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Petrography and Phenocryst Chemistry of Volcanic Units at Yucca Mountain, Nevada: A Comparison of Outcrop and Drill Hole Samples

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D. E. Broxton
F. M. Byers, Jr.
R. G. Warren

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

PETROGRAPHY AND PHENOCRYST CHEMISTRY OF VOLCANIC UNITS AT YUCCA MOUNTAIN, NEVADA: A COMPARISON OF OUTCROP AND DRILL HOLE SAMPLES

by

D. E. Broxton, F. M. Byers, Jr., and R. G. Warren

ABSTRACT

This report is a compilation of petrographic and mineral chemical data for stratigraphic units at Yucca Mountain. It supports a possible peer review of Yucca Mountain drill core by summarizing the available data in a form that allows comparison of stratigraphic units in drill holes with surface outcrops of the same units. Petrographic and mineral chemical data can be used in conjunction with other geologic and geophysical information to determine if stratigraphic relations in Yucca Mountain drill core are geologically reasonable and compare well with relations known from extensive surface studies. This compilation of petrographic and mineral chemical data is complete enough for most stratigraphic units to be used in a peer review of Yucca Mountain drill core. Additional data must be collected for a few units to complete the characterization.

Rock units at Yucca Mountain have unique petrographic and mineral chemical characteristics that can be used to make accurate stratigraphic assignments in drill core samples. Stratigraphic units can be differentiated on the basis of petrographic characteristics such as total phenocryst abundances, relative proportions of phenocryst minerals, and types and abundances of mafic and accessory minerals. The mineral chemistry of phenocrysts is also an important means of differentiating among stratigraphic units, especially when used in conjunction with the petrographic data. Sanidine phenocrysts and plagioclase rims have narrow compositional ranges for most units and often have well-defined dominant compositions. Biotite compositions are useful for identifying groups of related units (e.g., Paintbrush Tuff Members vs. Crater Flat Tuff Members) and for providing an important check on the consistency of the data.

I. INTRODUCTION

In the summer of 1986, the Waste Management Project Office (WMPO) of the Nevada Nuclear Waste Storage Investigations (NNWSI) Project (now the Yucca Mountain Project) formed a Steering Committee to assess documentation supporting the traceability of core samples collected from drill hole USW G-4 at the Yucca Mountain site. This action was taken because of concern that much of the existing core collected for the Yucca Mountain Project is not traceable as defined by Federal Regulation 10 CFR Part 50, Appendix B. Lack of sample traceability could seriously restrict the use of existing core and of scientific tests conducted on this core as primary licensing data for a nuclear waste repository.

The Steering Committee, made up of representatives from Lawrence Livermore National Laboratory, Los Alamos National Laboratory, Sandia National Laboratories, Science Applications International Corporation, the U.S. Geological Survey, and WMPO, submitted a final report and recommendations on October 26, 1986. The Steering Committee report concludes that design and implementation of the quality assurance (QA) program in effect at the time the USW G-4 drill core was collected are inadequate to meet requirements of 10 CFR Part 50, Appendix B, and that documentation related to the drill core is inadequate to provide sample traceability. Furthermore, the Steering Committee concluded that drill core collected before USW G-4 also lacks adequate documentation for sample traceability.

Although the documentation to support traceability was inadequate, the Steering Committee found no evidence that drill cores from Yucca Mountain were collected, transported, and stored in a manner that would compromise their integrity and warrant their exclusion from the licensing process. However, the lack of acceptable QA design, implementation, and documentation requires that these drill cores be qualified in some manner if they are to be used to support Quality Level I studies for the Yucca Mountain Project. The Nuclear Regulatory Commission provides a mechanism for qualifying data not collected in conformance with an established QA program through the "Generic Technical Position on Peer Review for High-Level Nuclear Waste Repositories." This position paper states that peer reviews may be employed as part of the QA actions necessary to provide confidence in the adequacy of the data not collected in conformance with an established QA program.

This report is a compilation of published and new modal petrographic data and phenocryst chemistry data for stratigraphic units at Yucca Mountain. This compilation will support peer review activities by summarizing the available petrographic and mineral chemistry data for stratigraphic units identified in drill holes with inadequate sample traceability. The drill hole data are compared with petrographic and mineral chemical data from well-constrained surface outcrops of the same units. Peer reviewers can use these data in conjunction with other geologic and geophysical information to determine if geologic relations determined by drill cores at Yucca Mountain are reasonable and compare well with relations known from extensive study of surface exposures by the U.S. Geological Survey in connection with the nuclear weapons testing program. Correlation of data from drill holes and outcrops could provide a basis for qualification of the drill core by the peer reviewers. The drill holes considered in this report include USW G-1, USW G-2, USW GU-3, USW G-3, USW G-4, UE-25a#1, UE-25b#1H, UE-25p#1, and J-13. The locations of these drill holes are shown in Fig. 1.

II. GEOLOGIC SETTING

Yucca Mountain is located south of the Timber Mountain-Oasis Valley caldera complex in the southwest Nevada volcanic field (Byers et al., 1976a and 1976b; Christiansen et al., 1977). Yucca Mountain is an east-tilted fault-block uplift underlain by at least 1.8 km of silicic volcanic rocks. Table I lists the major stratigraphic units at Yucca Mountain. These volcanic units were erupted from the Timber Mountain-Oasis Valley caldera complex (Byers et al., 1976b; Christiansen et al., 1977) between 9 and 16 m.y. ago (Kistler, 1968, and Marvin et al., 1970; corrected using new constants in Dalrymple, 1979). Most units consist of compositionally homogeneous rhyolitic ash-flow and ash-fall tuffs. However, the Topopah Spring and Tiva Canyon Members of the Paintbrush Tuff are large-volume compositionally zoned ash-flow sheets that grade up in section from high-silica rhyolite to quartz latite. Relatively small bodies of dacitic lavas and flow breccias were penetrated below the Crater Flat Tuff by drill holes USW G-1 (Spengler et al., 1981) and USW G-2 (Maldonado and Koether, 1983) in the northern part of Yucca Mountain. Stratigraphic relations within the volcanic field are summarized by Byers et al. (1976b) and by W. J. Carr et al. (1986). Most of the volcanic field was mapped at a scale of 1:24,000, and a map of the Timber Mountain-Oasis Valley caldera complex has been compiled at a scale of 1:48,000 (Byers et al., 1976a).

III. METHODS

Petrographic and mineral chemical data for the stratigraphic units at Yucca Mountain were compiled from published U.S. Geological Survey and Los Alamos National Laboratory reports. Petrographic data for 416 samples were compiled from Lipman et al. (1966), Quinlivan and Byers (1977), Sykes et al. (1979), Byers and Warren (1983), Warren et al. (1984), Scott and Castellanos (1984), Byers (1985), and Byers and Moore (1987). The reader is referred to these reports for a description of their methods. This report also contains 105 new modal analyses obtained by the authors. We used standard point counts employing both transmitted- and reflected-light microscope techniques to determine phenocryst volume percentages. Between 500 and 5000 counts per sample were made to determine the abundances of phenocrysts, lithic fragments, and voids in thin sections.

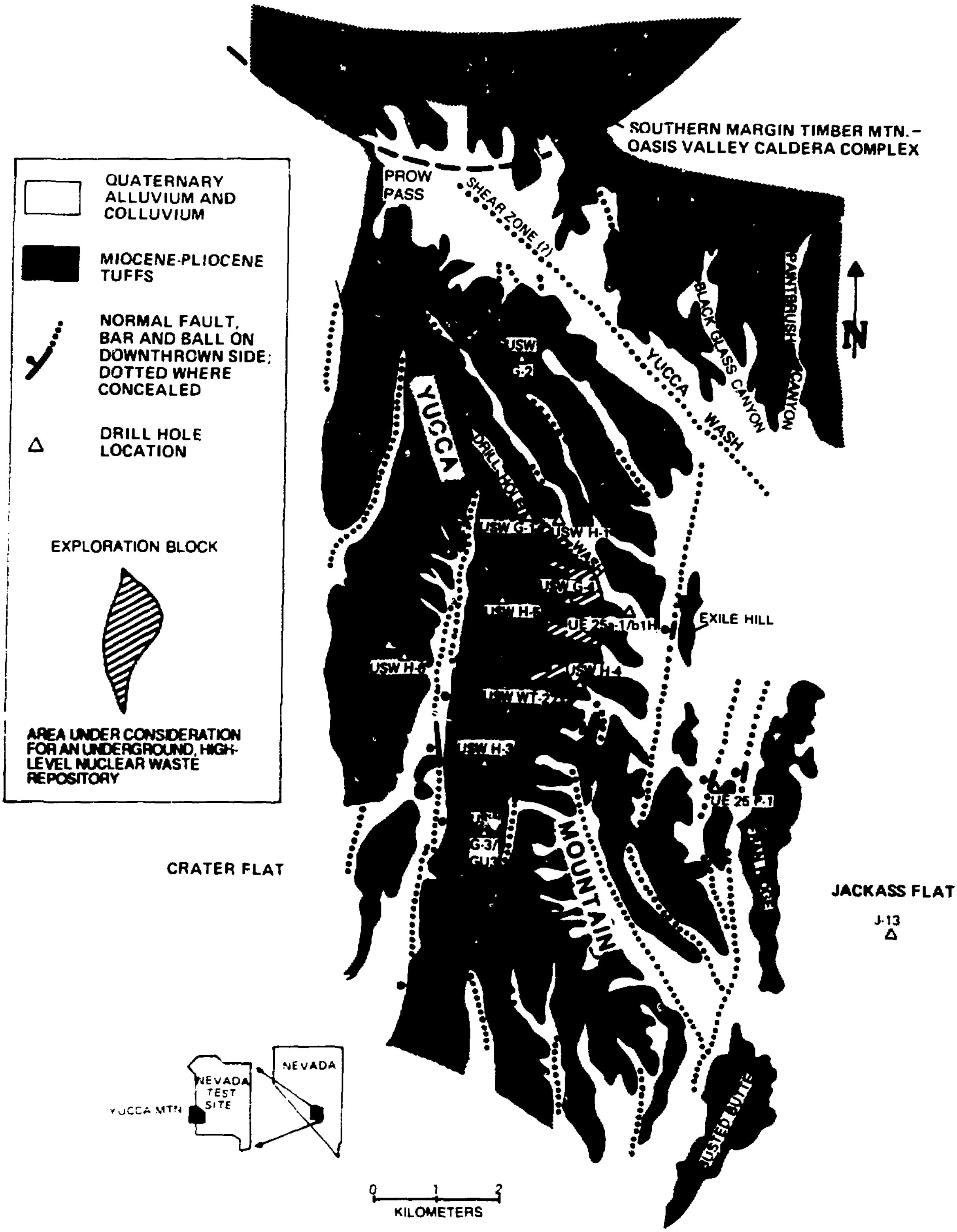


Fig. 1. Map of Yucca Mountain, Nevada, showing the locations of drill holes discussed in the text.

TABLE I

STRATIGRAPHY OF MAJOR VOLCANIC UNITS AT YUCCA MOUNTAIN, NEVADA[1]

Stratigraphic Unit[2]	Thickness (m)	Lithology
Paintbrush Tuff		
Tiva Canyon Member	27-114	Ash-flow tuff; compositionally zoned, compound cooling unit; nonwelded vitric base; moderately to densely welded, devitrified interior with some vapor-phase crystallization.
Yucca Mountain Member	0-29	Ash-flow tuff; nonwelded vitric top and base; partially welded devitrified interior with some vapor-phase crystallization; present under northern half of Yucca Mountain.
Pah Canyon Member	0-71	Ash-flow tuff; nonwelded to densely welded; present under northern half of Yucca Mountain.
Topopah Spring Member	287-356	Ash-flow tuff; compositionally zoned, compound cooling unit; nonwelded zones at top and base and moderately to densely welded, devitrified interior with zones of vapor-phase crystallization; vitrophyres at top and base of unit.
Tuffaceous Beds of Calico Hills	29-289	Ash-flow tuff; nonwelded to partially welded; also includes bedded tuffs; thoroughly zeolitized at north end of exploration block; become vitric southward. Unit consists of rhyolitic lava flows and interbedded tuffs in Paintbrush Canyon.
Crater Flat Tuff		
Prow Pass Member	107-176	Ash-flow tuff; nonwelded zones at top and base; moderately welded, devitrified interior with vapor-phase crystallization.
Bullfrog Member	67-187	Ash-flow tuff; compound cooling unit; nonwelded top and base, nonwelded to densely welded interior with thickness and occurrence of welding zones highly variable.
Tram Member	103-373	Ash-flow tuff; compound cooling unit; zones of partial to dense welding vary from drill hole to drill hole; lithic-rich base.
Dacite Flow Breccia	0-110	Flow breccia, lava, and tuffs; occurrence restricted to drill holes USW G-1 and USW G-2.
Lithic Ridge Tuff	185-304	Ash-flow tuff; nonwelded to moderately welded; devitrified; lithic-rich throughout at Yucca Mountain.
Unnamed older tuffs and lavas	365+	Ash-flow tuffs, lavas, reworked volcanic sediments; dacitic to rhyolitic compositions; includes units A, B, and C in drill holes USW G-1 and USW G-2.

[1]Spengler et al. (1979, 1981); Maldonado and Koether (1983); Scott and Castellanos (1984).

[2]Volumetrically minor bedded tuffs between major stratigraphic units not shown.

One of us (RGW) determined the abundances of accessory minerals in samples that he analyzed. The method for determining accessory mineral abundances is described in Warren et al. (1984). Briefly, thin sections are systematically searched in transmitted and reflected light for accessory minerals. Once located, the positions of these minerals are plotted on an 11- x 14-in. negative from a black and white photograph of the thin section. The photograph serves as a record of where each mineral is located and prevents duplicate measurement of individual minerals. A calibrated grid mounted in the microscope eyepiece is used to measure the surface area of each accessory mineral in reflected light. Identifications are aided by qualitative microprobe analysis where they are uncertain. The concentration of each accessory mineral is the areal sum of all measured grains divided by the thin section area.

Microprobe data presented in this report include our unpublished data and published data from Sykes et al. (1979), Broxton et al. (1982), and Warren et al. (1984). The data we present include the orthoclase and celsian (Or + Cn) component of sanidine, the anorthite (An) component of plagioclase, and Mg* [Mg/(Mg + Fe) x 100] in biotite. Other mineral chemical data such as Ba in feldspars and biotite and Ti in biotite can also be used to characterize stratigraphic units, but they are not discussed in this report. Chemical compositions of phenocrysts were determined by wave-length dispersive x-ray analysis with an automated Cameca electron microprobe operated at 15 keV and a 15- to 20-nA beam current. Procedures, standards, and analytical uncertainties for microprobe analysis are described in Warren et al. (1984). No attempt was made to tabulate the existing microprobe data in this report because of the large number of analyses that have been performed for these rocks. These data are summarized graphically to facilitate comparisons between drill hole and outcrop samples as well as comparisons among drill hole samples.

IV. RESULTS

Table II contains the petrographic data for the stratigraphic units at Yucca Mountain. These data are summarized for each unit as histograms of total phenocryst abundances and as triangular plots showing proportions of quartz, sanidine, and plagioclase phenocrysts. Additional figures contain histograms showing the range and dominant compositions of sanidine, plagioclase, and biotite for each unit. Data for outcrop and drill hole samples are presented separately in all figures to facilitate comparisons between these different sample types.

V. DISCUSSION

The following discussion describes the major stratigraphic units at Yucca Mountain in order of ascending stratigraphic position. Each description includes a brief overview of unit lithology, unit distribution in outcrop and in drill hole, and available data sources. Next, the characteristic petrographic and mineral chemical properties of the unit are discussed, and features that distinguish the unit from others are described. Finally, comparisons are made for drill hole vs. outcrop data and for data collected among the various drill holes. These comparisons are preliminary because evaluation of the data for the purpose of qualifying the core is the responsibility of a peer review panel.

A. Older Volcanic Units

The oldest volcanic units at Yucca Mountain are bedded and ash-flow tuffs and quartz latitic to rhyolitic lavas and flow breccias penetrated near the bottoms of drill holes UE-25p#1, USW G-1, USW G-2, and USW G-3. Stratigraphic correlations among these lowermost volcanic units are uncertain except for a sequence of nonwelded to moderately welded ash-flow tuffs and lavas informally designated in ascending order as Units C, B, and A (Spengler et al., 1981; Scott and Castellanos, 1984). Units C, B, and A are individual cooling units separated by bedded tuffs. They are thought to crop out in the Bullfrog Hills west of the Timber Mountain-Oasis Valley caldera complex (Maldonado, personal communication, 1985), but thus far no detailed petrographic work has been done on these possible surface equivalents. Unit C may be stratigraphically equivalent to the biotite-hornblende rhyolite west of Split Ridge on Pahute Mesa; both units are similar in petrography and mineral chemistry and occur at similar stratigraphic positions within the volcanic section. Unit C overlies the tuff of Yucca Flat in drill hole UE-25p#1 (M. D. Carr et al., 1986).

1. Older Tuffs Unit C. Petrographic and mineral chemical data for Unit C are presented for drill holes USW G-1 (Warren et al., 1984), USW G-2 (Broxton et al., 1982; and this report), and UE-25p#1 (this report) in Table II and in Figs. 2 and 3. Although data from equivalent outcrops cannot be included in this comparison because equivalent outcrops are uncertain or unknown, the data from the three drill holes can be examined for internal consistency within a drill hole as well as for consistency among drill holes.

Unit C is a plagioclase-rich tuff that contains 6% to 27% phenocrysts (Fig. 2a). Quartz and sanidine typically make up less than 15% of the felsic phenocrysts (Fig. 2b). Mafic phenocrysts consist of biotite, hornblende, and clinopyroxene in order of decreasing abundance (Table II). Accessory minerals include Fe-Ti oxides, apatite, allanite, sphene, zircon, and perrierite (Table II).

Despite pervasive diagenetic alteration, most feldspar phenocrysts in these rocks retain their original magmatic compositions (Warren et al., 1984). Sanidine compositions are relatively potassic in Unit C (Or_{70-74}; Fig. 2c) compared with most overlying units. Plagioclase compositions range from An_{26} to An_{46}. Biotites are magnesium rich with compositions averaging about Mg^*_{62} (Fig. 2c).

Unit C has similar phenocryst and accessory-mineral assemblages in the three drill holes that penetrated this unit (Table II). Total phenocryst contents are unusually variable for this unit (Fig. 2a), but this variability may reflect winnowing of glassy pyroclasts or physical sorting of phenocrysts during

TABLE II

MODAL PETROGRAPHIC DATA FOR VOLCANIC UNITS AT YUCCA MOUNTAIN, NEVADA

Sample Number	Location[1] Lat. (North)	Location[1] Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	AF	P
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]		
Tiva Canyon Member, Paintbrush Tuff - Upper Part													
62L-178-A			O	dwt	D	1310			0.2	16.8	<1	70	30
62L-178-B			O	dwt	D	3560			2.1	14.2	1	75	23
FBPP-6	793370	554260	O	vt	Gl/mG	300	0.0		9.7	20.0	2	54	45
FBPP-7	793370	554900	O	vt	Gl/mAx	275	0.0		1.8	13.1	0	88	12
AGE-4			O	dwt	D	1011			0.0	12.3	0	88	12
SC-3 C			O	dwt	D	1953			0.0	15.1	0	94	6
USW GU-3-38.3	752690	558501	C			1480			<0.1	15.0	1	69	30
USW GU-3-45.6	752690	558501	C			1680			<0.1	5.9	0	93	7
Ue-25p#1-210	756171	571485	Da						0.0	13.2	0	95	5
Tiva Canyon Member, Paintbrush Tuff - Lower Part													
RW31a-1	706870	540000	O	dwt	Ax/Gr/mVp	512	0.4		0.0	4.1	0	99	1
SC-3 A			O	dwt	D	6000			0.0	1.6	0	100	0
WH 1A			O	dwt	D	9620			0.0	2.1	0	100	<1
MC-274B			O	vt	Gl	1000			0.0	5.0	0	100	0
MC-274C			O	dwt	D	1000			0.0	4.4	2	98	0
To42R			O	dwt	D	7267			0.0	2.8	0	100	<1
MC-299			O	vt	Gl	0			0.0	2.1	0	100	<1
USW GU-3-78.4	752690	558501	C			1580			<0.1	2.5	0	100	<1
USW GU-3-245.7	752690	558501	C			1580			<0.1	3.3	0	96	4
USW GU-3-303.7	752690	558501	C			1680			1.0	3.1	0	100	0
USW GU-3-356.3	752690	558501	C			1580			<0.1	4.0	0	100	0
Ue-25a#1-83.7	764900	566350	C	dwt	mVp	600	0.0	28.0	0.0	3.0			
Ue-25a#1-157.5	764900	566350	C	dwt	Vp	723	0.0	8.7	0.0	3.6			
Ue-25a#1-187.0	764900	566350	C	mwt	mVp	1004	4.1	21.0	0.2	4.6			
J-13-427	749209	579651	C	dwt	Vp	300	0.0		0.0	3.0	0	100	0
Ue-25p#1-270	756171	571485	Da						0.0	2.1	0	100	0
Ue-25p#1-290	756171	571485	Da						0.0	1.5	0	100	0

1. Locations given are described in feet using the Nevada State Coordinate system. Locations are not listed for samples from published reports for which precise sample localities are lacking.

2. Sample types include whole rock samples from outcrop (O), pumice lapilli from outcrop (Op), drill core (C), and drill bit cuttings (Db). Phenocrysts may be artificially concentrated in some drill bit cuttings; Da indicates samples where this is suspected.

3. Rock types include welded tuff (wt), nonwelded tuff (nwt), partially welded tuff (pwt), moderately welded tuff (mwt), densely welded tuff (dwt), vitrophyre (vt), lava (l), flow breccia (fb), and bedded tuff (b).

4. D = high-temperature devitrification, Sp = spherulitic crystallization, Ax = axiolitic crystallization, Gr = granophyric crystallization, Vp = vapor phase alteration, Q = silicification, Ab = albitization, py = pyritization, Ar = argillic alteration, cc = calcification, Za = analcime zeolitization, Zc = clinoptilolite zeolitization, O = opal, and G = unaltered glassy pyroclasts that remain intact. The prefix "m" in front of alteration type indicates a minor amount of that type of alteration.

5. Felsic Phen. = quartz (Q), alkali feldspar (AF), and plagioclase (P) phenocrysts as volume percent of total rock; these values were determined by standard point counts for all samples. However, in samples indicated by an asterisk (*), the proportions of Q, AF, and P are based on relative areas of the 30+ largest felsic phenocrysts (Warren et al., 1984). In some units the size distribution varies substantially among the felsic phenocrysts, therefore we omit these data in figures showing relative proportions of felsic phenocrysts.

TABLE II (cont)

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Perr-ierite	Apatite	Zircon	Ref.[6]
Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]												
Tiva Canyon Member, Paintbrush Tuff - Upper Part												
62L-178-A	9000	2000	5000		5000		tr					2
62L-178-B	9000	1000	4000		3000		tr					2
FBPP-6	4800	120	2000	0	2400	370	20	0	37	840	190	3
FBPP-7	5700	670	5400	0	4400	220	45	0	95	620	280	3
AGE-4	5000	tr	2000		4000		tr					2
SC-3 C	2000	0	2000		3000		tr					2
USW GU-3-38.3	8050	0	tr	tr	1610		tr	0	tr	tr	tr	7
USW GU-3-45.6	1860	620	tr	tr	620		tr	0	tr	tr	tr	7
Ue-25p#1-210	5291	0	4290	0	1430		tr	0	tr		tr	3
Tiva Canyon Member, Paintbrush Tuff - Lower Part												
RW31a-1	330	520	0	0	510	17	450	0	0	21	34	3
SC-3 A	tr	0	0	0	1000		tr					2
WH 1A	tr	tr	0	0	1000		tr					2
MC-274B	0	1000	0	0	1000		0					2
MC-274C	0	3000	0	0	1000		0					2
To42R	1000	tr	0	0	tr		1000					2
MC-299	0	3000	0	0	1000		0					2
USW GU-3-78.4	tr	tr	0	0	tr		tr	0	0	0	tr	7
USW GU-3-245.7	tr	1360	0	0	tr		tr	0	0	0	tr	7
USW GU-3-303.7	0	1320	0	660	tr		tr	0	tr	tr	tr	7
USW GU-3-356.3	0	tr	0	0	tr		tr	0	tr	tr	tr	7
Ue-25a#1-83.7												4
Ue-25a#1-157.5												4
Ue-25a#1-187.0												4
J-13-427	46	880	0	0	290	0	230	0	2	4	19	3
Ue-25p#1-270	880	0	0	0	0		tr	0	tr		tr	3
Ue-25p#1-290	0	0	0	0	0		tr	0	tr		tr	3

6. 1 = Lipman et al., 1966; 2 = Quinlivan and Byers, 1977; 3 = new data, this report; 4 = Sykes et al., 1979; 5 = Byers and Warren, 1983; 6 = Warren et al., 1984; 7 = Scott and Castellanos, 1984; 8 = Byers, 1985; 9 = Byers and Moore, 1987.

7. Concentrations followed by "ps" indicate the mineral is altered and the concentration is based on pseudomorphs; tr = trace (accessory mineral identified in thin section but its concentration not determined). An entry of zero indicates a mineral is not present; a blank indicates no information on a mineral's presence or absence.

TABLE II (cont)

Sample Number	Location[1] Lat. (North)	Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	AF	P
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]		
Yucca Mountain Member, Paintbrush Tuff													
RWG2a11	778160	564100	O	mwt	Gl/mAr/mO	328	14.8	1.2	0.2	0.1	0	59	41
Pah Canyon Member, Paintbrush Tuff													
67FB-1A			O	pwt		1580			0.0	6.8	1	43	56
67FB-1B			O	pwt		3500			0.0	10.5	1	56	43
67FB-3D			O	dwt		1500			0.0	10.0	<1	45	55
67FB-3E			O	dwt		1550			0.0	10.1	0	47	53
Ue-25a#1-226.2	764900	566350	C	nwt	Gl/Zc	404			1.7	12.2	0	38	62
USW G-2-501	778824	560504	C	nwt	Gl	6926	11.3		0.4	4.7	2	38	60
USW G-2-547	778824	560504	C	nwt	Gl/mAr	6725	7.7		0.7	6.7	2	45	53
USW G-2-561	778824	560504	C	nwt	Ax/Sp	6690	7.3		0.5	4.2	4	37	59
USW G-2-584	778824	560504	C	pwt	Ax/Sp/Vp	7211	3.4		2.7	8.1	1	34	66
USW G-2-627	778824	560504	C	pwt	Sp/Vp	6414	0.6		0.6	6.8	5	31	64
USW G-2-675	778824	560504	C	pwt	D/Zc	6445	0.9		2.4	7.8	4	42	54
USW G-2-723	778824	560504	C	nwt	Gl/cc	6626			2.0	4.0	1	55	44
Topopah Spring Member, Paintbrush Tuff - Upper Part													
67L-17-B			O	vt	Gl?	2892				19.0	1	61	38
AGE-2B			O	dwt	D	2351				16.2	1	68	31
AGE-2A			O	vt	Gl?	2809				14.7	<1	65	35
DB28b-14			O	vt	Gl/mQ	303	0.0	2.0	0.3	10.6	0	71	29
RW31a-2			O	dwt	Gl	502	3.2	17.1	0.2	5.8	0	60	40
RW29a-9			O	vt	Gl	295	0.0		0.3	8.8	0	50	50
RW31a-5			Op	dwt	Gl/mGr	597	0.7	91.3	0.0	7.5	0	80	20
11-102-7G			O	dwt	D	2500				7.2	1	72	27
11-102-7F			O	dwt	D	3400				5.4	2	59	39
USW G-1-292	770500	561000	C	dwt	Sp/Gr	5664	3.4		0.3	10.8	0	67	32
USW G-1-385.7	770500	561000	C	dwt	Sp/Gr	6228	2.0			14.4	0	73	26
USW G-1-450	770500	561000	C	dwt	Sp/Gr	5688	1.1			8.4	0	80	19
USW G-2-770	778824	560504	C	dwt	Sp/Gr	5072	2.0		1.3	16.7	0	63	36
USW G-2-822	778824	560504	C	dwt	Sp/Gr	5936	1.0		0.1	11.6	0	70	29
USW G-2-855	778824	560504	C	dwt	Sp/Gr	5400	5.3		0.3	16.1	0	72	27
USW G-2-898	778824	560504	C	dwt	Sp/Gr	4545	4.9		0.1	15.0	0	71	28
USW GU-3-424.3	752690	558501	C			1680			3.0	5.6	1	59	40
USW GU-3-430.5	752690	558501	C	vt	Sp	5024	5.6		0.1	13.9	0	65	34
USW GU-3-430.7	752690	558501	C	vt	Sp/Gr	5993	5.3		0.2	13.7	0	50	49
USW GU-3-430.7	752690	558501	C			1580			<0.1	15.3	<1	52	48
USW GU-3-464.5	752690	558501	C			1580			<0.1	12.2	0	73	27
USW GU-3-464.5	752690	558501	C	dwt	Sp/Gr/Vp	5322	3.3			12.0	0	75	24
USW GU-3-465.5	752690	558501	C	dwt	Sp/Gr/Vp	5277	2.4		0.1	12.8	0	78	21
USW GU-3-525.4	752690	558501	C	dwt	Sp/Gr/Vp	5250	0.2			6.1	0	71	28
USW GU-3-525.7	752690	558501	C			1580			<0.1	4.6	0	75	25
USW G-4-241.6	765807	563082	C	vt	Ax/Gl	5229	1.8		0.9	10.3	<1	63	37
USW G-4-307.6	765807	563082	C	dwt	Sp/Ax/Gr/Vp	5663	3.7		0.1	14.3	0	53	47
USW G-4-383	765807	563082	C	dwt	Sp/Ax/Gr/Vp	5037	1.2		0.1	12.1	0	78	22
USW G-4-410	765807	563082	C	dwt	Sp/Ax/Gr/Vp	5165	10.5		0.1	6.5	1	70	29
USW G-4-416	765807	563082	C	dwt	Sp/Ax/Gr/Vp	5217	0.1			8.2	0	64	36

TABLE II (cont)

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Perr-ierite	Apatite	Zircon	Ref.[6]
Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]												
Yucca Mountain Member, Paintbrush Tuff												
RWG2a11	27	0	0	0	15	0	4	0	0	0.3	11	3
Pah Canyon Member, Paintbrush Tuff												
67FB-1A	3000	0	0	0	2000		tr					2
67FB-1B	7000	0	2000	0	2000		tr					2
67FB-3D	4000	0	1000	0	3000		tr					2
67FB-3E	5000	0	tr	0	3000		tr					2
Ue-25a#1-226.1	2000	520	0	0	1600	25	22	0	29	50	30	3
USW G-2-501	3200	0	430	0	1400		tr	0	tr	tr	tr	3
USW G-2-547	3900	0	600	0	1800		tr	0	tr	tr	tr	3
USW G-2-561	430[illegible]	0	600	0	1200		tr	0	tr	tr	tr	3
USW G-2-584	5100	0	800	0	3200		tr	0	tr	tr	tr	3
USW G-2-627	5000	0	tr	0	1700		tr	0	tr	tr	tr	3
USW G-2-675	3100	0	200	0	2500		tr	0	tr	tr	tr	3
USW G-2-723	2700	0	tr	0	900		tr	0	tr	tr	tr	3
Topopah Spring Member, Paintbrush Tuff - Upper Part												
67L-17-B	9000	tr	4000	0	4000	0	1000	0	0	0	-	1
AGE-2B	8000	tr	1000	0	3000		tr					1
AGE-2A	7000	tr	2000	0	5000		tr					1
DB28b-14	2500	8	1700	0	1300	500	0	0	230	140	1[illegible]	3
RW31a-2	1200	0	1400	0	1600	22	0	44	59	47	45	3
RW29a-9	7400	21	1200	0	3300	260	0	0	160	470	250	3
RW31a-5	940	0	730	0	830	320	0	0	110	32	42	3
11-102-7G	3000	0	2000	0	3000		0					1
11-102-7F	1000	0	0	0	2000		0					1
USW G-1-292	7021	0	476	0	3213		0	0	tr(?)			9
USW G-1-385.7	3952	152	1976	0	1672		0	0	0			9
USW G-1-450	2314	0	1246	0	534		0	0	0			9
USW G-2-770	12350	0	5130	0	4750		0	0	0			9
USW G-2-822	5375	0	1125	0	2250		0	0	tr(?)			9
USW G-2-855	8925	0	0	0	4375		0	0	tr(?)			9
USW G-2-898	5530	0	1264	0	948		0	0	tr			9
USW GU-3-424.3	2360	tr	tr	0	590		0	0	tr	tr	tr	7
USW GU-3-430.5	7296	152	2432	0	2584		0	0	tr(?)			9
USW GU-3-430.7	8892	0	5148	0	4680		0	0	0			9
USW GU-3-430.7	6800	0	3400	0	5100		0	0	tr	tr	tr	7
USW GU-3-464.5	5480	0	2740	0	6850		0	0	tr	tr	tr	7
USW GU-3-464.5	3225	0	3354	0	2322		0	0	0			9
USW GU-3-465.5	4320	0	1080	0	1080		0	0	tr(?)			9
USW GU-3-525.4	2479	0	1541	0	1139		0	0	0			9
USW GU-3-525.7	1470	0	tr	0	1960		0	0	tr	tr	tr	7
USW G-4-241.6	8591	0	3388	0	5929		0	0	tr			8
USW G-4-307.6	11932	0	1256	0	1413		0	0	tr			8
USW G-4-383	756	378	756	0	2394		0	0	tr			8
USW G-4-410	1156	0	612	0	1156		0	0	tr			8
USW G-4-416	765	595	935	0	1190		0	0	tr			8

TABLE II (cont)

Sample Number	Location[1] Lat. (North)	Location[1] Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	AF	P
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]		
Ue-25a#1-251.0	764900	566350	C	b	Zc/Gl	442	0.5		4.3	7.5	0	70	30
Ue-25a#1-277.0	764900	566350	C	dwt	Gl	430			1.9	14.0	0	66	34
Ue-25a#1-276.6	764900	566350	C	vt	D/mGl	6394	0.6		0.8	10.1	0	77	22
Ue-25a#1-334.7	764900	566350	C	dwt	Sp/Gr	6404	2.6			15.2	0	7[illegible]	23
J-13-608	749209	579651	C	b	Zx	300	2.0		6.7	8.6	10	48	42
J-13-801	749209	579651	C	dwt	Gr/Vp	300	0.7		0.9	11.6	0	62	38
Topopah Spring Member, Paintbrush Tuff - Lower Part													
11-102-7B-A			O	dwt	D	3400				0.7	0	43	57
11-102-7C			O	dwt	D	3500			0.0	1.2	<1	50	50
11-102-7E			O	dwt	D	3500			0.0	1.2	8	42	50
67L-128-B-1			O	dwt	D	5000			0.0	2.1	0	43	57
67L-17-D			O	dwt	D	2855			0.0	4.8	<1	67	33
67L-17-F			O	dwt	D	5671			0.0	1.9	5	65	30
67L-17-H			O	dwt	D	6000			0.0	1.3	8	54	38
67L-17-I			O	dwt	D	6000			0.0	0.9	<1	44	56
RW25p-1	754290	572750	O	b	Gl/mO	1881	40.9	19.7	<0.1	1.7	0	39	61
SC-1B			O	dwt	D	6500			0.0	1.1	<1	36	64
To41-C			O	dwt	D	6070			0.0	1.7	<1	18	82
USW G-1-504	770500	561000	C	dwt	Sp/Gr	12284	0.8			1.4	0	55	44
USW G-1-619	770500	561000	C	dwt	Sp/Gr	11972	0.8		0.1	0.4	0	55	44
USW G-1-722	770500	561000	C	dwt	Sp/Gr	11382	1.0		0.6	0.5	0	36	63
USW G-1-757	770500	561000	C	dwt	Sp/Gr	12980	0.8		0.2	0.2	7	61	31
USW G-1-772.3	770500	561000	C	dwt	Sp/Gr	12426	0.2		0.2	0.6	12	35	51
USW G-1-795.6	770500	561000	C	dwt	Sp/Gr	12292			0.6	0.5	3	70	26
USW G-1-809.9	770500	561000	C	dwt	Sp/Gr	12572			1.0	1.3	7	46	45
USW G-1-835.3	770500	561000	C	dwt	Sp/Gr	12206	0.3		0.9	1.0	4	39	56
USW G-1-874.7	770500	561000	C	dwt	Sp/Gr	12136	0.1		0.2	1.2	1	36	61
USW G-1-931.2	770500	561000	C	dwt	Sp/Gr	11884			0.4	0.9	9	37	52
USW G-1-995.5	770500	561000	C	dwt	Sp/Gr	12514			0.9	0.9	6	24	69
USW G-1-1049.1	770500	561000	C	dwt	Sp/Gr	12442			6.3	0.9	3	46	50
USW G-1-1113.2	770500	561000	C	dwt	Sp/Gr	12332			0.8	0.8	13	36	49
USW G-1-1150.3	770500	561000	C	dwt	Sp/Gr	12398			1.3	0.6	8	37	54
USW G-1-1191	770500	561000	C	dwt	Sp/Gr	11704			0.1	1.2	4	7	88
USW G-1-1191.9	770500	561000	C	dwt	Sp/Ax/mGr&Vp	500	0.0	31.6	1.2	1.8	1	11	88 *
USW G-1-1240	770500	561000	C	dwt	Sp/Gr	11298	0.4		0.3	1.1	6	13	79
USW G-1-1240.6	770500	561000	C	dwt	Ax/Gr/Sp	500	0.0	27.4	3.2	2.6	5	13	82 *
USW G-1-1286	770500	561000	C	vt	Sp/Gr/Zc	10790	1.5		9.3	0.9	18	25	56
USW G-1-1286.0	770500	561000	C	vt	Sp/Gr/Zc	500	0.4	12.9	10.4	1.7	16	46	38 *
USW G-1-1292	770500	561000	C	dwt	Sp/Gr	11830	2.1		3.0	1.2	11	25	63
USW G-1-1292.2	770500	561000	C	vt	Gl	539	0.0	21.9	4.5	0.9	10	17	73 *
USW G-1-1392.3	770500	561000	C	pwt	Gl/mAr	500	8.6	19.8	1.2	0.6	3	7	90 *
USW G-2-951	778824	560504	C	dwt	Sp/Gr	11400	0.5		1.4	1.0	2	55	42
USW G-2-1032	778824	560504	C	dwt	Sp/Gr	11790	0.1			1.1	3	26	70
USW G-2-1072	778824	560504	C	dwt	Sp/Gr	12278	7.5		0.3	0.9	1	13	85
USW G-2-1178	778824	560504	C	dwt	Sp/Gr	9342	1.9		0.4	0.4	0	42	57
USW G-2-1178b	778824	560504	C	dwt	Sp/Gr	9776	1.8		0.4	0.4	0	37	62
USW G-2-1234	778824	560504	C	dwt	Sp/Gr	9678	0.8			0.7	7	22	69

TABLE II (cont)

Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Perr-ierite	Apatite	Zircon	Ref.[6]
Ue-25a#1-251.0	9200	0	1000	0	2300	0	0	0	120	250	150	6
Ue-25a#1-277.0	6900	0	3000	100	1900	110	0	0	68	110	110	6
Ue-25a#1-276 5	12120	0	4680	0	2160		0	0	tr(?)			9
Ue-25a#1-334.7	5994	0	486	0	2592		0	0	tr(?)			9
J-13-608	1400	0	0	0	1700	0	0	0	0	1	21	3
J-13-801	1800	0	0	0	1100	0	0	0	110	27	16	3

Topopah Spring Member, Paintbrush Tuff - Lower Part

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Perr-ierite	Apatite	Zircon	Ref.[6]
11-102-7B-A	tr	0	0	0	1000		0					1
11-102-7C	tr	0	0	0	1000		0					1
11-102-7E	1000	0	0	0	1000		0					1
67L-120-B-1	tr	0	0	0	tr		0					1
67L-17-D	2000	0	0	0	3000		0					1
67L-17-F	tr	0	0	0	1000		0					1
67L-17-H	tr	0	0	0	tr		0					1
67L-17-I	tr	0	0	0	1000		0					1
RW25p-1	210	65	2500	0	1200	0	0	0	1	100	55	3
SC-1B	tr	0	0	0	tr		0					1
To41-C	tr	0	0	0	1000		0					1
USW G-1-504	340	0	0	0	2210							9
USW G-1-619	100	0	0	0	650		0	0	0			9
USW G-1-722	720	0	0	0	240		0	0	0			9
USW G-1-757	150	0	0	0	420		0	tr	0			9
USW G-1-772.3	420	0	0	0	70		0	0	0			9
USW G-1-795.6	350	0	210	0	560		0	0	0			9
USW G-1-809.9	280	0	0	0	280		0	0	0			9
USW G-1-835.3	330	0	0	0	660		0	0	0			9
USW G-1-874.7	390	0	0	0	195		0	0	0			9
USW G-1-931.2	660	0	0	0	385		0	0	0			9
USW G-1-995.5	0	0	0	0	600		0	0	0			9
USW G-1-1049.1	800	0	0	0	200		0	tr	0			9
USW G-1-1113.2	180	0	0	0	360		0	0	0			9
USW G-1-1150.3	800	0	0	0	240		0	0	0			9
USW G-1-1191	260	0	0	0	260		0	tr	0			9
USW G-1-1191.9	290	0	0	0	590	0	0	280	0	8	21	6
USW G-1-1240	180	0	0	0	420		0	tr(?)	0			9
USW G-1-1240.6	280	0	0	0	460	0	0	0	0	8	17	6
USW G-1-1286	200	0	0	0	0		0	0	0			9
USW G-1-1286.0	180	7	0	0	310	0	0	0	0	9	6	6
USW G-1-1292	130	0	0	0	130		0	0	0			9
USW G-1-1293.2	200	0	0	0	170	0	0	2	0	2	1	6
USW G-1-1392.3	280	0	0	0	160	0	0	0	0	6	13	6
USW G-2-951	440	0	0	0	220		0	0	0			9
USW G-2-1032	480	0	0	0	360		0	0	0			9
USW G-2-1072	200	0	0	0	700		0	0	0			9
USW G-2-1178	200	0	0	0	200		0	0	0			9
USW G-2-1178b	100	0	0	0	0		0	0	0			9
USW G-2-1234	400	0	0	0	560		0	0	0			9

TABLE II (cont)

Sample Number	Location[1] Lat. (North)	Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	AF	P
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]		
USW G-2-1267.6	778824	560504	C	dwt	Sp/Gr	11806	2.4		0.7	0.6	9	45	44
USW G-2-1331	778824	560504	C	dwt	Sp/Gr	9152	2.2		6.8	1.2	6	15	78
USW G-2-1420	778824	560504	C	dwt	Sp/Gr	10552	2.3		2.8	1.0	13	22	64
USW G-2-1461	778824	560504	C	dwt	Sp/Gr	10924	1.9		1.1	1.0	7	42	50
USW G-2-1556	778824	560504	C	dwt	Sp/Gr	11092	2.0		1.3	0.7	7	25	67
USW G-2-1585	778824	560504	C	dwt	Sp/Gr	10680	0.2		1.4	0.9	16	29	53
USW G-2-1634	778824	560504	C	vt	D/Gr/Zc	8070	0.1		0.7	0.3	7	7	85
USW G-2-1664	778824	560504	C	vt	Gl	10720			2.6	1.0	14	22	62
USW GU-3-525.7	752690	558501	C	dwt	Sp/Gr/Vp	5424	0.7			3.6	0	61	38
USW GU-3-633.3	752690	558501	C	dwt	Sp/Gr	12072			0.1	0.9	0	28	71
USW GU-3-633.3	752690	558501	C			1680			<0.1	1.2	0	32	68
USW GU-3-633.4	752690	558501	C	dwt	Sp/Gr	8846			0.0	0.7	0	61	38
USW GU-3-698.5	752690	558501	C	dwt	Sp/Gr	11344			0.6	1.3	0	16	83
USW GU-3-735.5	752690	558501	C	dwt	Sp/Gr	12824			0.3	0.8	2	59	38
USW GU-3-759.1	752690	558501	C	dwt	Sp/Gr	11806			0.6	0.5	3	55	40
USW GU-3-769.1	752690	558501	C			15[illegible]			<0.1	0.2	<1	25	75
USW GU-3-769.2	752690	558501	C	dwt	Sp/Gr	9734			0.4	0.7	0	28	71
USW GU-3-805.0	752690	558501	C	dwt	Sp/Gr	12260			0.0	0.5	0	17	82
USW GU-3-829.9	752690	558501	C	dwt	Sp/Gr	12176	1.5		1.3	1.0	3	24	72
USW GU-3-8[illegible].6	752690	558501	C	dwt	Sp/Gr	12390	0.2		4.0	1.0	8	16	75
USW GU-3-911.3	752690	558501	C	dwt	Sp/Gr	12658			4.2	0.9	10	46	43
USW GU-3-954.9	752690	558501	C	dwt	Sp/Gr	11560			1.0	0.9	11	8	30
USW GU-3-954.9	752690	558501	C			1480			<0.1	1.3	0	5	95
USW GU-3-958.8	752690	558501	C	dwt	Sp/Gr	10976			0.5	0.8	18	44	36
USW GU-3-1019.7	752690	558501	C	dwt	Sp/Gr	11836			2.7	0.9	9	35	54
USW GU-3-1079.4	752690	558501	C	dwt	Sp/Gr	11246	1.2		1.5	0.8	6	43	50
USW GU-3-1130.3	752690	558501	C	dwt	Sp/Gr	6041	0.5		4.8	0.9	13	23	63
USW GU-3-1130.4	752690	558501	C	dwt	Sp/Gr	5243	0.4		1.3	1.2	11	28	59
USW GU-3-1130.4	752690	558501	C			1580			4.0	1.1	11	28	61
USW GU-3-1151.7	752690	558501	C	dwt	Sp/Gr	11820	0.5		4.8	0.6	3	23	73
USW GU-3-1174.9	752690	558501	C	dwt	Sp/Gr	5076	0.5		7.9	1.4	0	60	40
USW GU-3-1195.8	752690	558501	C	vt	Sp/Ax/Zc	5065	0.5		5.9	1.6	24	22	52
USW GU-3-1226.8	752690	558501	C	vt	Gl	11354	0.5		3.5	0.9	9	60	29
USW GU-3-1226.9	752690	558501	C			1630			2.0	1.3	9	43	48
USW GU-3-1302.6	752690	558501	C			1480			8.0	1.3	10	39	51
USW G-4-447	765807	563082	C	dwt	Sp/Ax/Gr/Vp	6288			0.1	2.5	<1	53	47
USW G-4-500.9	765807	563082	C	dwt	Sp/Ax/Gr/Vp	12440	0.5		0.4	0.6	8	15	77
USW G-4-514	765807	563082	C	dwt	Sp/Ax/Gr/Vp	11344	3.5		0.0	1.3	1	53	47
USW G-4-556	765807	563082	C	dwt	Sp/Ax/Gr/Vp	11908	8.8		0.0	0.6	0	20	80
USW G-4-625	765807	563082	C	dwt	Sp/Ax/Gr/Vp	11112			1.5	1.3	1	51	48
USW G-4-625.7	765807	563082	C	dwt	Sp/Ax/Gr/Vp	11112			0.1	0.9	0	22	78
USW G-4-677	765807	563082	C	dwt	Sp/Ax/Gr/Vp	11248			0.1	0.5	0	23	77
USW G-4-694	765807	563082	C	mwt	Sp/Ax/Gr	11322			0.2	1.0	1	23	76
USW G-4-746	765807	563082	C	mwt	Sp/Ax/Gr	11258			0.1	0.4	<1	34	66
USW G-4-817	765807	563082	C	dwt	Sp/Ax/Gr/Vp	11538	0.4			1.5	3	21	76
USW G-4-934	765807	563082	C	dwt	Sp/Ax/Gr/Vp	11872			0.6	0.8	5	25	70
USW G-4-1026	765807	563082	C	dwt	Sp/Ax/Gr/Vp	10804	0.2		1.3	0.8	10	26	64
USW G-4-1089	765807	563082	C	dwt	Sp/Ax/Gr/Vp	11794			0.6	0.3	7	23	70
USW G-4-1117	765807	563082	C	dwt	Sp/Ax/Gr/Vp	10818	0.1		1.9	1.1	1	34	65
USW G-4-1190	765807	563082	C	dwt	Sp/Ax/Gr	9794	0.2		1.2	1.4	11	30	59

TABLE II (cont)

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Perr-ierite	Apatite	Zircon	Ref.[6]
Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]												
USW G-2-1267.6	105	0	0	0	315		0	0	0			9
USW G-2-1331	520	0	0	0	130		0	0	0			9
USW G-2-1420	660	0	0	0	330		0	0	0			9
USW G-2-1461	440	0	0	0	0		0	0	0			9
USW G-2-1556	800	0	0	0	160		0	0	0			9
USW G-2-1585	400	0	0	0	100		0	0	0			9
USW G-2-1634	440	0	0	0	320		0	0	0			9
USW G-2-1664	275	0	0	0	275		0	0	0			9
USW GU-3-525.7	897	0	0	0	1482		0	0	0			9
USW GU-3-633.3	200	0	0	0	400		0	0	0			9
USW GU-3-633.3	600	0	0	0	tr		tr	tr	0	tr	tr	7
USW GU-3-633.4	560	0	208	0	80		0	tr	0			9
USW GU-3-698.5	750	0	0	0	300		0	tr	0			9
USW GU-3-735.5	270	0	0	0	90		0	tr	0			9
USW GU-3-769.1	300	0	0	0	420		0	0	0			9
USW GU-3-769.1	tr	0	0	0	600		0	tr	0	tr	tr	7
USW GU-3-769.2	0	0	0	0	640		0	0	0			9
USW GU-3-805.0	665	0	0	0	420		0	tr	0			9
USW GU-3-829.9	165	0	0	0	33		0	tr	0			9
USW GU-3-877.6	220	0	0	0	110		0	0	0			9
USW GU-3-911.3	350	0	0	0	100		0	0	0			9
USW GU-3-954.9	0	0	0	0	200		0	tr	0			9
USW GU-3-954.9	700	0	0	0	tr		0	tr	0	tr	tr	7
USW GU-3-958.8	90	0	0	0	360		0	tr	0			9
USW GU-3-1019.7	400	0	0	0	100		0	0	0			9
USW GU-3-1079.4	270	0	0	0	630		0	tr	0			9
USW GU-3-1130.3	300	0	0	0	500		0	tr	0			9
USW GU-3-1130.4	420	0	0	0	980		0	tr	0			9
USW GU-3-1130.4	tr	0	0	0	tr		0	tr	0	tr	tr	7
USW GU-3-1151.7	320	0	0	0	1120		0	tr	0			9
USW GU-3-1174.9	150	0	0	0	600		0	0	0			9
USW GU-3-1195.8	170	0	0	0	340		0	tr	0			9
USW GU-3-1226.8	300	0	0	0	400		0	tr	0			9
USW GU-3-1226.9	600	0	0	0	1200		0	tr	0	tr	tr	7
USW GU-3-1302.6	1920	0	0	0	640		0	0	0	tr	tr	7
USW G-4-447	884	0	tr	0	260		0	0	tr			8
USW G-4-500.9	770	0	0	0	140		0	0	tr			8
USW G-4-514	420	0	140	0	420		0	0	0			8
USW G-4-556	120	0	0	0	0		0	0	0			8
USW G-4-625	210	0	210ps	0	560		0	0	0			8
USW G-4-625.7	600	0	0	0	500		0	0	0			8
USW G-4-677	300	0	0	0	720		0	tr	0			8
USW G-4-694	770	0	0	0	110		0	0	0			8
USW G-4-746	100	0	0	0	300		0	0	0			8
USW G-4-817	160	0	0	0	800		0	0	0			8
USW G-4-934	270	0	0	0	180		0	tr	0			8
USW G-4-1026	540	0	0	0	180		0	tr	0			8
USW G-4-1089	240	0	0	0	280		0	tr	0			8
USW G-4-1117	600	0	0	0	720		0	tr	0			8
USW G-4-1190	0	0	0	0	210		0	tr	0			8

TABLE II (cont)

Sample Number	Location[1] Lat. (North)	Location[1] Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	AF	P
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]		
USW G-4-1244	765807	563082	C	dwt	Sp/Ax/Gr	10250			2.6	1.2	27	17	56
USW G-4-1282	765807	563082	C	dwt	Sp/Ax/Gr	10234	0.1		1.4	1.6	1	35	64
USW G-4-1299	765807	563082	C	vt	Gl/Zc	9920	0.3		3.2	0.9	5	20	75
USW G-4-1311	765807	563082	C	vt	Gl/Zc	9842			3.1	1.1	13	21	66
USW G-4-1331	765807	563082	C	vt	Gl	10133			1.9	0.9	17	37	46
USW G-4-1390.2	765807	563082	C	nwt	Gl/Zc	4974			1.7	0.4	0	33	66
USW G-4-1400.4	765807	563082	C	nwt	Gl/Zc	5374			10.6	0.6	5	27	67
Ue-25a#1-450.1	764900	566350	C	dwt	Sp/Gr	6359	0.2			2.2	1	56	42
Ue-25a#1-469.2	764900	566350	C	dwt	Sp/Gr	6222	1.1		0.5	2.4	0	59	40
Ue-25a#1-510.4	764900	566350	C	dwt	Sp/Gr	5280	2.2		0.3	0.5	0	17	82
Ue-25a#1-609.6	764900	566350	C	dwt	Sp/Gr	5511			0.0	0.7	0	12	87
Ue-25a#1-651.6	764900	566350	C	dwt	Sp/Gr	10564	0.1		0.5	[illegible]	0	24	75
Ue-25a#1-672.5	764900	566350	C	dwt	Sp/Gr	12012	0.4		0.2	0.4	0	22	77
Ue-25a#1-677.2	764900	566350	C	dwt	Sp/Gr	12272	0.1		0.1	0.6	2	41	56
Ue-25a#1-701.0	764900	566350	C	dwt	Sp/Gr	12480	0.2		0.2	0.5	1	36	62
Ue-25a#1-732.6	764900	566350	C	dwt	Sp/Gr	12930	0.3		0.3	0.6	3	32	64
Ue-25a#1-744.1	764900	566350	C	dwt	Sp/Gr	12430	0.5		0.5	0.9	5	25	68
Ue-25a#1-836.0	764900	566350	C	dwt	Sp/Gr	13546	0.4		3.9	0.5	3	22	73
Ue-25a#1-848.1	764900	566350	C	dwt	Sp/Gr	11682	0.4		1.5	1.0	0	23	76
Ue-25a#1-878.9	764900	566350	C	dwt	Sp/Gr	11910			10.0	0.5	1	39	59
Ue-25a#1-894.0	764900	566350	C	dwt	Sp/Gr	11830			0.2	0.5	3	32	63
Ue-25a#1-937.3	764900	566350	C	dwt	Sp/Gr	12392			0.7	1.3	3	19	77
Ue-25a#1-1011.1	764900	566350	C	dwt	Sp/Gr	11914	0.2		0.2	1.0	4	34	61
Ue-25a#1-1060.7	764900	566350	C	dwt	Sp/Gr	12080	0.9		0.4	0.6	2	13	84
Ue-25a#1-1112.5	764900	566350	C	dwt	Sp/Gr	12242	0.1		0.7	0.6	7	37	55
Ue-25a#1-1152.6	764900	566350	C	dwt	Sp/Gr	11140			5.8	1.3	17	17	65
Ue-25a#1-1195.2	764900	566350	C	dwt	Sp/Gr	12408			1.6	0.9	11	29	58
Ue-25a#1-1264.4	764900	566350	C	vt	Sp/Gr/Zc	11584	1.7		16.7	0.8	27	27	44
Ue-25a#1-1279.2	764900	566350	C	vt	Gl	11650	0.2		1.1	1.2	15	27	57
Ue-25p#1-420	756171	571485	Da	dwt	Vp				0.0	2.6	0	52	48
Ue-25p#1-580	756171	571485	Da	dwt	D				0.1	0.3	0	56	44
Ue-25p#1-910	756171	571485	Da	dwt	D				0.4	0.3	8	41	50
Ue-25p#1-1050	756171	571485	Da	dwt	D				11.3	1.3	5	49	46
Ue-25p#1-1150	756171	571485	Da	vt	Gl				2.1	1.7	20	32	49
Tuffaceous Beds of Calico Hills - Upper Part													
3-15-82-5	786500	551000	O	nwt	Zc	4645	11.3		3.1	2.9	35	32	33
3-15-82-6	786400	551100	O	nwt	Zc	4274	9.4		6.2	2.2	34	30	36
3-15-82-7	786350	551200	O	nwt	Zc	4576	3.9		1.0	1.8	43	26	31
3-15-82-8	786350	551200	O	nwt	Zc	4607	6.5		1.0	2.1	49	30	21
3-15-82-9	786700	551400	O	nwt	Zc	4722	6.9		0.8	1.6	22	26	51
4-16-85-3A	787800	573900	O	l	Gl/Zc	5319	0.7		0.0	4.8	50	33	16
4-16-85-4	787750	574025	O	nwt	Zc	4994	3.9		4.7	2.1	50	22	28
4-16-85-5	786700	574400	O	l	Gl/mSp/mZc	5210	0.1		0.2	1.6	[illegible]	23	33
4-16-85-6	786800	575000	O	l	Gl/mSp/mZc	5297	0.1		0.0	1.8	38	50	12
4-16-85-8	786700	575400	O	b	Zc	5164	5.0		2.6	2.7	25	43	32
4-16-85-9	786675	575750	O	l	Gl	5193	0.0		0.0	1.9	14	29	57
4-16-85-12	787850	576650	O	l	Gl	5779	0.1		0.0	1.4	30	51	20
USW G-1-1436.8	770500	561000	C	nwt	Zc	500	10.6	28.6	3.2	4.8	56	22	22 *
USW G-1-1561.8	770500	561000	C	nwt	Zc	500	5.0	46.6	2.8	2.4	52	22	26 *
USW G-1-1561.8	770500	561000	C	nwt	Zc	3750			2.8	2.2	43	16	41

TABLE II (cont)

Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allanite	Perrierite	Apatite	Zircon	Ref.[6]
USW G-4-1244	980	0	0	0	420		0	tr	0			8
USW G-4-1282	170	0	0	0	850		0	tr	0			8
USW G-4-1299	300	0	0	0	300		0	tr	0			8
USW G-4-1311	330	0	0	0	110		0	tr	0			8
USW G-4-1331	500	190	0	0	100		0	tr	0			8
USW G-4-139[illegible]	200	0	0	0	600		0	tr	0		tr	3
USW G-4-1400.4	210	0	0	0	350		0	tr	0		tr	3
Ue-25a#1-450.1	1080	0	0	0	240		0	0	tr(?)			9
Ue-25a#1-469.2	1400	0	0	0	2240		0	0	tr(?)			9
Ue-25a#1-510.4	350	0	0	0	700		0	0	0			9
Ue-25a#1-609.6	320	0	0	0	400		0	0	0			9
Ue-25a#1-651.6	770	0	0	0	330		0	0	0			9
Ue-25a#1-672.5	240	180	0	0	600		0	0	0			9
Ue-25a#1-677.2	140	0	0	0	210		0	0	0			9
Ue-25a#1-701.0	150	0	0	0	690		0	0	0			9
Ue-25a#1-732.6	70	0	0	0	175		0	0	0			9
Ue-25a#1-744.1	500	0	0	0	200		0	0	0			9
Ue-25a#1-836.0	150	0	0	0	480		0	0	0			9
Ue-25a#1-848.1	660	0	0	0	220		0	0	0			9
Ue-25a#1-878.9	300	0	0	0	300		0	tr	0			9
Ue-25a#1-894.0	240	0	0	0	240		0	tr	0			9
Ue-25a#1-937.3	600	0	0	0	600		0	0	0			9
Ue-25a#1-1011.1	330	0	0	0	110		0	tr	0			9
Ue-25a#1-1060.7	70	0	0	0	350		0	0	0			9
Ue-25a#1-1112.5	210	0	0	0	70		0	0	0			9
Ue-25a#1-1152.6	0	0	0	0	140		0	tr	0			9
Ue-25a#1-1195.2	200	0	0	0	300		0	tr	0			9
Ue-25a#1-1264.4	360	0	0	0	180		0	0	0			9
Ue-25a#1-1279.2	260	0	0	0	650		0	tr	0			9
Ue-25p#1-420	1080	0	0	0	0		0	0	0		tr	3
Ue-25p#1-580	0	0	0	0	400		0	0	0		tr	3
Ue-25p#1-910	0	0	0	0	500		0	tr	0		0	3
Ue-25p#1-1050	280	0	0	0	420		0	0	0		0	3
Ue-25p#1-1150	1520	0	0	0	0		0	0	0		0	3

Tuffaceous Beds of Calico Hills - Upper Part

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allanite	Perrierite	Apatite	Zircon	Ref.[6]
3-15-82-5	600	0	0	0	tr		0	0	0			3
3-15-82-6	tr	0	0	0	tr		0	tr	0			3
3-15-82-7	tr	0	0	0	tr		0	0	0			3
3-15-82-8	400	0	0	0	700		0	0	0			3
3-15-82-9	1900	0	0	0	400		0	tr	0			3
4-16-85-3A	3200	0	0	0	tr		0	tr	0			3
4-16-85-4	400	0	0	0	200		0	tr	0			3
4-16-85-5	800	0	0	0	200		0	tr	0			3
4-16-85-6	400	0	0	0	400		0	tr	0			3
4-16-85-8	800	0	0	0	200		0	0	0			3
4-16-85-9	2100	tr	0	0	200		0	tr	0			3
4-16-85-12	500	0	0	0	tr		0	tr	0			3
USW G-1-1436.8	210	0	0	0	160	10	0	8	0	0	4	6
USW G-1-1561.8	300	0	0	0	110	0	0	0	0	0	2	6
USW G-1-1561.8	270	0	0	0	0		0	0	0	0	0	6

TABLE II (cont)

Sample Number	Location[1] Lat. (North)	Location[1] Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	AF	P	
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]			
USW G-1-1640.3	770500	561000	C	nwt	Zc	500	2.4	40.0	1.4	3.6	58	17	25	*
USW G-1-1689.5	770500	561000	C	nwt	Zc	8000			1.8	2.0	51	24	25	
USW G-2-1770	778824	560504	C	nwt	Zc	5800			1.6	1.4	41	40	18	
USW GU-3-1413.1	752690	558501	C			1480			2.0	2.9	16	32	52	
USW GU-3-1439.4	752690	558501	C	nwt	Gl	5100			1.4	0.7	38	38	24	
USW GU-3-1439.5	752690	558501	C			1580			2.0	2.0	25	39	36	
USW GU-3-1439.5	752690	558501	C	nwt	Gl	5150			5.2	1.3	64	23	13	
USW GU-3-1498.4	752690	558501	C	nwt	Zc	1480			2.0	1.8	7	63	30	
USW G-4-1472.2	765807	563082	C	nwt	Zc	5547			2.5	1.6	39	38	23	
Tuffaceous Beds of Calico Hills - Lower Part														
RWG2a-7			O	b	Zc	4470			3.4	17.3	32	10	58	
82FB-1	789700	549700	O	nwt	Zc	1580			3.9	7.8	37	26	37	
82FB-2	789200	549600	O	nwt	Zc	1595			9.5	7.1	28	19	53	
82FB-3A	789300	549800	O	nwt	Zc	5400			4.0	7.5	26	22	52	
82FB-3B	789300	549800	O	nwt	Zc	5200			7.1	9.3	31	26	42	
DB28b-15	736400	639390	O	b	Zc	338	2.7		5.3	8.9	40	13	47	
3-15-82-1	786700	550800	O	nwt	Zc	553	4.0		18.8	17.0	23	67	10	
3-15-82-3	786600	550900	O	b	Zc	2374	5.3		3.3	7.4	33	33	34	
USW G-1-1775.1	770500	561000	C	b	Zc	500	3.4	25.4	3.0	24.8	31	14	54	*
USW G-2-2261	778824	560504	C	nwt	Zc	2750			3.4	5.0	48	30	22	
USW G-2-2328	778824	560504	C	nwt	Zc	1600			6.7	6.0	42	35	23	
USW G-2-2358	778824	560504	C	mwt	Zc	1100			5.6	5.6	56	15	29	
USW G-2-2449.7	778824	560504	C	nwt	Zc	1160			5.9	10.5	37	21	42	
USW G-2-2504	778824	560504	C	mwt	Zc	1450			5.1	9.2	33	26	41	
USW G-2-2551	778824	560504	C	nwt	Zc	1450			6.8	10.6	34	20	46	
USW G-2-2602.8	778824	560504	C	mwt	Zc	1450			5.4	14.9	35	20	45	
USW G-2-2650	778824	560504	C	nwt	Zc	1300			3.4	20.2	37	22	41	
USW GU-3-1537.4	752690	558501	C	nwt	Gl	5200			5.9	20.9	31	13	55	
USW GU-3-1571.5	752690	558501	C	mwt	Gl	5185			1.0	7.9	20	37	43	
Prow Pass Member, Crater Flat Tuff														
O-1-70-13			O			4100			0.0	10.7	11	33	56	
CF520			O			1410			0.0	13.1	22	40	38	
RW31a-6	706350	538740	O	nwt	Vp	597	13.1		0.2	4.9	28	31	41	
RWG2a-3	788510	550250	O	dwt	Gl/Gr	516	0.0	23.4	0.8	16.3	13	46	40	
USW G-1-1811.7	770500	561000	C	pwt	Zc	3600			0.1	6.2	15	53	32	
USW G-1-1820.2	770500	561000	C	pwt	Zc	500	2.6	20.6	1.4	7.8	12	43	45	*
USW G-1-1854.4	770500	561000	C	pwt	Zc	486	3.1	24.7	1.0	10.5	15	39	46	*
USW G-1-1884.3	770500	561000	C	pwt	Vp	500	0.4	26.1	1.0	15.8	13	46	41	*
USW G-1-1943.4	770500	561000	C	mwt	Vp	3300			0.4	14.4	13	39	48	
USW G-1-1983.4	770500	561000	C	mwt	Ax/Sp	500	1.0	23.6	0.4	11.0	8	49	43	*
USW G-1-2009.8	770500	561000	C	pwt		3750			2.6	7.9	15	47	38	
USW G-1-2083.8	770500	561000	C	pwt	Zc	500	3.8	21.4	0.6	9.6	10	42	48	*
USW G-1-2124.7	770500	561000	C	nwt		3600			0.6	8.8	6	50	44	
USW G-2-2708	778824	560504	C	mwt		1450			0.3	9.7	13	54	33	
USW G-2-2755	778824	560504	C	pwt		1500			0.5	13.2	16	41	43	
USW G-2-3042	778824	560504	C	pwt	Zc/Ar	1650			7.3	13.0	16	47	36	
USW G-2-3064	778824	560504	C	mwt	Zc	1650			2.3	13.5	8	45	47	
USW G-2-3108.1	778824	560504	C	pwt	Zc	1500			1.8	12.1	4	35	61	
USW G-2-3122.2	778824	560504	C	mwt		1500			0.7	11.2	9	54	37	
USW G-2-3143.5	778824	560504	C	pwt	Zc/Ar	1470			2.4	11.2	11	49	39	

TABLE II (cont)

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Perr-ierite	Apatite	Zircon	Ref.[6]
Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]												
USW G-1-1640.3	150	0	0	0	300	16	0	0	0	0	12	6
USW G-1-1689.5	375	0	0	0	125		0	0	0	0	tr	6
USW G-2-1770	168	0	0	0	0							3
USW GU-3-1413.1	1280	1280	0	tr	tr		0	0	0	tr	tr	7
USW GU-3-1439.4	160	0	0	0	320		0	tr	0			3
USW GU-3-1439.5	630	tr	0	0	tr		0	tr	0	tr	tr	7
USW GU-3-1439.5	840	0	0	0	0							3
USW GU-3-1498.4	tr	0	0	0	tr		0	tr	0	0	tr	7
USW G-4-1472.2	340	0	0	0	170		0	0	tr(?)		0	3
Tuffaceous Beds of Calico Hills - Lower Part												
RWG2a-7	13724	0	0	0	940		0	0	0		tr	3
82FB-1	5712	0	0	0	672		0	0	0		tr	3
82FB-2	2409	0	0	0	0		0	0	0		0	3
82FB-3A	6132	0	0	0	1848		0	0	0		tr	3
82FB-3B	7100	0	0	0	200		0	0	0		tr	3
DB28b-15	420	860	49	510ps	400	41	5	10	0	8	12	3
3-15-82-1	12700	0	0	0	1800		0	tr	0			3
3-15-82-3	1700	0	0	0	tr		0	0	0			3
USW G-1-1775.1	3000	0	0	0	950	120	0	0	0	17	53	6
USW G-2-2261	2544	0	0	0	371		0	0	0	tr	tr	3
USW G-2-2328	1260	0	0	0	1890		0	0	0	tr	tr	3
USW G-2-2358	8255	0	0	0	910		0	0	0		tr	3
USW G-2-2449.7	4290	0	0	0	880		0	0	0		tr	3
USW G-2-2504	6237	0	0	0	693		0	0	0	tr	tr	3
USW G-2-2551	7590	0	0	0	1380		0	0	0	tr	tr	3
USW G-2-2602.8	10335	0	0	0	0		0	0	0	tr	tr	3
USW G-2-2650	10682	3052ps	0	0	2398		0	0	0	tr	tr	3
USW GU-3-1537.4	6880	3440	215	645	2795		0	tr	0		tr	3
USW GU-3-1571.5	3652	tr	0	415	747		0	0	0		tr	3
Prow Pass Member, Crater Flat Tuff												
O-1-70-13	2000	0	0	0	2000		0					2
CF520	1000	0	0	4000	3000		0					2
RW31a-6	150	13	0	ps	1200	0	0	9	0	12	23	6
RWG2a-3	860	310	0	4800	1400	0	0	350	0	56	46	6
USW G-1-1811.7	280	ps	0	1900ps	560		0	0	0	0	tr	6
USW G-1-1820.2	210	0	0	ps	450	0	0	0	0	8	10	6
USW G-1-1854.4	500	3	0	ps	660	0	0	0	0	7	28	6
USW G-1-1884.3	580	0	0	ps	1200	0	0	0	0	0	26	6
USW G-1-1943.4	280	0	0	910ps	610		0	0	0	0	tr	6
USW G-1-1983.4	ps	0	0	ps	1300	0	0	0	0	1	9	6
USW G-1-2009.8	280	280	0	2100ps	530		0	tr	0	tr	tr	6
USW G-1-2083.8	ps	0	0	ps	630	0	0	62	0	1	13	6
USW G-1-2124.7	280	ps	0	0	1100		0	tr	0	tr	tr	6
USW G-2-2708	1414	2121ps	0	ps	0		0	0	0	0	tr	3
USW G-2-2755	685	3288ps	0	ps	1370		0	0	0	0	tr	3
USW G-2-3042	tr	0	0	tr	655		0	0	0	0	tr	3
USW G-2-3064	tr	564	0	2961	2395		0	tr	0	tr	tr	3
USW G-2-3108.1	0	635	0	4064	1397		0	tr	0	0	tr	3
USW G-2-3122.2	tr	0	0	0	1356		0	0	0	0	tr	3
USW G-2-3143.5	678	0	0	0	678		0	tr	0	tr	tr	3

TABLE II (cont)

Sample Number	Location[1] Lat. (North)	Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	AF	P
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]		
USW G-2-3159.4	778824	560504	C	nwt	Zc	1500			2.6	9.4	7	43	49
USW G-2-3216.7	778824	560504	C	nwt	Zc	1500			0.0	6.7	14	30	55
USW G-2-3244.4	778824	560504	C	nwt	Zc	1500			2.4	5.9	17	39	44
USW GU-3-1571.7	752690	558501	C			1530			1.0	7.2	14	46	40
USW GU-3-1598.9	752690	558501	C			1380			1.0	8.6	17	32	51
USW GU-3-1603.2	752690	558501	C			1680			1.0	8.1	6	39	55
USW GU-3-1744.0	752690	558501	C			1280			2.0	10.4	15	31	54
USW GU-3-1873.8	752690	558501	C			1480			3.0	8.9	7	36	56
USW GU-3-1986.3	752690	558501	C			1480			2.0	8.5	8	48	44
USW G-4-2069.0	765807	563082	C	pwt	Zc	5086			1.0	8.8	6	38	56
USW G-4-2226.7	765807	563082	C	nwt	Zc	5402			2.2	7.7	9	46	45
Ue-25a#1-1852.1	764900	566350	C	wt	mVp	298	0.0	43.0	0.7	9.0			
Ue-25a#1-1869.1	764900	566350	C	wt	mVp	300	0.0	36.0	0.0	9.6			
Ue-25a#1-1930.5	764900	566350	C	wt	mVp	505	9.3	9.9	0.6	13.1			
Ue-25a#1-2001.7	764900	566350	C	dwt	Sp	300	0.0	31.0	0.3	12.7			
Ue-25a#1-2087.7	764900	566350	C	nwt	Zc	300	0.0	18.0	5.0	13.0			
Ue-25a#1-2113.6	764900	566350	C	nwt	Zc	501	0.4	24.0	1.4	7.6			
Ue-25a#1-2220.6	764900	566350	C	nwt	Zc	461	0.0	11.0	1.7	7.1			
Ue-25a#1-2304.6	764900	566350	C	nwt	Zc	300	0.0	18.0	5.0	9.4			
Ue-25a#1-2331.5	764900	566350	C	nwt	Zc	300	0.0	2.7	2.0	6.0			
J-13-1882	749209	579651	C	pwt	Ax/cc	300	0.0		1.0	19.0	17	39	43 *
J-13-1883	749209	579651	C						1.6	5.4	11	56	33
J-13-1992	749209	579651	C	b	Za	300			1.0	18.0			
Bullfrog Member, Crater Flat Tuff													
CF115			O	wt	D	3400			0.0	16.1	14	41	45
O-7-84-3			O	wt	D	3500			0 0	8.7	13	30	57
BC149			O	wt	D				0.0	19.7	24	40	36
CF55v			O	vt	Gl	3600			0.0	17.9	16	22	63
RMRyb-3	753610	414350	O	pwt	Gr	614	2.3		0.5	10.1	31	35	34
TBF-1	704950	538520	O	vt	Gl/Ax	464	6.2	48.7	1.5	12.5	11	32	56
TBF-4	705480	538610	O	nwt	Vp	558	0.5	14.7	1.1	9.9	20	31	49
CF LSM-5	715500	598540	O	pwt	Zc/Ax/mQ	480	0.2	10.8	4.4	15.0	15	32	53
CF LSM-1	715350	598880	O	mwt	Sp/Gr	516	0.8	13.6	2.5	11.4	24	38	38
RMG2a-5	788860	549970	O	mwt	Ax/Gr/mVp	462	3.7		0.0	14.9	22	39	39
RMG2a-4	788730	550240	O	nwt	Ax/cc/mGr	509	16.3		0.2	8.4	19	42	40
USW G-1-2166.3	770500	561000	C	b	Zc	527	0.4	41.4	2.6	9.1	0	52	48
USW G-1-2231.0	770500	561000	C	pwt		3700			0.0	12.2	22	36	42
USW G-1-2233.6	770500	561000	C	pwt	Zc	500	2.2	20.4	0.4	14.6	32	26	42 *
USW G-1-2246.0	770500	561000	C	pwt		3000			0.0	11.8	19	45	36
USW G-1-2247.6	770500	561000	C	nwt	Zc	500	3.4	16.2	0.4	12.4	32	29	39 *
USW G-1-2289	770500	561000	C	nwt	Zc	500	1.4	14.8	1.0	14.2	13	29	58 *
USW G-1-2291.3	770500	561000	C	nwt	Zc	500	3.8	20.2	0.6	13.2	33	32	35 *
USW G-1-2300.4	770500	561000	C	pwt		3750			0.0	13.6	24	31	45
USW G-1-2318.2	770500	561000	C	nwt	Sp/Gr	500	4.8	27.6	0.0	24.4	31	33	36 *
USW G-1-2354.6	770500	561000	C	mwt	Gr	3750			0.0	14.6	27	30	43
USW G-1-2363.6	770500	561000	C	pwt	Sp/Gr	500	0.4	25.6	0.2	19.6	22	40	38 *
USW G-1-2397	770500	561000	C	pwt	Vp	3750			0.2	13.0	23	32	45
USW G-1-2411.6	770500	561000	C	pwt	Ax/Sp	431	0.9	13.2	3.0	15.6	22	34	44 *
USW G-1-2436.3	770500	561000	C	mwt	Sp/Gr	500	0.0	38.6	0.6	18.4	12	39	49 *

TABLE II (cont)

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Perr-ierite	Apatite	Zircon	Ref.[6]
Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]												
USW G-2-3159.4	0	0	0	0	1330		tr	tr	0	tr	tr	3
USW G-2-3216.7	670	0	0	0	0		0	tr	0	0	tr	3
USW G-2-3244.4	600	0	0	600	0		tr	tr	0	0	tr	3
USW GU-3-1571.7	tr	tr	0	22	tr		0	tr	0	tr	tr	7
USW GU-3-1598.9	920	tr	0	1840	2760		0	tr	0	tr	tr	7
USW GU-3-1603.2	830	0	0	830	tr		0	tr	0	tr	tr	7
USW GU-3-1744.0	1605	0	0	tr	1605		0	tr	0	tr	tr	7
USW GU-3-1873.8	930	tr	0	930	1860		0	tr	0	tr	tr	7
USW GU-3-1986.3	tr	tr	0	1320	1760		0	tr	0	tr	tr	7
USW G-4-2069.0	0	0	0	2000ps	1000		0	tr	0	tr	tr	3
USW G-4-2226.7	158	0	0	0	1975		0	0	0	tr	tr	3
Ue-25a#1-1852.1	0	0	0	0	0							4
Ue-25a#1-1869.1	0	0	0	0	0							4
Ue-25a#1-1930.5	0	0	0	0	0							4
Ue-25a#1-2001.7	0	0	0	0	0							4
Ue-25a#1-2087.7	0	0	0	0	0							4
Ue-25a#1-2113.6	0	0	0	0	0							4
Ue-25a#1-2220.6	0	0	0	0	0							4
Ue-25a#1-2304.6	0	0	0	0	0							4
Ue-25a#1-2331 5	0	0	0	0	0							4
J-13-1882	1200	0	0	ps	ps	0	0	0	0	22	34	6
J-13-1883	0	3100	0	ps	800							5
J-13-1992												6
Bullfrog Member, Crater Flat Tuff												
CF115	6000	0	1000	0	3000		tr					2
0-7-84-3	9000	0	0	0	1000		0					2
BC149	8000	0	0	0	0		0					2
CF55v	14000	3000	0	0	3000		tr					2
RMRyb-3	1900	0	0	0	540	0	0	0	0	18	26	6
TBF-1	3700	1300	0	0	4500	0	420	150	0	120	91	6
TBF-4	2700	2400	0	0	1700	160	0	440	0	130	71	6
CF LSM-5	3600	290ps	0	0	1100	0	0	0	0	24	15	6
CF LSM-1	1700	0	0	0	1500	0	0	0	0	15	11	6
RMG2a-5	4600	ps	0	0	1800	0	11	0	0	79	67	6
RMG2a-4	3400	ps	0	0	1600	0	0	0	0	80	28	6
USW G-1-2166.3	880	0	0	0	950	0	0	0	0	1	13	6
USW G-1-2231.0	2700	1300ps	0	0	810		0	0	0	tr	tr	6
USW G-1-2233.6	2700	1	0	0	660	0	0	0	0	1	14	6
USW G-1-2246.0	4300	1000ps	0	0	1700	0	0	0	0	0	tr	6
USW G-1-2247.6	3200	0	0	0	1600	0	0	0	0	1	27	6
USW G-1-2289	2900	ps	0	0	2200	0	0	0	0	8	26	6
USW G-1-2291.3	2000	ps	0	0	820	0	0	0	0	4	17	6
USW G-1-2300.4	1600	2400ps	0	0	1600		0	0	0	tr	tr	6
USW G-1-2318.2	4200	0	0	0	2100	0	0	0	0	17	87	6
USW G-1-2354.6	3500	2400ps	0	0	1900		0	0	0	tr	tr	6
USW G-1-2363.6	2800	ps	0	0	1700	0	0	0	0	45	40	6
USW G-1-2397	5300	1300ps	0	0	530		0	0	0	tr	tr	6
USW G-1-2411.6	2400	ps	0	0	920	0	0	0	0	27	82	6
USW G-1-2436.3	2900	ps	0	0	1800	0	0	0	0	54	43	6

TABLE II (cont)

Sample Number	Location[1] Lat. (North)	Location[1] Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	AF	P	
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]			
USW G-1-2461.5	770500	561000	C	mwt	Vp	3650			0.9	7.1	5	44	51	
USW G-1-2470.6	770500	561000	C	pwt	Vp	3700			1.6	8.3	18	29	53	
USW G-1-2477.0	770500	561000	C	mwt	Ax/Sp/Gr	459	0.0	20.3	0.9	8.3	13	33	54	*
USW G-1-2478.3	770500	561000	C	pwt	Vp	3750			0.5	10.0	14	39	47	
USW G-1-2487.0	770500	561000	C	pwt	Ax/Sp	500	0.0	16.6	5.2	9.6	6	52	42	*
USW G-1-2507	770500	561000	C	mwt		3700			1.2	9.6	13	36	51	
USW G-1-2555.6	770500	561000	C	pwt	Zc	2516	0.6	14.5	2.3	10.5	6	45	48	
USW G-1-2555.6	770500	561000	C	mwt	Zc	3520			0.8	9.9	9	40	51	
USW G-1-2594.2	770500	561000	C	pwt		3750			2.2	7.1	17	32	51	
USW G-1-2600.6	770500	561000	C	pwt	Zc	500	1.4	8.6	2.0	8.8	11	39	50	*
USW G-2-3292.5	778824	560504	C	nwt	Zc	1300			0.4	15.8	21	31	48	
USW G-2-3294.0	778824	560504	C	nwt	Zc	1500			0.0	10.0	25	34	41	
USW G-2-3313.0	778824	560504	C	pwt		1365			0.4	11.7	19	34	47	
USW G-2-3326.0	778824	560504	C	mwt		1430			0.3	14.8	18	42	40	
USW G-2-3362.1	778824	560504	C	pwt		1500			0.7	10.1	15	45	40	
USW G-2-3433.9	778824	560504	C	pwt		1500			0.0	10.3	7	42	51	
USW GU-3-2018.9	752690	558501	C			1580			<0.1	8.3	20	31	49	
USW GU-3-2070.4	752690	558501	C			1530			<0.1	10.9	17	37	46	
USW GU-3-2138.5	752690	558501	C			1630			<0.1	16.5	22	36	42	
USW GU-3-2181.4	752690	558501	C			1380			2.0	16.5	18	34	48	
USW GU-3-2369.6	752690	558501	C			1580			<0.1	18.3	20	37	43	
USW GU-3-2467.3	752690	558501	C			1655			<0.1	20.6	20	34	46	
USW GU-3-2577.6	752690	558501	C			1480			3.0	8.3	11	36	53	
USW G-4-2354.9	765807	563082	C	dwt		5131			1.0	16.4	33	33	34	
J-13-2132	749209	579651	C						0.5	17.6	20	42	39	
J-13-2135	749209	579651	C	pwt	Sp	301	0.3		0.3	20.0				
J-13-2175	749209	579651	C	mwt	Gr	300	0.0		0.0	24.0	26	39	35	*
J-13-2183	749209	579651	C						0.0	17.4	25	40	36	
Ue-25a#1-2361.7	764900	566350	C	wt	Sp/Gr	326	1.5	17.0	0.0	12.0				
Ue-25a#1-2419.7	764900	566350	C	wt	Sp/Gr	304	0.7	8.4	0.0	17.0				
Ue-25a#1-2491.3	764900	566350	C	wt	Sp/Gr	488	0.0	45.0	0.0	16.4				
Tram Member, Crater Flat Tuff														
RW18a-5	887080	617440	O	b	Gl	506	21.5	19.4	1.4	12.1	30	38	32	
RWRyb-1	752980	415190	O	nwt	Zc/Ar/K	497	3.6		8.0	11.9	34	31	36	
RWBWa-5	807680	507740	O	mwt	Sp/Gr	467	0.4		0.1	12.4	24	40	36	
USW G-1-2641.6	770500	561000	C	pwt	Zc	500	2.8	12.4	1.6	13.8	12	32	56	*
USW G-1-2678.0	770500	561000	C	pwt		3980			1.3	7.5	15	34	51	
USW G-1-2699.2	770500	561000	C	pwt	Zc	500	5.2	30.6	1.0	10.4	48	31	21	*
USW G-1-2772.6	770500	561000	C	pwt		3800			2.1	10.2	29	34	37	
USW G-1-2790.3	770500	561000	C	pwt	Sp/Gr	599	6.5	10.5	9.3	9.2	68	17	15	*
USW G-1-2851.7	770500	561000	C	mwt		3900			4.5	13.6	41	37	22	
USW G-1-2854.5	770500	561000	C	pwt	Ax/Sp/Gr	411	3.4	31.4	2.0	11.9	65	26	9	*
USW G-1-2869.0	770500	561000	C	dwt	Sp/Gr/Ax	2023	3.6	22.6	4.4	13.8	40	35	25	
USW G-1-2869.0	770500	561000	C	mwt		3360			3.8	12.1	41	35	24	
USW G-1-2902.0	770500	561000	C	dwt	Sp/Gr/mcc	500	1.4	18.2	2.0	14.6	56	25	19	*
USW G-1-2931.4	770500	561000	C	mwt		4000			3.3	12.8	37	32	31	
USW G-1-2938.8	770500	561000	C	dwt	Ax	425	0.5	34.8	1.9	11.3	43	38	19	*
USW G-1-3001	770500	561000	C	dwt	Ax/mZa	500	6.4	16.4	5.4	15.0	45	30	25	*
USW G-1-3013.9	770500	561000	C	pwt		3500			12.3	12.9	27	44	29	
USW G-1-3117.2	770500	561000	C	pwt	Za	500	4.6	12.4	21.4	11.8	68	13	19	*
USW G-1-3192.8	770500	561000	C	pwt		3600			23.8	9.4	33	30	37	
USW G-1-3196.8	770500	561000	C	nwt	Zc/py	2154	0.8	9.7	26.7	8.9	29	29	42	

TABLE II (cont)

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Perr-ierite	Apatite	Zircon	Ref.[6]
Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]												
USW G-1-2461.5	2200	1600ps	0	0	550		0	0	0	tr	tr	6
USW G-1-2470.6	4900	1100ps	0	0	1300		0	0	0	tr	tr	6
USW G-1-2477.0	2800	ps	0	0	1400	0	0	0	0	41	66	6
USW G-1-2478.3	4000	530ps	0	0	270		0	0	0	tr	tr	6
USW G-1-2487.0	2200	ps	0	0	1300	0	0	0	0	28	12	6
USW G-1-2507	4100	3200ps	0	0	2400		0	0	0	tr	tr	6
USW G-1-2555.6	1700	2300	0	0	820	0	0	0	0	33	32	6
USW G-1-2555.6	2300	2300	280ps	0	280		0	0	0	tr(?)	tr	6
USW G-1-2594.2	4300	270ps	0	0	800		0	tr	0	tr	tr	6
USW G-1-2600.6	1900	ps	0	0	1100	0	0	340	0	26	38	6
USW G-2-3292.5	6105	0	0	0	825		0	tr	0	tr	tr	3
USW G-2-3294.0	4725	0	0	0	630		0	0	0	0	tr	3
USW G-2-3313.0	5828	ps	0	0	744		0	0	0	0	tr	3
USW G-2-3326.0	4104	0	0	0	0		0	0	0	0	tr	3
USW G-2-3362.1	1976	ps	0	0	728		0	0	0	0	tr	3
USW G-2-3433.9	2675	ps	0	0	1391		0	0	0	0	tr	3
USW GU-3-2018.9	2640	tr	0	0	2640		0	tr	0	tr	tr	7
USW GU-3-2070.4	4640	11650	0	0	1160		0	0	0	tr	tr	7
USW GU-3-2138.5	7040	1760	0	0	1760		tr	tr	0	tr	tr	7
USW GU-3-2181.4	5250	1750	0	0	3500		0	tr	0	tr	tr	7
USW GU-3-2369.6	5790	tr	0	0	3860		tr	tr	0	tr	tr	7
USW GU-3-2467.3	6570	4380	0	0	2190		0	tr	0	tr	tr	7
USW GU-3-2577.6	3600	900	0	0	1800		tr	tr	0	tr	tr	7
USW G-4-2354.9	4275	2223ps	0	0	171		0	0	0	tr	tr	3
J-13-2132	5000	3500	0	0	1500							5
J-13-2135												6
J-13-2175	3700	0	0	0	1300	0	0	0	0	54	34	6
J-13-2183	9300	3600	0	0	2800							5
Ue-25a#1-2361.7												4
Ue-25a#1-2419.7												4
Ue-25a#1-2491.3												4
Tram Member, Crater Flat Tuff												
RW18a-5	4000	9	0	0	770	0	0	99	4	77	28	3
RWRyb-1	4100	0	0	0	520	0	0	46	0	58	26	6
RWBWa-5	3700	0	0	0	1400	0	0	310	0	120	66	6
USW G-1-2641.6	5700	0	0	0	2000	0	0	0	0	43	25	6
USW G-1-2678.0	7300	0	0	0	1000		tr	tr	0	tr	tr	6
USW G-1-2699.2	5200	0	0	0	1700	0	0	0	0	92	25	6
USW G-1-2772.6	5800	1600ps	0	0	530		0	0	0	tr	tr	6
USW G-1-2790.3	3400	0	0	0	630	0	0	0	0	32	20	6
USW G-1-2851.7	4400	0	0	0	1800		0	0	0	tr	tr	6
USW G-1-2854.5	3400	0	0	0	980	0	0	0	0	46	39	6
USW G-1-2869.0	4500	0	0	0	1000	0	0	0	0	73	48	6
USW G-1-2869.0	6000	0	0	0	890		0	0	0		tr	6
USW G-1-2901.2	3700	0	0	0	1100	0	0	0	0	70	9	6
USW G-1-2931.4	7000	0	0	0	500		0	0	0		tr	6
USW G-1-2938.8	6300	0	0	0	1400	0	0	0	0	89	61	6
USW G-1-3001	3200	0	0	0	1900	0	0	0	0	63	68	6
USW G-1-3013.9	4900	ps	0	0	860		0	tr	0		tr	6
USW G-1-3117.2	1400	0	0	0	ps	0	0	90	0	36	13	6
USW G-1-3192.8	4200	0	0	0	280		0	0	0	tr	tr	6
USW G-1-3196.8	2500	0	0	0	22ps	0	0	0	0	13	8	6

TABLE II (cont)

Sample Number	Location[1] Lat. (North)	Location[1] Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	AF	P	
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]			
USW G-1-3196.8	770500	561000	C	mwt		3460			22.3	7.4	38	29	33	
USW G-1-3258.0	770500	561000	C	nwt	Zc/py	2157	0.0	9.1	20.1	10.1	34	33	33	
USW G-1-3284.5	770500	561000	C	pwt	Ar/cc	3600			9.0	8.6	35	31	34	
USW G-1-3321.3	770500	561000	C	nwt	Za/py	500	2.2	4.4	22.6	11.6	68	19	13	*
USW G-1-3372.0	770500	561000	C	nwt	Za/py	500	0.0	1.6	36.8	6.4	43	36	21	*
USW G-1-3501.5	770500	561000	C	pwt	Za/py	500	0.2	6.6	33.9	9.8	40	19	42	*
USW G-1-3515.1	770500	561000	C	pwt		3800			25.8	8.3	34	22	44	
USW G-2-3834	778824	560504	C		Za/Ar	2950			12.4	4.1	37	24	40	
USW G-3-2627.3	752780	558483	C			1630			1.0	8.6	20	16	64	
USW G-3-2656.8	752780	558483	C			1580			2.0	10.6	26	31	43	
USW G-3-2699.0	752780	558483	C			1630			4.0	12.2	29	25	46	
USW G-3-2733.0	752780	558483	C			1630			2.0	11.0	35	32	32	
USW G-3-2801.6	752780	558483	C			1580			<0.1	11.6	33	34	33	
USW G-3-2867.0	752780	558483	C			1630			2.0	9.4	33	33	33	
USW G-3-2914.6	752780	558483	C			1680			3.0	14.4	38	33	29	
USW G-3-3045.5	752780	558483	C			1680			13.0	12.1	30	32	38	
USW G-3-3072.3	752780	558483	C			1680			2.0	14.3	32	34	34	
USW G-3-3113.3	752780	558483	C			1655			14.0	14.4	38	27	35	
USW G-3-3164.4	752780	558483	C			1580			20.0	13.1	29	32	39	
USW G-3-3226.1	752780	558483	C			1680			18.0	11.9	36	37	28	
USW G-3-3343.8	752780	558483	C			1680			19.0	9.9	50	26	24	
USW G-3-3441.8	752780	558483	C			1680			28.0	10.5	38	24	38	
USW G-3-3475.6	752780	558483	C			1530			25.0	7.5	24	25	51	
USW G-3-3682.9	752780	558483	C			1630			34.0	8.4	49	15	35	
USW G-3-3730.5	752780	558483	C			1580			31.0	7.4	35	24	41	
USW G-3-3759.2	752780	558483	C			1680			28.0	8.1	27	27	47	
USW G-4-2875.6	765807	563082	C	mwt		5074			14.2	10.4	38	29	34	
Ue-25p#1-2380	756171	571485	Da						3.1	8.1	33	45	22	
Ue-25p#1-2660	756171	571485	Da						10.5	7.6	29	26	45	
Ue-25p#1-2760	756171	571485	Da						9.5	5.9	33	35	32	
J-13-2382	749209	579651	C	nwt	Za/cc	300	0.0		1.3	7.0	25	34	41	*
J-13-2382.5	749209	579651	C						0.7	8.1	18	43	39	
J-13-2532.1	749209	579651	C						0.9	9.6	28	39	33	
J-13-2535	749209	579651	C	wt	Za	300	1.0			11.3				
J-13-2680	749209	579651	C	wt	Sp	300			6.3	8.5				
J-13-2684	749209	579651	C						3.4	11.5	34	34	31	
J-13-2685.2	749209	579651	C						1.4	12.7	34	29	37	
J-13-2843	749209	579651	C						0.8	13.7	38	34	28	
J-13-2980	749209	579651	C	mwt	Sp/cc	300	0.0		5.3	12.7	40	27	34	*
J-13-2997	749209	579651	C	wt	Sp/cc	300	1.7		10.0	9.0				
J-13-2998	749209	579651	C						13.5	7.7	28	31	41	
J-13-3005	749209	579651	C						8.4	7.9	34	29	37	
J-13-3030	749209	579651	Db						7.0	12.4	41	27	32	
J-13-3110	749209	579651	Db						2.0	8.8	20	53	27	
J-13-3150	749209	579651	Db						2.0	6.8	19	36	45	
J-13-3190	749209	579651	Db						4.0	4.6	29	41	29	
J-13-3200	749209	579651	Db						2.0	3.6	20	40	40	

TABLE II (cont)

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Perr-ierite	Apatite	Zircon	Ref.[6]
Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]												
USW G-1-3196.8	3200	0	0	0	280		0	0	0	tr(?)	tr	6
USW G-1-3258.0	2300	0	0	0	ps	16	0	68	0	18	13	6
USW G-1-3284.5	3300	ps	0	0	1700		0	tr	0	tr	tr	6
USW G-1-3321.3	2100	0	0	0	250ps	0	0	180	0	22	5	6
USW G-1-3372.0	1900	0	0	0	ps	0	0	30	0	3	2	6
USW G-1-3501.5	1500	0	0	0	ps	0	0	120	0	28	8	6
USW G-1-3515.1	2900	260ps	0	0	1300		0	tr	0	tr	tr	6
USW G-2-3834	774	258ps	0	0	774		tr	0	0	0	tr	3
USW G-3-2627.3	7520	470	0	0	470		tr	tr	0	tr	tr	7
USW G-3-2656.8	6780	0	0	0	tr		tr	tr	0	tr	tr	7
USW G-3-2699.0	2520	0	0	0	630		tr	0	0	tr	tr	7
USW G-3-2733.0	5900	0	0	0	2360		0	0	0	tr	tr	7
USW G-3-2801.6	7380	tr	0	0	tr		tr	0	0	tr	tr	7
USW G-3-2867.0	6060	tr	0	0	1010		0	tr	0	tr	tr	7
USW G-3-2914.6	9300	tr	0	0	1550		tr	tr	0	tr	tr	7
USW G-3-3045.5	7920	0	0	0	2640		0	0	0	tr	tr	7
USW G-3-3072.3	6080	tr	0	0	3040		tr	0	0	tr	tr	7
USW G-3-3113.3	4500	750	0	0	750		0	0	0	tr	tr	7
USW G-3-3164.4	2760	tr	0	0	4140		0	0	0	tr	tr	7
USW G-3-3226.1	7920	660	0	0	3960		0	0	0	tr	tr	7
USW G-3-3343.8	4480	0	0	0	3360		0	0	0	tr	tr	7
USW G-3-3441.8	2200	0	0	0	3300		tr	0	0	tr	tr	7
USW G-3-3475.6	4300	tr	0	0	5880		tr	0	0	tr	tr	7
USW G-3-3682.9	5520	0	0	0	2760		0	0	0	tr	tr	7
USW G-3-3730.5	4000	0	0	0	1600		0	0	0	tr	tr	7
USW G-3-3759.2	4500	900	0	0	3600		tr	0	0	0	tr	7
USW G-4-2875.6	6327	222ps	0	0	555		0	0	0	tr	tr	3
Ue-25p#1-2380	415	0	0	0	1909		0	0	0		tr	3
Ue-25p#1-2660	3807	405ps	0	0	405		0	0	0		tr	3
Ue-25p#1-2760	3168	0	0	0	4224		0	0	0		tr	3
J-13-2382	4800	0	0	0	2400	0	33	0	0	130	48	6
J-13-2382.5	4300	800	0	0	800							5
J-13-2532.1	9300	600	0	0	600							5
J-13-2535												6
J-13-2680												6
J-13-2684	6600	900	0	0	900							5
J-13-2685.2	10000	700	0	0	10000							5
J-13-2843	8600	2700	0	0	600							5
J-13-2980	3500	0	0	0	1900	0	0	0	0	73	42	6
J-13-2997												6
J-13-2998	800	600	0	0	600							5
J-13-3005	4500	0	0	0	1300							5
J-13-3030	3900	0	0	0	2600							5
J-13-3110	900	0	0	0	0							5
J-13-3150	2100	0	0	0	0							5
J-13-3190	4000	0	0	0	0							5
J-13-3200	2000	0	0	0	1600							5

TABLE II (cont)

Sample Number	Location[1] Lat. (North)	Location[1] Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	AF	P	
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]			
Rhyodacite Flow Breccia														
USW G-1-3598	770500	561000	C	fb	Zc/Q/cc	500	0.0		0.0	11.4	0	0	100	*
USW G-1-3659	770500	561000	C	fb	Ar	500	0.0		0.0	16.6	0	0	100	*
USW G-1-3706	770500	561000	C	fb	Zc/Q	500	0.0		0.0	17.8	0	0	100	*
USW G-1-3724.0	770500	561000	C	fb	Gl/O	3700			0.0	8.8	0	0	100	
USW G-1-3850	770500	561000	C	fb	Zc/Q/Ar	500	0.0		0.0	16.8	0	0	100	*
USW G-1-3908.2	770500	561000	C	fb	Gl	3150			0.0	10.0	0	0	100	
USW G-2-4134.2	778824	560504	C	fb		2400			0.0	19.7	0	0	100	
Lithic Ridge Tuff														
RWBWa-4	807680	505810	O	nwt	Ar	467	8.3	4.3	18.7	6.6	3	39	58	
TW8-479	879468	609999	C	pwt	Zc	573	5.8		5.6	5.2	0	45	55	
TSV-417A-82	881920	593430	O	pwt	Gl/mZc	489	8.8	11.1	3.7	4.5	4	32	64	
FB16a-8	821930	637480	O	nwt	Zc	1997	5.3		2.3	3.0	8	21	70	
USW G-1-3941.1	770500	561000	C	b	Ar	599	0.3	16.7	6.8	15.0	0	0	100	*
USW G-1-3969.9	770500	561000	C	mwt	Ar	3300			9.0	17.5	2	34	64	
USW G-1-3992	770500	561000	C	pwt		3500			26.5	11.3	4	31	65	
USW G-1-3997.7	770500	561000	C	nwt	Za	577	4.8	6.9	13.0	12.7	6	58	36	*
USW G-1-4095.6	770500	561000	C	nwt	Za	597	1.7	9.5	25.6	10.3	2	45	53	*
USW G-1-4150.4	770500	561000	C	pwt		3400			13.8	8.5	2	35	63	
USW G-1-4208.9	770500	561000	C	nwt	Za	610	0.0	6.2	39.2	9.5	0	71	29	*
USW G-1-4222.1	770500	561000	C	pwt		3200			42.7	6.1	7	40	53	
USW G-1-4296.5	770500	561000	C	nwt	Za	675	0.9	8.6	18.5	11.8	8	70	22	*
USW G-1-4342.0	770500	561000	C	nwt	Ab/Za	557	0.4	10.2	10.4	12.6	7	35	58	*
USW G-1-4401.9	770500	561000	C	nwt	Za/Ab	560	7.1	9.3	16.8	10.3	2	67	32	*
USW G-1-4408.4	770500	561000	C	pwt		1800			11.8	9.2	1	37	62	
USW G-1-4471.0	770500	561000	C	pwt		3600			26.4	5.1	7	36	57	
USW G-1-4504.4	770500	561000	C	nwt	Za	629	1.3	11.0	20.0	8.2	5	68	28	*
USW G-1-4578.2	770500	561000	C	pwt		3800			23.8	7.6	5	39	56	
USW G-1-4612.8	770500	561000	C	nwt	Za	650	0.0	6.6	30.0	9.0	3	47	49	*
USW G-1-4701.1	770500	561000	C	pwt	Za	579	4.8	11.9	19.2	7.1	10	35	55	*
USW G-1-4758.4	770500	561000	C	pwt		3900			19.0	9.2	9	38	53	
USW G-1-4805.1	770500	561000	C	pwt	Za	601	0.0	10.0	18.6	13.3	1	44	55	*
USW G-1-4849.0	770500	561000	C	pwt		3900			13.0	8.9	10	35	55	
USW G-1-4877.3	770500	561000	C	pwt	Za/cc	656	0.3	11.4	11.4	8.6	6	50	44	*
USW G-1-4913.3	770500	561000	C	pwt	Za	553	0.0	13.0	9.6	6.9	12	50	38	*
USW G-1-4917.0	770500	561000	C	nwt		3800			5.9	5.6	14	51	35	
USW G-2-4199	778824	560504	C	mwt		1900			4.7	15.2	0	0	100	
USW G-2-4267	778824	560504	C	nwt		1750			7.8	10.8	4	35	61	
USW G-2-4467	778824	560504	C	nwt		1900			11.2	8.5	10	29	62	
USW G-3-3883.3	752780	558483	C			1580			3.0	18.0	2	16	82	
USW G-3-4008.6	752780	558483	C			1600			16.0	18.2	2	25	73	
USW G-3-4039.17	752780	558483	C			1580			18.0	7.6	8	33	59	
USW G-3-4149.8	752780	558483	C			1630			16.0	7.3	12	33	55	
USW G-3-4240.7	752780	558483	C			1200			25.0	7.5	11	34	55	
USW G-3-4288.6	752780	558483	C			1430			28.0	10.2	5	49	46	
USW G-3-4388.3	752780	558483	C			1580			21.0	9.1	6	40	54	
USW G-3-4423.2	752780	558483	C			1630			17.0	8.9	4	48	48	
USW G-3-4438.4	752780	558483	C			1630			30.0	5.9	6	38	56	
USW G-3-4568.7	752780	558483	C			1530			20.0	11.2	4	36	60	

TABLE II (cont)

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Perr-ierite	Apatite	Zircon	Ref.[6]
Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]												
Rhyodacite Flow Breccia												
USW G-1-3598.6	0	2300	1200	ps	0	2100	0	0	0	440	0	6
USW G-1-3659.0	0	9500	2700	11300	0	4500	0	0	0	1300	0	6
USW G-1-3706.7	0	1500	ps	ps	1200	1100	0	0	0	1700	0	6
USW G-1-3724.0	0	11100		015100ps	8100		0	0	0	tr	0	6
USW G-1-3851.3	1	2400	250	ps	1300	1000	0	0	0	880	0	6
USW G-1-3908.2	0	7900	2500	8200ps	5700		0	0	0	tr	0	6
USW G-2-4134.2	15435	94185	1260	0	6300		0	0	0	tr	tr	3
Lithic Ridge Tuff												
RWBWa-4	1600	0	0	0	590	0	0	0	0	26	24	6
TW8-479	1000	1000	0	0	780	120	140	0	48	54	34	3
TSV-417A-82	890	1400	130	26	620	37	190	0	3	59	19	3
FB16a-8	1340	85ps	0	0	1190	6	690	0	0	12	23	3
USW G-1-3941	3200	600	0	0	0	ps	9	0	1	29	3	6
USW G-1-3969.9	5500	ps	0	0	2400		tr	tr	0	tr	tr	6
USW G-1-3992	9700	0	0	0	2000		tr	tr	0	tr	tr	6
USW G-1-3997.7	5400	0	0	0	2300	59	230	0	3	110	68	6
USW G-1-4095.6	1100	0	0	0	1200	0	200	170	4	22	18	6
USW G-1-4150.4	1200	0	0	0	600		tr	tr	0	tr	tr	6
USW G-1-4208.9	1900	0	0	0	1100	86	200	160	0	54	28	6
USW G-1-4222.1	1600	0	0	0	1600		tr	0	0	tr	tr	6
USW G-1-4296.5	1600	0	0	0	1300	112	84	20	6	44	23	6
USW G-1-4342.0	1900	0	0	0	1600	9	130	66	3	65	64	6
USW G-1-4400.9	1800	0	0	0	1800	0	30	15	2	110	88	6
USW G-1-4408.4	5000	0	0	0	1100		tr	tr	0	tr	tr	6
USW G-1-4471.0	3600	0	0	0	560		tr	tr	0	tr	tr	6
USW G-1-4504.4	2900	0	0	0	1600	74	0	0	0	76	31	6
USW G-1-4578.2	2600	0	0	0	530		tr	tr	0	tr	tr	6
USW G-1-4612.8	2000	0	0	0	1100	4	0	43	8	45	4	6
USW G-1-4701.0	1800	0	0	0	840	41	0	0	0	40	13	6
USW G-1-4758.4	2600	0	0	0	1500		tr	0	8	tr	tr	6
USW G-1-4805.1	3000	0	0	0	1400	64	0	59	8	83	45	6
USW G-1-4849.0	3300	0	0	0	1000		tr	0	0	tr	tr	6
USW G-1-4877.3	2700	0	0	0	730	0	0	18	0	13	26	6
USW G-1-4913.3	1200	0	0	0	1200	10	0	0	0	40	27	6
USW G-1-4917.0	3200	0	0	0	1800		tr	tr	0	tr	tr	6
USW G-2-4199	8366	13172ps	0	0	4860		0	0	8	tr	tr	3
USW G-2-4267	3955	0	0	0	1130		tr	0	0	0	tr	3
USW G-2-4467	1068	0	0	0	3204		tr	0	0	tr	tr	3
USW G-3-3883.3	28600	4400	2200	0	6600		tr	tr	0	tr	tr	7
USW G-3-4008.6	8050	1150	0	0	3450		tr	tr	0	tr	tr	7
USW G-3-4039.17	3400	1700	0	0	3400		tr	tr	8	tr	tr	7
USW G-3-4149.8	3200	0	0	0	4000		tr	tr	0	tr	tr	7
USW G-3-4240.7	2400	0	0	0	1600		tr	tr	0	tr	tr	7
USW G-3-4288.6	1060	0	0	0	3180		tr	tr	0	tr	tr	7
USW G-3-4388.3	3920	0	0	0	2940		tr	tr	0	tr	tr	7
USW G-3-4423.2	3840	0	0	0	1920		tr	tr	0	tr	tr	7
USW G-3-4438.4	3960	0	0	0	1980		tr	tr	0	tr	tr	7
USW G-3-4568.7	2240	0	0	0	1120		tr	tr	0	tr	tr	7

TABLE II (cont)

Sample Number	Location[1] Lat. (North)	Location[1] Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	AF	P
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]		
USW G-3-4689.1	752780	558483	C			1600			20.0	8.5	10	39	51
USW G-3-4709.0	752780	558483	C			1450			22.0	9.4	8	37	55
USW G-3-4756.9	752780	558483	C			1630			23.0	10.8	7	29	64
USW G-3-4839.4	752780	558483	C			1655			15.0	9.4	11	29	61
Ue-25p#1-2950	756171	571485	Da						13.3	6.7	4	35	61
Ue-25p#1-3453.3	756171	571485	C						11.7	5.9	3	20	77
J-13-3246	749209	579651	C						8.7	8.8	3	23	75
J-13-3251	749209	579651	C						8.4	11.5	1	16	83
J-13-3253	749209	579651	C	nwt	Ab	307			12.0	12.0			
J-13-3290	749209	579651	Db						5.0	13.9	1	19	80
J-13-3450	749209	579651	Db						23.0	10.6	8	41	51
J-13-3491	749209	579651	C						13.4	9.4	5	31	64
J-13-3493	749209	579651	C	nwt	Zc/cc	300	1.7		11.0	12.3	3	49	48 *
J-13-3497	749209	579651	C						10.8	6.6	6	36	58
Older Tuffs - Unit A													
USW G-1-4946.4	770500	561000	C	nwt		3450			4.4	9.8	20	58	22
USW G-1-4969.0	770500	561000	C	pwt		3700			3.1	11.9	24	31	45
USW G-1-4998.2	770500	561000	C	b	Ar/Ab/Ze	457	4.4	18.1	4.2	19.7	37	31	32 *
USW G-1-5002.3	770500	561000	C	nwt		3700			2.5	17.0	32	31	37
USW G-1-5026.6	770500	561000	C	pwt	Ab	650	0.0	21.8	1.8	16.3	34	40	26 *
USW G-1-5045.0	770500	561000	C	mwt		3700			8.9	19.9	28	43	29
USW G-1-5094.5	770500	561000	C	pwt	Ab/Ze	546	0.2	27.7	2.0	13.4	49	19	32 *
USW G-1-5097.9	770500	561000	C	mwt		3600			0.5	17.4	28	41	31
USW G-1-5115.5	770500	561000	C	mwt		3750			3.1	18.3	24	42	34
USW G-1-5127.3	770500	561000	C	pwt	Ze	632	0.0	19.1	3.5	23.1	29	33	38 *
USW G-1-5141.5	770500	561000	C	mwt		3700			9.2	14.1	27	33	40
USW G-1-5142.2	770500	561000	C	pwt		3750			2.2	19.4	28	36	36
USW G-1-5167.6	770500	561000	C	nwt	Ze/Ab/cc	688	0.9	14.2	15.0	17.6	22	42	36 *
USW G-1-5187.0	770500	561000	C	nwt		3650			2.1	17.6	24	38	38
USW G-1-5213.6	770500	561000	C	pwt	Ze	571	0.0	21.2	7.5	21.0	39	36	25 *
USW G-1-5265.6	770500	561000	C	pwt		3400			5.4	17.4	35	31	34
USW G-1-5296.9	770500	561000	C	pwt	Ze/Ab	584	1.0	32.2	2.7	18.5	23	55	22 *
USW G-1-5312.6	770500	561000	C	b	Ab/Ze	626	0.3	16.0	3.8	13.9	35	46	19 *
USW G-1-5316.0	770500	561000	C	b		3600			2.4	21.6	33	36	31
USW G-3-4906.5	752780	558483	C			1680			2.0	17.9	29	36	35
USW G-3-5014.6	752780	558483	C			1650			2.0	15.2	30	35	35
Ue-25p#1-3570	756171	571485	Da						1.2	15.8	32	30	37
Ue-25p#1-3600	756171	571485	Da						1.9	17.5	21	38	41
Older Tuffs - Unit B													
USW G-1-5348.8	770500	561000	C	b	Ab/cc	421	0.0	22.3	19.7	17.4	13	16	71 *
USW G-1-5373.7	770500	561000	C	pwt		3650			0.6	11.3	13	26	61
USW G-1-5400.0	770500	561000	C	pwt		3800			2.3	13.6	12	30	58
USW G-1-5413.4	770500	561000	C	pwt	Ze/Ab	610	0.2	17.7	11.1	16.8	44	8	48 *
USW G-1-5416.6	770500	561000	C	pwt		3700			12.8	11.2	11	27	62

TABLE II (cont)

Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Perr-ierite	Apatite	Zircon	Ref.[6]
USW G-3-4689.1	1760	0	0	0	880		tr	tr	0	tr	tr	7
USW G-3-4709.0	3960	0	0	0	990		tr	0	0	tr	tr	7
USW G-3-4756.9	3510	0	0	0	5850		tr	tr	0	tr	tr	7
USW G-3-4839.4	3000	0	0	0	3000		tr	tr	0	tr	tr	7
Ue-25p#1-2950	3774	0	0	0	2516		440	220	0		tr	3
Ue-25p#1-3453.3	2340	0	0	0	3185		520	0	0			3
J-13-3246	600	1100	0	0	2600							5
J-13-3251	4000	tr	0	0	5000							5
J-13-3253												6
J-13-3290	tr	tr	0	0	tr							5
J-13-3450	2200	0	0	0	2000							5
J-13-3491	4900	0	0	0	600							5
J-13-3493	2200	0	0	0	1800	0	0	260	0	65	40	6
J-13-3497	1800	0	0	0	1500							5
Older Tuffs Unit A												
USW G-1-4946.4	3000	0	0	0	300		tr	tr	0		tr	6
USW G-1-4969.0	4900	0	0	0	2700		tr	0	0	tr	tr	6
USW G-1-4998.2	4000	0	0	0	1400	130	0	210	0	100	54	6
USW G-1-5002.3	5100	0	0	0	2400		tr	tr	0	tr	tr	6
USW G-1-5026.6	2200	0	0	0	1900	62	0	0	0	74	37	6
USW G-1-5045.0	4100	0	0	0	1900		tr	0	0	tr	tr	6
USW G-1-5094.5	1700	0	0	0	1800	23	0	46	0	88	84	6
USW G-1-5097.9	2200	0	0	0	2000		tr	tr	0	tr	tr	6
USW G-1-5115.5	4800	0	0	0	1900		tr	tr	0	tr	tr	6
USW G-1-5127.3	2300	0	0	0	2300	0	62	140	0	110	42	6
USW G-1-5141.5	2100	0	0	0	1200		tr	tr	0	tr	tr	6
USW G-1-5142.2	3700	270	0	0	1900		tr	tr	0	tr	tr	6
USW G-1-5167.6	880	730	0	0	1800	37	200	210	0	70	25	6
USW G-1-5187.0	1600	270	0	0	2200		tr	tr	0	tr	tr	6
USW G-1-5213.6	2400	160	0	0	2300	280	51	270	0	100	66	6
USW G-1-5265.6	2400	590	0	0	1800		tr	tr	0	tr	tr	6
USW G-1-5296.9	2400	830	0	0	2100	9	210	130	0	84	57	6
USW G-1-5312.6	940	0	0	0	1800	0	58	66	0	32	17	6
USW G-1-5316.0	1400	0	0	0	2800		tr	tr	0	tr	tr	6
USW G-3-4906.5	3660	0	0	0	1830		0	tr	0	tr	tr	7
USW G-3-5014.6	6480	0	0	0	3240		0	tr	0	tr	tr	7
Ue-25p#1-3570	3220	0	0	0			tr	0	0		tr	3
Ue-25p#1-3600	1780	0	0	0	1424		0	0	0		tr	[illegible]
Older Tuffs Unit B												
USW G-1-5348.8	1900	0	0	0	3300	0	65	46	0	100	20	6
USW G-1-5373.7	9000	0	0	0	3300		tr	tr	0	tr	tr	6
USW G-1-5400.0	4500	0	0	0	3200		tr	tr	0	tr	tr	6
USW G-1-5413.4	5600	0	0	0	2000	0	110	130	42	130	33	6
USW G-1-5416.6	2700	0	0	0	3200		tr	tr	0	tr	tr	6

TABLE II (cont)

Sample Number	Location[1] Lat. (North)	Location[1] Long. (East)	Sample Type[2]	Rock Type[3]	Alteration[4]	Points Counted	Voids	Pumice	Lithics	Felsic Phen.[5]	Q	Af	P	
							Volume Percent of Total Rock				% of Felsic Phenocrysts[5]			
Older Tuffs - Unit C														
USW G-1-5438.2	770500	561000	C	pwt		3900			0.7	12.9	1	3	96	
USW G-1-5454.1	770500	561000	C	b		3800			1.9	14.9	16	18	66	
USW G-1-5496.1	770500	561000	C	pwt		3900			7.5	10.1	1	4	95	
USW G-1-5499.5	770500	561000	C	pwt	Za/Ab	622	0.3	24.8	6.8	13.8	0	8	92	*
USW G-1-5517.3	770500	561000	C	pwt		3600			10.3	11.8	2	9	89	
USW G-1-5540.0	770500	561000	C	pwt		3700			8.5	13.5	1	0	99	
USW G-1-5558.7	770500	561000	C	pwt		3600			0.6	19.1	4	4	92	
USW G-1-5600.0	770500	561000	C	mwt		3750			8.4	14.8	5	7	88	
USW G-1-5637.9	770500	561000	C	mwt	Za/Ab/cc	659	0.1	4.6	5.9	15.9	0	5	95	*
USW G-1-5642.0	770500	561000	C	mwt		3300			5.8	15.4	2	4	94	
USW G-1-5680.1	770500	561000	C	b	Za	660	0.3	22.6	5.9	20.4	0	2	98	*
USW G-1-5728.0	770500	561000	C	mwt		1650			21.1	21.6	0	1	99	
USW G-1-5747.2	770500	561000	C	pwt	Za/Ab	583	1.4	15.6	6.3	27.5	0	0	100	*
USW G-1-5841.0	770500	561000	C	mwt		1650			10.8	18.0	0	4	96	
USW G-1-5848.2	770500	561000	C	pwt	Ab	627	0.0	14.8	19.6	23.3	0	10	90	*
USW G-1-5894.3	770500	561000	C	mwt		1650			7.2	15.5	0	4	96	
USW G-1-5929.8	770500	561000	C	mwt		1650			5.9	18.2	4	4	92	
USW G-1-5944.9	770500	561000	C	mwt		1600			6.3	21.6	1	6	93	
USW G-1-5948.2	770500	561000	C	pwt	Za/Ab	636	0.0	13.1	4.2	23.4	0	12	88	*
USW G-1-5980.0	770500	561000	C	mwt		1650			3.3	20.9	0	1	99	
USW G-1-5984.7	770500	561000	C	mwt		1650			2.3	25.3	0	0	100	
USW G-2-4838	778824	560504	C	pwt		1850			1.5	14.8	1	3	96	
USW G-2-4924	778824	560504	C	l		1800			0.0	5.8	0	0	100	
USW G-2-5017	778824	560504	C	l		1800			0.0	7.6	0	10	90	
Ue-25p#1-3640	756171	571485	Da						7.0	14.4	1	5	94	
Ue-25p#1-3670	756171	571485	Da						10.5	14.0	1	2	97	
Ue-25p#1-3730	756171	571485	Da						9.0	17.6	0	2	98	

TABLE II (cont)

Sample Number	Biotite	Hb	Cpx	Opx	Fe-Ti Oxides	Ilm	Sphene	Allan-ite	Ferr-ierite	Apatite	Zircon	Ref.[6]
Mafic- and Accessory-Mineral Concentrations in Parts per Million[7]												
Older Tuffs Unit C												
USW G-1-5438.2	12000	0	0	0	4600		0	tr(?)	0	tr	tr	6
USW G-1-5454.1	7100	0	0	0	5000		tr	tr(?)	0	tr	tr	6
USW G-1-5496.1	21000	0	0	0	4900		tr	tr(?)	0	tr	tr	6
USW G-1-5499.5	5400	0	0	0	2500	260	47	160	0	210	78	6
USW G-1-5517.3	11400	0	0	0	4500		tr	tr(?)	0	tr	tr	6
USW G-1-5540.0	19200	810ps	0	0	4300		tr	0	0	tr	tr	6
USW G-1-5558.7	16400	1100ps	0	0	5300		tr	tr(?)	0	tr	tr	6
USW G-1-5600.0	10100	800ps	0	0	6400		tr	tr(?)	0	tr	tr	6
USW G-1-5637.9	10500	ps	0	0	3900	51	110	45	0	260	56	6
USW G-1-5642.0	21500	1500ps	0	0	5800		tr	tr(?)	0	tr	tr	6
USW G-1-5680.1	3800	470	0	0	2200	640	200	410	0	200	66	6
USW G-1-5728.0	18200	ps	0	0	7900		tr	tr(?)	0	tr	tr	6
USW G-1-5747.2	9900	0	0	0			65	55	0			6
USW G-1-5841.0	12100	600ps	0	0	8500		tr	tr(?)	0	tr	tr	6
USW G-1-5848.2	6200	0	0	0	2900	410	10	15	0	210	98	6
USW G-1-5894.3	6100	6100	0	0	3600		tr	tr(?)	0	tr	tr	6
USW G-1-5929.8	13300	5500ps	0	0	6100		tr	tr(?)	0	tr	tr	6
USW G-1-5944.9	6900	7500ps	ps	0	5000		tr	tr(?)	0	tr	tr	6
USW G-1-5948.2	5200	340	0	0	3100	0	0	0	30	180	50	6
USW G-1-5980.0	24200	7300ps	1800ps	0	7300		tr	tr(?)	0	tr	tr	6
USW G-1-5984.7	27200	8500ps	1200ps	0	9700		tr	tr(?)	0	tr	tr	6
USW G-2-4838	10269	0	0	0	4890		tr	0	0	tr	tr	3
USW G-2-4924	11400	3800ps	0	0	3040		0	tr(?)	0	tr	tr	3
USW G-2-5017	9570ps	0	0	0	1740		tr	0	0	tr	tr	3
Ue-25p#1-3640	14685	0	0	0	6600		0	0	0	0	tr	3
Ue-25p#1-3670	10676	1727ps	0	0	4553		0	0	0	0	tr	3
Ue-25p#1-3730	16037	2639ps	0	0	8323		tr	0	0	0	tr	3

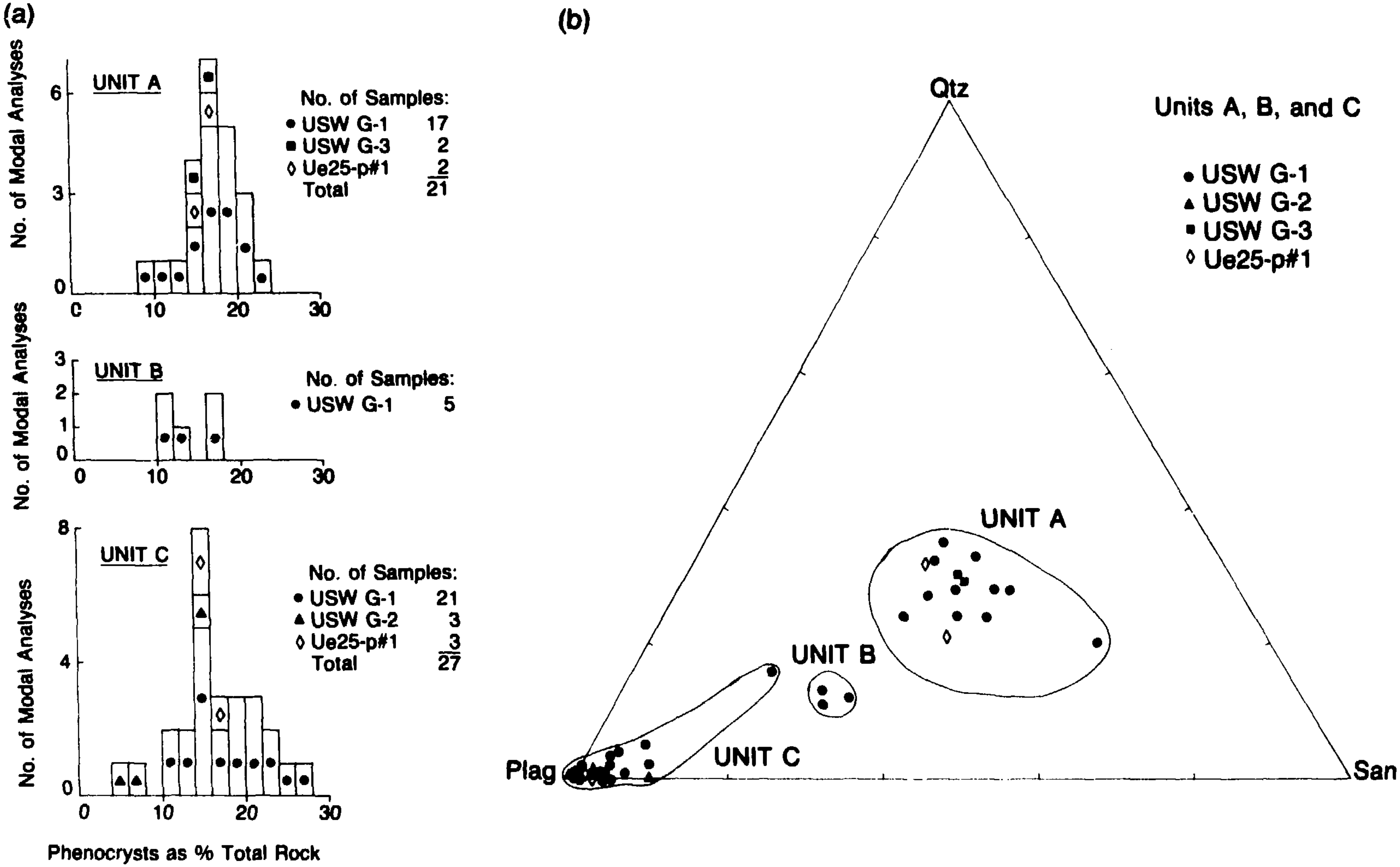


Fig. 2. Summary of petrographic data for the Older Tuff Units A, B, and C at Yucca Mountain, Nevada. (a) Histograms showing distribution of total phenocryst abundances. (b) Triangular diagram showing the proportions of quartz (Qtz), sanidine (San), and plagioclase (Plag) phenocrysts. There are no data for outcrop samples. (c) Histograms showing the distribution of Or + Cn (orthoclase and celsian) in sanidine, An (anorthite) in plagioclase, and Mg* in biotite phenocrysts for Older Tuff Units A, B, and C at Yucca Mountain, Nevada. Number of samples equals thin sections probed; number of analyses equals the number of chemical determinations performed. Shaded areas of histograms for plagioclase phenocryst compositions indicate rim compositions; unshaded areas indicate cores, midzones, and rims undivided. There are no data for outcrop samples.

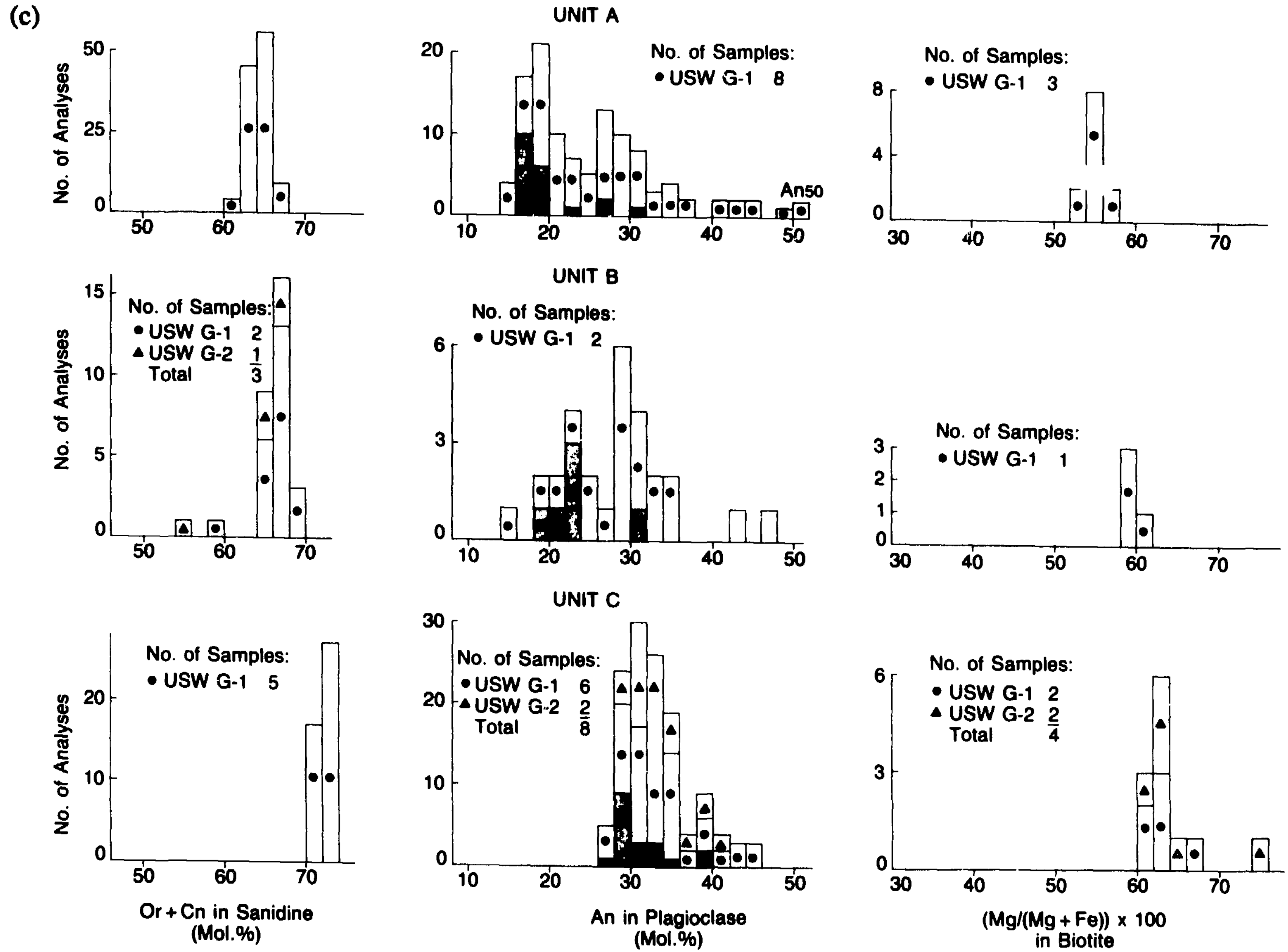

(c)
UNIT A
UNIT B
UNIT C
No. of Analyses
No. of Samples:
USW G-1 8
USW G-1 3
USW G-1 2
USW G-2 1
Total 3
USW G-1 1
USW G-1 5
USW G-1 6
USW G-2 2
Total 8
USW G-1 2
USW G-2 2
Total 4
An50
Or + Cn in Sanidine (Mol.%)
An in Plagioclase (Mol.%)
(Mg/(Mg + Fe)) x 100 in Biotite

Fig. 2. (cont)

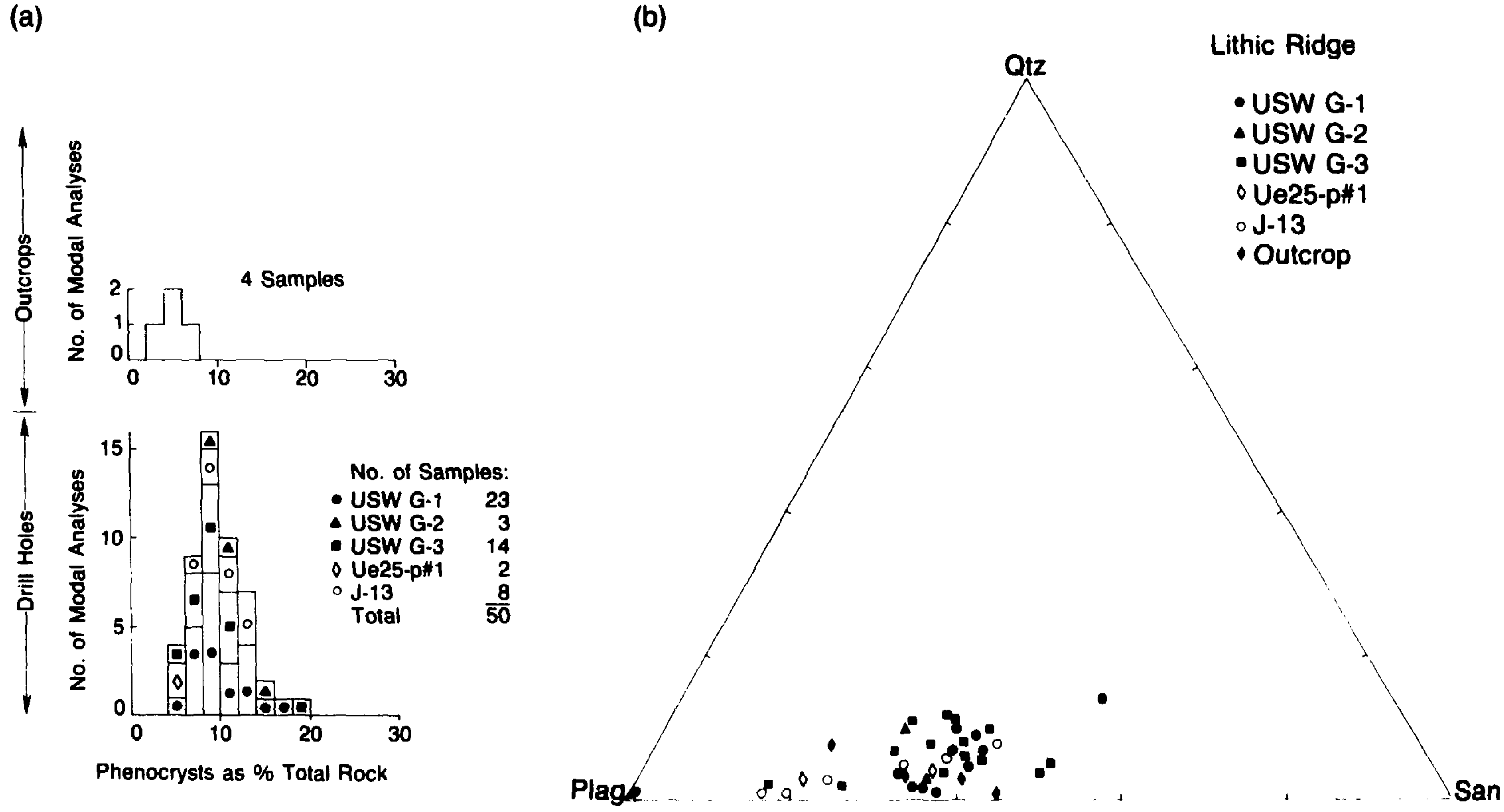


Fig. 3. Summary of petrographic data for the Lithic Ridge Tuff at Yucca Mountain, Nevada. (a) Histograms showing distribution of total phenocryst abundances. (b) Triangular diagram showing the proportions of quartz (Qtz), sanidine (San), and plagioclase (Plag) phenocrysts. (c) Histograms showing the distribution of Or + Cn in sanidine, An in plagioclase, and Mg* in biotite phenocrysts for the Lithic Ridge Tuff at Yucca Mountain, Nevada. Shaded areas of histograms for plagioclase phenocryst compositions indicate rim compositions; unshaded areas indicate cores, midzones, and rims undivided.

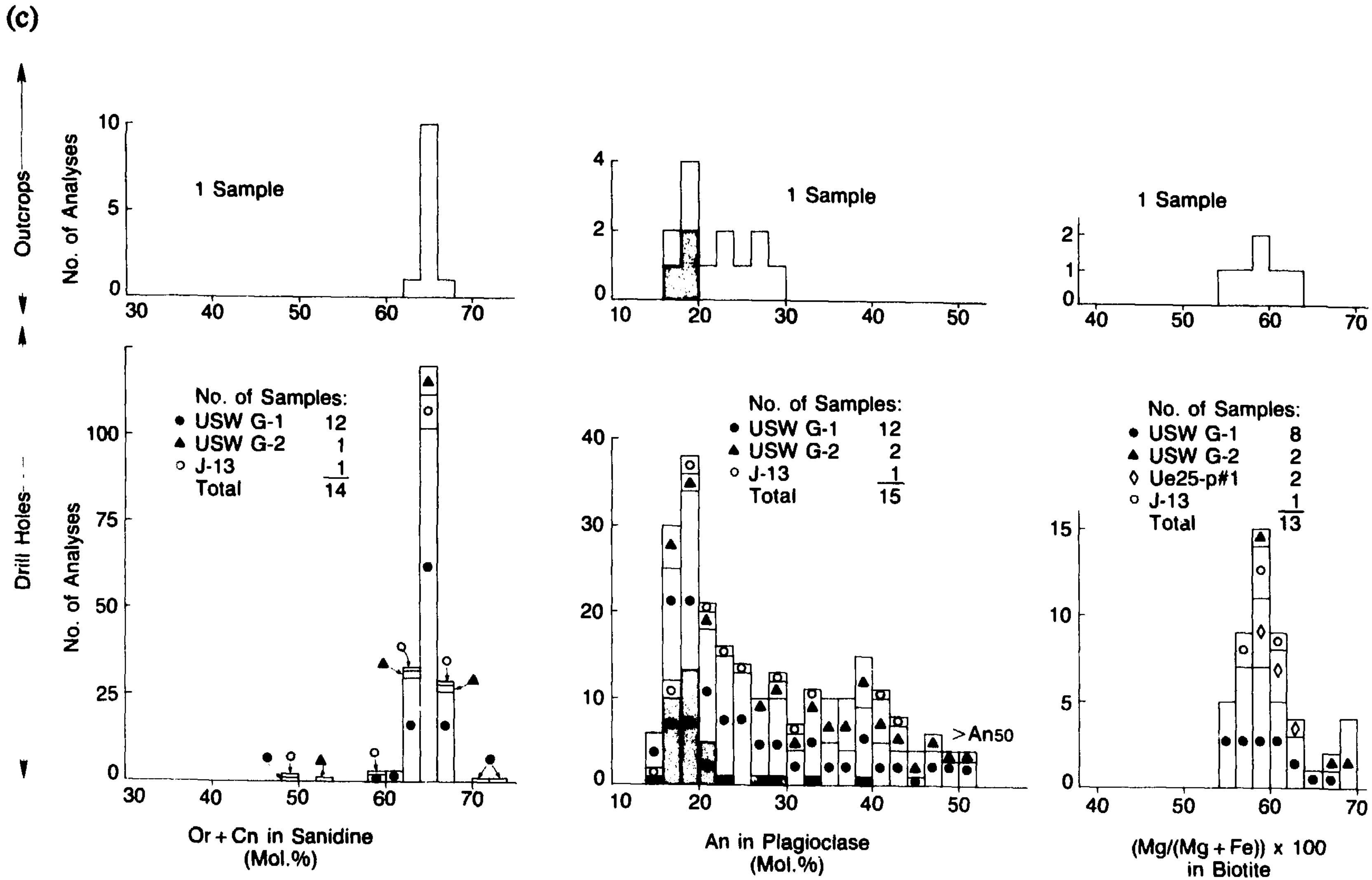

(c)
Outcrops
Drill Holes
No. of Analyses
1 Sample
No. of Samples:
USW G-1 12
USW G-2 1
J-13 1
Total 14
Or + Cn in Sanidine
(Mol.%)
1 Sample
No. of Samples:
USW G-1 12
USW G-2 2
J-13 1
Total 15
>An50
An in Plagioclase
(Mol.%)
1 Sample
No. of Samples:
USW G-1 8
USW G-2 2
Ue25-p#1 2
J-13 1
Total 13
(Mg/(Mg + Fe)) x 100
in Biotite

Fig. 3. (cont)

emplacement of these tuffs. Felsic phenocryst proportions and mineral compositions, which are unaffected by such processes, are similar for drill holes USW G-1 and USW G-2 (Figs. 2b and 2c).

2. Older Tuffs Unit B. Modal petrographic data for Unit B are available only for drill hole USW G-1 (Warren et al., 1984). Phenocryst compositions are also limited to two samples from USW G-1 (Warren et al., 1984). These data are summarized in Table II and in Fig. 2.

Unit B contains 10% to 18% phenocrysts (Fig. 2a) consisting of plagioclase, sanidine, and quartz. Together, sanidine and quartz make up about 40% of the felsic phenocryst phases (Fig. 2b). Biotite is the only major mafic phenocryst phase. Accessory minerals include Fe-Ti oxides, apatite, allanite, sphene, zircon, and perrierite (Table II).

Most sanidine phenocrysts have compositions ranging between Or_{66-70} (Fig. 2c). Plagioclase compositions appear to be bimodal with modes clustering around An_{23} and An_{30} (Fig. 2c). Plagioclase compositions clustering around An_{30} may represent xenocrysts picked up from the underlying plagioclase-rich Unit C or may reflect the dominant compositions of calcic cores in zoned plagioclase crystals. Biotite compositions are magnesium rich (Mg^*_{59}; Fig. 2c).

Unit B is distinguished from Unit C by a higher proportion of sanidine and quartz as felsic phenocrysts (Fig. 2a) and by more sodic sanidine compositions (Fig. 2c). If the plagioclase compositions clustering near An_{30} are xenocrystic, then plagioclase compositions representing magmatic values for Unit B are also more sodic than those in Unit C. Existing modal and mineral chemical data are too sparse to assess the internal consistency of petrochemical characteristics in Unit B.

3. Older Tuff Unit A. Modal petrographic data for Unit A of the older tuffs are reported for USW G-1 (Warren et al., 1984), USW G-3 (this report), and UE-25p#1 (this report). Microprobe data for plagioclase, sanidine, and biotite are presented in Warren et al. (1984). These data are summarized in Table II and in Fig. 2.

Unit A contains 8% to 24% phenocrysts (Fig. 2a) consisting predominantly of plagioclase, sanidine, and quartz. Sanidine and quartz make up 55% to 70% of the felsic phenocrysts (Fig. 2b). Biotite and trace amounts of hornblende are the mafic phenocrysts (Table II). Accessory minerals consist of Fe-Ti oxides, apatite, allanite, sphene, and zircon (Table II).

Sanidine compositions in Unit A are more sodic (mostly Or_{62-68}) than those in Units B or C (Fig. 2c). Plagioclase compositions are bimodal with modes clustering around An_{19} and An_{30}. Plagioclase rim compositions range from An_{14-20}. Plagioclase compositions clustering around An_{30} are similar to those found in Units B and C and represent core and midzone compositions in chemically zoned crystals. Biotite compositions, which cluster around Mg^*_{55}, are more iron rich than those in Units B and C (Fig. 2c).

The modal data for Unit A are consistent for drill holes USW G-1, USW G-3, and UE-25p#1. Total phenocryst contents (Fig. 2a), relative proportions of felsic phenocrysts (Fig. 2b), and accessory mineral assemblages (Table II) overlap among the three drill holes. Mineral chemical data are available only for USW G-1; of these data sanidine and biotite compositions have narrow compositional ranges and together with the modal data show internal consistency within the drill hole (Table II). In a broader comparison, each of these older units is clearly distinguishable from another. Going upsection, each unit becomes systematically richer in sanidine and quartz (Fig. 2b), has more sodic sanidine and plagioclase compositions (Fig. 2c), and has more iron-rich biotites (Fig. 2c).

B. Lithic Ridge Tuff

Modal petrographic data for the Lithic Ridge Tuff were compiled from Warren et al. (1984) for drill holes USW G-1 and J-13, from Byers and Warren (1983) for drill hole J-13, and from Scott and Castellanos (1984) for drill hole USW G-3 . New modal analyses are also presented for drill holes USW G-2, J-13, and UE-25p#1 as well as for three outcrop samples. Modal data for outcrop samples were taken from Quinlivan and Byers (1977) and Warren et al. (1984). Microprobe analyses of phenocrysts were compiled for drill holes USW G-1, USW G-2, and J-13 from Warren et al. (1984) and Broxton et al. (1982). These data are summarized in Table II and in Fig. 3.

The Lithic Ridge Tuff is a quartz-poor unit that typically contains about 10% phenocrysts (Fig. 3a). Plagioclase predominates over sanidine (Fig. 3b), and biotite is the major mafic phenocryst phase. Small amounts of hornblende occur in a few samples. Accessory minerals include Fe-Ti oxides, sphene, allanite, apatite, and zircon (Table II). Lithic fragments of pilotaxitic lavas and welded tuff are abundant throughout the unit commonly making up 10%-40% of the rock (Table II). The persistence of high lithic fragment contents throughout the Lithic Ridge Tuff makes it an excellent marker bed (W. J. Carr et al., 1986).

Sanidine compositions cluster between Or_{62} and Or_{68} (Fig. 3c) and thus are similar to those of Unit A. Plagioclase core compositions are widely scattered, falling primarily between An_{14} and An_{50}. Plagioclase rims define a narrower compositional range occurring mostly between An_{16-22} (Fig. 3c). Biotite compositions are relatively magnesium rich, ranging in composition between Mg^*_{54-70} and concentrating around Mg^*_{59} (Fig. 3c).

The four outcrop samples of the Lithic Ridge Tuff are slightly less phenocryst rich than most drill core samples owing to less dense welding (compaction); however, the phenocryst abundances of the outcrop samples overlap the lower end of the range observed in drill holes (Fig. 3a). The proportions of felsic phenocrysts in the outcrop samples are similar to those in drill core samples, and the assemblage of mafic and accessory phases is the same (Fig. 3b; Table II). Compositions of sanidine phenocrysts match well when drill core samples are compared with the one outcrop sample that was analyzed (Fig. 3c). Plagioclase and biotite compositions do not form as tight a compositional group as the sanidines, but it is clear from Fig. 3c that the compositional ranges for these minerals in outcrop and drill core overlap. In addition to a generally favorable comparison between drill hole and outcrop data, there is good agreement among the various drill holes when the modal and mineral chemical data are compared (Figs. 3a, b, and c). One exception is the high-Mg biotite (Mg^{*}_{70}) reported in one sample (USW G2-4199); the biotite in this sample is substantially more magnesium rich than other samples for this unit (Fig. 3c). This sample is the stratigraphically highest sample of Lithic Ridge Tuff in USW G-2. It contains no sanidine and quartz, has Ca-rich plagioclase, and has >1% hornblende. This sample may represent ash flows that tapped deeper, more mafic levels of the Lithic Ridge magma chamber.

Dacitic lava flows and flow breccias overlie the Lithic Ridge Tuff in the subsurface in the northern part of Yucca Mountain. These dacitic rocks were penetrated in drill holes USW G-2 and USW G-1. Modal data for these intermediate composition rocks are presented in Table II, but they are not discussed further in this report. Mineral chemical data for these rocks are presented in Warren et al. (1984).

C. Crater Flat Tuff

The Crater Flat Tuff comprises three ash-flow tuff cooling units. In ascending order these are the Tram, Bullfrog, and Prow Pass Members (Table I). These three ash-flow sheets are rhyolitic in composition and crop out south and east of the Timber Mountain-Oasis Valley caldera complex; tuffs and lavas with similar petrochemical characteristics occur in the same stratigraphic interval in the subsurface at the Silent Canyon caldera to the north (Warren, 1983). At Yucca Mountain, the Crater Flat Tuff overlies dacitic lavas and flow breccias in the northern part of Yucca Mountain and the Lithic Ridge Tuff in the southern part. The Bullfrog Member has a K/Ar age of 13.9 Ma (Marvin et al., 1970; W. J. Carr et al., 1986).

1. Tram Member. Modal data for the Tram Member were compiled from Byers and Warren (1983) for samples from J-13, from Scott and Castellanos (1984) for samples from USW G-3, and from Warren et al. (1984) for outcrop samples and samples from USW G-1 and J-13. In addition, new modal data are presented for one outcrop sample and for samples from drill holes UE-25p#1, USW G-2, and USW G-4 in Table II and Figs. 4a and 4b. Microprobe analyses of phenocrysts (Fig. 4c) were compiled for drill holes USW G-1, USW G-2, UE-25b#1H, UE-25p#1, and J-13 from Warren et al. (1984), Broxton et al. (1982), and M. D. Carr et al. (1986). Additional unpublished microprobe data for feldspar phenocrysts in one outcrop sample and for two samples from UE-25p#1 are also presented in Fig. 4c.

The Tram Member commonly contains between 6% and 16% phenocrysts (Fig. 4a) consisting primarily of subequal amounts of quartz, sanidine, and plagioclase (Fig. 4a). Mafic phenocrysts include biotite and trace amounts of hornblende. Accessory minerals consist of Fe-Ti oxides, apatite, allanite, and zircon (Table II). Higher quartz contents and lack of sphene readily distinguish the Tram Member from the underlying Lithic Ridge Tuff. Also, the Tram Member is generally lithic rich only in its lower part [e.g., USW G-1 and USW G-3 (Table II)], whereas the Lithic Ridge Tuff is lithic rich throughout.

Sanidine compositions cluster around Or_{67}, and plagioclase core compositions fall primarily between An_{16} and An_{40} (Fig. 4c). Plagioclase rims have compositions mostly between An_{18-24}. The compositions of these feldspar phenocrysts are similar to those found in the Lithic Ridge Tuff (Fig. 3c). Biotite phenocrysts in the Tram Member, on the other hand, are distinctly more iron rich (Mg^*_{34-52}) than those in the Lithic Ridge Tuff (Mg^*_{54-70}). The few magnesium-rich biotites found in the Tram Member (Fig. 4c) are probably xenocrysts from underlying units.

There is good agreement between the drill hole samples and the outcrop samples when the petrographic and mineral chemistry data are compared. The phenocryst and accessory mineral assemblages are similar for samples from drill hole and from outcrop. The mineral chemistry of phenocrysts also matches well, particularly for sanidine and biotite. Modal and mineral chemical data also compare well among the drill holes for which data are available.

2. Bullfrog Member. Modal petrographic data for the Bullfrog Member were compiled from Quinlivan and Byers (1977) for outcrop samples, from Byers and Warren (1983) for samples from J-13, from Scott and Castellanos (1984) for samples from USW G-3, and from Warren et al. (1984) for outcrop samples and samples from USW G-1, J-13, and UE-25a#1. In addition, new modal data are presented for samples from drill holes USW G-2 and USW G-4 in Table II. Microprobe analyses of phenocrysts were compiled for drill holes USW G-1, USW G-2, UE-25a#1, UE-25b#1H, and J-13 from Warren et al. (1984), Broxton et al. (1982), and Sykes et al. (1979). New feldspar compositional data are presented for one sample from UE-25p#1.

The Bullfrog Member commonly contains between 8% and 20% phenocrysts (Fig. 5a) consisting primarily of plagioclase, sanidine, and quartz in order of decreasing abundance (Fig. 5b). The mafic phenocrysts are biotite, hornblende, and trace clinopyroxene (Table II). Accessory minerals consist of Fe-Ti oxides, apatite, allanite, and zircon. Lower quartz contents, wormy quartz, and relatively abundant hornblende readily distinquish the Bullfrog Member from the underlying Tram Member. In addition, the Bullfrog Member is generally lithic poor throughout, whereas the Tram Member has a lithic-rich base in the vicinity of Yucca Mountain.

Sanidine compositions in the Bullfrog Member are dominantly Or_{60-64}, and plagioclase core compositions fall primarily between An_{10} and An_{40} (Fig. 5c). Plagioclase rim compositions cluster from An_{10-18}. Both plagioclase and sanidine tend to have more sodic compositions than those found in the Tram Member. Biotite compositions in the Bullfrog Member partially overlap those of the Tram Member, but generally they are slightly more iron rich ($\sim Mg^*_{40}$).

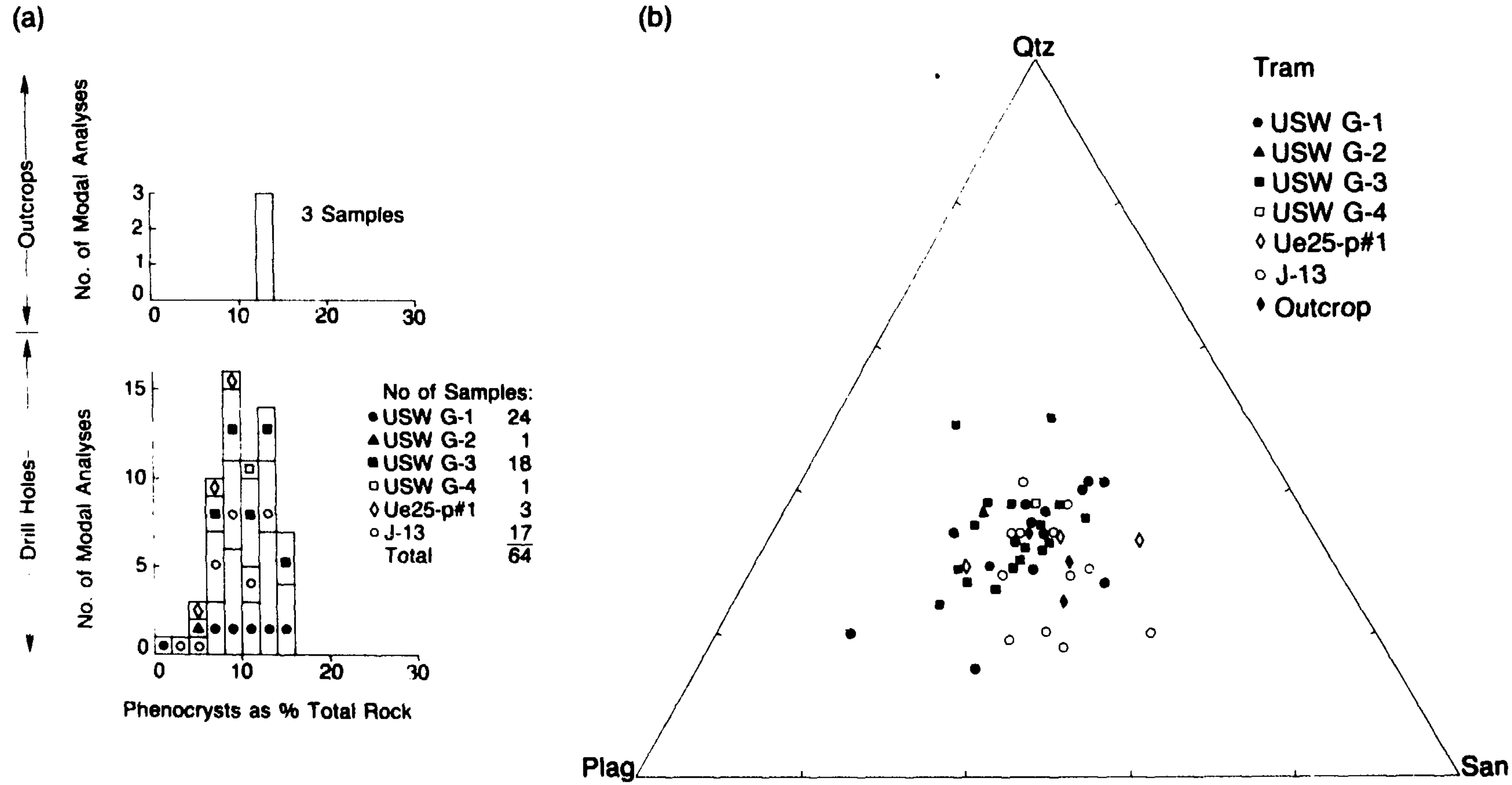
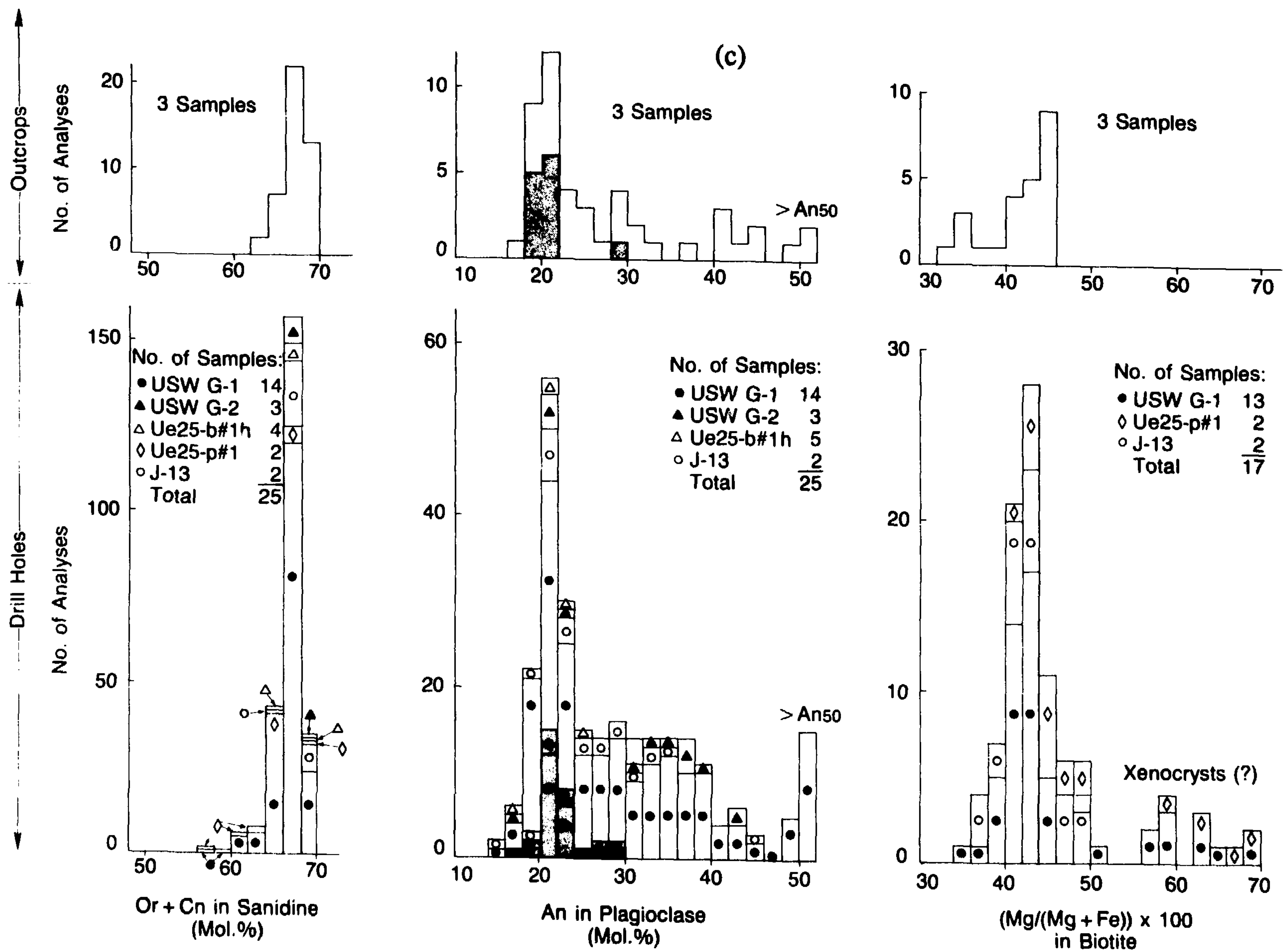


Fig. 4. Summary of petrographic data for the Tram Member of the Crater Flat Tuff at Yucca Mountain, Nevada. (a) Histograms showing distribution of total phenocryst abundances. (b) Triangular diagram showing the proportions of quartz (Qtz), sanidine (San), and plagioclase (Plag) phenocrysts. (c) Histograms showing the distribution of Or + Cn in sanidine, An in plagioclase, and Mg* in biotite phenocrysts for the Tram Member of the Crater Flat Tuff at Yucca Mountain, Nevada. Shaded areas of histograms for plagioclase phenocryst compositions indicate rim compositions; unshaded areas indicate cores, midzones, and rims undivided.



(c)
Outcrops
Drill Holes
No. of Analyses
3 Samples
> An50
No. of Samples:
USW G-1 14
USW G-2 3
Ue25-b#1h 4
Ue25-p#1 2
J-13 2
Total 25
No. of Samples:
USW G-1 14
USW G-2 3
Ue25-b#1h 5
J-13 2
Total 25
No. of Samples:
USW G-1 13
Ue25-p#1 2
J-13 2
Total 17
Xenocrysts (?)
Or + Cn in Sanidine (Mol.%)
An in Plagioclase (Mol.%)
(Mg/(Mg + Fe)) x 100 in Biotite

Fig. 4 (cont)

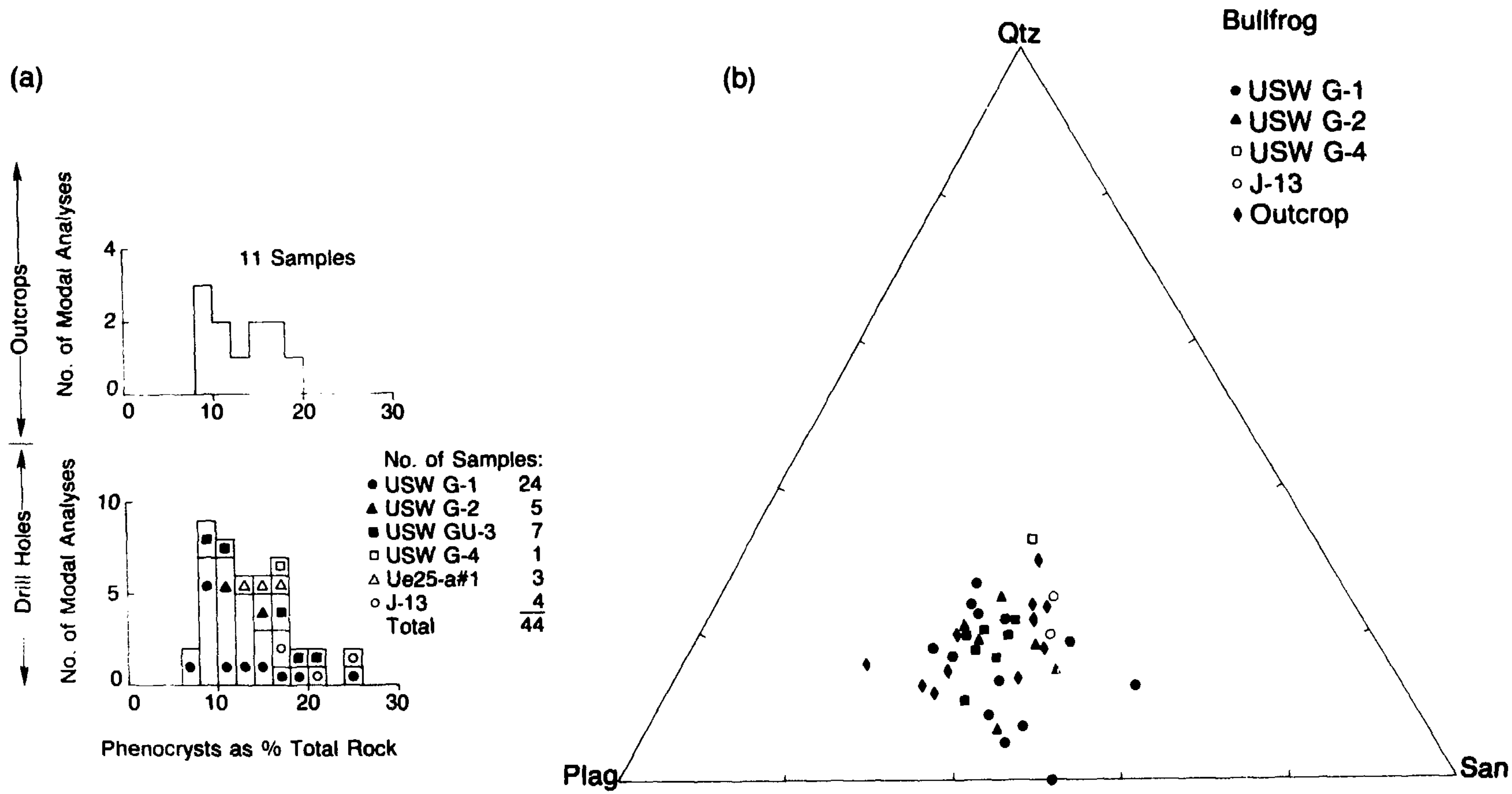


Fig. 5. Summary of petrographic data for the Bullfrog Member of the Crater Flat Tuff at Yucca Mountain, Nevada. (a) Histograms showing distribution of total phenocryst abundances. (b) Triangular diagram showing the proportions of quartz (Qtz), sanidine (San), and plagioclase (Plag) phenocrysts. (c) Histograms showing the distribution of Or + Cn in sanidine, An in plagioclase, and Mg* in biotite phenocrysts for the Bullfrog Member of the Crater Flat Tuff at Yucca Mountain, Nevada. Shaded areas of histograms for plagioclase phenocryst compositions indicate rim compositions; unshaded areas indicate cores, midzones, and rims undivided.

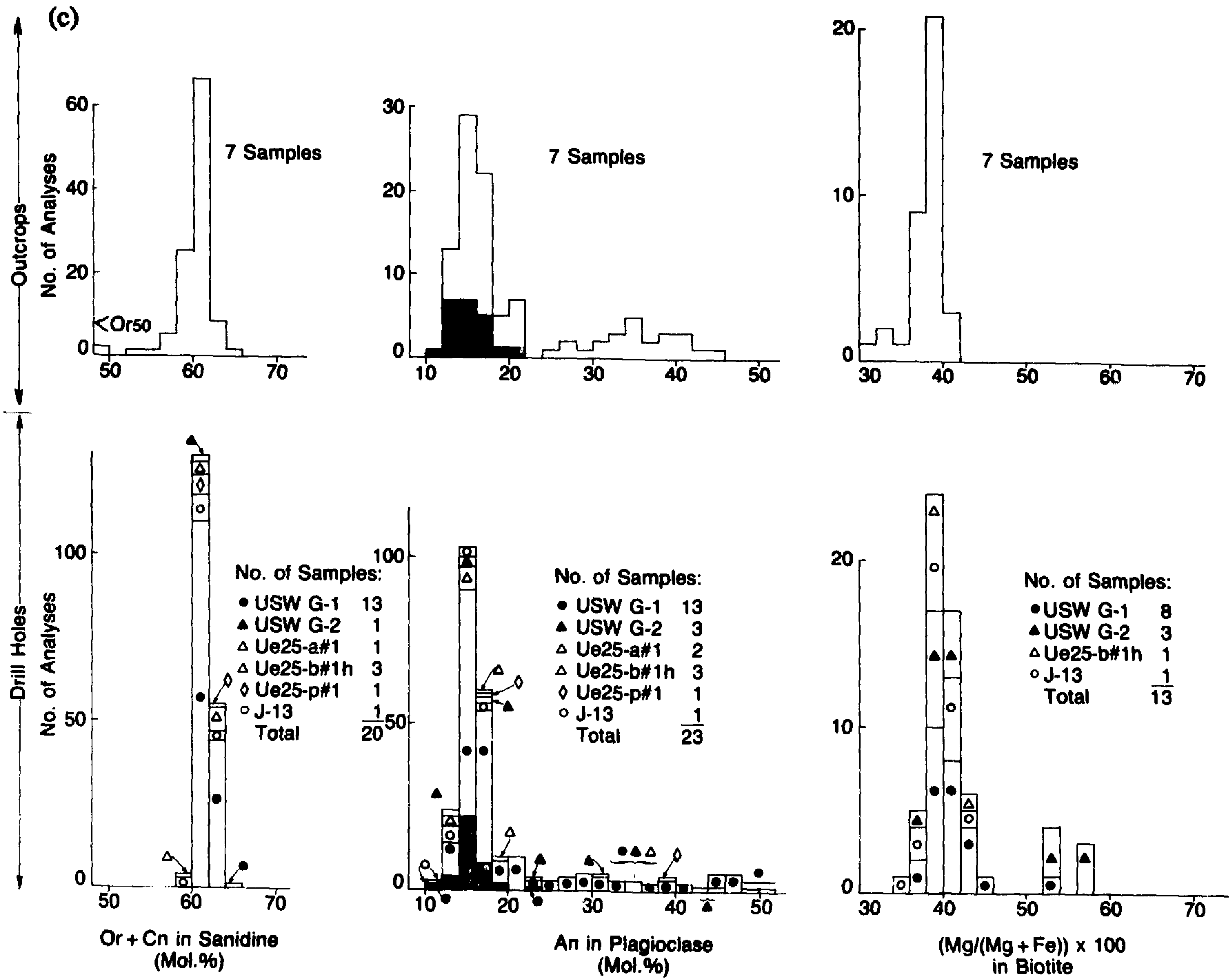

(c)
Outcrops
No. of Analyses
7 Samples
<Or50
7 Samples
7 Samples
Drill Holes
No. of Analyses
No. of Samples:
USW G-1 13
USW G-2 1
Ue25-a#1 1
Ue25-b#1h 3
Ue25-p#1 1
J-13 1
Total 20
No. of Samples:
USW G-1 13
USW G-2 3
Ue25-a#1 2
Ue25-b#1h 3
Ue25-p#1 1
J-13 1
Total 23
No. of Samples:
USW G-1 8
USW G-2 3
Ue25-b#1h 1
J-13 1
Total 13
Or + Cn in Sanidine (Mol.%)
An in Plagioclase (Mol.%)
(Mg/(Mg + Fe)) x 100 in Biotite

Fig. 5 (cont)

Phenocryst abundances of outcrop samples overlap those of drill hole samples for the Bullfrog Member (Fig. 5a). The proportions of felsic phenocrysts in the outcrop samples agree well with those in drill core samples, and the assemblage of mafic and accessory phases is the same in outcrop samples and in drill core samples (Table II). The Bullfrog Member is characterized by sanidines that define the same narrow compositional range in outcrop and in drill core (Fig. 5c). Plagioclase and biotite compositions do not form as tight a compositional group as the sanidines, but the compositional ranges for these minerals in outcrop and drill core overlap. Plagioclase rims, on the other hand, have distinct sodium-rich compositions in both outcrop and drill holes; these sodic plagioclase rims distinguish the Bullfrog Member from underlying units. Like the comparison between drill hole and outcrop data, there is good agreement among the various drill holes when the modal and mineral chemical data are compared (Figs. 5a, b, and c).

3. Prow Pass Member. Modal data for the Prow Pass Member were compiled from Quinlivan and Byers (1977) for outcrop samples, from Byers and Warren (1983) for samples from J-13, from Scott and Castellanos (1984) for samples from USW G-3, and from Warren et al. (1984) for outcrop samples and samples from USW G-1, J-13, and UE-25a#1. In addition, new modal data are presented for samples from drill holes USW G-2 and USW G-4 in Table II. Microprobe analyses of phenocrysts were compiled for drill holes USW G-1, USW G-2, UE-25a#1, and J-13 from Warren et al. (1984), Broxton et al. (1982), and Sykes et al. (1979). New data for sanidine compositions are presented for UE-25p#1. A few of the quartz-rich samples of the Prow Pass Member from northern Crater Flat analyzed by Quinlivan and Byers may actually be samples of the altered Bullfrog Member.

The Prow Pass Member generally contains 6% to 14% phenocrysts (Fig. 6a) consisting primarily of plagioclase, sanidine, and quartz. The Prow Pass Member contains slightly less quartz (Fig. 6b) than the lower members of the Crater Flat Tuff contain (Figs. 4b and 5b); characteristically, this quartz is extremely embayed and wormy. Mafic phenocrysts are biotite, hornblende, and orthopyroxene (Table II). The presence of Fe-rich orthopyroxene is useful in identifying the Prow Pass Member because it is found only in this unit at Yucca Mountain. The accessory mineral assemblage of the Prow Pass Member consists of Fe-Ti oxides, apatite, allanite, and zircon (Table II).

Feldspar phenocryst compositions in the Prow Pass Member are more sodic than those of the two lower members of the Crater Flat Tuff (Figs. 4c, 5c, and 6c). The compositions of sanidine phenocrysts are dominantly Or_{50-56}. Plagioclase compositions concentrate between An_8 and An_{14}, though crystals with more calcic midzones and cores are found in a few samples. Plagioclase rim compositions are dominantly An_{10-12}. There are relatively few analyses of biotite phenocrysts for the Prow Pass Member (Fig. 6c). Most of the available biotite compositions fall between Mg^*_{38-54} and thus overlap those of the two older members of the formation.

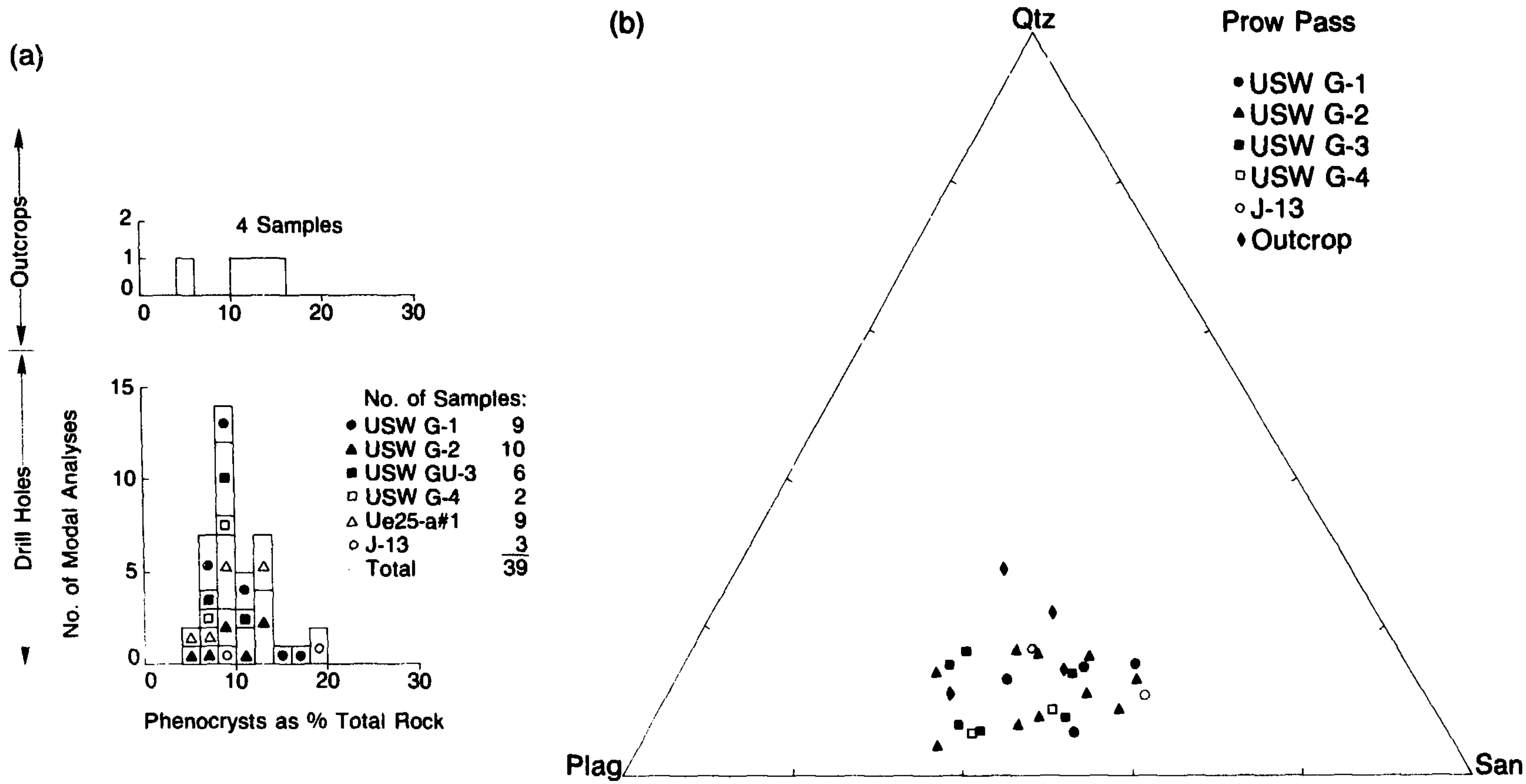
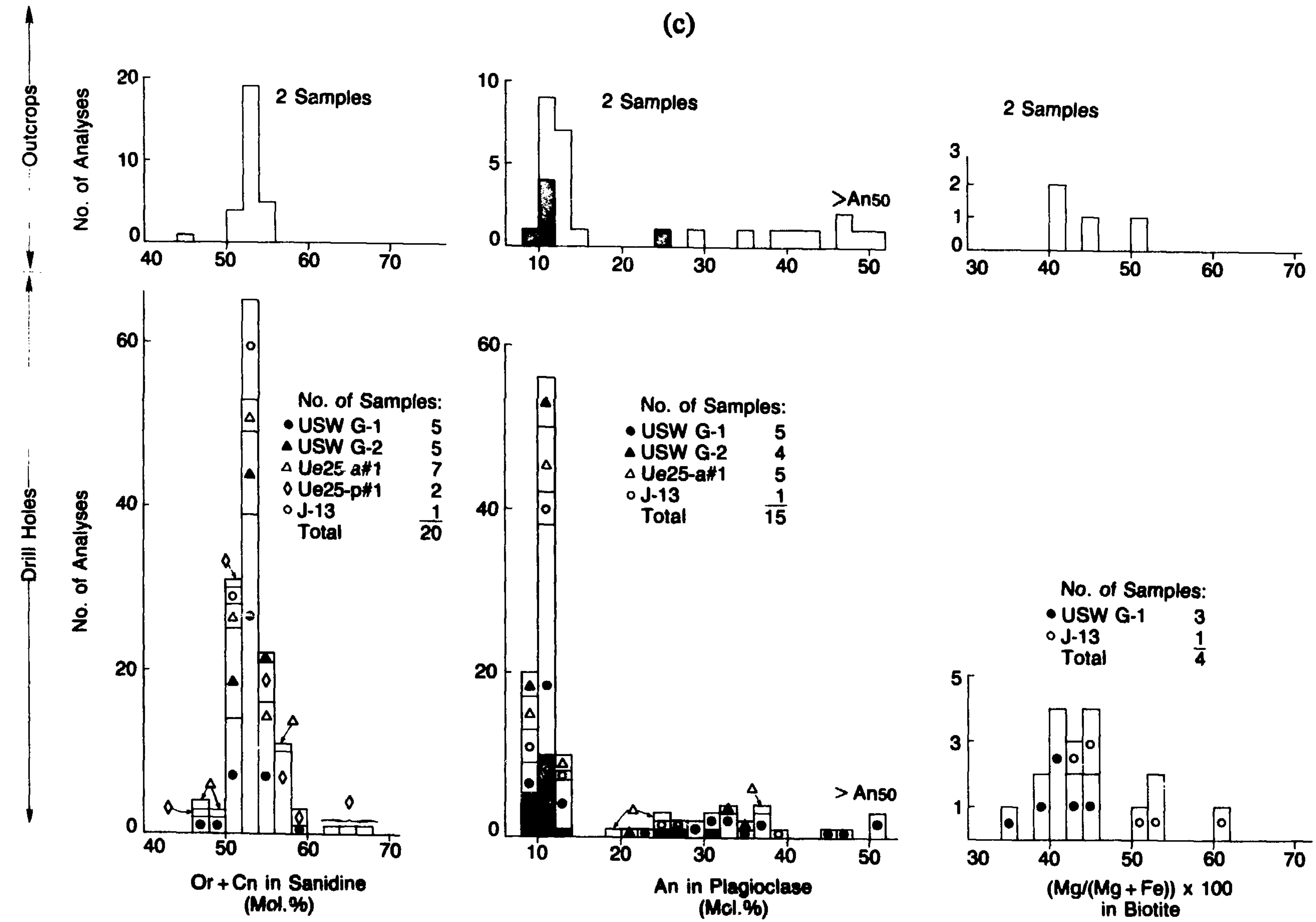


Fig. 6. Summary of petrographic data for the Prow Pass Member of the Crater Flat Tuff at Yucca Mountain, Nevada. (a) Histograms showing distribution of total phenocryst abundances. (b) Triangular diagram showing the proportions of quartz (Qtz), sanidine (San), and plagioclase (Plag) phenocrysts. (c) Histograms showing the distribution of Or + Cn in sanidine, An in plagioclase, and Mg^* in biotite phenocrysts for the Prow Pass Member of the Crater Flat Tuff at Yucca Mountain, Nevada. Shaded areas of histograms for plagioclase phenocryst compositions indicate rim compositions; unshaded areas indicate cores, midzones, and rims undivided.



(c)
Outcrops
Drill Holes
No. of Analyses
2 Samples
>An50
> An50
No. of Samples:
● USW G-1 5
▲ USW G-2 5
△ Ue25 a#1 7
◊ Ue25-p#1 2
○ J-13 1
Total 20
No. of Samples:
● USW G-1 5
▲ USW G-2 4
△ Ue25-a#1 5
○ J-13 1
Total 15
No. of Samples:
● USW G-1 3
○ J-13 1
Total 4
Or + Cn in Sanidine
(Mol.%)
An in Plagioclase
(Mol.%)
(Mg/(Mg + Fe)) x 100
in Biotite

Fig. 6 (cont)

Outcrop data for the Prow Pass Member are sparse, consisting of modal analyses for four samples and mineral chemical data for two samples. Data for the sample with the second highest proportion of quartz in Fig. 6b are from an outcrop sample in northern Crater Flat (Quinlivan and Byers, 1977). The outcrop from which this sample was collected is probably the Bullfrog Member. Only two members of the Crater Flat Tuff, Bullfrog and Prow Pass, were recognized in northern Crater Flat when these authors compiled their data. As a result of recent mapping (Paul P. Orkild, USGS, unpublished data), the two Crater Flat units in northern Crater Flat are the Tram and Bullfrog Members.

Agreement between the data sets for outcrop and drill hole samples is generally good, but additional work should be conducted on outcrop samples to better establish this relationship. Phenocryst abundances in the four outcrop samples overlap the upper end of the range observed in drill holes (Fig. 6a). The proportions of felsic phenocrysts in the outcrop samples are similar to those in drill core samples (Fig. 6b) with the possible exception of two quartz-rich samples, one of which is probably Bullfrog as discussed above. The assemblages of mafic and accessory phases are the same (Table II). Compositions of sanidine and plagioclase phenocrysts match well when drill core samples are compared with the two outcrop samples that were analyzed (Fig. 6c). Biotite compositions are sparse for both drill holes and outcrops; however, the two data sets overlap for the available analyses (Fig. 6c). There is good agreement among the various drill holes when the modal and mineral chemical data are compared (Figs. 6a, b, and c). Feldspars in particular have distinct compositional signatures that are found in all of the drill hole samples analyzed. Although there is considerable scatter in modal data, there is generally a good correspondence between data from different drill holes. Two of the three samples from J-13 are somewhat more crystal rich than samples from other drill holes. The proportions of felsic phenocrysts are known in only one of these two samples; these felsic phenocryst proportions are similar to those found in other samples of the Prow Pass Member.

D. Tuffaceous Beds of Calico Hills

The tuffaceous beds of Calico Hills are a sequence of ash-flow and ash-fall tuff, volcaniclastic sediment, and rhyolitic lavas. At Yucca Mountain, the unit consists primarily of numerous nonwelded ash-flow tuffs that in places are separated by thin ash-fall and reworked tuffs. The Calico Hills unit thins southward from 289 m at USW G-2 (Maldonado and Koether, 1983) to about 29 m in USW GU-3 (Scott and Castellanos, 1984). The tuffaceous beds of Calico Hills have been dated at 13.8 Ma by K-Ar methods (Marvin et al., 1970; using the new constants in Dalrymple, 1979).

Modal data for the tuffaceous beds of Calico Hills were compiled from Warren et al. (1984) for samples from USW G-1 and from Scott and Castellanos (1984) for samples from USW GU-3. New modal data are presented for samples from drill holes USW G-2, USW GU-3, and USW G-4 and for outcrops of tuffs north of Yucca Mountain and lavas in Paintbrush Canyon. Microprobe analyses of phenocrysts were compiled for drill holes USW G-1 (Warren et al., 1984) and USW G-2 (Broxton et al., 1982). New microprobe data are presented for three outcrop samples.

The Calico Hills unit is generally phenocryst poor (<4% crystals) at Yucca Mountain (Fig. 7a). However, the lower part of the unit is phenocryst rich (up to 25% crystals) in drill holes USW G-1 and USW G-2 as well as in outcrop north of Prow Pass (Fig. 7a). Phenocrysts consist of plagioclase, sanidine, and quartz (Fig. 7b) and minor amounts of biotite (Table II). Hornblende, clinopyroxene, and orthopyroxene occur in trace amounts in a few samples. Quartz is commonly wormy, but this texture is not as well developed as it is in the Bullfrog and Prow Pass Members. Accessory minerals include Fe-Ti oxides, allanite, apatite, and zircon (Table II).

The compositions of sanidine phenocrysts are dominantly Or_{66-74} (Fig. 7c). Sanidine compositions in the lower phenocryst-rich subunits are slightly more potassic (Or_{70-74}) than those in the phenocryst-poor rocks (Or_{66-70}); these subunits are not subdivided in Fig. 7c, except for outcrop samples, which are all from the lower phenocryst-rich subunit. Most plagioclase compositions concentrate between An_{14} and An_{30}. The dominant plagioclase rim compositions are An_{20} for phenocryst-poor rocks and An_{25} for phenocryst-rich rocks. Analyses of biotite phenocrysts are published for drill holes USW G-1 and USW G-2. These biotites have compositions ranging between Mg^*_{34-50}; biotites in outcrop samples have not been analyzed yet.

Comparison of outcrop and drill hole data is complicated by the vertical mineralogic and mineral-chemical gradients in the tuffaceous beds of Calico Hills. The comparison of modal data is also made difficult by scatter in the proportions of felsic phenocrysts, particularly for phenocryst-poor samples (Fig. 7b). This scatter is due to the crystal-poor nature of the unit, which results in poor counting statistics and in gross inhomogeneities in phenocryst assemblages at the thin-section scale. Nevertheless, the lower crystal contents in the upper part of the unit and the higher proportion of quartz phenocrysts throughout clearly distinguish the tuffaceous beds of Calico Hills from the underlying Prow Pass Member. The available data for feldspar compositions for outcrop samples mostly represent the lower phenocryst-rich subunit whereas the drill hole data include both phenocryst-poor and phenocryst-rich rocks. These feldspar compositions clearly distinguish the Calico Hills unit from the Prow Pass Member, which has significantly more sodic feldspars (Figs. 6c and 7c).

E. Paintbrush Tuff

The Paintbrush Tuff is composed of four ash-flow tuff cooling units consisting of, in ascending order, the Topopah Spring, Pah Canyon, Yucca Mountain, and Tiva Canyon Members (Table I). The Topopah Spring and Tiva Canyon Members are large-volume compositionally zoned ash-flow tuffs that crop out east and south of the Timber Mountain-Oasis Valley caldera complex. These units also occur in the subsurface north of the caldera complex. The caldera source for the Topopah Spring Member was buried by younger calderas related to the Timber Mountain Tuffs (Byers et al., 1976b). The Tiva Canyon Member was erupted from the Claim Canyon caldera, a small segment of which is preserved north of Yucca Mountain (Byers et al., 1976b). The Pah Canyon and Yucca Mountain Members are relatively small rhyolitic ash-flow tuff cooling units exposed south of the Timber Mountain-Oasis Valley caldera complex. At Yucca Mountain these units thin southward away from their source areas in the caldera complex and are absent in drill holes south of UE-25a#1. Bedded and nonwelded ash-flow tuffs are locally present between the members of the Paintbrush Tuff at Yucca Mountain; lavas are intercalated in the Paintbrush Tuff north of Yucca Mountain and in Yucca Wash. The Topopah Spring Member has a K/Ar age of 13.4 Ma (Kistler 1968; Marvin et al., 1970). The age of the Tiva Canyon Member is 12.9 Ma (Kistler, 1968; Marvin et al., 1970).

1. Topopah Spring Member. Modal data for the Topopah Spring Member were compiled from Lipman et al. (1966) for outcrop samples; from Byers (1985) for USW G-4; from Byers and Moore (1987) for USW G-1, USW G-2, USW GU-3, and UE-25a#1; from Scott and Castellanos (1984) for samples from USW GU-3; and from Warren et al. (1984) for samples from USW G-1. In addition, new modal data are presented for outcrop samples and for samples from drill holes J-13, UE-25a#1, and UE-25p#1 in Table II. Microprobe analyses of phenocrysts were compiled for drill hole USW G-1 from Warren et al. (1984) and for USW G-2 from Broxton et al. (1982). New microprobe data for phenocryst compositions are presented for samples from UE-25a#1, J-13, USW G-4, and UE-25p#1 as well as for outcrop samples.

At Yucca Mountain the Topopah Spring Member is about 300 m thick. About 250 m in the lower part of the unit consists of compositionally homogeneous, crystal-poor, high-silica rhyolite; this rhyolite grades abruptly upward into a 50-m caprock of crystal-rich quartz latite. Data for these compositionally distinct zones are presented separately in Fig. 8.

Phenocrysts make up less than 2% of the rock in the rhyolitic part of the member and make up 5%-20% of the rock in the quartz latitic part (Fig. 8a). Modal data for the rhyolitic portion of the member are characterized by considerable scatter because of its crystal-poor nature (Fig. 8b). Plagioclase and sanidine are the principal felsic phenocrysts with plagioclase being the more abundant felsic phase in most samples of rhyolite, whereas sanidine is more abundant in the quartz latite (Fig. 8b). Sanidine occurs as phenocrysts in the rhyolite and quartz latite; it also occurs as mantles around plagioclase phenocrysts in the quartz latite. Quartz is found in small amounts in the rhyolite and mostly occurs near the base of the unit. Quartz is rarely found in samples of quartz latite. Mafic phenocrysts in the rhyolite consist of biotite and of trace amounts of clinopyroxene and hornblende (Table II). The quartz latite contains biotite,

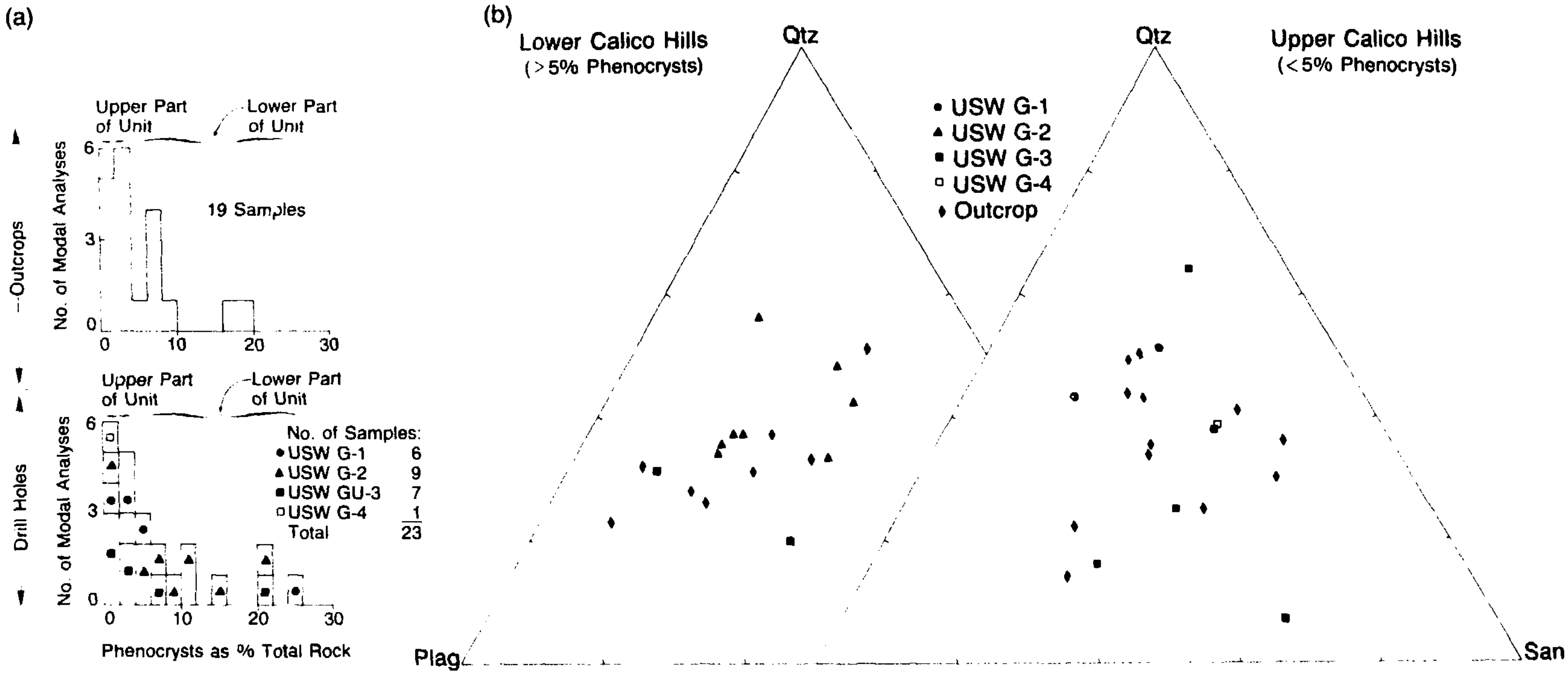


Fig. 7. Summary of petrographic data for the tuffaceous beds of Calico Hills at Yucca Mountain, Nevada. (a) Histograms showing distribution of total phenocryst abundances. (b) Triangular diagrams showing the proportions of quartz (Qtz), sanidine (San), and plagioclase (Plag) phenocrysts in the phenocryst-poor (<5% crystals) and phenocryst-rich (>5% crystals) subunits. (c) Histograms showing the distribution of Or + Cn in sanidine, An in plagioclase, and Mg* in biotite phenocrysts for the tuffaceous beds of Calico Hills at Yucca Mountain, Nevada. Shaded areas of histograms for plagioclase phenocryst compositions indicate rim compositions; unshaded areas indicate cores, midzones, and rims undivided. Data for phenocryst-poor and phenocryst-rich subunits are not differentiated.

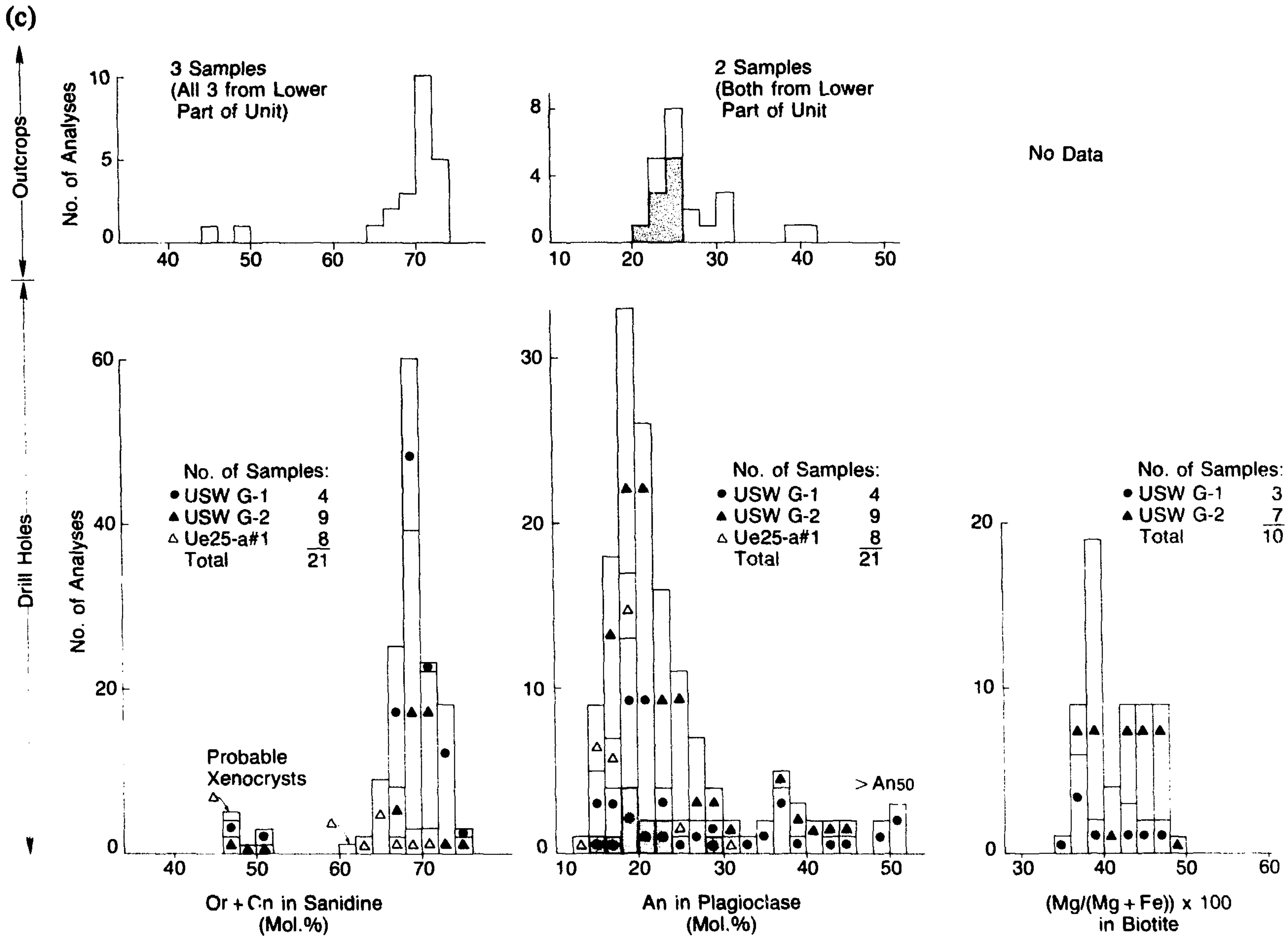

(c)
Outcrops
Drill Holes
No. of Analyses
3 Samples (All 3 from Lower Part of Unit)
2 Samples (Both from Lower Part of Unit
No Data
No. of Samples:
USW G-1 4
USW G-2 9
Ue25-a#1 8
Total 21
No. of Samples:
USW G-1 3
USW G-2 7
Total 10
Probable Xenocrysts
> An50
Or + Cn in Sanidine (Mol.%)
An in Plagioclase (Mol.%)
(Mg/(Mg + Fe)) x 100 in Biotite

Fig 7.(cont)

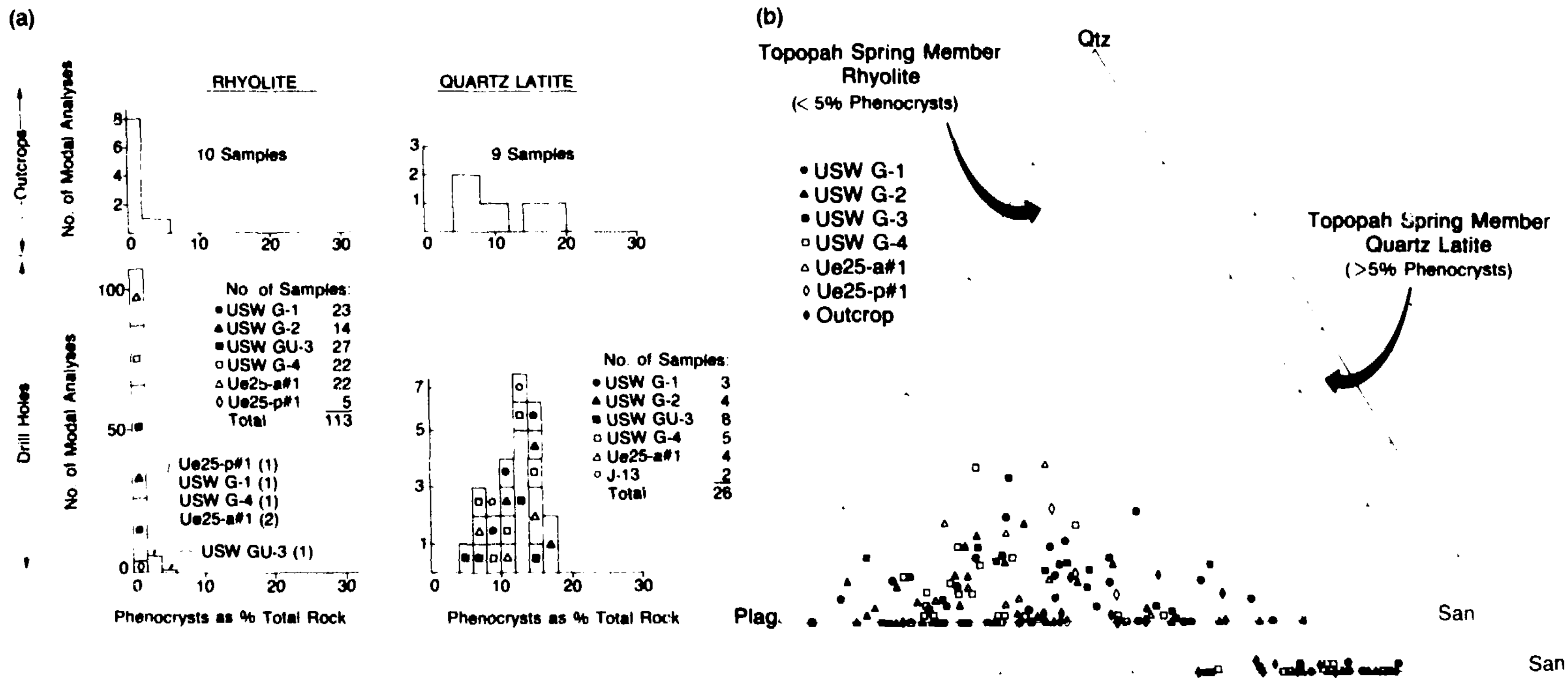


Fig. 8. Summary of petrographic data for the Topopah Spring Member of the Paintbrush Tuff at Yucca Mountain, Nevada. Data for rhyolitic and quartz latitic tuffs shown separately. (a) Histograms showing distribution of total phenocryst abundances. (b) Triangular diagrams showing the proportions of quartz (Qtz), sanidine (San), and plagioclase (Plag) phenocrysts. (c) Histograms showing the distribution of Or + Cn in sanidine, An in plagioclase, and Mg* in biotite phenocrysts for drill hole samples of the rhyolitic portion of the Topopah Spring Member of the Paintbrush Tuff at Yucca Mountain, Nevada. Shaded areas of histogram for plagioclase phenocryst compositions indicate rim compositions; unshaded areas indicate cores, midzones, and rims undivided. There are no data for outcrop samples. (d) Histograms showing the distribution of Or + Cn in sanidine, An in plagioclase, and Mg* in biotite phenocrysts for the quartz latitic portion of the Topopah Spring Member of the Paintbrush Tuff at Yucca Mountain, Nevada. Shaded areas of histograms for plagioclase phenocryst compositions indicate rim compositions; unshaded areas indicate cores, midzones, and rims undivided.

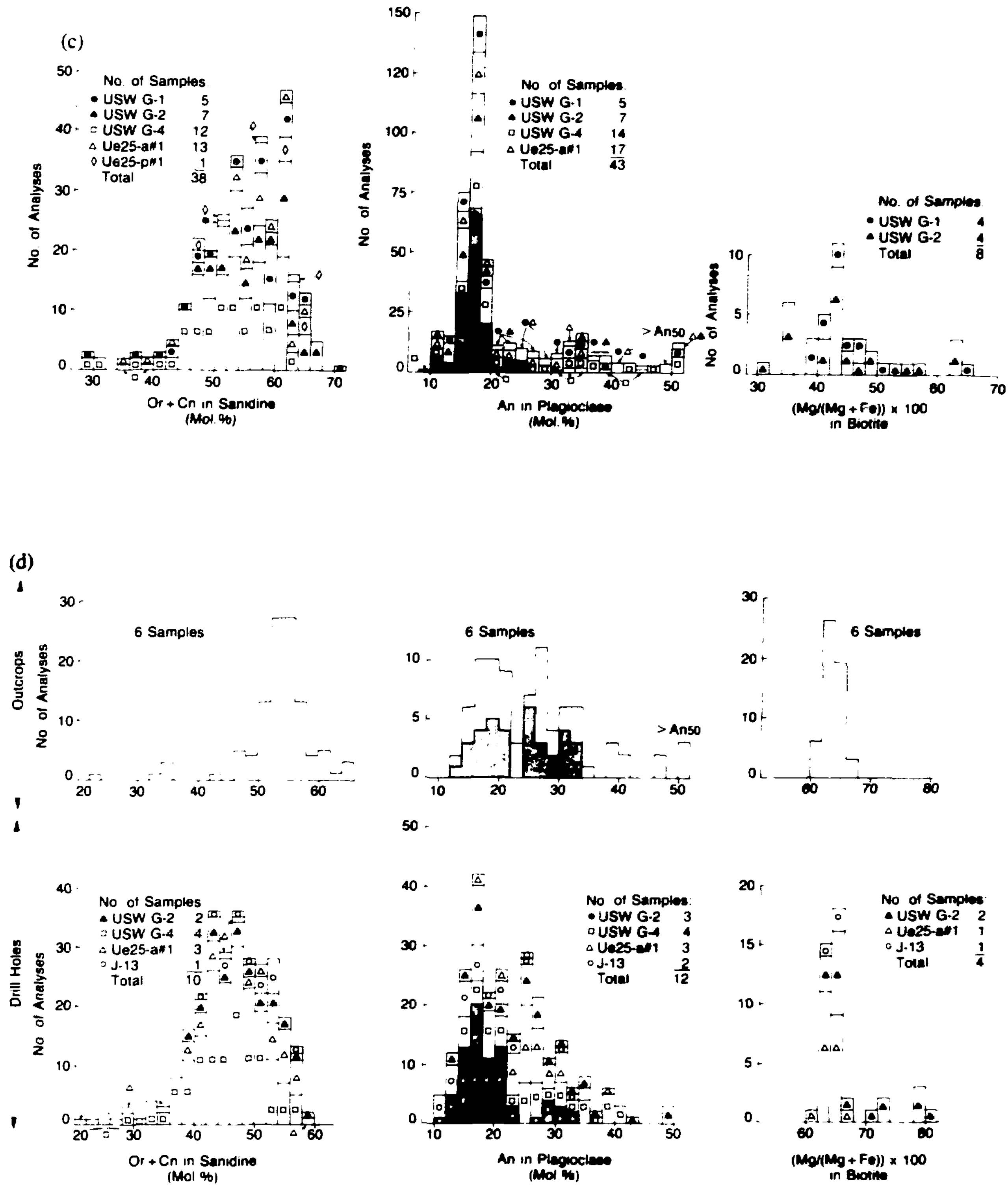

(c)
No. of Samples
USW G-1 5
USW G-2 7
USW G-4 12
Ue25-a#1 13
Ue25-p#1 1
Total 38
No. of Analyses
Or + Cn in Sanidine (Mol.%)
No. of Samples
USW G-1 5
USW G-2 7
USW G-4 14
Ue25-a#1 17
Total 43
> An50
An in Plagioclase (Mol.%)
No. of Samples
USW G-1 4
USW G-2 4
Total 8
(Mg/(Mg + Fe)) x 100 in Biotite
(d)
Outcrops
6 Samples
Drill Holes
No. of Samples
USW G-2 2
USW G-4 4
Ue25-a#1 3
J-13 1
Total 10
Or + Cn in Sanidine (Mol %)
No. of Samples
USW G-2 3
USW G-4 4
Ue25-a#1 3
J-13 2
Total 12
An in Plagioclase (Mol %)
No. of Samples
USW G-2 2
Ue25-a#1 1
J-13 1
Total 4
(Mg/(Mg + Fe)) x 100 in Biotite

Fig. 8 (cont)

clinopyroxene, and trace hornblende (Table II). The member contains Fe-Ti oxides, apatite, and zircon as accessory minerals. In addition, the rhyolite contains allanite as the common rare-earth-bearing phase, whereas the quartz latite contains perrierite (Table II).

Sanidine compositions in the Topopah Spring Member, compared with most underlying units, are relatively broad (Figs. 8c and 8d). Sanidine compositions of the rhyolites and quartz latites concentrate primarily between Or_{38} and Or_{66}. The ranges in sanidine compositions overlap between the rhyolite and the quartz latite; however, sanidine is typically more potassic in the rhyolite. Within the rhyolite, sanidine compositions become increasingly potassic toward the base of the unit. Plagioclase phenocrysts also have a wide range of compositions in the Topopah Spring Member. Most compositions in the rhyolite fall between An_{14} and An_{20} with the dominant composition occurring at An_{17}. A minor compositional mode occurs at An_{35}. Plagioclase in the quartz latite also appears to be bimodal with major modes occurring at An_{17} and An_{26}. Biotite compositions are relatively iron rich (primarily Mg^*_{34-50}) in the rhyolite compared with the quartz latite (primarily Mg^*_{60-66}).

In rhyolitic samples, the proportions of felsic phenocrysts are similar for outcrop and drill hole samples (Fig. 8b). Phenocryst contents are consistently less than 2% in samples from both drill holes and outcrop (Fig. 8a). Sanidine and biotite compositions in the rhyolitic part of the member agree well when comparisons are made between drill holes (Fig. 8c), but compositional data are lacking for a comparison of drill hole and outcrop samples. Nonwelded rhyolitic tuffs near the base of the member can be distinguished from the underlying tuffaceous beds of Calico Hills by lower quartz contents (Figs. 7a and 8b) and by generally more sodic feldspar compositions in the Topopah Spring Member. In the quartz latitic samples, modal and mineral chemical characteristics for outcrop and drill hole samples are similar (Figs. 8a, b, and d). The quartz-poor, sanidine-rich petrography of the Topopah Spring quartz latite distinguishes it from all underlying units. The compositional fields and dominant compositions for feldspar and biotite phenocrysts in the quartz latite are similar for outcrop and drill holes (Fig. 8d).

<u>2. Pah Canyon Member.</u> Published modal and mineral-chemical data for the Pah Canyon Member are sparse. Modal analyses for four outcrop samples were compiled from Quinlivan and Byers (1977). Eight new modal analyses are presented for drill holes USW G-2 and UE-25a#1. At present there are no microprobe analyses of phenocrysts from outcrop samples. Broxton et al. (1982) present mineral chemical data for the Pah Canyon Member in drill hole USW G-2. New mineral chemical data for one sample from UE-25a#1 are presented in this paper.

The Pah Canyon Member contains 4% to 12% phenocrysts (Fig. 9a) consisting primarily of subequal amounts of plagioclase and sanidine (Fig. 9b). Sanidine occurs both as phenocrysts and as mantles around plagioclase phenocrysts. Biotite and clinopyroxene form the mafic phenocryst assemblage (Table II). Like other members of the Paintbrush Tuff, the Pah Canyon Member contains only trace amounts of quartz. Accessory minerals consist of Fe-Ti oxides, apatite, perrierite, sphene, and zircon (Table II). The petrography of the Pah Canyon Member is very similar to that of the quartz latite in the Topopah Spring Member. Except for the presence of sphene in the Pah Canyon Member, the two units have similar phenocryst assemblages. However, in 10 of the 12 samples for which data are available, the Pah Canyon has a greater proportion of plagioclase phenocrysts than does the Topopah Spring quartz latite.

Phenocryst compositions in the Pah Canyon Member are also very similar to those found in the Topopah Spring quartz latite. Sanidine compositions range from Or_{46-60} with a dominant mode at Or_{52-54} (Fig. 9c). Plagioclase compositions concentrate between An_{14} and An_{22}, though crystals with more calcic midzones and cores are found in a few samples. Biotite phenocrysts define a narrow compositional range (Mg^*_{58-68}) with most analyses occurring between Mg^*_{62-68} (Fig. 9c).

The modal data for drill hole and outcrop samples compare favorably. Phenocryst abundances and modal proportions overlap between the two data sets (Figs. 9a and b). Compositions of sanidine and plagioclase phenocrysts also match well for samples in the two drill holes analyzed (Fig. 9c); however, there are no mineral-chemical data for any outcrop samples for comparison. Biotite compositions also match well for the samples in the two drill holes (Fig. 9c).

3. Yucca Mountain Member. The Yucca Mountain Member is a shard-rich ash-flow tuff that is essentially phenocryst free (<0.1% crystals). The rare phenocrysts occurring in this unit include sanidine, plagioclase, and biotite. These phenocrysts are much smaller (<0.3 mm) than phenocrysts typically found in other units at Yucca Mountain. The paucity of phenocrysts, the shard-rich nature of the matrix, and the presence of diagnostic grayish-red lithics less than 1 cm in diameter clearly distinguish the Yucca Mountain Member from other stratigraphic units at Yucca Mountain. Because of its nearly phenocryst-free character, no modal analyses are published for the Yucca Mountain Member. One new modal analysis of an outcrop sample is given in Table II. Mineral compositions for feldspar and biotite phenocrysts were published in Broxton et al. (1982); these data are summarized in Fig. 10.

4. Tiva Canyon Member. The Tiva Canyon Member is the youngest volcanic unit in the exploration block. Modal data for the Tiva Canyon Member were compiled from Quinlivan and Byers (1977) for 10 outcrop samples and from Scott and Castellanos (1984) for 6 samples from USW GU-3. In addition, new modal data are presented for three outcrop samples, one sample from J-13, three samples from UE-25a#1, and three samples from UE-25p#1 in Table II. New microprobe data for phenocryst compositions are presented for one sample from J-13 and for two outcrop samples.

The Tiva Canyon Member is a compositionally zoned unit that grades up in section from rhyolite to quartz latite. Like the Topopah Spring Member, the lower part of the Tiva Canyon Member consists of

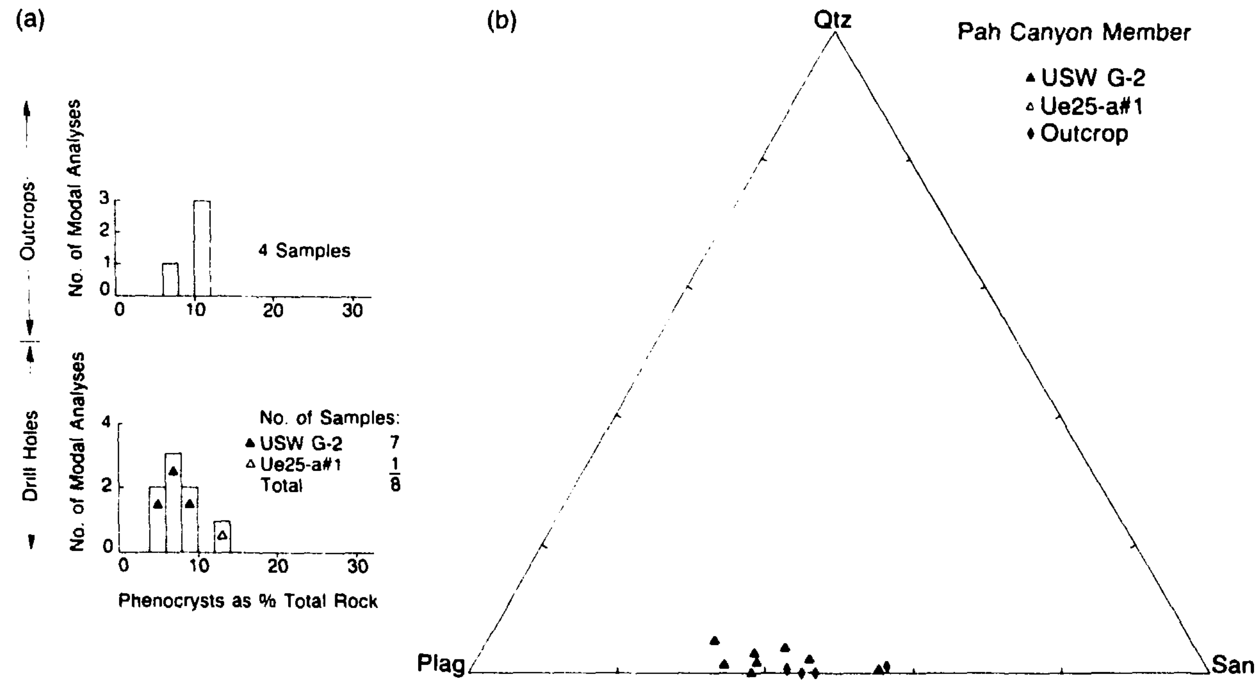


Fig. 9. Summary of petrographic data for the Pah Canyon Member of the Paintbrush Tuff at Yucca Mountain, Nevada. (a) Histograms showing distribution of total phenocryst abundances. (b) Triangular diagram showing the proportions of quartz (Qtz), sanidine (San), and plagioclase (Plag) phenocrysts. (c) Histograms showing the distribution of Or + Cn in sanidine, An in plagioclase, and Mg^* in biotite phenocrysts for drill hole samples of the Pah Canyon Member of the Paintbrush Tuff at Yucca Mountain, Nevada. Shaded areas of histograms for plagioclase phenocryst compositions indicate rim compositions; unshaded areas indicate cores, midzones, and rims undivided. There are no data for outcrop samples.

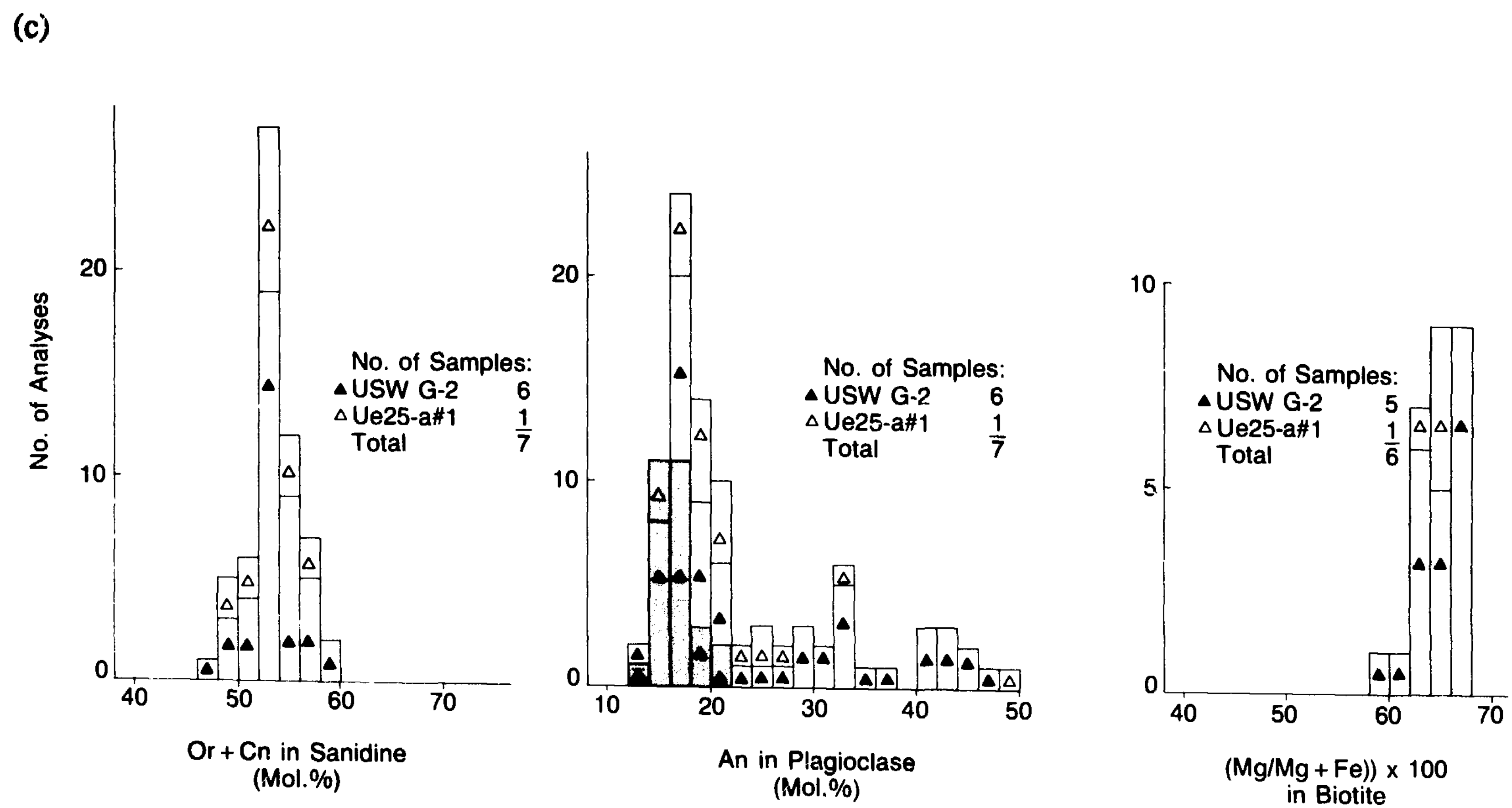

(c)
No. of Analyses
20
10
0
40
50
60
70
No. of Samples:
▲USW G-2 6
△Ue25-a#1 1
Total 7
Or + Cn in Sanidine
(Mol.%)
20
10
0
10
20
30
40
50
No. of Samples:
▲USW G-2 6
△Ue25-a#1 1
Total 7
An in Plagioclase
(Mol.%)
10
5
0
40
50
60
70
No. of Samples:
▲USW G-2 5
△Ue25-a#1 1
Total 6
(Mg/Mg + Fe)) x 100
in Biotite

Fig. 9 (cont)

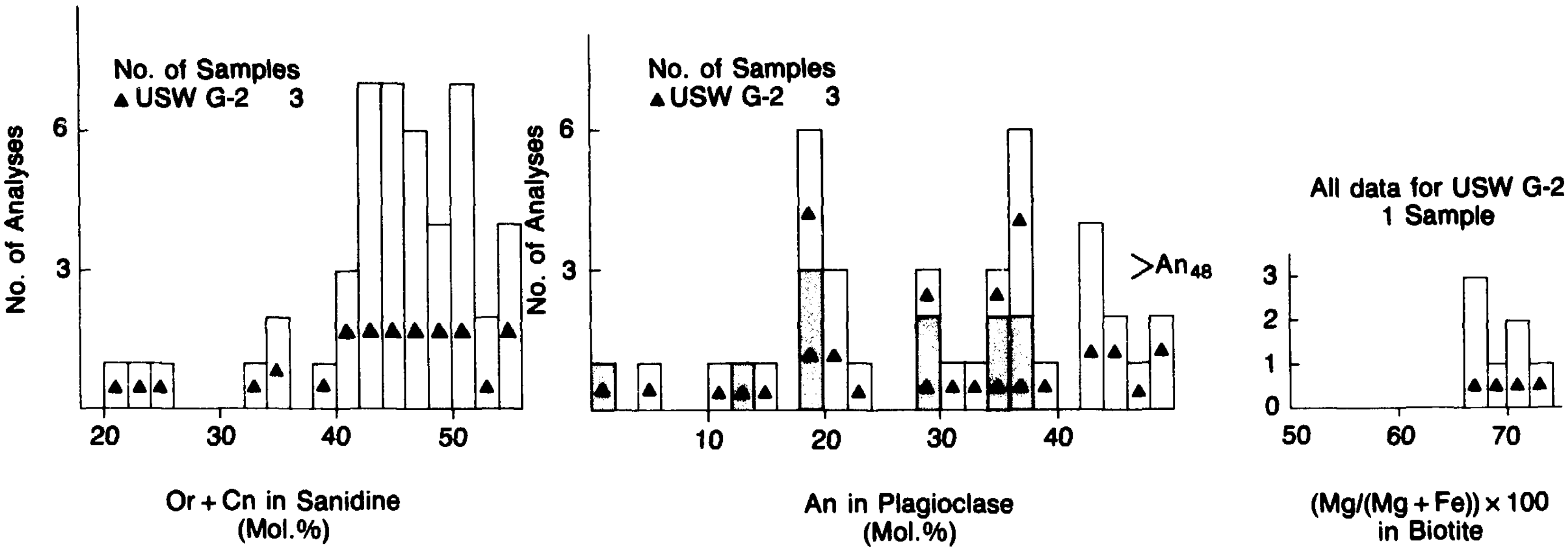


Fig. 10. Histograms showing the distribution of Or + Cn in sanidine, An in plagioclase, and Mg* in biotite phenocrysts for drill hole samples of the Yucca Mountain Member of the Paintbrush Tuff at Yucca Mountain, Nevada. Shaded areas of histograms for plagioclase phenocryst compositions indicate rim compositions; unshaded areas indicate cores, midzones, and rims undivided. There are no data for outcrop samples.

crystal-poor, high-silica rhyolite; this rhyolite grades upward into a thin crystal-rich quartz latite caprock. Data for these compositionally distinct zones are presented separately in Fig. 11.

Phenocrysts typically make up between 1% and 5% of the rock in the lower part of the member and make up 6%-20% of the rock in the upper part (Fig. 11a). Sanidine and plagioclase are the dominant felsic phenocrysts. Sanidine makes up >95% of all felsic phenocrysts in the rhyolite and 54%-95% of all felsic phenocrysts in the quartz latite (Fig. 11b). Quartz occurs only in trace amounts in both the rhyolite and the quartz latite. Mafic phenocrysts in the rhyolite consist of hornblende, subordinate biotite, and trace clinopyroxene (Table II). The quartz latite contains biotite, clinopyroxene, and small amounts of hornblende. Accessory minerals in the rhyolite include Fe-Ti oxides, abundant sphene, zircon, and apatite (Table II). The quartz latite contains Fe-Ti oxides, apatite, zircon, perrierite, and sphene.

Microprobe data for the Tiva Canyon Member are incomplete, particularly for drill hole samples. Sanidine compositions in the rhyolitic portion of the member concentrate between Or_{32} and Or_{42} for one sample from outcrop and one from drill hole J-13 (Fig. 11c). In contrast, two outcrop samples of quartz latite have sanidine compositions that occur dominantly between Or_{42} and Or_{50} (Fig. 11d). Sanidine compositions have not been determined for drill hole samples from the quartz latitic portion of the member. Biotite compositions for one quartz latitic outcrop sample range between Mg^*_{64} and Mg^*_{70} (Fig. 11d).

The modal data for outcrop and drill hole samples are very similar for the Tiva Canyon Member. The rhyolite in particular is unique among all units at Yucca Mountain for the high proportion of sanidine that it contains (Fig. 11b). Although data are sparse for the quartz latite, its increased plagioclase contents relative to rhyolite occur in both drill hole samples and in outcrop samples (Fig. 11b). Except for sanidine compositions in rhyolite, mineral-chemical data for the Tiva Canyon Member are too incomplete for meaningful comparison. In the rhyolite, the compositional range and dominant compositional mode for sanidine in the one outcrop sample are the same as that for sanidine for one sample from J-13 (Fig. 11c).

VI. SUMMARY AND CONCLUSIONS

This report summarizes the available petrographic and mineral chemical data for stratigraphic units at Yucca Mountain to assist a potential review of the drill core by a peer review panel. A peer review is one method being considered to qualify the drill cores so that data derived from them can be used as primary data during the license application for the Yucca Mountain site. Such a review is necessary because existing documentation does not meet QA requirements to provide comprehensive sample traceability.

Comparing data for drill hole samples with data from well-established surface exposures of the same unit is a widely accepted practice for making subsurface correlations in the oil and gas industry and in the nuclear testing program. This method is particularly well suited for confirming the identity

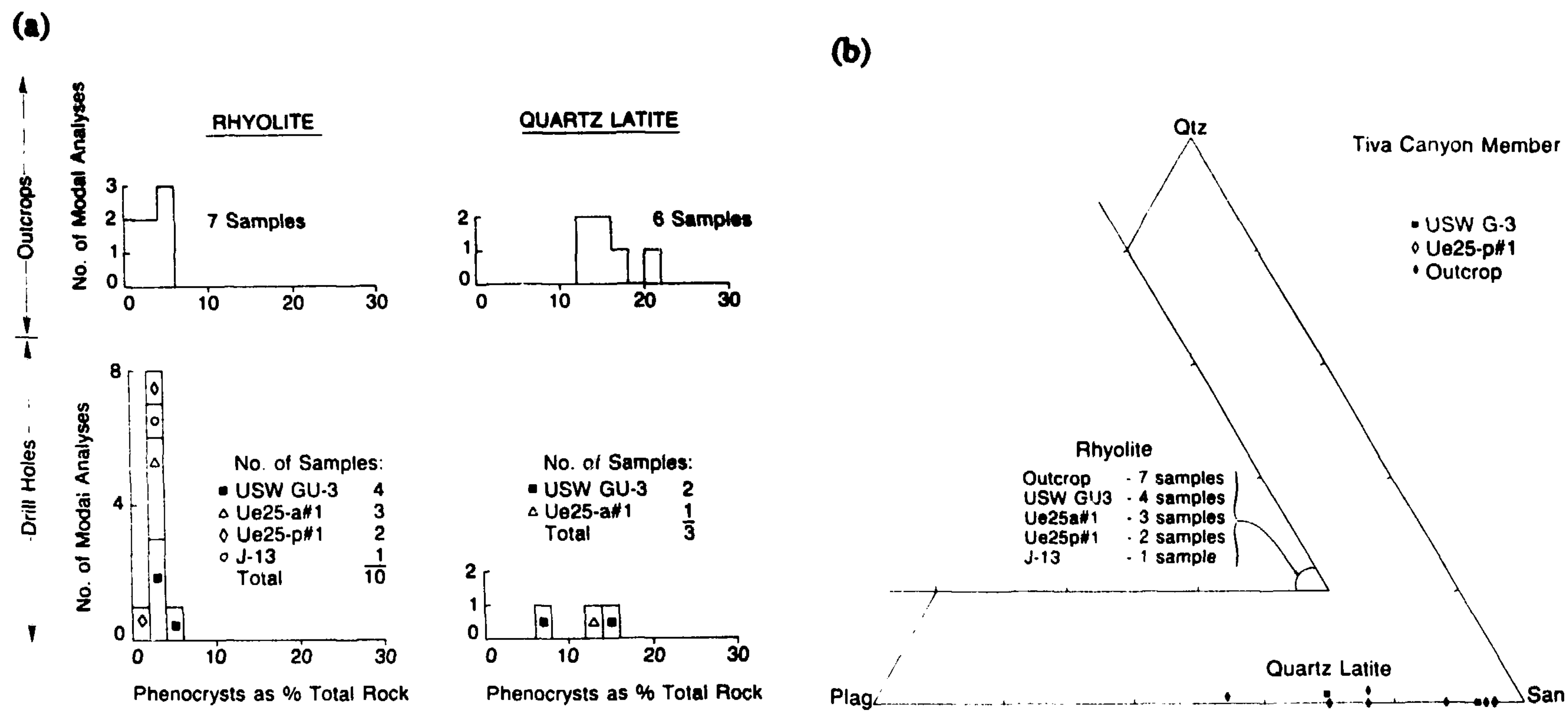
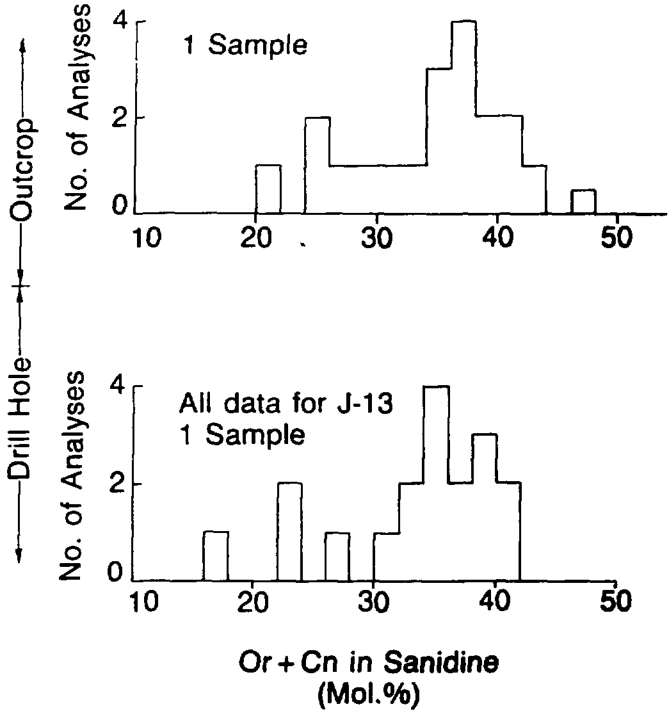


Fig. 11. Summary of petrographic data for the Tiva Canyon Member of the Paintbrush Tuff at Yucca Mountain, Nevada. Data for rhyolitic and quartz latitic tuffs shown separately. (a) Histograms showing distribution of total phenocryst abundances. (b) Triangular diagrams showing the proportions of quartz (Qtz), sanidine (San), and plagioclase (Plag) phenocrysts. (c) Histograms showing the distribution of Or + Cn in sanidine phenocrysts for the rhyolitic portion of the Tiva Canyon Member of the Paintbrush Tuff at Yucca Mountain, Nevada. There are no data for plagioclase or biotite compositions. (d) Histograms showing the distribution of Or in sanidine, An in plagioclase, and Mg* in biotite phenocrysts for outcrop samples of the quartz latitic portion of the Tiva Canyon Member of the Paintbrush Tuff at Yucca Mountain, Nevada. Shaded areas of histograms for plagioclase phenocryst compositions indicate rim compositions; unshaded areas indicate cores, midzones, and rims undivided. There are no data for drill hole samples.

(c)



(d)

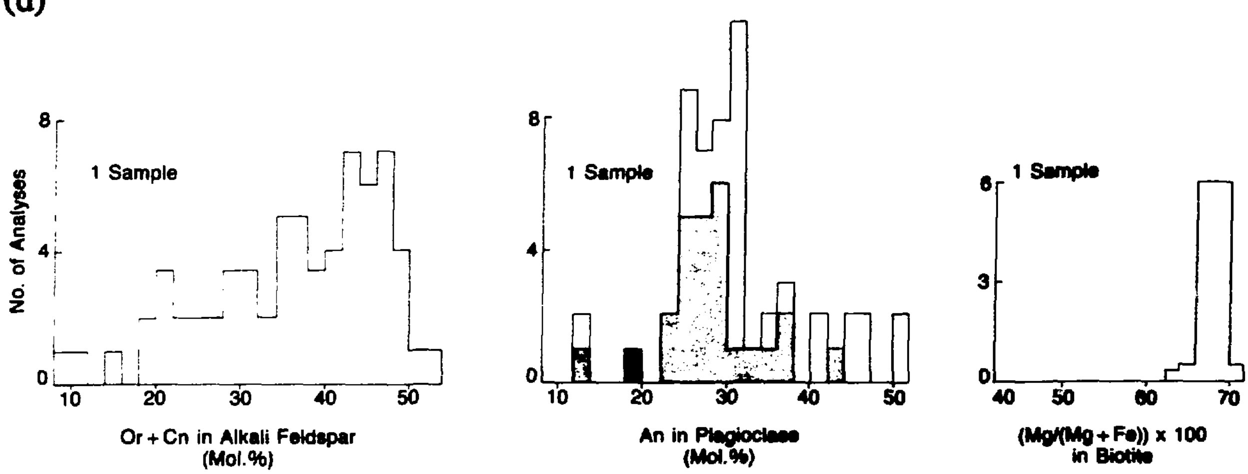


Fig. 11 (cont)

of units in drill core from Yucca Mountain because stratigraphic relations for the region are so well known from surface studies. Except for the Older Tuff Units A, B, and C, the volcanic units underlying Yucca Mountain are also known to crop out in surface exposures.

Each stratigraphic unit has unique petrographic and mineral-chemical characteristics (Fig. 12), and stratigraphic identifications based on these characteristics can be confidently made in most cases. Petrographic characteristics can have a relatively high degree of variability (e.g., Figs. 12a and b) because of factors such as (1) poor representation of sample inhomogeneities by the limited surface areas of thin sections, (2) poor counting statistics in phenocryst-poor units (e.g., Topopah Spring rhyolite and the upper part of the tuffaceous beds of Calico Hills), (3) mechanical winnowing and sorting of pyroclastic components during emplacement of some units (e.g., bedded tuffs), (4) vertical variations in rock composition in units erupted from compositionally zoned magma systems (e.g., Tiva Canyon and Topopah Spring Members), and (5) differences in porosity associated with degree of welding (e.g., compaction and welding decrease the porosity of the tuffs resulting in systematically higher phenocryst contents in densely welded tuffs compared with the nonwelded portions of the same unit). Despite these complications, careful consideration of a variety of petrographic characteristics including total phenocryst abundances, relative proportions of phenocryst minerals, and types and abundances of mafic and accessory minerals is an effective approach for uniquely identifying stratigraphic units.

The mineral chemistry of phenocrysts is also an important means of distinguishing stratigraphic units, especially when it is used in conjunction with the petrographic data. Sanidine phenocrysts in particular have narrow compositional ranges for most units and often have distinctive dominant compositions (Fig. 12c). Commonly, plagioclase phenocrysts are normally zoned from core to rim; because of this they typically have a larger compositional range than do sanidines, which show little or no zonation. However, plagioclases have relatively restricted rim compositions that are useful for stratigraphic identifications (Fig. 12d). Biotite compositions are less useful for identifying individual units, tending to be relatively iron rich or relatively iron poor for thick stratigraphic sequences made up of several units (Fig. 12c). For example, the Crater Flat Tuffs, the tuffaceous beds of Calico Hills, and the rhyolitic part of the Topopah Spring Member are characterized by relatively iron-rich biotite compositions. All other units contain relatively magnesium-rich biotites. Although less specific than sanidine or plagioclase, biotite compositions provide an additional check for compositional consistency for the units described above.

Petrographic and mineral chemical data, when used in combination with other geologic and geophysical information, provide a method for uniquely identifying stratigraphic units in Yucca Mountain drill cores. Correct stratigraphic relations in the drill core provide a strong argument that the core was not

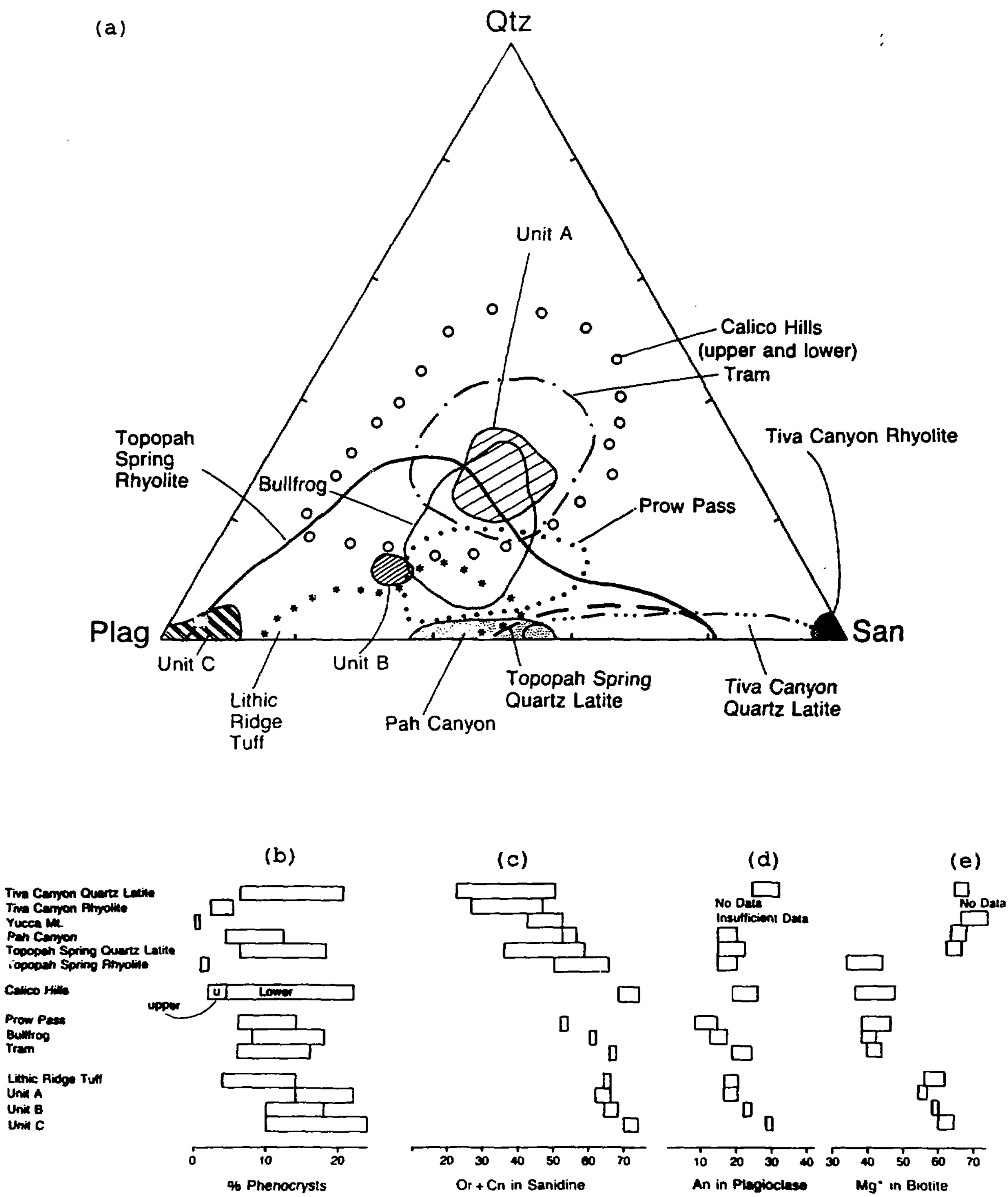


Fig. 12. Summary diagrams showing typical modal and mineral chemical compositions for rock units at Yucca Mountain, Nevada. (a) Proportions of felsic phenocrysts, (b) phenocryst abundances, (c) Or + Cn in sanidine, (d) An in plagioclase, and (e) Mg* in biotite.

severely compromised during its collection or storage. Although much of the information necessary for a peer review has already been collected, additional petrographic and mineral chemical data are needed to fully characterize certain stratigraphic units at Yucca Mountain.

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