New radiometric ages and tephra correlations from the San Jose and the northeastern part of the Monterrey 1:100,000 map quadrangles, California

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Isochron/West, Bulletin of Isotopic Geochronology, v. 60, pp. 19-32

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NEW RADIOMETRIC AGES AND TEPHRA CORRELATIONS FROM THE SAN JOSE AND THE NORTHEASTERN PART OF THE MONTEREY 1:100,000 MAP QUADRANGLES, CALIFORNIA

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This geochronologic study was carried out as part of a project to compile a geologic map of the San Jose 1:100,000 quadrangle under the National Geologic Mapping Framework Program. An ARC/INFO-derived digital topographic base is used for the compilation with data transfer facilitated by ALACARTE, a "user friendly" interface developed for the project by Fitzgibbon and Wentworth [Fitzgibbon and Wentworth (1991), Fitzgibbon (1991) and Wentworth and Fitzgibbon (1991)].

The San Jose quadrangle is bounded by lat 37°00′00″–37°30′00″N and long 121°00′00″–122°00′00″W (fig. 1). Proceeding from southwest to northeast on figure 2, the major geographic features include: the Santa Cruz Mountains and San Andreas Fault; southern Santa Clara Valley; Calaveras fault zone; Diablo Range with the Greenville, Ortigalita, and San Joaquin faults, and terminating in the major structural depression of the San Joaquin Valley.

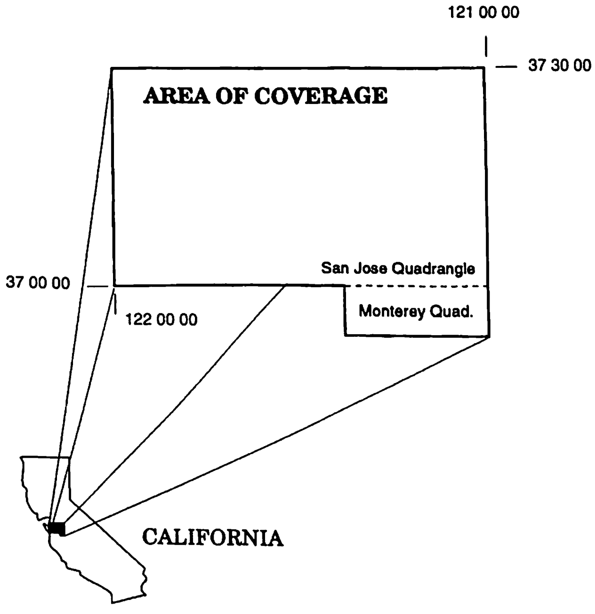


FIGURE 1. Index map.

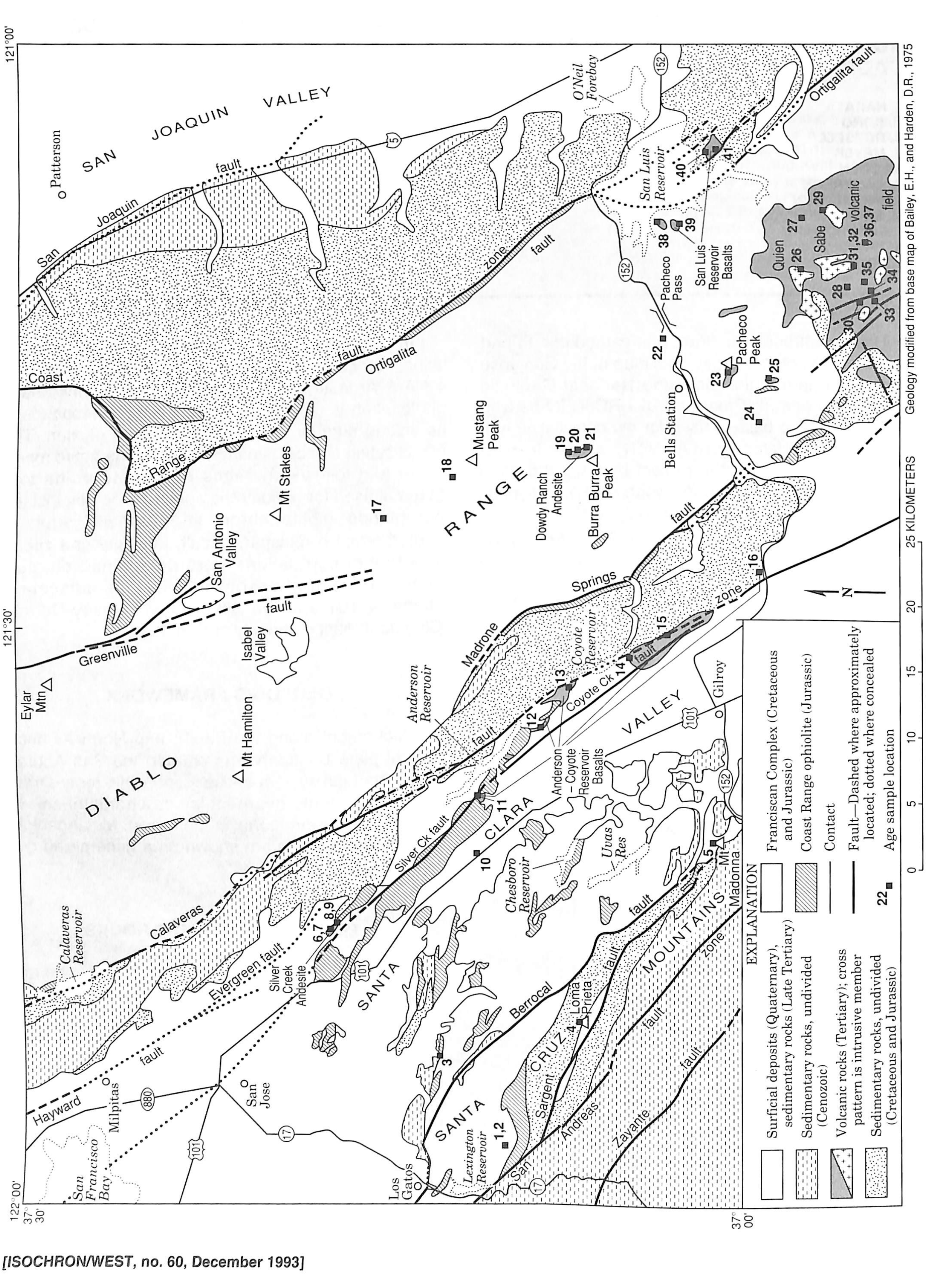
In this paper we report 2 tephrochronology correlations, 33 conventional K-Ar, 2 conventional ^{40}Ar/^{39}Ar, 4 ^{40}Ar/^{39}Ar laser, and 2 U-Pb zircon ages. Each sample location is plotted on figure 2 and corresponds to its unique number in the analytical data section. This identification number is carried through the entire manuscript and follows any ages referred to in the text. Material used for radiometric ages include plagioclase, hornblende, biotite, chromium muscovite, adularia, hydrothermal K-feldspar, basalt, andesite and zircon. The tephra correlations were determined on glass shards from newly exposed tuff units adjacent to Highway 101 and the Silver Creek Valley Country Club southeast of the city of San Jose.

GEOLOGIC FRAMEWORK

Movement along the Pacific and North American crustal plate boundary has created the San Andreas transform fault system and is responsible for the transpressive tectonic overprint which characterizes the major geologic structures in the region. Major geologic structures and units are shown on a generalized geologic map (fig. 2).

MESOZOIC BASEMENT ROCKS

Mesozoic basement rocks exposed within the map area can be divided into three separate packages. The Jurassic and Cretaceous Franciscan Complex underlies most of the Diablo Range and part of the Santa Cruz Mountains east of the San Andreas Fault. The Jurassic and Cretaceous Great Valley sequence is composed of marine sedimentary rocks that are restricted to the flanks of the uplifted core of the Diablo Range. These basement rocks are separated by the Coast Range Fault along which are found dismembered fragments of the Jurassic Coast Range ophiolite of Bailey and others (1970).



Geology modified from base map of Bailey, E.H., and Harden, D.R., 1975

FIGURE 2. Simplified geologic map of the San Jose and the northeastern part of the Monterey 1:100,000 map quadrangles, California.

Franciscan Complex

In the greater San Francisco Bay region the Franciscan Complex can be divided into twelve separate tectonostratigraphic terranes, four of which are represented in the area covered by this report. These terranes are distinctive, mappable, fault-bounded geologic units of regional extent characterized by unique histories (Blake and others, 1984). These four terranes range from relatively coherent, massive to thin-bedded metagraywacke and metashales with minor interbeds of chert and oceanic volcanic rocks to profoundly dismembered melange terranes that contain tectonically included blocks of chert, conglomerate, metavolcanic, metagraywacke and blueschist-facies rocks.

An age of 90.7 Ma (#22) was determined on an albite from a quartz-carbonate vein which cuts jadeitized metagraywacke near Pacheco Pass. The albite is thought to have formed by a retrograde process in which jadeitic pyroxene yields sodium to form albite as the subducted slab of metagraywacke is returned to the surface through tectonic and isostatic processes, (M. C. Blake, Jr., oral communication, 1993). This age probably represents the time at which the rising buoyant slab cooled through the blocking temperature for albite. Additional albite samples are being dated from the Diablo Range to verify this age. An earlier whole-rock K-Ar age of 85 Ma was obtained on a jadeitized metagraywacke from near this locality (Wagner and others, 1990).

An area of extensive epithermal hydrothermal alteration is present along a northeast-trending normal fault that cuts Franciscan Complex melange along the south fork of Orestimba Creek 2 km northeast of Mustang Peak. A heat source for this alteration has been traced to andesite dikes intruded at several locations along this fault zone (C. Blake, and D. Sorg, geologic mapping in progress, 1993). Age determinations for these newly identified dikes are in progress. However, chemically and petrologically similar andesite dikes a few kilometers north and south of this locality have yielded ages that range from 9.4 to 8.2 Ma (#17, #21). To test whether this volcanic episode reset any ages, we dated chromium muscovite (fuchsite) from an exotic block of greenschist that had been incorporated into the hydrothermally altered fault zone. An age of 127.7 Ma (#18) was determined and falls within the 131 to 106 Ma range reported by Cowan (1974) for several other unaltered exotic blocks from the same melange. Our age suggests that the hydrothermal fluids did not reset the chromium muscovite by exceeding its blocking temperature.

Adularia from a quartz-carbonate vein that cuts the Franciscan Complex near Mount Madonna was dated at 17.3 Ma (#5). Sixteen kilometers further northwest, near the summit of Loma Prieta, another adularia-bearing vein that cuts the Coast Range ophiolite was dated at 10.2 and 10.0 Ma (#4). This northward "younging" of volcanism and associated hydrothermal systems may result from the northward migration of the Mendocino triple junction (Fox and others, 1985). However, our anomalously young mineralization ages from Loma Prieta does not precisely fit the trend of northward "younging" as presented by Russell and others (1989). This may be the result of a long-lived hydrothermal system or an overprint by a younger volcanic activity.

Great Valley Sequence

The Great Valley sequence has been divided into three tectonostratigraphic terranes by Blake and others (1984). The terrane identified in the mapped area consists of a thick section of relatively undeformed, well-bedded upper Jurassic and Cretaceous marine sedimentary rocks that structurally overlie the Franciscan Complex rocks along the Coast Range Fault. On the northeastern flank of the Diablo Range, the Great Valley sequence and overlying Tertiary sedimentary rocks form a northwest-trending monocline that dips northeastward beneath the relatively flat-lying Quaternary continental sediments of the San Joaquin Valley. The Great Valley sequence rocks exposed on the southwest flank of the Diablo Range and in the Santa Cruz Mountains have in contrast been fragmented by the more complex deformation associated with continuing transpression along the major strike-slip fault systems.

Ophiolitic rocks (168 - 138.5 Ma)

The Coast Range ophiolite consists of an assemblage of serpentinized ultramafic rocks, diorites, gabbros, diabases, mafic submarine volcanic flows and breccias, and fine-grained tuffs that underlie the Great Valley sequence. All of the ophiolitic rocks have been subjected to repeated tectonic thinning and dismemberment along the Coast Range Fault, leaving an incomplete ophiolite sequence.

Adjacent to the San Andreas Fault on the southwest side of Santa Clara Valley, pegmatitic dikelets of plagiogranite are locally present in the dikes and sills assigned to the Sierra Azul block of the Coast Range ophiolite (McLaughlin and others, 1991). A coarse-grained hornblende separate from the plagiogranite yields a K-Ar age of 138.5 Ma (#1). This age is discordant with U-Pb ages on zircon from the same rock, which lie on concordia between 144 and 168 Ma [fig. 3, table 1, sample (#2)]. Both the hornblende and U-Pb zircon ages have been partly to completely reset by at least two hydrothermal events: one in the Cretaceous; another in the middle Miocene (McLaughlin, written communication, 1993).

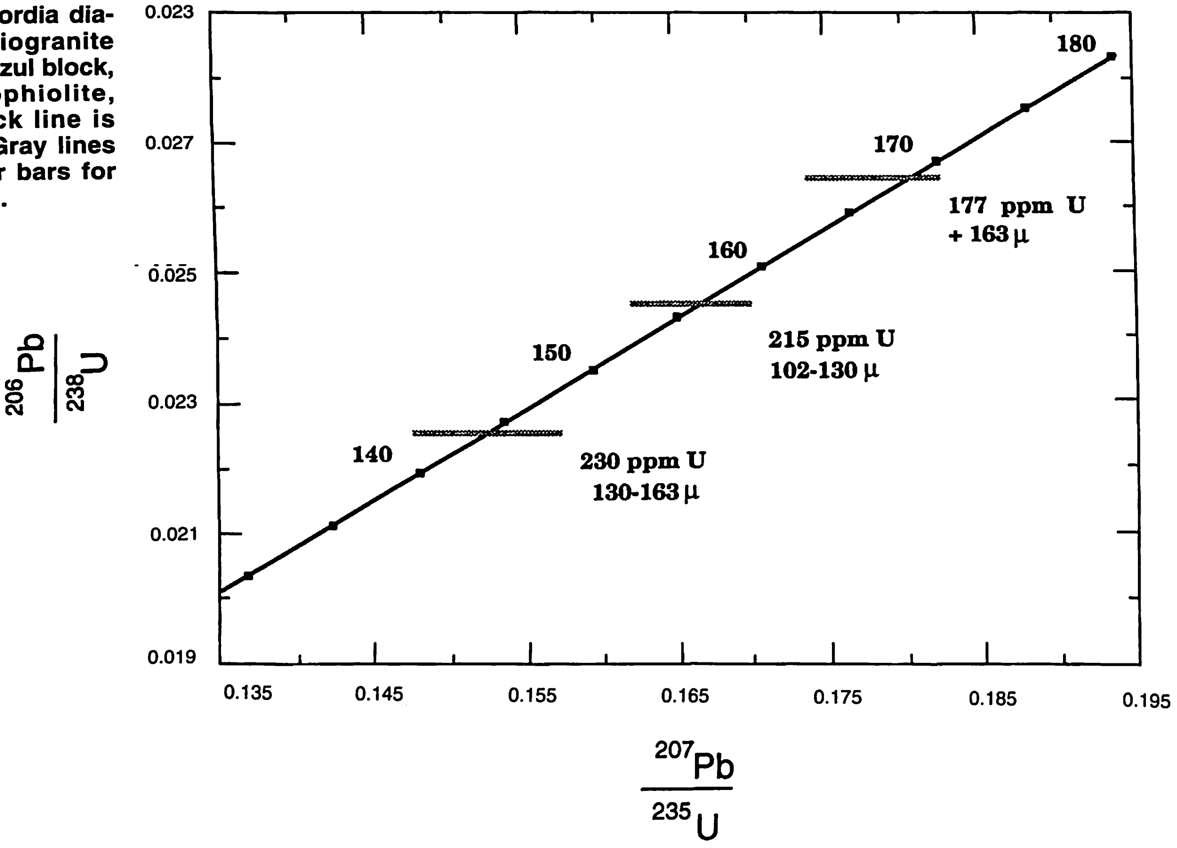


FIGURE 3. Concordia diagram from plagiogranite (zircon), Sierra Azul block, Coast Range ophiolite, California. Black line is the concordia. Gray lines represents error bars for individual points.

CENOZOIC SEDIMENTARY ROCKS

Cenozoic marine and continentally derived sedimentary rocks that range in age from Paleocene to Pleistocene occur on the northeastern and southwestern flanks of the Diablo Range (Bartow and others, 1985) and the Santa Cruz Mountains. Like the Great Valley sequence, the Cenozoic rocks in the southwestern third of the region have been tectonically fragmented.

Santa Clara Formation and Packwood Gravels

Nonmarine gravels and sands of late Cenozoic age in Santa Clara Valley were first called the Santa Clara Formation by Cooper (1894). Cummings (1972) believed that the Santa Clara Formation is composed of numerous lithologic facies that may or may not have formed a continuous blanket. Isolated areas of clastic sediments deposited during the Pliocene and Pleistocene may be considered part of the formation on the basis of stratigraphic position and clast composition.

On a median strip of California State Highway 101, 25 km southeast of San Jose, a tuff (#10) is interbedded within the Santa Clara Formation (fig. 2). Its shard morphology and major-oxide chemistry provide a convincing match with the Rockland tephra, which erupted from the Lassen Peak area of northern California 400,000 yr B.P. (#10), (table 2). In the Anderson-Coyote area, 3.6 to 2.5 Ma basalts (#11-#16) are interbedded with the Santa Clara Formation and Packwood gravels(?) of Crittenden (1951). These

TABLE 1. U-Pb ages of zircon from a plagiogranite, Sierra Azul block, Coast Range ophiolite, California.

Size	Corrected for blank and common Pb												Measured	
microns	Wt mg	ppm U	ppm Pb	$^{206}Pb/^{238}U$	% error	**Age (Ma)**	$^{207}Pb/^{235}U$	% error	**Age (Ma)**	$^{207}Pb/^{206}Pb$	% error	**Age (Ma)**	$^{208}Pb/^{206}Pb$	$^{206}Pb/^{204}Pb$
+163	4.9	176.9	5.4	0.02635	0.2	167.7	0.17609	2.2	164.7	121.8	2.1	121.8	0.2820	1515
130-163	9.0	229.8	5.9	0.02259	0.2	144.0	0.15252	1.8	144.1	145.9	1.7	145.9	0.2642	1887
102-163	4.1	215.5	5.9	0.02448	0.1	155.9	0.16621	1.3	156.1	159.3	1.2	159.3	0.2537	2564

TABLE 2. Tephra correlation table.

Electron microprobe analysis of glass shards from a distal sample of the Rockland tephra layer found in the Santa Clara Formation near Gilroy, California, and comparison to distal and proximal occurrences of the Rockland tephra layer.

Sample		Oxides									Orig. Total	Correl Coef.
#	ID	SiO_2*	Al_2O_3*	Fe_2O_3*	MgO	MnO	CaO*	TiO_2	Na_2O*	K_2O*		
U	**SC-5**	**78.02**	**12.45**	**0.87**	**0.18**	**0.04**	**0.87**	**0.15**	**3.88**	**3.55**	**93.9**	
1	T-1245	78.14	12.36	0.87	0.17	0.04	0.86	0.16	3.89	3.51	93.2	**.994**
2	RPT(L)15	77.84	12.56	0.89	0.16	0.02	0.85	0.18	3.84	3.66	95.8	**.984**
3	RPT(M)7	77.78	12.77	0.87	0.17	0.03	0.89	0.16	3.72	3.61	95.4	**.982**

* Oxides used in correlation

U. Sample found in median strip of Highway 101, 25 km south of San Jose

1. Distal sample of Rockland tephra layer from 59 m depth of Tule Lake core, Tule Lake, California
2. Proximal sample of Lassen Lodge member, Rockland tephra layer, Lassen County, California
3. Proximal sample of Manton member, Rockland tephra layer, Lassen County, California

dates place significant age constraints on the deposition of the Pliocene and Pleistocene gravels in the southern Santa Clara Valley.

In his unpublished study of the proposed Coyote Dam site, Tolman (1934) first described a sequence of nonmarine clastic sediments in the Morgan Hill area and informally named them Packwood Gravels. Ortalda (1948) and Frames (1955) adopted the name for a sequence of relatively unconsolidated sediments found west of the Anderson-Coyote Reservoir area. These same gravel packages were mapped as the Santa Clara Formation by Dibblee (1972), Prowell (1979), and Nakata (1980). However, southwest of Anderson Reservoir these two units may differentiated by the presence of thinly laminated, dense porcelaneous shale clasts of the Monterey Formation that occur only in the older Packwood Gravels (D.L. Jones, oral communication, 1992).

TERTIARY VOLCANIC ROCKS

In our study area, Tertiary volcanic rocks provided the most dateable material for establishing a chronologic framework. They have been grouped in five geographic localities and presented as histograms in figure 4.

Basalts at Anderson-Coyote Reservoir (3.6–2.5 Ma)

The Anderson-Coyote Reservoir volcanic package contains pyroclastics with andesitic affinities and olivine basalt flows which plot within Kuno's (1966) alkali basalt field. The basalts contain a suite of mafic and ultramafic xenoliths derived from the lower crust and upper mantle (Nakata, 1980; Wilshire and others, 1988). Their close proximity to the Calaveras Fault suggests that the magma used the fault plane as a conduit to reach the surface. A recent thermobarometric study by Jové (1992) suggests that mantle upwelling in this area is responsible for the ultramafic xenoliths associated with these basalts. Two episodes of volcanism are recognized that cluster around 3.6 and 2.5 Ma (#11-#16), figure 4.

Basalts at San Luis Reservoir (9.0 - 7.4 Ma)

Moderately deformed erosional remnants of late Miocene high-alumina basalt flows dated at 9.0 Ma (#38), 7.9 Ma (#39), and 7.4 Ma (#41), and associated basaltic to andesitic pyroclastic deposits dated at 8.3 Ma (#40) occupy two areas of less than 1 km^2, southwest of San Luis Reservoir Dam. These basalt flows have been previously interpreted as flow outliers derived from vents in the Quien Sabe Volcanic field, located approximately 10 km southwest of the reservoir (Lettis, 1982). Geologic mapping (Sorg, unpublished data, 1990) has identified local vents for these basalt flows, thus avoiding the need to postulate a source from the older, more highly differentiated andesitic rocks of the Quien Sabe Volcanic field. The close proximity of these vents and flows to the Ortigalita fault zone suggests that this fault may also have provided a conduit for the basaltic magma in its ascent to the surface.

Andesite of Dowdy Ranch (8.2 Ma) and Xenoliths (12.3 - 8.5 Ma)

The andesite of Dowdy Ranch 8.2 Ma, (#21), occurs as a northwest-trending, 1.5 km long by 400 meter wide, steeply northeast-dipping dike that intrudes Franciscan Complex melange on the northeast flank of Burra Burra Peak, approximately 9.5 km northwest of Bell Station on Highway 152 west of Pacheco Pass .

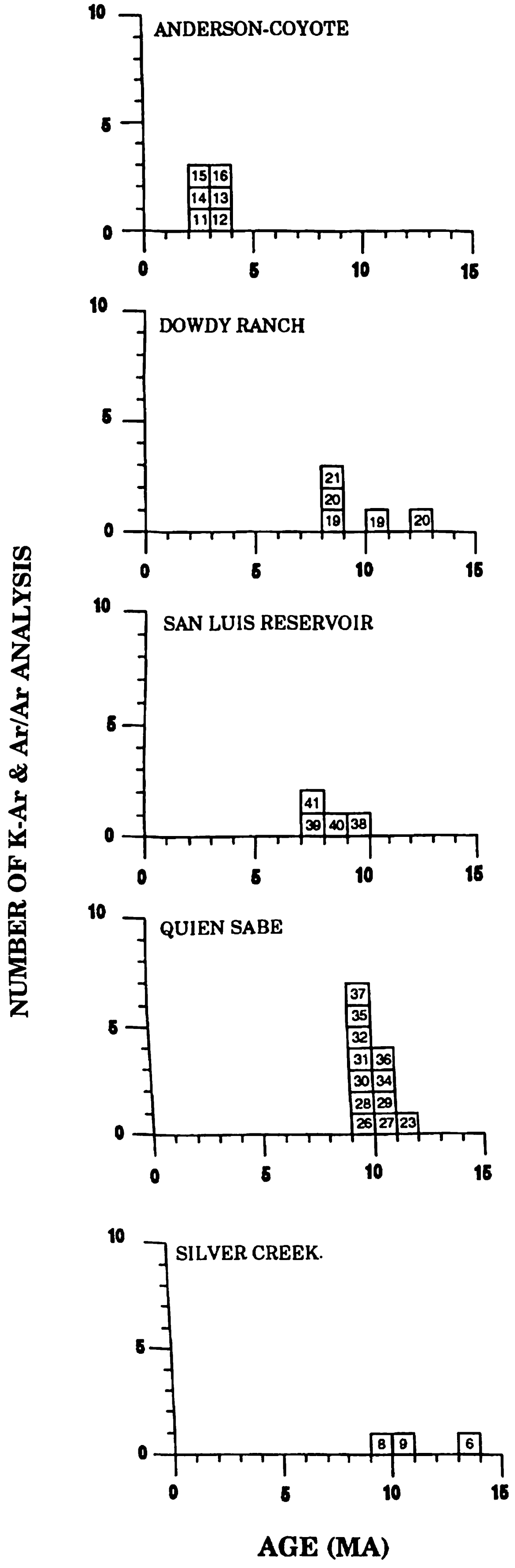
Recent investigations by Sorg (unpublished data, 1992) have identified a lower crustal suite of mafic and metamorphic xenoliths in this andesite which include coarse-grained hornblende gabbro, diorite, feldspathic granitoid (?), biotite schist and a fine-grained corundum-sillimanite bearing schist. No ultramafic xenoliths similar to those found in the Anderson-Coyote Reservoir area have been recognized. Two representative mafic xenoliths were dated using the Ar/Ar laser fusion method. A plagioclase/biotite mineral pair from a diorite xenolith, (#20) yielded ages of 12.3 Ma (table 3) and 8.5 Ma (table 4). Plagioclase and hornblende from a gabbroic xenolith, (#19) yielded ages of 10.9 Ma (table 5) and 8.9 Ma (table 6). The close agreement of these xenoliths to the age of the host andesite 8.2 Ma, (#21) indicates that the minerals in the xenoliths were almost completely reset during their residency in the magma.

Andesite (10.5, 9.3 Ma) and Tuff (13.9 Ma) at Silver Creek

A northwest-trending andesite dike (9.3 Ma, 10.5 Ma, #8, #9) is exposed along newly cut housing pads and measures 0.8 km in length and dips gently to the northeast. We consider the older age to be more accurate, because the younger age is from the less argon-retentive glassy chill margin of the intrusion. The dike is emplaced near a northwest-trending, northeast-dipping thrust(?) fault within the Silver Creek fault zone, which cuts serpentinite, unnamed Miocene(?) sedimentary rocks, Packwood Gravels(?) and Santa Clara Formation gravels of Crittenden (1951). Whether the andesite intruded along the thrust fault is still uncertain. Interbedded(?) with the unnamed biotite-rich Miocene sandstone is a silicic crystal tuff dated at 13.9 Ma (#6). This tuff is not genetically related to the andesite dike but instead has chemical affinities to a family of tephras erupted from the Timber Mountain volcanic center in the Great Basin area of southeastern Nevada (table 7, #7). It is most similar to distal tephras from the upper White Basin Tertiary nonmarine section near Lake Mead, southeastern Nevada, which have been dated at 11.0 Ma (Bohannon, 1984).

Quien Sabe Volcanic field (9.3-11.6 Ma)

The late Miocene Quien Sabe Volcanic field originally described by Taliaferro (1948) and Leith (1949) occupies an area of approximately 260 km^2 along the



◀ FIGURE 4. Histogram of volcanic ages from five localities in the Diablo Range, California.

TABLE 3. Laser fusion data from sample # 89SgPP-6A PLAGIOCLASE.

J Value .003943

Run	^{40}Ar/^{39}Ar	^{37}Ar/^{39}Ar*	^{36}Ar/^{39}Ar	% ^{36}Ar$_{Ca}$**	% ^{40}Ar$_{R}$*	Age (Ma)	Error ±
1	4.655	7.805	0.01242	16.9	34.3	11.38	1.11
2	4.256	7.271	0.01061	18.4	39.6	12.02	0.38
3	8.154	7.494	0.02360	8.5	21.7	12.59	0.39
Avg						**12.3**	**.3**

TABLE 4. Laser fusion data from sample # 89SgPP-6A BIOTITE.

J Value .003975

Run	^{40}Ar/^{39}Ar	^{37}Ar/^{39}Ar*	^{36}Ar/^{39}Ar	% ^{36}Ar$_{Ca}$**	% ^{40}Ar$_{R}$*	Age (Ma)	Error ±
1	7.417	.01781	0.02114	0.02	15.7	8.31	0.21
2	8.062	.02249	0.02310	0.03	15.3	8.80	0.29
3	7.598	.01435	0.02159	0.02	15.9	8.67	0.24
4	9.136	.01114	0.02686	0.01	13.0	8.51	0.28
Avg						**8.5**	**.1**

TABLE 5. Laser fusion data from sample # 89SgPP-6C PLAGIOCLASE.

J Value .00395

Run	^{40}Ar/^{39}Ar	^{37}Ar/^{39}Ar*	^{36}Ar/^{39}Ar	% ^{36}Ar$_{Ca}$**	% ^{40}Ar$_{R}$*	Age (Ma)	Error ±
1	15.35	21.56	0.05239	11.1	10.2	11.31	0.80
2	18.09	22.38	0.06287	9.6	7.1	9.24	0.96
3	20.15	23.98	0.06868	9.4	8.7	12.67	1.27
Avg						**10.9**	**.5**

TABLE 6. Laser fusion data from sample # 89SgPP-6C HORNBLENDE.

J Value .003955

Run	^{40}Ar/^{39}Ar	^{37}Ar/^{39}Ar*	^{36}Ar/^{39}Ar	% ^{36}Ar$_{Ca}$**	% ^{40}Ar$_{R}$*	Age (Ma)	Error ±
1	5.395	9.275	0.01647	15.1	23.3	9.00	0.31
2	5.240	9.411	0.01611	15.7	23.2	8.72	0.41
3	5.377	9.356	0.01645	15.3	23.2	8.95	0.35
Avg						**8.9**	**.2**

*Corrected for ^{37}Ar decay, half-life = 35.1 days

**Subscripts indicate calcium-derived (Ca) and radiogenic (R) argon

TABLE 7. Tephra correlation table.

Electron microprobe analysis of glass shards from a Timber Mountain volcanic center-like tephra layer and comparison to chemically similar Miocene age ash layers.

Sample		Oxides									Orig. Total	Correl Coef.
#	ID	SiO_2*	Al_2O_3*	Fe_2O_3*	MgO	MnO	CaO*	TiO_2	Na_2O*	K_2O*		
U	**91SgSJE52A**	**78.86**	**12.87**	**0.69**	**0.07**	**0.07**	**0.43**	**0.11**	**3.43**	**3.49**	**91.0**	
1	UWB-19	77.50	12.68	0.71	0.05	0.07	0.44	0.10	5.30	2.20	94.4	**.967**
2	UWB-9	76.44	13.01	0.76	0.06	0.11	0.42	0.11	3.30	5.79	92.7	**.953**
3	UWB-6	76.12	13.30	0.82	0.09	0.12	0.42	0.10	3.37	5.92	94.2	**.944**

* Oxides used in correlation

U. Sample collected on recently graded housing pad

1. Upper White basin, southeastern Nevada
2. Upper White basin, southeastern Nevada
3. Upper White basin, southeastern Nevada

crest of the central Diablo Range about 15 km east of Hollister. The K-Ar ages presented for Quien Sabe volcanic rocks and associated epithermal alteration are from samples collected in the northern half of the volcanic field by Drinkwater and Sorg.

The Quien Sabe Volcanic rocks are a highly differentiated andesitic suite, as indicated by their mineralogy, petrography, and chemistry, and are considered typical of volcanic rocks with a calc-alkaline affinity (Drinkwater and others, 1988, 1992). They range from basalt to rhyolite in composition and consist of nearly 1,220 meters of thick flows and volcanic breccias with minor interbedded tuffs and volcanic sedimentary rocks. Andesites and dacites are the most voluminous but are localized, whereas basalts and basaltic andesites are less abundant but are widely distributed. Rhyolite occurs as relatively small domes, vents, dikes, and sills in the lower units and as reworked clasts in volcanoclasitc deposits of the upper units.

K-Ar dating was concentrated in three main vent complexes that are characterized by numerous plugs, domes, large dikes, and irregular-shaped intrusive bodies composed chiefly of dacite 9.8 Ma (#35), 9.9 Ma (#32), 10.0 Ma (#31), 10.0 Ma (#34), 10.1 Ma (#33), 10.7 Ma (#29); rhyodacite 9.5 Ma (#37), 10.0 Ma (#27), 10.1 Ma (#36); and rhyolite 9.3 Ma (#26). Andesites and basalts were also collected, but were found to be too altered for dating.

The earliest recognized period of Quien Sabe volcanism was centered at the andesitic vent of Pacheco Peak (11.6 Ma, #23), located 12.8 km northwest of the major vent areas of the younger, main part of the volcanic field. In the northwestern part of the volcanic field, extensive areas of hydrothermal alteration are associated with a northwest-trending system of steeply dipping normal and reverse faults. K-Ar ages of 9.1 Ma (#30) and 9.4 Ma (#28) have been determined for hydrothermal alteration that hosts the epithermal antimony-mercury mineralization that has been intermittently mined since the late 1800s.

MINERAL PREPARATION, DATING AND CORRELATION METHODS

Mineral Preparation

K-Ar

All minerals used for radiometric ages were separated by standard heavy liquid and magnetic methods in laboratories of the U.S. Geological Survey at Menlo Park, California. All whole-rock samples, hydrothermal K-feldspar, adularia, and plagioclase mineral separates were treated with 10% HF and 15% HNO_3, using the method described by Silverman (personal communication, 1978) [10% HF for two minutes followed by 15% HNO_3 for thirty minutes]. Purity of the mineral separates was determined by x-ray diffraction and examination of mineral grains in immersion liquids under the petrographic microscope.

U-Pb

Zircon concentrates were prepared using a Wilfley table, heavy liquids and magnetic separation. The final zircon separation was done using a Frantz magnetic separator at full power with 1 to 0.5 degree side tilt and 20 degree forward tilt. Magnetic and non-magnetic fractions from this step were divided using disposable nylon mesh into size fractions from +163 microns to -63 microns as appropriate for the particular sample. Individual size fractions to be used for analysis were hand-picked to remove the remaining impurities.

Dating Techniques

Conventional K-Ar

The K-Ar age determinations were made in the isotope laboratories of the U.S. Geological Survey at Menlo Park, California, using the methods described by Dalrymple and Lanphere (1969). Argon was extracted on an ultra-high vacuum system by fusion; the reactive gases were then scrubbed by an artificial molecular sieve, Cu-CuO and Ti metals.

The spectrometry was performed on a Nier-type, 15-cm radius, 60° sector and a multichannel, 23-cm radius, 90° sector mass spectrometers, both operated in the static mode. Argon was analyzed by comparing the liberated gas to a "pure" ^{38}Ar spike of known volume and composition added during fusion. The decay constants used are those published by Steiger and Jager (1977):

^{40}K/K	1.67×10^{-4} mol/mol
λ ($^{40}K_b$-)	4.962×10^{-10} yr^{-1}
λ (^{40}Ke) + λ' (^{40}Ke)	0.581×10^{-10} yr^{-1}

Flame photometry with a lithium internal standard was used to analyze potassium using the procedure described by Cremer and others (1984). All samples were run in duplicate to check analytical precision.

The 2.5(±) error represents a conservative estimate of the overall analytical precision for samples with greater than 10% radiogenic argon. This is based on empirical tests over a period of 14 years at the U.S. Geological Survey Isotope laboratory in Menlo Park, California (Tabor and others, 1985). Results averaged from determinations on two splits of the same sample, the error reflects the same conservative 2.5% estimates at ± 1 standard deviation and 68% confidence level. However, for those samples with less than 10% radiogenic argon and not run in duplicate, we used the error predicted by Tabor and others (1985).

Laser Argon 40/39

^{40}Ar/^{39}Ar measurements were carried out on the GLM Continuous Laser System described by Dalrymple (1989). Samples were irradiated in the U.S. Geological Survey TRIGA reactor to induce the reaction ^{39}K(n,p) ^{39}Ar. Details about the reactor, sample handling, and corrections for interfering isotopes produced by other neutron reactions are given by Dalrymple and others (1981). The neutron flux (J) was calculated by using an internal standard of sanidine (85GOO3 Taylor Creek) distributed both vertically and horizontally and placed in quartz vials within an aluminum reactor vessel. Standard errors of the mean for J-values are about 0.5% (M. S. Pringle, oral communications, 1992).

Fusion of mineral grains is accomplished by a 5-W argon-ion laser with principal wavelengths at 488 nm and 514 nm. The liberated gas package is scrubbed by a Zr-V-Fe getter for hydrogen and a Zr-Al getter to crack hydrocarbons and remove other reactive gases. Mass spectrometry is carried-out on-line using a 90° sector direction-focusing instrument with a radius of 15 cm.

Ages are calculated using the ^{40}Ar/^{39}Ar ratio corrected for interfering Ar isotopes derived from neutron reactions with Ca and K during irradiation. The age of the sample t_u is calculated using the following formula:

$$t_u=1/\lambda \log_e(1 + F \times J)$$

where λ is the decay constant of ^{40}K (5.543×10^{-10}) and F ($^{40}Ar/^{39}Ar_K$) is the ratio of radiogenic ^{40}Ar to potassium-derived ^{39}Ar in the sample. J is a function of the integrated fast-neutron flux in the reactor and is determined by a monitor mineral of known age.

Conventional Argon 40/39

The conventional argon ^{40}Ar/^{39}Ar samples were irradiated using the same procedure as described in the laser section, where argon 39 acts as proxy for potassium through the reaction K^{39} to Ar^{39}. The fusion and subsequent scrubbing of reactive gasses and spectrometry is identical to the conventional K-Ar method.

Tephrochronology

Tephra samples were examined under a petrographic microscope to determine the presence of datable glass. Glass shards were then separated from other mineral phases and analyzed with a 9 channel electron microprobe for major-oxide compositions (tables 1 and 6) using the methods described by Sarna-Wojcicki and others (1984). Sample compositions were then compared against a database of tephra from the western U.S. and deep sea sites (Sarna-Wojcicki and others, 1985; Meyer and others, 1991).

Values for glass compositions in tables 1 and 6 are normalized to 100 percent to correct for varying degrees of hydration of the volcanic glass. Original totals are approximate guides to the degree of hydration of each sample. Because some post-depositional alkali exchange appears to have occurred in the older Miocene samples (table 6), potassium, magnesium, titanium and manganese were not utilized for correlations in those cases where concentrations were too low to be meaningful.

U-Pb Zircon

Zircons were dissolved with concentrated HF and a small amount of concentrated HNO_3 in small Teflon capsules covered with Teflon sleeves and metal jackets and confined in screw tightened metal frames. Samples remained in these self-pressurized capsules at 210 degrees C for 1 to 2 weeks. Samples were then removed from the dissolution capsules, transferred to 7 ml translucent screw-top Teflon vials, carefully inspected to insure full dissolution, dried, and re-dissolved in (1N) HNO_3. This solution is split by weight approximately 70/30 and a mixed ^{235}U and ^{208}Pb spike added to the smaller split. Both solutions are dried and re-dissolved in 0.5 ml of (3N) HCl. Zr, Pb, and U are separated using an anion exchange resin in a 200 microliter column with 3N HCl, 6N HCl, and water. Total blanks for Pb average 0.3 ng and are less than 0.01 ng for U. Pb is loaded on single Re filaments with H_3PO_4 and silica gel, and U is loaded as a nitrate on double Re filaments. Isotopic ratios are measured in static mode on a MAT 262 mass spectrometer in the Pb isotopic laboratory at the U.S. Geological Survey in Menlo Park, California. Pb isotopic ratios are corrected by 0.11% per mass unit for thermal fractionation as determined by numerous analyses of Pb standards NBS-981, -982 and -983. Data are reduced and analyzed using the most recent versions of Ken Ludwig's PBDAT and ISOPLOT programs (1988). Whenever possible, feldspar Pb isotopic compositions are used for common Pb corrections; if this data is not available, a composition for the appropriate age is taken from the Stacey and Kramers (1975) model.

ACKNOWLEDGMENTS

We are grateful to the following people who contributed their time and expertise to this project. B. Hamachi and E. Wan of Western Regional Geology for preparing exceptional mineral and glass separates for K-Ar dating and electron microanalysis. S. Pribble, D. Vivit and P. Klock of Analytical Labs for extremely consistent potassium analysis. J. Von Essen of Isotope Geology for providing invaluable advice on extraction and spectrometry. K. Nimz for rendering the geologic map and plotting sample locations. We appreciate the insightful review of the manuscript by C. Wentworth, C. Blake, S. Starratt and J. Troll of the U.S. Geological Survey. Field discussions with the following facilitated our geochonologic studies: D. Jones, R. Graymer (University of California, Berkeley); L. DeVito, S. Korbay, R. Aliperti (Kleinfelder); D. Hardin, A. Gallego (San Jose State University); S. Hoose, (Santa Clara County Water District); B. Page, B. Coleman, (Stanford University); and E. Brabb, E. Helley (USGS).

SAMPLE DESCRIPTIONS

1. *MSJ47-90* conventional K-Ar
Granite (37°08′30″, 121°56′33″; Los Gatos quad., Santa Clara County, CA). *Analytical data:* K_2O = 0.16; $^{40}Ar^*$ mol/gm = 3.21×10^{-11}; $^{40}Ar^*/\Sigma^{40}Ar$ = 51%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* McLaughlin. *Comment:* Hornblende-bearing plagiogranite pegmatite dike (see #2).
(hornblende) 138.5 ± 3.5 Ma

2. *MSJ47-90* U-Pb
Granite (37°08′30″, 121°56′33″; Los Gatos quad., Santa Clara County, CA). *Analytical data:* See figure 3 and sample #1. *Analyzed by:* J. Wooden. *Collected by:* McLaughlin.
(zircon) 144-168 Ma

3. *89SgLG-26* conventional K-Ar
Lithic tuff (37°12′50″, 121°53′15″; Los Gatos quad., Santa Clara County, CA). *Analytical data:* K_2O = 0.62; $^{40}Ar^*$ mol/gm = 1.39×10^{-11}; $^{40}Ar^*/\Sigma^{40}Ar$ = 68%. *Analyzed by:* S. Pribble and P. Russell. *Collected by:* Sorg.
(plagioclase) 15.6 ± 0.4 Ma

4. *88SGLP-16B* conventional K-Ar
Vein (37°06′40″, 121°50′30″; Mt. Madonna quad., Santa Clara County, CA). *Analytical data:* K_2O = 13.70; $^{40}Ar^*$ mol/gm = 1.97×10^{-10}, 2.01×10^{-10}; $^{40}Ar^*/\Sigma^{40}Ar$ = 56%, 52%. *Analyzed by:* S. Pribble and P. Russell. *Collected by:* Sorg. *Comment:* Adularia bearing quartz-carbonate vein cutting ophiolitic rocks of Loma Prieta.
(adularia) 10.0 ± 0.1 Ma
10.2 ± 0.1 Ma

5. *88SGMD-3* conventional K-Ar
Vein (37°01′30″, 121°41′35″; Mt. Madonna quad., Santa Clara County, CA). *Analytical data:* K_2O = 14.10; $^{40}Ar^*$ mol/gm = 3.35×10^{-10}; $^{40}Ar^*/\Sigma^{40}Ar$ = 67%. *Analyzed by:* S. Pribble and P. Russell. *Collected by:* Sorg. *Comment:* Adularia bearing quartz-carbonate veinlets cutting Franciscan Complex melange near Mount Madonna.
(adularia) 17.3 ± 0.1 Ma

6. *91SgSJE-52A* conventional K-Ar
Tuff (37°17′15″, 121°46′05″; San Jose East quad., Santa Clara County, CA). *Analytical data:* K_2O = 0.95; $^{40}Ar^*$ mol/gm = 1.90×10^{-11}; $^{40}Ar^*/\Sigma^{40}Ar$ = 41%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Sorg and Nakata. *Comment:* Tephrochronologically correlates to middle Miocene eruptive centers in southeastern Nevada dated at 11 Ma (#7).
(plagioclase) 13.9 ± 0.3

7. *91SgSJE-52A* tephrochronology
Tuff (37°17′15″, 121°46′05″; San Jose East quad., Santa Clara County, CA). *Analytical data:* A plagioclase separate was dated at 13.9 Ma (#6), see

table 2. *Analyzed by:* C. Meyer. *Collected by:* Sorg and Nakata. *Comment:* A plagioclase separate was dated at 13.9 Ma (#6). *Correlation:* Correlates to Timber Mountain caldera-type deposits found at Lake Mead, southeastern Nevada and dated at 11 Ma.

(glass)

8. *91SGSJE-53A* conventional K-Ar

Andesite (37°17′15″, 121°46′05″; San Jose East quad., Santa Clara County, CA). *Analytical data:* K$_2$O = 2.64; ^{40}Ar* mol/gm = 3.99 × 10^{-11}; ^{40}Ar*/Σ^{40}Ar = 80%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Sorg and Nakata. *Comment:* Core of andesite dike. Glassy margin is sample 91SGSJE-53B dated at 9.3 Ma (#9).

(whole rock) 10.5 ± 0.3 Ma

9. *91SGSJE-53B* conventional K-Ar

Andesite (37°17′15″, 121°46′05″; San Jose East quad., Santa Clara County, CA). *Analytical data:* K$_2$O = 2.64; ^{40}Ar* mol/gm = 2.83 × 10^{-11}; ^{40}Ar*/Σ^{40}Ar = 55%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Sorg and Nakata. *Comment:* Chilled glassy margin of dike. Nonglassy portion of dike gives 10.5 Ma age (#8).

(whole rock) 9.3 ± 0.2 Ma

10. *SC-5* tephrochronology

Lithic tuff (37°12′30″, 121°42′30″; San Jose East quad., Santa Clara County, CA). *Analytical data:* see table 6. *Analyzed by:* C. Meyer. *Collected by:* Meyer and Sarna-Wojcicki. *Comment:* Found in median strip of Highway 101. *Correlation:* Correlates to Rockland tephra 400,000 yr B.P.

(glass)

11. *JKN-100* conventional K-Ar

Basalt (37°11′00″, 121°40′00″; Morgan Hill quad., Santa Clara County, CA). *Analytical data:* K$_2$O = 1.22; ^{40}Ar* mol/gm = 4.72 × 10^{-12}, 4.88 × 10^{-12}; ^{40}Ar*/Σ^{40}Ar = 37%, 46%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Nakata. *Comment:* Vent for northern most flows of Anderson-Coyote Reservoir volcanic package. Outcrops lie west of the Calaveras Fault and between Coyote Creek and Silver Creek Faults.

(whole rock) 2.6 ± 0.1 Ma
2.7 ± 0.1 Ma

12. *JKN-90-1* conventional K-Ar

Basalt (37°07′35″, 121°35′52″; Mt. Sizer quad., Santa Clara County, CA). *Analytical data:* K$_2$O = 1.22; ^{40}Ar* mol/gm = 6.00 × 10^{-12}; ^{40}Ar*/Σ^{40}Ar = 60%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Nakata. *Comment:* Interbedded with Santa Clara Formation gravels.

(whole rock) 3.4 ± 0.1 Ma

13. *GI-2* conventional K-Ar

Basalt (37°15′00″, 121°34′00″; Gilroy quad., Santa Clara County, CA). *Analytical data:* K$_2$O = 1.76; ^{40}Ar* mol/gm = 7.42 × 10^{-12}, 1.02 × 10^{-11}, 9.34 × 10^{-12}, 7.92 × 10^{-12}; ^{40}Ar*/Σ^{40}Ar = 55%, 53%, 61%, 48%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Nakata. *Comment:* Sample found in colluvium, adjacent to Calaveras Fault, weighted average of 4 runs is 3.4 Ma. The large spread of ages suggests inhomnogenity of sample.

(whole rock) 2.9 ± 0.1 Ma
4.0 ± 0.1 Ma
3.7 ± 0.1 Ma
3.1 ± 0.1 Ma

14. *GI-1* conventional K-Ar

Basalt (37°06′00″, 121°33′00″; Gilroy quad., Santa Clara County, CA). *Analytical data:* K$_2$O = 1.03; ^{40}Ar* mol/gm = 4.13 × 10^{-12}, 3.65 × 10^{-12}; ^{40}Ar*/Σ^{40}Ar = 39%, 31%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Nakata. *Comment:* Main vent for Anderson-Coyote Reservoir volcanic rocks, 2.7 Ma average.

(whole rock) 2.8 ± 0.1 Ma
2.5 ± 0.1 Ma

15. *JKN-91-2* conventional K-Ar

Basalt (37°06′00″, 121°33′00″; Gilroy quad., Santa Clara County, CA). *Analytical data:* K$_2$O = 1.03; ^{40}Ar* mol/gm = 4.61 × 10^{-12}; ^{40}Ar*/Σ^{40}Ar = 54%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Nakata. *Comment:* Recollected from same area that Sarna-Wojcicki and Curtis, U.C. Berkeley determined an age of 3.5 Ma in 1960. When corrected for the new constants the age is 3.6 Ma. Two ages of volcanism is consistent with the Anderson-Coyote Reservoir area (fig. 4).

(whole rock) 2.5 ± 0.1 Ma

16. *JKN-00* conventional K-Ar

Basalt (36°56′00″, 121°22′00″; San Felipe quad., Santa Clara County, CA). *Analytical data:* K$_2$O = 1.33; ^{40}Ar* mol/gm = 6.87 × 10^{-12}, 6.88 × 10^{-12}; ^{40}Ar*/Σ^{40}Ar = 32%, 36%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Nakata. *Comment:* Only recognized basalt adjacent to and east of the Calaveras Fault.

(whole rock) 3.6 ± 0.1 Ma
3.6 ± 0.1 Ma

17. *89SgMC-7* conventional K-Ar

Andesite (37°14′30″, 121°24′00″; Mississippi Creek quad., Santa Clara County, CA). *Analytical data:* K$_2$O = 8.42; ^{40}Ar* mol/gm = 1.14 × 10^{-10}, 1.17 × 10^{-10}; ^{40}Ar*/Σ^{40}Ar = 31%, 38%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Sorg. *Comment:* 9.5 ± 0.2 Ma average.

(biotite) 9.4 ± 0.2 Ma
9.6 ± 0.2 Ma

18. *89SgMC-11* conventional K-Ar

Fault Gouge (37°12′10″, 121°22′40″; Mississippi Creek quad., Santa Clara County, CA). *Analytical* *data:* K_2O = 9.02; $^{40}\text{Ar}^{*}$ mol/gm = 1.72×10^{-09}; $^{40}\text{Ar}^{*}/\Sigma^{40}\text{Ar}$ = 95%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Sorg. *Comment:* Chrome muscovite (fuchsite?), from a tectonic block of greenschist within a hydrothermally altered fault zone that cuts Franciscan Complex melange.

(chrome muscovite) 127.7 ± 3.0 Ma

19. *89SgPP-6C* laser Ar/Ar
Xenolith (36°58′55″, 121°18′00″; Pacheco Peak quad., Santa Clara County, CA). *Analytical data:* See tables 4 and 5. *Analyzed by:* J. Saburomaru. *Collected by:* Sorg and Nakata. *Comment:* Hornblende gabbro xenolith.

(plagioclase) 10.9 ± 0.2 Ma
(hornblende) 8.9 ± 0.5 Ma

20. *89SgPP-6A* laser Ar/Ar
Xenolith (36°58′55″, 121°18′00″; Pacheco Peak quad., Santa Clara County, CA). *Analytical data:* See tables 2 and 3. *Analyzed by:* M. Pringle. *Collected by:* Sorg and Nakata. *Comment:* Diorite xenolith.

(biotite) 8.5 ± 0.1 Ma
(plagioclase) 12.3 ± 0.3 Ma

21. *89SgPP-5* conventional Ar/Ar
Andesite (37°06′30″, 121°21′30″; Pacheco Peak quad., Santa Clara County, CA). *Analytical data:* $^{40}\text{Ar}/^{39}\text{Ar}$ = 5.5; $^{37}\text{Ar}/^{39}\text{Ar}^{*}$ = .11; $^{36}\text{Ar}/^{39}\text{Ar}$ = 1.58×10^{-2}; %$^{36}\text{Ar Ca}^{**}$ = .19; %^{40}Ar radiogenic = 15.4. *Analyzed by:* J. K. Nakata. *Collected by:* Sorg.

(biotite) 8.2 ± 2.8 Ma

*Corrected for 37 argon decay, half-life (35.1 days)
**Indicates calcium derived argon

22. *92 SgPP-90* conventional K-Ar
Albite (37°02′10″, 121°15′12″; Pacheco Peak quad., Santa Clara County, CA). *Analytical data:* K_2O^{**} = 0.03; $^{40}\text{Ar}^{*}$ mol/gm = 3.35×10^{-12}; $^{40}\text{Ar}^{*}/\Sigma^{40}\text{Ar}$ = 4%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Sorg. *Comment:* Albite-bearing quartz-carbonate vein cutting Franciscan Complex jadeitized metagraywacke. Error calculated using Tabor and others, 1985.

(albite) 90.7 ± 22.0 Ma

**Limit of detection for K_2O; 90.7 Ma should be considered a minimum age.

23. *88SGPP-12* conventional K-Ar
Andesite (37°00′30″, 121°17′15″; Pacheco Peak quad., Santa Clara County, CA). *Analytical data:* K_2O = 7.90; $^{40}\text{Ar}^{*}$ mol/gm = 1.32×10^{-10}; $^{40}\text{Ar}^{*}/\Sigma^{40}\text{Ar}$ = 43%. *Analyzed by:* S. Pribble and P. Russell. *Collected by:* Sorg. *Comment:* Biotite andesite vent of Pacheco Peak.

(biotite) 11.6 ± 0.1 Ma

24. *89SgTS-12* conventional Ar/Ar
Andesite (36°59′30″, 121°19′58″; Three Sisters quad., Santa Clara County, CA). *Analytical data:* $^{40}\text{Ar}/^{39}\text{Ar}$ = 2.7; $^{37}\text{Ar}/^{39}\text{Ar}^{*}$ = 5.2×10^{-2}; $^{36}\text{Ar}/^{39}\text{Ar}$ = 5.7×10^{-3}; %$^{36}\text{Ar Ca}^{**}$ = .25; %^{40}Ar radiogenic = 38.4. *Analyzed by:* J. K. Nakata. *Collected by:* Sorg.

(biotite) 9.7 ± 0.8 Ma
9.8 ± 0.9 Ma

*Corrected for 37 argon decay, half-life (35.1 days)
**Indicates calcium derived argon

25. *89-SgTS-15* conventional K-Ar
Andesite (36°58′55″, 121°18′00″; Three Sisters quad., Santa Clara County, CA). *Analytical data:* K_2O = 7.60; $^{40}\text{Ar}^{*}$ mol/gm = 1.22×10^{-10}, 1.18×10^{-10}; $^{40}\text{Ar}^{*}/\Sigma^{40}\text{Ar}$ = 32%, 51%. *Analyzed by:* S. Pribble and J. K. Nakata. *Collected by:* Sorg. *Comment:* Porphyritic, biotite andesite dike intruding Franciscan Complex melange. 11.0 ± 0.3 Ma average.

(biotite) 11.2 ± 0.3 Ma
10.8 ± 0.2 Ma

26. *85SG-6* conventional K-Ar
Rhyolite (36°57′40″, 121°12′29″; Mariposa Peak quad., Merced County, CA). *Analytical data:* K_2O = 8.34; $^{40}\text{Ar}^{*}$ mol/gm = 1.12×10^{-10}; $^{40}\text{Ar}^{*}/\Sigma^{40}\text{Ar}$ = 30%. *Analyzed by:* D. Vivit and P. Russell. *Collected by:* Sorg. *Comment:* Vitrophyric, flow-banded biotite rhyolite intrusive of Cathedral Peak.

(biotite) 9.3 ± 0.1 Ma

27. *81JD-23* conventional K-Ar
Rhyodacite (36°57′30″, 121°09′00″; Mariposa Peak quad., Merced County, CA). *Analytical data:* K_2O = 0.50; $^{40}\text{Ar}^{*}$ mol/gm = 1.12×10^{-10}; $^{40}\text{Ar}^{*}/\Sigma^{40}\text{Ar}$ = 45%. *Analyzed by:* P. Klock and J. Saburomaru. *Collected by:* Drinkwater. *Comment:* Porphyritic, hornblende-biotite rhyodacite dome.

(biotite) 10.0 ± 0.3 Ma

28. *85SG-16* conventional K-Ar
Dacite (36°55′30″, 121°13′10″; Mariposa Peak quad., Merced County, CA). *Analytical data:* K_2O = 6.89; $^{40}\text{Ar}^{*}$ mol/gm = 9.31×10^{-11}; $^{40}\text{Ar}^{*}/\Sigma^{40}\text{Ar}$ = 28%. *Analyzed by:* D. Vivit and P. Russell. *Collected by:* Sorg. *Comment:* Brecciated, K-spar-bearing epithermal quartz vein (Stayton Vein).

(potassium feldspar) 9.4 ± 0.1 Ma

29. *81JD-71* conventional K-Ar
Dacite (36°57′00″, 121°09′00″; Mariposa Peak quad., Merced County, CA). *Analytical data:* K_2O = 7.88; $^{40}\text{Ar}^{*}$ mol/gm = 1.22×10^{-10}; $^{40}\text{Ar}^{*}/\Sigma^{40}\text{Ar}$ = 45%. *Analyzed by:* P. Klock and J. Von Essen. *Collected by:* Drinkwater. *Comment:* Porphyritic, hornblende-biotite dacite flow.

(biotite) 10.7 ± 0.3 Ma

30. *85SG-2A* conventional K-Ar
Quartz vein (36°55′02″, 121°13′45″; Mariposa Peak quad., San Benito County, CA). *Analytical*

data: K_2O = 8.03; $^{40}Ar^*$ mol/gm = 1.05×10^{-10}; $^{40}Ar^*/\Sigma^{40}Ar$ = 41%. *Analyzed by:* D. Vivit and P. Russell. *Collected by:* Sorg. *Comment:* Brecciated, potassium feldspar-bearing, epithermal quartz vein (Shriver Vein).

(potassium feldspar) 9.1 ± 0.1 Ma

31. *84Sg-6H* conventional K-Ar
Dacite (36°55′15″, 121°12′00″; Mariposa quad., Merced County, CA). *Analytical data:* K_2O = 0.45; $^{40}Ar^*$ mol/gm = 6.56×10^{-12}; $^{40}Ar^*/\Sigma^{40}Ar$ = 20%. *Analyzed by:* S. Pribble and P. Russell. *Collected by:* Sorg. *Comment:* Porphyritic, hornblende-biotite dacite plug. Vent complex. Mineral pair (#32).

(hornblende) 10.0 ± 3.4 Ma

32. *84Sg-6B* conventional K-Ar
Dacite (36°55′15″, 121°12′00″; Mariposa quad., Merced County, CA). *Analytical data:* K_2O = 8.24; $^{40}Ar^*$ mol/gm = 1.18×10^{-10}; $^{40}Ar^*/\Sigma^{40}Ar$ = 29%. *Analyzed by:* S. Pribble and P. Russell. *Collected by:* Sorg. *Comment:* Porphyritic, hornblende-biotite dacite plug. Vent complex. Mineral pair (#31).

(biotite) 9.9 ± 0.5 Ma

33. *86SG-8A* conventional K-Ar
Lithic-crystal tuff (36°54′15″, 121°13′40″; Mariposa Peak quad., San Benito, CA). *Analytical data:* K_2O = 8.26; $^{40}Ar^*$ mol/gm = 1.10×10^{-10}; $^{40}Ar^*/\Sigma^{40}Ar$ = 53%. *Analyzed by:* D. Vivit and P. Russell. *Collected by:* Sorg. *Comment:* Biotite lithic-crystal tuff of Henrietta Peak.

(biotite) 10.1 ± 0.1 Ma

34. *86SG-9* conventional K-Ar
Dacite (36°54′30″, 121°13′10″; Mariposa Peak quad., San Benito County, CA). *Analytical data:* K_2O = 7.34; $^{40}Ar^*$ mol/gm = 1.06×10^{-10}; $^{40}Ar^*/\Sigma^{40}Ar$ = 40%. *Analyzed by:* D. Vivit and P. Russell. *Collected by:* Sorg. *Comment:* Porphyritic, biotite dacite flow of Henrietta Peak.

(biotite) 10.0 ± 0.2 Ma

35. *84Sg-3* conventional K-Ar
Dacite (36°54′30″, 121°12′30″; Mariposa Peak quad., San Benito County, CA). *Analytical data:* K_2O = 6.63; $^{40}Ar^*$ mol/gm = 1.22×10^{-10}; $^{40}Ar^*/\Sigma^{40}Ar$ = 38%. *Analyzed by:* S. Pribble and P. Russell. *Collected by:* Sorg. *Comment:* Porphyritic, biotite dacite intrusive. Vent complex.

(biotite) 9.8 ± 0.4 Ma

36. *84SG-8(H)* conventional K-Ar
Rhyodacite (36°55′30″, 121°11′30″; Mariposa Peak quad., Merced County, CA). *Analytical data:* K_2O = 0.50; $^{40}Ar^*$ mol/gm = 7.36×10^{-12}; $^{40}Ar^*/\Sigma^{40}Ar$ = 11%. *Analyzed by:* S. Pribble and P. Russell. *Collected by:* Sorg. *Comment:* Porphyritic, hornblende rhyodacite intrusive. Mineral pair, biotite 9.5 Ma (#40).

(hornblende) 10.1 ± 0.5 Ma

37. *84SG-8(B)* conventional K-Ar
Rhyodacite (36°55′30″, 121°11′30″; Mariposa Peak quad., Merced County, CA). *Analytical data:* K_2O = 8.54; $^{40}Ar^*$ mol/gm = 1.17×10^{-10}; $^{40}Ar^*/\Sigma^{40}Ar$ = 33%. *Analyzed by:* S. Pribble and P. Russell. *Collected by:* Sorg. *Comment:* Porphyritic, hornblende rhyodacite intrusive. Mineral pair, hornblende 10.1 Ma (#39).

(biotite) 9.5 ± 0.4 Ma

38. *85-SG-10* conventional K-Ar
Basalt (37°03′30″, 121°09′30″; Pacheco Pass quad., Merced County, CA). *Analytical data:* K_2O = 0.83; $^{40}Ar^*$ mol/gm = 1.07×10^{-11}; $^{40}Ar^*/\Sigma^{40}Ar$ = 36%. *Analyzed by:* D. Vivit and P. Russell. *Collected by:* Sorg. *Comment:* Basalt flow of Dinosaur Point. Basalt at San Luis Reservoir.

(whole rock) 9.0 ± 0.1 Ma

39. *89SGPP-45A* conventional K-Ar
Basalt (37°03′30″, 121°09′30″; Pacheco Pass quad., Merced County, CA). *Analytical data:* K_2O = 1.13; $^{40}Ar^*$ mol/gm = 1.28×10^{-11}; $^{40}Ar^*/\Sigma^{40}Ar$ = 61%. *Analyzed by:* S. Pribble and P. Russell. *Collected by:* Sorg. *Comment:* Basaltic vent of Dinosaur Point. Basalt at San Luis Reservoir.

(whole rock) 7.9 ± 0.2 Ma

40. *88SGBH-4A* conventional K-Ar
Lithic tuff (37°01′30″, 121°06′00″; San Luis Dam quad., Merced County, CA). *Analytical data:* K_2O = 6.92; $^{40}Ar^*$ mol/gm = 8.26×10^{-11}; $^{40}Ar^*/\Sigma^{40}Ar$ = 47%. *Analyzed by:* S. Pribble and P. Russell. *Collected by:* Sorg. *Comment:* Basalt andesitic lithic-crystal tuff of Basalt Hill. Basalt at San Luis Reservoir.

(biotite) 8.3 ± 0.1 Ma

41. *85-SG-8* conventional K-Ar
Basalt (37°01′30″, 121°05′45″; San Luis Dam quad., Merced County, CA). *Analytical data:* K_2O = 0.96; $^{40}Ar^*$ mol/gm = 1.02×10^{-11}; $^{40}Ar^*/\Sigma^{40}Ar$ = 15%. *Analyzed by:* D. Vivit and P. Russell. *Collected by:* Sorg. *Comment:* Upper basalt flow of Basalt Hill, San Luis Reservoir.

(whole rock) 7.4 ± 0.2 Ma

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