$^{40}Ar/^{39}Ar$ geochronology of basaltic rocks and constraints on late Cenozoic stratigraphy and landscape development in the Red Hill-Quemado area, New Mexico

William C. McIntosh and Steven M. Cather

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$^{40}Ar/^{39}Ar$ GEOCHRONOLOGY OF BASALTIC ROCKS AND CONSTRAINTS ON LATE CENOZOIC STRATIGRAPHY AND LANDSCAPE DEVELOPMENT IN THE RED HILL-QUEMADO AREA, NEW MEXICO

WILLIAM C. MCINTOSH and STEVEN M. CATHER
New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico 87801

Abstract—Basaltic samples from the Red Hill-Quemado volcanic field of New Mexico and the White Mountains field of Arizona were dated by the $^{40}Ar/^{39}Ar$ incremental heating method to aid mapping and interpretation of the upper Tertiary sedimentary and volcanic rocks. The samples included 15 basaltic lavas, one volcanic bomb, and two shallow intrusive units. Step heating of groundmass concentrates from 17 of the samples yielded relatively flat age spectra from which accurate plateau or isochron ages could be determined. These results indicate two intervals of eruptive activity: 7.9-5.2 Ma and 2.5 Ma-71 ka. Vents for the late Miocene lavas define a narrow ENE-trending zone subparallel to the Jemez lineament. Vents for the late Pliocene-Pleistocene lavas occupy a broad N-S trending zone, within which $^{40}Ar/^{39}Ar$ results indicate south-to-north migration of volcanic activity. Late Pleistocene centers, including Red Hill (71 ka) and Zuni Salt Lake (86-114 ka), are confined to the northern end of the zone of Plio-Pleistocene activity; it is likely that future eruptions will occur in this area. Based in part on the ages reported here, several episodes of middle to late Cenozoic erosion and sedimentation can be discerned. The Red Hill-Quemado area aggraded until the end of Mogollon-Datil volcanism, about 24-26 Ma. The ensuing degradational regime continued until <14.5 Ma, when aggradation of the Fence Lake Formation began, and continued until about 7 Ma, although cutting and filling of local insets within the Fence Lake may have continued until about 5 Ma. Local late Miocene basaltic volcanism accompanied the waning stages of Fence Lake sedimentation. Post-Fence Lake erosion continued until 3-4 Ma, when aggradation of the Quemado Formation began. The end of Quemado deposition appears to have been diachronous, possibly ending about 4 Ma near Springerville, Arizona, about 2.5 Ma near Cow Springs Draw in western New Mexico, and <1 Ma near Red Hill, New Mexico. Late Pliocene-Pleistocene volcanism occurred during and after Quemado sedimentation. A regime of fluvial degradation has prevailed in most areas since the end of Quemado deposition.

INTRODUCTION

The Red Hill-Quemado volcanic field of western New Mexico (Fig. 1) is one of a series of late Cenozoic volcanic fields that define the Jemez lineament (Mayo, 1958; Aldrich, 1986). The Red Hill-Quemado field is probably the least studied of the volcanic fields along the Jemez lineament. Previous investigations of the late Cenozoic geology and volcanology were largely reconnaissance (Willard and Weber, 1958; Crumpler and Aubele, 1990; Chamberlin et al., 1994). The only detailed studies are those of Hoffer and Corbitt (1989), who described the volcanology of the Quemado crater, and Baldridge et al. (1989) who reported several K-Ar ages for Tertiary volcanic rocks in the Red Hill-Quemado area. Geothermal data and some additional K-Ar results were reported by Minier et al. (1988). No systematic investigation of the petrology or geochemistry of the volcanic rocks has yet been attempted. This preliminary report integrates $^{40}Ar/^{39}Ar$ ages for late Cenozoic volcanic rocks of the Red Hill-Quemado field with the sedimentologic history and landscape development recently elucidated by reconnaissance mapping by Chamberlin et al. (1994) and by geological reconnaissance in eastern Arizona by the junior author.

DATING METHODS

Hand samples, typically 1-2 kg of unweathered lava, were collected from 18 localities. Wherever possible, samples were collected from holocrystalline flow interiors, avoiding glassy, vesicular, or brecciated flow margins or areas of hydrothermal alteration. Groundmass concentrates of samples were prepared by crushing, then sieving to 250-500 μm. After ultrasonic cleaning in dilute nitric acid and removal of phenocrysts by Frantz magnetic separator and hand picking, 40-60 mg aliquots of concentrate were packaged in tinfoil and sealed in quartz irradiation tubes with alternating flux monitors of Fish Canyon Tuff sanidine (27.84 Ma). The sample-filled quartz tubes were then irradiated for one to five hours in the L67 position of the Ford reactor at the University of Michigan.

Analyses were performed at the New Mexico Geochronology Research Laboratory at New Mexico Tech in Socorro, New Mexico.

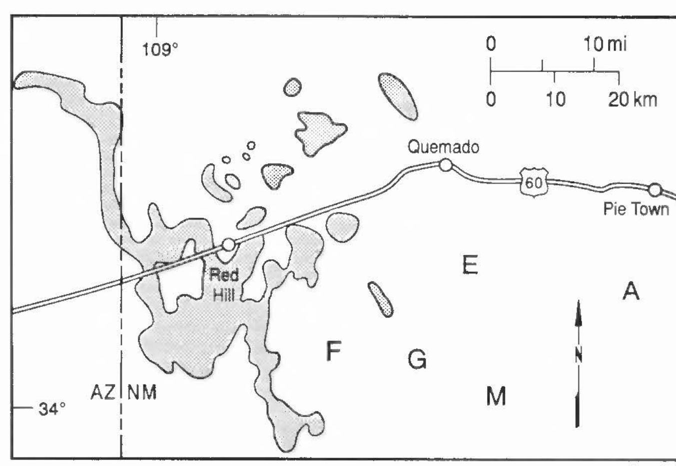


FIGURE 1. Map showing generalized distribution of late Miocene to Pleistocene volcanic rocks in the Red Hill-Quemado volcanic field and selected landforms, after New Mexico Geological Society (1982) and Reynolds (1988). **A**, Alegres Mountain; **E**, Escondido Mountain; **M**, Mangas Mountains; **G**, Gallo Mountains; **F**, Fox Mountain.

This facility includes an MAP 215-50 mass spectrometer attached to a computer-automated all-metal argon extraction line. Monitor sanidines were fused by CO_2 laser for 15 seconds, and reactive gases were removed using a SAES GP-50 getter prior to expansion into the mass spectrometer. Extraction line blanks during these laser analyses ranged from 5 x 10^{-17} to 2 x 10^{-16} moles ^{40}Ar and 5 x 10^{-19} to 2 x 10^{-18} moles ^{36}Ar. The pooled results of four three-to-four crystal subsamples (approximately 1 mg) of each monitor allowed the neutron flux (J-values) along the irradiation tubes to be determined to a precision of ±0.25%. A double-vacuum resistance furnace was used to heat the unknown samples. Samples were preheated to 500°C to degas the tin foil package, and then samples were incrementally heated in eight to ten steps from 650°C to 1650°C. Heating times of eight to ten minutes were followed by five to ten minutes of cleanup with SAES AP-10 and GP-50 getters. Data from each heating step were corrected for extraction line blank, which for furnace analyses ranged from 3 x10^{-16} to 3 x 10^{-15} moles ^{40}Ar and from 2 x 10^{-18} to 9 x 10^{-18} moles ^{36}Ar.

RESULTS

Results of step-heating analyses from each sample are displayed as age spectra in Appendix 1, are detailed in Appendix 2, and ages are summarized in Table 1. Age spectra are accompanied by plots of apparent K/Ca (a function of measured ^{37}Ar/^{39}Ar) and radiogenic yield (the percent of measured ^{40}Ar that cannot be attributed to trapped argon of atmospheric composition, i.e. ^{40}Ar/^{36}Ar=295.5).

Of the 18 samples analyzed (Table 1, Appendix 1), ten yielded age spectra that satisfy age "plateau" criteria of three or more contiguous steps, totaling more than 50% of ^{39}Ar released, that agree within analytical error at the 95% confidence level. With the exception of some low-temperature or high-temperature steps with large uncertainties related to low radiogenic yield and low signal-to-blank ratios (e.g. Appendix 1: 2b), most individual steps have analytical uncertainties of approximately ±10-50 ka (1σ). Plateau ages were calculated for each of these ten samples by weighting steps by the inverse of their variance (Appendix 1, 2).

Seven samples have age spectra with relatively flat segments which approach, but do not meet plateau criteria. Of these samples, two (nm1158, Appendix 1:d; nm1108, Appendix 1:h) gave spectra with flat segments constituting less than 50% of the ^{39}Ar released and the rest yielded spectra with central segments that are slightly climbing (nm1160, Appendix 1:k) or falling (nm1111, Appendix 1:j; nm1159, Appendix 1:n; SMC-1, Appendix 1:p; SMC-5, Appendix 1:q). These slightly disturbed spectra may be related to alteration, interstitial glass, or minor recoil of ^{39}Ar from fine-grained groundmass minerals during irradiation. For each of the seven samples that have slightly disturbed spectra, mean ages were calculated as the inverse-variance-weighted average of the heating steps that comprise the nearly flat parts of the age spectra. Sample nm1155 (Appendix 1:e) yielded a highly disturbed spectrum that fell far short of meeting plateau criteria; this sample is rejected from further consideration other than as indicating an approximate age near 1.0 Ma.

The K/Ca and radiogenic-yield plots show common behavior. Typically, radiogenic yields start low, increase to maxima at heating steps of 800-1000°C, then decrease at higher temperatures (Appendix 1). K/Ca ratios generally decline steadily with increasing step-heating temperatures. These behaviors are probably related to initial degassing of atmospheric contamination from interstitial glass and intergrain boundaries, followed by degassing dominated by groundmass plagioclase, and ending with increasing degassing of retentive, low-K groundmass pyroxene. This behavior of radiogenic yield and K/Ca ratios during step heating, as well as the general form of the age spectra, are similar to results reported from young alkali basalts elsewhere (e.g. Laughlin et al., 1993).

The age spectra in Appendix 1 are accompanied by inverse isochron diagrams, which offer an alternative means of calculating ages from step-heating data, as well as a means of testing the assumption, implicit in the apparent ages presented in each age spectrum, that trapped, non-radiogenic argon components have atmospheric composition (^{40}Ar/^{36}Ar = 295.5). The isochron ages for all samples are within 1 σ of the plateau age or the mean age of near-plateau steps. Mean standard weighted deviation (MSWD) values for the isochrons range from 1.2 to 11.4 for the samples that satisfied plateau criteria and from 2.8 to 44.7 for the samples which nearly satisfy plateau criteria (Appendix 1, 2). These relatively high MSWD values indicate that much of the scatter cannot be attributed solely to analytical error, and may reflect minor alteration or heterogeneous trapped initial argon compositions. ^{40}Ar/^{36}Ar intercept values range from 290 to 300, but most are not significantly different (±2 σ) from atmospheric argon. These isochron results indicate that excess argon is not a significant problem, and support the interpretation that the plateau ages, mean ages of near-plateau steps, or isochron ages represent the time of crystallization of the sampled units.

Our ^{40}Ar/^{39}Ar results are in reasonable accord with K-Ar data reported by Baldridge et al. (1989) and Dethier et al. (1986), which include late Miocene 6.4-6.7-Ma ages for mesa-capping basaltic lavas in the Quemado-Red Hill volcanic field. Our results are also in accord with the K-Ar results for older basalts of Minier et al. (1988), who similarly indicated late Miocene 5.7-6.7-Ma ages for some of the mesa-capping lavas. Minier et al. (1988), however, indicated mid-Pleistocene (1.03 ± 0.27 to 1.23 ± 0.23 Ma) ages for Red Hill and Blaines Lake lavas, in

TABLE 1. Summary of ^{40}Ar/^{39}Ar ages for Red Hill-Quemado volcanic rocks.

Unit	Sample #	Age Type	Age (Ma)	± Err(1s)
lava, Red Hill cinder cone	nm1161	plateau	0.071	0.012
ring intrusive, Zuni Salt Lake	nm1107	plateau	0.086	0.031
bomb, Zuni Salt Lake	nm1106	plateau	0.114	0.038
lava, hornito fissure, NE of Blaines Lake	nm1158	isochron	0.206	0.034
lava, overlying Quemado Fm., Ponderosa Tank quad	nm1155	disturbed spectrum	ca. 1.0	
lava, interbedded with Quemado Fm., E of Blaines Lake	nm1157	plateau	0.970	0.014
lava, interbedded with Quemado Fm., Rt. 60, SE of Blaines Lk.	nm1156	plateau	1.51	0.01
lava, wall of Quemado Crater	nm1108	isochron	1.55	0.01
lava, S of Cerro la Mula	nm1110	plateau	1.95	0.05
lava, N of Mangitas Flat, Black Peak quad	nm1111	isochron	2.05	0.02
lava, overlying Bidahochi Fm., N of Mesa Parada, AZ	nm1160	isochron	2.37	0.03
lava, overlying Quemado Fm., US 60, E of NM/AZ border	SMC-3	plateau	2.46	0.04
lava, interbedded in Fence Lake Fm., US 60, W of Red Hill	SMC-2	plateau	5.20	0.03
lava, mesa capping, N of Blaines Lake	nm1159	isochron	6.08	0.04
lava, capping SW edge of Cimarron Mesa	SMC-4	plateau	6.05	0.02
lava, overlying Fence Lake Fm., E of Cow Springs Draw	SMC-1	isochron	6.03	0.02
lava, Flat Top, S of Springerville, AZ (White Mountains field)	SMC-5	isochron	6.80	0.02
intermediate intrusive body, El Portocito	nm1104	plateau	7.92	0.20

sharp contrast to our ages at 0.07 ± 0.01 and 0.206 ± 0.03 Ma, respectively. We cannot offer a specific explanation for why these K-Ar data differ so much from the $^{40}Ar/^{39}Ar$ results for the young basalts, but note that the $^{40}Ar/^{39}Ar$ method is inherently more precise than K-Ar, offers means of testing whether Ar systematics have been disturbed (e.g. excess argon and argon loss), and has in numerous studies been shown to be more accurate than K-Ar for dating of volcanic rocks (e.g. McIntosh et al., 1990). Based on the observed discordance with our $^{40}Ar/^{39}Ar$ results, we regard the younger (Plio-Pleistocene) ages reported by Minier et al. (1988) as incorrect.

CONSTRAINTS ON STRATIGRAPHY AND LANDSCAPE DEVELOPMENT

Table 1 and Figure 2 summarize results for the 17 Red Hill-Quemado samples discussed above; the plateau ages are considered best estimates of eruptive age for the ten samples that satisfy plateau criteria, and isochron ages are used for the seven samples that closely approach plateau criteria. These ages range from 7.92 Ma to 71 ka and fall into two distinct eruptive intervals: 7.9-5.2 Ma and 2.5 Ma–71 ka. The volcanic rocks within these two eruptive intervals occupy distinct landscape positions within the study area and constrain the timing of episodes of erosion and sedimentation.

In the area south of Quemado, the topographically highest landforms (Alegres Mountain, Escondido Mountain, Mangas Mountain, Gallo Mountains, Fox Mountain; Fig. 1) consist of an aggradational sequence of mid-Tertiary volcanic and volcaniclastic rocks in the northwest part of the Mogollon-Datil volcanic field that are locally as young as 24-26 Ma (Bearwallow Mountain Andesite). In the topographically lower areas to the north, near US-60 in western New Mexico and eastern Arizona, dated basalts of late Miocene age (7.9-5.2 Ma) cap many of the topographically most prominent landforms. These landforms include Flat Top, Cimarron Mesa, Tejana Mesa, and the unnamed mesa east of Cow Springs Draw (Figs. 3, 4). Basalts capping other high mesas in the area (Mesa Redonda, unnamed mesas west of Tejana Mesa) have not yet been dated, but appear to be correlative with the dated upper Miocene basalts on the basis of concordance of elevation, flow thickness and hand-specimen petrology. The upper Miocene basalts generally overlie the Fence Lake Formation, and thus constrain its upper age limit (about 5-7 Ma). The lower age limit of the Fence Lake is about 14.5 Ma or younger, based on vertebrate remains (Lucas and Anderson, this volume). Possible inset relations within the Fence Lake are indicated by the landscape position of a 5.2-Ma basalt within the Fence Lake Formation west of Red Hill Draw (Fig. 3).

The Plio-Pleistocene basalts (2.5 Ma-71 Ka) occupy landscape positions inset below the late Miocene basalts (Fig. 4), but above the level of the modern drainages. Two basalt flows in eastern Arizona near Nutrioso Creek (Fig. 4) were K-Ar dated by Laughlin et al. (1979, 1980) at 3.87 and 3.67 Ma. These flows are topographically

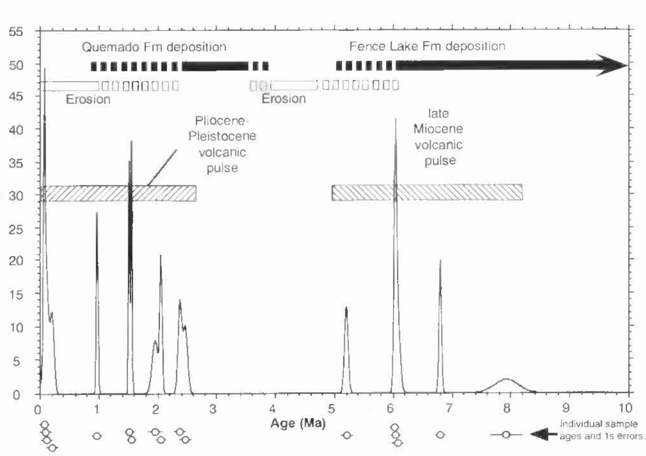


FIGURE 2. Ideogram showing age distribution of dated samples and inferences about timing of volcanic activity, aggradation and erosion.

lower than, and apparently inset against, the 6.80-Ma basalt that caps nearby Flat Top.

Plio-Pleistocene basalts locally interfinger with and cap the Quemado Formation (Cather and McIntosh, this volume). At the type section in the Cow Springs Basin, the Quemado is capped by Pliocene basalt (about 2.5 Ma). In the Nutrioso Basin of eastern Arizona, thin gravelly sequences possibly correlative with the Quemado are capped by lower Pliocene basalt (3.87-3.67 Ma, Fig. 4). In the Red Hill Basin east of Cimarron Mesa, the Quemado Formation is interbedded with basalts as young as 0.970 Ma (Fig. 4), significantly younger than in basins to the west. In the Largo Basin, the Quemado can only be constrained to be younger than the 6.73 ± 0.18 Ma basalt that caps Tejana Mesa (K-Ar date of Dethier et al., 1986). The age of the Quemado in the Omega Basin to the east is poorly constrained due to lack of fossils or interbedded lavas.

Based on the relationships summarized above, it is apparent that a regime of net degradation, punctuated by at least two episodes of fluvial aggradation, has prevailed in western New Mexico and eastern Arizona since the late Oligocene. Initial degradation began after eruption of the Bearwallow Mountain Andesite (24-26 Ma), and continued until aggradation of the Fence Lake Formation began sometime after 14.5 Ma. Culminal aggradation of the Fence Lake occurred about 7 Ma, although local cutting and filling of insets within the Fence Lake may have continued until about 5 Ma (Fig. 4), when regional degradation continued following the cessation of late Miocene volcanism. Aggradation again ensued at 3-4 Ma, resulting in deposition of the Quemado Formation within incised paleovalley/basin systems. Quemado deposition ceased diachronously from west to east, ending about 4 Ma for possible Quemado correlatives near Springerville, about 2.5 Ma for the Quemado in the Cow Springs Basin, and <1 Ma for Quemado deposits in the Red Hill Basin. Age constraints for the cessation of Quemado deposition in the Largo Basin and the Omega Basin are lacking. The apparent easterly decrease in the age of Quemado deposition may be due to the proximity of the western outcrops to the trunk stream of the Little Colorado River, where headward migration of erosion and degradation may have been manifested earlier than in the more distal basins to the east. Alternatively, disruption of drainage by voluminous late Pliocene-Pleistocene volcanism in the Cow Springs and Red Hill Basins may have prolonged deposition in these areas. A degradational regime continues today in most areas; the youngest dated flows in the area (Red Hill flow, 71 ka; unnamed flow north of Blaines Lake, 206 ka) are topographically a few meters higher than modern drainages.

SPACE-TIME VARIATIONS IN MAGMATISM

In their reconnaissance mapping of the Quemado 30'x 60' quadrangle, Chamberlin et al. (1994) recognized over 40 volcanic vents of late Cenozoic age. These vents are restricted to the Red Hill-Quemado field in the western part of the quadrangle, between Quemado and the New Mexico-Arizona state line (Fig 5). We divide these vents into two groups (late Miocene and Plio-Pleistocene) on the basis of radioisotopic constraints on vents or associated lavas, or by topographic and petrologic correlation with adjacent, dated flows. The late Miocene vents are restricted to a strikingly narrow and linear zone, which begins at Tejana Mesa and Cerro Prieto (a volcanic neck about 13 km north of Tejana Mesa, dated 6.0 ± 0.5 Ma [K-Ar, Baldridge et al., 1989] and 5.98 ± 0.14 [K-Ar, Minier et al., 1988]) and extends southwestward toward the late Miocene eruptive centers in the White Mountains of Arizona (Merrill and Péwé, 1977). About half of the late Miocene vents are closely associated with known faults or fracture zones. No age trends are apparent within the late Miocene vent zone.

Plio-Pleistocene vents occupy a broad zone that trends southward from an apex near Zuni Salt Lake (Fig. 5) to an ill-defined terminus in the area south of Black Peak. The Plio-Pleistocene vent zone is much broader than, and trends athwart, the late Miocene vent zone. Although several Plio-Pleistocene vents are closely associated with fracture systems, the Plio-Pleistocene vents are not as closely associated with known fractures as are the late Miocene vents. In contrast to the late Miocene eruptive centers, Plio-Pleistocene vents become distinctly

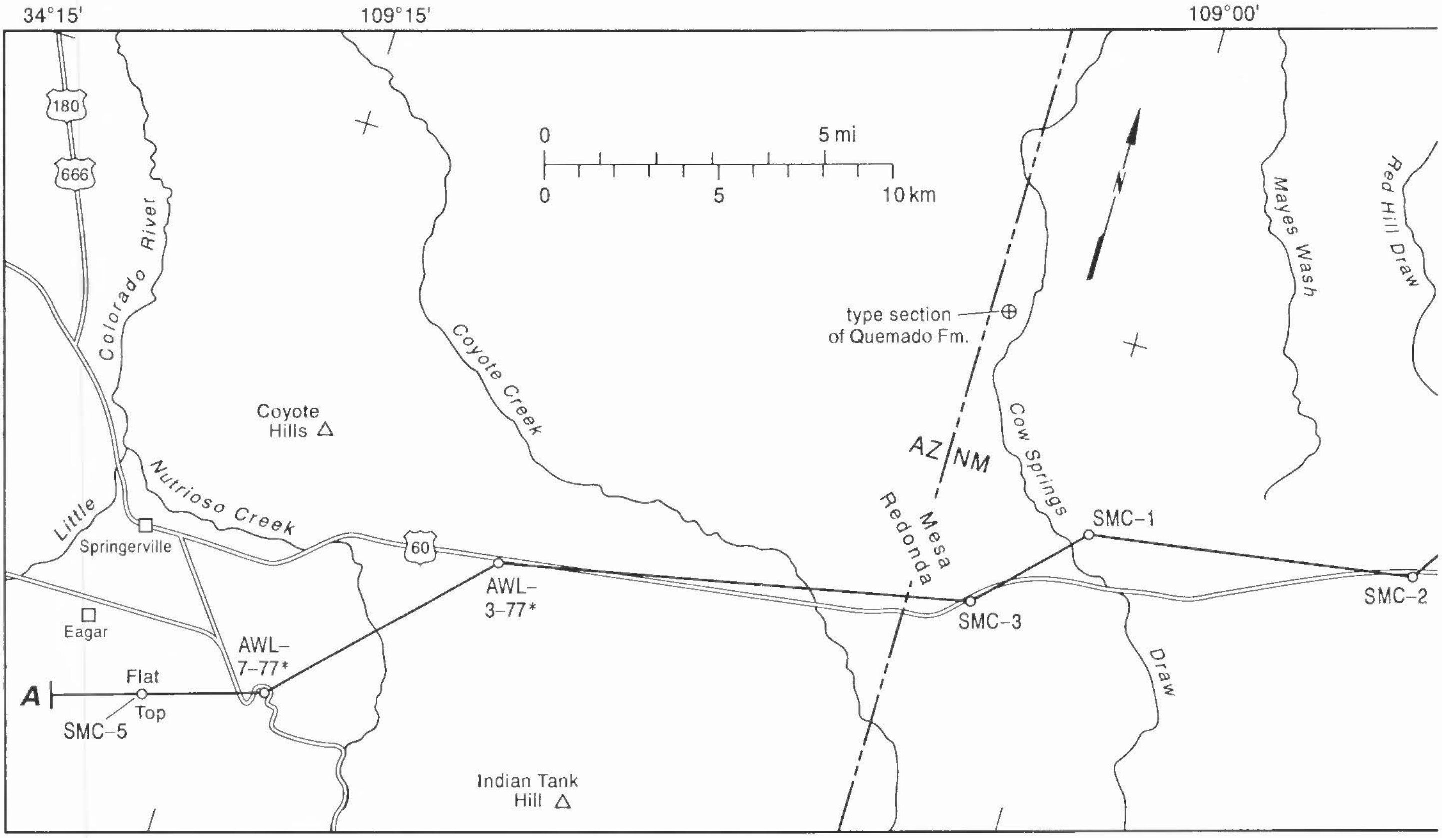


FIGURE 3. Map showing selected drainages and landforms in west-central New Mexico and eastern Arizona, sample numbers and locations, and location of cross section A-A' (Fig. 4). All sample localities are from this study except * = Laughlin et al. (1979), 1980; ** = Dethier et al. (1986).

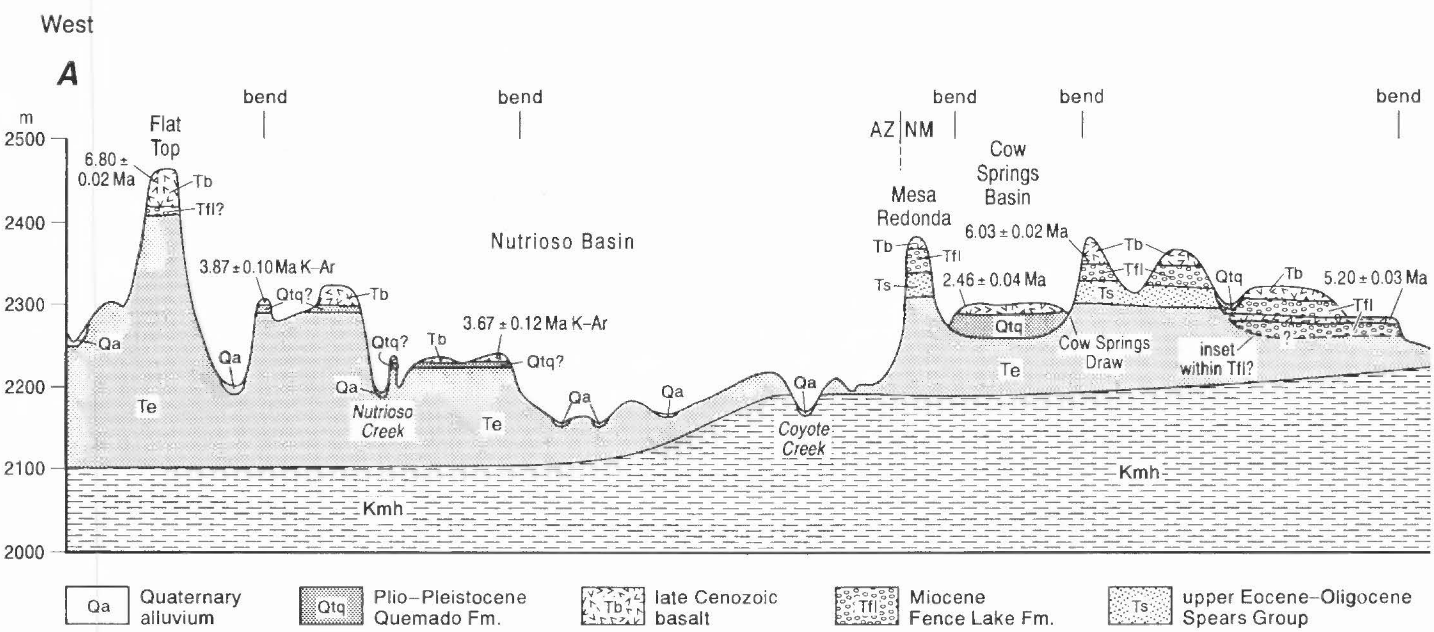
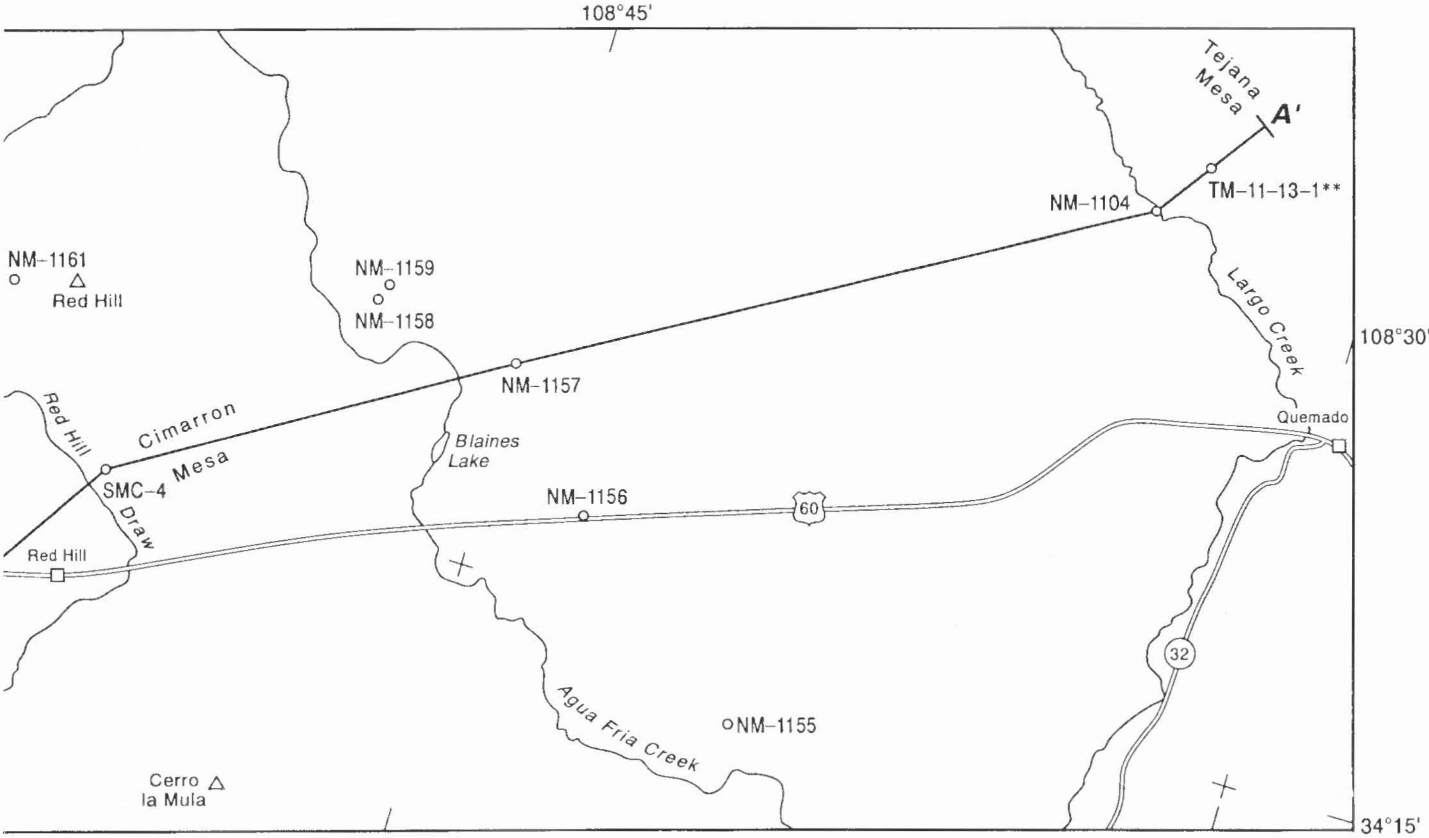
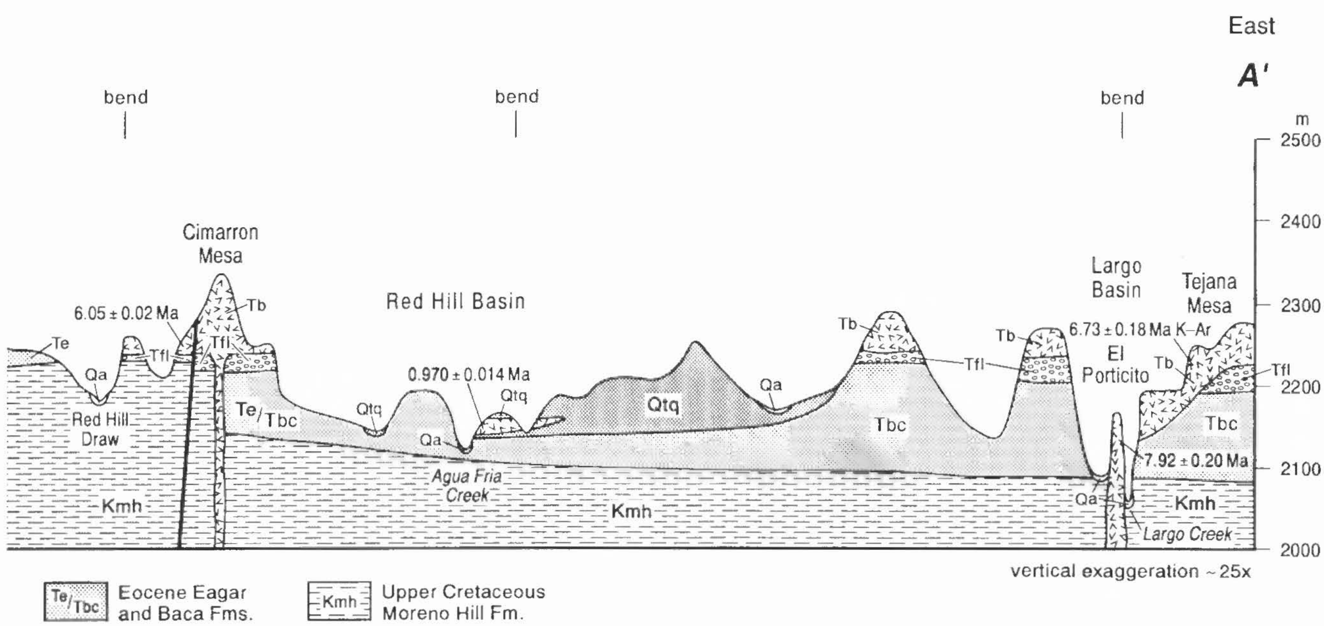


FIGURE 4. Cross section A-A' showing stratigraphy and landscape positions of dated basalts. Location of cross section shown in Figure 3. Geology based on Chamberlin et al. (1994) and on reconnaissance in Arizona by junior author. All depicted dates are from this study except the 3.87 Ma and 3.67 Ma dates (K-Ar) near Nutrioso Creek (Laughlin et al., 1979, 1980) and the 6.73 Ma date (K-Ar) on Tejana Mesa (Dethier et al., 1986).


108°45'
Tejana Mesa
A'
TM-11-13-1**
NM-1104
NM-1161
Red Hill
NM-1159
NM-1158
Largo Creek
108°30'
NM-1157
Red Hill
Cimarron Mesa
Blaines Lake
Quemado
SMC-4
Draw
NM-1156
60
Red Hill
32
Agua Fria Creek
NM-1155
Cerro la Mula
34°15'


East
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2100
2000
Cimarron Mesa
Red Hill Basin
Largo Basin
Tejana Mesa
6.05 ± 0.02 Ma
Te
Tb
Tfl
Qa
Red Hill Draw
Te/Tbc
0.970 ± 0.014 Ma
Qtq
Qtq
Qa
Agua Fria Creek
Kmh
Kmh
Tb
Tfl
Tb
6.73 ± 0.18 Ma K-Ar
El Porticito
Tbc
Tbc
7.92 ± 0.20 Ma
Largo Creek
vertical exaggeration ~25x
Te/Tbc Eocene Eagar and Baca Fms.
Kmh Upper Cretaceous Moreno Hill Fm.

younger to the north. In the southern part of Figure 5 at the latitude of Black Peak, dates range from 1.9 to 2.5 Ma (our sample nm1111; samples 420 and 429 of Baldridge et al., 1989). Plio-Pleistocene basalts at the latitude of US-60 range from 0.97 to 1.95 Ma (our samples nm1155, nm1157, nm1156, nm1108, nm1110). In the northern part of the Plio-Pleistocene vent zone, samples range from 71 ka to 206 ka (our samples nm1161, nm1107, nm1106, nm1158). These age trends and the youthfulness of the northern vents suggest that locus of volcanism is migrating northward and that future eruptions may be expected in this area.

TECTONIC IMPLICATIONS

The late Cenozoic tectonic history of the Red Hill-Quemado area is characterized by extension; all of the faults depicted in Figure 5 are normal. For the purpose of the following analysis, all faults are assumed to be dip-slip. Although no systematic kinematic analysis has been attempted, observations by R. M. Chamberlin (oral commun., 1994) during mapping of the eastern part of the Quemado 30' x 60' quadrangle indicates a dominance of dip-slip on late Cenozoic faults, based on slickenlines and fault offsets on dikes.

Most of the late Cenozoic normal faults in the Red Hill-Quemado area strike northeast (average about N35°E). In contrast, the narrow zone of late Miocene vents trends east-northeast (about N60°E), subparallel to the average trend of the Jemez lineament (N52°E, Laughlin et al., 1982). At least two northeast-striking faults controlled the location of eruptive centers within the late Miocene vent zone; these faults are exposed on Cimarron and Tejana Mesas (Fig. 5). Assuming dip-slip behavior, the en echelon arrangement of faults within the vent zone implies left-oblique transtension across the zone in the late Miocene. The obliquity between the trend of the late Miocene vent zone and the strike of the normal faults within it is similar to the obliquity between orientations of the Jemez lineament and faults in the Zuni-Bandera field (Laughlin et al., 1982).

Obliquity also exists between the northerly trend of the Plio-Pleistocene vent zone and the northeast strike of the faults within it (Fig. 5). If dip-slip is assumed on these en echelon faults, then the Plio-Pleistocene vent zone comprised an area of right-oblique transtension. Although volcanic rocks within the vent zone become younger to the north, a similar trend for ages of faulting is not apparent. Indeed, the most youthful-appearing fault scarps occur in the central part of the Plio-Pleistocene vent area, near Quemado crater and Cerro la Mula.

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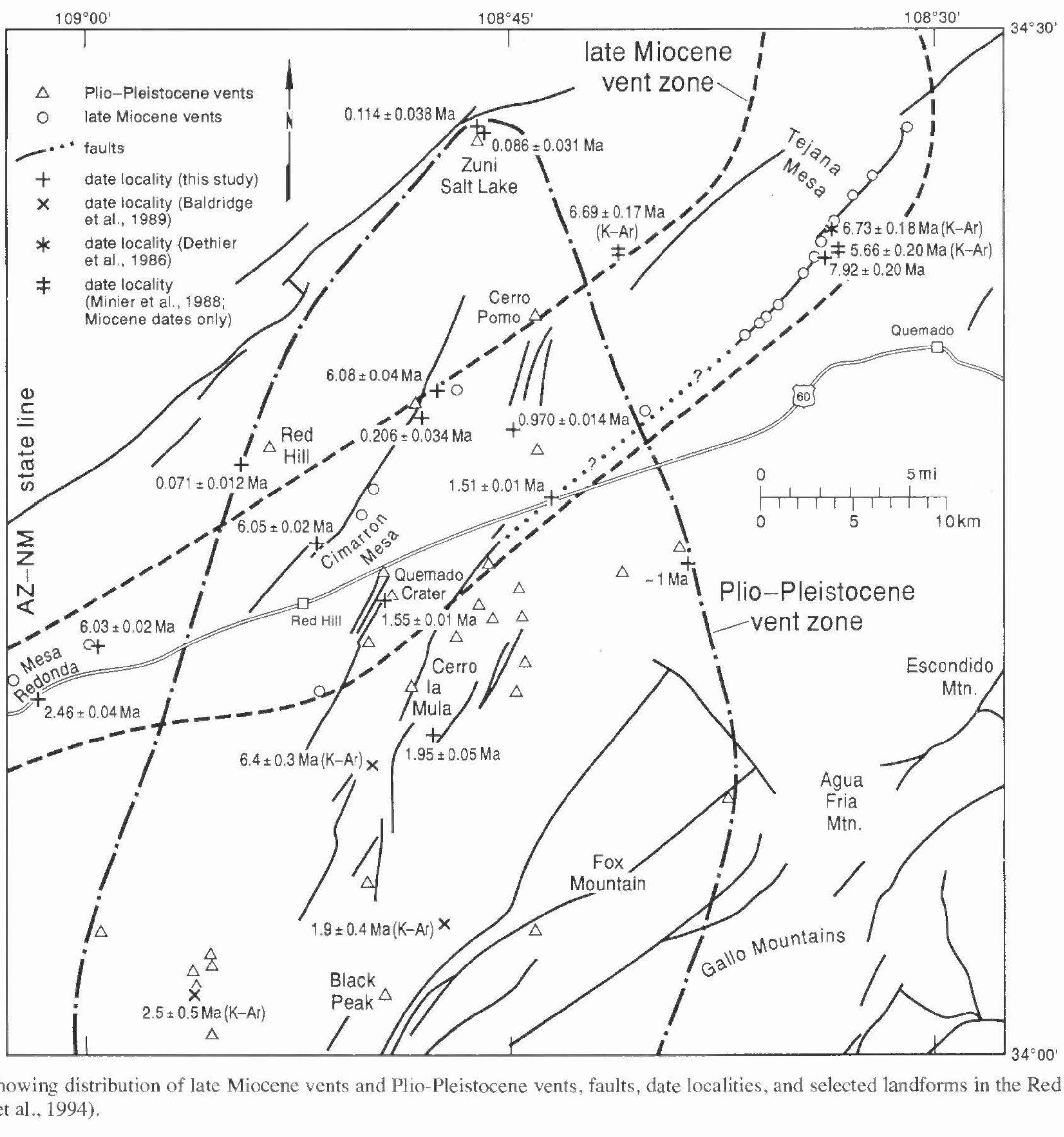

FIGURE 5. Map showing distribution of late Miocene vents and Plio-Pleistocene vents, faults, date localities, and selected landforms in the Red Hill-Quemado area (after Chamberlin et al., 1994).

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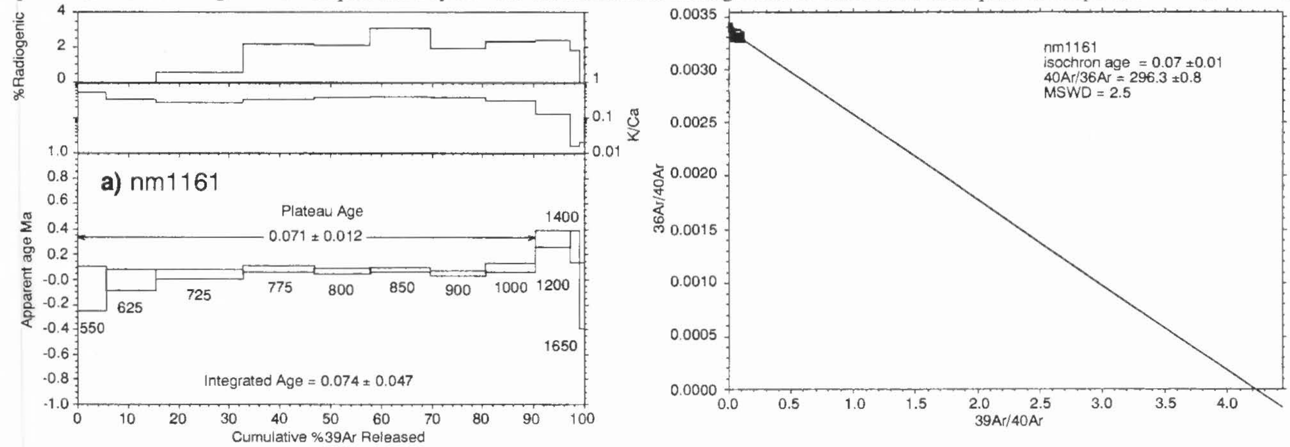
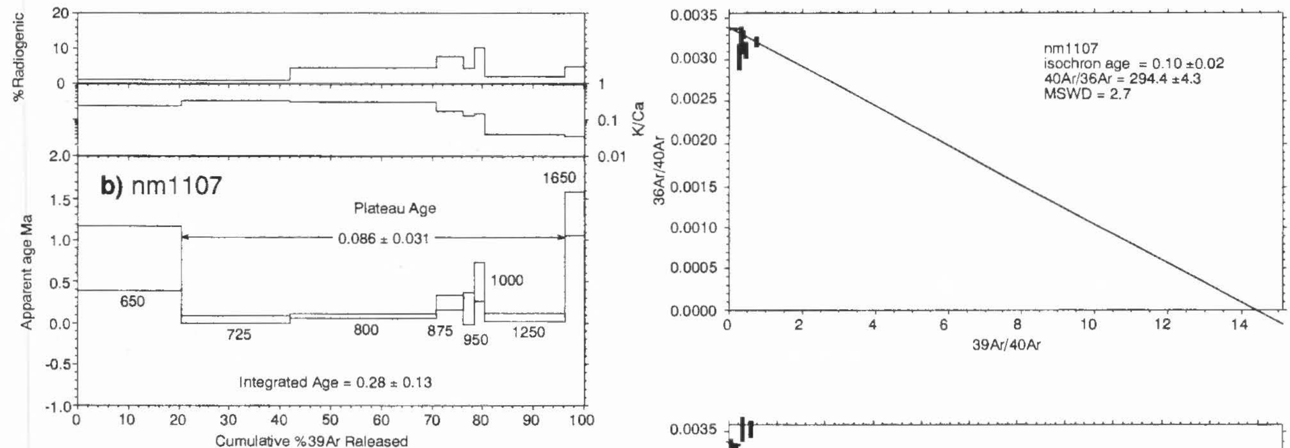
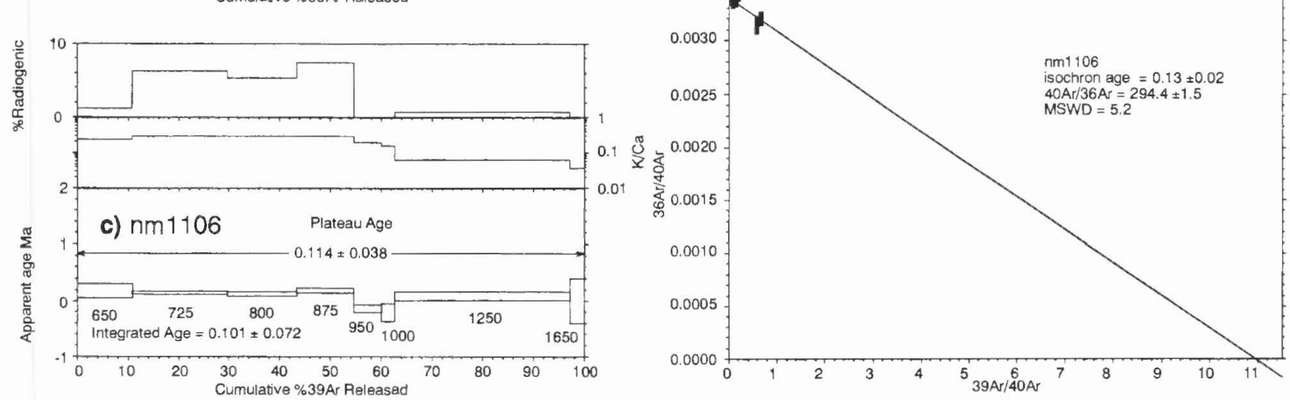
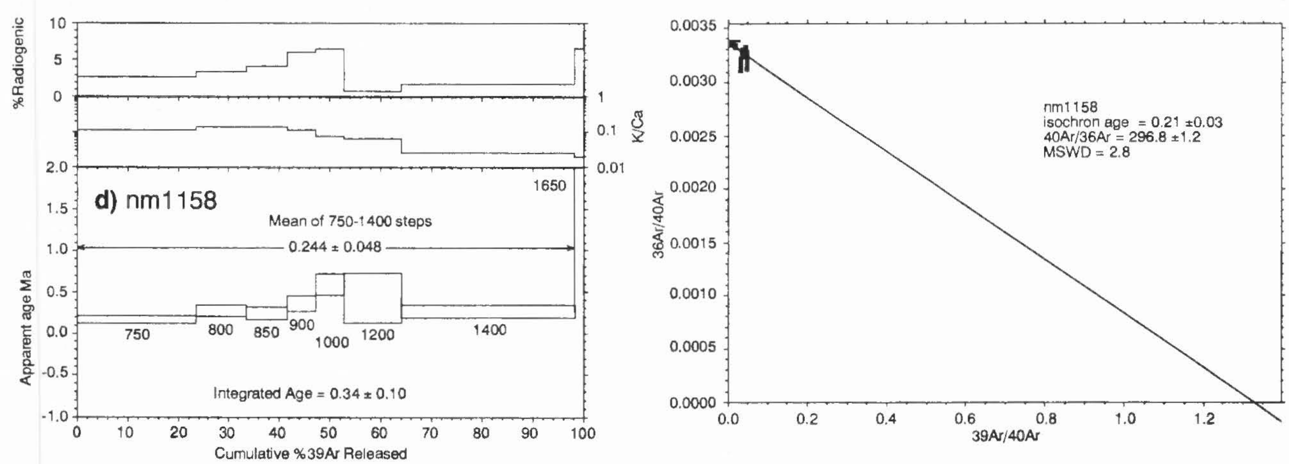
APPENDIX 1

Age spectra and isochron diagrams for samples dated by the $^{40}Ar/^{39}Ar$ incremental heating method. Letters a to r correspond to sample number 1 to 18 in Table 1.









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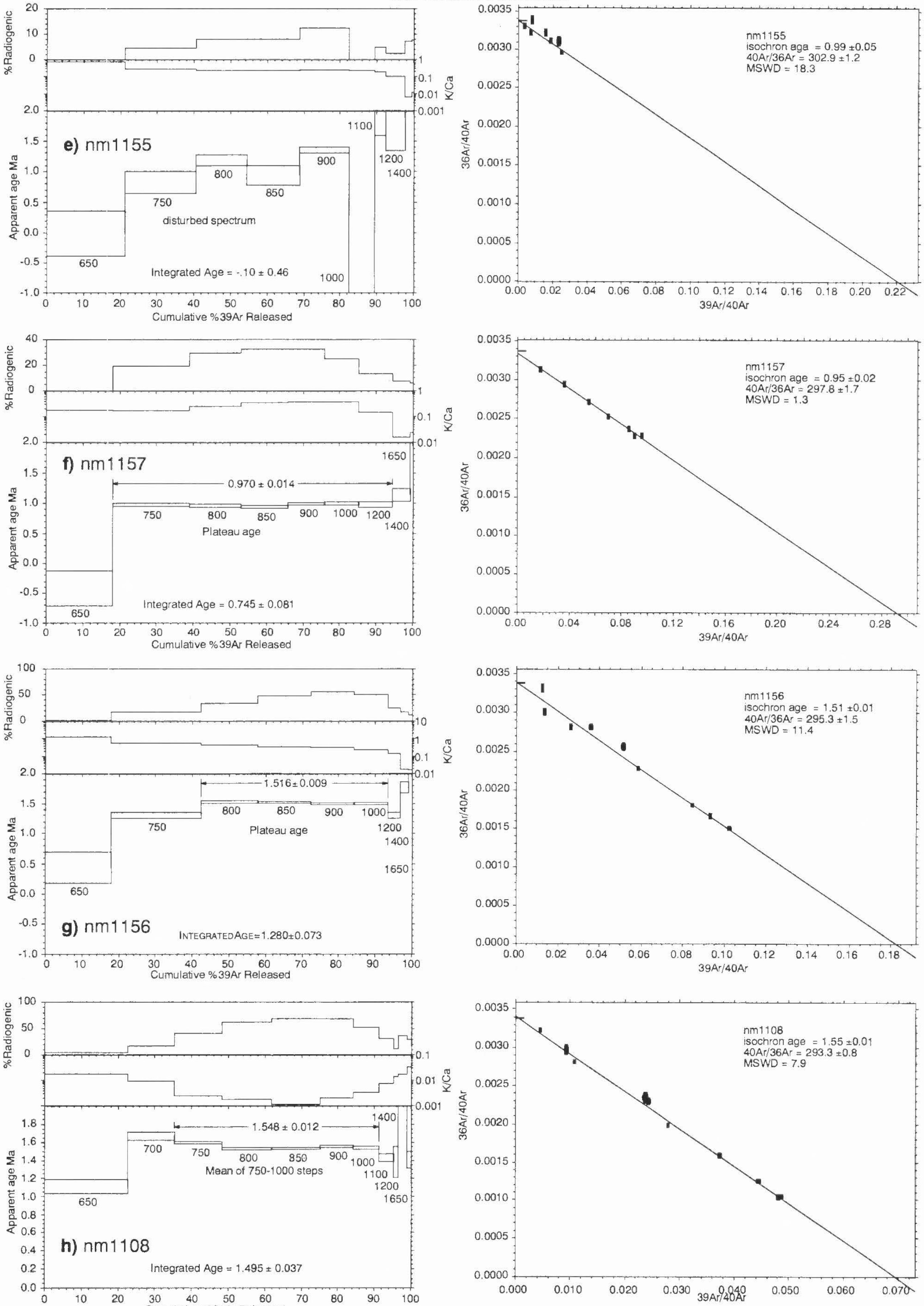

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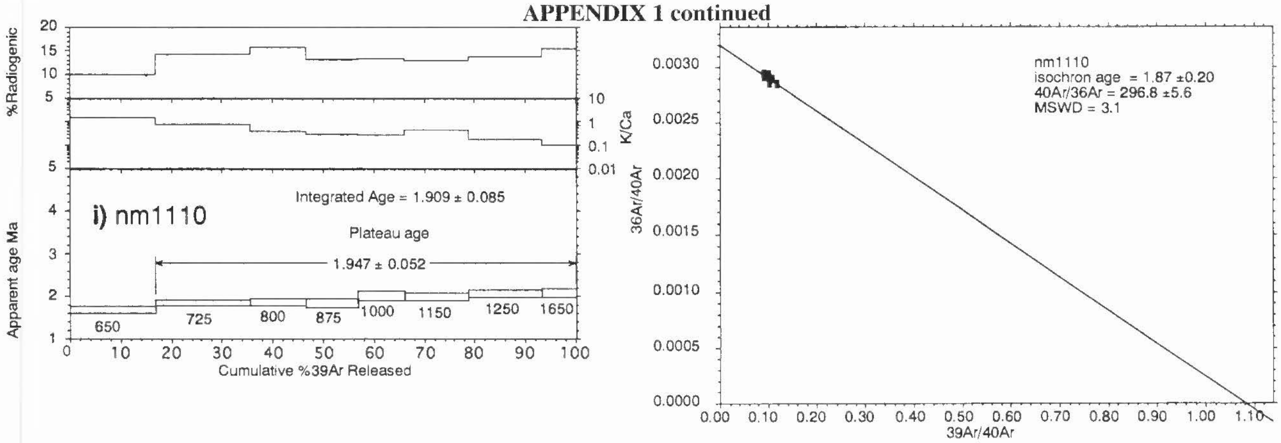

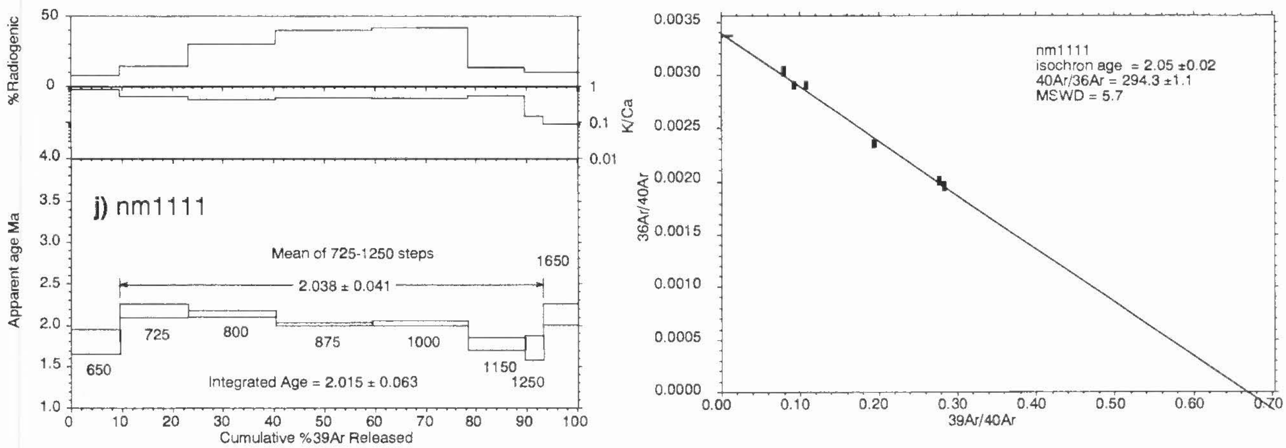

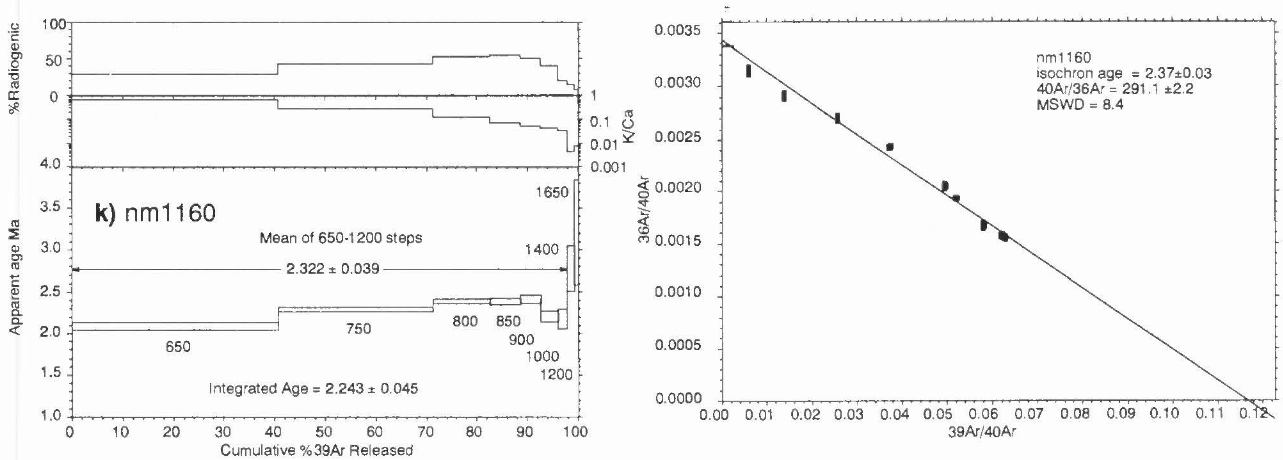

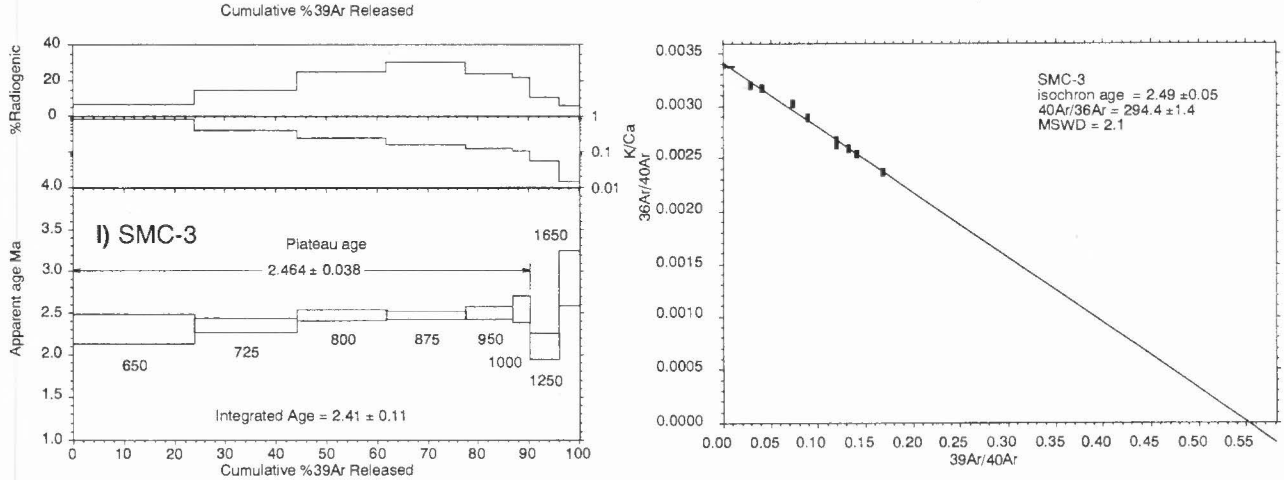

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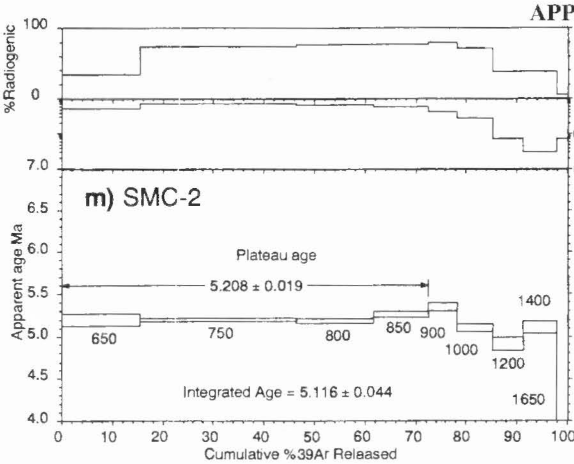

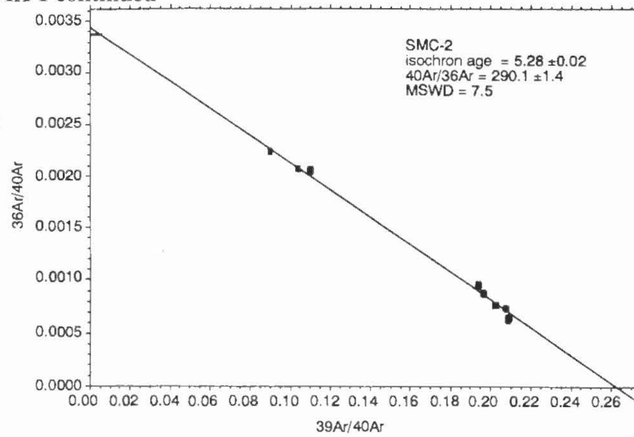

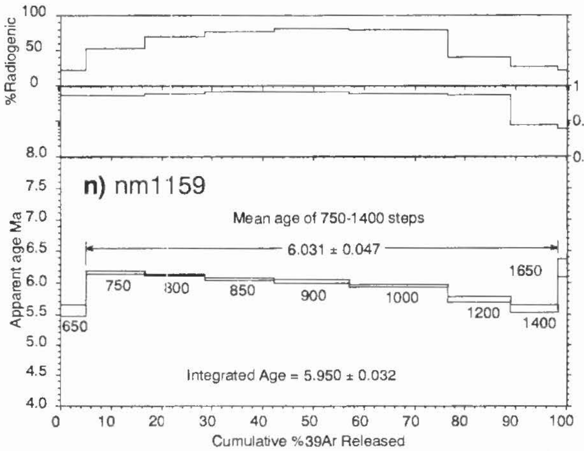

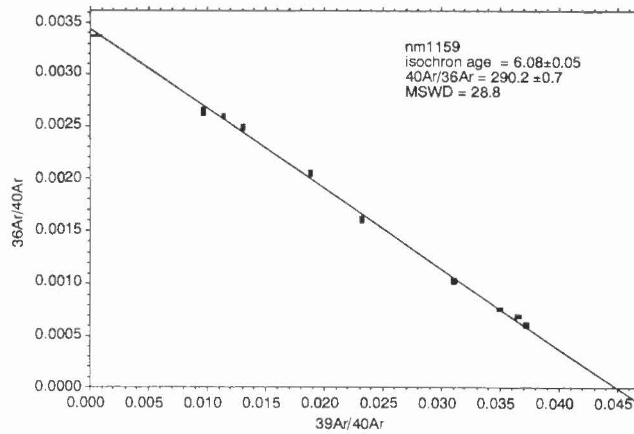

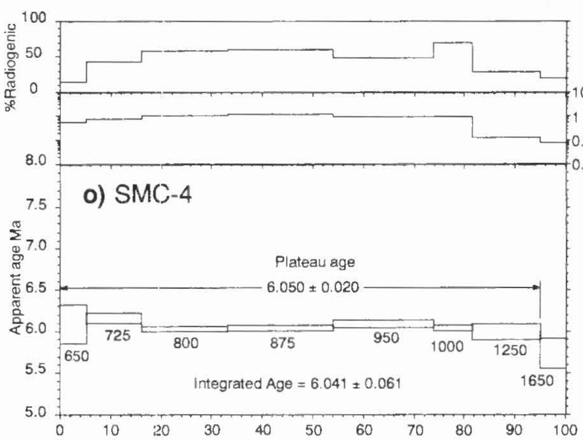

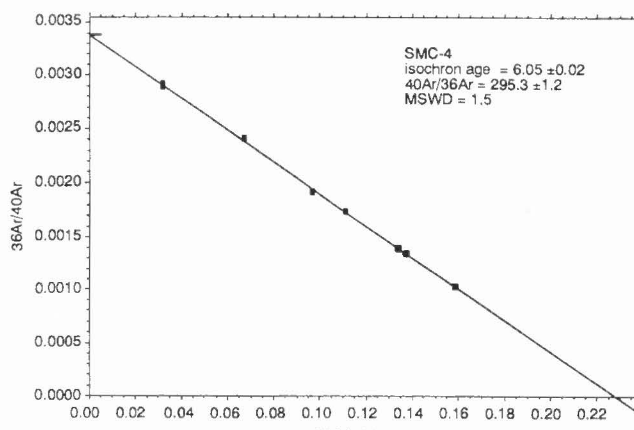

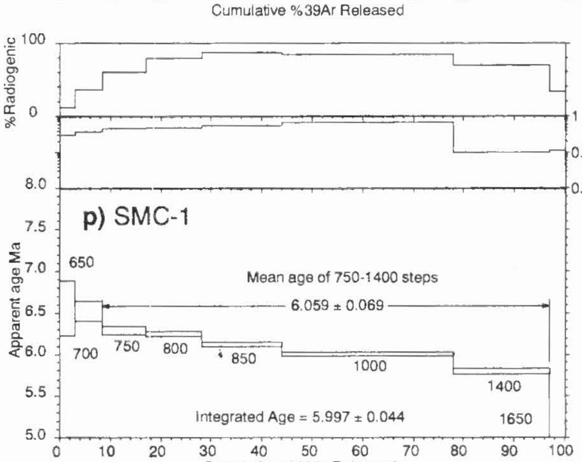

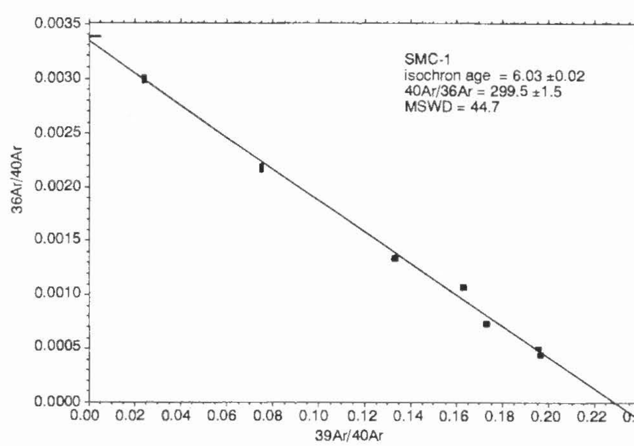

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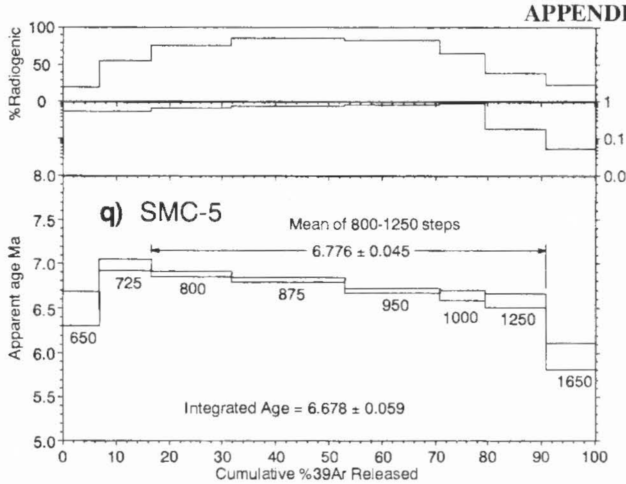

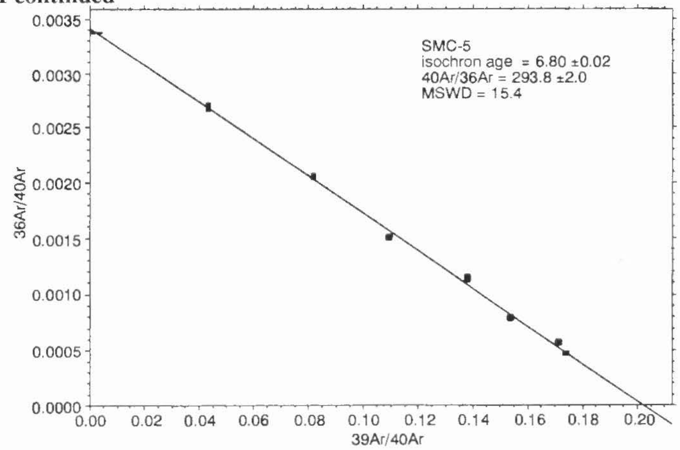

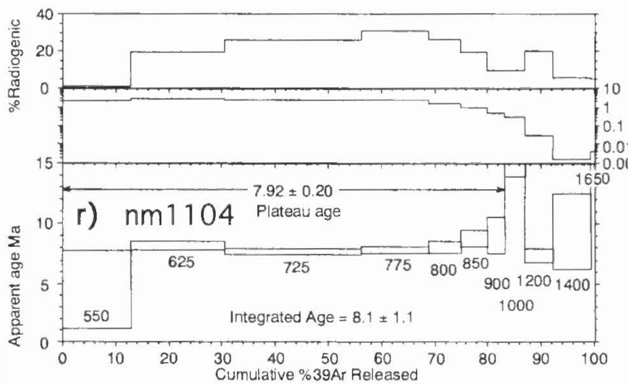

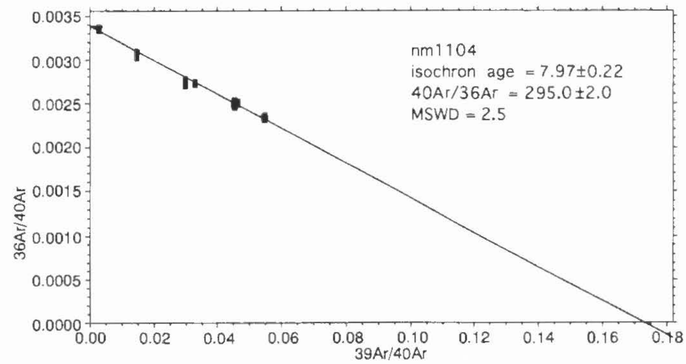

APPENDIX 2

$^{40}Ar/^{39}Ar$ step-heating results for Red Hill-Quemado volcanic rocks.

Lab#	Temp	40/39	37/39	36/39	39K moles	K/Ca	Cl/K	%40*	%39Ar	Age	± Err
nm1161, basaltic lava, Red Hill cinder cone, J=0.0001543 ± 0.0000009, Goat Spring quad., 34.288N, 108.913W.											
1005-01A	550	1.18e+02	1.01e+00	4.00e-01	6.9e-16	0.5	3.9e-02	-0.2	5.7	-0.071	0.174
1005-01B	625	6.60e+01	1.58e+00	2.24e-01	1.2e-15	0.3	2.8e-02	0.0	15.4	0.003	0.081
1005-01C	725	2.93e+01	1.87e+00	9.89e-02	2.1e-15	0.3	1.0e-02	0.5	32.8	0.044	0.037
1005-01D	775	1.47e+01	1.56e+00	4.91e-02	1.7e-15	0.3	2.6e-03	2.2	46.8	0.089	0.022
1005-01E	800	1.15e+01	1.33e+00	3.84e-02	1.4e-15	0.4	1.8e-03	2.1	57.9	0.068	0.020
1005-01F	850	9.52e+00	1.30e+00	3.15e-02	1.5e-15	0.4	1.2e-03	3.1	69.8	0.082	0.018
1005-01G	900	9.38e+00	1.37e+00	3.14e-02	1.3e-15	0.4	1.5e-03	1.9	80.6	0.051	0.019
1005-01H	1000	1.48e+01	1.69e+00	4.94e-02	1.2e-15	0.3	2.9e-03	2.4	90.5	0.098	0.033
1005-01I	1200	4.84e+01	4.01e+00	1.61e-01	8.2e-16	0.1	7.8e-03	2.4	97.2	0.326	0.066
1005-01J	1400	5.13e+01	3.17e+01	1.79e-01	2.2e-16	0.0	1.2e-02	1.8	98.9	0.263	0.127
1005-01K	1625	9.49e+01	2.41e+01	3.29e-01	1.3e-16	0.0	1.3e-02	-0.5	100.0	-0.124	0.266
total gas age					1.2e-14				n=11	0.074	0.046
plateau age									A-H	**0.071**	**0.012**
isochron age					40/36=296.3±0.8	MSWD=2.5			A-H	0.066	0.011
nm1107, ring intrusive, Zuni Salt Lake, J=0.000768 ± 0.000001, Zuni Salt Lake quad., 34.456N, 108.769W.											
849-01A	650	5.25e+01	2.23e+00	1.76e-01	3.6e-15	0.2	1.4e-03	1.1	20.6	0.784	0.392
849-01B	653	3.02e+00	1.61e+00	1.05e-02	3.7e-15	0.3	1.7e-04	0.9	42.0	0.040	0.043
849-01C	786	1.34e+00	1.71e+00	4.70e-03	5.1e-15	0.3	4.8e-04	4.6	71.1	0.086	0.025
849-01D	665	2.29e+00	2.96e+00	7.84e-03	9.1e-16	0.2	1.4e-03	7.6	76.3	0.242	0.087
849-01E	950	2.97e+00	3.96e+00	1.06e-02	3.7e-16	0.1	2.1e-03	4.3	78.4	0.177	0.195
849-01F	1000	3.54e+00	3.54e+00	1.16e-02	3.4e-16	0.1	2.3e-03	10.2	80.4	0.500	0.234
849-01G	1250	2.64e+00	1.28e+01	1.20e-02	2.8e-15	0.0	2.9e-03	2.0	96.2	0.075	0.050
849-01H	1614	1.98e+01	1.42e+01	6.75e-02	6.7e-16	0.0	4.6e-03	4.8	100.0	1.322	0.265
total gas age					1.7e-14				n=8	0.283	0.128
plateau age									B-G	**0.086**	**0.031**
isochron age					40/36=294.4±4.3	MSWD=2.7			B-G	0.095	0.024
nm1106, bomb in hydrovolcanic tuff, Zuni Salt Lake, J=0.0007665 ± 0.000001, Zuni Salt Lake quad., 34.546N, 108.768W.											
850-01A	650	1.13e+01	2.17e+00	3.84e-02	2.4e-15	0.2	4.0e-03	1.1	10.9	0.179	0.128
850-01B	725	1.75e+00	1.79e+00	5.93e-03	4.2e-15	0.3	1.4e-03	6.2	29.7	0.150	0.031
850-01C	800	1.55e+00	1.80e+00	5.37e-03	3.1e-15	0.3	2.0e-03	5.3	43.5	0.115	0.033
850-01D	875	1.79e+00	1.83e+00	6.02e-03	2.5e-15	0.3	3.1e-03	7.4	54.7	0.185	0.043
850-01E	950	2.28e+00	2.64e+00	8.66e-03	1.2e-15	0.2	5.8e-03	-4.3	60.0	-0.136	0.065
850-01F	1000	3.54e+00	3.16e+00	1.32e-02	5.8e-16	0.2	8.0e-03	-4.2	62.6	-0.207	0.153
850-01G	1250	7.97e+00	8.22e+00	2.88e-02	7.7e-15	0.1	1.0e-02	0.8	97.1	0.084	0.069
850-01H	1615	2.87e+01	1.40e+01	1.01e-01	6.4e-16	0.0	9.1e-03	0.0	100.0	-0.003	0.402
nm1106 (cont'd)											
total gas age					2.2e-14				n=8	0.101	0.072
plateau age									A-H	**0.114**	**0.038**
isochron age					40/36=294.4±1.5	MSWD=5.2			A-H	0.126	0.016
nm1158, basaltic lava, hornito fissure, N of Blaines Lake, J=0.0001522 ± 0.0000009, Blaines Lake quad., 34.311N, 108.801W.											
1000-01B	750	2.23e+01	4.39e+00	7.45e-02	9.7e-16	0.1	2.5e-03	2.6	23.6	0.162	0.040
1000-01C	800	2.98e+01	3.59e+00	9.82e-02	4.1e-16	0.1	2.2e-03	3.4	33.6	0.277	0.070
1000-01D	850	2.15e+01	3.56e+00	7.05e-02	3.4e-16	0.1	2.5e-03	4.1	41.8	0.243	0.072
1000-01E	900	2.17e+01	4.52e+00	6.99e-02	2.3e-16	0.1	2.3e-03	6.0	47.5	0.360	0.087
1000-01F	1000	3.37e+01	6.68e+00	1.08e-01	2.3e-16	0.1	5.1e-03	6.4	53.0	0.593	0.129
1000-01G	1200	2.45e+02	8.29e+00	8.24e-01	4.6e-16	0.1	1.4e-02	0.6	64.3	0.434	0.298
1000-01H	1400	5.81e+01	2.07e+01	1.99e-01	1.4e-15	0.0	2.2e-02	1.7	98.3	0.268	0.070
1000-01I	1623	1.77e+02	2.58e+01	5.67e-01	7.0e-17	0.0	7.5e-02	6.6	100.0	3.254	0.640
total gas age					4.1e-15				n=8	0.335	0.103
mean age of near-plateau steps								A-H	0.244	0.048	
isochron age					40/36=296.8±1.2	MSWD=2.8			A-H	**0.206**	**0.034**
nm1155, basalt lava, overlying Quemado Fm., J=0.000153 ± 0.0000009, Ponderosa Tank quad., 34.230N, 108.657W.											
1002-01A	650	1.26e+02	6.79e-01	4.26e-01	2.1e-15	0.8	1.9e-02	0.0	21.3	-0.006	0.376
1002-01B	750	6.37e+01	1.79e+00	2.06e-01	1.9e-15	0.3	1.3e-02	4.7	40.6	0.828	0.176
1002-01C	800	5.31e+01	2.33e+00	1.66e-01	1.4e-15	0.2	4.6e-03	8.1	54.4	1.182	0.082
1002-01D	850	4.21e+01	2.23e+00	1.31e-01	1.4e-15	0.2	2.7e-03	8.1	69.0	0.941	0.159
1002-01E	900	3.95e+01	1.98e+00	1.18e-01	1.3e-15	0.3	1.1e-03	12.4	82.5	1.352	0.048

APPENDIX 2 continued

Lab#	Temp	40/39	37/39	36/39	39K moles	K/Ca	Cl/K	%40*	%39Ar	Age	± Err
1002-01F	1000	1.03e+03	2.15e+00	3.68e+00	6.8e-16	0.2	4.9e-03	-5.3	89.5	-15.139	3.600
1002-01G	1000	1.35e+02	2.66e+00	4.36e-01	2.9e-16	0.2	2.5e-03	4.9	92.4	1.818	0.226
1002-01H	1200	2.96e+02	4.86e+00	9.79e-01	5.2e-16	0.1	6.8e-03	2.3	97.7	1.885	0.546
1002-01I	1400	2.83e+02	7.67e+01	9.08e-01	1.6e-16	0.0	1.3e-02	7.2	99.4	5.904	0.485
1002-01J	1627	3.34e+02	4.23e+01	1.05e+00	6.4e-17	0.0	3.1e-02	7.8	100.0	7.396	1.136
total gas age					9.8e-15				n=10	-0.109	0.456
disturbed spectrum - no mean age calculated											
isochron age					40/36=302.9±1.2		MSWD=18.3		A-J	0.990	0.050
nm1157, basaltic lava, interbedded with Quemado Fm., NE of Blaines Lake, J=0.0001525 ± 0.0000009, Blaines Lake quad., 34.305N, 108.751W.											
1001-01A	650	1.88e+02	2.75e+00	6.41e-01	1.5e-15	0.2	3.7e-02	-0.8	18.1	-0.418	0.292
1001-01B	750	1.81e+01	3.08e+00	5.01e-02	1.7e-15	0.2	1.2e-02	19.6	39.0	0.980	0.024
1001-01C	800	1.17e+01	2.03e+00	2.82e-02	1.2e-15	0.3	5.8e-03	29.9	53.0	0.962	0.020
1001-01D	850	1.05e+01	1.51e+00	2.42e-02	1.1e-15	0.3	4.2e-03	32.6	65.8	0.940	0.018
1001-01E	900	1.11e+01	1.36e+00	2.57e-02	8.3e-16	0.4	4.4e-03	32.5	75.9	0.992	0.021
1001-01F	1000	1.44e+01	1.35e+00	3.68e-02	7.6e-16	0.4	8.9e-03	25.2	85.1	1.001	0.028
1001-01G	1200	2.76e+01	3.41e+00	8.23e-02	7.7e-16	0.1	1.2e-02	12.9	94.5	0.982	0.044
1001-01H	1400	5.49e+01	3.19e+01	1.80e-01	3.9e-16	0.0	1.3e-02	7.4	99.3	1.145	0.103
1001-01I	1623	1.74e+02	2.15e+01	5.56e-01	5.8e-17	0.0	5.6e-02	6.3	100.0	3.049	0.557
total gas age					8.2e-15				n=9	0.745	0.081
plateau age									B-G	**0.970**	**0.014**
isochron age					40/36=297.8±2.4		MSWD=1.3		B-G	0.949	0.024
nm1156, basaltic lava, interbedded with Quemado Fm., US 60, SE of Blaines Lake, J=0.0001534 ± 0.0000009, Tejana Mesa SW quad., 34.270N, 108.719W.											
1003-01A	650	8.17e+01	3.98e-01	2.71e-01	2.5e-15	1.3	2.0e-02	1.9	17.9	0.44	0.26
1003-01B	750	2.81e+01	8.61e-01	7.92e-02	3.5e-15	0.6	1.5e-02	16.8	42.4	1.30	0.05
1003-01C	800	1.71e+01	1.23e+00	3.96e-02	2.2e-15	0.4	8.9e-03	32.2	57.9	1.53	0.02
1003-01D	850	1.19e+01	1.46e+00	2.18e-02	2.1e-15	0.3	4.6e-03	46.4	72.4	1.53	0.01
1003-01E	900	9.81e+00	1.66e+00	1.51e-02	1.7e-15	0.3	2.8e-03	55.4	84.3	1.51	0.01
1003-01F	1000	1.08e+01	2.14e+00	1.85e-02	1.3e-15	0.2	4.2e-03	50.6	93.4	1.51	0.02
1003-01G	1200	1.95e+01	3.52e+00	5.11e-02	4.9e-16	0.1	1.3e-02	24.1	96.8	1.31	0.05
1003-01H	1400	3.77e+01	2.90e+01	1.14e-01	3.0e-16	0.0	1.3e-02	16.7	98.9	1.77	0.09
1003-01I	1625	7.36e+01	3.05e+01	2.29e-01	1.5e-16	0.0	1.6e-02	11.2	100.0	2.32	0.22
total gas age					1.4e-14				n=9	1.28	0.07
plateau age									C-F	**1.51**	**0.01**
isochron age					40/36=295.3±1.5		MSWD=11.4		A-I	1.51	0.01
nm1108, basaltic lava, wall of Quemado crater, J=0.00006 ± 0.0000002, Red Hill quad., 34.232N, 108.828W.											
1310-01B	650	2.27e+02	1.26e+00	7.34e-01	1.2e-15	0.4	1.8e-02	4.5	22.8	1.11	0.08
1310-01C	700	9.28e+01	1.76e+00	2.62e-01	6.8e-16	0.3	9.6e-03	16.6	35.3	1.67	0.04
1310-01D	750	3.58e+01	1.69e+00	7.16e-02	7.1e-16	0.3	2.6e-03	41.2	48.2	1.60	0.02
1310-01E	800	2.25e+01	1.47e+00	2.87e-02	7.4e-16	0.3	1.8e-03	62.8	61.8	1.53	0.01
1310-01F	850	2.06e+01	1.45e+00	2.20e-02	7.3e-16	0.4	1.1e-03	68.9	75.1	1.54	0.01
1310-01G	900	2.08e+01	1.63e+00	2.20e-02	5.0e-16	0.3	2.0e-03	69.2	84.2	1.56	0.01
1310-01H	1000	2.68e+01	1.65e+00	4.30e-02	3.9e-16	0.3	3.3e-03	53.0	91.3	1.54	0.02
1310-01I	1100	4.13e+01	1.89e+00	9.54e-02	2.2e-16	0.3	7.7e-03	32.0	95.2	1.43	0.04
1310-01J	1200	1.05e+02	3.25e+01	3.20e-01	6.7e-17	0.0	1.4e-02	11.9	96.5	1.38	0.17
1310-01K	1400	7.46e+01	2.96e+01	1.67e-01	1.3e-16	0.0	1.7e-02	36.8	98.9	3.03	0.06
1310-01L	1570	4.16e+01	2.39e+01	1.04e-01	6.1e-17	0.0	3.4e-02	30.7	100.0	1.41	0.09
total gas age					5.5e-15				n=11	1.49	0.04
mean age of near-plateau steps								D-H	1.55	0.01	
isochron age					40/36=293.3±0.8		MSWD=7.9		A-L	**1.55**	**0.01**
nm1110, basaltic lava, S side of Cerro la Mula, J=0.0007672 ± 0.000001, Red Hill quad., 34.160N, 108.832W											
851-01A	650	1.21e+01	3.40e-01	3.70e-02	6.8e-15	1.5	8.2e-03	10.0	16.9	1.68	0.09
851-01B	725	9.41e+00	6.73e-01	2.74e-02	7.6e-15	0.8	7.8e-03	14.2	35.7	1.85	0.07
851-01C	800	8.60e+00	1.32e+00	2.48e-02	4.5e-15	0.4	7.0e-03	15.7	46.7	1.87	0.07
851-01D	875	1.00e+01	1.82e+00	2.98e-02	4.1e-15	0.3	7.0e-03	13.2	56.8	1.83	0.10
851-01E	1000	1.10e+01	2.00e+00	3.26e-02	3.8e-15	0.3	9.0e-03	13.3	66.2	2.01	0.11
851-01F	1150	1.12e+01	1.25e+00	3.31e-02	5.1e-15	0.4	9.2e-03	13.0	78.8	2.01	0.08
851-01G	1250	1.10e+01	2.84e+00	3.27e-02	5.8e-15	0.2	8.9e-03	13.7	93.2	2.08	0.08
851-01H	1603	9.77e+00	5.44e+00	2.93e-02	2.8e-15	0.1	8.4e-03	15.4	100.0	2.09	0.10
total gas age					4.0e-14				n=8	1.91	0.09

APPENDIX 2 continued

Lab#	Temp	40/39	37/39	36/39	39K moles	K/Ca	Cl/K	%40*	%39Ar	Age	± Err
plateau age									B-H	**1.95**	**0.05**
isochron age					40/36=296.8±5.6	MSWD=3.1			A-H	1.87	0.20

nm1111, basaltic lava, N of Mangitas Flat, J=0.000769 ± 0.000001, Black Peak quad., 34.104N, 108.853W.

Lab#	Temp	40/39	37/39	36/39	39K moles	K/Ca	Cl/K	%40*	%39Ar	Age	± Err
852-01A	650	1.69e+01	6.24e-01	5.30e-02	5.5e-15	0.8	2.0e-02	7.7	9.7	1.81	0.14
852-01B	725	1.10e+01	9.66e-01	3.19e-02	7.6e-15	0.5	1.2e-02	14.3	23.0	2.18	0.08
852-01C	800	5.15e+00	1.19e+00	1.24e-02	9.9e-15	0.4	4.4e-03	30.1	40.3	2.15	0.04
852-01D	875	3.62e+00	1.07e+00	7.54e-03	1.1e-14	0.5	1.9e-03	40.2	59.4	2.02	0.02
852-01E	1000	3.54e+00	1.10e+00	7.22e-03	1.1e-14	0.5	2.0e-03	41.4	78.4	2.03	0.03
852-01F	1150	9.33e+00	9.39e-01	2.74e-02	6.4e-15	0.5	6.8e-03	13.7	89.7	1.78	0.07
852-01G	1250	1.25e+01	3.54e+00	3.91e-02	2.0e-15	0.1	1.2e-02	10.0	93.1	1.74	0.15
852-01H	1616	1.49e+01	5.95e+00	4.68e-02	3.9e-15	0.1	1.1e-02	10.3	100.0	2.14	0.12
total gas age					5.7e-14				n=8	2.02	0.06
mean age of near-plateau steps								B-G	2.04	0.04	
isochron age					40/36=294.3±1.1	MSWD=5.7			A-G	**2.05**	**0.02**

nm1160, basaltic lava, overlying Bidahochi Fm., N of Mesa Parada, AZ, J=0.0001537 ± 0.0000009, Mesa Parada quad., 34.460N, 109.091W.

Lab#	Temp	40/39	37/39	36/39	39K moles	K/Ca	Cl/K	%40*	%39Ar	Age	± Err
1004-01A	650	2.68e+01	7.26e-01	6.54e-02	3.1e-15	0.7	1.2e-02	28.1	40.9	2.09	0.05
1004-01B	750	1.93e+01	1.81e+00	3.77e-02	2.3e-15	0.3	1.0e-02	42.9	71.5	2.29	0.02
1004-01C	800	1.61e+01	4.08e+00	2.63e-02	8.4e-16	0.1	8.0e-03	53.5	82.7	2.39	0.02
1004-01D	850	1.59e+01	7.19e+00	2.64e-02	4.6e-16	0.1	5.0e-03	54.1	88.8	2.39	0.04
1004-01E	900	1.71e+01	1.02e+01	3.11e-02	3.0e-16	0.1	3.6e-03	50.7	92.7	2.42	0.05
1004-01F	1000	2.00e+01	1.25e+01	4.42e-02	2.5e-16	0.0	3.6e-03	39.5	96.1	2.21	0.06
1004-01G	1200	3.86e+01	1.39e+01	1.08e-01	1.4e-16	0.0	9.8e-03	20.2	98.0	2.18	0.11
1004-01H	1400	6.69e+01	1.16e+02	2.25e-01	9.7e-17	0.0	1.0e-02	13.9	99.2	2.78	0.27
1004-01I	1637	1.63e+02	6.22e+01	5.30e-01	5.8e-17	0.0	1.9e-02	6.8	100.0	3.22	0.63
total gas age					7.5e-15				n=9	2.24	0.04
mean age of near-plateau steps								A-G	2.32	0.04	
isochron age					40/36=291.1±2.2	MSWD=8.4			A-I	**2.37**	**0.03**

SMC-3, basaltic lava, overlying Quemado Fm., US 60, NM-AZ border, J=0.0007629 ± 0.000001, Nelson Reservoir NE quad., 34.025N, 109.028W.

Lab#	Temp	40/39	37/39	36/39	39K moles	K/Ca	Cl/K	%40*	%39Ar	Age	± Err
848-01A	650	2.45e+01	6.03e-01	7.74e-02	6.6e-15	0.8	2.2e-02	6.8	23.9	2.31	0.18
848-01B	725	1.13e+01	1.25e+00	3.28e-02	5.6e-15	0.4	1.6e-02	15.1	44.1	2.35	0.08
848-01C	800	7.12e+00	2.16e+00	1.85e-02	4.9e-15	0.2	7.7e-03	25.2	61.9	2.48	0.06
848-01D	875	5.95e+00	3.12e+00	1.48e-02	4.3e-15	0.2	3.4e-03	30.2	77.5	2.48	0.05
848-01E	950	7.59e+00	4.31e+00	2.06e-02	2.6e-15	0.1	3.1e-03	23.9	86.8	2.50	0.07
848-01F	1000	8.38e+00	4.84e+00	2.33e-02	9.6e-16	0.1	6.3e-03	22.0	90.3	2.54	0.16
848-01G	1250	1.38e+01	9.03e+00	4.37e-02	1.6e-15	0.1	1.1e-02	11.0	96.0	2.10	0.15
848-01H	1612	3.42e+01	3.39e+01	1.18e-01	1.1e-15	0.0	1.4e-02	6.0	100.0	2.91	0.33
total gas age					2.8e-14				n=8	2.41	0.11
plateau age									A-F	**2.46**	**0.04**
isochron age					40/36=294.4±1.4	MSWD=2.1			A-H	2.49	0.05

SMC-2, basaltic lava, interbedded in Fence Lake Fm., US 60, W of Red Hill, J=0.0007649 ± 0.000001, Cow Springs quad., 34.213N, 108.896W.

Lab#	Temp	40/39	37/39	36/39	39K moles	K/Ca	Cl/K	%40*	%39Ar	Age	± Err
844-01A	650	1.12e+01	9.87e-01	2.52e-02	8.7e-15	0.5	1.0e-02	33.7	15.4	5.20	0.07
844-01B	750	5.11e+00	6.99e-01	4.64e-03	1.8e-14	0.7	5.5e-03	73.8	46.4	5.20	0.02
844-01C	800	4.84e+00	7.34e-01	3.78e-03	8.7e-15	0.7	4.1e-03	77.7	61.7	5.18	0.02
844-01D	850	4.96e+00	8.76e-01	4.04e-03	6.2e-15	0.6	3.5e-03	76.8	72.6	5.25	0.03
844-01E	900	4.81e+00	1.22e+00	3.41e-03	3.2e-15	0.4	4.3e-03	80.5	78.3	5.34	0.04
844-01F	1000	5.17e+00	1.80e+00	5.41e-03	3.9e-15	0.3	5.7e-03	71.4	85.3	5.09	0.04
844-01G	1200	9.08e+00	6.91e+00	2.05e-02	3.4e-15	0.1	6.8e-03	39.0	91.2	4.91	0.07
844-01H	1400	9.53e+00	1.62e+01	2.40e-02	3.7e-15	0.0	1.3e-02	38.4	97.8	5.10	0.07
844-01I	1621	2.92e+01	7.25e+00	9.57e-02	1.2e-15	0.1	6.3e-03	5.1	100.0	2.05	0.31
total gas age					5.7e-14				n=9	5.11	0.04
plateau age									A-D	**5.20**	**0.03**
isochron age					40/36=290.1±1.4	MSWD=7.5			A-H	5.23	0.02

nm1159, basaltic lava, caps mesa N of Blaines Lake, J=0.0001518 ± 0.0000009, Blaines Lake quad., 34.315N, 108798W.

Lab#	Temp	40/39	37/39	36/39	39K moles	K/Ca	Cl/K	%40*	%39Ar	Age	± Err
999-01A	650	8.78e+01	9.07e-01	2.28e-01	9.1e-16	0.6	2.7e-02	23.2	5.1	5.58	0.09
999-01B	750	4.31e+01	9.80e-01	6.97e-02	2.1e-15	0.5	8.1e-03	52.3	16.7	6.17	0.03
999-01C	800	3.22e+01	8.39e-01	3.34e-02	2.1e-15	0.6	3.4e-03	69.5	28.6	6.13	0.02
999-01D	850	2.86e+01	7.51e-01	2.19e-02	2.5e-15	0.7	2.0e-03	77.6	42.2	6.07	0.02

APPENDIX 2 continued

Lab#	Temp	40/39	37/39	36/39	39K moles	K/Ca	Cl/K	%40*	%39Ar	Age	± Err
999-01E	900	2.69e+01	7.46e-01	1.67e-02	2.7e-15	0.7	1.6e-03	81.8	57.1	6.02	0.02
999-01F	1000	2.74e+01	8.77e-01	1.92e-02	3.5e-15	0.6	1.9e-03	79.5	76.4	5.96	0.02
999-01G	1200	5.31e+01	9.45e-01	1.09e-01	2.2e-15	0.5	4.8e-03	39.4	88.9	5.73	0.04
999-01H	1400	7.65e+01	6.74e+00	1.92e-01	1.7e-15	0.1	1.3e-02	26.6	98.2	5.58	0.06
999-01I	1622	1.03e+02	8.52e+00	2.75e-01	3.3e-16	0.1	5.1e-02	21.9	100.0	6.24	0.14
total gas age					1.8e-14				n=9	5.95	0.03
mean age of near-plateau steps								B-H	**6.03**	**0.05**	
isochron age					40/36=290.2±0.7	MSWD=28.8			A-I	6.08	0.04
SMC-4, basaltic lava, capping SW edge Cimarron Mesa, J=0.0007624 ± 0.000001, Red Hill quad., 34.250N, 108.869W.											
847-01A	650	3.13e+01	8.60e-01	9.12e-02	3.7e-15	0.6	3.4e-03	14.1	5.1	6.08	0.23
847-01B	725	1.04e+01	6.34e-01	2.01e-02	7.7e-15	0.8	9.2e-04	43.1	16.0	6.15	0.06
847-01C	800	7.49e+00	5.05e-01	1.06e-02	1.2e-14	1.0	3.2e-04	58.6	33.0	6.03	0.03
847-01D	875	7.31e+00	4.42e-01	9.91e-03	1.5e-14	1.2	3.4e-04	60.1	53.9	6.03	0.03
847-01E	950	9.07e+00	5.31e-01	1.58e-02	1.4e-14	1.0	7.7e-04	48.8	73.8	6.08	0.04
847-01F	1000	6.33e+00	5.19e-01	6.63e-03	5.5e-15	1.0	1.6e-03	69.4	81.5	6.03	0.03
847-01G	1250	1.49e+01	3.77e+00	3.67e-02	9.6e-15	0.1	7.4e-03	29.1	95.0	5.99	0.09
847-01H	1624	2.00e+01	6.24e+00	5.53e-02	3.6e-15	0.1	8.9e-03	20.7	100.0	5.73	0.18
total gas age					7.1e-14				n=8	6.03	0.06
plateau age									A-G	**6.05**	**0.02**
isochron age					40/36=295.3±1.2	MSWD=1.5			A-H	6.05	0.03
SMC-1, basaltic lava, overlying Fence Lake Fm., E of Cow Springs Draw, J=0.0007694 ± 0.000001, Cow Springs quad., 34.198N, 108.996W.											
845-01A	650	4.16e+01	1.68e+00	1.25e-01	1.3e-15	0.3	4.1e-03	11.4	3.1	6.58	0.33
845-01B	700	1.33e+01	1.34e+00	2.94e-02	2.2e-15	0.4	1.8e-03	35.4	8.5	6.54	0.12
845-01C	750	7.54e+00	1.10e+00	1.04e-02	3.6e-15	0.5	9.2e-04	60.3	17.2	6.30	0.05
845-01D	800	5.80e+00	1.04e+00	4.52e-03	4.5e-15	0.5	6.9e-04	77.9	28.1	6.26	0.03
845-01E	850	5.11e+00	9.26e-01	2.49e-03	6.6e-15	0.6	7.1e-04	86.6	44.1	6.14	0.02
845-01F	1000	5.13e+00	7.48e-01	2.79e-03	1.4e-14	0.7	1.9e-03	84.6	78.0	6.02	0.02
845-01G	1400	6.15e+00	5.15e+00	7.95e-03	7.8e-15	0.1	1.1e-02	67.9	97.0	5.81	0.03
845-01H	1603	6.89e+00	4.45e+00	1.68e-02	1.2e-15	0.1	7.4e-03	32.5	100.0	3.11	0.11
total gas age					4.1e-14				n=8	6.01	0.04
mean age of near-plateau steps								C-G	6.06	0.07	
isochron age					40/36=299.5±1.5	MSWD=44.7			A-G	**6.03**	**0.02**
SMC-5, basaltic lava, Flat Top, S of Springerville, AZ, White Mtns field, J=0.0007643 ± 0.000001, Springerville quad., 34.354N, 109.271W.											
846-01A	650	2.31e+01	9.43e-01	6.24e-02	3.0e-15	0.5	1.8e-02	20.4	6.9	6.48	0.18
846-01B	726	9.16e+00	9.11e-01	1.40e-02	4.3e-15	0.6	6.8e-03	55.4	16.6	6.98	0.06
846-01C	800	6.54e+00	7.39e-01	5.35e-03	6.7e-15	0.7	3.1e-03	76.3	31.8	6.87	0.03
846-01D	875	5.77e+00	6.55e-01	2.90e-03	9.4e-15	0.8	1.9e-03	85.6	53.0	6.81	0.02
846-01E	950	5.86e+00	6.17e-01	3.49e-03	7.9e-15	0.8	2.0e-03	82.8	70.9	6.68	0.03
846-01F	1000	7.28e+00	5.66e-01	8.41e-03	3.8e-15	0.9	3.8e-03	66.2	79.5	6.63	0.05
846-01G	1250	1.22e+01	2.88e+00	2.59e-02	5.0e-15	0.2	7.0e-03	39.0	90.7	6.58	0.07
846-01H	1612	1.82e+01	9.70e+00	4.97e-02	4.1e-15	0.1	1.0e-02	23.6	100.0	5.96	0.15
total gas age					4.4e-14				n=8	6.67	0.06
mean age of near-plateau steps								C-G	6.78	0.05	
isochron age					40/36=293.8±2.0	MSWD=15.4			B-G	**6.80**	**0.02**
nm1104, intermediate intrusive body, El Porticito, J=0.0007662 ± 0.000002, Tejana Mesa quad., 34.389N, 108.569W.											
1006-01A	550	3.54e+02	2.42e-01	1.19e+00	2.4e-16	2.1	1.4e-02	0.9	13.1	4.48	3.34
1006-01B	625	3.06e+01	1.93e-01	8.35e-02	3.3e-16	2.6	8.4e-03	19.4	31.1	8.20	0.35
1006-01C	725	2.17e+01	2.04e-01	5.46e-02	4.8e-16	2.5	8.2e-03	25.8	57.1	7.72	0.23
1006-01D	775	1.83e+01	2.07e-01	4.26e-02	2.4e-16	2.5	7.0e-03	31.1	69.9	7.85	0.28
1006-01E	800	2.22e+01	3.21e-01	5.53e-02	1.1e-16	1.6	7.4e-03	26.3	76.2	8.06	0.48
1006-01F	850	3.34e+01	5.53e-01	9.15e-02	9.2e-17	0.9	7.4e-03	19.2	81.2	8.84	0.68
1006-01G	900	6.83e+01	1.02e+00	2.09e-01	6.0e-17	0.5	1.1e-02	9.6	84.5	9.09	1.48
1006-01H	1000	1.22e+02	1.82e+00	3.75e-01	7.0e-17	0.3	2.9e-02	9.5	88.3	16.07	2.18
1006-01I	1200	2.66e+01	1.63e+01	7.63e-02	9.6e-17	0.0	9.7e-02	19.9	93.5	7.37	0.57
1006-01J	1400	9.31e+01	2.99e+02	3.75e-01	1.0e-16	0.0	6.5e-01	5.7	99.2	9.32	3.13
1006-01K	1634	4.18e+02	1.13e+02	1.37e+00	1.5e-17	0.0	2.2e-01	5.2	100.0	32.61	11.64
total gas age					1.8e-15				n=11	8.11	1.09
plateau age									A-G	**7.92**	**0.20**
isochron age					40/36=295.0±2.0	MSWD=2.5			A-G	7.97	0.22