Geochronology of Cenozoic Rocks in the Bodie Hills, California and Nevada

Data Series 916

Cover. Steeply flow-banded lava dome, trachyandesite of Willow Springs, east of Warm Spring in the Bodie Hills, California.

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By Robert J. Fleck, Edward A. du Bray, David A. John, Peter G. Vikre, Michael A. Cosca, Lawrence W. Snee, and Stephen E. Box

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[Available for download at <http://pubs.usgs.gov/ds/916/>]

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2. Analytical results of furnace incremental heating $^{40}\text{Ar}/^{39}\text{Ar}$ experiments (Denver lab, Snee) for samples of the Bodie Hills volcanic field
3. Analytical results of CO_2 -laser incremental heating $^{40}\text{Ar}/^{39}\text{Ar}$ experiments (Denver lab, Cosca) for samples of the Bodie Hills volcanic field

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Introduction

The purpose of this report is to present geochronologic data for unaltered volcanic rocks, hydrothermally altered volcanic rocks, and mineral deposits of the Miocene Bodie Hills and Pliocene to Pleistocene Aurora volcanic fields of east-central California and west-central Nevada. Most of the data presented here were derived from samples collected between 2000–13, but some of the geochronologic data, compiled from a variety of sources, pertain to samples collected during prior investigations. New data presented here (tables 1 and 2; Appendixes 1–3) were acquired in three U.S. Geological Survey (USGS) $^{40}\text{Ar}/^{39}\text{Ar}$ labs by three different geochronologists: Robert J. Fleck (Menlo Park, CA), Lawrence W. Snee (Denver, CO), and Michael A. Cosca (Denver, CO). Analytical methods and data derived from each of these labs are presented separately.

The middle to late Miocene Bodie Hills volcanic field (BHVF) is a large ($>700\text{ km}^2$), long-lived (~ 9 million years [m.y.]), episodic eruptive complex (John and others, 2012) in the southern segment of the ancestral Cascades arc (du Bray and others, written commun., 2015) north of Mono Lake and east of Bridgeport, California (fig. 1). The field is near the west edge of the Walker Lane and the northwest edge of the Mina deflection where structures related to these shear zones may have localized magmatism. The Walker Lane (fig. 1) is a broad, northwest-striking zone of right-lateral shear that accommodates right-lateral motion between the Pacific and North America plates; the Mina deflection constitutes a 60-km-long right step in the Walker Lane (Faulds and Henry, 2008; Oldow, 1992, 2003; Stewart, 1988). The Bodie Hills volcanic field includes at least 31 volcanic rock units erupted from 21 significant volcanic eruptive centers.

Four trachyandesite stratovolcanoes developed along the margins of the volcanic field and numerous silicic trachyandesite to rhyolite flow dome complexes erupted more centrally. Volcanism in the Bodie Hills volcanic field peaked at two periods, ~ 15.0 to 12.6 million years before present (Ma) and ~ 9.9 to 8.0 Ma, which were dominated by emplacement of large stratovolcanoes and large silicic trachyandesite-dacite lava domes, respectively. A final period of small-volume silicic dome emplacement began in the western part of the volcanic field at ~ 6 Ma and culminated at ~ 5.5 Ma (John and others, 2012).

Compositions of Bodie Hills volcanic rocks vary from ~ 50 to 78 weight percent SiO_2 , although rocks with <55 weight percent SiO_2 are rare. Rock compositions form a high-potassium (K) calc-alkaline series with pronounced negative titanium-phosphorus-niobium-tantalum anomalies and high barium/niobium, barium/tantalum, and lanthanum/niobium typical of subduction-related continental margin arcs (Gill, 1981). Most rocks are porphyritic and commonly contain 15–35 volume percent phenocrysts of plagioclase, pyroxene, and hornblende±biotite. Although the oldest eruptive centers have the most mafic compositions, erupted rock compositions oscillated between mafic and intermediate to felsic compositions through time. Following a brief hiatus in volcanism, post subduction rocks of the ~ 3.9 - to 0.1 -Ma, bimodal, high-K Aurora volcanic field were erupted onto the Bodie Hills volcanic field. Volcanism in the Bodie Hills volcanic field persisted until 8 Ma without apparent changes in rock composition or style of eruption despite the transition from subduction of the Farallon plate beneath the west coast of North America to establishment of a transform plate margin at ~ 10 Ma (John and others, 2012).

The eastern and southeastern parts of the Bodie Hills volcanic field and Miocene sedimentary rocks on the southern edge of Fletcher Valley are unconformably overlain by Pliocene to late Pleistocene (~ 3.9 to 0.1 Ma) rocks of the Aurora volcanic field (Gilbert and others, 1968; Al-Rawi, 1969; Chesterman and Gray, 1975; Kleinhampl and others, 1975; Lange and others, 1993; Lange and Carmichael, 1996; Kingdon and others 2013). The field covers $\sim 325\text{ km}^2$ and includes many well-preserved volcanic centers. These centers consist of monogenetic lava and cinder cones, valley-filling lava flows, shield volcanoes, and lava domes. Compositions of the Aurora volcanic field rocks are bimodally distributed and consist principally of trachyandesite and trachydacite to high-silica rhyolite.

Numerous hydrothermal systems were operative in the Bodie Hills during the Miocene (Vikre and others, in press). Structurally focused hydrothermal systems formed large epithermal gold-silver vein deposits in the Bodie and Aurora mining districts that are temporally and spatially related to intermediate- to silicic-composition dome complexes (John and others, 2012).

2 Geochronology of Cenozoic Rocks in the Bodie Hills, California and Nevada

Table 1. Map location numbers for $^{40}\text{Ar}/^{39}\text{Ar}$ geochronology samples from the Bodie Hills volcanic field, California and Nevada.

Map location number	Sample number	Latitude	Longitude	Unit; alteration zone; or mining district	Appendix number
1	098-12B	38.38762	-119.18139	Trachyandesite of Masonic	1
2	098-12A	38.35923	-119.19917	Eureka Valley Tuff	1
3	MAS10-72	38.40189	-119.13718	Trachyandesite of Masonic Gulch	1
4	RW08-1	38.41123	-119.12414	Alteration: Red Wash-East Walker River alteration zone	1
5	MAS10-73	38.39643	-119.13470	Trachyandesite of Masonic Gulch	1
6	098-12D	38.39951	-119.11939	Trachyandesite of Masonic	1
7	MAS10-55	38.41419	-119.10259	Alteration: Red Wash-East Walker River alteration zone	1
8	098-12E	38.39143	-119.12397	Trachyandesite of Masonic Gulch	1
9	MAS10-75	38.39169	-119.11549	Trachyandesite of Masonic Gulch	1
10	07-BA-38	38.36049	-119.14502	Andesite of Lakeview Spring	1
11	MAS07-1A	38.34992	-119.14832	Alteration: Masonic mining district, Chemung mine	1
12	MAS12-10 #1	38.33716	-119.16013	Alteration: Masonic mining district, Success mine	1
13	MAS12-10 #2	38.33716	-119.16013	Alteration: Masonic mining district, Success mine	1
14	MAS10-76	38.38169	-119.11534	Trachyandesite of Masonic, plug	1
15	MAS09-1A	38.35847	-119.13824	Alteration: Masonic mining district, Red Rock mine	1
16	12-BA-20	38.33410	-119.15949	Trachyandesite of Masonic	1
17	MAS09-1	38.35783	-119.13268	Alteration: Masonic mining district, Red Rock mine	1
18	098-12F	38.37542	-119.11418	Trachyandesite of Masonic	1
19	MAS07-3	38.35968	-119.12682	Alteration: Masonic mining district, Sarita mine	1
20	07-BA-40	38.36544	-119.11607	Alteration: Masonic mining district, Pittsburg-Liberty mine	1
21	088-22A	38.36731	-119.10727	Alteration: Masonic mining district, Maybelle mine	1
22	10-BA-15	38.34130	-119.11570	Trachyandesite of Masonic	1
23	10-BA-13	38.35154	-119.10419	Trachyandesite of Masonic	1
24	088-22B	38.37937	-119.07802	Trachyandesite of Masonic	1
25	MAS11-2B	38.36064	-119.08681	Alteration: Masonic mining district, Perini mine	1
26	MAS11-1	38.36041	-119.08369	Alteration: Masonic mining district, Perini mine	1
27	11-BA-40	38.41155	-119.01907	Trachydacite of Rough Creek	1
28	09-BA-7	38.33786	-119.08727	Trachyandesite of Masonic	1
29	12-BA-9	38.33679	-119.07378	Trachydacite of East Canyon	1
30	08SB038	38.40828	-118.97383	Trachyandesite of Del Monte	1
31	10-BA-29	38.36466	-119.01452	Trachydacite of Rough Creek	1
32	10-BA-9	38.35278	-119.02068	Trachyandesite of Masonic, plug	1
33	6-289-2/45/DD72	38.3729	-118.9993	Eureka Valley Tuff	2
34	10-BA-62	38.36327	-119.00635	Tephra in sedimentary rocks of Fletcher Valley	1
35	10-BA-6	38.33375	-119.02470	Trachydacite of Rough Creek	1
36	10-BA-5	38.33945	-118.99699	Pyroxene rhyolite	1
37	11-BA-41	38.35057	-118.98085	Trachyandesite of Del Monte	1
38	11-BA-32	38.33637	-118.97804	Rhyolite of Bodie Creek	1
39	08SB032	38.34561	-118.95580	Unwelded tuff, Fletcher Basin	1
40	5-152-9/50/72	38.3548	-118.9261	Hornblende trachydacite	2
41	5-152-9/56/72	38.3548	-118.9261	Hornblende trachydacite	2
42	12-BA-3	38.34974	-118.84729	Trachyandesite of Mud Spring Canyon	3
43	10-BA-69	38.30537	-119.13652	Trachyandesite of Masonic	1
44	098-13D	38.27655	-119.16062	Trachyandesite of Clark Canyon	1
45	09-BA-43	38.26358	-119.16825	Trachyandesite of Clark Canyon	1
46	203195	38.2823	-119.1479	Basaltic andesite of Locomotive Point	3
47	09-BA-47	38.28409	-119.13821	Rhyolite of Bodie Hills	1
48	09-BA-42	38.27001	-119.14887	Rhyolite of Big Alkali	1

Table 1.—Continued

Map location number	Sample number	Latitude	Longitude	Unit; alteration zone; or mining district	Appendix number
49	088-21A	38.27363	-119.13962	Trachyandesite of Aurora Canyon	1
50	098-13B	38.26802	-119.13218	Rhyolite of Bodie Hills	1
51	MC-12-20	38.2701	-119.1261	Hornblende trachyandesite plug	3
52	088-23F	38.31068	-119.11700	Trachyandesite of Masonic	1
53	088-23D	38.28113	-119.10206	Trachyandesite of Aurora Canyon	1
54	088-23A	38.27852	-119.10021	Trachyandesite of Aurora Canyon	1
55	088-23B	38.27831	-119.09908	Trachyandesite of Aurora Canyon	1
56	08-BA-62	38.32006	-119.04943	Trachyandesite of Masonic	1
57	088-25A	38.27322	-119.09077	Trachyandesite of Aurora Canyon	1
58	09-BA-1	38.31968	-119.04411	Trachyandesite of Cow Camp Creek	3
59	077-8C	38.27145	-119.07783	Trachyandesite of Aurora Canyon	1
60	077-8B	38.28334	-119.05617	Trachydacite intrusion	1
61	088-21B	38.26418	-119.07504	Trachydacite of Potato Peak	1
62	09-BA-35	38.29048	-119.04642	Trachydacite intrusion	1
63	09-BA-49	38.26389	-119.04748	Eureka Valley Tuff	1
64	11-BA-60	38.32693	-118.97204	Rhyolite of Bodie Creek	1
65	08-BA-65	38.31071	-118.97808	Rhyolite of Bald Peak	1
66	10-BA-67	38.26200	-118.98300	Rhyolite of Bald Peak	1
67	AU-10/61/DD61	38.26	-118.981	Eureka Valley Tuff	2
68	108-11A	38.27826	-118.94807	Rhyolite of Bodie Creek	1
69	077-9B	38.26971	-118.95063	Rhyolite of Bodie Creek	1
70	077-9D	38.28562	-118.92803	Rhyolite of Del Monte Canyon	1
71	AU-6/60/DD61	38.285	-118.928	Rhyolite of Del Monte Canyon	2
72	077-9C	38.27661	-118.93036	Rhyolite of Del Monte Canyon	1
73	SAW11-9	38.29036	-118.91657	Alteration: Sawtooth Ridge alteration zone	1
74	077-9E	38.31905	-118.91003	Trachyandesite of Del Monte	1
75	10-BA-20	38.31679	-118.91129	Rhyolite of Aurora Creek	1
76	10-BA-21	38.30315	-118.89740	Rhyolite of Aurora Creek	1
77	108-10C	38.28052	-118.90623	Trachyandesite of West Brawley Peak	1
78	108-10A	38.27293	-118.91272	Trachyandesite of Aurora	1
79	FA1	38.2931	-118.8914	Alteration: Aurora mining district, adularia in Prospectus vein	2
80	10-BA-27	38.27500	-118.90498	Rhyolite of East Brawley Peak	1
81	AU-2/59/DD61	38.282	-118.896	Aurora mining district, adularia in Del Monte shaft dump	2
82	AU-1/58/DD61	38.266	-118.9	Alteration: Aurora mining district, adularia in Esmeralda vein dump	2
83	00-BA-16	38.2708	-118.8908	Trachyandesite of Aurora	2
84	MC-12-19	38.31952	-118.78154	Trachyandesite of Borealis	3
85	39509-10	38.21532	-119.22755	Dacite of Hot Springs Canyon	1
86	39509-3K	38.20793	-119.22751	Alteration: Cinnabar Canyon-US 395 alteration zone	1
87	088-24B	38.25504	-119.14115	Trachyandesite of Willow Springs	1
88	088-24A	38.25278	-119.13951	Rhyolite of Big Alkali	1
89	PP09-10A1	38.25309	-119.13844	Alteration: Aurora Canyon alteration zone	1
90	098-13A	38.25754	-119.12788	Rhyolite of Big Alkali	1
91	CC09-9D1	38.19869	-119.17050	Alteration: Cinnabar Canyon-US 395 alteration zone	1
92	CC09-9D2	38.19869	-119.17050	Alteration: Cinnabar Canyon-US 395 alteration zone	1
93	088-24C	38.24786	-119.11208	Trachydacite of Potato Peak	1
94	12-BA-1	38.18995	-119.16513	Trachydacite of Cinnabar Canyon	1
95	077-7C	38.19677	-119.15829	Rhyolite of Del Monte Canyon	1
96	08-BA-46	38.24430	-119.10385	Alteration: Potato Peak alteration zone, Alta Pina mine	1

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Table 1.—Continued

Map location number	Sample number	Latitude	Longitude	Unit; alteration zone; or mining district	Appendix number
97	08-BA-50	38.24816	-119.09663	Rhyolite of Bodie Hills	1
98	077-7B	38.19178	-119.15240	Trachyandesite of Willow Springs	1
99	098-13C	38.25072	-119.09223	Trachydacite of Potato Peak	1
100	098-10C	38.24919	-119.09203	Trachydacite of Potato Peak	1
101	088-21D	38.24330	-119.09209	Trachydacite of Potato Peak	1
102	098-10B	38.25135	-119.08382	Rhyolite of Bodie Hills	1
103	088-21C	38.25134	-119.08382	Rhyolite of Bodie Hills	1
104	088-24D	38.22678	-119.10376	Trachydacite of Potato Peak	1
105	088-21E	38.23457	-119.08582	Trachydacite of Potato Peak	1
106	088-24E	38.21809	-119.10188	Trachydacite of Potato Peak	1
107	08-BA-61	38.20769	-119.10175	Trachydacite of Potato Peak	1
108	088-24F	38.20176	-119.08978	Trachyandesite of Willow Springs	1
109	108-12A	38.24252	-119.04825	Trachydacite of Potato Peak	1
110	08-BA-68	38.19323	-119.06835	Trachydacite of Potato Peak	1
111	108-12B	38.23830	-119.00784	Trachydacite of Potato Peak	1
112	08-BA-66	38.18629	-119.05680	Dacite of Silver Hill, debris flow clast	1
113	12-BA-17	38.21961	-119.00019	Alteration: Bodie mining district, vein adularia, west of Bodie Bluff	1
114	077-7F	38.20252	-119.02630	Dacite of Silver Hill	1
115	BOD11-3A	38.21961	-119.00354	Alteration: Bodie mining district, vein adularia, Upper Hobart Tunnel dump	1
116	BOD11-3B	38.21961	-119.00354	Alteration: Bodie mining district, vein adularia, Bodie Bluff	1
117	077-6C	38.21870	-119.00050	Alteration: Bodie mining district, vein adularia, Bodie Bluff	1
118	AU-16/63/DD61	38.215	-119.004	Alteration: Bodie mining district, vein adularia, south of Bodie Bluff	2
119	077-6A	38.21490	-119.00370	Alteration: Bodie mining district, vein adularia, south of Bodie Bluff	1
120	11-BA-22	38.21257	-119.00402	Alteration: Bodie mining district, vein adularia, south of Bodie Bluff	1
121	BOD11-4E	38.21257	-119.00402	Alteration: Bodie mining district, vein adularia, Standard Hill Mine	1
122	11-BA-21	38.20370	-119.00919	Alteration: Bodie mining district, vein adularia, Red Cloud mine	1
123	AU-17/64/DD61	38.215	-118.997	Alteration: Bodie mining district, vein adularia, south of Bodie Bluff	2
124	BOD09-5	38.20424	-119.00755	Alteration: Bodie mining district, vein adularia, Oro mine dump	1
125	11-BA-7G	38.20420	-119.00649	Alteration: Bodie mining district, vein adularia, Silver Hill	1
126	BOD09-3	38.20138	-119.00575	Alteration: Bodie mining district, vein adularia, Red Cloud Mine	1
127	09-BA-28I	38.20151	-119.00360	Alteration or mineralization: Bodie, Red Cloud mine	1
128	AU-18/65/DD61	38.201	-119.004	Alteration or mineralization: Bodie, Red Cloud mine	2
129	09-BA-26	38.20360	-119.00021	Dacite of Silver Hill	1
130	077-7G	38.23439	-118.96671	Trachyandesite of West Brawley Peak	1
131	077-6F	38.18809	-119.00854	Dacite of Silver Hill-Sugarloaf plug	1
132	077-9A	38.22088	-118.97443	Eureka Valley Tuff	1
133	108-12C	38.18925	-118.98343	Dacite of Silver Hill	1
134	108-12E	38.20763	-118.96489	Dacite of Silver Hill	1
135	FA66	38.2375	-118.9008	Alteration: East Brawley Peak alteration zone, vein alunite	2
136	00-BA-26	38.2542	-118.8841	Trachyandesite of Aurora	2
137	AUR10-3	38.23752	-118.89919	Alteration: East Brawley Peak alteration zone, vein alunite	1
138	077-7A	38.17860	-119.19476	Trachyandesite of Willow Springs	1
139	08-BA-51	38.17449	-119.15441	Trachyandesite of Willow Springs	1
140	09-BA-22	38.14302	-119.17974	Trachyandesite of Mt. Biedeman	1
141	09-BA-23	38.12851	-119.17491	Tuff of Jacks Spring	1
142	098-11B	38.12451	-119.17126	Trachydacite of Bridgeport Canyon	1
143	098-11A	38.12239	-119.16954	Tuff of Jacks Spring	1

Table 1.—Continued

Map location number	Sample number	Latitude	Longitude	Unit; alteration zone; or mining district	Appendix number
144	10-BA-46	38.17380	-119.11508	Trachyandesite of Mount Biedeman	1
145	10-BA-66	38.17250	-119.10125	Trachydacite of Potato Peak	1
146	09SB015A	38.12310	-119.14843	Trachyandesite of Mount Biedeman	1
147	098-11E	38.11099	-119.15841	Trachyandesite of Mount Biedeman	1
148	077-7D	38.16719	-119.09983	Rhyolite of Bodie Hills	1
149	09SB020A	38.13230	-119.13277	Trachydacite of Bridgeport Canyon	1
150	108-9A	38.16540	-119.09816	Trachyandesite of Mount Biedeman	1
151	108-12F	38.16336	-119.09918	Trachyandesite of Mount Biedeman	1
152	MC-12-18	38.15575	-119.07825	Trachyandesite of Mount Biedeman	3
153	12-BA-22	38.10151	-119.12400	Trachyandesite of Mount Biedeman	1
154	6-181-12/52/DD72	38.1193	-119.1039	Tuff of Jacks Spring	2
155	6-181-12/53/DD72	38.1193	-119.1039	Tuff of Jacks Spring	2
156	6-215-1/121/72	38.1344	-119.0825	Trachyandesite of Mount Biedeman	2
157	119-20B	38.13452	-119.07613	Trachyandesite of Mount Biedeman, plug	1
158	09-BA-20	38.15662	-119.04741	Rhyolite of Bodie Hills	1
159	10-BA-61	38.14005	-119.01551	Trachyandesite of Mount Biedeman	1
160	108-12D	38.17315	-118.97800	Dacite of Silver Hill	1

Table 2. Map location numbers for K-Ar geochronology samples from the Bodie Hills volcanic field, California and Nevada.

Map location letter	Sample number	Latitude	Longitude	Unit
A	1071	38.175	-118.832	Pyroxene trachyandesite of Cedar Hill
B	469	38.179	-118.826	Pyroxene trachyandesite of Cedar Hill
C	468	38.178	-118.819	Hornblende trachydacite of Cedar Hill
D	466	38.179	-118.821	Pyroxene trachyandesite of Cedar Hill
E	465	38.181	-118.823	Pyroxene trachyandesite of Cedar Hill
F	1069	38.188	-118.850	Hornblende trachydacite of Cedar Hill
G	139	38.209	-118.880	Hornblende trachydacite of Cedar Hill
H	199	38.153	-119.008	Hornblende trachydacite of Cedar Hill
I	144	38.184	-118.894	Trachyandesite of Cedar Hill
J	1092A	38.255	-118.810	Rhyolite of Spring Peak
K	25	38.261	-118.973	Basaltic trachyandesite of Beauty Peak
L	120	38.240	-118.829	Trachyandesite of Mount Hicks
M	15	38.194	-118.961	Dacite of Silver Hill
N	414	38.177	-119.193	Trachyandesite of Willow Springs
O	406	38.234	-119.085	Trachydacite of Potato Peak
P	507	38.154	-119.089	Rhyolite of Bodie Hills
Q	459	38.097	-119.064	Eureka Valley Tuff
R	31	38.247	-118.990	Eureka Valley Tuff
S	27	38.247	-118.990	Eureka Valley Tuff
T	W24	38.102	-119.066	Eureka Valley Tuff
U	W25	38.131	-119.181	Eureka Valley Tuff
V	547	38.255	-118.948	Trachyandesite of West Brawley Peak
W	USGS(M)-711-67	38.2894	-118.9092	Trachyandesite of Aurora

6 Geochronology of Cenozoic Rocks in the Bodie Hills, California and Nevada

Table 2.—Continued

Map location letter	Sample number	Latitude	Longitude	Unit
X	USGS(M)-668-G10	38.2403	-118.8917	Trachyandesite of Aurora
Y	USGS(M)-711-8	38.2681	-118.8917	Trachyandesite of Aurora
Z	USGS(M)-712-1	38.2522	-118.9175	Trachyandesite of West Brawley Peak
AA	USGS(M)-710-7	38.2822	-118.9281	Rhyolite of Del Monte Canyon
BB	USGS(M)-NTS10B	38.3021	-118.8967	Rhyolite of Aurora Creek
CC	USGS(M)-Baghdad	38.2786	-118.9467	Rhyolite of Bodie Creek
DD	USGS(M)-670G4	38.2811	-118.8842	Rhyolite of Martinez Hill
EE	USGS(M)-610-1B	38.2778	-118.8586	Rhyodacite of Aurora Peak
FF	USGS(M)-672-2	38.3128	-118.8825	Trachyandesite of Aurora Crater
GG	USGS(M)-611-5	38.2578	-118.8558	Trachyandesite south of Aurora Peak
HH	BH31	38.194	-119.008	Dacite of Silver Hill, plug
II	5	38.0978	-119.1475	Trachyandesite of Sinnamon Cut
JJ	6	38.1256	-119.1697	Basaltic trachyandesite of Rancheria
KK	37	38.287	-118.887	Alteration or mineralization: Trachyandesite of Aurora
LL	CH8Z1	38.288	-118.882	Trachyandesite of Aurora
MM	USGS(M)-7346-1	38.215	-119.004	Alteration or mineralization: Bodie
NN	USGS(M)-RCD1B	38.201	-119.005	Alteration or mineralization: Bodie
OO	USGS(M)-B270	38.216	-119.004	Alteration or mineralization: Bodie
PP	USGS(M)-BH15	38.201	-119.003	Dacite of Silver Hill
QQ	USGS(M)-S1	38.188	-119.008	Dacite of Silver Hill
RR	USGS(M)-B271	38.215	-119.003	Dacite of Silver Hill
SS	USGS(M)-856-8	38.214	-119.004	Dacite of Silver Hill
TT	USGS(M)-BH17	38.193	-119.012	Dacite of Silver Hill
UU	USGS(M)-7346-3	38.216	-118.981	Hornblende trachydacite of Cedar Hill
VV	USGS(M)-BH32	38.200	-118.995	Dacite of Silver Hill
WW	USGS(M)-856-32	38.209	-118.997	Dacite of Silver Hill
XX	USGS(M)-856-10	38.205	-119.028	Trachydacite of Potato Peak
YY	USGS(M)-BH26	38.194	-119.003	Dacite of Silver Hill
ZZ	USGS(M)-BH16	38.200	-118.999	Dacite of Silver Hill
AAA	USGS(M)-854-1	38.182	-119.003	Dacite of Silver Hill
BBB	USGS(M)-BH29	38.196	-118.958	Dacite of Silver Hill
CCC	USGS(M)-BM2	38.221	-119.057	Trachydacite of Potato Peak
DDD	USGS(M)-BH9	38.157	-119.116	Trachyandesite of Mount Biedeman
EEE	USGS(M)-MTB1	38.146	-119.073	Trachyandesite of Mount Biedeman
FFF	USGS(M)-BH27	38.140	-119.056	Rhyolite of Bodie Hills
GGG	USGS(M)-BH19A	38.222	-119.172	Trachyandesite of Willow Springs
HHH	USGS(M)-BH6	38.1655	-119.1512	Rhyolite of Big Alkali
III	USGS(M)-BH20	38.220	-119.149	Rhyolite of Big Alkali
JJJ	23	38.156	-118.860	Trachybasalt of Cedar Hill
KKK	158	38.368	-118.812	Trachyandesite of Mud Spring
LLL	160	38.357	-118.896	Trachyandesite of Aurora Crater
MMM	KA2362	38.4408	-118.9725	Hornblende andesite
NNN	KA2364	38.4408	-118.9725	Hornblende andesite
OOO	KA2368	38.4408	-118.9725	Hornblende andesite
PPP	KA2379R	38.4133	-118.9417	Aldrich Station Formation, tuff
QQQ	742-45	38.0869	-119.1431	Basaltic trachyandesite of Rancheria
RRR	EL-KA-2	38.3047	-118.7799	Andesite

Figure 1. Map showing location of and major physiographic features near the Bodie Hills volcanic field (BH). Mina deflection (vertical red line pattern) and outline of the Walker Lane (red shaded area) modified from Faulds and Henry (2008), Busby (2013), and Carlson and others (2013). Also see John and others, 2015.

⁴⁰Ar/³⁹Ar Analytical Methods

New ⁴⁰Ar/³⁹Ar age determinations provide temporal constraints on volcanic and hydrothermal activity in the Bodie Hills (figs. 2 and 3). Volcanic rocks were dated using either separates of one or more phenocryst mineral (plagioclase, sanidine, biotite, hornblende) or whole-rock aggregates. Ages of hydrothermal alteration were determined using separates of alunite, K-feldspar, or adularia. Where practical, multiple minerals from individual samples were dated to provide abundant confirmation of the results, but also to evaluate and document argon systematics of the different mineral phases nucleated under various magmatic and hydrothermal conditions.

Samples collected for ⁴⁰Ar/³⁹Ar analysis were crushed and sieved to sizes appropriate for preparation of high-purity separates. Standard magnetic and heavy-liquid separation techniques were used to make mineral separations. Whole-rock samples were prepared by crushing and isolating ~1 mm³ rock fragments from fresh rock that was free of obvious alteration and xenocrysts. Analyzed samples were washed in deionized water. In many cases, final separates were prepared by hand picking individual crystals.

Samples whose ages were determined at the U.S. Geological Survey ⁴⁰Ar/³⁹Ar lab in Menlo Park, CA (Appendix 1) were irradiated in the U.S. Geological Survey TRIGA Reactor Facility in Denver, Colorado; irradiation times were between 10 and 16 hours, although biotite, plagioclase, and sanidine from the rhyolite of Bodie Hills (map location number 102) were also analyzed in both 2-hour and 24-hour irradiations. Plagioclase, biotite, hornblende, and alunite ages were obtained using incremental-heating analysis, that is, incremental extraction of argon at progressively higher temperatures until all gas is released. Incremental heating analyses utilized a low-blank, tantalum and molybdenum, resistance-heated furnace. During heating, all argon gas was released in 8–15 temperature-controlled increments or steps; a few hornblende and potassium feldspar experiments required as many as 18 steps. Ages from incremental-heating experiments were determined by evaluating ⁴⁰Ar/³⁹Ar age spectra and isochron diagrams. Data for many of the individual sample ages constitute ⁴⁰Ar/³⁹Ar plateaus, defined as the weighted mean age of contiguous gas fractions representing >50% of the ³⁹Ar released for which no difference can be detected between the ages of any two fractions at the 95% level of confidence (Fleck and others, 1977). Where no plateau was defined, either the ⁴⁰Ar/³⁹Ar isochron age or the integrated age of all increments was defined as the age of the sample.

Most sanidine and biotite ages determined at the U.S. Geological Survey ⁴⁰Ar/³⁹Ar lab in Menlo Park, CA were obtained by laser-fusion analysis, whereby grains were fused with a CO₂ laser in a single heating step (Appendix 1). One or several grains were used in each analysis, depending on grain size. In all cases, a minimum number of grains were used to permit recognition and elimination of most xenocrystic or

detrital contamination through identification of outliers. The reported age for laser-fusion analyses represents the weighted mean of the replicate analyses, with the inverse variance of propagated, within-run (internal) errors of each used as its weighting factor (Taylor, 1982). Sanidine from the Taylor Creek Rhyolite (TCR-2) was used for calculation of neutron flux in all irradiations up to IRR290 (Appendix 1). Subsequent irradiations (higher IRR numbers in Appendix 1) used Bodie Hills sanidine (098-10B), calibrated to TCR-2, as the flux monitor. Regardless of the monitor mineral used, all ages in Appendix 1 are reported relative to an age of 28.02 Ma for the Fish Canyon Tuff sanidine standard (Renne and others, 1998) with uncertainties estimated at the one-sigma level, unless stated. Decay and abundance constants are those recommended by Steiger and Jäger (1977). Ages were calculated assuming a ⁴⁰Ar/³⁶Ar ratio of trapped argon equal to the atmospheric value of 295.5.

The ⁴⁰Ar/³⁹Ar ages reported in Appendix 2, determined in the U.S. Geological Survey ⁴⁰Ar/³⁹Ar lab in Denver, Colorado by L.W. Snee, are based on analyses of biotite, hornblende, plagioclase, or sanidine phenocrysts; hydrothermal K-feldspar, adularia, or alunite; and one whole rock analysis (Appendix 2). Analyzed materials were packaged in aluminum foil and stacked in quartz glass vials with monitor minerals placed between every second sample and at the top and bottom of each vial. Samples were irradiated in the U.S. Geological Survey's TRIGA reactor in Denver, Colorado, in irradiation packages DD61, DD72, and DD78. Irradiated samples were heated in temperature steps in a double-vacuum furnace, and the released gasses were cleaned according to procedures described by Snee (2002). Argon isotopic total abundances (⁴⁰Ar_T, ³⁹Ar_T, ³⁸Ar_T, ³⁷Ar_T, and ³⁶Ar_T) were measured on a MAP 215 mass spectrometer on a Faraday collector in volts to five decimal places. Corrected abundances for ⁴⁰Ar_R (radiogenic ⁴⁰Ar), ⁴⁰Ar_K (irradiation-produced K-derived ⁴⁰Ar), ⁴⁰Ar_I (initial ⁴⁰Ar), ³⁹Ar_K (irradiation-produced K-derived ³⁹Ar), ³⁸Ar_{Cl} (irradiation-produced Cl-derived ³⁸Ar), ³⁷Ar_{Ca} (irradiation produced Ca-derived ³⁷Ar, and ³⁶Ar_I (initial ³⁶Ar) are in volts. All estimated uncertainties in measured voltages are reported in Appendix 2 at one sigma. Voltages may be converted to moles using 1.160×10^{-12} moles argon per volt signal. The "F" value (⁴⁰Ar_R/³⁹Ar_K) for each temperature step was directly calculated from ⁴⁰Ar_R divided by ³⁹Ar_K. K/Ca was calculated from the expression $K/Ca = 0.5(^{39}Ar_K / ^{37}Ar_{Ca})$. All isotopic abundances in Appendix 2 have been corrected for mass discrimination. Mass discrimination was determined by calculating the ⁴⁰Ar/³⁶Ar ratio of aliquots of atmospheric argon pipetted from a fixed pipette on the extraction line; the ratio during these experiments was 298.9, which was corrected to 295.5 to account for mass discrimination. Final isotopic abundances were corrected for all interfering isotopes of argon including atmospheric argon. ³⁷Ar and ³⁹Ar, which are produced during irradiation, are radioactive and their

abundances were corrected for radioactive decay. Abundances of interfering isotopes from K and Ca were calculated from reactor production ratios determined by irradiating and analyzing pure CaF_2 and K_2SO_4 ; the K_2SO_4 was degassed in a vacuum furnace prior to irradiation to release extraneous argon. Corrections for Cl-derived ^{36}Ar were determined using the method of Roddick (1983). Production ratios for these experiments are documented by Snee (2002). Apparent ages of each fraction include the error in J value (0.1 percent), which was calculated from the reproducibility of splits of the argon from several standards. The standards for this experiment were hornblende MMhb-1, using an age of 523.1 ± 2.6 Ma (Samson and Alexander, 1987; Renne and others, 1998), and sanidine FCT1, using an age of 27.84 Ma, as measured in the Denver Argon Laboratory against MMhb-1 (Snee, 2002). Apparent ages were calculated using decay constants of Steiger and Jäger (1977). All apparent age errors are cited at one sigma. Uncertainties associated with apparent ages of individual fractions were calculated using equations of Dalrymple and others (1981). Isochron diagrams were produced for all samples and may be derived by using $^{40}\text{Ar}_i$ (initial ^{40}Ar) and $^{36}\text{Ar}_i$ (initial ^{36}Ar). Plateaus were determined according to the method of Fleck and others (1977).

The $^{40}\text{Ar}/^{39}\text{Ar}$ ages reported in Appendix 3, determined in the U.S. Geological Survey $^{40}\text{Ar}/^{39}\text{Ar}$ lab in Denver, CO by M.A. Cosca, are based on analyses of amphibole (hornblende), plagioclase, and whole rock samples. Samples, together with standards, were irradiated for 20 MW (megawatt) hours in the central thimble position of the USGS TRIGA reactor. Laser fusion of >10 individual Fish Canyon Tuff sanidine crystals (28.201 ± 0.09 Ma; Kuiper and others, 2008) at each closely monitored position within the irradiation package resulted in neutron flux ratios reproducible to $\pm 0.25\%$ (two sigma). Isotopic production ratios and interfering nucleogenic reactions were determined from irradiated CaF_2 and KCl salts and zero age K-silicate glass, and for this study the following values were measured: $(^{36}\text{Ar}/^{37}\text{Ar})_{\text{Ca}} = (2.77 \pm 0.03) \times 10^{-4}$; $(^{39}\text{Ar}/^{37}\text{Ar})_{\text{Ca}} = (6.54 \pm 0.33) \times 10^{-4}$; and $(^{38}\text{Ar}/^{39}\text{Ar})_{\text{K}} = (1.29 \pm 0.03) \times 10^{-2}$. Cadmium shielding during irradiation prevented any measurable nucleogenic $(^{40}\text{Ar}/^{39}\text{Ar})_{\text{K}}$. The irradiated samples and standards were loaded into numbered positions of a stainless steel planchette, placed into a laser sample chamber with an externally pumped ZnSe window, and evacuated to ultrahigh vacuum conditions in a fully automated stainless steel extraction line designed and built at the USGS in Denver. The samples were incrementally heated using a 25W CO_2 laser equipped with a beam homogenizing lens and the liberated gas was expanded and purified by exposure to a cryogenic trap maintained at -140°C and two hot SAES GP50 getters. Following purification the gas was expanded online into a Thermo Scientific ARGUS VI mass spectrometer (except sample 203195, which was analyzed using a Mass Analyzer Products 215–50 mass spectrometer) in static mode and Ar isotopes were measured by peak jumping using an electron multiplier in analog mode. Data were acquired during 10 measurement cycles and time zero intercepts were determined

by best-fit linear and (or) polynomial regressions to the data. Ages were calculated assuming a $^{40}\text{Ar}/^{36}\text{Ar}$ ratio of trapped argon equal to the atmospheric value of 298.56 (Lee and others, 2006) and using decay constants of Steiger and Jäger (1977). Data were corrected for mass discrimination, blanks, radioactive decay, and interfering nucleogenic reactions.

K-Ar Analytical Methods

Conventional K-Ar analyses were not carried out as part of this study, but previous workers produced considerable K-Ar age data that constitute an important source of stratigraphic information on the Bodie Hills volcanic field and on the timing of mineralization in the Bodie and Aurora mining districts. Many earlier K-Ar analyses were performed in K-Ar laboratories at USGS facilities in Menlo Park and Denver or at University of California laboratories in Berkeley. An appropriate reference for K-Ar techniques used in all three laboratories is found in Dalrymple and Lanphere (1969).

Data

All available geochronology data for Bodie Hills volcanic field are summarized in table 3. These data are synthesized and interpreted in other publications, including John and others (2012, 2015), Vikre and others (2015) and du Bray and others (written commun., 2015). As described previously, ages reported in Appendixes 1–3 utilized several slightly different ages for the Fish Canyon Tuff sanidine standard as a consequence of these age determinations having been conducted in several different labs, over a period of almost fifteen years, during which the accepted age for the sanidine standard was refined. In order to render ages calculated using different values for the sanidine standard comparable, ages calculated using a sanidine standard age different from 28.02 Ma were recalculated using that value and are summarized in the column titled “Age recalculated for FCT= 28.02” (table 3).

Acknowledgments

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Figure 2. (A) Locations of samples (solid black circles) with $^{40}\text{Ar}/^{39}\text{Ar}$ age determinations (table 1) shown on a simplified geologic map of the Bodie Hills volcanic field, California and Nevada. Colored polygons portray extent of eruptive products associated with particular volcanic centers within the Bodie Hills volcanic field (modified from John and others, 2012; 2015). Uncolored areas are underlain by either older basement rocks, rocks of the Aurora volcanic field, or surficial deposits. (B) Inset map showing locations of samples (solid circles) with $^{40}\text{Ar}/^{39}\text{Ar}$ age determinations (table 1) in densely sampled Bodie mining district.

Figure 2.—Continued

A

Figure 3. (A) Locations of samples (solid black circles) with K-Ar age determinations (table 2) shown on a simplified geologic map of the Bodie Hills volcanic field, California and Nevada. Colored polygons portray extent of eruptive products associated with particular volcanic centers within the Bodie Hills volcanic field (modified from John and others, 2012, 2015). (B) Inset map showing locations of samples (solid circles) with K-Ar age determinations (table 2) in densely sampled Bodie mining district.

Figure 3.—Continued

Table 3. Summary compilation of geochronologic data for samples of the Bodie Hills volcanic field, California and Nevada.

[Entries in the "Summary age" column represent a recapitulation of K-Ar ages, recalculated using the decay constants of Steiger and Jäger (1977), and $^{40}\text{Ar}/^{39}\text{Ar}$ ages, calculated assuming a Fish Canyon Tuff age of 28.02 Ma]

Sample number	Lab. no.	Latitude	Longitude	Unit	Age, Ma	Error, Ma	Method	Source ¹	Mineral	Decay constant ²	Recalculated		
											age, using new decay constants	Age recalculated for FCT=28.02 Ma	Summary age
158	—	38.368	-118.812	Trachyandesite of Mud Spring	0.11	0.08	K-Ar	8	Groundmass	new	—	—	0.11
EL-KA-6	—	38.3635	-118.8169	Trachyandesite of Mud Spring	0.04	0.04	Ar-Ar ³	13	Groundmass	—	—	0.04	0.04
USGS(M)-672-2	—	38.3128	-118.8825	Trachyandesite of Aurora Crater	0.25	0.05	K-Ar	2	Whole rock	old*	0.26	—	0.26
160	—	38.357	-118.896	Trachyandesite of Aurora Crater	0.47	0.19	K-Ar	8	Groundmass	new	—	—	0.47
EL-KA-9	—	38.3630	-118.8461	Trachyandesite 2	1.32	0.08	Ar-Ar ³	13	Groundmass	—	—	1.33	1.33
EL-KA-2	—	38.3047	-118.7799	Andesite	1.44	0.06	K-Ar	13	Whole rock	new	—	—	1.44
EL-KA-7	—	38.3306	-118.7901	Andesite	1.6	0.02	Ar-Ar ³	13	Groundmass	—	—	1.6	1.6
120	KA-2089	38.240	-118.829	Trachyandesite of Mount Hicks	1.6	0.1	K-Ar	1	Whole rock	old*	1.6	—	1.6
09-BA-1	—	38.31968	-119.04411	Trachyandesite of Cow Camp Creek	2.00	0.04	Ar-Ar ⁴	14	Whole rock	—	—	1.99	1.99
USGS(M)-611-5	—	38.2578	-118.8558	Trachyandesite south of Aurora Peak	2.2	0.1	K-Ar	2	Whole rock	old*	2.3	—	2.3
USGS(M)-611-5	—	38.2578	-118.8558	Trachyandesite south of Aurora Peak	2.5	0.2	K-Ar	2	Hornblende	old*	2.6	—	2.6
USGS(M)-670G4	—	38.2811	-118.8842	Rhyolite of Martinez Hill	2.5	0.1	K-Ar	2	Biotite	old*	2.6	—	2.6
23	—	38.156	-118.860	Trachybasalt of Cedar Hill	2.60	0.06	K-Ar	8	Groundmass	new	—	—	2.60
USGS(M)-610-1B	—	38.2778	-118.8586	Trachydacite of Aurora Peak	2.5	0.2	K-Ar	2	Biotite	old*	2.6	—	2.6
USGS(M)-610-1B	—	38.2778	-118.8586	Trachydacite of Aurora Peak	2.7	0.2	K-Ar	2	Hornblende	old*	2.8	—	2.8
1071	KA-1999	38.175	-118.832	Pyroxene trachyandesite of Cedar Hill	61.0	0.1	K-Ar	1	Plagioclase	old*	61.0	—	61.0
469	KA-2003	38.179	-118.826	Pyroxene trachyandesite of Cedar Hill	2.7	0.8	K-Ar	1	Plagioclase	old*	2.8	—	2.8
466	KA-1912	38.179	-118.821	Pyroxene trachyandesite of Cedar Hill	2.7	0.2	K-Ar	1	Biotite	old*	2.8	—	2.8
465	KA-1857	38.181	-118.823	Pyroxene trachyandesite of Cedar Hill	66.2	2.5	K-Ar	1	Plagioclase	old*	66.4	—	66.4
25	KA-2086	38.261	-118.973	Basaltic trachyandesite of Beauty Peak	2.8	0.1	K-Ar	1	Whole rock	old*	2.9	—	2.9
468	KA-1859	38.178	-118.819	Hornblende trachydacite of Cedar Hill	2.8	0.4	K-Ar	1	Plagioclase	old*	2.9	—	2.9
1069	KA-2002	38.188	-118.850	Hornblende trachydacite of Cedar Hill	2.5	0.3	K-Ar	1	Plagioclase	old*	2.6	—	2.6
1069	KA-2004	38.188	-118.850	Hornblende trachydacite of Cedar Hill	2.5	0.1	K-Ar	1	Biotite	old*	2.6	—	2.6

Table 3.—Continued

Sample number	Lab_no.	Latitude	Longitude	Unit	Age, Ma	Error, Ma	Method	Source'	Mineral	Decay constant ^c	Recalculated age, using new decay constants	Age recalculated for FCT=28.02 Ma	Summary age
139	KA-1984	38.209	-118.880	Hornblende trachydacite of Cedar Hill	3.4	0.3	K-Ar	1	Biotite	old*	3.5	—	3.5
139	KA-1984R	38.209	-118.880	Hornblende trachydacite of Cedar Hill	3.1	0.3	K-Ar	1	Biotite	old*	3.2	—	3.2
139	KA-1993	38.209	-118.880	Hornblende trachydacite of Cedar Hill	2.3	1.6	K-Ar	1	Plagioclase	old*	2.4	—	2.4
199	KA-1980	38.153	-119.008	Hornblende trachydacite of Cedar Hill	3.2	0.7	K-Ar	1	Plagioclase	old*	3.3	—	3.3
USGS(M)-7346-3	—	38.216	-118.981	Hornblende trachydacite of Cedar Hill	2.7	0.1	K-Ar	6	Whole rock	old*	2.8	—	2.8
5-152-9/50/72	—	38.3548	-118.9261	Hornblende trachydacite	3.04	0.03	Ar-Ar ³	9	Whole rock	—	—	3.06	3.06
5-152-9/56/72	—	38.3548	-118.9261	Hornblende trachydacite	3.53	0.18	Ar-Ar ³	9	Plagioclase	—	—	3.55	3.55
144	KA-2076	38.184	-118.894	Trachyandesite of Cedar Hill	3.6	0.4	K-Ar	1	Plagioclase	old*	3.7	—	3.7
1092A	KA-2066	38.255	-118.810	Rhyolite of Spring Peak	3.6	0.1	K-Ar	1	Sanidine	old*	3.7	—	3.7
203195	—	38.2823	-119.1479	Basaltic andesite of Locomotive Point	3.9	0.06	Ar-Ar ⁴	14	Groundmass	—	—	3.87	3.87
USGS(M)-BH6	—	38.1655	-119.1512	Rhyolite of Big Alkali	5.7	0.2	K-Ar	6	Biotite	old*	5.9	—	5.9
USGS(M)-BH20	—	38.220	-119.149	Rhyolite of Big Alkali	5.2	0.3	K-Ar	6	Biotite	old*	5.3	—	5.3
USGS(M)-BH20	—	38.220	-119.149	Rhyolite of Big Alkali	5.4	0.6	K-Ar	6	Hornblende	old*	5.5	—	5.5
077-7C	—	38.19677	-119.15829	Rhyolite of Big Alkali	5.478	0.024	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	5.478
088-24A	—	38.25278	-119.13951	Rhyolite of Big Alkali	6.201	0.026	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	6.201
098-13A	—	38.25754	-119.12788	Rhyolite of Big Alkali	6.173	0.028	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	6.173
09-BA-42	—	38.27001	-119.14887	Rhyolite of Big Alkali	5.455	0.025	Ar-Ar	7	Biotite	FCT=28.02	—	—	5.455
39509-10	—	38.2153	-119.22755	Dacite of Hot Springs Canyon	8.070	0.017	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.070
414	KA-1973	38.177	-119.193	Trachyandesite of Willow Springs	7.8	0.2	K-Ar	1	Plagioclase	old*	8.0	—	8.0
USGS(M)-BH19A	—	38.222	-119.172	Trachyandesite of Willow Springs	8.0	0.2	K-Ar	6	Biotite	old*	8.2	—	8.2
077-7A	—	38.17860	-119.19476	Trachyandesite of Willow Springs	8.004	0.037	Ar-Ar	7	Biotite	FCT=28.02	—	—	8.004
077-7A	—	38.17860	-119.19476	Trachyandesite of Willow Springs	8.051	0.019	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.051
077-7B	—	38.19178	-119.15240	Trachyandesite of Willow Springs	8.122	0.029	Ar-Ar	7	Biotite	FCT=28.02	—	—	8.122
077-7B	—	38.19178	-119.15240	Trachyandesite of Willow Springs	8.070	0.021	Ar-Ar	7	Hornblende	FCT=28.02	—	—	8.070
077-7B	—	38.19178	-119.15240	Trachyandesite of Willow Springs	8.139	0.024	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.139
088-24B	—	38.25504	-119.14115	Trachyandesite of Willow Springs	8.575	0.022	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.575

Table 3.—Continued

Sample number	Lab_no.	Latitude	Longitude	Unit	Age, Ma	Error, Ma	Method	Source'	Mineral	Decay constant ^c	Recalculated age, using new decay constants	Age recalculated for FCT=28.02 Ma	Summary age
088-24F	—	38.20176	-119.08978	Trachyandesite of Willow Springs	8.155	0.019	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.155
08-BA-51	—	38.17449	-119.15441	Trachyandesite of Willow Springs	8.305	0.017	Ar-Ar	7	Sanidine	FCT=28.02	—	—	8.305
12-BA-1	—	38.18995	-119.16512	Trachydacite of Cinnabar Canyon	8.548	0.028	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.548
406	KA-1990	38.234	-119.085	Trachydacite of Potato Peak	8.4	0.2	K-Ar	1	Plagioclase	old*	8.6	—	8.6
USGS(M)-856-10	—	38.205	-119.028	Trachydacite of Potato Peak	8.9	0.2	K-Ar	6	Biotite	old*	9.1	—	9.1
USGS(M)-856-10	—	38.205	-119.028	Trachydacite of Potato Peak	9.0	0.2	K-Ar	6	Hornblende	old*	9.2	—	9.2
USGS(M)-BM2	—	38.221	-119.057	Trachydacite of Potato Peak	9.1	0.1	K-Ar	6	Biotite	old*	9.3	—	9.3
088-21B Run 2	—	38.26418	-119.07504	Trachydacite of Potato Peak	8.927	0.010	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.927
088-21D	—	38.24330	-119.09209	Trachydacite of Potato Peak	8.964	0.027	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.964
088-21E	—	38.23457	-119.08582	Trachydacite of Potato Peak	8.863	0.050	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.863
088-24C	—	38.24786	-119.11208	Trachydacite of Potato Peak	8.996	0.025	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.996
088-24D	—	38.22678	-119.10376	Trachydacite of Potato Peak	9.056	0.045	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.056
088-24E	—	38.21809	-119.10188	Trachydacite of Potato Peak	8.926	0.025	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.926
08-BA-68	—	38.19323	-119.06835	Trachydacite of Potato Peak	8.99	0.02	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.99
098-10C	—	38.24919	-119.09203	Trachydacite of Potato Peak	8.982	0.023	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.982
098-13C	—	38.25072	-119.09223	Trachydacite of Potato Peak	8.998	0.021	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.998
108-12A	—	38.24252	-119.04825	Trachydacite of Potato Peak	8.963	0.016	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.963
108-12B	—	38.23830	-119.00784	Trachydacite of Potato Peak	9.032	0.022	Ar-Ar	7	Biotite	FCT=28.02	—	—	9.032
10-BA-66	—	38.17250	-119.10125	Trachydacite of Potato Peak	8.749	0.019	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.749
10-BA-66	—	38.17250	-119.10125	Trachydacite of Potato Peak	8.735	0.015	Ar-Ar	7	Sanidine	FCT=28.02	—	—	8.735
15	KA-1972	38.194	-118.961	Dacite of Silver Hill	8.9	0.2	K-Ar	1	Plagioclase	old*	9.1	—	9.1
USGS(M)-BH15	—	38.201	-119.003	Dacite of Silver Hill	8.6	0.4	K-Ar	6	Hornblende	old*	8.8	—	8.8
USGS(M)-BH15	—	38.201	-119.003	Dacite of Silver Hill	8.7	0.2	K-Ar	6	Biotite	old*	8.9	—	8.9
USGS(M)-S1	—	38.188	-119.008	Dacite of Silver Hill	8.5	0.4	K-Ar	6	Whole rock	old*	8.7	—	8.7
USGS(M)-S1	—	38.188	-119.008	Dacite of Silver Hill	8.3	0.4	K-Ar	6	Plagioclase	old*	8.5	—	8.5
USGS(M)-S1	—	38.188	-119.008	Dacite of Silver Hill	8.9	0.4	K-Ar	6	Plagioclase	old*	9.1	—	9.1
USGS(M)-B271	—	38.215	-119.003	Dacite of Silver Hill	8.4	0.2	K-Ar	6	Hornblende	old*	8.6	—	8.6
USGS(M)-B271	—	38.215	-119.003	Dacite of Silver Hill	8.5	0.3	K-Ar	6	Plagioclase	old*	8.7	—	8.7
USGS(M)-856-8	—	38.214	-119.004	Dacite of Silver Hill	8.2	0.2	K-Ar	6	Whole rock	old*	8.4	—	8.4
USGS(M)-856-8	—	38.214	-119.004	Dacite of Silver Hill	9.2	0.5	K-Ar	6	Hornblende	old*	9.4	—	9.4
USGS(M)-BH17	—	38.193	-119.012	Dacite of Silver Hill	9.2	0.5	K-Ar	6	Hornblende	old*	9.4	—	9.4
USGS(M)-BH32	—	38.200	-118.995	Dacite of Silver Hill	8.8	0.2	K-Ar	6	Biotite	old*	9.0	—	9.0
USGS(M)-856-32	—	38.209	-118.997	Dacite of Silver Hill	8.9	0.3	K-Ar	6	Biotite	old*	9.1	—	9.1
USGS(M)-BH26	—	38.194	-119.003	Dacite of Silver Hill	9.1	0.5	K-Ar	6	Hornblende	old*	9.3	—	9.3
USGS(M)-BH16	—	38.200	-118.999	Dacite of Silver Hill	9.4	0.2	K-Ar	6	Biotite	old*	9.7	—	9.7
USGS(M)-854-1	—	38.182	-119.003	Dacite of Silver Hill	8.7	0.2	K-Ar	6	Biotite	old*	8.9	—	8.9

Table 3.—Continued

Sample number	Lab_no.	Latitude	Longitude	Unit	Age, Ma	Error, Ma	Method	Source'	Mineral	Decay constant ^c	Recalculated age, using new decay constants	Age recalculated for FCT=28.02 Ma	Summary age
USGS(M)-BH29	—	38.196	-118.958	Dacite of Silver Hill	8.7	0.2	K-Ar	6	Biotite	old*	8.9	—	8.9
077-7F	—	38.20252	-119.02630	Dacite of Silver Hill	8.928	0.024	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.928
09-BA-26	—	38.20360	-119.00021	Dacite of Silver Hill	9.132	0.020	Ar-Ar	7	Biotite	FCT=28.02	—	—	9.132
108-12C	—	38.18925	-118.98343	Dacite of Silver Hill	9.089	0.014	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.089
108-12D	—	38.17315	-118.97800	Dacite of Silver Hill	9.018	0.014	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.018
108-12E	—	38.20763	-118.96489	Dacite of Silver Hill	9.140	0.020	Ar-Ar	7	Plagioclase or Biotite	FCT=28.02	—	—	9.140
08-BA-66	—	38.18629	-119.05680	Dacite of Silver Hill debris flow clast	9.064	0.024	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.064
BH31	—	38.194	-119.008	Dacite of Silver Hill, plug	8.6	0.4	K-Ar	3	Sericite-chlorite	old*	8.8	—	8.8
077-6F	—	38.18809	-119.00854	Dacite of Silver Hill-Sugarloaf plug	9.086	0.028	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.086
459	KA-1907	38.097	-119.064	Eureka Valley Tuff	9.8	0.2	K-Ar	1	Biotite	old*	10.1	—	10.1
31	KA-1909	38.247	-118.990	Eureka Valley Tuff	9.5	0.3	K-Ar	1	Biotite	old*	9.8	—	9.8
27	KA-1908	38.247	-118.990	Eureka Valley Tuff	9.6	0.3	K-Ar	1	Biotite	old*	9.9	—	9.9
W24	—	38.102	-119.066	Eureka Valley Tuff	9.19	0.28	K-Ar	1	Biotite	old*	9.4	—	9.4
W25	—	38.131	-119.181	Eureka Valley Tuff	9.35	0.37	K-Ar	1	Biotite	old*	9.6	—	9.6
W25	—	38.131	-119.181	Eureka Valley Tuff	9.01	0.27	K-Ar	1	Biotite	old*	9.2	—	9.2
077-9A	—	38.22088	-118.97443	Eureka Valley Tuff	9.401	0.023	Ar-Ar	7	Biotite	FCT=28.02	—	—	9.401
077-9A	—	38.22088	-118.97443	Eureka Valley Tuff	9.383	0.026	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.383
098-12A	—	38.35923	-119.19917	Eureka Valley Tuff	9.45	0.04	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.45
09-BA-49	—	38.26389	-119.04748	Eureka Valley Tuff	9.267	0.019	Ar-Ar	7	Biotite	FCT=28.02	—	—	9.267
AU-10/61/DD61	—	38.260	-118.981	Eureka Valley Tuff	9.20	0.04	Ar-Ar ³	9	Biotite	—	—	9.26	9.26
6-289-2	—	38.3729	-118.9993	Eureka Valley Tuff	9.30	0.29	Ar-Ar ³	9	Biotite	—	—	9.36	9.36
USGS(M)-BH9	—	38.157	-119.116	Trachyandesite of Mount Biedeman	9.3	0.3	K-Ar	6	Whole rock	old*	9.5	—	9.5
USGS(M)-MTB1	—	38.146	-119.073	Trachyandesite of Mount Biedeman	9.5	0.2	K-Ar	6	Hornblende	old*	9.8	—	9.8
098-11E	—	38.11099	-119.15841	Trachyandesite of Mount Biedeman	9.019	0.028	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.019
09-BA-22	—	38.14302	-119.17974	Trachyandesite of Mount Biedeman	9.022	0.024	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.022
09SB015A	—	38.12310	-119.14843	Trachyandesite of Mount Biedeman	8.890	0.064	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.890
108-12F	—	38.16336	-119.09918	Trachyandesite of Mount Biedeman	9.987	0.015	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.987
108-9A	—	38.16540	-119.09816	Trachyandesite of Mount Biedeman	9.947	0.019	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.947
10-BA-46	—	38.17380	-119.11508	Trachyandesite of Mount Biedeman	8.779	0.013	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.779

Table 3.—Continued

Sample number	Lab. no.	Latitude	Longitude	Unit	Age, Ma	Error, Ma	Method	Source ¹	Mineral	Decay constant ²	Recalculated age, using new decay constants	Age recalculated for FCT=28.02 Ma	Summary age
10-BA-61	—	38.14005	-119.01551	Trachyandesite of Mount Biedeman	10.018	0.164	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.018
12-BA-22	—	38.10155	-119.12395	Trachyandesite of Mount Biedeman	8.933	0.042	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	8.933
6-215-1/121/72	—	38.1344	-119.0825	Trachyandesite of Mount Biedeman	9.18	0.08	Ar-Ar ³	9	Hornblende	—	—	9.24	9.24
MC-12-18	—	38.15575	-119.07825	Trachyandesite of Mount Biedeman	9.24	0.09	Ar-Ar ⁴	14	Hornblende	—	—	9.18	9.18
119-20B	—	38.13452	-119.07613	Trachyandesite of Mount Biedeman, plug	9.073	0.033	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.073
08-BA-65	—	38.31071	-118.97808	Rhyolite of Bald Peak	9.682	0.013	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.682
10-BA-67	—	38.26203	-118.98303	Rhyolite of Bald Peak	9.652	0.016	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.652
507	KA-1998	38.154	-119.089	Rhyolite of Bodie Hills	9.5	0.3	K-Ar	1	Plagioclase	old*	9.8	—	9.8
507	KA-2049	38.154	-119.089	Rhyolite of Bodie Hills	9.3	0.3	K-Ar	1	Biotite	old*	9.5	—	9.5
USGS(M)-BH27	—	38.140	-119.056	Rhyolite of Bodie Hills	9.1	0.2	K-Ar	6	Biotite	old*	9.3	—	9.3
077-7D	—	38.16719	-119.09983	Rhyolite of Bodie Hills	9.858	0.027	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.858
077-7D	—	38.16719	-119.09983	Rhyolite of Bodie Hills	9.860	0.013	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.860
088-21C	—	38.25134	-119.08382	Rhyolite of Bodie Hills	9.776	0.017	Ar-Ar	7	Biotite	FCT=28.02	—	—	9.776
088-21C	—	38.25134	-119.08382	Rhyolite of Bodie Hills	9.893	0.025	Ar-Ar	7	Biotite	FCT=28.02	—	—	9.893
088-21C	—	38.25134	-119.08382	Rhyolite of Bodie Hills	9.800	0.020	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.800
088-21C	—	38.25134	-119.08382	Rhyolite of Bodie Hills	9.806	0.018	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.806
088-21C	—	38.25134	-119.08382	Rhyolite of Bodie Hills	9.740	0.023	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.740
088-21C	—	38.25134	-119.08382	Rhyolite of Bodie Hills	9.766	0.020	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.766
088-21C	—	38.25134	-119.08382	Rhyolite of Bodie Hills	9.770	0.009	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.770
088-21C	—	38.25134	-119.08382	Rhyolite of Bodie Hills	9.774	0.008	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.774
08-BA-50	—	38.24816	-119.09663	Rhyolite of Bodie Hills	9.757	0.013	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.757
098-10B	—	38.25135	-119.08382	Rhyolite of Bodie Hills	9.819	0.013	Ar-Ar	7	Biotite	FCT=28.02	—	—	9.819
098-10B	—	38.25135	-119.08382	Rhyolite of Bodie Hills	9.786	0.022	Ar-Ar	7	Biotite	FCT=28.02	—	—	9.786
098-10B (BHb)	—	38.25135	-119.08382	Rhyolite of Bodie Hills	9.819	0.017	Ar-Ar	7	Biotite	FCT=28.02	—	—	9.819
098-10B	—	38.25135	-119.08382	Rhyolite of Bodie Hills	9.778	0.031	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	9.778
098-10B	—	38.25135	-119.08382	Rhyolite of Bodie Hills	9.748	0.021	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.748
098-10B	—	38.25135	-119.08382	Rhyolite of Bodie Hills	9.779	0.005	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.779
098-10B	—	38.25135	-119.08382	Rhyolite of Bodie Hills	9.756	0.002	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.756
098-13B	—	38.26802	-119.13218	Rhyolite of Bodie Hills	9.813	0.027	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.813
09-BA-20	—	38.15662	-119.04741	Rhyolite of Bodie Hills	9.609	0.013	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.609
09-BA-47	—	38.28409	-119.13821	Rhyolite of Bodie Hills	9.877	0.012	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.877
USGS(M)-Baghdad	—	38.2786	-118.9467	Rhyolite of Bodie Creek	9.9	0.3	K-Ar	2	Sanidine	old*	10.2	—	10.2
USGS(M)-Baghdad	—	38.2786	-118.9467	Rhyolite of Bodie Creek	10.2	0.4	K-Ar	2	Plagioclase	old*	10.5	—	10.5
077-9B	—	38.26971	-118.95063	Rhyolite of Bodie Creek	10.163	0.029	Ar-Ar	7	Sanidine	FCT=28.02	—	—	10.163

Table 3.—Continued

Sample number	Lab_no.	Latitude	Longitude	Unit	Age, Ma	Error, Ma	Method	Source ¹	Mineral	Decay constant ²	Recalculated age, using new decay constants	Age recalculated for FCT=28.02 Ma	Summary age
108-11A	—	38.27826	-118.94807	Rhyolite of Bodie Creek	9.890	0.008	Ar-Ar	7	Sanidine	FCT=28.02	—	—	9.890
11-BA-32	—	38.3364	-118.97804	Rhyolite of Bodie Creek	10.127	0.013	Ar-Ar	7	Sanidine	FCT=28.02	—	—	10.127
11-BA-60	—	38.32693	-118.97204	Rhyolite of Bodie Creek	11.335	0.138	Ar-Ar	7	Feldspar	FCT=28.02	—	—	11.335
077-8C	—	38.27145	-119.07783	Trachyandesite of Aurora Canyon	10.460	0.020	Ar-Ar	7	Biotite	FCT=28.02	—	—	10.460
077-8C#2	—	38.27145	-119.07783	Trachyandesite of Aurora Canyon	10.481	0.025	Ar-Ar	7	Biotite	FCT=28.02	—	—	10.481
077-8C Run 1	—	38.27145	-119.07783	Trachyandesite of Aurora Canyon	10.427	0.028	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.427
077-8C Run 2	—	38.27145	-119.07783	Trachyandesite of Aurora Canyon	10.426	0.030	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.426
077-8C	—	38.27145	-119.07783	Trachyandesite of Aurora Canyon	10.444	0.014	Ar-Ar	7	Sanidine	FCT=28.02	—	—	10.444
077-8C Run 2	—	38.27145	-119.07783	Trachyandesite of Aurora Canyon	10.464	0.015	Ar-Ar	7	Sanidine	FCT=28.02	—	—	10.464
077-8C Run 3	—	38.27145	-119.07783	Trachyandesite of Aurora Canyon	10.458	0.016	Ar-Ar	7	Sanidine	FCT=28.02	—	—	10.458
088-21A	—	38.27363	-119.13962	Trachyandesite of Aurora Canyon	10.358	0.025	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.358
088-23A	—	38.27852	-119.10021	Trachyandesite of Aurora Canyon	10.583	0.032	Ar-Ar	7	Biotite	FCT=28.02	—	—	10.583
088-23A	—	38.27852	-119.10021	Trachyandesite of Aurora Canyon	10.275	0.109	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.275
088-23B	—	38.27831	-119.09908	Trachyandesite of Aurora Canyon	10.534	0.052	Ar-Ar	7	Biotite	FCT=28.02	—	—	10.534
088-23B	—	38.27831	-119.09908	Trachyandesite of Aurora Canyon	10.318	0.023	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.318
088-23D	—	38.28113	-119.10206	Trachyandesite of Aurora Canyon	10.463	0.047	Ar-Ar	7	Biotite	FCT=28.02	—	—	10.463
088-23D	—	38.28113	-119.10206	Trachyandesite of Aurora Canyon	10.265	0.052	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.265
088-25A	—	38.27322	-119.09077	Trachyandesite of Aurora Canyon	10.425	0.026	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.425
10-BA-62	—	38.36327	-119.00635	Tephra in sedimentary rocks of Fletcher Valley	10.464	0.041	Ar-Ar	7	Biotite	FCT=28.02	—	—	10.464
10-BA-62	—	38.36327	-119.00635	Fletcher Valley sediments	10.582	0.023	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.582
077-9E	—	38.31905	-118.91003	Trachyandesite of Del Monte	10.949	0.025	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.949
08SB038	—	38.40828	-118.97383	Trachyandesite of Del Monte	10.982	0.050	Ar-Ar	7	Biotite	FCT=28.02	—	—	10.982
11-BA-41	—	38.35057	-118.98085	Trachyandesite of Del Monte	10.942	0.024	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.942
098-11B	—	38.12451	-119.17126	Trachydacite of Bridgeport Canyon	11.067	0.022	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.067

Table 3.—Continued

Sample number	Lab_no.	Latitude	Longitude	Unit	Age, Ma	Error, Ma	Method	Source ¹	Mineral	Decay constant ²	Recalculated age, using new decay constants	Age recalculated for FCT=28.02 Ma	Summary age
09SB020A	—	38.13230	-119.13277	Trachydacite of Bridgeport Canyon	11.080	0.019	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.080
08SB032	—	38.34561	-118.95580	Unwelded tuff in sedimentary rocks of Fletcher Valley	10.918	0.043	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	10.918
10-BA-5	—	38.33945	-118.99699	Pyroxene rhyolite	11.153	0.011	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.153
10-BA-27	—	38.27500	-118.90498	Rhyolite of East Brawley Peak	11.179	0.016	Ar-Ar	7	Sanidine	FCT=28.02	—	—	11.179
USGS(M)-NTS10B	—	38.3021	-118.8967	Rhyolite of Aurora Creek	10.9	0.2	K-Ar	2	Biotite	old*	11.2	—	—
USGS(M)-NTS10B	—	38.3021	-118.8967	Rhyolite of Aurora Creek	11.0	0.2	K-Ar	2	Sanidine	old*	11.3	—	—
10-BA-20	—	38.31679	-118.91129	Rhyolite of Aurora Creek	11.177	0.013	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.177
10-BA-21	—	38.30315	-118.89740	Rhyolite of Aurora Creek	11.181	0.022	Ar-Ar	7	Sanidine	FCT=28.02	—	—	11.181
077-9D	—	38.28562	-118.92803	Rhyolite of Del Monte Canyon	11.200	0.032	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.200
077-9D	—	38.28562	-118.92803	Rhyolite of Del Monte Canyon	11.139	0.020	Ar-Ar	7	Sanidine	FCT=28.02	—	—	11.139
AU-6/60/DD61	—	38.285	-118.928	Rhyolite of Del Monte Canyon	11.21	0.03	Ar-Ar ³	9	Biotite	—	—	11.28	11.28
USGS(M)-710-7	—	38.2822	-118.9281	Rhyolite of Del Monte Canyon?	11.2	0.2	K-Ar	2	Biotite	old*	11.5	—	11.5
077-9C	—	38.27661	-118.93036	Rhyolite of Del Monte Canyon	11.258	0.142	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.258
077-9C	—	38.27661	-118.93036	Rhyolite of Del Monte Canyon	11.220	0.017	Ar-Ar	7	Sanidine	FCT=28.02	—	—	11.220
077-8B	—	38.28334	-119.05617	Trachydacite intrusion	11.153	0.028	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.153
09-BA-35	—	38.29048	-119.04642	Trachydacite intrusion	11.269	0.034	Ar-Ar	7	Biotite	FCT=28.02	—	—	11.269
098-13D	—	38.27655	-119.16062	Trachyandesite of Clark Canyon	11.341	0.017	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.341
09-BA-43	—	38.26358	-119.16825	Trachyandesite of Clark Canyon	11.268	0.112	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.268
KA2379R	—	38.4133	-118.9417	Tuff in Aldrich Station Formation	11.40	0.54	K-Ar	11	Biotite	old*	11.70	—	11.70
547	KA-2048	38.255	-118.948	Trachyandesite of West Brawley Peak	12.5	0.2	K-Ar	1	Plagioclase	old*	12.8	—	12.8
USGS(M)-712-1	—	38.2522	-118.9175	Trachyandesite of West Brawley Peak	11.2	0.2	K-Ar	2	Biotite	old*	11.5	—	11.5
USGS(M)-712-1	—	38.2522	-118.9175	Trachyandesite of West Brawley Peak	10.9	0.3	K-Ar	2	Plagioclase	old*	11.2	—	11.2
USGS(M)-712-1	—	38.2522	-118.9175	Trachyandesite of West Brawley Peak	11.6	0.3	K-Ar	2	Hornblende	old*	11.9	—	11.9
077-7G	—	38.23439	-118.96671	Trachyandesite of West Brawley Peak	11.323	0.032	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.323

Table 3.—Continued

Sample number	Lab_no.	Latitude	Longitude	Unit	Age, Ma	Error, Ma	Method	Source ¹	Mineral	Decay constant ²	Recalculated age, using new decay constants	Age recalculated for FCT=28.02 Ma	Summary age
108-10C	—	38.28052	-118.90623	Trachyandesite of West Brawley Peak	11.514	0.019	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.514
6	—	38.1256	-119.1697	Basaltic trachyandesite of Rancheria	11.3	0.9	K-Ar	4	Whole rock	old*	11.6	—	11.6
742-45	—	38.0869	-119.1431	Basaltic trachyandesite of Rancheria	11.7	0.5	K-Ar	12	Whole rock	new	—	—	11.7
MC-12-20	—	38.27010	-119.12610	Hornblende trachyandesite intrusion	11.9	0.20	Ar-Ar ⁴	14	Hornblende	—	—	11.82	11.82
098-11A	—	38.12239	-119.16954	Tuff of Jacks Spring	12.069	0.015	Ar-Ar	7	Sanidine	FCT=28.02	—	—	12.069
09-BA-23	—	38.12851	-119.17491	Tuff of Jacks Spring	12.044	0.015	Ar-Ar	7	Sanidine	FCT=28.02	—	—	12.044
6-181-12/52/DD72	—	38.1193	-119.1039	Tuff of Jacks Spring	11.87	0.16	Ar-Ar ³	9	Sanidine	—	—	11.95	11.95
6-181-12/53/DD72	—	38.1193	-119.1039	Tuff of Jacks Spring	11.90	0.14	Ar-Ar ³	9	Sanidine	—	—	11.98	11.98
KA2362	—	38.4408	-118.9725	Hornblende andesite	12.11	0.39	K-Ar	11	Plagioclase	old	12.43	—	12.43
KA2364	—	38.4408	-118.9725	Hornblende andesite	12.07	0.50	K-Ar	11	Hornblende	old	12.39	—	12.39
KA2368	—	38.4408	-118.9725	Hornblende andesite	12.33	0.31	K-Ar	11	Biotite	old	12.66	—	12.66
10-BA-29	—	38.36466	-119.01452	Trachydacite of Rough Creek	11.675	0.016	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	11.675
10-BA-6	—	38.33375	-119.02470	Trachydacite of Rough Creek	12.945	0.020	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	12.945
11-BA-40	—	38.41155	-119.01907	Trachydacite of Rough Creek	12.804	0.023	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	12.804
07-BA-38	—	38.36049	-119.14502	Andesite of Lakeview Spring	12.930	0.033	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	12.930
USGS(M)-711-67	—	38.2894	-118.9092	Trachyandesite of Aurora	13.5	0.3	K-Ar	2	Hornblende	old*	13.9	—	13.9
USGS(M)-668-G10	—	38.2403	-118.8917	Trachyandesite of Aurora	14.4	0.3	K-Ar	2	Hornblende	old*	14.8	—	—
USGS(M)-711-8	—	38.2681	-118.8917	Trachyandesite of Aurora	15.4	0.3	K-Ar	2	Plagioclase	old*	15.8	—	15.8
CH8Z1	—	38.288	-118.882	Trachyandesite of Aurora	10.9	0.3	K-Ar	5	Whole rock	new	—	—	10.9
108-10A	—	38.27293	-118.91272	Trachyandesite of Aurora	12.580	0.024	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	12.580
00-BA-16	—	38.2708	-118.8908	Trachyandesite of Aurora	13.05	0.44	Ar-Ar ³	9	Hornblende	—	—	13.13	13.13
00-BA-26	—	38.2542	-118.8841	Trachyandesite of Aurora	13.05	0.08	Ar-Ar ³	9	Hornblende	—	—	13.13	13.13
098-12E	—	38.39143	-119.12397	Trachyandesite of Masonic Gulch	13.441	0.026	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	13.441
MAS10-72	—	38.40189	-119.13718	Trachyandesite of Masonic Gulch	13.485	0.017	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	13.485
MAS10-73	—	38.39643	-119.13470	Trachyandesite of Masonic Gulch	13.467	0.016	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	13.467
MAS10-75	—	38.39169	-119.11549	Trachyandesite of Masonic Gulch	<13.497	0.024	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	<13.497
12-BA-9	—	38.33681	-119.07377	Trachydacite of East Canyon	13.782	0.025	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	13.782
5	—	38.0978	-119.1475	Trachyandesite of Simmonon Cut	13.3	0.4	K-Ar	4	Hornblende	old*	13.7	—	13.7
12-BA-3	—	38.34974	-118.84729	Trachyandesite of Mud Spring Canyon	13.96	0.11	Ar-Ar ⁴	14	Plagioclase	—	—	13.87	13.87
10-BA-9	—	38.35278	-119.02068	Trachyandesite of Masonic, plug	14.998	0.019	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	14.998

Table 3.—Continued

Sample number	Lab_no.	Latitude	Longitude	Unit	Age, Ma	Error, Ma	Method	Source ¹	Mineral	Decay constant ²	Recalculated age, using new decay constants	Age recalculated for FCT=28.02 Ma	Summary age
MAS10-76	—	38.38169	-119.11534	Trachyandesite of Masonic, plug	14.190	0.021	Ar-Ar	7	Hornblende	FCT=28.02	—	—	14.190
088-22B	—	38.37937	-119.07802	Trachyandesite of Masonic	14.067	0.081	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	14.067
088-23F	—	38.31068	-119.11700	Trachyandesite of Masonic	14.193	0.039	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	14.193
08-BA-62	—	38.32006	-119.04943	Trachyandesite of Masonic	14.131	0.030	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	14.131
098-12B	—	38.38762	-119.18139	Trachyandesite of Masonic	14.715	0.025	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	14.715
098-12D	—	38.39951	-119.11939	Trachyandesite of Masonic	<14.80	0.02	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	<14.80
098-12F	—	38.37542	-119.11418	Trachyandesite of Masonic	14.094	0.017	Ar-Ar	7	Hornblende	FCT=28.02	—	—	14.094
09-BA-7	—	38.33786	-119.08727	Trachyandesite of Masonic	14.674	0.025	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	14.674
10-BA-13	—	38.35154	-119.10419	Trachyandesite of Masonic	14.410	0.016	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	14.410
10-BA-15	—	38.34130	-119.11570	Trachyandesite of Masonic	14.141	0.017	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	14.141
10-BA-69	—	38.30537	-119.13652	Trachyandesite of Masonic	14.107	0.014	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	14.107
12-BA-20	—	38.33410	-119.15949	Trachyandesite of Masonic	14.136	0.020	Ar-Ar	7	Plagioclase	FCT=28.02	—	—	14.136
MC-12-19	—	38.31952	-118.78154	Trachyandesite of Borealis	16.06	0.10	Ar-Ar ⁴	14	Hornblende	—	—	15.96	15.96
FA1	—	38.2931	-118.8914	Alteration: Aurora	10.04	0.03	Ar-Ar ³	10	Adularia	—	—	10.10	10.10
FA66	—	38.2375	-118.9008	Alteration: East Brawley Peak alteration zone	12.34	0.04	Ar-Ar ³	10	Alumite	—	—	12.42	12.42
PP09-10A1	—	38.25309	-119.13844	Alteration: Aurora Canyon alteration zone	10.865	0.065	Ar-Ar	7	Alumite	FCT=28.02	—	—	10.865
USGS(M)-7346-1	—	38.215	-119.004	Alteration: Bodie, Standard Hill	7.2	0.1	K-Ar	6	Adularia	old*	7.4	—	7.4
USGS(M)-7346-1	—	38.215	-119.004	Alteration: Bodie, Standard Hill	7.0	0.1	K-Ar	6	Adularia	old*	7.2	—	7.2
USGS(M)-RCDIB	—	38.201	-119.005	Alteration: Bodie, Red Cloud mine	7.7	0.1	K-Ar	6	Adularia	old*	7.9	—	7.9
USGS(M)-B270	—	38.216	-119.004	Alteration: Bodie, Standard Hill	8.0	0.2	K-Ar	6	Adularia	old*	8.2	—	8.2
077-6A	—	38.2149	-119.0037	Alteration: Bodie, south of Bodie Bluff	8.286	0.024	Ar-Ar	7	Adularia	FCT=28.02	—	—	8.286
077-6C	—	38.2187	-119.0005	Alteration: Bodie, Bodie Bluff	7.179	0.417	Ar-Ar	7	Adularia	FCT=28.02	—	—	7.179
11-BA-7G	—	38.20420	-119.00649	Alteration: Bodie, Silver Hill	8.217	0.012	Ar-Ar	7	Adularia	FCT=28.02	—	—	8.217
11-BA-21	—	38.20370	-119.00919	Alteration: Bodie, Red Cloud mine	8.124	0.006	Ar-Ar	7	Adularia	FCT=28.02	—	—	8.124
BOD09-5	—	38.20430	-119.00660	Alteration: Bodie, Oro mine dump	8.473	0.007	Ar-Ar	7	Adularia	FCT=28.02	—	—	8.473
BOD09-3	—	38.20146	-119.0048	Alteration: Bodie, Red Cloud mine	8.628	0.014	Ar-Ar	7	Adularia	FCT=28.02	—	—	8.628
09-BA-28I	—	38.2015	-119.0036	Alteration: Bodie, Red Cloud mine	8.852	0.013	Ar-Ar	7	Adularia	FCT=28.02	—	—	8.852
11-BA-22	—	38.21257	-119.00402	Alteration: Bodie, south of Bodie Bluff	8.498	0.005	Ar-Ar	7	Adularia	FCT=28.02	—	—	8.498

Table 3.—Continued

Sample number	Lab_no.	Latitude	Longitude	Unit	Age, Ma	Error, Ma	Method	Source ¹	Mineral	Decay constant ²	Recalculated age, using new decay constants	Age recalculated for FCT=28.02 Ma	Summary age
AU-18/65/DD61	—	38.201	-119.004	Alteration: Bodie, Red Cloud mine	8.41	0.02	Ar-Ar ³	9	Adularia	—	—	8.46	8.46
AU-17/64/DD61	—	38.215	-118.997	Alteration: Bodie, south of Bodie Bluff	8.23	0.04	Ar-Ar ³	9	Adularia	—	—	8.28	8.28
AU-16/63/DD61	—	38.215	-119.004	Alteration: Bodie, south of Bodie Bluff	8.33	0.02	Ar-Ar ³	9	Adularia	—	—	8.38	8.38
SAW11-9	—	39.29036	-118.91657	Alteration: Sawtooth alteration zone	11.105	0.011	Ar-Ar	7	Alumite	FCT=28.02	—	—	11.105
39509-3K	—	38.20793	-119.22751	Alteration: Hwy 395 alteration zone	8.169	0.013	Ar-Ar	7	Alumite	FCT=28.02	—	—	8.169
08-BA-46	—	38.24430	-119.10385	Alteration: Potato Peak alteration zone, Alta Pina mine	10.769	0.034	Ar-Ar	7	Alumite	FCT=28.02	—	—	10.769
MAS09-1	—	38.35783	-119.13268	Alteration: Masonic, Red Rock mine	13.269	0.144	Ar-Ar	7	Alumite	FCT=28.02	—	—	13.269
MAS09-1A	—	38.35847	-119.13824	Alteration: Masonic, Red Rock mine	13.471	0.038	Ar-Ar	7	Alumite	FCT=28.02	—	—	13.471
MAS07-1A	—	38.34992	-119.14832	Alteration: Masonic, Chemung mine	13.386	0.068	Ar-Ar	7	Alumite	FCT=28.02	—	—	13.386
088-22A	—	38.36731	-119.10727	Alteration: Masonic, Maybelle mine	13.018	0.061	Ar-Ar	7	Alumite	FCT=28.02	—	—	13.018
07-BA-40	—	38.36544	-119.11607	Alteration: Masonic, Pittsburg-Liberty mine	13.027	0.049	Ar-Ar	7	Alumite	FCT=28.02	—	—	13.027
MAS10-55	—	38.41419	-119.10259	Alteration: Masonic, Redwash alteration zone	13.27	0.02	Ar-Ar	7	Alumite	FCT=28.02	—	—	13.27
RW08-1	—	38.41123	-119.12414	Alteration: Masonic, Redwash alteration zone	13.338	0.035	Ar-Ar	7	Alumite	FCT=28.02	—	—	13.338
MAS07-3	—	38.35968	-119.12682	Alteration: Masonic, Sarita mine	13.253	0.051	Ar-Ar	7	Alumite	FCT=28.02	—	—	13.253
CC09-9D1	—	38.19869	-119.17050	Alteration: Cinnabar Canyon alteration zone	8.824	0.294	Ar-Ar	7	Alumite	FCT=28.02	—	—	8.824
CC09-9D2	—	38.19869	-119.17050	Alteration: Cinnabar Canyon alteration zone	8.682	0.020	Ar-Ar	7	Alumite	FCT=28.02	—	—	8.682
MAS11-1A	—	38.36041	-119.08369	Alteration: Masonic, Perini mine	12.956	0.020	Ar-Ar	7	Alumite	FCT=28.02	—	—	12.956
MAS11-2B	—	38.36064	-119.08681	Alteration: Masonic, Perini mine	12.960	0.014	Ar-Ar	7	Alumite	FCT=28.02	—	—	12.960
AUR10-3	—	38.23752	-118.89919	Alteration: East Brawley Peak alteration zone	11.954	0.016	Ar-Ar	7	Alumite	FCT=28.02	—	—	11.954
BOD11-4E	—	38.21257	-119.00402	Alteration: Bodie, Standard Hill mine	8.425	0.003	Ar-Ar	7	Adularia	FCT=28.02	—	—	8.425

Table 3.—Continued

Sample number	Lab_no.	Latitude	Longitude	Unit	Age, Ma	Error, Ma	Method	Source ¹	Mineral	Decay constant ²	Recalculated age, using new decay constants	Age recalculated for FCT=28.02 Ma	Summary age
MAS12-10 (#1)	—	38.33716	-119.16013	Alteration: Masonic, Success mine	13.398	0.081	Ar-Ar	7	Alunite	FCT=28.02	—	—	13.398
MAS12-10 (#2)	—	38.33716	-119.16013	Alteration: Masonic, Success mine	13.638	0.077	Ar-Ar	7	Alunite	FCT=28.02	—	—	13.638
37	—	38.287	-118.887	Altered trachyandesite of Aurora	10.3	0.2	K-Ar	4	Adularia	old*	10.6	—	10.6
AU-1/58/DD61	—	38.266	-118.900	Alteration: Aurora, Esmeralda vein	10.63	0.05	Ar-Ar ⁵	9	K-feldspar	—	—	10.70	10.70
AU-2/59/DD61	—	38.282	-118.896	Alteration: Aurora, Del Monte shaft	10.28	0.05	Ar-Ar ⁵	9	K-feldspar	—	—	10.35	10.35
BOD11-3A	—	38.21961	-119.00354	Alteration: Bodie, Upper Hobart Tunnel	8.194	0.005	Ar-Ar	7	Adularia	FCT=28.02	—	—	8.194
BOD11-3B	—	38.21961	-119.00354	Alteration: Bodie Bluff, Incline vein	8.542	0.025	Ar-Ar	7	Adularia	FCT=28.02	—	—	8.542
12-BA-17	—	38.21961	-119.00019	Alteration: Bodie Bluff, west side	8.357	0.028	Ar-Ar	7	Adularia	FCT=28.02	—	—	8.357

¹Sources: 1, Gilbert and others (1968); 2, Silberman and McKee (1972); 3, Silberman and others (1972); 4, Kleinhampl and others (1975); 5, Morton and others (1977); 6, Silberman and Chesterman (1972); 7, R.J. Fleck, this report; 8, Lange and others (1993); 9, L. W. Snee, this report; 10, Breit, (2000); 11, Gilbert and Reynolds (1973); 12, Marvin and Dobson (1979); 13, Reheis and others (2002); 14, M.A. Cosca, this report.

²Old*: All ages with this notation adjusted in "Recalculated age" column to account for new decay constants of Steiger and Jäger (1977).

³Age initially calculated for Fish Canyon tuff=27.84 Ma.

⁴Age initially calculated for Fish Canyon Tuff=28.201 Ma.

⁵Age initially calculated for Fish Canyon tuff=27.84 Ma; isochron age.

⁶Likely an inaccurate age.

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