U.S. DEPARTMENT OF THE INTERIOR — S-12/15
U.S. GEOLOGICAL SURVEY — S-11

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SCIENTIFIC INVESTIGATIONS MAP 2812
Version 1.0 — S-12/15, S-11/16, SI-10, .25 (6.5)

IF PAMPHLET ACCOMPANIES MAP.... add this note to heading on map sheet, using this type style, size, and spacing → Pamphlet accompanies map

FLUSH LEFT — FLUSH RIGHT

PURPOSES OF STYLE GUIDE

(Additions and deletions were made to the original I-2182, a color map, for example purposes only)

Guidelines shown on this sheet (from the Cartographic Technical Standards of the U.S. Geological Survey, 1978, and recent updates) are provided as an aid in preparing your map or creating a style sheet with your own software. The sheet shows components that an average map might contain, but it cannot show all possibilities and all the technical standards. If you need additional information, please consult a map editor.

These guidelines are based on standards that cartographers follow routinely, but they should be used with good judgment and common sense. Spacing, leading, type sizes, and line weights can be increased or decreased depending on the size of features shown, complexity of the map, and overall sheet or plate size.

Two groups of type styles are used on USGS maps: (1) the serif group (such as Souvenir, Times Roman, or New Century Schoolbook) and (2) the sans serif group (such as Univers, Helvetica, or Optima). Serifs are the little feet at the ends of strokes of letters; they create a consistent horizontal direction at the ends of strokes. Sans serif type does not have the little feet and does not show the same contrast of thick and thin strokes that is found in serif type.

Souvenir and Univers fonts were used for this map, and the font size and leading reflect that. However, you may use other type styles so long as serif and sans serif styles are used as indicated on this style guide and the font size and leading are adjusted accordingly. For instance, if Times Roman is used, we suggest adjusting the font size and leading from 9/11 to 10/12 for legibility and a conservative use of space.

EXPLANATION

Type style and font size
- S-9 — Serif—Showing font size in points
- SI — Serif italic
- SB — Serif bold
- SBI — Serif bold italic
- Sans — Sans serif
- SansB — Sans serif bold
- SansI — Sans serif italic
- 3 Ld — Leading (space between lines of type)—In points
- 12/15 — Type size/type size plus leading—In this case, 12-point/12-point type plus 3-point leading
- 0.006 (0.15) — Measurement for spacing or lineweight—In inches (millimeters)
- □ — Em space—Used to show indents, square is point-size of type being used. An em in 8-point type is 8 points wide by 8 points high, and an em in 9-point type is 9 points wide by 9 points high
- 1 M — Long dash (1 em)—Option, Shift, dash on Microsoft Word

BRANCH OF PRINTING SIZES FOR MACHINE-FOLDED MAPS

Sheet size (in inches)	Maximum image size (in inches)
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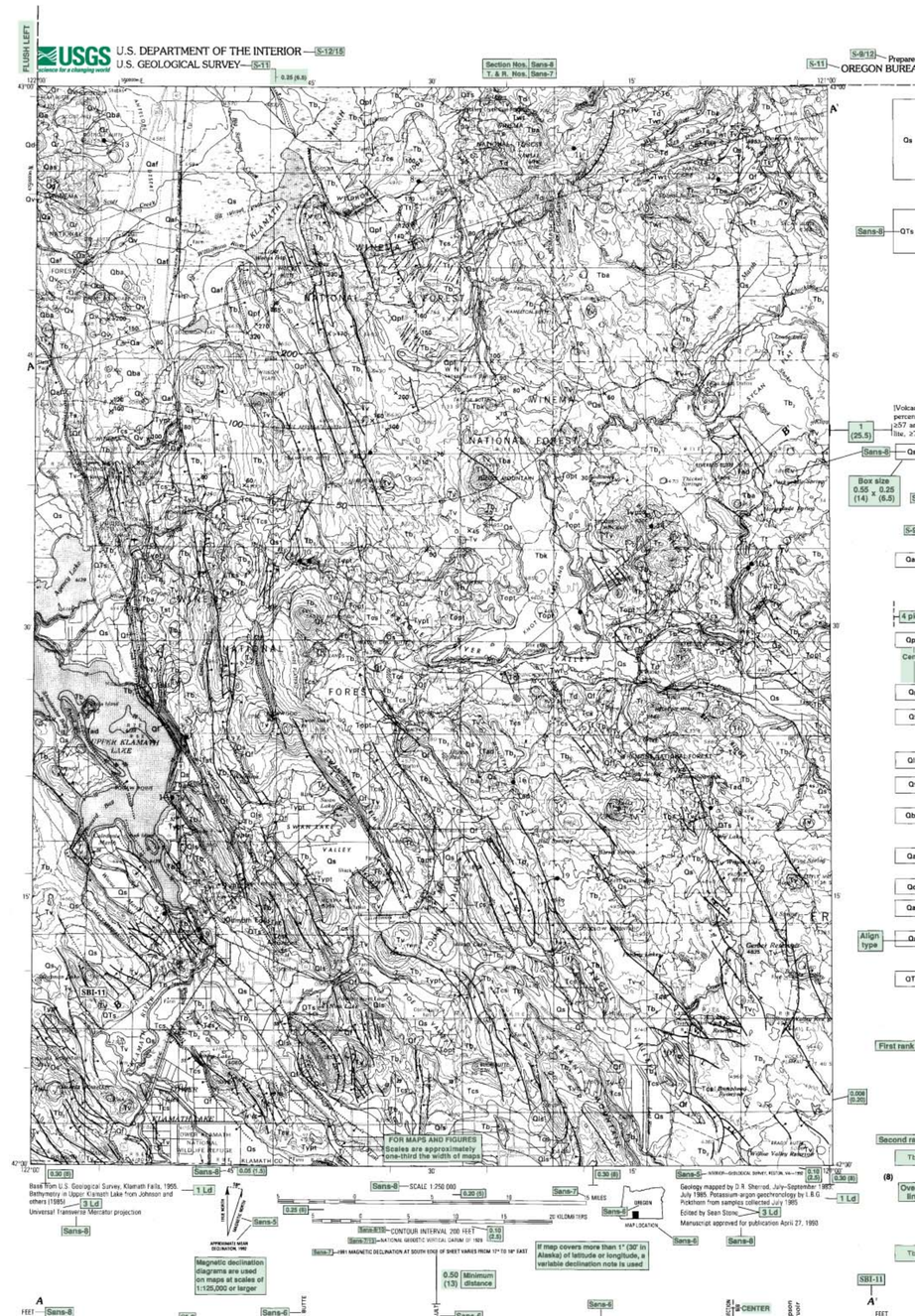
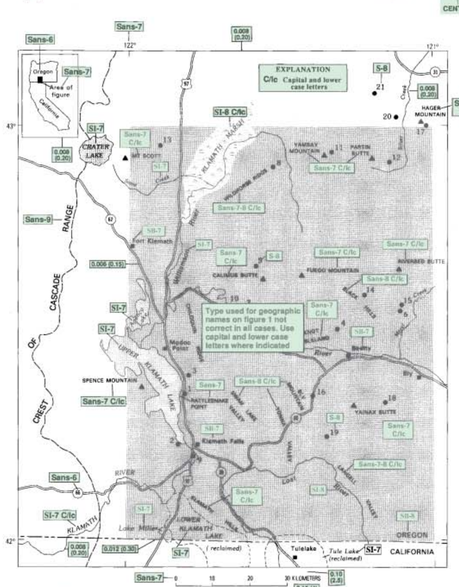
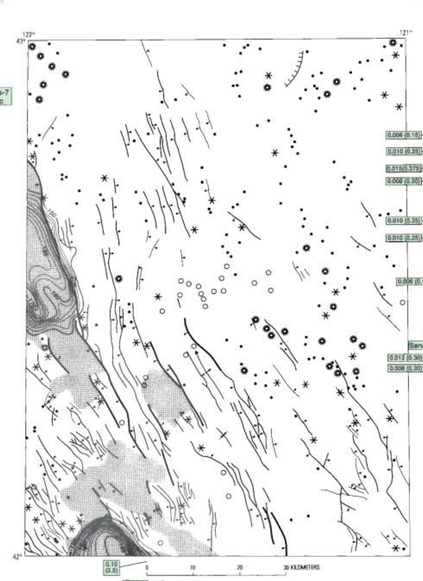
36 x 54	33.5 x 52
42 x 58	40 x 56

The absolute maximum image area available is 41 x 56 inches





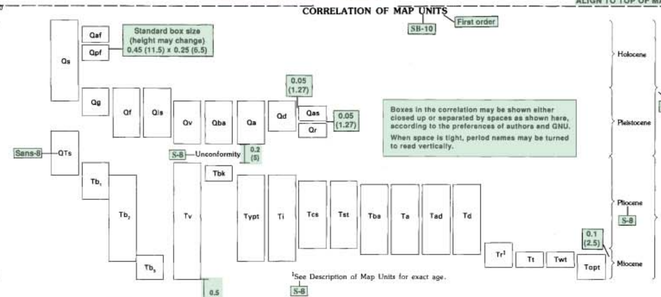
SB-9 — **Figure 1.** Index map showing selected geographic features, locations of K-Ar samples (solid circle, number refers to table 1), and area of report (shaded).



6.15 (4) — **Figure 2.** Tectonic sketch map.

CORRELATION OF MAP UNITS

ALIGN TO TOP OF MAP — First order — Second order — S-9 — STRATIGRAPHY — 4 Ld — SB-10



SB-10 — **DESCRIPTION OF MAP UNITS** — First order — 1 Ld

[Volcanic rocks are named according to chemical classification, in terms of weight percent SiO_2, as follows: basalt, <52 percent; basaltic andesite, ≥52 and <57 percent; andesite, ≥57 and <62 percent; dacite, ≥62 and <67 percent; rhyodacite, ≥67 and <72 percent; rhyolite, ≥72 percent]

Surficial deposits (Holocene and Pleistocene)—Fine- to coarse-grained sediment deposited in channels, flood plains, marshes, and lakes. Includes playa deposits in closed depressions in Swan Lake and Yonna Valleys. Deposits in Klamath Marsh contain rounded pumiceous gravel derived from fluvial and lacustrine reworking of Holocene pumice-fall, Qpf, and ash-flow (Qaf) deposits; gravels form terraces at three distinct levels as high as 8 m above present wetlands along east side of Klamath Marsh. Pattern in northwest corner of map delineates Sand Creek fan bui… Highwa… on nor… d dunes of U.S.

Ash-flow de… sorted, … were e… at Mou… area (W… much e… partial… of map… poorly …h flows …uptions …of map …sions as …may be …corner …rce

Pumice-fall about … erupted …azama. Mapped only where underlying units are buried over large areas; smaller discontinuous patches (not shown) blanket much of northern part of map area. Isopachs indicate thickness of deposit in centimeters

Glacial deposits (Pleistocene)—Till in lateral and terminal moraines on east side of Mount Scott in High Cascades (fig. 1)

Alluvial fan and talus deposits (Pleistocene)—Poorly to well-sorted sand and gravel in alluvial fans. Includes extensive talus sheets that mantle some fa… deposits on nort… ogin

Landslide d… of steep slopes … landform

Vent depo… glutinate … basaltic … der, ag… or basalt, …va flows and minor breccia erupted from vents in High Cascades. Short-dashed contact indicates separate lava flow erupted from cinder cone 10 km east of Fort Klamath

Andesite (Pleistocene)—Slightly to moderately porphyritic two-pyroxene andesite lava flows in High Cascades. Some andesite contains minor amount of olivine

Dacite (Pleistocene)—Moderately porphyritic hornblende-bearing lava flow or dom… …ltic two-pyroxene … 0.42 Ma (Bacon, 1983, addendum to p. 63)

Rhyolite and rhyodacite (Pleistocene)—Light-gray to white, aphyric to porphyritic flow-banded rhyolite and rhyodacite forming large domes. Potassium-argon ages between 0.7 and 0.6 Ma (Bacon, 1983, addendum to p. 63)

Sedimentary deposits and rocks (Pleistocene and Pliocene)—Unconsolidated sand and gravel, poorly to moderately indurated sandstone and conglomerate, and diatomite exposed mainly in Lower Klamath Lake basin, east of Agency Lake, and on west slope of Yamsay Mountain. Includes strata that unconformably overlie the Miocene and Pliocene continental sedimentary rocks (Tcs) as well as strata of uncertain relation to that unit

Basalt of Basin and Range (Pliocene and Miocene)—Aphyric to porphyritic lava flows and minor breccia; chiefly intergranular to subophitic and locally diktytaxitic basalt and lesser amount of intergranular basaltic andesite. Contains phenocrysts (1–2 mm long) of olivine and greater or lesser amounts of plagioclase and, locally, clinopyroxene. Locally includes interbedded, poorly exposed, poorly indurated sedimentary and pyroclastic volcanic rocks, which are commonly buried by basalt flout. Units Tb_1, Tb_2, and Tb_3 (basalt flows) are separated on basis of degree of alteration and tectonic deformation, stratigraphic relations with sedimentary units, and geomorphic criteria such as nesting of flows; however, isotopic ages of the different units overlap when compared regionally. Divided into:

Unit 1 (Pliocene)—Lava flows extending from Wildhorse Ridge south through Calimus Butte area and southwest through Chiloquin Ridge area. Unconformably overlies Miocene and Pliocene unit Tb_2 near Sprague River but conformably overlies it at most other localities. Potassium-argon ages from Wildhorse Ridge and Calimus Butte areas are 3.68±0.08 and 3.44±0.13 Ma, respectively, whereas ages from southeast of Modoc Point are 2.80±0.06 and 1.9±0.5 Ma (table 1, map Nos. 1, 3, 5, and 8). The latter two ages are from about the same stratigraphic position, and the preferred age there is 2.80 Ma (Pickthorn and Sherrod, in press)

Unit 2 (Pliocene and Miocene)—Lava flows throughout southwestern, south-central, and northeastern parts of map area. Lithologically indistinguishable from unit Tb_1 and is separated chiefly on geomorphic and structural criteria; overall, the unit probably contains a greater proportion of diktytaxitic lava compared to lava in unit Tb_1 which is dominantly intergranular in texture. Part of unit in south-central area was included in the basalt of Devils Garden by McKee and others (1983) (named for Devils Garden in Modoc County, Calif.). Potassium-argon ages in map area range from 6.88 to 3.61 Ma (table 1, map Nos. 6, 10, 18, and 19); age is late Miocene and Pliocene

Unit 3 (Miocene)—Lava flows in east half of map area. Flows commonly show extensive alteration of groundmass glass to greenish smectite. Potassium-argon age of 5.78±0.12 Ma from lava flow east of Black Hills in east-central part of map area (table 1, map No. 15); unit is in part older than rhyolite domes (Tr). Age is late Miocene; correlative with the regionally defined basalt of Devils Garden of McKee and others (1983)

Vent deposits (Pliocene and Miocene)—Cones and irregular piles of cinder, agglutinate, and minor lava flows and intrusions. Forms vents for the basalt of Basin and Range (Tb_1, Tb_2, and Tb_3)

Basalt of Knot Tableland (Pliocene)—Diktytaxitic olivine basalt lava flow or flows that form prominent bench north of Sprague River in central part of map area. Unit is lithologically similar to the adjacent basalt of Basin and Range (Tb_1, Tb_2, and Tb_3) but is younger on basis of its topographic inversion—it fills a broad surface that is cut, in part, into unit Tb_2—and lack of deformation. Potassium-argon age of 3.0±0.9 Ma (table 1, map No. 4)

Younger palagonite tuff (Pliocene and Miocene)—Poorly bedded deposits of palagonitized basaltic ash and lapilli and minor interbedded lava flows. Forms some of the vents that erupted a part (Tb_3) of the basalt of Basin and Range (other vents in unit Tv). Commonly forms discrete, circular tuff cones centered around individual vents. Elsewhere, vent deposits have coalesced to form large masses of palagonite in which individual eruptive centers are inferred from circular physiographic features and outwardly dipping beds; outline of individual centers shown by short dashed line. Unit is interbedded with and overlies the continental sedimentary rocks (Tcs). Partial equivalent of the herein-abandoned Yonna Formation

Intrusions (Pliocene and Miocene)—Exposed in three areas: (1) plugs of very fine to fine-grained basalt and basaltic andesite that intrude vent deposits (Tv) at Yainax Butte and Fuego Mountain, (2) gabbro sill northeast of Klamath Falls, and (3) basalt sills or auto-invasive flows southwest of Klamath Falls

Continental sedimentary rocks (Pliocene and Miocene)—Thinly bedded to very thick bedded ashy diatomite; thin- to medium-bedded sandstone, siltstone, and laminated mudstone; conglomerate; and minor tuff and basalt lava flows. Overlies welded tuff and tuff units (Twt and Tt) in northeastern and east-central part of map area but is interbedded with oldest unit (Tb_3) of the basalt of Basin and Range in southeastern part. Partial equivalent of the herein-abandoned Yonna Formation

Tuff and sandstone (Pliocene and Miocene)—Pale-gray to medium-gray lithic tuff and weakly lithified tuffaceous sandstone, some of which was probably deposited as lahars. Includes very poorly exposed rocks that underlie youngest unit (Tb_3) of the basalt of Basin and Range in Modoc Point area and laharic sandstone exposed beneath basalt (Tb_3) in fault scarps southeast of Klamath Falls. Probably interbedded with unit Tb_3 regionally

Basaltic andesite and andesite (Pliocene and Miocene)—Aphyric to porphyritic, intergranular to pilotaxitic lava flows and minor breccia. Near Yamsay Mountain, unit is basaltic andesite, where SiO_2 content is mostly in the range of 53 to 58 percent (29 analyses, Hering, 1981). Includes … mountain, … d Butte. Probabl…

Andesite (P… tain (flo… flow in …

Andesite a… and hor… Summit… varying … in the r…

Dacite (Plio… cludes d… Hering, … (table 1… part of …

Rhyolite an… erately … Potassium-argon ages range from … Ma (table 1, map Nos. 12, 14, 16, and 17); age of unit is late Miocene and Pliocene(?). Crops out in east-central and northeastern part of map area

Tuff and lapilli tuff (Miocene)—Lithic-bearing and pumiceous lapilli tuff, largely of ash-flow or hot-avalanche origin. Also includes thin- to medium-bedded fine-grained tuff, coarse pumicite (air fall), and very thick to thin-bedded pebbly sandstone that was probably deposited as lahars. Unit chiefly overlies oldest unit (Tb_3) of the basalt of Basin and Range but is also interbedded with oldest unit (Tb_3) of the basalt of Basin and Range in the herein-abandoned Yonna Formation

Welded tuff (Miocene)—Densely welded to locally unwelded dacitic or rhyodacitic ash-flow tuff. Unit consists of two separate subunits: the Silver Creek Welded Tuff of Hering (1981, 1982) in northeast corner of map area and welded tuff exposed on and around K Davis Hill (4 km west of Beatty). The Silver Creek Welded Tuff has K-Ar ages of 7.36±1.58 and 6.95±1.13 Ma (table 1, map N… 20 and 21)

Older palagonite tuff (Miocene)—Poorly bedded deposits of palagonitized basaltic ash and lapilli. Forms some vents for oldest unit (Tb_3) of the basalt of Basin and Range (other vents in unit Tv). Individual eruptive centers within large masses of palagonite are inferred from circular physiographic features and outwardly dipping beds; outline of individual centers shown by short-dashed line. Underlies rhyolite dome (Tr) in Black Hills, which has K-Ar age of 5.52±0.55 Ma (table 1, map No.14). Partial equivalent of the herein-abandoned Yonna Formation

Geology line symbols on the map and those in the explanation should be the same

Contact—Approximately located. Short dash indicates separate lava flow within basaltic andesite (Qba) 10 km east of Fort Klamath and outline of individual eruptive center in large mass of palagonite tuff (Topt and Typt)

Fault—Dashed where approximately located or inferred; dotted where concealed. Showing dip; ball and bar on downthrown side; hall arrows indicate direction of relative movement in cross sections

Fault having probable Holocene displacement—Dashed where approximately located or inferred; dotted where concealed. Showing dip; ball and bar on downthrown side. Shown only in Klamath basin. See section entitled "Structure" for discussion of age criteria

Caldera ring fault—Shown only at Yamsay Mountain

Lineament—Interpreted from aerial photographs; shown only in north-central part of map

Anticline—Dotted where concealed. Showing crestline and direction of plunge

Syncline

Bathymetric contours—In Upper Klamath Lake, datum is mean lake level, contour interval is 10 ft (from Johnson and others, 1985)

Ridgecrest of sand dunes—Shown only within unit Qs in southwest corner of map

Thickness of Holocene pumice-fall deposits (Qpf)—Thickness in centimeters; shown in northwest corner of map

Isopach

Measurement locality

Strike and dip of clastic strata—Parentheses indicate photogeologic interpretation of dip in basalt of unit Tb_3

Potassium-argon sample locality—Number refers to table 1 and figure 1

Column width 3" - 5"

Table 1. *Summary of K-Ar ages in map area and vicinity.*

S-8	Map No.	Sample No.	Location: Latitude (N.)	Location: Longitude (W.)	General geographic local and map unit	Rock type	Material dated	Calculated age (Ma)[1]	Reference
	1	KFE-11	42°21.0′	121°45.0′	Southeast of Modoc Point; Tb_1	Basalt	Whole rock	1.9±0.5	M. O'Brien and S. Hanson, in Fiebelkorn and others (1983)[2]
	2	KPW-6	42°14.0′ (location not exact)	121°50.0′ (location not exact)	South of Upper Klamath Lake; map unit uncertain	Andesite, tuff	Whole rock	2.3±0.2	Do.
	3	SS-1	42°23.8′	121°48.6′	Southeast of Modoc Point; Tb_1	Basalt	Whole rock	2.80±0.06	Pickthorn and Sherrod (in press)
	4	SS-6	42°30.9′	121°18.9′	Knot Tableland, Tbk	Basalt	Whole rock	3.0±0.9	Do.
	5	SS-3	42°39.7′	121°34.8′	North of Calimus Butte; Tb_1	Basalt	Whole rock	3.44±0.13	Do.
	6	SS-8	42°33.3′	121°06.1′	East of Black Hills; Tbg	Basalt	Whole rock	3.61±0.14	Do.
	7	SS-4	42°33.6′	121°39.3′	S'Ochoits Canyon; Tcs	Pumiceous lahar	Plagioclase	3.62±0.12	Do.
S-8	8	SS-2	42°54.8′	121°31.2′	Wildhorse Ridge; Tb_1	Basalt	Whole rock	3.68±0.08	Do.
	9	SS-12	42°12.6′	121°47.2′	Klamath Falls; lava flow in Tcs	Basalt	Plagioclase	4.47±0.28	Do.
	10	SS-5	42°33.6′	121°40.0′	S'Ochoits Canyon; Tbg	Basalt	Plagioclase	4.56±0.57	Do.
	11	M4-131	42°56.6′	121°19.5′	Yamsay Mountain; Td	Dacite	Whole rock	4.79±0.17	MacLeod and others (1976); McKee and others (1976); Fiebelkorn and others (1983).
	12	M4-130	42°54.9′	121°08.5′	Pertin Butte; Tr	Rhyolite	Whole rock	5.15±0.21	Do.
	13	M5-45	42°56.9′	121°54.8′	East of Crater Lake; Qr	Rhyodacite	Plagioclase	5.5±0.5	Bacon (1983); E.H. McKee, (written commun., 1986)
	14	M3-106	42°35.6′	121°13.4′	Black Hills; Tr— S-8	Rhyolite	Plagioclase	5.52±0.5	MacLeod and others (1976); McKee and others (1976); Fiebelkorn and others (1983).
	15	SS-7	42°33.4′	121°05.9′	East of Black Hills; Tbg	Basalt	Plagioclase	5.78±0.12	Pickthorn and Sherrod (in press)
	16	M5-2	42°21.1′	121°23.9′	Bly Mountain; Tr	Rhyolite	Plagioclase	5.8±4	Fiebelkorn and others (1983).
	17[3]	M3-61	43°00.6′	121°01.2′	Hager Mountain; Tr	Rhyolite	Obsidian	6.06±0.09	MacLeod and others (1976); McKee and others (1976); Fiebelkorn and others (1983).
	18	SS-9	42°20.0′	121°09.1′	East of Yainax Butte; Tbg	Basalt	Whole rock	6.16±0.13	Pickthorn and Sherrod (in press)
	19	SS-10	42°16.0′	121°20.7′	Southwest of Yainax Butte; Tbg	Basalt	Plagioclase	6.88±0.60	Do.
	20[4]	M4-74	43°01.6′	121°06.9′	West of Silver Creek; Twt	Silicic ash-flow tuff	Plagioclase	6.95±1.13	McKee and others (1976); Fiebelkorn and others (1983).
	21[4]	M4-73	43°05.2′	121°11.7′	West of Silver Creek; Twt	Silicic ash-flow tuff	Plagioclase	7.36±1.58	Do.

[1] K-Ar ages were calculated from data or references using the constants for the radioactive decay and abundance of ^{40}K recommended by the Subcommittee on Geochronology (Steiger and Jäger, 1977). These constants are: $\lambda_\beta = 0.580 \times 10^{-10}$ yr^{-1}, $\lambda_\gamma = 4.962 \times 10^{-10}$ yr^{-1}, and $^{40}K/K_{total} = 1.167 \times 10^{-4}$ mol/mol.
[2] Using a greater, Fiebelkorn and others (1983) published the data and referenced it to Lawrence Berkeley Laboratory Report No. 11290 (1981), which never was published.
[3] Age of 5.5 Ma is incorrect. Subsequent determinations from domes in the same area are 6.7 to 6.6 Ma (Baron, 1983, addendum to p. 63).
[4] Sample locality is outside boundary of geologic map. See figure 1 for location.

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Column width 3" - 5"

GEOLOGIC MAP OF THE WEST HALF OF THE KLAMATH FALLS 1° × 2° QUADRANGLE, SOUTH-CENTRAL OREGON

SB-24 — 0.25 (6.5) — By — SB-18

David R. Sherrod and Leda Beth G. Pickthorn — SB-18

0.15 (4) — 1992 — SB-12

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(VERSION 1.4)

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