Sample dep,ft	
	Major Elements (XRF, analyzed values, weight%)
SiO_2	53.50
Al_2O_3	25.00
TiO_2	1.04
$FeTO_3$	3.13
MnO	0.01
CaO	0.98
MgO	0.53
K_2O	0.18
Na_2O	0.15
P_2O_5	0.05
LOI @ 925°C	16.20
Total	100.77
FeO*	2.82
Total w/o LOI	84.26
	Major Elements (XRF, normalized values, weight%)
SiO_2	63.50
Al_2O_3	29.67
TiO_2	1.23
FeO*	3.34
MnO	0.01
CaO	1.16
MgO	0.63
K_2O	0.21
Na_2O	0.18
P_2O_5	0.06
Total	100.00
	Trace Elements (XRF, ppm)
Ni	53
Cr	80
Ba	44
Rb	<10
Sr	43
Zr	156
Y	14
Nb	11
Cu	116
Zn	320
La	<30
Ce	36
Th	nd
	Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)
Lab no.	na
Analysis	- - -
Fe	- - -
Na	- - -
K	- - -
Ca	- - -
Ti	- - -
Sc	- - -
Cr	- - -
Co	- - -
Ni	- - -
Zn	- - -
As	- - -
Se	- - -
Br	- - -
Rb	- - -
Sr	- - -
Mo	- - -
Sb	- - -
Au	- - -
Cs	- - -
Ba	- - -
La	- - -
Ce	- - -
Nd	- - -
Sm	- - -
Eu	- - -
Gd	- - -
Tb	- - -
Ho	- - -
Tm	- - -
Yb	- - -
Lu	- - -
Zr	- - -
Hf	- - -
Ta	- - -
W	- - -
Th	- - -
U	- - -

Table 6. Analyses of tuff and lava flow samples from Naches Formation, southwestern Washington

[Naches Formation includes Spencer Creek beds, and "Puget Group" in Bumping Lake area. Other unit sampled: Wildcat Creek beds. Analyses listed in approximate stratigraphic order]

Sample no.	SWW83148	SWW83149	SWW84011	SWW93038	SWW93132	SWW93018	SWW93019	SWW93029	SWW83134	SWW83135	SWW83138	SWW83139
Lab no.	D-572959	D-572960	D-501216	D-546917	D-546930	D-546897	D-546698	D-546908	D-572954	D-572955	D-572956	D-572957
Analysis/Run	WD16	WD16	UX20	VS21	VS22	VS21	VS21	VS21	WD16	WD16	WD16	WD16
Batch	F	F	A	E	E	E	E	E	F	F	F	F
Field no.	1A.26VIII83F	1B.26VIII83F	CT-11	1.31VIII93T	10.31VIII93T	2A.26VII93M	2B.26VII93M	5.28VII93W	1A.25VIII83T	1B.25VIII83T	3A.25VIII83T	3B.25VIII83T
Lithology	cl xl(q) tuff	cl xl(q-fs) tf	xl(q-fs) tuff	xl(q-pc)vittf	xl(q-pc)vittf	xl(q)vit tf	xl(q)vit tf	pmxl(q-pc)tf	vitric tuff	lam siltstone	claystone	claystone
Source/tk,cm	oc/1500	oc/1500	rc/900	rc/500	rc/900	rc/100	rc/100	rc/500	oc/100	oc/175	oc/70	oc/100
Strat position	base Naches	base Naches	lower Naches	lower Naches	lower Naches	lower Naches	lower Naches	lower Naches	lower Naches	lower Naches	lower Naches	lower Naches
Section/Well	Quartz Mtn tf	Quartz Mtn tf	E Quartz Cr tf FS 1903 rd	E Quartz Cr tf FS 1901-61E	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1917	Mt. Clifty tuff	Mt. Clifty tuff	Mt. Clifty tuff	Mt. Clifty tuff
1/4,1/4,1/4	NENWNE	NENWNE	NWNWSW	SENWSW	NWSENE	NESENW	NESENW	NWSENW	SWSENE	SWSENE	SESWNE	SESWNE
STR	9-18N-14E	9-18N-14E	29-18N-14E	29-18N-14E	32-18N-14E	33-18N-14E	33-18N-14E	23-18N-14E	25-19M-13E	25-19M-13E	25-19N-13E	25-19N-13E
7.5' quad	Quartz Mtn	Quartz Mtn	Mt. Clifty	Mt. Clifty	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Mt. Clifty	Mt. Clifty	Mt. Clifty	Mt. Clifty
Lat N	47°04'14"	47°04'14"	47°01'10"	47°00'58"	47°00'23"	47°00'31"	47°00'31"	47°02'11"	47°06'23"	47°06'23"	47°06'21"	47°08'21"
Long W	121°05'43"	121°05'43"	121°07'50"	121°07'40"	121°06'45"	121°06'03"	121°06'03"	121°03'08"	121°09'22"	121°09'22"	121°10'30"	121°10'30"
Kelly/elev,ft	4605	4605	2700	2940	3010	3080	3080	4440	5445	5445	5640	5640
Sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	na	na	64.20	63.50	77.20	64.00	63.80	76.20	na	na	na	na
Al_2O_3	- - -	- - -	13.20	14.70	12.20	13.50	13.50	11.50	- - -	- - -	- - -	- - -
TiO_2	- - -	- - -	0.55	0.67	0.28	0.55	0.54	0.19	- - -	- - -	- - -	- - -
$FeTO_3$	- - -	- - -	4.11	4.26	0.99	4.19	4.19	1.67	- - -	- - -	- - -	- - -
MnO	- - -	- - -	0.08	0.05	0.02	0.04	0.04	0.01	- - -	- - -	- - -	- - -
CaO	- - -	- - -	3.59	3.53	1.28	3.98	4.04	0.54	- - -	- - -	- - -	- - -
MgO	- - -	- - -	0.83	1.30	0.10	1.07	1.04	0.23	- - -	- - -	- - -	- - -
K_2O	- - -	- - -	0.74	1.29	2.60	1.25	1.49	5.32	- - -	- - -	- - -	- - -
Na_2O	- - -	- - -	2.44	1.91	4.00	1.40	1.43	0.71	- - -	- - -	- - -	- - -
P_2O_5	- - -	- - -	0.12	0.14	0.07	0.12	0.12	0.05	- - -	- - -	- - -	- - -
LOI @ 925°C	- - -	- - -	9.23	7.78	0.74	9.18	8.99	2.45	- - -	- - -	- - -	- - -
Total	- - -	- - -	99.09	99.13	99.48	99.28	99.18	98.87	- - -	- - -	- - -	- - -
FeO*	- - -	- - -	3.70	3.83	0.89	3.77	3.77	1.50	- - -	- - -	- - -	- - -
Total w/o LOI	- - -	- - -	89.45	90.92	98.84	89.68	89.77	96.25	- - -	- - -	- - -	- - -
Major Elements (XRF, normalized values, weight%)												
SiO_2	- - -	- - -	71.77	69.84	78.26	71.36	71.07	79.17	- - -	- - -	- - -	- - -
Al_2O_3	- - -	- - -	14.76	16.17	12.37	15.05	15.04	11.95	- - -	- - -	- - -	- - -
TiO_2	- - -	- - -	0.81	0.74	0.28	0.61	0.60	0.20	- - -	- - -	- - -	- - -
FeO*	- - -	- - -	4.13	4.22	0.90	4.20	4.20	1.56	- - -	- - -	- - -	- - -
MnO	- - -	- - -	0.09	0.05	0.02	0.04	0.04	0.01	- - -	- - -	- - -	- - -
CaO	- - -	- - -	4.01	3.88	1.30	4.44	4.50	0.56	- - -	- - -	- - -	- - -
MgO	- - -	- - -	0.93	1.43	0.10	1.19	1.16	0.24	- - -	- - -	- - -	- - -
K_2O	- - -	- - -	0.83	1.42	2.64	1.39	1.66	5.53	- - -	- - -	- - -	- - -
Na_2O	- - -	- - -	2.73	2.10	4.06	1.56	1.59	0.74	- - -	- - -	- - -	- - -
P_2O_5	- - -	- - -	0.13	0.15	0.07	0.13	0.13	0.05	- - -	- - -	- - -	- - -
Total	- - -	- - -	100.00	100.00	100.00	100.00	100.00	100.00	- - -	- - -	- - -	- - -
Trace Elements (XRF, ppm)												
Ni	<10	<10	<10	<10	<10	<10	<10	<10	<10	13	<10	<10
Cr	<20	<20	<20	20	<20	<20	<20	<20	<20	<20	<20	<20
Ba	1050	1100	770	1300	720	610	740	1150	1000	1000	930	870
Rb	118	142	26	44	84	40	47	154	130	130	130	132
Sr	47	47	315	680	140	340	340	46	37	40	45	35
Zr	240	245	310	300	162	280	280	230	235	205	225	215
Y	51	62	45	31	44	36	37	49	77	62	78	79
Nb	10	<10	15	10	10	12	13	14	18	14	15	18
Cu	17	17	31	23	<10	23	24	<10	14	32	10	14
Zn	88	59	63	56	10	61	65	93	88	102	78	89
La	<30	<30	<30	<30	55	<30	<30	<30	<30	<30	<30	<30
Ce	70	66	55	38	57	<30	57	61	86	65	78	57
Th	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)												
Lab no.	na	na	D-501782	na	na	na	na	na	na	na	na	na
Analysis	- - -	- - -	UX44	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Fe	- - -	- - -	3.10	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Na	- - -	- - -	1.97	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
K	- - -	- - -	0.762	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ca	- - -	- - -	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ti	- - -	- - -	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sc	- - -	- - -	12.10	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Cr	- - -	- - -	10.50	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Co	- - -	- - -	5.83	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ni	- - -	- - -	4.05	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zn	- - -	- - -	63.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
As	- - -	- - -	0.742	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Se	- - -	- - -	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Br	- - -	- - -	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Rb	- - -	- - -	23.90	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sr	- - -	- - -	369.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mo	- - -	- - -	nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sb	- - -	- - -	0.385	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Au	- - -	- - -	0.732	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ce	- - -	- - -	0.512	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ba	- - -	- - -	795.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
La	- - -	- - -	25.90	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ce	- - -	- - -	51.80	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Nd	- - -	- - -	31.50	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sm	- - -	- - -	7.86	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Eu	- - -	- - -	1.36	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Gd	- - -	- - -	7.29	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tb	- - -	- - -	1.06	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ho	- - -	- - -	1.51	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tm	- - -	- - -	0.653	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Yb	- - -	- - -	4.15	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lu	- - -	- - -	0.595	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zr	- - -	- - -	293.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Hf	- - -	- - -	7.84	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ta	- - -	- - -	1.09	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
W	- - -	- - -	1.18	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Th	- - -	- - -	8.00	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
U	- - -	- - -	2.38	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Table 6. Analyses of tuff and lava flow samples from Naches Formation, southwestern Washington (continued)

[Naches Formation includes Spencer Creek beds, and "Puget Group" in Bumping Lake area. Other unit sampled: Wildcat Creek beds. Analyses listed in approximate stratigraphic order]

Sample no.	SWW83140	SWW93025	SWW93026	SWW93027	SWW93028	SWW93024	SWW93048	SWW93049	SWW93051	SWW93052	SWW93030	SWW93031
Lab no.	D-572958	D-546904	D-546905	D-546906	D-546907	D-546903	D-546919	D-546920	D-546921	D-546922	D-546909	D-546910
Analysis/Run	WD16	VS21	VS21	VS21	VS21	VS21	VS22	VS22	VS22	VS22	VS21	VS21
Batch	F	E	E	E	E	E	E	E	E	E	E	E
Field no.	3C.25VIII83T	4A.28VII93W	4B.28VII93W	4C.28VII93W	4D.28VII93W	3.28VII93W	2A.1IX93W	2B.1IX93W	3.1IX93W	4.1IX93W	3A.30VII93F	3B.30VII93F
Lithology	siltstone	clayey tuff	clayey tuff	clayey tuff	rhyolite lf	clxl(q-pc) tf	claystone	clayey tuff	clxl(q-pc) tf	clayey tuff	clayey tuff	clayey tuff
Source/tk,cm	oc/100	rc/10	rc/13	rc/20	rc/1200	rc/4	rc/10	rc/6	rc/10	rc/10	rc/9	rc/25
Strat position	lower Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches
Section/Well	Mt. Clifty tuff	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1903 rd	FS 1903 rd
1/4,1/4,1/4	SESWNE	NWNENE	NWNENE	NWNENE	NWNENE	SENENE	NENENE	NENENE	NENENE	SENWNW	SWSENE	SWSENE
STR	25-19N-13E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	27-18N-14E	29-18N-14E	29-18N-14E
7.5' quad	Mt. Clifty	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn
Lat N	47°06'21"	47°01'35"	47°01'35"	47°01'35"	47°01'35"	47°01'30"	47°01'35"	47°01'35"	47°01'35"	47°01'35"	47°01'12"	47°01'12"
Long W	121°10'30"	121°05'34"	121°05'34"	121°05'34"	121°05'34"	121°05'22"	121°05'25"	121°05'25"	121°05'18"	121°05'04"	121°06'46"	121°06'46"
Kelly/elev,ft	5460	3735	3735	3735	3735	3660	3710	3710	3690	3650	3040	3040
Sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	na	56.10	58.80	48.70	71.70	51.20	45.30	48.00	51.80	42.90	47.20	55.80
Al_2O_3	- - -	23.00	22.10	29.90	15.30	22.70	20.80	20.00	22.70	19.00	25.90	22.10
TiO_2	- - -	0.30	0.35	0.51	0.21	0.77	4.14	3.96	0.34	0.81	1.77	1.07
$FeTO_3$	- - -	3.91	3.17	3.00	0.29	3.75	8.95	7.30	4.29	3.21	3.39	4.48
MnO	- - -	0.01	0.01	0.01	0.01	0.01	0.25	0.20	0.02	0.14	0.01	0.01
CaO	- - -	0.41	0.31	0.29	0.24	3.29	2.36	2.07	2.41	10.80	1.29	0.81
MgO	- - -	0.95	0.77	0.43	0.14	1.93	1.42	1.88	2.12	1.44	1.48	1.23
K_2O	- - -	2.46	2.26	0.97	7.13	0.35	0.54	0.30	0.74	0.44	1.87	1.53
Na_2O	- - -	0.15	0.15	0.15	1.28	1.78	0.19	0.15	1.23	0.23	0.15	0.77
P_2O_5	- - -	0.05	0.11	0.05	0.05	0.08	1.00	0.54	0.05	6.98	0.07	0.05
LOI @ 925°C	- - -	12.00	10.80	15.20	2.36	13.50	14.10	15.00	13.30	13.10	16.00	11.30
Total	- - -	99.36	98.83	99.21	98.71	99.36	99.05	99.20	99.00	99.05	99.13	99.15
FeO*	- - -	3.52	2.85	2.70	0.26	3.37	8.05	6.57	3.86	2.89	3.05	4.03
Total w/o LOI	- - -	86.97	87.71	83.71	96.32	85.48	84.05	83.47	85.27	85.63	82.79	87.40
Major Elements (XRF, normalized values, weight%)												
SiO_2	- - -	64.51	67.04	58.18	74.44	59.89	53.89	57.51	60.75	50.10	57.01	63.84
Al_2O_3	- - -	26.45	25.20	35.72	15.88	26.55	24.75	23.96	26.62	22.19	31.28	25.29
TiO_2	- - -	0.34	0.40	0.61	0.22	0.90	4.93	4.74	0.40	0.95	2.14	1.22
FeO*	- - -	4.05	3.25	3.22	0.27	3.95	9.58	7.87	4.53	3.37	3.68	4.61
MnO	- - -	0.01	0.01	0.01	0.01	0.01	0.30	0.24	0.02	0.16	0.01	0.01
CaO	- - -	0.47	0.35	0.35	0.25	3.85	2.81	2.48	2.83	12.61	1.56	0.93
MgO	- - -	1.09	0.88	0.51	0.15	2.26	1.69	2.01	2.49	1.68	1.79	1.41
K_2O	- - -	2.85	2.58	1.16	7.40	0.41	0.64	0.36	0.87	0.51	2.26	1.75
Na_2O	- - -	0.17	0.17	0.18	1.33	2.08	0.23	0.18	1.44	0.27	0.18	0.88
P_2O_5	- - -	0.06	0.13	0.06	0.05	0.09	1.19	0.65	0.06	8.15	0.08	0.06
Total	- - -	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	<10	14	20	<10	<10	<10	21	18	12	26	23	43
Cr	<20	<20	<20	<20	<20	38	73	114	<20	78	66	112
Ba	520	122	100	114	1800	94	250	176	295	275	230	440
Rb	55	124	116	43	190	15	23	<10	21	16	66	55
Sr	142	47	39	38	26	345	84	74	132	250	66	11
Zr	290	395	380	500	270	198	360	360	375	350	710	192
Y	45	110	>150	64	72	20	96	69	70	>150	91	26
Nb	22	30	30	40	20	10	27	24	16	21	35	15
Cu	44	35	30	28	<10	56	87	57	23	44	44	35
Zn	78	265	205	118	<10	40	178	154	102	70	70	90
La	<30	64	138	48	34	34	<30	<30	78	265	38	<30
Ce	68	142	300	79	64	66	56	50	170	411	73	42
Th	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)												
Lab no.	na	na	na	na	na	na	na	na	na	na	na	na
Analysis	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Fe	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Na	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
K	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ca	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ti	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sc	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Cr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Co	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ni	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zn	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
As	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Se	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Br	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Rb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mo	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Au	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ce	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ba	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
La	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ce	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sm	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Eu	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Gd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ho	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tm	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Yb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lu	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Hf	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ta	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
W	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Th	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
U	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Table 6. Analyses of tuff and lava flow samples from Naches Formation, southwestern Washington (continued)

[Naches Formation includes Spencer Creek beds, and "Puget Group" in Bumping Lake area. Other unit sampled: Wildcat Creek beds. Analyses listed in approximate stratigraphic order]

Sample no.	SWW93032	SWW93033	SWW93034	SWW93047	SWW93023	SWW93037	SWW93021	SWW93020	SWW93036	SWW93035	SWW93017	SWW93016
Lab no.	D-546911	D-546912	D-546913	D-546918	D-546902	D-546916	D-546900	D-546899	D-546915	D-546914	D-546896	D-546895
Analysis/Run	VS21	VS21	VS21	VS22	VS21	VS21	VS21	VS21	VS21	VS21	VS21	VS21
Batch	E	E	E	E	E	E	E	E	E	E	E	E
Field no.	3C.30VII93F	3D.30VII93F	3E.30VII93F	1.11X93W	2G.28VII93W	2F.28VII93W	2E.28VII93W	2D.28VII93W	2C.28VII93W	2B.28VII93W	2A.28VII93W	1E.28VII93W
Lithology	clayey tuff	clayey tuff	clayey lth tf	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff
Source/tk,cm	rc/10	rc/3	rc/15	rc/5	rc/20	rc/3	rc/30	rc/5	rc/5	rc/3	rc/25	rc/25
Strat position	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middla Naches	middle Naches	middle Naches	middla Naches	middle Naches
Section/Well	FS 1903 rd	FS 1903 rd	FS 1503 rd	FS 1503 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd
1/4,1/4,1/4	SWSENE	SWSENE	SWSENE	NWSWSW	SWSWNE	SWSWNE	SWSWNE	SWSWNE	SWSWNE	SWSWNE	SWSWNE	SWSENW
STR	29-18N-14E	29-18N-14E	29-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E
7.5' quad	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn
Lat N	47°01'12"	47°01'12"	47°01'12"	47°00'58"	47°01'13"	47°01'13"	47°01'13"	47°01'13"	47°01'13"	47°01'13"	47°01'13"	47°01'16"
Long W	121°06'46"	121°06'46"	121°06'46"	121°06'31"	121°05'53"	121°05'53"	121°05'53"	121°05'53"	121°05'53"	121°05'53"	121°05'53"	121°06'07"
Kelly/elev,ft	3040	3040	3040	3170	3600	3600	3600	3600	3600	3600	3600	3560
Sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	52.90	51.90	52.00	55.40	58.70	49.30	51.90	49.90	50.70	48.80	58.00	50.10
Al_2O_3	23.00	20.50	19.90	25.40	18.80	23.40	20.60	24.30	23.10	27.00	21.00	19.00
TiO_2	0.74	0.75	0.62	1.01	0.88	2.63	2.24	0.69	3.15	1.73	1.07	2.33
$FeTO_3$	4.21	5.34	5.47	2.52	5.59	3.23	4.51	3.85	2.97	2.51	4.21	6.91
MnO	0.01	0.03	0.05	0.02	0.04	0.01	0.01	0.01	0.01	0.01	0.02	0.06
CaO	0.94	1.97	1.96	0.70	1.16	0.65	0.94	0.83	1.02	0.96	0.55	1.78
MgO	1.73	1.95	2.00	0.86	1.70	2.06	2.18	2.22	1.94	1.44	1.47	1.86
K_2O	2.63	1.12	1.23	2.07	1.74	1.67	0.85	2.81	1.85	2.33	1.72	0.74
Na_2O	0.28	0.99	1.04	0.61	1.97	0.15	0.36	0.15	0.15	0.15	0.98	0.60
P_2O_5	0.08	0.11	0.13	0.05	0.09	0.11	0.08	0.08	0.05	0.16	0.05	0.08
LOI @ 925°C	12.70	14.80	14.60	10.20	8.29	16.00	15.60	14.50	14.50	14.20	9.82	15.80
Total	99.22	99.46	99.00	98.84	98.96	99.21	99.27	99.34	99.44	99.29	98.89	99.26
FeO*	3.79	4.80	4.92	2.27	5.03	2.91	4.06	3.46	2.67	2.26	3.79	6.22
Total w/o LOI	86.10	84.12	83.85	88.39	90.11	82.89	83.22	84.45	84.64	84.84	88.65	82.77
Major Elements (XRF, normalized values, weight%)												
SiO_2	61.44	61.69	62.01	62.68	65.14	59.48	62.37	59.09	59.90	57.52	65.43	60.53
Al_2O_3	26.71	24.37	23.73	28.74	20.86	28.23	24.75	28.77	27.29	31.83	23.69	22.96
TiO_2	0.86	0.89	0.74	1.14	0.98	3.17	2.69	0.82	3.72	2.04	1.21	2.82
FeO*	4.40	5.71	5.87	2.57	5.58	3.51	4.88	4.10	3.16	2.66	4.27	7.51
MnO	0.01	0.04	0.06	0.02	0.04	0.01	0.01	0.01	0.01	0.01	0.02	0.07
CaO	1.09	2.34	2.34	0.79	1.29	0.78	1.13	0.98	1.21	1.13	0.62	2.15
MgO	2.01	2.32	2.39	0.97	1.89	2.49	2.62	2.63	2.29	1.70	1.66	2.25
K_2O	3.05	1.33	1.47	2.34	1.93	2.01	1.02	3.33	2.19	2.75	1.94	0.89
Na_2O	0.33	1.18	1.24	0.69	2.19	0.18	0.43	0.18	0.18	0.18	1.11	0.72
P_2O_5	0.09	0.13	0.16	0.06	0.10	0.13	0.10	0.09	0.06	0.19	0.06	0.10
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	19	27	22	16	39	10	35	17	17	<10	36	35
Cr	50	45	40	77	106	53	205	<20	138	<20	116	152
Ba	640	650	830	600	680	330	375	235	455	210	490	335
Rb	120	34	37	80	60	50	31	82	53	55	72	27
Sr	90	172	210	106	230	112	158	104	108	70	96	104
Zr	530	530	550	160	162	186	270	445	245	470	156	210
Y	87	70	69	25	21	25	44	82	36	82	20	25
Nb	43	40	38	20	11	13	13	27	20	22	10	20
Cu	26	31	35	25	47	18	51	44	37	19	44	58
Zn	98	160	146	88	114	70	93	83	68	30	112	110
La	40	42	<30	<30	<30	<30	30	116	<30	84	<30	<30
Ce	73	71	<30	63	32	<30	53	235	68	210	<30	33
Th	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)												
Lab no.	na	na	na	na	na	na	na	na	na	na	na	na
Analysis	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Fe	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Na	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
K	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ca	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ti	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sc	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
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Rb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mo	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Au	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ce	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ba	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
La	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ce	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sm	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Eu	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Gd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ho	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tm	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Yb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lu	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Hf	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ta	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
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Th	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
U	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Table 6. Analyses of tuff and lava flow samples from Naches Formation, southwestern Washington (continued)

[Naches Formation includes Spencer Creek beds, and 'Puget Group' in Bumping Lake area. Other unit sampled: Wildcat Creek beds. Analyses listed in approximate stratigraphic order]

Sample no.	SWW93015	SWW93014	SWW93013	SWW93012	SWW93008	SWW93009	SWW93010	SWW93011	SWW93007	SWW93003	SWW93004	SWW93005
Lab no.	D-546894	D-546893	D-546892	D-546891	D-546887	D-546888	D-546889	D-546890	D-546886	D-546882	D-546883	D-546884
Analysis/Run	VS21	VS21	VS21	VS21	VS21	VS21	VS21	VS21	VS21	VS21	VS21	VS21
Batch	E	E	E	E	E	E	E	E	E	E	E	E
Field no.	1D.28VII93W	1C.28VII93W	1B.28VII93W	1A.28VII93W	5A.27VII93T	5B.27VII93T	5C.27VII93T	5D.27VII93T	4.27VII93T	3A.27VII93T	3B.27VII93T	3C.27VII93T
Lithology	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff
Source/tk,cm	rc/30	rc/15	rc/5	rc/10	rc/20	rc/30	rc/5	rc/15	rc/6	rc/10	rc/20	rc/20
Strat position	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches	middle Naches
Section/Well	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd
1/4,1/4,1/4	SWSENW	SWSENW	SWSENW	SWSENW	SWSENW	SWSENW	SWSENW	SWSENW	NWNESW	SENESW	SENESW	SENESW
STR	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E	28-18N-14E
7.5' quad	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn
Lat N	47°01'16"	47°01'16"	47°01'16"	47°01'16"	47°01'16"	47°01'16"	47°01'16"	47°01'16"	47°01'08"	47°01'04"	47°01'04"	47°01'04"
Long W	121°06'07"	121°06'07"	121°06'07"	121°06'07"	121°06'08"	121°06'08"	121°06'08"	121°06'08"	121°06'03"	121°06'03"	121°06'03"	121°06'03"
Kelly/elev,ft	3560	3560	3560	3560	3670	3670	3670	3670	3570	3540	3540	3540
Sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	50.10	57.40	50.80	56.70	57.30	49.80	50.60	52.60	50.00	51.00	52.40	50.40
Al_2O_3	19.60	19.30	24.80	18.60	21.80	22.00	22.50	22.70	21.70	23.80	23.50	24.90
TiO_2	0.61	0.93	1.56	0.96	1.20	2.39	1.25	1.18	2.87	0.99	1.40	1.57
$FeTO_3$	7.20	5.78	3.77	6.56	2.84	2.90	3.24	3.19	3.26	4.02	4.08	3.83
MnO	0.05	0.05	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CaO	1.83	0.92	0.53	0.61	0.86	1.19	0.84	0.81	1.58	0.92	0.69	0.68
MgO	2.18	1.90	1.47	2.00	1.62	2.60	2.73	2.03	2.19	2.01	1.53	1.52
K_2O	1.09	2.32	1.22	1.42	2.11	1.12	1.83	1.68	1.39	1.76	1.46	1.19
Na_2O	0.25	1.46	0.37	1.14	1.00	0.15	0.15	0.39	0.32	0.30	0.37	0.22
P_2O_5	0.09	0.05	0.05	0.05	0.05	0.10	0.08	0.07	0.06	0.07	0.05	0.06
LOI @ 925°C	16.00	9.13	14.70	11.20	10.40	17.30	16.30	14.50	16.10	14.50	13.70	15.00
Total	99.60	99.24	99.28	99.26	99.19	99.56	99.53	99.16	99.48	99.38	99.19	99.38
FeO*	6.48	5.20	3.39	5.90	2.56	2.61	2.92	2.87	2.93	3.62	3.67	3.45
Total w/o LOI	82.28	89.53	84.20	87.40	88.51	81.97	82.91	84.34	83.05	84.48	85.08	84.00
Major Elements (XRF, normalized values, weight%)												
SiO_2	60.89	64.11	60.33	64.87	64.74	60.75	61.03	62.37	60.20	60.37	61.59	60.00
Al_2O_3	23.82	21.56	29.45	21.28	24.63	26.84	27.14	26.91	26.13	28.17	27.62	29.64
TiO_2	0.74	1.04	1.85	1.10	1.36	2.92	1.51	1.40	3.46	1.17	1.65	1.87
FeO*	7.87	5.81	4.03	6.75	2.89	3.18	3.52	3.40	3.53	4.28	4.31	4.10
MnO	0.06	0.06	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CaO	2.22	1.03	0.63	0.70	0.97	1.45	1.01	0.96	1.90	1.09	0.81	0.81
MgO	2.65	2.12	1.75	2.29	1.83	3.17	3.29	2.41	2.64	2.38	1.80	1.81
K_2O	1.32	2.59	1.45	1.62	2.38	1.37	2.21	1.99	1.67	2.08	1.72	1.42
Na_2O	0.30	1.63	0.44	1.30	1.13	0.18	0.18	0.46	0.39	0.36	0.43	0.26
P_2O_5	0.11	0.06	0.06	0.06	0.06	0.12	0.10	0.08	0.07	0.08	0.06	0.07
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	30	35	21	39	31	36	20	22	13	25	27	21
Cr	29	106	108	128	122	250	22	47	184	52	106	104
Ba	260	700	360	490	610	570	198	410	265	250	395	325
Rb	46	72	42	46	74	37	59	54	48	57	54	42
Sr	57	168	85	126	126	50	53	90	118	102	102	90
Zr	340	130	225	240	144	245	360	405	310	410	194	230
Y	56	15	37	37	20	34	52	58	30	68	27	30
Nb	18	12	17	16	14	18	20	25	26	20	15	19
Cu	65	31	46	36	28	60	50	72	20	44	63	54
Zn	93	128	84	108	95	146	78	108	52	79	102	88
La	<30	<30	<30	39	<30	<30	52	<30	<30	31	38	<30
Ce	85	37	53	70	<30	44	120	46	50	93	64	43
Th	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)												
Lab no.	na	na	na	na	na	na	na	na	na	na	na	na
Analysis	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Fe	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Na	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
K	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ca	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
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Yb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lu	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Hf	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
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Table 6. Analyses of tuff and lava flow samples from Naches Formation, southwestern Washington (continued)

[Naches Formation includes Spencer Creek beds, and "Puget Group" in Bumping Lake area. Other unit sampled: Wildcat Creek beds. Analyses listed in approximate stratigraphic order]

Sample no.	SWW93006	SWW93000	SWW93001	SWW93002	SWW93061	SWW93054	SWW93059	SWW93060	SWW83152	SWW83153	SWW93075	SWW92118
Lab no.	D-546685	D-546679	D-546880	D-546881	D-546928	D-546923	D-546926	D-546927	D-572961	D-572962	D-546929	D-526522
Analysis/Run	VS21	VS21	VS21	VS21	VS22	VS22	VS22	VS22	WD16	WD16	VS22	VJ24
Batch	E	E	E	E	E	E	E	E	F	F	E	C
Field no.	3D.27VII93T	1.27VII93T	2A.27VII93T	2B.27VII93T	CCH-80	CCH-27B	CCH-*25	CCH-*27	4A.26VIII83T	4B.26VIII83T	9B.22VIII93S	3A.29VII92S
Lithology	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clayey tuff	clxl(fs-fm)tf	xl(pcfm)vittf	xl(pc)vit tf	cl xl(q) tuff	cl xl(q) tuff	vitric? tuff	xl(q-pc)vlttf
Source/tk,cm	rc/10	rc/15	rc/25	rc/8	rc/4	rc/50	rc/800	RC/50	rc/600	rc/600	oc/500	rc/100
Strat position	middle Naches	middle Naches	middle Naches	middle Naches	mid? Naches	mid? Naches	mid? Naches	mid? Naches	mid? Naches	mid? Naches	mid? Naches	upper Naches
Section/Well	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1901 rd	FS 1904 rd	FS 1900-75(	FS 1900-75(	FS 1900-75(	Mt. Cath R I-90 at Hyak	Mt. Cath R I-90 at Hyak	N.Nelson Rdg	FS1900 rd
1/4,1/4,1/4	SENESW	NWSESW	NWSESW	NWSESW	SWNWSW	SENWNW	SENWNW	SENWNW	SENWSE	SENWSE	NENWSW	NESENE
STR	28-18N-14E	28-18N-14E	26-16N-14E	28-18N-14E	20-18N-14E	19-18N-14E	19-18N-14E	19-18N-14E	15-22N-11E	15-22N-11E	30-16N-13E	6-18N-13E
7.5' quad	Quartz Mtn	Quartz Mtn	Quartz Mtn	Quartz Mtn	Mt. Clifty	Mt. Clifty	Mt. Clifty	Mt. Clifty	Snoq Pass	Snoq Pass	Bumping Lake	Raven Roost
Lat N	47°01'04"	47°00'56"	47°01'00"	47°01'00"	47°01'54"	47°02'18"	47°02'13"	47°02'18"	47°23'40"	47°23'40"	46°50'50"	47°04'47"
Long W	121°06'03"	121°06'06"	121°06'08"	121°06'08"	121°07'40"	121°08'54"	121°08'56"	121°08'54"	121°23'11"	121°23'11"	121°15'35"	121°15'35"
Kelly/elev,ft	3540	3450	3490	3490	3450	3320	3220	3320	2555	2555	6925	3240
Sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	49.40	53.90	53.50	49.70	48.60	57.00	71.40	57.80	na	na	73.90	58.20
Al_2O_3	22.00	19.00	24.30	23.40	25.30	16.40	15.00	15.40	- - -	- - -	13.40	13.00
TiO_2	2.15	0.97	1.90	2.62	2.11	1.56	0.68	1.20	- - -	- - -	0.13	0.73
$FeTO_3$	4.52	9.19	2.16	2.41	5.39	7.76	1.65	8.75	- - -	- - -	2.16	5.90
MnO	0.01	0.30	0.01	0.01	0.02	0.16	0.02	0.11	- - -	- - -	0.05	0.13
CaO	1.58	1.11	0.41	0.71	1.16	4.56	2.04	6.49	- - -	- - -	1.47	4.35
MgO	2.04	1.42	1.26	2.30	1.54	1.93	0.25	2.68	- - -	- - -	0.19	1.74
K_2O	1.23	1.07	1.27	0.98	1.73	0.59	2.39	0.35	- - -	- - -	2.70	0.82
Na_2O	0.43	1.75	0.25	0.15	0.30	3.79	4.42	4.14	- - -	- - -	3.10	0.56
P_2O_5	0.36	0.28	0.05	0.06	0.13	0.31	0.17	0.39	- - -	- - -	0.05	0.18
LOI @ 925°C	15.70	10.70	14.10	17.10	12.70	5.15	1.54	2.23	- - -	- - -	2.05	14.40
Total	99.42	99.69	99.21	99.44	96.98	99.21	99.56	99.54	- - -	- - -	99.20	100.03
FeO*	4.07	8.27	1.94	2.17	4.85	6.98	1.48	7.87	- - -	- - -	1.94	5.31
Total w/o LOI	83.27	88.07	84.89	82.10	85.74	93.28	97.85	96.43	- - -	- - -	96.93	85.04
Major Elements (XRF, normalized values, weight%)												
SiO_2	59.33	61.20	63.02	60.54	56.66	61.10	72.97	59.94	- - -	- - -	76.24	68.44
Al_2O_3	26.42	21.57	28.62	28.50	29.51	17.58	15.33	15.97	- - -	- - -	13.82	15.29
TiO_2	2.56	1.10	2.24	3.19	2.46	1.67	0.69	1.24	- - -	- - -	0.13	0.86
FeO*	4.88	9.39	2.29	2.64	5.66	7.49	1.52	8.16	- - -	- - -	2.01	6.24
MnO	0.01	0.34	0.01	0.01	0.02	0.17	0.02	0.11	- - -	- - -	0.05	0.15
CaO	1.90	1.26	0.48	0.86	1.35	4.89	2.08	6.73	- - -	- - -	1.52	5.12
MgO	2.45	1.61	1.48	2.80	1.80	2.07	0.26	2.78	- - -	- - -	0.20	2.05
K_2O	1.48	1.21	1.50	1.19	2.02	0.63	2.44	0.36	- - -	- - -	2.79	0.96
Na_2O	0.52	1.99	0.29	0.16	0.35	4.06	4.52	4.29	- - -	- - -	3.20	0.68
P_2O_5	0.43	0.32	0.06	0.07	0.15	0.33	0.17	0.40	- - -	- - -	0.05	0.21
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	- - -	- - -	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	39	60	14	<10	48	14	<10	19	<10	<10	<10	<10
Cr	198	124	85	59	108	53	<20	64	<20	<20	<20	<20
Ba	415	610	990	275	410	335	600	156	1350	660	620	455
Rb	37	38	43	35	63	10	64	<10	152	106	55	17
Sr	130	196	68	62	220	275	148	200	43	80	90	220
Zr	305	174	138	168	188	142	310	148	194	210	235	230
Y	50	26	30	14	17	30	48	35	58	64	35	44
Nb	23	10	18	18	17	10	12	<10	10	12	11	12
Cu	62	45	30	25	126	50	<10	37	12	15	<10	13
Zn	78	91	86	55	106	83	46	72	49	97	26	100
La	<30	<30	<30	<30	108	<30	40	<30	<30	31	<30	<30
Ce	40	40	37	<30	144	40	59	30	65	60	38	30
Th	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)												
Lab no.	na	na	na	na	na	na	na	na	na	na	na	na
Analysis	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Fe	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Na	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
K	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ca	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ti	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sc	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Cr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Co	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ni	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zn	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
As	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Se	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Br	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Rb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mo	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Au	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ca	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ba	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
La	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ce	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sm	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Eu	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Gd	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ho	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tm	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Yb	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lu	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zr	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Hf	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ta	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
W	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Th	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
U	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -

Table 6. Analyses of tuff and lava flow samples from Naches Formation, southwestern Washington (continued)

[Naches Formation includes Spencer Creek beds, and "Puget Group" in Bumping Lake area. Other unit sampled: Wildcat Creek beds. Analyses listed in approximate stratigraphic order]

Sample no.	SWW93022	SWW84006	SWW84001	SWW92228
Lab no.	D-546901	D-501212	D-501208	D-526523
Analysis/Run	VS21	UX20	UX20	VJ24
Batch	E	A	A	C
Field no.	7.26VII93M	CT-6/12	CT1/2E1.24V	1.18IX92F
Lithology	xl(q-pc)vittf	clayey tuff	clayey tuff	pm lap vit tf
Source/tk,cm	rc/300	oc/80	oc/50	oc/30
Strat position	top Naches	lo WC beds	lo WC beds	lo WC beds
Section/Well	FS 1708 rd	Spencer Creek unit #4	Spencer Creek unit #5	Wildcat Creek FS 1306 rd
1/4,1/4,1/4	NWSESW	SWNESW	SWNESW	SWSWNW
STR	2-17N-14E	20-13N-14E	20-13N-14E	26-14N-13E
7.5' quad	Cliffdell	FoundationRdg	FoundationRdg	Rimrock Lake
Lat N	46°59'11"	46°35'52"	46°35'52"	46°40'28"
Long W	121°03'13"	121°06'30"	121°06'30"	121°10'36"
Kally/elev,ft	3000	4350	4350	3990
Sample dep,ft				
				Major Elements (XRF, analyzed values, weight%)
SiO_2	66.50	63.60	70.10	60.10
Al_2O_3	12.70	21.90	16.90	15.50
TiO_2	0.40	1.33	0.95	1.76
$FeTO_3$	3.45	2.43	2.72	10.30
MnO	0.03	0.01	0.02	0.19
CaO	3.24	0.13	0.26	1.98
MgO	0.84	0.28	0.41	1.25
K_2O	1.65	0.63	0.95	0.60
Na_2O	1.42	0.15	0.15	4.24
P_2O_5	0.08	0.05	0.06	0.18
LOI @ 925°C	8.93	9.13	7.22	3.55
Total	99.24	99.64	99.74	99.65
FeO*	3.10	2.19	2.45	9.27
Total w/o LOI	89.96	90.27	92.25	95.07
				Major Elements (XRF, normalized values, weight%)
SiO_2	73.92	70.46	75.99	63.22
Al_2O_3	14.12	24.26	18.32	16.30
TiO_2	0.44	1.47	1.03	1.85
FeO*	3.45	2.42	2.65	9.75
MnO	0.03	0.01	0.02	0.20
CaO	3.60	0.14	0.28	2.08
MgO	0.93	0.31	0.44	1.31
K_2O	1.83	0.70	1.03	0.63
Na_2O	1.58	0.17	0.16	4.46
P_2O_5	0.09	0.06	0.07	0.19
Total	100.00	100.00	100.00	100.00
				Trace Elements (XRF, ppm)
Ni	<10	22	19	11
Cr	<20	82	120	24
Ba	610	220	205	184
Rb	63	40	40	20
Sr	188	86	148	182
Zr	240	300	200	205
Y	38	18	29	41
Nb	12	26	12	12
Cu	<10	31	43	51
Zn	74	51	44	112
La	<30	42	<30	<30
Ce	37	49	<30	35
Th	nd	nd	nd	nd
				Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)
Lab no.	na	na	na	na
Analysis	- - -	- - -	- - -	- - -
Fe	- - -	- - -	- - -	- - -
Na	- - -	- - -	- - -	- - -
K	- - -	- - -	- - -	- - -
Ca	- - -	- - -	- - -	- - -
Ti	- - -	- - -	- - -	- - -
Sc	- - -	- - -	- - -	- - -
Cr	- - -	- - -	- - -	- - -
Co	- - -	- - -	- - -	- - -
Ni	- - -	- - -	- - -	- - -
Zn	- - -	- - -	- - -	- - -
As	- - -	- - -	- - -	- - -
Se	- - -	- - -	- - -	- - -
Br	- - -	- - -	- - -	- - -
Rb	- - -	- - -	- - -	- - -
Sr	- - -	- - -	- - -	- - -
Mo	- - -	- - -	- - -	- - -
Sb	- - -	- - -	- - -	- - -
Au	- - -	- - -	- - -	- - -
Ce	- - -	- - -	- - -	- - -
Ba	- - -	- - -	- - -	- - -
La	- - -	- - -	- - -	- - -
Ce	- - -	- - -	- - -	- - -
Nd	- - -	- - -	- - -	- - -
Sm	- - -	- - -	- - -	- - -
Eu	- - -	- - -	- - -	- - -
Gd	- - -	- - -	- - -	- - -
Tb	- - -	- - -	- - -	- - -
Ho	- - -	- - -	- - -	- - -
Tm	- - -	- - -	- - -	- - -
Yb	- - -	- - -	- - -	- - -
Lu	- - -	- - -	- - -	- - -
Zr	- - -	- - -	- - -	- - -
Hf	- - -	- - -	- - -	- - -
Ta	- - -	- - -	- - -	- - -
W	- - -	- - -	- - -	- - -
Th	- - -	- - -	- - -	- - -
U	- - -	- - -	- - -	- - -

Table 7. Analyses of tuff samples from Chumstick Formation, northwestern Washington

[Analyses listed in approximate stratigraphic order]

Sample no.	NNW86005	NNW86004	NWW86003	NWW86001	NWW86002	NNW86006
Lab no.	D-501228	D-501227	D-501226	D-501224	D-501225	D-501229
Analysis	UX21	UX21	UX21	UX20	UX20	UX21
Batch	A	A	A	A	A	A
Field no.	MJM #54	MJM #56	MJM #4	MJM #59	MJM #32	MJM #38
Lithology	si fn tf,50 bt	si fn tf,65 ab	si fn tf	si fn tf,42 ab	si fn tf	si fn tf
Source/tk,cm	oc/300	oc/300	oc/300	oc/200	oc/60	oc/425
Strat position	lo-mid CS	lo-mid CS	lo-mid CS	lo-mid CS	upper CS	upper CS
Section/Well	Yaxon Cny 3	Yaxon Cny 3	Yaxon Cny 3	Yaxon Cny 2	Clark Cny 5	Clark Cny 3
1/4,1/4,1/4	NWNWSE	NWNWSE	SENWNE	NESWNW	SWSWNW	NWNENE
STR	32-24N-19E	32-24N-19E	16-23N19E	32-24N-19E	9-25N-18E	31-26N-18E
7.5' quad	Cashmere	Cashmere	Monitor	Cashmere	Van Creek	Winton
Lat N	47°31'58"	47°31'58"	47°29'33"	47°32'07"	47°40'45"	47°42'58"
Long W	120°29'00"	120°29'00"	120°27'33"	120°29'28"	120°36'27"	120°37'59"
Kelly/elev,ft	1200	1200	1400	1080	2000	1700
sample dep,ft						
Major Elements (XRF, analyzed values, weight%)						
SiO_2	67.50	66.40	66.70	67.90	53.50	69.00
Al_2O_3	12.40	12.10	12.30	10.90	24.20	13.00
TiO_2	0.21	0.15	0.21	0.26	1.45	0.15
$FeTO_3$	1.75	1.71	1.78	2.82	3.53	1.45
MnO	0.03	0.03	0.03	0.06	0.02	0.02
CaO	3.34	3.37	3.53	3.45	0.14	2.19
MgO	1.04	1.15	1.10	0.95	0.97	1.24
K_2O	0.89	0.60	0.77	0.55	1.47	2.18
Na_2O	0.80	0.39	0.60	0.28	0.19	0.91
P_2O_5	0.06	0.05	0.06	0.05	0.08	0.05
LOI @ 925°C	10.90	13.10	11.90	11.80	13.50	8.47
Total	98.92	99.05	98.98	99.02	99.05	98.66
FeO*	1.57	1.54	1.60	2.54	3.18	1.30
Total w/o LOI	87.84	85.78	86.90	86.89	85.20	89.99
Major Elements (XRF, normalized values, weight%)						
SiO_2	76.84	77.41	76.75	78.15	62.80	76.67
Al_2O_3	14.12	14.11	14.15	12.54	28.40	14.45
TiO_2	0.24	0.17	0.24	0.30	1.70	0.17
FeO*	1.79	1.79	1.84	2.92	3.73	1.45
MnO	0.03	0.03	0.03	0.07	0.02	0.02
CaO	3.80	3.93	4.06	3.97	0.16	2.43
MgO	1.18	1.34	1.27	1.09	1.14	1.38
K_2O	1.01	0.70	0.89	0.63	1.73	2.42
Na_2O	0.91	0.45	0.69	0.32	0.22	1.01
P_2O_5	0.07	0.06	0.07	0.06	0.09	0.06
Total	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)						
Ni	<10	<10	<10	<10	19	<10
Cr	<20	<20	<20	<20	96	<20
Ba	1300	1100	1100	1200	405	495
Rb	64	40	55	58	55	154
Sr	3000	2400	2900	4700	54	3300
Zr	160	134	170	425	210	205
Y	19	26	17	54	38	21
Nb	<10	<10	<10	<10	23	<10
Cu	17	17	21	18	31	11
Zn	75	86	80	130	77	89
La	<30	<30	<30	<30	38	<30
Ce	37	51	42	76	81	45
Th	nd	nd	nd	nd	nd	nd
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%)						
Lab no.	D-501793	D-501792	D-501791	D-501789	D-501790	D-501794
Analysis	UX44	UX44	UX44	UX44	UX44	UX44
Fe	1.25	1.19	1.31	2.06	0.984	1.05
Na	0.58	0.245	0.432	0.175	1.39	0.676
K	0.706	0.486	0.74	0.345	0.154	1.85
Ca	nd	nd	nd	nd	nd	nd
Ti	nd	nd	nd	nd	nd	nd
Sc	8.97	9.09	9.74	3.25	2.36	1.69
Cr	7.96	6.31	8.70	0.00	11.30	9.42
Co	1.99	1.53	2.22	0.295	1.78	1.19
Ni	6.21	16.00	12.30	2.17	9.02	4.70
Zn	60.30	67.00	63.80	115.00	81.20	70.60
As	0.613	1.65	0.789	0.442	3.98	0.979
Se	nd	nd	nd	nd	nd	nd
Br	nd	nd	nd	nd	nd	nd
Rb	nd	nd	nd	nd	nd	nd
Sr	3280.00	2550.00	3090.00	5080.00	5680.00	3550.00
Mo	nd	nd	nd	nd	nd	nd
Sb	0.711	0.786	0.741	0.918	0.365	0.468
Au	2.03	1.05	0.333	0.232	0.669	0.744
Cs	2.21	2.19	2.70	1.14	3.19	8.54
Ba	1250.00	1040.00	1120.00	1260.00	581.00	486.00
La	25.70	26.80	26.90	34.90	19.20	17.40
Ce	52.80	57.10	57.80	74.90	47.00	43.00
Nd	27.30	31.80	33.60	41.50	29.10	25.90
Sm	7.24	8.60	7.89	10.70	8.44	7.60
Eu	0.677	0.613	0.707	1.22	0.249	0.177
Gd	7.34	9.10	7.78	11.30	8.16	7.66
Tb	1.07	1.30	1.17	1.86	1.17	1.11
Ho	1.34	1.59	1.43	2.81	1.56	1.59
Tm	0.552	0.563	0.555	1.27	0.689	0.694
Yb	3.48	3.33	3.29	8.23	4.35	4.30
Lu	0.497	0.444	0.433	1.18	0.633	0.594
Zr	173.00	135.00	177.00	377.00	163.00	176.00
Hf	5.12	4.55	5.50	10.00	6.08	7.06
Ta	1.22	1.29	1.32	1.11	1.42	1.62
W	0.865	1.71	0.906	0.619	0.558	0.592
Th	9.66	10.20	10.40	9.46	14.10	15.60
U	3.79	4.28	4.10	3.45	4.99	5.03

Table 8. Analyses of miscellaneous tuff samples from western Oregon and Washington

Tuffs in Cascade Range, southern Washington:

Sample no.	SWW89156	SWW92088	SWW89045	SW89091A	SW89091B	SWW90093	SWW92229	SWW89049	SWW84004	SWW84005	SWW84007	SWW92046
Lab no.	D-501222	D-526521	D-501218	D-501220	D-501221	D-501223	D-526524	D-501219	D-501210	D-501211	D-501213	D-526498
Analysis	UX20	VJ24	UX20	UX20	UX20	UX20	VJ24	UX20	UX20	UX20	UX20	VJ24
Batch	A	C	A	A	A	A	C	A	A	A	A	C
Unit/Fm	BRT	BRT	FPT	FPT	FPT	FPT	BMT	CPT	SRT, lac	SRT, lac	SRT, lac	SRT
Field no.	6D.16IX89S	1.17Viii92M	7B.8IX89F	11FA.11IX89M	11FB.11IX89M	4A.11IX90T	2.18IX92F	1A.9IX89S	3A.21VI82M/CT-4	3B.21VI82M/CT-5	3C.21VI82M/CT-1	13A.31VII92F
Lithology	xl(q-pc)vittf	xl(q-pc)vittf	fn vit tuff	wh lth lap tf	brn lth lap tf	yel lth lap tf	gry xl(pc) tf	pmxl(q-pc)tf	cs vit tuff	cs vit tuff	cs vit tuff	ithxl(q-pc)tf
Source/tk,cm	oc/500	oc/300	rc/80	oc/40	oc/40	oc/40	rc/500	oc/100	rc/10	rc/10	rc/10	rc/300
Strat position	mid to lo-up	lens in colbrc	lower				lower?	lower unit	lower?	lower?	lower?	lower part
Section/Well	Bumping Rive	Mt. Aix calder	FS 1500 rd	E Am Ridge	E Am Ridge	SE FPks volc caldera-fill	FS1306 rd Wildcat Cr area	Cash Prairie	N.Packwd qry off hwy US 12	N.Packwd qry off hwy US 12	N.Packwd qry off hwy US 12	Mowich Lk rd
1/4,1/4,1/4	NWNENE	NWNESE	NENENW	SWNESE	SWNESE	SENWSE	SWSWNW	SENENW	SENESW	SENESW	SENESW	SENESE
STR	27-17N-13E	24-15N-12E	16-15N-14E	15-17N-13E	15-17N-13E	1-17N-12E	26-14N-13E	13-14N-13E	15-13N-9E	15-13N-9E	15-13N-9E	22-17N-7E
7.5' quad	Old Scab Mtn	Bumping Lake	Meeks Table	Old Scab Mtn	Old Scab Mtn	Goose Prairie	Rimrock Lake	Rimrock Lake	Packwood	Packwood	Packwood	Golden Lakes
Lat N	46°56'25"	46°46'27"	46°47'49"	46°57'42"	46°57'42"	46°59'21"	46°41'02"	46°42'42"	46°36'55"	46°36'55"	46°36'55"	46°56'25"
Long W	121°11'53"	121°15'55"	121°05'13"	121°11'55"	121°11'55"	121°17'19"	121°08'02"	121°08'45"	121°39'53"	121°39'53"	121°39'53"	121°53'38"
Kelly/elev,ft	2980	5830	3170	4460	4460	5750	4200	5620	1120	1120	1120	3850
sample dep,ft												
Major Elements (XRF, analyzed values, weight%)												
SiO_2	64.50	75.00	58.20	55.40	51.80	49.30	62.80	64.60	53.70	54.10	69.90	63.60
Al_2O_3	13.00	12.80	11.90	14.60	16.10	14.80	15.50	15.30	22.90	23.60	12.80	15.60
TiO_2	0.26	0.20	1.05	0.61	1.27	1.26	0.81	0.63	1.62	1.30	0.84	0.80
$FeTO_3$	2.35	2.12	8.48	10.00	8.06	9.29	6.06	2.96	3.58	3.02	2.55	3.99
MnO	0.05	0.07	0.09	0.16	0.21	0.08	0.13	0.03	0.04	0.03	0.10	0.10
CaO	3.14	1.35	3.06	3.13	4.05	5.67	4.79	3.10	1.54	0.52	0.54	3.49
MgO	0.49	0.30	1.66	0.81	0.90	3.34	1.48	0.96	0.61	0.52	0.54	1.15
K_2O	2.16	3.35	1.49	1.48	0.53	0.56	2.51	2.36	1.33	1.35	0.60	3.21
Na_2O	2.48	3.53	0.97	1.64	1.23	1.59	3.20	2.60	0.66	0.20	2.37	3.27
P_2O_5	0.06	0.06	0.20	0.12	0.07	0.15	0.27	0.15	0.33	0.27	0.17	0.16
LOI @ 925°C	10.90	0.67	12.60	11.60	15.20	9.29	1.94	6.86	13.30	13.40	6.32	3.65
Total	99.39	99.45	99.70	99.55	99.42	95.33	99.49	99.55	99.61	98.31	96.73	99.02
FeO*	2.11	1.91	7.63	9.00	7.25	8.36	5.45	2.66	3.22	2.72	2.29	3.59
Total w/o LOI	88.25	100.49	86.25	86.95	83.41	85.11	102.19	92.39	87.91	86.33	91.86	98.16
Major Elements (XRF, normalized values, weight%)												
SiO_2	73.08	74.64	67.48	63.72	62.10	57.93	61.45	69.92	61.08	62.67	76.09	64.79
Al_2O_3	14.73	12.74	13.80	16.79	19.30	17.39	15.17	16.56	26.05	27.34	13.93	15.89
TiO_2	0.29	1.90	1.22	0.70	1.52	1.48	5.34	0.68	3.66	3.15	2.50	3.66
FeO*	2.40	2.11	8.85	10.35	8.69	9.82	5.93	2.88	4.07	3.50	2.78	4.06
MnO	0.06	0.07	0.10	0.18	0.25	0.09	0.13	0.03	0.05	0.03	0.11	0.10
CaO	3.56	1.34	3.55	3.60	4.86	6.66	4.69	3.36	1.75	0.60	0.59	3.56
MgO	0.56	0.30	1.92	0.93	1.08	3.92	1.45	1.04	0.69	0.60	0.59	1.17
K_2O	2.45	3.33	1.73	1.70	0.64	0.66	2.46	2.55	1.51	1.56	0.65	3.27
Na_2O	2.81	3.51	1.12	1.89	1.47	1.87	3.13	2.81	0.75	0.23	2.58	3.33
P_2O_5	0.07	0.06	0.23	0.14	0.06	0.18	0.26	0.16	0.38	0.31	0.19	0.16
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Trace Elements (XRF, ppm)												
Ni	<10	<10	<10	<10	25	<10	<10	<10	13	<10	<10	<10
Cr	<20	<20	<20	<20	34	<20	<20	<20	<20	<20	<20	40
Ba	660	1050	550	450	360	310	730	690	136	126	142	980
Rb	61	86	40	37	24	26	44	96	39	40	23	88
Sr	122	118	168	200	250	250	270	200	56	47	67	290
Zr	158	114	168	350	152	140	170	188	385	390	122	166
Y	28	20	30	42	23	18	32	36	67	70	33	18
Nb	11	<10	12	13	11	<10	10	15	28	24	14	<10
Cu	10	13	32	33	55	45	11	22	43	37	90	32
Zn	74	17	85	95	91	85	45	47	144	154	106	45
La	<30	<30	<30	<30	35	<30	<30	34	38	53	<30	<30
Ce	46	60	33	58	<30	36	48	81	89	110	40	40
Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%))												
Lab no.	D-501787	na	D-501784	na	D-501786	D-501788	na	D-501785	na	D-501780	na	na
Analysis	UX44	- - -	UX44	- - -	UX44	UX44	- - -	UX44	- - -	UX44	- - -	- - -
Fe	1.74	- - -	6.27	- - -	6.05	7.17	- - -	2.26	- - -	2.36	- - -	- - -
Na	2.00	- - -	0.762	- - -	0.952	1.29	- - -	2.10	- - -	0.127	- - -	- - -
K	1.91	- - -	1.31	- - -	0.00	0.396	- - -	2.09	- - -	1.32	- - -	- - -
Ca	nd	- - -	nd	- - -	nd	nd	- - -	nd	- - -	nd	- - -	- - -
Tl	nd	- - -	nd	- - -	nd	nd	- - -	nd	- - -	nd	- - -	- - -
Sc	6.61	- - -	22.50	- - -	28.90	27.80	- - -	12.10	- - -	30.90	- - -	- - -
Cr	2.95	- - -	7.41	- - -	45.70	5.60	- - -	11.90	- - -	9.51	- - -	- - -
Co	3.09	- - -	13.70	- - -	32.00	20.50	- - -	5.86	- - -	7.42	- - -	- - -
Ni	5.84	- - -	0.00	- - -	27.00	11.40	- - -	11.40	- - -	5.38	- - -	- - -
Zn	58.30	- - -	73.50	- - -	74.70	81.00	- - -	37.70	- - -	143.00	- - -	- - -
As	3.12	- - -	3.70	- - -	14.90	0.655	- - -	8.34	- - -	8.44	- - -	- - -
Se	nd	- - -	nd	- - -	nd	nd	- - -	nd	- - -	nd	- - -	- - -
Br	nd	- - -	nd	- - -	nd	nd	- - -	nd	- - -	nd	- - -	- - -
Rb	62.90	- - -	42.00	- - -	24.00	25.30	- - -	103.00	- - -	47.60	- - -	- - -
Sr	152.00	- - -	173.00	- - -	281.00	327.00	- - -	212.00	- - -	79.90	- - -	- - -
Mo	nd	- - -	nd	- - -	nd	nd	- - -	nd	- - -	nd	- - -	- - -
Sb	0.401	- - -	0.236	- - -	0.299	0.13	- - -	0.756	- - -	0.791	- - -	- - -
Au	1.21	- - -	0.00	- - -	4.34	1.57	- - -	0.092	- - -	0.978	- - -	- - -
Ce	3.82	- - -	1.95	- - -	1.51	1.88	- - -	19.80	- - -	11.90	- - -	- - -
Ba	708.00	- - -	530.00	- - -	378.00	293.00	- - -	681.00	- - -	142.00	- - -	- - -
La	25.40	- - -	13.70	- - -	15.90	17.40	- - -	31.20	- - -	51.30	- - -	- - -
Ce	51.90	- - -	31.10	- - -	34.40	36.80	- - -	63.60	- - -	112.00	- - -	- - -
Nd	26.80	- - -	20.30	- - -	22.10	23.60	- - -	30.10	- - -	60.40	- - -	- - -
Sm	6.04	- - -	5.44	- - -	5.57	6.24	- - -	6.72	- - -	14.20	- - -	- - -
Eu	0.884	- - -	1.31	- - -	1.33	1.74	- - -	1.14	- - -	2.58	- - -	- - -
Gd	5.35	- - -	5.14	- - -	5.19	6.32	- - -	6.12	- - -	13.50	- - -	- - -
Tb	0.863	- - -	0.779	- - -	0.723	0.908	- - -	0.795	- - -	1.95	- - -	- - -
Ho	1.40	- - -	1.04	- - -	0.968	1.23	- - -	1.17	- - -	2.58	- - -	- - -
Tm	0.661	- - -	0.431	- - -	0.404	0.518	- - -	0.492	- - -	0.955	- - -	- - -
Yb	4.39	- - -	2.63	- - -	2.46	3.22	- - -	3.08	- - -	5.89	- - -	- - -
Lu	0.67	- - -	0.378	- - -	0.362	0.467	- - -	0.433	- - -	0.824	- - -	- - -
Zr	146.00	- - -	159.00	- - -	145.00	153.00	- - -	183.00	- - -	427.00	- - -	- - -
Hf	4.42	- - -	4.24	- - -	3.90	3.47	- - -	5.16	- - -	10.80	- - -	- - -
Ta	0.788	- - -	0.638	- - -	0.583	0.493	- - -	0.992	- - -	1.83	- - -	- - -
W	4.95	- - -	3.25	- - -	2.14	0.00	- - -	10.70	- - -	1.23	- - -	- - -
Th	7.48	- - -	3.76	- - -	2.68	2.57	- - -	12.50	- - -	9.96	- - -	- - -
U	2.23	- - -	1.08	- - -	0.927	0.934	- - -	4.59	- - -	3.87	- - -	- - -

Table 8. Analyses of miscellaneous tuff samples from western Oregon and Washington

	Mazama O tephra: in Columbia River sediments					northeast of Lava Butte, central Oregon	
Sample no.	**NWO 90001**	**NWO 90002**	**NWO 90003**	**NWO 90004**	**NWO 90005**	**SWO93001**	**SWO93002**
Lab no.	D-501267	D-501268	D-501269	D-501270	D-501271	D-572964	D-572965
Analysis	UX22	UX22	UX22	UX22	UX22	WD16	WD16
Batch	A	A	A	A	A	F	F
Unit/Fm	rw Mazama ash	rw Mazama ash	rw Mazama ash	rw Mazama ash	rw Mazama ash	airfall tephra	airfall tephra
Field no.	KCR/28(1)	KCR/48	KCR/64	KCR/67	KCR/L-7	RAJ:1A.13Xl93S	RAJ:1B.13Xl93S
Lithology	wh silty ash	wh silty ash	wh silty ash	wh silty ash	wh silty ash	gry fn pm ash	gry cs pm ash
Source/tk,cm	cu/60	cu/150	cu/5	cu/60	cu/150	rc/13	rc/23
Strat position	?	?	?	?	?	?	?
Section/Well	nr Mult Chan	Hayden Island	Swan Island	Pearcy Island	W Longview	FS 1907 rd	FS 1907 rd
1/4,1/4,1/4	NWSWNE	NWNESE	NWNENW	NWNESW	NWNENW	SWSENE	SWSENE
STR	53-2N-1W	33-2N-1E	20-1N-1E	24-2N-1W	36-8N-3W	13-19S-11E	13-19S-11E
7.5' quad	Linnton	Portland	Portland	Sauvie Island	Clatskanie	Lava Butte	Lava Butte
Lat N	45°36'52"	45°36'48"	45°33'44"	45°37'56"	46°08'29"	43°55'47"	43°55'47"
Long W	122°47'35"	122°41'25"	122°43'01"	122°45'55"	123°00'00"	121°20'53"	121°20'53"
Kelly/elev,ft	19	21.5	30	29.5	17	4345	4345
sample dep,ft	69	79	130	109	89	6	5
	Major Elements (XRF, analyzed values, weight%)						
SiO_2	67.20	67.80	65.70	67.40	67.60	na	na
Al_2O_3	14.20	14.00	14.40	14.20	14.30	- - -	- - -
TiO_2	3.01	2.63	3.51	2.71	2.78	- - -	- - -
$FeTO_3$	0.78	0.66	0.96	0.73	0.76	- - -	- - -
MnO	2.08	1.83	2.32	2.00	1.84	- - -	- - -
CaO	4.48	4.55	4.23	4.50	4.26	- - -	- - -
MgO	2.50	2.61	2.33	2.54	2.58	- - -	- - -
K_2O	0.53	0.48	0.60	0.49	0.51	- - -	- - -
Na_2O	0.13	0.12	0.14	0.12	0.11	- - -	- - -
P_2O_5	0.06	0.06	0.07	0.06	0.06	- - -	- - -
LOI @ 925°C	4.14	4.31	4.91	4.14	4.67	- - -	- - -
Total	99.11	99.05	99.17	98.89	99.47	- - -	- - -
FeO*	2.71	2.37	3.16	2.44	2.50	- - -	- - -
Total w/o LOI	94.67	94.48	93.91	94.48	94.52	- - -	- - -
	Major Elements (XRF, normalized values, weight%)						
SiO_2	70.98	71.76	69.96	71.34	71.52	- - -	- - -
Al_2O_3	15.00	14.82	15.33	15.03	15.13	- - -	- - -
TiO_2	2.86	2.50	3.36	2.58	2.65	- - -	- - -
FeO*	0.82	0.70	1.02	0.77	0.80	- - -	- - -
MnO	2.20	1.94	2.47	2.12	1.95	- - -	- - -
CaO	4.73	4.82	4.50	4.76	4.51	- - -	- - -
MgO	2.64	2.76	2.48	2.69	2.73	- - -	- - -
K_2O	0.56	0.51	0.64	0.52	0.54	- - -	- - -
Na_2O	0.14	0.13	0.15	0.13	0.12	- - -	- - -
P_2O_5	0.06	0.06	0.07	0.06	0.06	- - -	- - -
Total	100.00	100.00	100.00	100.00	100.00	- - -	- - -
	Trace Elements (XRF, ppm)						
Ni	<10	<10	13	<10	<10	<10	<10
Cr	<20	<20	<20	<20	<20	<20	<20
Ba	750	790	720	780	800	520	510
Rb	52	47	45	51	62	33	33
Sr	305	280	325	315	290	770	800
Zr	250	245	235	245	255	148	146
Y	27	22	26	25	28	<10	<10
Nb	<10	<10	<10	<10	12	<10	<10
Cu	26	24	28	29	31	26	15
Zn	54	52	65	60	60	44	46
La	<30	<30	<30	30	35	<30	<30
Ce	<30	41	<30	38	46	<30	<30
	Trace Elements (INAA, ppm, except Fe, Na, K, Ca, and Ti in weight%))						
Lab no.	na	na	na	na	na	na	na
Analysis	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Fe	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Na	- - -	- - -	- - -	- - -	- - -	- - -	- - -
K	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ca	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ti	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sc	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Cr	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Co	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ni	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zn	- - -	- - -	- - -	- - -	- - -	- - -	- - -
As	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Se	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Br	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Rb	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sr	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Mo	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sb	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Au	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ce	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ba	- - -	- - -	- - -	- - -	- - -	- - -	- - -
La	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ce	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Nd	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Sm	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Eu	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Gd	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tb	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ho	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Tm	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Yb	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Lu	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Zr	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Hf	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Ta	- - -	- - -	- - -	- - -	- - -	- - -	- - -
W	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Th	- - -	- - -	- - -	- - -	- - -	- - -	- - -
U	- - -	- - -	- - -	- - -	- - -	- - -	- - -