DEPARTMENT OF THE INTERIOR

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Oxygen isotopic data for plutonic rocks and gneisses of the Glacier Peak Wilderness and vicinity, northern Cascades, Washington

By

L. Douglass White[1], Cynthia A. Maley[1], Ivan Barnes[1], and Arthur B. Ford[1]

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[1]USGS, Menlo Park, California

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INTRODUCTION

This preliminary report provides data on the oxygen isotopic composition of rock samples from most of the plutons and major gneiss units of the Glacier Peak Wilderness and vicinity, northern Cascades, Washington (fig. 1). The study is an outgrowth of the U.S. Geological Survey's geological investigations (Ford and others, 1985; that were carried out in 1980-82 as part of an assessment of the mineral-resource potential of the wilderness (Church and others, 1984).

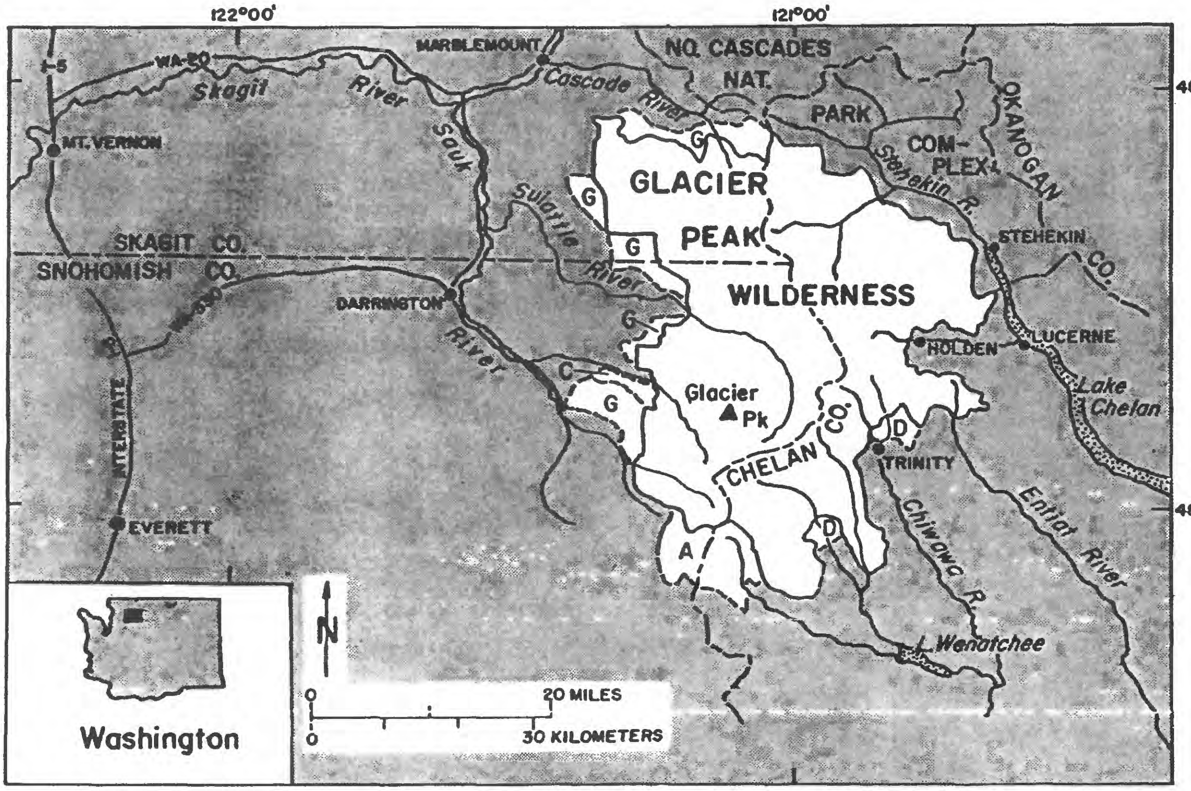

Figure 1. Map showing location of the Glacier Peak Wilderness

The data were obtained because oxygen isotopic compositions combined with other data are useful for interpreting the geological history of rocks such as occur in this area; and because very little data of this type are presently available for this region, except for the Cloudy Pass batholith (Sans, 1983).

Many studies show the importance of oxygen isotopic data for interpreting the origin of granitic and mafic magmas and their tectonic setting; and particularly for identifying the nature of magma sources, the extent of contamination of magmas with country rocks, and effects of water-rock interactions (Fleck and Criss, 1985; Andrew and others, 1983; Taylor and Magaritz, 1978; Taylor, 1977, 1978; and O'Neil and others, 1977); and in studies of mineral deposits (Allegré and Michard, 1974, p. 113).

Criss and Champion (1984) discuss relations between oxygen isotopic compositions and magnetic susceptibilities of plutonic rocks of the Idaho batholith, north-central Idaho. Magnetic susceptibility data for most samples of the present study are given by Ford and others (1986). Flanigan and others (1983) provide a preliminary geologic interpretation of the aeromagneitc survey (Flanigan and Sherrard, 1985) of the Glacier Peak Wilderness and vicinity.

In the Idaho batholith, isotopic compositions of oxygen and strontium reflect variations in magma source terranes and magmatic histories across a concealed Precambrian continental margin, as defined by the eastern limit of plutonic rocks with initial $^{87}Sr/^{86}Sr$ ratio (r_i) of 0.704 or lower that are related to a Mesozoic island arc (Armstrong and others, 1977; Fleck and Criss, 1985). Plutons east of the limit have higher r_i reflecting the Precambrian continental crust, and oxygen isotope ratios also reflect this sialic source (Fleck and Criss, 1985).

The strontium "r_i=0.704" line appears to trend westward from the Idaho batholith area across southern Washington (but concealed by the Columbia River Basalt Group) to near the Cascades Range, where it swings northward and 200 km farther north crosses the Glacier Peak Wilderness from somewhere south of Glacier Peak volcano to about the northwest corner of the wilderness, as shown approximately on a map of Armstrong and others' (1977, fig. 10). Magmas west of the line ascended through relatively young crust not greatly enriched in ^{87}Sr and they crystallized with low radiogenic Sr ratios, whereas some magmas to the east crystallized with higher ratios reflecting an older (Precambrian?) sialic source (Armstrong and others, 1977).

The only previous oxygen isotopic determinations of rocks of the Glacier peak region---and, as far as we know, of all the northern Cascades of Washington State, except for those used in Babcock and others' (1985) study of the Skagit Gneiss of Misch (1966)---are those of rocks and minerals in Sans's (1979, 1983) detailed study of the Miocene Cloudy pass batholith and its hydrothermal alteration. The nearest other area for which abundant oxygen isotopic data are available is the transect (the southernmost of three) of the Coast plutonic-metamorphic complex north of the U.S.-Canada border, about 80 km north of our study area (Taylor and Magaritz, 1978; Magaritz and Taylor, 1986).

We undertook the present study in conjunction with other studies of the Glacier Peak Wilderness (Church and others, 1984; Ford and others, 1985; 1986) in order to obtain oxygen isotopic data of sufficiently broad geographic and geologic coverage to isotopically characterize most units and, using the data as a "mapping tool," to determine variations within units as well as across a large area of nearly 3,000 sq km in this first reconnaissance oxygen isotopic transect of a major part of the northern Cascades of Washington State.

A complete discussion of the geology of the area and of the oxygen isotopic data are beyond the scope of this preliminary data report. Interpretation of the isotopic data requires completion of other studies in progress. The geology and petrology of the units of this report (fig. 2) are discussed in sources cited by Ford (1983a). According to those sources the units and geologic record of the Glacier Peak study area are broadly representative of those of the northern Cascades in general, as described by Misch (1966). Based on data of R.J. Fleck (written communication, 1984) and otehrs cited in Ford (1983a) the geologic record of igneous activity ranges from early Paleozoic or older (volcanic? protolith of Swakane Biotite Gneiss) and Triassic (Dumbell Mountain plutons and Marblemount Meta Quartz Diorite) to Late Cretaceous (Tenpeak, Sloan Creek, and Mount Chaval plutons among others), Eocene (Railroad Creek and other plutons), Miocene (Cloudy Pass Batholith and Mount Buckindy and Cascade Pass plutons), and late Cenozoic (Cool stock and volcanics of Glacier Peak).

ACKNOWLEDGMENTS

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PRESENT STUDIES

Samples and locations

A total of 357 rock samples were analyzed in this study. The selection of sample sites was based on obtaining a broad lithologic and geographic representation of all major plutons and gneis units and many smaller bodies, as shown in figure 2, as the study is a first reconnaissance of oxygen isotopic compositions across a major transect of the northern Cascades of Washington State.

Sites sampled are shown approximately on geologic sketch maps of each unit in Ford and others (1985). More exact locations are shown on a 1:100,000-scale topographic base of the Glacier Peak Wilderness and vicinity (Ford, 1983b).

Modes of rocks and magnetic susceptibility data for the samples are given by Ford and others (1985, 1986). Modal data and rock types based on modes are shown diagrammatically in figs. 3-5.

Figure 2. (facing page)--Sketch geologic map of the Glacier Peak Wilderness (unshaded) and vicinity showing generalized map units and major faults. Names of units from original sources given in Ford (1983a). TE includes area (TEw) mapped as White Mountain plutons by Cater and Crowder (1967). Unit abbrevations used in this report are as follows:

BE	Tonalite of Bench Lake	JO	Jordan Lakes pluton
BU	Mount Buckindy pluton	LC	Leroy Creek pluton
CA	Cascade Pass pluton	MA	Marblemount Meta Quartz Diorite
CD	Cardinal Peak pluton	MM	Magic Mountain Gneiss
CG	South Cascade Glacier stock	PL	Pear Lake pluton
CH	Mount Chaval pluton	RC	Railroad Creek pluton
CM	Clark Mountain stocks	RP	Riddle Peaks pluton
CO	Cool stock	SI	Sitkum stock
CP	Cloudy Pass batholith	SF	Seven-fingered Jack plutons
CY	Cyclone lake pluton	SG	Skagit Gneiss
DD	Dead Duck pluton	SL	Sloan Creek plutons
DH	Duncan Hill pluton	SU	Sulphur Mountain pluton
DM	Downey Mountain stock	SW	Swakane Biotite Gneiss
DO	Downey Creek pluton	TE	Tenpeak pluton
DU	Dumbell Mountain plutons	WG	White Chuck Glacier pluton
EG	Eldorado Orthogneiss	gns	gneiss and schist, mixed
FO	Foam Creek stock	gs	greenschist and blueschist
GR	Grassy Point stock	vlc	volcanic materials
HI	Hidden Lake stock	sch	mostly schist of biotite grade
HO	Holden Lake pluton		
HP	High Pass pluton		

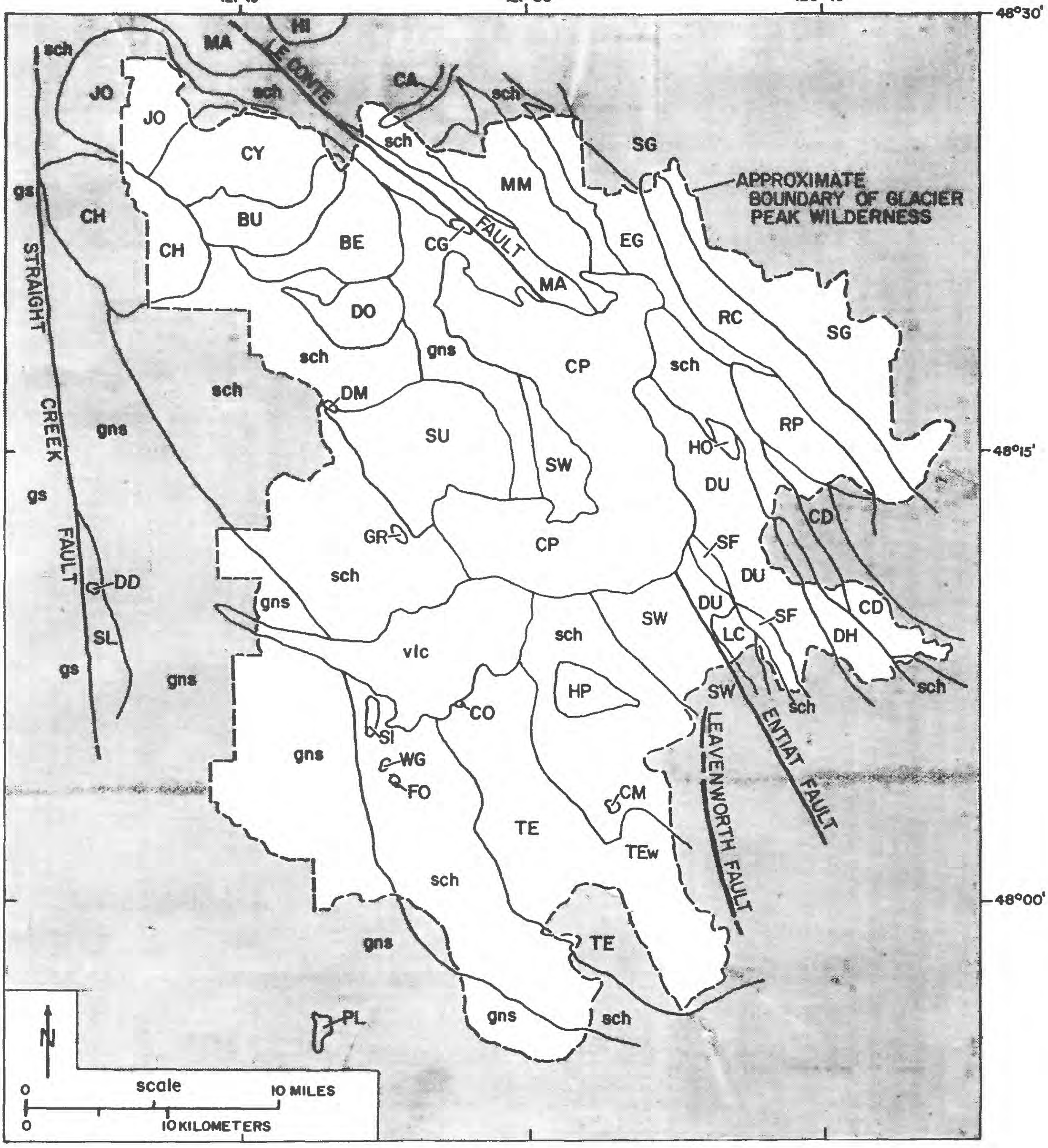

Figure 2. Caption on previous page.

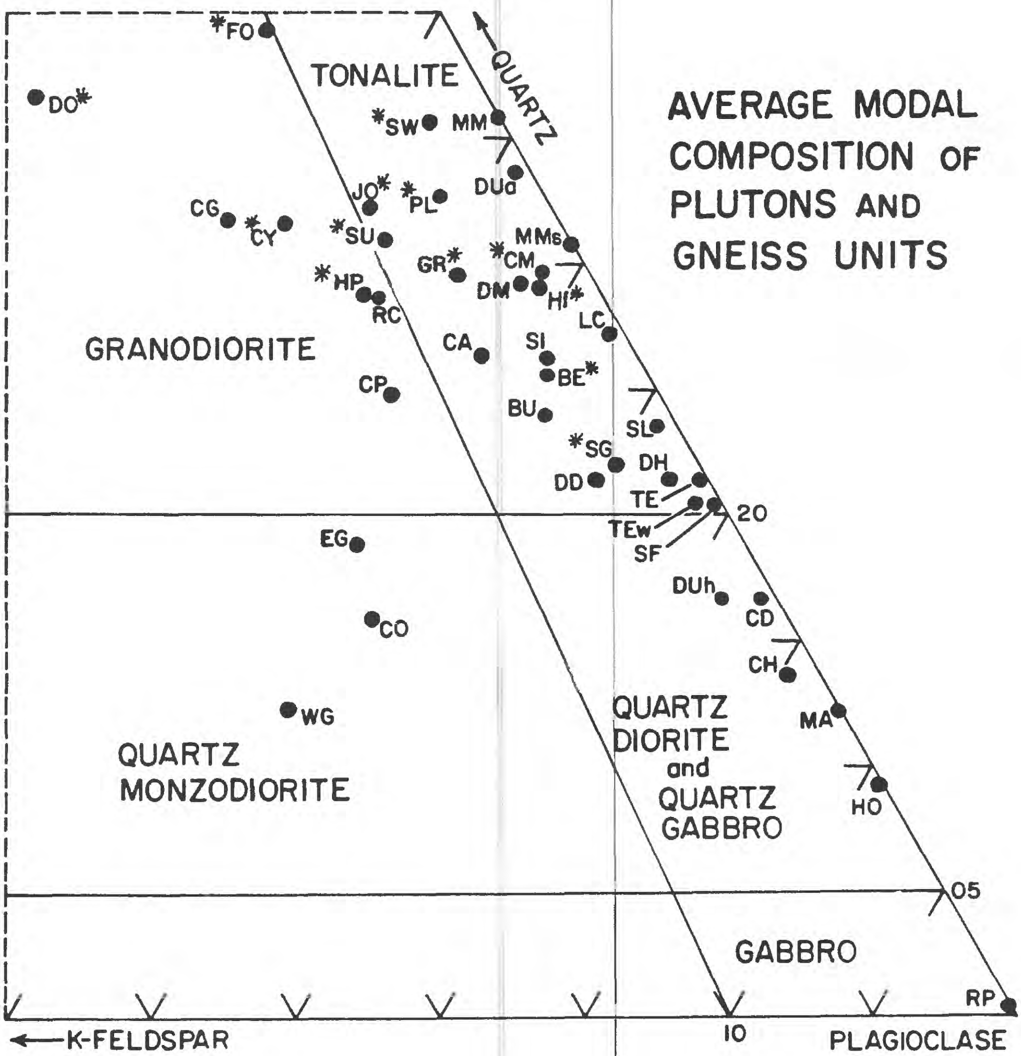

Figure 3.---Modal rock classification of average compositions of plutons and gneiss units of the Glacier Peak Wilderness and vicinity, showing those of the high $\delta^{18}O$ group by asterisk (see text). Classification from Ford and others (1985). Unit symbols explained in fig. 2 and as follows: DUa, Duh, and DUq = map units dag, dhg, and dqg of Cater and Crowder (1967); TEw = part of Tenpeak pluton mapped as White Mountain pluton by Cater and Crowder (1967); and MMs = undifferentiated rocks possibly correlative with MM in area shown as "sch" southeast of MM in fig. 2.

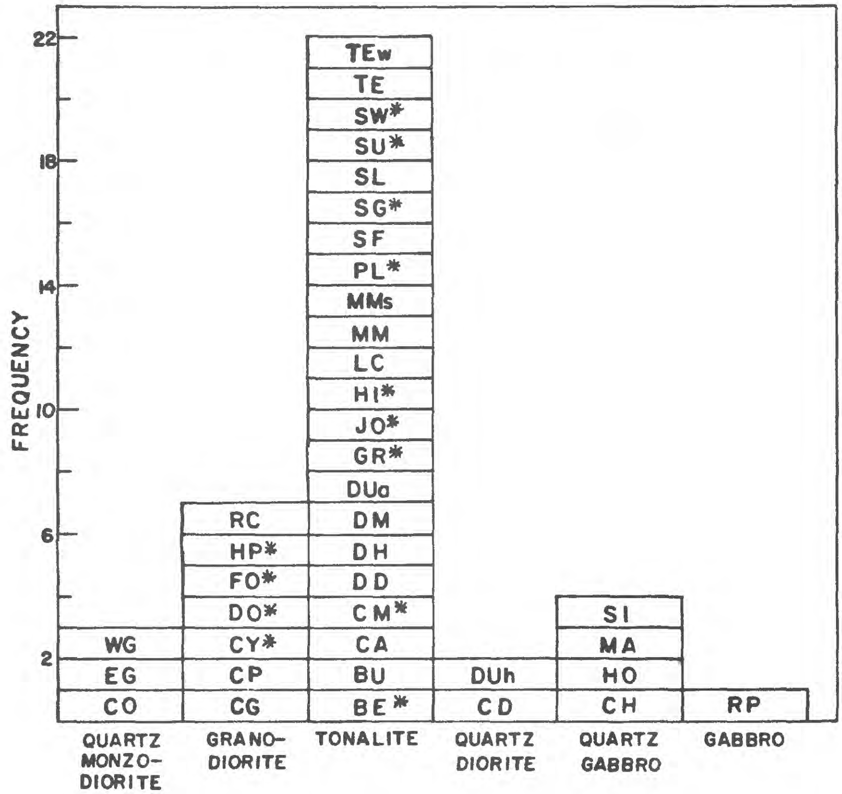

Figure 4.---Histogram of average rock types of plutons and gneiss units of the Glacier Peak Wilderness and vicinity, showing those of the high $\delta^{18}O$ group by asterisk (see text). Lithologic classification from Ford and others (1985).

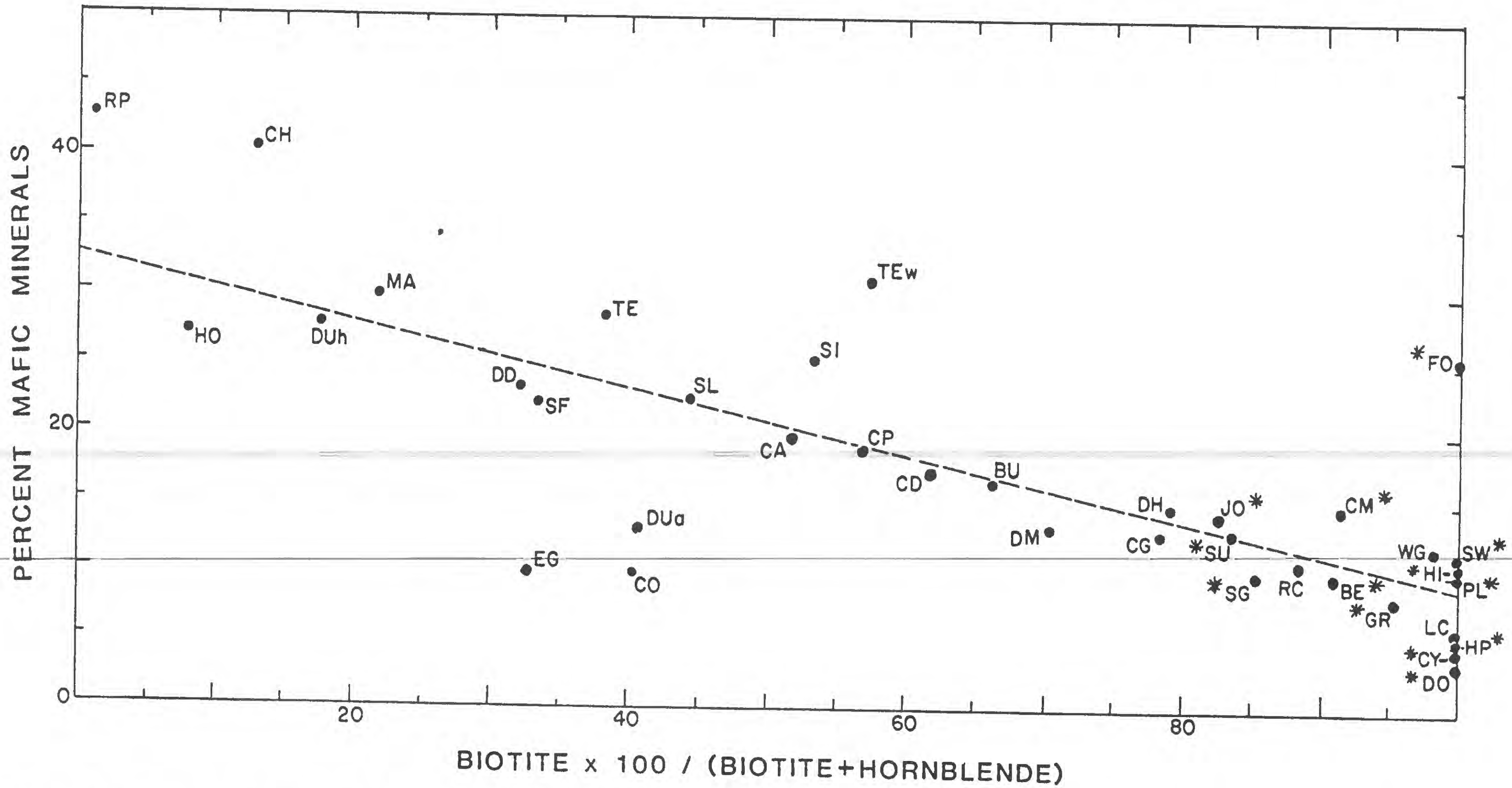

Figure 5.---Variation between average modal biotite and hornblende ratio with total content of mafic minerals in plutons and gneiss units of the Glacier Peak Wilderness and vicinity. Symbols for units explained in figs. 2 and 3. (Unit MM of fig. 2 not shown due to general absence of biotite and hornblende.) From Ford and others (1985). Units in the high $\delta^{18}O$ group (see text) marked by asterisk.

Method of sample preparation and analysis

The isotopic compositions of oxygen are expressed in the δnotation, $\delta^{18}O$, in which

$$x = \frac{R_x - R_{standard}}{R_{Standard}} \times 10^3 \quad \text{where } R_x = (^{18}O/^{16}O)_x.$$

The δvalues are reported relative to the SMOW (Standard Mean Ocean Water) international reference standard, and are reproducible to ± 0.3 per mil.

Preparation of silicate samples for subsequent determination of oxygen isotope ratios is performed on a vacuum-line extraction system. This system provides for the preparation of 10 samples in duplicate. Ten milligrams of powdered sample (~0.074 mm or 200 mesh Tyler sieve) are placed in nickel reaction vessels through a funnel. The system is then evacuated and the nickel tubes are heated to 100°C for one hour to drive off any excess water. After cooling, chlorine triflouride (ClF_3) is condensed into each nickel tube. The tubes are heated to 550°C overnight resulting in the liberation of oxygen gas. Samples containing 10 percent of high temperature minerals (e.g. pyroxene, garnet, magnetite) require a temperature of 650°C for complete reaction. Following overnight reaction, the resulting oxygen is expanded into a reaction vessel with a carbon rod at 600°C and converted to CO_2. The CO_2 is measured for yield by a mercury manometer and then condensed into a sample tube. The sample tube is removed from the extraction line and placed directly on a Finnigan Mat 251 mass spectrometer[1] for measurement of the oxygen isotope ratios.

Other data

The tables of oxygen isotope data (tables 1-28) contain additional chemical data such as found in other studies to show relationships with $\delta^{18}O$ variations. For example, some studies show distinct positive correlation between $\delta^{18}O$ and SiO_2 content (Leeman and Whelan, 1983; Hawkesworth, 1982; and Andrew and others, 1983); and with K_2O (Leeman and Whelan, 1983); iron oxidation ratio (OXR), in which OXR=$Fe_2O_3/(FeO+Fe_2O_3)$ (Spooner and others, 1977); and water content (Spooner and others, 1977; Ding and Schwarcz, 1984; and Ferrara and others, 1985). SiO_2 (tables 1-28) and Fe_2O_3 were determined by X-ray fluorescence; FeO by wet chemical methods; and total volatiles by weight loss on ignition (LOI) at 900°C.

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[1]Use of brand names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

DATA SUMMARY

The $\delta^{18}O$ values found in our study (tables 1-28) range widely from a maximum of +13.3 in the tonalite of Bench lake (table 11) to <0 in the Cloudy Pass batholith (table 3), Duncan Hill pluton (table 6), and Riddle Peaks pluton (table 20) and others. The ranges of $\delta^{18}O$ values are small within some units but are wide within others, such as the Cloudy Pass batholith, the Railroad Creek, Riddle Peaks, and Dumbell Mountain plutons, the Eldorado Orthogneiss, the Magic Mountain Gneiss, the Eldorado Orthogneiss, and the Skagit Gneiss (fig. 6). Variations between $\delta^{18}O$ and magnetic susceptibility of samples from the Cloudy Pass batholith and the Railroad Creek, Riddle Peaks, and Mount Chaval plutons are shown in Ford and others (1986, figs. 9 and 10).

Based on the histograms and maxima of fig. 6 the units (or parts of units) of the study area can be classified according to Taylor's (1978) three "somewhat arbitrary" groups of $\delta^{18}O$ values as follows:

1. Normal (+6 <^{18}O< +10)---Mount Buckindy, Cascade Pass, South Cascade Glacier, Duncan Hill, Sloan Creek, Tenpeak, Seven-fingered Jack (and Entiat), Mount Chaval, Leroy Creek, and Dead Duck plutons, and major parts of the Cloudy Pass batholith and Marblemount Meta Quartz Diorite;

2. High ($\delta^{18}O$ >+10)---Cyclone Lake, Downey Creek, High Pass, Jordan Lakes, and Sulphur Mountain plutons, Clark Mountain and Hidden Lake stocks, the tonalite of Bench Lake, the Skagit Gneiss, Swakane Biotite Gneiss, and some small plutons (PL, FO, GR, fig. 6).

Low ($\delta^{18}O$ <+6)---parts of Cloudy Pass batholith, Marblemount Meta Quartz Diorite, Magic Mountain Gneiss, Eldorado Orthogneiss, Skagit Gneiss, Swakane Biotite Gneiss, and the Railroad Creek, Duncan Hill, Seven-fingered Jack (and Entiat), Holden, Cardinal Peak, Riddle Peaks, and Dumbell Mountain plutons.

The plutons and gneiss units with normal and low $\delta^{18}O$ compositions range widely from gabbro to granodiorite and quartz monzodiorite, but those of the high $\delta^{18}O$ group are limited to tonalite and granodiorite (figs. 3 and 4) with biotite greatly predominant over hornblende (fig. 5). As shown in the AFM diagram of fig. 7 the rocks are calcalkalic except for those of tholeiitic composition of the Riddle Peaks and Holden Lake plutons. The plutons and gneiss units with high $\delta^{18}O$ composition generally have higher alkali (fig. 7) and SiO_2 (fig. 8) contents than others and have higher $Al_2O_3/(CaO+Na_2O+K_2O)$ ratios (fig. 9). The three oxygen isotopic groups of this area appear to be unrelated to geologic age except that all units of the high $\delta^{18}O$ group are dated as or inferred to be early Tertiary or older.

Except for the Skagit Gneiss the major high $\delta^{18}O$ units form an about 15-km-wide northwest-trending belt along the west side of the Entiat fault and its northwestward extension as the Le Conte fault (fig. 10). Only two very small plutons of this isotopic group lie west of the belt (PL and FO, fig. 10). The western margin of the belt coincides approximately with Armstrong and others' (1977, fig. 10) line marking $^{87}Sr/^{86}Sr_i$=0.704 (higher values to east) along this part of the northern Cascades. The Skagit Gneiss is grouped with the high $\delta^{18}O$ units and may form another northwest-trending belt about 20

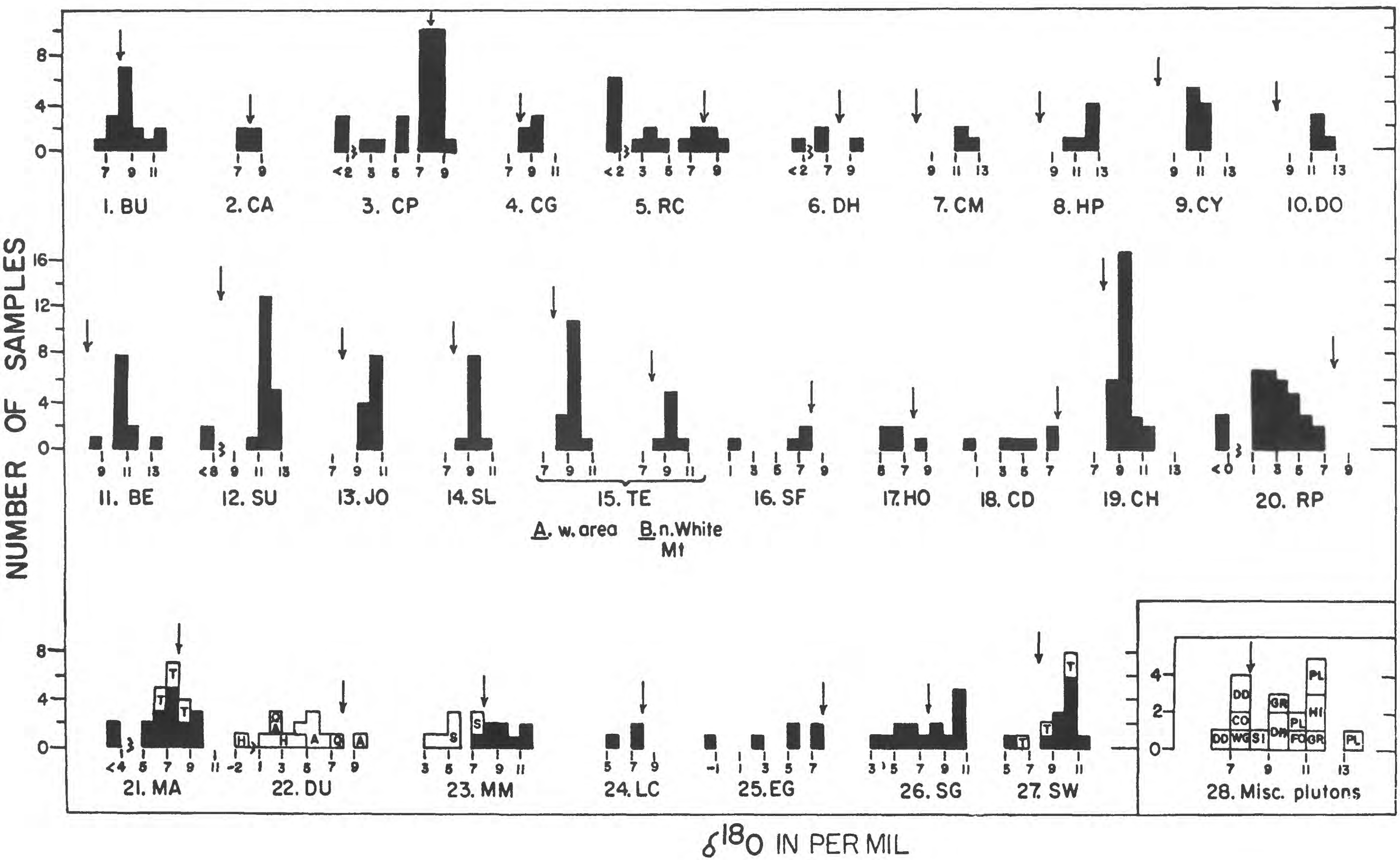

Figure 6.---Histograms of oxygen isotopic values for plutons and gneiss units of the Glacier Peak Wilderness and vicinity. Histogram numbers correspond with data table numbers. Unit symbols explained in figs. 2 and 3, plus T = type area samples for MA and SW (see text). Vertical arrows mark a $\delta^{18}O$ value of +8 for comparison of histograms. Note scale difference for no. 28.

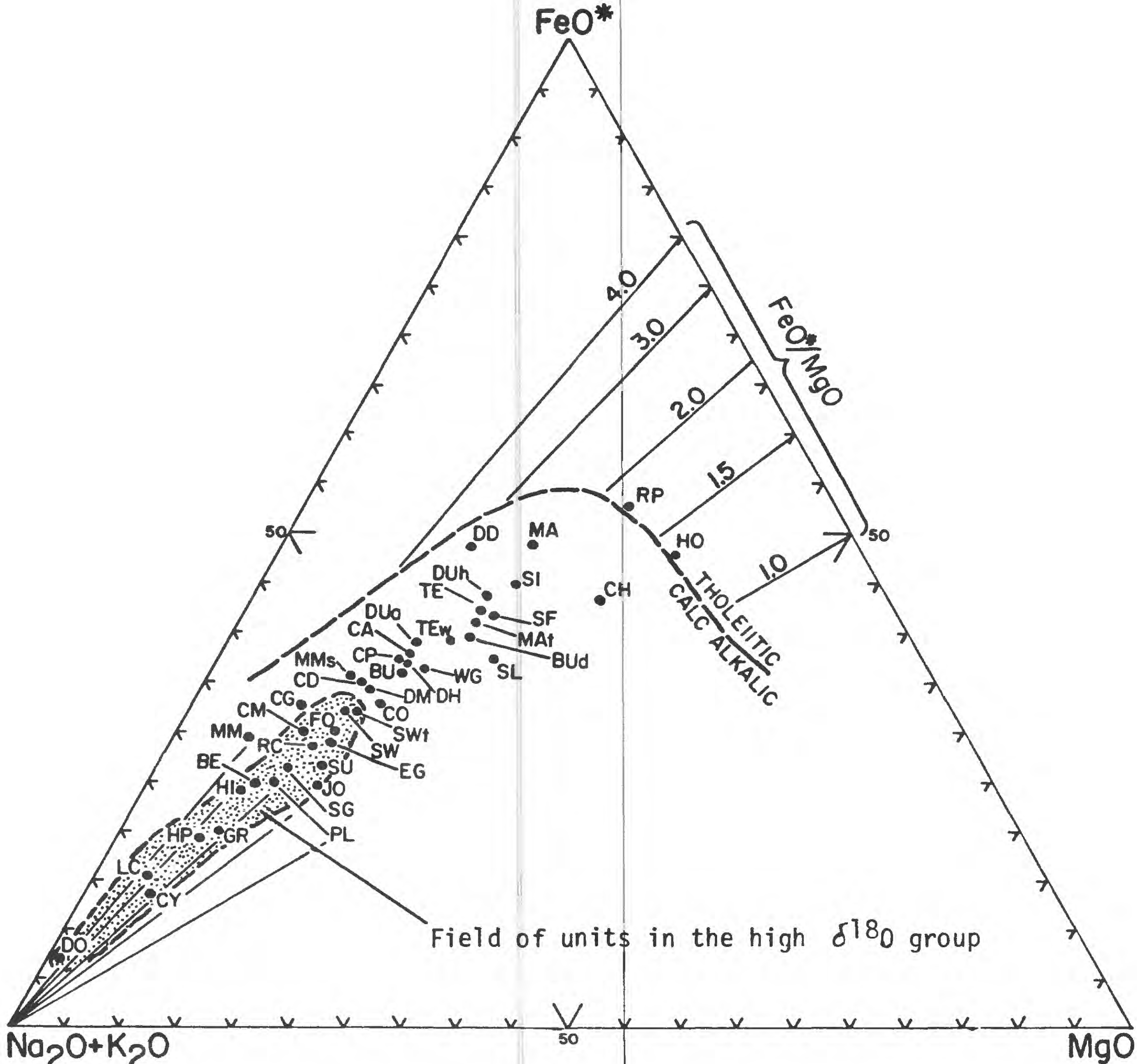

Figure 7.---AFM diagram of average total alkalies-FeO*(total iron as FeO)-MgO of plutons and gneiss units of the Glacier Peak Wilderness and vicinity, showing field of high $\delta^{18}O$ units (see text). Modified from Ford and others (1985). Unit symbols explained in figs. 2 and 3 and text. Stippled area includes some units of lower $\delta^{18}O$ group (EG, LC, RC).

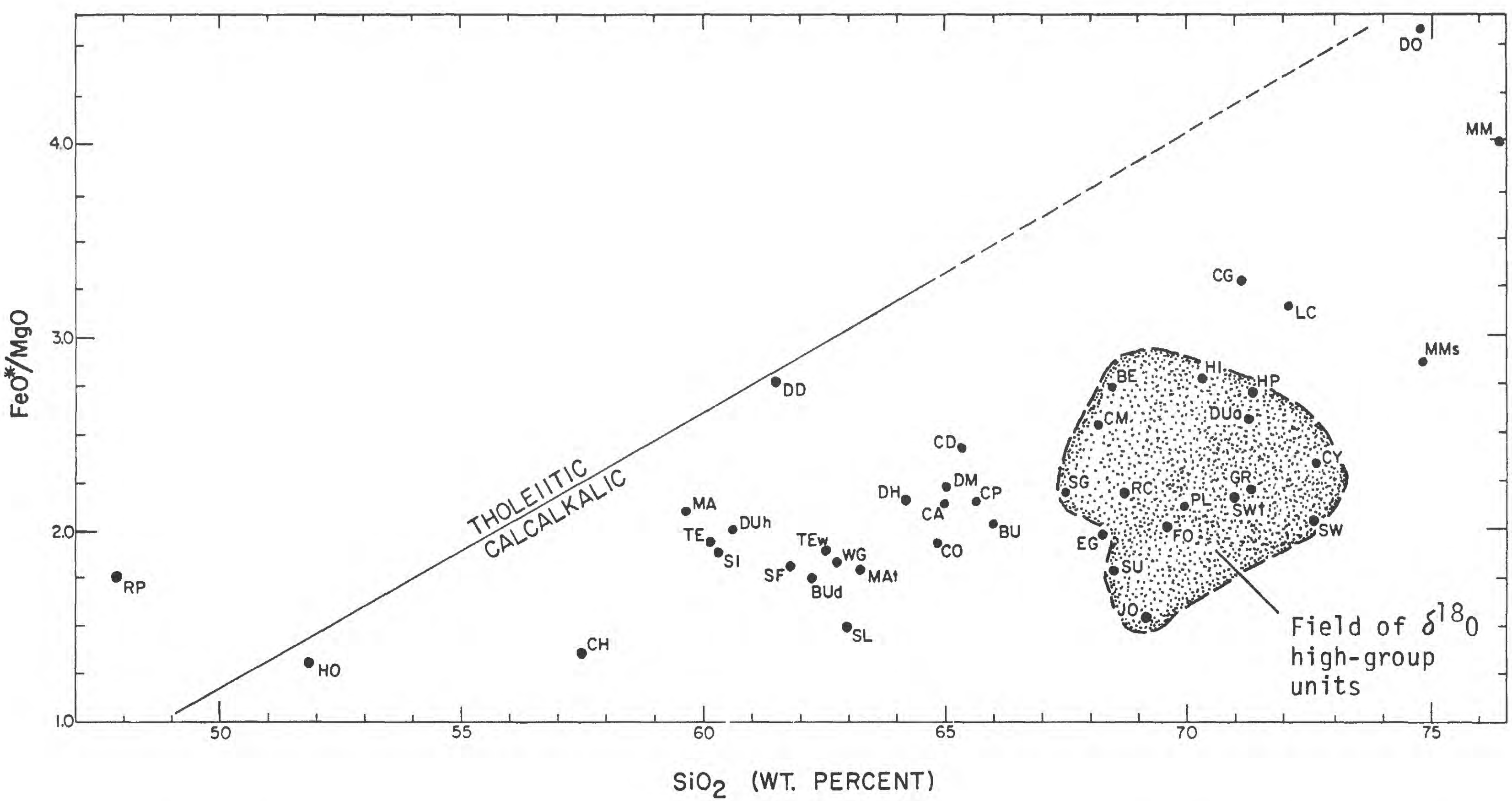

Figure 8.--Variation between average FeO^*/MgO and SiO_2 of plutons and gneiss units of the Glacier Peak Wilderness and vicinity, showing field of high ^{18}O units. (FeO^*=total iron, as FeO.) Modified from Ford and others (1985). Unit symbols explained in figs. 2 and 3. Stippled area includes some units of lower $\delta^{18}O$ group(DUa, RC).

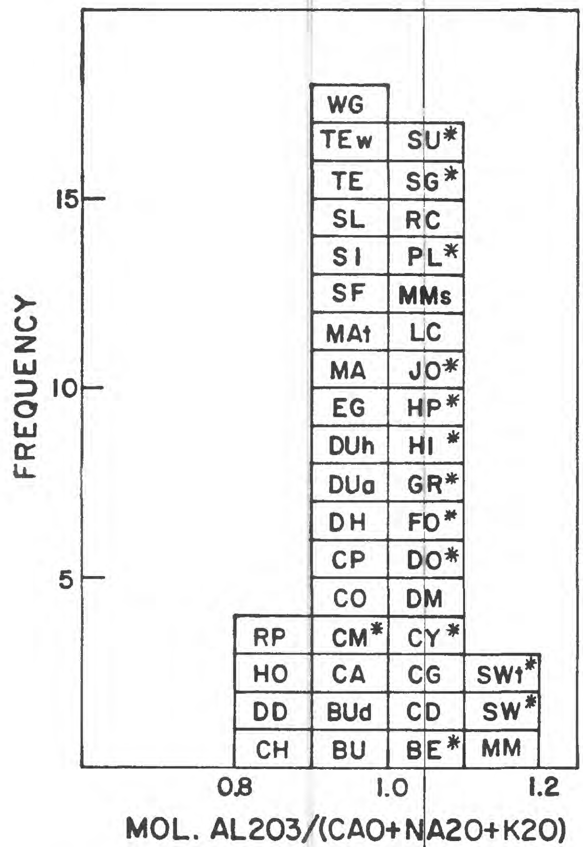

Figure 9.---Histogram of molecular Al_2O_3/($CaO+Na_2O+K_2O$) ratios of plutons and gneiss units of the Glacier Peak Wilderness and vicinity, showing units of the high $\delta^{18}O$ group by asterisk (see text). Modified from Ford and others (1985). Unit symbols explained in figs. 2 and 3 and text.

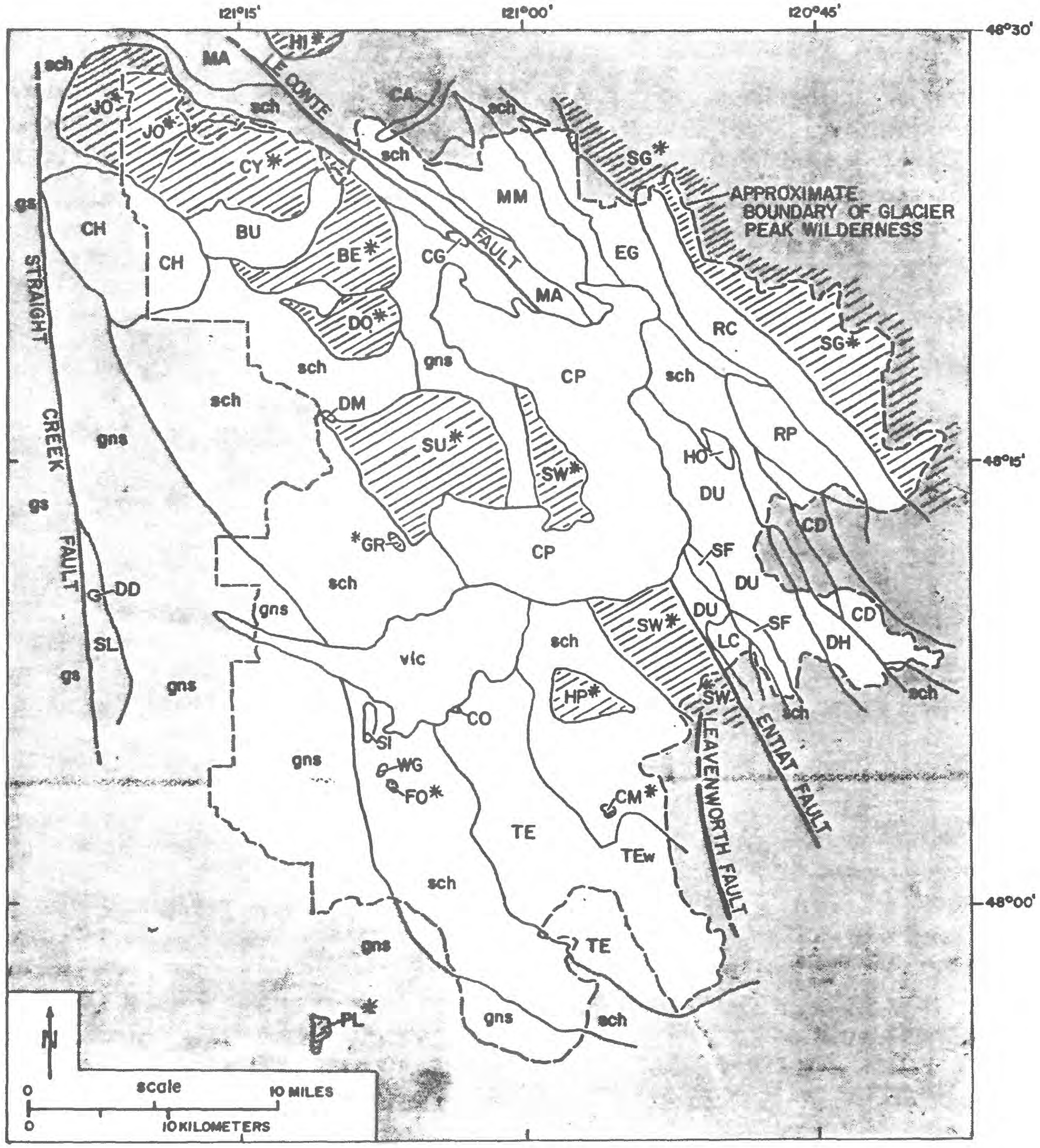

Figure 10.---Geographic distribution of high $\delta^{18}O$ plutons and gneiss units of the Glacier Peak Wilderness and vicinity (by * and lined areas). Unit symbols explained in fig. 2.

km east of the first (fig. 10). However, a large percentage of its $\delta^{18}O$ values are of the normal and lower groups (fig. 6) and therefore its classification is uncertain (see next paragraph).

In general, units with wide ranges of $\delta^{18}O$ values (for example, RC, RP, DU, MM, EG, and CP, fig. 6) show little or no discernable geographic variation or geologic relations, possibly due to inadequate sampling. In places, however, rocks with unusually low values have different types of geological relationships suggesting different mechanisms of origins. Unusually low $\delta^{18}O$ values of some samples are obviously of thermal contact origin as they are from aureoles of younger plutons such as near contacts with the Cloudy Pass batholith (tables 11, 12, and 21). Other areas of low $\delta^{18}O$ values are probably related to hydrothermal alteration, such as suggested by the general occurrence of $\delta^{18}O$ values $<+6$ of the Cloudy Pass batholith (table 3) to western Miners Ridge, an area of hydrothermal porphyry copper-molybdenum mineralization (Church and others, 1984). Sans (1983) provides much more abundant oxygen isotopic data for the batholith and its interpretation. The Skagit Gneiss contains some isotopic values in the high $\delta^{18}O$ group, some in the normal group, and a large percentage near or in the low group. The analyzed samples are of orthogneiss members of the Skagit Gneiss. All $\delta^{18}O$ values of about +7 and below of the Skagit Gneiss occur within 2 km of the widely sheared and locally mylonitic contact with the Railroad Creek pluton (fig. 11), suggesting an origin by isotopic exchange during cataclasis as in Lee and others' (1986) study. Thus the Skagit gneiss may be a locally modified original high $\delta^{18}O$ unit.

Plutonic rocks in the high $\delta^{18}O$ group require significant involvement of high $\delta^{18}O$ metasedimentary or altered volcanic rocks in the melting process (Taylor, 1978). In the Australian New England batholith granitic magmas derived from sedimentary protoliths (S-type granite) have $\delta^{18}O$ values of +10 or higher and those from igneous protoliths (I-type granite) range from +7.7 to +9.9 (O'Neil and others, 1977). Accordingly, Glacier peak-area units that may be analogous to the Australian S granites are the Cyclone Lake, Downey Creek, High Pass, Jordan Lakes and Sulphur Mountain plutons, the Clark Mountain and Hidden Lake stocks, tonalite of Bench Lake and possibly the Skagit Gneiss. Many of the units contain minor muscovite and some contain garnet but none are known to contain cordierite (Ford and others, 1985), a characteristic restite mineral of S granite.

A preliminary study of some units with a wide range in $\delta^{18}O$ values shows generally weak positive or negative correlations with other data of the tables. Only three values of linear correlation coefficient (r) for the units studied show statistical significance at 95 percent probability (based on the t distribution test) as underlined below:

Unit	n	SiO_2	K_2O	LOI	OXR
Buckindy pluton	16	-.10	.17	.21	-.31
Cloudy Pass batholith	29	-.26	-.53	-.24	-.67
Railroad Creek pluton	15	.25	.31	-.49	-.01
Riddle Peaks pluton	32	.01	.10	-.09	-.38
Eldorado Orthogneiss	6	-.02	-.65	-.31	-.18

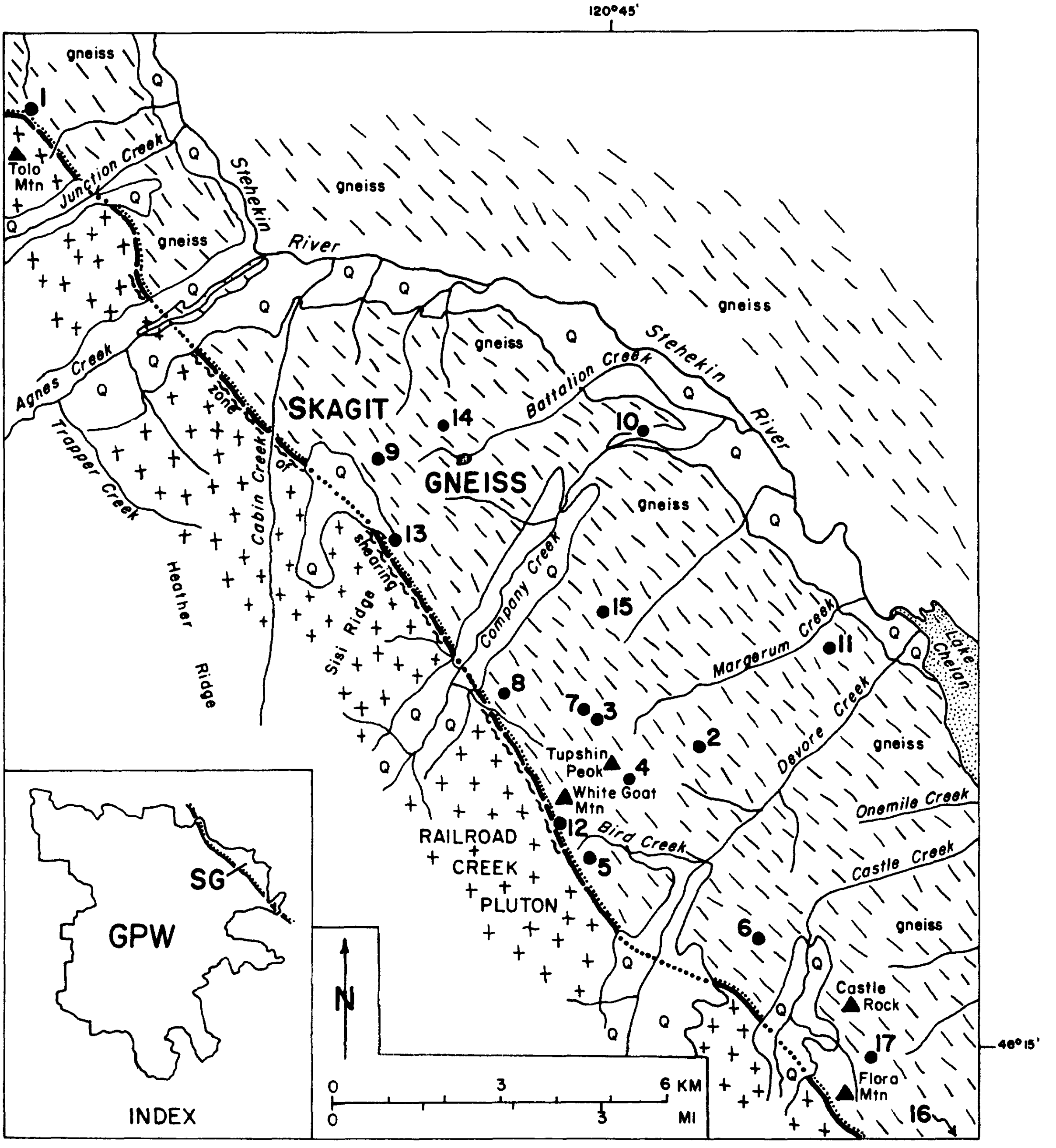

Figure 11.---Sketch geologic map of the Skagit Gneiss (SG) in northeastern part of the Glacier Peak Wilderness (GPW), showing areal variation of $\delta^{18}O$ values (table 26). Map from Ford and others (1985).

DATA REPORTS

Symbols used in tables

General. Plot numbers in tables 1 to 28 are the same used to show sample localities on sketch geologic maps of units (Ford and others, 1985). LOI is loss on ignition (900°C). OXR (oxidation ratio) = $Fe_2O_3/(FeO+Fe_2O_3)$.

Rock names. Rock names and minerals present are from Ford and others (1985). Rock names are indicated by the following symbols:

AL	alaskite	GAL	leucogabbro	MQ	metaquartz diorite
AP	aplite	GAM	melagabbro	QD	quartz diorite
DI	diorite	GD	granodiorite	QG	quartz gabbro
G	gneiss	GR	granite	QM	quartz monzodiorite
GA	gabbro	HB	hornblendite	TO	tonalite

Letters preceding rock-name symbols indicate the following principal auxiliary minerals present, in increasing abundance order:

b	biotite	h	hornblende	p	pyroxene
c	chlorite	m	muscovite (white mica)		
e	epidote	o	iron-titanium oxides		

The letters "p" and "f" after rock-name symbols respectively indicate a strongly porphyritic texture and presence of foliation. For alaskite, a compositional rock-name symbol is also given, as in "bALto," a biotite-bearing alaskite of tonalitic composition in terms of the quartz-feldspar diagram of fig. 3.

Type-area samples. Isotopic analyses are given for samples of two units from type areas outside the Glacier Peak Wilderness: Marblemount Meta Quartz Diorite from the vicinity of Marblemount (plot nos. t-1 to t-6, table 21) and Swakane Biotite Gneiss from the vicinity of Lake Chelan (plot nos. t-1 to t-4, table 27).

TABLE 1.---Data for samples from the Buckindy pluton

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR	Remarks
80F60A	1	h-bTO	7.06	60.4	1.51	0.62	0.42	
80F61A	2	h-bTOp	8.63	60.6	1.20	1.59	.47	
80GX2189	3	h-bGD	8.52	67.0	1.88	0.41	.45	
80L19B	4	h-bTO	8.24	65.0	1.79	.41	.42	
81F107A	5	h-bTO	6.99	65.6	1.36	.37	.43	
81F169B	6	h-bTOp	8.25	64.2	1.83	.23	.39	
81F172A	7	h-bGD	7.48	67.7	2.19	.26	.41	
81F251A	8	h-bTO	8.13	65.1	1.64	.30	.39	
81N62A	9	h-bTOp	8.38	63.6	1.74	.68	.38	
82F157A	10	h-bGD	9.05	66.4	1.90	.38	.42	
82F312A	16	h-bQDp	9.08	61.0	1.79	.52	.17	Dike
82S86E	17	h-bQDp	7.99	65.4	1.67	.57	.29	Dike
82T2A	20	hQDp	8.24	59.4	1.33	.51	.40	Dike
82S78D2	21	e-m-cAP	11.25	70.6	1.20	2.31	.15	Breccia pipe matrix
82S79A	22	e-m-cAP	10.98	62.1	2.10	1.98	.18	Ditto
82S78D1	23	e-m-cTO	11.96	70.6	1.46	2.06	.14	Breccia pipe clast

TABLE 2.---Data for samples from the Cascade Pass pluton
(Headings as in table 1)

80S29A	1	h-bGD	8.20	65.7	2.36	0.75	0.24
81F218B	2	h-bGD	8.49	64.9	2.18	.75	.12
81F221A	3	h-bTO	7.28	65.1	2.17	.35	.32
82F151A	4	b-hTOp	7.88	59.4	1.44	.72	.32

TABLE 3.---Data for samples from the Cloudy Pass batholith

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR	Remarks
80R128A	1	h-b-cGR	.71	72.6	3.25	0.76	0.43	
80S60A	2	c-h-bGD	3.20	66.1	2.62	1.19	.34	
81F5A	3	h-bTO	7.59	63.7	1.94	0.45	.31	
81F8A	4	h-bTOp	7.87	63.4	1.97	.81	.20	
81F37A	5	c-h-bGDp	8.63	67.5	2.63	.75	.11	
81F41B	6	b-hGD	8.76	65.5	2.57	.58	.20	
81F66A	7	c-b-hGD	7.80	63.7	2.32	.73	.31	
81F68A	8	c-b-hGD	7.70	62.2	2.05	.66	.34	
81F72A	9	c-h-bTO	8.22	63.9	1.93	.41	.24	
81F73A	10	p-h-bGD	8.17	63.7	2.02	.33	.28	
81F118A	11	c-h-bTO	7.45	63.4	1.73	.68	.31	
81F119A	12	c-h-bTO	9.02	62.8	1.68	1.25	.15	
81F148A	13	c-h-bTO	7.60	63.3	1.96	.52	.29	
81F184C	14	c-b-hQD	5.93	56.2	1.40	.90	.31	
81F214A	15	c-h-bTO	7.74	63.0	2.04	.79	.28	
81F217A	16	h-bTO	8.38	66.2	1.80	.50	.27	
81L19A	17	h-bTO	7.59	65.4	1.84	.62	.31	
81L35A	18	p-h-bQDp	8.15	61.1	2.32	.32	.29	
81L36A	19	b-hQMp	-2.42	62.9	2.83	.60	.41	
81L38A	20	c-hGR	2.07	67.5	3.23	1.25	.36	
81N42A	21	b-h-cGDp	8.59	69.7	3.48	0.66	.35	
81N67A	22	p-b-hQDp	5.65	58.6	1.67	.94	.22	
81N69A	23	c-b-hTO	7.64	66.0	2.01	.60	.32	
81N84A	24	p-h-bGD	8.88	65.0	2.12	.40	.13	
81N101A	25	h-bTO	8.26	66.4	2.09	.54	.28	
81N124A	26	c-h-bTOp	7.74	62.5	1.92	.71	.29	
81S27A	27	h-bGR	1.97	70.8	3.06	.65	.52	
81S29A	28	h-bGR	5.92	70.4	2.88	.49	.43	
81S31A	29	h-c-bGD	8.43	63.1	2.28	1.20	.32	
81F150B	30	h-p-bTOp	10.28	63.4	.91	.42	.07	Dike
81F159B	31	c-hGD	4.78	64.4	2.00	1.07	.11	Trinity mine

TABLE 4.---Data for samples from the South Cascade Glacier stock

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR	Remarks
81F112A	1	c-bGD	9.18	69.3	2.11	0.90	0.16	
81F113A	2	h-c-bTO	8.64	66.9	1.46	.68	.11	
81F134A	3	c-h-bQD	8.83	64.0	1.08	1.04	.10	
81F135A	4	b-cALgr	9.15	73.6	3.24	1.05	.10	
81F136A	5	b-cGD	9.31	72.5	3.11	1.00	.11	

TABLE 5.---Data for samples from the Railroad Creek pluton (Headings as in table 4)

81F45A	1	h-bGDf	4.25	68.9	2.44	0.81	0.20
81F48A	2	bGDf	6.08	67.4	1.95	.41	.18
81F176A	6	c-h-bTO	2.82	62.4	1.35	.51	.13
81F246A	8	c-h-bTOf	1.06	65.4	2.35	.71	.19
81F248A	9	bTOf	9.04	67.2	2.03	.35	.22
81F295A	10	c-h-bGDf	8.40	69.2	2.33	.43	.14
81N34A	12	h-bTOf	3.07	63.2	1.74	.74	.15
81N149A	13	c-h-bQDf	3.19	62.5	1.29	.67	.15
81S16A	14	c-bTO	1.47	69.7	1.79	.51	.13
81S24A	15	bGD	1.72	69.3	2.19	.91	.12
81S25A	16	c-h-bTO	.94	67.1	1.75	.59	.35
82F50A	17	bGD	8.82	68.9	2.37	.69	.25
82F54A	18	c-bGD	7.75	69.0	2.29	.48	.18
82F83B	19	b-cQDf	1.96	68.5	2.34	.49	.26
82G43A	20	c-bGD	1.79	68.4	2.13	.95	.19

TABLE 6.---Data for samples from the Duncan Hill pluton (Headings as in table 4)

82F41A	1	bTOf	9.36	64.8	1.76	0.70	0.14	
82S4A	4	h-bQDf	-5.11	59.2	2.14	1.00	.24	Contact complex
82S6A	5	h-c-bQDf	6.98	61.0	1.72	0.73	.23	
82S8A	7	c-bTOf	6.80	70.6	1.54	.86	.15	

TABLE 7.---Data for samples from the Clark Mountain stocks

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR	Remarks
82F101A	1	m-e-bTO	11.39	67.1	1.66	0.61	0.21	
82F103A	2	h-e-bQD	12.91	64.0	1.05	.60	.30	
82G56A	3	b-e-mTO	11.76	68.3	1.71	.80	.30	

TABLE 8.---Data for samples from the High Pass pluton
(Headings as in table 7)

82F10A	1	e-bGDf	10.56	68.1	2.07	0.59	0.28
82F11A	2	m-bGD	12.78	71.3	2.03	.51	.17
82F23A	3	m-bGD	12.37	70.6	1.80	.40	.16
82G4A	4	e-m-bTOf	11.75	68.8	1.63	.57	.29
82G58A	5	m-bTO	12.56	70.6	1.82	.54	.21
82S40A	6	m-bGD	12.49	69.9	1.70	.50	.22

TABLE 9.---Data for samples from the Cyclone Lake pluton and inferred related bodies
(Headings as in table 7)

81F17A	1	bALto	11.19	71.1	1.98	0.45	0.15	
81F18A	2	b-mALto	10.76	70.7	1.72	.42	.12	
81F20A	4	b-mALgr	11.25	74.1	3.44	.38	.30	
81F28A	6	m-bTO	10.67	70.0	1.54	.46	.12	
81F106A	8	bALto	10.03	70.7	1.54	.40	.10	In thermal aureole of Buckindy pluton
81F170A	9	m-bGD	10.84	71.7	2.20	.43	.16	
81N64A	10	b-e-mALgd	10.71	72.7	3.29	.42	.23	
81N106B	11	m-bALgd	11.79	72.8	2.65	.50	.36	Dike
81F181A	12	m-bALgr	11.47	72.8	4.33	.70	.11	Separate small plug

TABLE 10.---Data for samples from the Downey Creek pluton
(Headings as in table 7)

80F93A	2	b-mALgr	11.47	74.8	3.85	0.35	0.23
80F106A	3	m-bTO	11.80	72.6	1.98	.27	.12
81F125A	5	b-mALgd	11.97	74.5	3.67	.16	.27
81N89A	7	mALto	12.02	74.4	4.07	.26	.05

TABLE 11.---Data for samples from the tonalite of Bench Lake

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR	Remarks
80F36A	1	e-bTOf	13.32	62.6	1.89	0.70	0.20	
80F65A	2	e-h-bQDf	11.03	60.7	1.28	.54	.16	
80F68A	3	e-bTOf	10.61	68.2	1.28	.37	.13	
80N33D	4	e-h-bQDf	10.93	62.3	1.49	.85	.17	
81F26A	5	e-h-bTOf	10.25	64.1	1.17	1.79	.19	
81F27A	6	h-bTOf	10.82	64.6	1.62	1.01	.24	
81F171A	7	e-c-bTOf	10.98	67.4	1.13	0.60	.17	
81F184A	8	c-bTOf	8.89	69.0	1.56	.40	.16	In thermal aureole of Cloudy Pass batholith
81F222A	9	bTOf	10.60	67.6	1.40	.45	.13	
81F224A	10	bTOf	10.77	68.8	1.42	.34	.15	
81N95A	18	bGDf	10.87	71.1	2.01	.36	.13	
82F320A	19	bTOf	11.11	70.8	1.12	.50	.19	

TABLE 12.---Data for samples from the Sulphur Mountain pluton (Headings as in table 11)

80H133A	1	c-e-bGD	11.82	67.8	2.16	0.94	0.21	
80H146A	2	e-h-bGDf	11.48	67.1	2.06	.74	.26	
80R117A	3	p-e-bGD	12.58	68.8	2.40	.52	.22	
80R124A	4	c-p-bGDf	11.03	67.0	2.63	.64	.17	
80R125A	5	h-c-bGDf	10.75	66.7	2.50	1.00	.14	
80R129A	6	b-hTOf	2.17	65.3	1.94	0.48	.20	In thermal aureole of Cloudy Pass batholith
80R131A	7	e-h-bTOf	11.33	64.6	2.29	.41	.18	
81F2A	8	h-bGDf	11.48	66.6	1.99	.86	.18	
81F4A	9	p-e-bTOf	12.27	67.7	2.28	.57	.18	
81F4B	10	h-bTOf	12.45	67.2	2.19	.31	.20	
81F74A	11	c-h-bGDf	11.41	67.4	2.10	1.04	.15	
81F143A	12	p-b-cGDf	11.99	68.0	2.03	0.70	.20	
81F144A	13	h-bGDf	11.20	66.8	2.30	.55	.16	
81F145A	14	bTOf	11.15	67.2	1.87	.55	.15	
81F163A	15	e-c-bTOf	7.28	66.6	2.10	1.42	.19	Correlation uncertain
81F164A	16	h-c-bGDf	11.27	69.5	2.44	0.54	.20	
81F165A	17	e-h-bTOf	11.11	65.7	1.90	.99	.20	
81F270A	18	p-h-bGDf	11.62	66.4	2.80	1.15	.25	
81N83A	19	h-p-bTOf	11.91	68.5	1.81	0.53	.14	
82F211A	20	p-bGDf	12.36	69.9	2.76	.30	.17	
82F212A	21	p-bTOf	12.46	65.2	2.29	.73	.18	

TABLE 13.---Data for samples from the Jordan Lakes pluton

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR
80L4A	1	b-h-eGD	9.20	69.0	2.16	0.75	0.15
80S26E	2	e-h-bTO	9.01	65.3	2.33	.60	.14
81F24A	3	b-h-cTO	10.23	67.5	2.54	.40	.15
81F30A	4	e-bTOf	10.23	66.8	2.20	.54	.18
81F36A	5	c-e-bGD	9.17	68.8	2.35	.71	.18
81F110A	6	h-e-bTOf	10.23	68.2	2.44	.50	.19
81F111A	7	e-bTOf	10.41	69.0	2.16	.43	.15
81N1A	8	e-h-bGD	10.42	69.6	2.33	.46	.14
81N3A	9	e-h-bTO	9.81	65.8	2.54	1.06	.19
81N15A	10	e-h-bTO	10.06	65.8	2.20	1.15	.15
82F152A	11	e-bTO	10.19	68.6	2.35	0.55	.17
82F153A	12	e-bGD	10.25	70.5	2.44	.50	.20

TABLE 14.---Data for samples from the Sloan Creek plutons

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR
80F104E	1	e-c-hTOf	9.57	60.0	1.33	1.36	0.11
80R122A	2	c-h-bTO	8.56	64.4	1.16	.68	.12
80R136A	3	c-b-hTOf	9.53	60.5	0.95	1.11	.18
80R138A	4	c-b-hTOf	9.34	62.0	.97	1.04	.16
80S5A	5	c-h-bTOf	9.58	61.4	1.10	1.20	.14
81F312A	6	c-h-bTO	9.12	60.9	1.14	2.23	.12
81S48A	7	c-b-hQD	9.06	57.4	0.81	1.44	.17
82F160A	8	b-hTOf	9.47	59.9	1.26	0.65	.14
82F162A	9	b-hTOf	10.06	60.5	1.26	.98	.14
82F272A	10	h-bTOf	9.75	61.6	1.32	.39	.13

TABLE 15.---Data for samples from the Tenpeak pluton

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR	Remarks
81F300A	1	b-e-hQDf	9.46	52.7	0.74	0.65	0.22	
81F302A	2	c-b-hQDf	8.33	52.8	.69	.75	.19	
81F332A	3	e-h-bTOf	9.86	62.2	1.24	.68	.22	
81F334A	4	e-b-hTOf	9.02	59.6	0.97	.59	.19	
81F340A	5	e-b-hTOf	9.20	60.6	.97	.50	.17	
82F13A	6	c-e-hQDf	8.82	55.7	.82	1.90	.29	
82F14A	7	e-b-hTO	9.04	60.1	1.11	1.01	.23	
82F15A	8	b-e-hTOf	9.43	59.6	0.83	1.20	.35	
82F109A	9	h-e-bTOf	9.49	59.2	1.11	0.65	.27	
82F110A	10	e-b-hTOf	9.88	59.8	1.08	.43	.20	
82F111A	11	e-h-bTOf	10.00	61.0	1.21	.50	.20	
82F115A	12	e-b-hTOf	9.38	60.8	0.89	.31	.29	
82F139A	13	e-h-bTOf	9.76	61.7	1.37	.59	.17	
82G61A	14	b-hQDf	8.23	56.0	1.28	.65	.13	
82G89A	15	h-e-bTOf	9.45	63.0	1.71	.44	.22	
81F338A	w-1	e-h-bQDf	9.75	60.3	1.64	.40	.29	No. White Mts area
81F339A	w-2	e-b-hQD	8.97	56.6	1.24	.56	.28	Ditto
82F1A	w-3	e-h-bTOf	9.50	62.6	1.43	.50	.17	Ditto
82F3A	w-4	e-h-bTO	9.74	66.7	1.87	.76	.30	Ditto
82F16A	w-5	e-h-bTOf	9.30	60.0	1.55	.51	.29	Ditto
82F210A	w-6	e-b-hQDf	10.52	59.8	1.51	.65	.20	Ditto
82G12A	w-7	e-h-bQDf	9.25	62.8	1.51	.67	.41	Ditto

TABLE 16.---Data for samples from the Seven-fingered Jack and Entiat plutons
(Headings as in table 15)

81F282A	1	c-e-bTO	6.48	65.5	1.66	1.15	0.32
81F283A	2	e-h-cQDf	1.60	56.3	1.07	4.74	.18
82F37A	4	e-b-hQDf	7.08	58.5	1.37	0.76	.25
82G30A	5	e-b-hTOf	7.38	61.2	0.95	.65	.21

TABLE 17.---Data for samples from the Holden Lake pluton
(Headings as in table 15)

81F262B	1	p-b-hQG	6.56	55.8	0.48	0.86	0.15
81F263A	2	b-hQG	6.88	53.1	.77	.61	.11
81F264A	3	b-c-hQG	5.19	49.7	.32	1.24	.10
82F56A	4	c-b-hGA	8.41	49.2	.36	0.44	.11
82F57A	5	h-pQG	5.82	46.5	.07	.30	.32

TABLE 18.---Data for samples from the Cardinal Peak pluton

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR	Remarks
82F47A	1	bTOf	7.90	64.2	1.26	0.60	0.38	
82F48A	2	c-h-bTOf	5.57	66.2	0.74	1.32	.24	
82G39A	3	c-e-bTOf	4.66	65.0	.72	0.94	.28	
82G48A	4	c-b-hQDf	7.20	60.7	.88	1.03	.36	
82S10A	5	c-bTOf	0.23	64.9	1.27	1.75	.39	
82S11A	6	c-e-bTOf	3.40	65.0	1.18	0.79	.42	

TABLE 19.---Data for samples from the Chaval pluton
(Headings as in table 18)

80F71A	1	e-b-cTOf	8.96	61.9	1.66	2.56	0.25	
80F74A	2	b-e-cTOf	10.75	61.6	1.94	4.56	.22	
80F75A	3	e-c-hTOf	9.86	60.5	1.03	2.61	.24	
80H130A	4	c-b-hQG	10.82	53.3	0.84	2.79	.10	
80L36A	5	c-hQG	9.86	51.0	.51	2.30	.08	
80N40A	7	c-b-hQGf	9.00	55.7	.83	2.86	.19	
80N41A	8	b-hGA	8.80	48.8	.29	2.34	.12	
80R113B	9	c-hGA	11.42	43.7	.60	3.10	.13	
80R146A	10	QG	11.72	55.7	.77	2.48	.12	
80R147A	11	b-c-hQG	9.62	56.9	1.07	1.76	.11	
80R149B	12	c-p-hQGf	9.20	52.7	0.38	1.08	.14	
80R151A	13	p-b-hQG	9.17	54.6	.74	0.65	.08	
80S14A	14	b-hQGf	9.76	60.4	1.00	.59	.12	Dike
80S36A	15	e-b-hTO	8.51	59.9	0.86	.50	.30	
81F101A	16	e-b-hTOf	9.92	61.5	1.36	1.50	.20	
81F102A	17	e-c-hGDf	9.56	62.3	1.70	1.63	.19	
81F104A	18	e-c-hQG	9.19	53.7	0.52	1.41	.07	
81F127A	19	b-hQGf	9.77	53.7	.60	0.75	.09	
81F128A	20	c-hQG	9.29	54.6	.50	1.46	.11	
81F129A	21	b-hGAf	9.14	53.0	.48	1.20	.16	
81F132A	22	e-b-hQGf	9.41	57.1	.78	0.81	.15	
81F167A	23	b-hQG	10.31	54.9	.59	.87	.16	
81F168A	24	e-c-hQG	8.71	52.9	.74	1.95	.14	
81L9A	25	c-b-hQDf	9.76	58.6	1.05	1.59	.13	
81L10A	26	c-b-hQGf	9.27	55.8	0.66	0.92	.12	
81N8A	27	c-hQG	9.45	59.5	.95	.48	.13	
82C16B	30	b-p-hQGf	8.84	53.7	.40	.58	.10	
82C18A	31	p-hGAf	8.48	52.0	.22	.39	.10	

TABLE 20.---Data for samples from the Riddle Peaks pluton

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR
80H37B	1	c-o-hGAM	3.30	39.1	0.39	1.93	0.49
80H63B	2	e-o-hGA	3.62	46.9	.28	.96	.51
0H70A	3	c-o-hGA	2.38	42.3	.22	1.97	.48
80H72A	4	o-hGA	1.38	46.5	.38	2.32	.42
80H89B	5	e-p-hHB	5.44	47.8	.15	1.17	.26
80H97A	6	o-hGAM	4.46	43.8	.27	1.12	.35
80H98A	7	c-o-hGA	4.99	42.0	.18	0.43	.51
80H127A	8	c-b-hGA	1.90	41.4	.16	1.26	.41
80R32A	10	c-o-hGA	2.93	43.7	.57	2.16	.44
80R35A	11	o-hHB	6.40	43.5	.23	1.45	.37
80R40A	12	o-c-hGA	3.67	52.4	.12	1.17	.44
80R83A	13	o-hGA	2.51	43.8	.21	0.78	.49
81F178A	14	o-hGA	-0.51	43.2	.25	1.09	.48
81F178B	15	c-o-hGA	-0.58	42.8	.28	1.30	.48
81F178C	16	c-o-hGAL	-2.78	46.8	.30	1.10	.55
81F178D	17	e-o-hGAM	1.00	42.3	.33	1.18	.38
81F179A	18	o-hGA	1.25	44.2	.18	1.30	.37
81N32A	19	c-o-hGA	3.50	48.5	.32	0.38	.52
81N144A	20	c-o-hGA	2.82	52.3	.25	.61	.33
81N147A	21	b-c-hQG	5.00	56.3	1.57	1.13	.28
82F60A	22	c-o-hGA	4.19	41.9	0.19	1.06	.50
82F64A	23	c-o-hQG	3.05	52.8	.28	3.02	.42
82F65A	24	e-c-hQG	2.85	57.3	.75	1.70	.23
82F78A	28	c-o-hGA	1.02	44.9	.14	0.53	.51
82F78C	30	o-hHB	5.63	42.2	.36	1.20	.36
82F78D	31	c-o-hGAL	1.15	44.9	.12	0.90	.53
82F79A	32	o-hGA	4.20	39.2	.16	.70	.52
82F79B	33	o-hHB	6.01	42.2	.36	.94	.32
82F89A	34	o-c-hQGf	1.52	59.2	1.33	1.39	.22
82F90A	35	o-c-hQG	2.87	53.9	0.90	2.11	.40
82F96A	37	c-b-hQGf	3.71	60.7	1.14	1.02	.29
82G46A	39	o-c-hGA	4.45	46.2	0.51	1.08	.21

TABLE 21.---Data for samples of the Marblemount Meta Quartz Diorite

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR	Remarks
80N62D	1	b-e-hMQf	9.16	60.4	0.75	0.90	0.53	
81F85A	2	o-c-eMQf	8.23	57.8	1.01	2.58	.40	
81F86A	3	c-h-eMQf	5.65	48.7	0.12	2.51	.29	
81F87A	4	o-c-eMQf	7.84	59.3	1.00	2.81	.43	
81F90A	5	c-e-hMQf	7.21	55.6	0.51	2.16	.28	
81F91A	6	b-e-cMQf	6.89	60.8	.33	1.55	.47	
81F139A	7	b-e-hMQf	8.23	56.5	.92	1.00	.34	
81F140A	8	c-e-hMQf	7.35	53.3	.52	1.39	.33	
81F231A	9	c-e-hMQf	5.83	51.0	.53	1.80	.27	
81L20A	10	h-e-cMQf	7.25	61.8	.44	1.51	.53	
81L29A	11	c-h-bMQf	9.10	58.3	1.27	1.09	.24	
81L55A	12	o-c-eMQf	7.19	61.7	0.52	2.30	.42	
81N126A	13	o-c-bMQf	-0.50	64.6	1.42	0.50	.27	In thermal aureole of Cloudy Pass batholith
81S9A	14	c-e-hMQf	6.40	54.6	0.54	1.51	.30	
81S40E	15	o-b-hMQf	3.53	55.7	.65	0.40	.26	Ditto
82F348A	16	o-e-cMQf	9.02	62.4	.59	1.73	.45	
6.23.49.14	t-1	e-cMQf	8.16	62.7	.81	1.76	.49	Type area
6.23.49.16	t-2	e-cMQf	7.31	62.1	.59	2.13	.46	Ditto
9.15.52.22	t-3	e-cMQf	6.37	63.3	1.01	1.70	.54	Ditto
10.7.54.25	t-4	c-e-hMQf	6.65	57.8	1.31	1.60	.37	Ditto
4.8.55.8	t-5	c-e-hMQf	7.13	61.6	0.94	1.14	.47	Ditto
10.18.59.14	t-6	c-eMQf	8.06	58.6	.85	3.64	.34	Ditto

TABLE 22.---Data for samples from the Dumbell Mountain plutons. Unit designations from geologic map of Cater and Crowder (1967)

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR	Remarks
81F279A	h-1	b-e-hGqd	4.50	58.2	0.85	1.62	0.38	Unit dhg
81F280A	h-2	o-e-cGqd	-1.91	52.5	1.68	2.45	.48	Ditto
81F281A	h-3	e-c-hGqd	2.30	57.9	1.20	1.85	.34	Ditto
82F36A	h-4	c-b-hGqd	0.82	57.5	0.64	0.67	.32	Ditto
82F58A	h-5	e-b-hGto	3.02	59.4	.96	.77	.36	Ditto
81F287A	a-1	o-hGto	5.52	67.8	.16	.35	.48	Unit dag
81N159A	a-2	e-b-hGto	2.86	68.0	1.03	.71	.37	Ditto
82F38A	a-3	hGto	5.76	75.8	0.12	.26	.48	Ditto
82F42A	a-4	c-e-bGto	4.60	68.8	1.04	.84	.34	Ditto
82F43A	a-5	e-bGto	6.81	71.9	2.13	.39	.41	Ditto
82F55A	a-6	o-c-hGto	5.27	59.8	0.46	.53	.38	Ditto
82G36A	a-7	c-bGto	9.06	76.0	2.10	.95	.19	Ditto
82S17A	q-1	hGto	7.99	76.5	0.43	.30	.56	Unit dqg
82S18A	q-2	b-e-hGqd	1.51	56.1	.75	.93	.28	Ditto

TABLE 23.---Data for samples from the Magic Mountain Gneiss and possible correlatives (plot nos. s-1 to s-7) south of Flat Creek (Headings as in table 22)

81F95A	1	o-e-cGto	9.28	74.6	0.19	0.70	0.52
81F96A	2	c-e-oGal	11.52	74.8	.84	1.20	.49
81F97A	3	c-eGto	8.62	71.6	.36	0.75	.70
81F100A	4	e-o-cGal	10.77	76.4	.09	.56	.52
81F201A	5	c-m-eGal	8.52	73.7	.67	1.44	.55
81L1A	6	e-m-cGqd	11.55	75.5	.43	0.94	.19
81N112A	7	e-o-cGal	7.86	72.6	.66	1.24	.57
82F234A	8	o-c-mGal	9.80	76.8	.87	0.90	.58
81F233B	s-1	e-o-cGal	4.76	77.1	.29	.41	.31
81F234A	s-2	e-b-cGto	3.29	74.5	.55	.76	.31
81F237A	s-3	h-o-cGal	7.70	77.6	.33	.68	.44
81F238A	s-4	h-o-cGal	7.55	75.7	.24	.45	.42
82F119A	s-5	e-o-cGal	5.13	74.4	.63	.89	.55
82F121A	s-6	e-c-hGto	5.72	69.6	.19	.71	.51
82F123A	s-7	e-c-hGto	5.86	67.0	.22	1.01	.49

TABLE 24.---Data for samples from the Leroy Creek pluton

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR
81F277A	1	o-b-cALto	5.92	72.5	0.57	0.95	0.40
81F278A	2	o-e-bALto	7.55	70.4	.62	.53	.41
82G26A	4	e-o-bTO	7.57	71.3	.56	.39	.48

TABLE 25.---Data for samples from the Eldorado Orthogneiss (Headings as in table 24)

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR
81F63A	1	e-c-hGqm	2.72	65.6	3.35	1.51	0.27
81F174A	2	e-c-hGqm	-1.45	67.1	4.02	1.08	.41
81F205A	4	e-h-bGto	7.17	65.6	1.75	0.73	.30
81F229A	5	e-c-bGto	7.72	67.4	3.11	1.24	.39
81F244A	6	o-c-hGqm	5.12	68.9	3.68	0.83	.37
81N117A	7	o-b-hGqm	5.33	66.7	3.58	.85	.39

TABLE 26.---Data for samples from the Skagit Gneiss (Headings as in table 24)

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR
81F57A	1	h-bGqd	4.53	61.2	1.27	0.53	0.12
81F289A	2	h-bTOf	10.55	64.2	0.76	.46	.21
81F290B	3	c-bTOf	6.35	67.0	1.23	.75	.21
81F291A	4	c-bTOf	8.56	68.2	1.09	.59	.15
81F292A	5	b-c-hGqd	6.64	61.7	1.29	.70	.13
81F293A	6	c-bTOf	7.94	64.8	2.09	.45	.18
81L49A	7	bTOf	8.39	67.0	2.37	.45	.12
81N104A	8	c-bGto	5.02	68.8	2.34	1.38	.14
81N138A	9	bGto	3.03	63.9	1.86	0.76	.24
81N139A	10	bGgr	10.17	73.1	4.32	.35	.08
81N140A	11	c-bGDf	9.65	71.5	3.46	.15	.10
81N163A	12	c-h-bGto	5.95	62.8	1.31	.59	.15
81S17A	13	c-bTOf	10.82	70.0	0.76	.33	.19
81S21A	14	bGDf	10.35	65.9	3.35	.54	.22
81S22A	15	b-hTOf	10.44	70.2	1.02	.51	.21

TABLE 27.---Data for samples from the Swakane Biotite Gneiss

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR	Remarks
81F71A	1	bGqd	8.21	72.9	2.54	0.79	0.07	Tr. garnet
81F81A	2	bGto	10.08	71.5	1.91	.71	.16	
81F83A	3	bGto	10.92	72.4	0.93	.38	.13	
81F271A	4	m-bGqd	10.26	73.2	2.38	.83	.13	
81F276A	5	c-m-bGto	8.41	71.8	1.46	.77	.15	
81L44A	6	m-bGto	10.25	74.5	1.96	.50	.12	
81L46A	7	bGto	9.51	70.2	2.00	.49	.14	Tr. garnet
81N98A	8	bGto	5.18	72.7	1.47	.66	.14	
81N102A	9	bGto	10.01	71.0	1.95	.96	.17	
82G23A	10	bGto	9.76	74.3	1.28	.88	.25	
82G24A	11	bGto	10.53	73.5	2.21	.85	.30	Tr. garnet
82S22A	12	m-bGqd	11.94	57.5	2.06	2.08	.11	Tr. kyanite
82SW1	t-1	m-o-cGto	6.41	67.6	2.32	2.12	.12	Type area
82SW2	t-2	bGto	10.49	71.9	1.93	1.74	.10	Ditto
82SW3	t-3	c-bGto	9.70	66.8	1.97	1.65	.14	Ditto
82SW4	t-4	bGto	10.14	70.2	1.78	0.97	.17	Ditto

TABLE 28.---Data for samples from miscellaneous small plutons (Headings as in table 27)

A. Sitkum stock							
81F307A	1	p-h-bTO	8.07	59.0	1.54	0.36	0.23
B. White Chuck Glacier stock							
81F326A	1	o-b-pQM	7.98	62.8	2.14	0.40	0.43
C. Cool stock							
81F345A	1	c-b-hQM	7.06	62.9	2.36	0.99	0.29
D. Dead Duck pluton							
81F319A	1	p-b-hTO	6.96	60.0	1.12	0.13	0.23
81F321A	2	p-b-hTO	7.57	59.4	1.28	.05	.15
82F158A	3	o-b-hQD	7.41	61.6	1.21	.16	.23
E. Foam Creek stock							
81F329A	1	bGDf	10.31	67.7	2.39	0.76	0.16

(Continued next page)

TABLE 28.---Data for samples from miscellaneous small plutons, continued

Field no.	Plot no.	Rock type	$\delta^{18}O$ (per mil)	SiO_2 (wt.%)	K_2O (wt.%)	LOI (wt.%)	OXR
F. Downey Mountain stock							
80F120A	1	h-bTO	9.54	65.3	1.31	0.87	0.26
81F258A	2	h-bTO	9.19	61.9	0.93	.56	.16
G. Grassy Point stock							
80F110A	1	c-e-bTO	11.03	70.1	1.78	0.64	0.18
80F111A	2	c-e-bTO	9.95	69.1	1.70	.74	.19
H. Hidden Lake stock							
82F155A	1	e-bTO	11.46	68.6	1.97	0.65	0.30
82F156A	2	e-bTO	11.71	68.4	2.07	.50	.26
I. Pear Lake pluton							
82F176A	1	bGDf	11.51	70.6	3.45	0.61	0.15
82F179A	2	bTOf	11.09	69.2	1.14	.54	.15
82F184A	3	p-bTO	10.76	67.3	1.33	.66	.48
82F186A	4	bTOf	13.12	69.8	1.23	.90	.27

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