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William C. McIntosh and Richard M. Chamberlin
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$^{40}AR/^{39}AR$ GEOCHRONOLOGY OF MIDDLE TO LATE CENOZOIC IGNIMBRITES, MAFIC LAVAS, AND VOLCANICLASTIC ROCKS IN THE QUEMADO REGION, NEW MEXICO

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Abstract—In order to better address stratigraphic problems identified during geologic mapping in the Quemado, New Mexico, area, $^{40}Ar/^{39}Ar$ dating methods were applied to 33 samples of volcanic and volcaniclastic rocks. Single-crystal laser-fusion techniques were used to determine eruptive ages of rhyolitic ignimbrites and of volcanic pumice and ash in sandstones. Mafic lavas were analyzed by step-heating of bulk samples. Sanidine phenocrysts from Quemado area ignimbrites range in age from 34.98 ± 0.19 to 27.23 ± 0.09 Ma. Age and K/Ca results allow these distal-facies outflow sheets to be confidently correlated with 11 well-known regional ignimbrites erupted from calderas in the Mogollon-Datil volcanic field. Ages for the Datil Well Tuff (34.98 ± 0.19 Ma) and Rock House Canyon Tuff (34.17 ± 0.08 Ma) are significantly younger than published values, probably reflecting xenocrystic contamination in previously analyzed bulk samples. Lithic-rich ignimbrites within the South Crosby Peak Formation contain phenocrystic plagioclase that indicates an eruptive age near 29.67 Ma. These units lack phenocrystic sanidine but contain sanidine xenocrysts derived from older rhyolitic ignimbrites. Sparse sanidine and abundant plagioclase from syneruptive volcaniclastic facies suggest depositional ages of 35 to 33 Ma for the volcaniclastic unit of Cañon del Leon and approximately 37 Ma for ash-rich beds in the Dog Springs Formation. Phenocrystic plagioclase from the Cerrito Viejo dacitic intrusion yielded low-resolution results indicating emplacement near 30.6 ± 1.5 Ma. Step heating of groundmass concentrates from Oligocene and Pliocene mafic to intermediate lavas gave disturbed spectra and approximate isochron ages for the andesite of San Antone Canyon (29.2 Ma, new unit), Squirrel Springs Andesite (28.8 Ma), Bearwallow Mountain Andesite (26.1 Ma), and basalts of Blue Mesa (5.7-4.5 Ma). In combination with recent mapping and stratigraphic data, $^{40}Ar/^{39}Ar$ dating results provide a valuable chronostratigraphic framework for interpretation of stratigraphy, sedimentation and tectonic history of the Quemado area.

INTRODUCTION

This study presents a chronostratigraphic framework for volcanic and volcaniclastic rocks exposed near Quemado, New Mexico, an area recently mapped by Chamberlin et al. (1994a). $^{40}Ar/^{39}Ar$ dating methods were applied to four rock types: ignimbrites, pumice-and-ash-rich volcaniclastic rocks, mafic to intermediate lavas, and a dacitic intrusion. Dating of ignimbrites was the primary focus of the study. Large-volume ignimbrites (ash-flow-tuffs) are emplaced nearly instantaneously over wide areas, and hence provide regional time-stratigraphic marker horizons. The Quemado region exposes numerous thin ignimbrites that represent the northern distal fringes of regional ignimbrites erupted from calderas of the Mogollon-Datil volcanic field. The stratigraphy and age of Mogollon-Datil volcanic field ignimbrites has been well established by mapping, paleomagnetic correlation, and high-precision $^{40}Ar/^{39}Ar$ dating of sanidine phenocrysts (McIntosh et al., 1992). However, it is not possible to make reliable lithologic correlations of Quemado distal-facies ignimbrites with established Mogollon-Datil ignimbrites, because of lithologic similarities between some units and lithologic variations within others. In this study, $^{40}Ar/^{39}Ar$ ages and K/Ca ratios of sanidine phenocrysts were used help establish these correlations.

Pumice-and-ash-rich volcaniclastic rocks were also investigated using $^{40}Ar/^{39}Ar$ laser-fusion analyses of individual feldspar crystals. Where sanidine is present in such rocks, high-precision single-crystal dates help to precisely constrain provenance and maximum depositional age. Where only plagioclase is present, the $^{40}Ar/^{39}Ar$ results are less precise and provide more approximate constraints. In addition, a few mafic-to-intermediate lavas and one dacitic intrusion were analyzed by step-heating and laser-fusion $^{40}Ar/^{39}Ar$ methods. The results of these analyses have lower precision, because high-K, highly retentive phenocrysts like sanidine were not present.

GEOLOGIC SETTING

The Quemado region lies on the northern periphery of the Mogollon-Datil volcanic field, near the northern end of a 3000-km-long middle Tertiary volcanic arc mostly defined by the Sierra Madre Occidental in old Mexico (Elston, 1978). This subduction-related magmatic arc terminates abruptly against the southeastern margin of the Colorado Plateau (Mogollon slope) and then reappears approximately 350 km farther north in the San Juan volcanic field of southwestern Colorado and the Latir field of northern New Mexico. This significant middle Tertiary magma gap is associated with a major ENE-trending crustal boundary, presently expressed by the San Agustin arm of the Rio Grande rift (Chapin, 1971) and the Morenci lineament (Ratté, 1989). Based on regional seismic reflection profile data, Garmezy (1990) described this major crustal boundary as a ENE-trending, right-lateral, wrench-fault zone of Laramide ancestry. Transpressional welts formed along the Laramide Morenci lineament were part of the source terrane for siliciclastic red beds of the middle to upper Eocene Baca Formation (Chapin and Cather, 1981; Cather and Johnson, 1984).

Andesitic volcanism began in the northern Mogollon-Datil field about 40 Ma and apparently buried these Laramide welts. Middle Tertiary volcanic apron deposits in the Quemado-Datil region, as much as 1.5 km thick, loaded and downwarped the southeastern Colorado Plateau margin to form the gently south dipping homocline of the Mogollon slope (Chamberlin and Cather, this volume).

During the late Eocene to Oligocene (35-26 Ma), the northern Mogollon-Datil volcanic field erupted numerous large-volume rhyolitic ignimbrite sheets from calderas located 50-100 km south and east of the Quemado area (Osburn and Chapin, 1983; McIntosh et al., 1992). Caldera-related catastrophic eruptions were preceded, accompanied and followed by smaller-volume silicic, intermediate and mafic volcanism. The sequence that accumulated in the Quemado region during this period includes interbedded distal ignimbrites, lavas, and volcaniclastic sediments derived from lavas and pyroclastic material rapidly eroded from the volcanic highlands to the south. This volcanogenic sequence intertongues with volcaniclastic eolian deposits representing distal alluvial fan material that was blown back over the fluviatile volcaniclastic apron by prevailing westerly winds off the Colorado Plateau in Oligocene time.

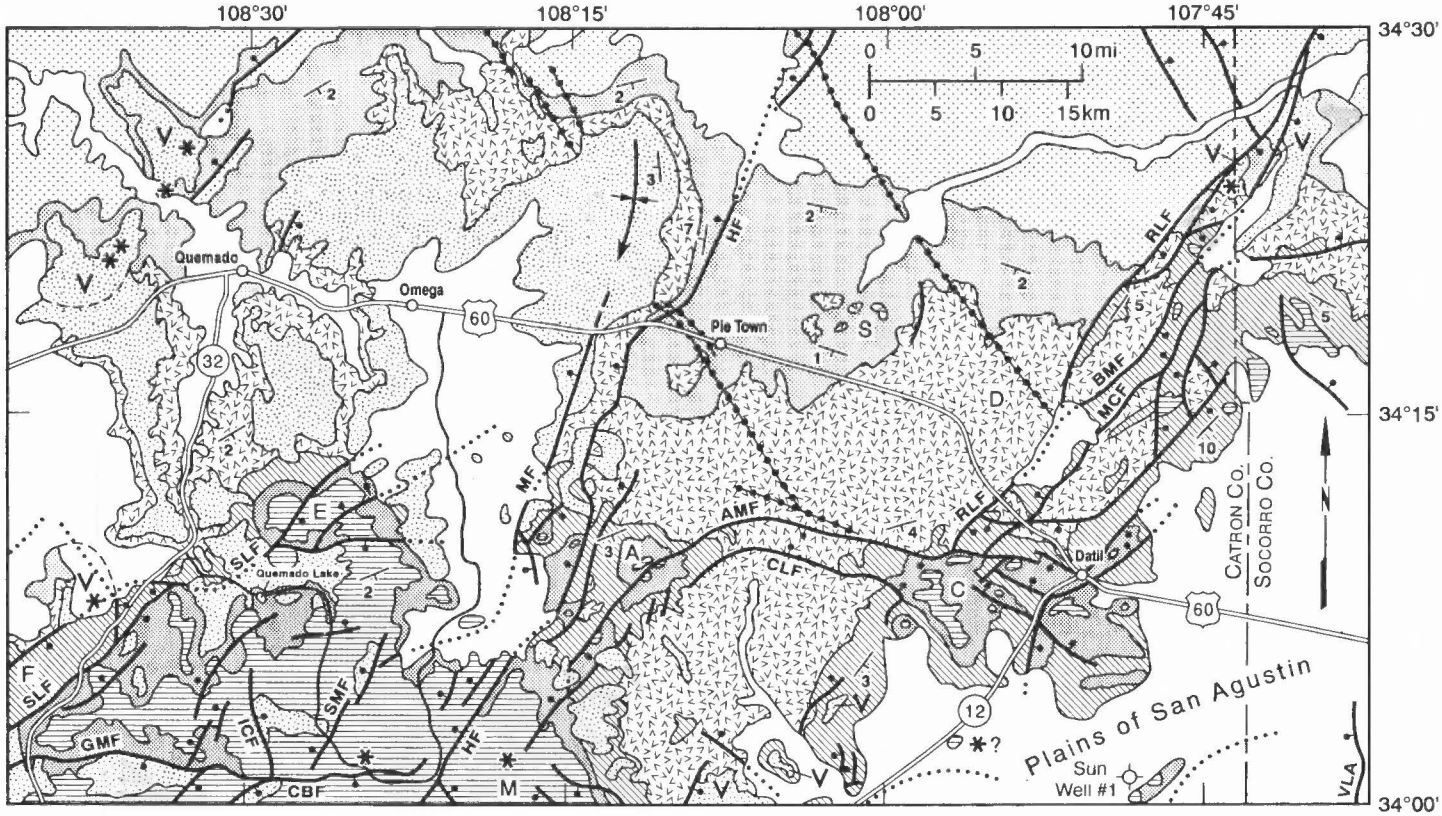
The generalized geology of the Quemado area is summarized in Figure 1. Regional normal fault zones control the distribution of Miocene fluviatile conglomerates derived from erosional remnants of the Oligocene volcanic highlands. These Neogene normal fault zones probably reflect extensional reactivation of basement zones of weakness previously activated by Laramide transpression. The predominance of NNE-trending normal faults probably reflects regional westerly extension, although the overall pattern of faulting records multiple periods of basement deformation.

Details of the Eocene-Oligocene stratigraphy in the Quemado area are discussed below after presentation of dating results.

METHODS

Hand samples, typically 1-2 kg of unweathered, unaltered rock, were collected from 33 localities representing selected ignimbrites, volcaniclastic rock, lavas, and one intrusive quartz diorite in the Quemado area (Fig. 2). Ignimbrites were collected from the densest, most welded outcrops available and lava samples were collected from holocrystalline flow interiors where exposed.

Feldspar separates were prepared from ignimbrite samples by crushing and sieving samples to 125-500 μm, then applying magnetic and density-liquid techniques followed by hand picking. Most of these separates consisted entirely of sanidine grains, although a few contained plagioclase, and one was entirely plagioclase (sample 9, an ignimbrite with sanidine-free pumice, Appendix 1). Similar methods were used to prepare feldspar separates from volcaniclastic samples, except for three samples (samples 22, 24, 25, Appendix 1), from which pumice clasts were hand-picked prior to crushing. Feldspar separates from the volcaniclastic samples are predominantly plagioclase, but include a few sanidine grains. For the lava samples, matrix concentrates of samples



REGIONAL FAULTS:
- RLF = Red Lake
- BMF = Blue Mesa
- MCF = Main Canyon
- AMF = Alegres Mountain
- CLF = Cox Lake
- HF = Hickman
- MF = Mangas
- SMF = Slaughter Mesa
- ICF = Indio Canyon
- CBF = Cañon del Buey
- GMF = Gallo Mountains
- SLF = Spur Lake
- VLA = VLA

normal fault, ball on downthrown side, dotted where concealed

syncline

basaltic–andesite dike

volcanic vent

strike and dip of strata (avg.)

LANDMARKS:
- A = Alegres Mtn
- C = Crosby Mts
- D = Datil Mts
- E = Escondido Mtn
- F = Fox Mtn
- M = Mangas Mtn
- S = Sawtooth Mts

Pliocene and Quaternary alluvium and lavas (V)

Miocene conglomerates, sandstones and lavas (V)

Mogollon Group basaltic–andesite lavas and rhyolite ignimbrites (Oligocene)

upper Spears Group conglomeratic sandstones, eolian sandstones and Mogollon Group ignimbrites (Oligocene)

middle Spears Group conglomeratic and tuffaceous sandstones and Datil Group ignimbrites (Eocene and Oligocene)

lower Spears Group andesitic debris-flow deposits grading northwest into argillaceous andesitic sandstones (Eocene)

Baca Formation quartzo–feldspathic red beds (Eocene)

Mesozoic sandstones, shales, coals and red beds (Cretaceous and Triassic)

= regional unconformity

FIGURE 1. Generalized geology of the Quemado region, after Chamberlin et al. (1994a).

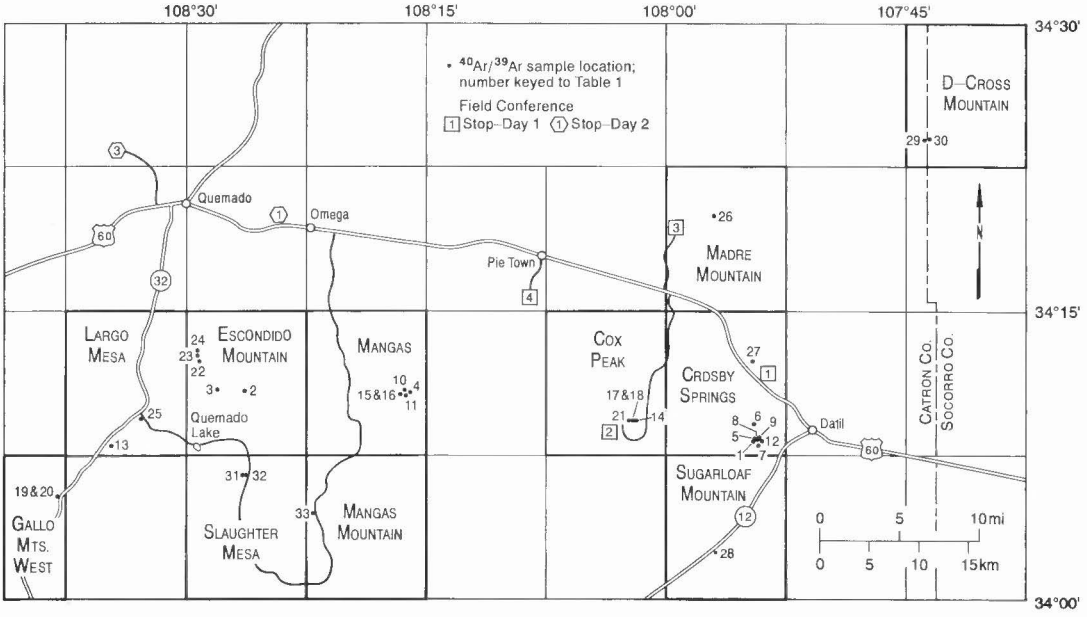


FIGURE 2. Location of $^{40}Ar/^{39}Ar$ dating samples, with numbers keyed to Table 1 and appendices.

were prepared by crushing and sieving to 250-500 μm, followed by ultrasonic cleaning in dilute (5%) nitric acid, then by removal of phenocrysts by Frantz magnetic separator and hand picking. Aliquots of feldspar separates (10-20 mg) and of groundmass concentrates (40-60 mg) were packaged with alternating flux monitors of Fish Canyon Tuff sanidine (27.84 Ma) and were irradiated for one to five hours in the L67 position of the Ford reactor at the University of Michigan.

$^{40}Ar/^{39}Ar$ analyses were performed at the New Mexico Geochronology Research Laboratory at New Mexico Tech, Socorro. This facility includes an MAP 215-50 mass spectrometer attached to a computer-automated, all-metal, argon extraction line. Grains of feldspar separates and monitor sanidines were fused by CO_2 laser for 15 seconds, then reactive gasses were removed using a SAES GP-50 prior to expansion into the mass spectrometer. Extraction line blanks during these laser analyses ranged from 5×10^{-17} to 2×10^{-16} moles ^{40}Ar and 5×10^{-19} to 2×10^{-18} moles ^{36}Ar. The pooled results of four subsamples (3-4 crystals, 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 groundmass concentrate samples. Samples were preheated at 500°C to degas the tin foil package, and then were incrementally heated in eight to ten steps from 650°C to 1650°C. Heating times of 8-10 minutes were followed by 5-10 minutes of cleanup with SAES AP-10 and GP-50 getters. Data from each step were corrected for extraction line blanks, which for furnace analyses ranged from 3×10^{-16} to 3×10^{-15} moles ^{40}Ar and from 2×10^{-18} to 9×10^{-18} moles ^{36}Ar.

RESULTS

Results of single-crystal laser-fusion analyses of feldspar separates are detailed in Appendix 1 and displayed on ideogram and isochron diagrams in Appendix 3. Results of step-heating analyses are detailed in Appendix 2 and displayed as age spectra and isochron diagrams in Appendix 4. 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. $^{40}Ar/^{36}Ar = 295.5$). Age data for all samples is summarized in Table 1.

Ignimbrites

Age determinations of individual sanidine grains from ignimbrites generally have high radiogenic yields (95-100%) and 1σ analytical precision of ±0.1-0.5%. Analyses of plagioclase grains (identified by K/Ca < 2.0; Appendix 1) are generally less precise (1σ = ±0.8-2%) and many have lower radiogenic yields (40-80%).

Except for the sanidine-poor tuff of South Crosby Peak (samples 7, 8, 9; Appendix 1, 3), the ages of most sanidine grains are tightly grouped within each ignimbrite sample. A few samples include one or more grains that are significantly older than the mean. In some cases (e.g., sample 2; Table 1), the aberrant grains have low radiogenic yields and are only slightly older than the majority of grains; this effect may be due to large melt inclusions, observed optically in some grains. In other cases (e.g., samples 6 and 15; Appendix 1, 3), the aberrant grains have high radiogenic yields and are as much as 3 Ma older than the majority of grains. These grains are interpreted as older xenocrysts that were incorporated into the ignimbrite during eruption or emplacement but not heated sufficiently by the ignimbrite to release all preexisting ^{40}Ar.

Mean ages were calculated for each sanidine-rich ignimbrite sample, after excluding results from plagioclase and aberrant sanidine grains discussed above. Mean ages have within-sample precision (1 σ) ranging from ±0.3 to ±0.7% (Appendix 1, 3; Table 1). These mean ages, calculated assuming a trapped component of atmospheric composition ($^{40}Ar/^{36}Ar = 295.5$), agree well with ages calculated by the isochron method (Appendix 1, 3). Isochrons for samples with relatively low radiogenic yields confirm the assumption of an atmospheric trapped component (e.g., sample 11, Appendix 3), but isochrons for many samples show variable $^{40}Ar/^{36}Ar$ intercept values with large uncertainties; this variation is merely an artifact of the high radiogenic yields (>99%) of grains from these samples. The mean ages of samples of sanidine-rich ignimbrites range from 34.98 ±0.19 Ma to 27.23 ±0.09 Ma and are interpreted as the eruption ages of these units; correlation with previously studied regional ignimbrites of the Mogollon-Datil volcanic field is considered in the discussion below. Results from sanidine-poor ignimbrite members of the tuff of South Crosby Peak are less representative of the eruption ages. The few sanidine grains analyzed from the upper and middle ignimbrite members (samples 7, 8; Appendix 3) are interpreted as xenocrysts of preexisting regional ignimbrites. Results from plagioclase grains from the lower ignimbrite member (sample 9; Appendix 3) have relatively high radiogenic yields (92-100%), but compared to typical sanidines have poorly grouped ages (1 σ = ±3%) with a mean of 29.67 ±0.86 Ma.

Volcaniclastic rocks

Age determinations of individual plagioclase and sanidine crystals separated from pumice and ash-rich layers within the volcaniclastic

TABLE 1. Summary of $^{40}Ar/^{39}Ar$ results from Quemado-Datil region samples.

Sample Unit	Field #	7.5' Quad	Lat	Long	mineral	n	Age	±Err	comment
Ignimbrites									
1) South Canyon Tuff	ANDSNMTN-5	Crosby Springs	34.137	107.908	sanidine	10	27.23	0.09	
2) Bloodgood Canyon Tuff	nm1100	Escondido Mt	34.182	108.436	sanidine	6	27.98	0.09	
3) Vicks Peak Tuff	nm1102	Escondido Mt	34.182	108.465	sanidine	7	28.56	0.09	
4) Vicks Peak Tuff	nm1080	Mangas	34.183	108.265	sanidine	11	28.44	0.08	
5) Vicks Peak Tuff	ANDSNMTN-6	Crosby Springs	34.138	107.907	sanidine	10	28.40	0.12	
6) La Jencia Tuff	ESGLFMT-1	Crosby Springs	34.185	107.907	sanidine	13	28.64	0.18	
7) tuff of S. Crosby Peak, upper ignimbrite	ANDSNMTN-4	Crosby Springs	34.134	107.902	sanidine	3	31.39	0.12	xenocrysts of Caballo Blanco
					sanidine	6	31.97	0.17	xenocrysts of Hells Mesa
8) tuff of South Crosby Peak, middle ignimbrite	ANDSNMTN-3	Crosby Springs	34.138	107.903	sanidine	6	31.97	0.18	xenocrysts of Hells Mesa
					sanidine	1	35.12	0.12	xenocrysts of Datil Well
9) tuff of South Crosby Peak, lower ignimbrite	ANDSNMTN-2	Crosby Springs	34.137	107.901	plagioclase	8	29.67	0.86	
10) Caballo Blanco Tuff	nm1078	Mangas	34.182	108.269	sanidine	8	31.54	0.15	
11) Caballo Blanco Tuff	nm1079	Mangas	34.184	108.268	sanidine	12	31.46	0.09	
12) Hells Mesa Tuff	ANDSNMT-1	Crosby Springs	34.138	107.899	sanidine	10	31.93	0.07	
13) tuff of Luna	LGMSA-1	Largo Mesa	34.133	108.576	sanidine	10	33.39	0.12	
14) Blue Canyon Tuff	nm1098	Cox Peak	34.155	108.034	sanidine	8	33.59	0.06	
15) Blue Canyon Tuff	nm1077	Mangas	34.183	108.271	sanidine	9	33.75	0.10	
16) Blue Canyon Tuff	nm1076	Mangas	34.183	108.271	sanidine	9	33.71	0.10	
17) Rockhouse Canyon Tuff	nm1097	Cox Peak	34.156	108.036	sanidine	6	34.18	0.10	
18) Rockhouse Canyon Tuff	nm1096	Cox Peak	34.156	108.036	sanidine	5	34.16	0.07	
19) Bishop Peak Tuff	nm1112	Gallo Mts West	34.088	107.626	sanidine	6	34.84	0.08	
20) Bishop Peak Tuff	GMW-1-93	Gallo Mts West	34.088	107.626	sanidine	8	34.97	0.28	
21) Datil Well Tuff	nm1095	Cox Peak	34.156	107.037	sanidine	6	34.98	0.19	
Volcaniclastic units									
22) volcaniclastic unit of Canon de Leon, upper	CDL-10/2-4	Escondido Mt	34.205	108.480	plagioclase	3	33.21	0.50	
					sanidine	1	34.17	0.13	Rock House Can Tuff san
23) volcaniclastic unit of Canon de Leon, lower	CDL-10/2-9B	Escondido Mt	34.210	108.486	plagioclase	8	35.19	0.36	
24) volcaniclastic unit of Canon de Leon, basal	CDL-10/2-11B	Escondido Mt	34.212	108.487	plagioclase	5	35.48	0.42	
25) volcaniclastic unit of Canon de Leon, basal	CR-93-1-XR	Largo Mesa	34.158	108.548	plagioclase	8	35.59	0.87	
					sanidine	2	35.33	0.06	
26) Dog Springs Fm, tuff layer	nm1115	Madre Mt	34.340	107.945	anorthoclase?	7	34.92	0.15	authigenic K-spar?
					plagioclase	8	38.70	1.18	
27) Dog Springs Fm, tuff breccia	nm1121	Crosby Springs	34.207	107.912	plagioclase	6	37.57	1.29	
					sanidine	1	36.94	0.07	
Intrusion									
28) Cerrito Viejo	nm1114	Sugarloaf Mt	34.042	107.943	plagioclase	8	30.56	1.42	
Mafic Lavas									
29) Basalt of Blue Mesa, upper lava	BLUMSA-2	D-Cross Mt	34.403	107.723	groundmass		4.48	0.02	poor isochron age
30) Basalt of Blue Mesa, lower lava	BLUMSA-1	D-Cross Mt	34.400	107.723	groundmass		5.71	0.06	poor isochron age
31) Bearwallow Mt Andesite, basal lava	SLTRMS-2	Slaughter Mesa	34.106	108.433	groundmass		26.1	0.1	poor isochron age
32) Squirrel Springs Canyon Andesite	SLTRMS-1	Slaughter Mesa	34.105	108.431	groundmass		28.8	0.1	poor isochron age
33) andesite of San Antone Canyon	MNGSMT-2	Mangas Mt	34.079	108.360	groundmass		29.2	0.1	poor isochron age

unit of Cañon de Leon and the Dog Springs Formation (samples 22-27, Appendix 1) have radiogenic yields and analytical precision similar to single crystals from ignimbrites. Of the 26 single crystals analyzed from the unit of Cañon de Leon (samples 22-25, Appendix 1) only three are sanidine; these ages (35.38-35.17 Ma) provide the best available maximum depositional age estimates for this unit. Considering the syneruptive character of this tuffaceous sandstone (Chamberlin and Harris, this volume), these ages probably closely approximate the depositional age. Ages of plagioclase crystals have between-grain variations (1 σ = 1-3%) that are much larger than analytical precision for individual grains (1 σ = 0.2-1.0%). Mean plagioclase ages from the unit of Cañon de Leon range from 35.48 ±0.42 Ma to 33.95 ±0.25 Ma.

Ages of plagioclase crystals from the Dog Springs Formation (samples 26, 27, Appendix 1) vary widely among grains (1 σ = ±4%), probably due to low K content, small grain size, and, possibly, alteration. Mean ages of plagioclase grains from these sample (38.70 ±1.18 Ma and 37.57 ±1.29 Ma) are probably generally representative of the eruptive age of volcaniclastic material within the Dog Springs Formation and also approximate the depositional age of this syneruptive unit. This interpretation is supported by the 36.94 ±0.07 Ma age of a single sanidine grain from one of the samples of the Dog Springs Formation (sample 27, Appendix 1). The other sample (sample 26, Appendix 1) contains unusual, small, low K/Ca (<6.8) K-feldspar grains with a mean age of 34.92 ±0.15 Ma. These grains are interpreted as post-depositional authigenic feldspar, and their age determinations are rejected as maximum ages for deposition of the Dog Springs Formation.

Intrusion

Analyses of plagioclase grains from the quartz diorite Cerrito Viejo intrusion have low radiogenic yields (16-17%), low analytical precision (1 σ = 1-8%) and a mean age of 30.56 ±1.42%. However, because the isochron age is nearly identical and the $^{40}Ar/^{36}Ar$ intercept value is atmospheric (Appendix 1, 3), this imprecise mean age is considered to be a reasonable estimate of the time of emplacement of the intrusion.

Mafic lavas

Age spectra from all five samples of mafic lava analyzed by incremental heating of bulk samples failed to form well-defined age "plateaus" (Appendix 2, 4). The form of the spectra ranged from nearly flat (samples 29, 31; Appendix 4), to steadily falling (samples 32, 33; Appendix 4) to highly irregular (sample 30; Appendix 4). Isochron ages are considered the best estimate of eruptive age for these mafic lavas (Appendix 2, 4); they range from 4.68 ±0.02 to 5.7 ±0.3 Ma for the two late Cenozoic lavas and from 26.1 ±0.1 to 29.2 ±0.1 for the three mid-Cenozoic lavas.

DISCUSSION

Correlation of Quemado ignimbrites with regional units

One of the main goals of this study was the correlation of distal-outflow-facies ignimbrites in the Quemado area with regional ignimbrites from the Mogollon-Datil field. The two correlation criteria generated by this study are $^{40}Ar/^{39}Ar$ age and sanidine K/Ca ratio (determined from the measured $^{37}Ar/^{39}Ar$ ratio). These criteria, added to lithologic and stratigraphic position data, allow nearly all of the sampled Quemado area ignimbrites to be confidently correlated with regional units. A paleomagnetic study to provide an additional correlation criterion is presently underway; some initial results are mentioned below.

The following sections discuss the correlation of Quemado area ignimbrites with regional outflow sheets. Figures 3 and 4 summarize comparisons of age and K/Ca data from Quemado samples with published data from regional units. In making these comparisons, it is important to consider that the samples in this study were analyzed by the single-crystal laser-fusion $^{40}Ar/^{39}Ar$ method, whereas the published data from regional units (Fig. 3; McIntosh et al., 1992) was obtained by step-heating of bulk samples containing several hundred sanidine grains, a method that tends to average variations between individual grains. Following the unit-by-unit presentation below is a discussion of some apparent systematic differences between results from the two dating methods.

Datil Well Tuff

The Datil Well Tuff, previously dated at 35.47 ±0.07 Ma by the $^{40}Ar/^{39}Ar$ bulk-sample method (Fig. 3), is the oldest rhyolitic ignimbrite in the northern Mogollon-Datil volcanic field (McIntosh et al., 1992). It is widespread throughout the Datil area as a thin (<30 m) moderately- to densely-welded ignimbrite, but no source caldera has been recognized. Sample 21, the basal ignimbrite in the Cox Peak quadrangle (Fig. 2), has lithology and sanidine K/Ca values indistinguishable from published values from the Datil Well Tuff (Figs. 3, 4). Correlation is further supported by the similarity of its paleomagnetic direction (McIntosh, unpubl. data) with the distinctive north to north-northeast normal remanence direction reported from the Datil Well Tuff elsewhere (McIntosh et. al, 1991, 1992). However, the single-crystal laser fusion age of sample 21 is about 0.5 Ma younger than the published age of Datil Well Tuff (Figs. 3, 4). This difference, significant at the 2s level, probably reflects small amounts of incompletely degassed xenolithic feldspar in the bulk sanidine separates analyzed by McIntosh et al. (1992). The single-crystal laser fusion age from this study, 34.98 ±0.19 Ma, is now considered the best available estimate for the eruption age of the Datil Well Tuff.

Tuff of Bishop Peak

The tuff of Bishop Peak is a relatively local ignimbrite exposed in the vicinity of Luna, southwest of the present study area. It has been dated at 34.70 ±0.10 Ma (Fig. 3) and tentatively correlated with the tuff of Leyba Well, exposed near Old Horse Springs, south of the present study area. The tuff of Bishop Peak has reverse magnetic polarity that distinguishes it from the normal polarity Datil Well Tuff. Samples 19 and 20 (Fig. 2), from a thin, nonwelded ignimbrite that underlies the Leggett Canyon andesite in the southwestern corner of the study yielded age (Fig. 3) and sanidine K/Ca values (Fig. 4) that agree closely with published data from the tuff of Bishop Peak, which has mapped outcrops only 32 km to the southwest (McIntosh et al., 1991, 1992). These data would also permit correlation with the more distant Datil Well Tuff, which has indistinguishable age and sanidine K/Ca values (Fig. 4). This correlation is presently being addressed by paleomagnetic analysis.

Rock House Canyon Tuff

The Rock House Canyon Tuff is a thin regional ignimbrite widely exposed in the northern Mogollon-Datil volcanic field and best known from the Datil area. It has a distinctive crystal-poor lithology (<1% phenocrysts) and has been dated by the bulk-sample $^{40}Ar/^{39}Ar$ method at 34.42 ±0.12 Ma (Fig. 3), although intersample variations in age suggested some effects of sample contamination by xenocrystic feldspar (McIntosh et al., 1992). The source cauldron for this ignimbrite is unknown. Results from samples 17 and 18 (Fig. 2) support identification of the thin, crystal-poor ignimbrite in the Cox Peak quadrangle as Rock House Canyon Tuff. Sanidine K/Ca values from these samples overlap with published Rock House Canyon Tuff values (Fig. 4), although the published mean age is about 0.25 Ma older (Fig. 3). As is the case for the Datil Well Tuff, this discrepancy is attributed to undetected xenolithic feldspar in the bulk sanidine separates analyzed for the published age (Fig. 3). The mean (34.17 ±0.08 Ma) of the two single-crystal laser fusion ages from samples 17 and 18, is now considered to be the best available estimate for the eruption age of the Rock House Canyon Tuff.

Blue Canyon Tuff

The Blue Canyon Tuff is yet another thin, regional ignimbrite widely exposed in the northern Mogollon-Datil volcanic field and was dated by the bulk-sample $^{40}Ar/^{39}Ar$ method at 33.66 ±0.07 Ma. Results from samples 14-16, from a thin ignimbrite in the Cox Peak and Mangas quadrangles in the central study area, confirm correlation with the regional Blue Canyon Tuff. Sanidine ages (33.59-33.75 Ma) and K/Ca values are indistinguishable from published values (Figs. 3, 4).

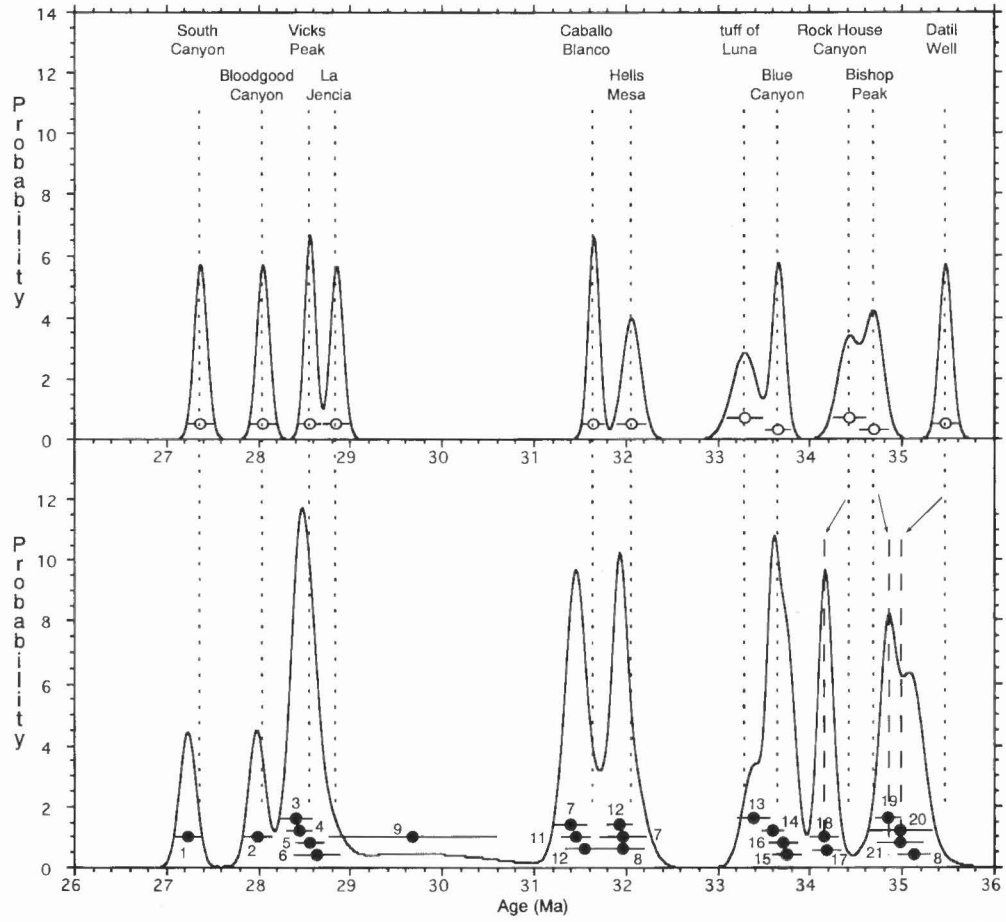


FIGURE 3. Ideogram comparing published $^{40}Ar/^{39}Ar$ ages of Mogollon-Datil regional ignimbrites (upper panel, after McIntosh et al., 1992) with ages of samples dated in this study (lower panel). Open circles and bars show published age and error (1 σ) for regional ignimbrites. Closed circles and bars show age and error of samples dated in this study, with sample numbers keyed to Appendices 1 and 2. Arrows at upper right of lower panel show where mean ignimbrite ages from this study differ significantly from published values.

Tuff of Luna

The tuff of Luna is a thin, relatively local ignimbrite exposed in the vicinity of Luna. It was dated at 33.29 ±0.14 Ma and tentatively correlated with Box Canyon Tuff in the southern Mogollon-Datil field (McIntosh et al., 1992). A thin ignimbrite in the southeastern part of the study area, represented by sample 13 (Fig. 2), yielded an age (33.39 ±0.12 Ma) that agrees at the 1 σ level with published mean ages of both the Blue Canyon Tuff and tuff of Luna. However, the high sanidine K/Ca value of sample 13 clearly supports correlation with the tuff of Luna (Fig. 4).

Hells Mesa Tuff

Hells Mesa Tuff is a large-volume (1200 km^3) regional ignimbrite exposed widely throughout the northern Mogollon-Datil volcanic field. It erupted from a cauldron near Socorro at 32.06 ±0.10 Ma (McIntosh et al., 1991, 1992). Results from sample 12 confirm that the crystal-rich ignimbrite exposed in the Crosby Mountains, mapped as tuff of Rock Tank by Lopez and Bornhorst (1979), is correlative with the Hells Mesa Tuff (Figs. 3, 4; McIntosh et al., 1991, 1992).

Caballo Blanco Tuff

Caballo Blanco is a 31.65 ±0.06-Ma, crystal-rich ignimbrite, lithologically similar to Hells Mesa Tuff, that is widely exposed in the southern Mogollon-Datil volcanic field (McIntosh et al., 1991, 1992). Although the source cauldron in not well known, distal outflow facies are known to extend to the area immediately south of the present study area (McIntosh et al., 1991). A poorly-welded crystal-rich ignimbrite exposed in the Mangas quadrangle and represented by samples 10 and 11 was originally thought to be Hells Mesa Tuff on the basis of lithology and stratigraphic position. However, the $^{40}Ar/^{39}Ar$ age determinations (31.46 ±0.09 and 31.54 ±0.15 Ma) are significantly younger than published data from the Hells Mesa Tuff, and instead support correlation with the Caballo Blanco Tuff (Fig. 3). K/Ca data cannot be used to distinguish between Hells Mesa Tuff and Caballo Blanco Tuff, because their measured sanidine K/Ca values are indistinguishable.

Tuffs of South Crosby Peak (lower, middle, and upper)

The tuffs of South Crosby Peak are exposed only in the Crosby Mountains in the east-central study area and include at least three thin, sanidine-poor, lithic-rich ignimbrites intercalated with epiclastic conglomerates of the South Crosby Peak Formation. The tuffs of South Crosby Peak are stratigraphically bracketed between the 32.0-Ma Hells Mesa Tuff and the 28.8-Ma La Jencia Tuff, but have never been precisely dated, largely because they lack sanidine phenocrysts. Although the lithology of this unit precludes correlation with any of the well-established, sanidine-bearing, rhyolitic regional ignimbrites of the Mogollon-Datil volcanic field, similar nonwelded, lithic-rich ignimbrites and other tuffs are present elsewhere between the Hells Mesa and La Jencia Tuffs. These include thin deposits east of Socorro and the thick, heterogeneous Luis Lopez Formation (Osburn and Chapin, 1983).

Three sanidine-poor, nonwelded South Crosby Peak ignimbrites (samples 7-9, Fig. 2) were analyzed in this study to better constrain their eruptive age. Sanidine crystals separated from the upper and middle ignimbrites (samples 7 and 8) yielded $^{40}Ar/^{39}Ar$ ages near 32.0 and

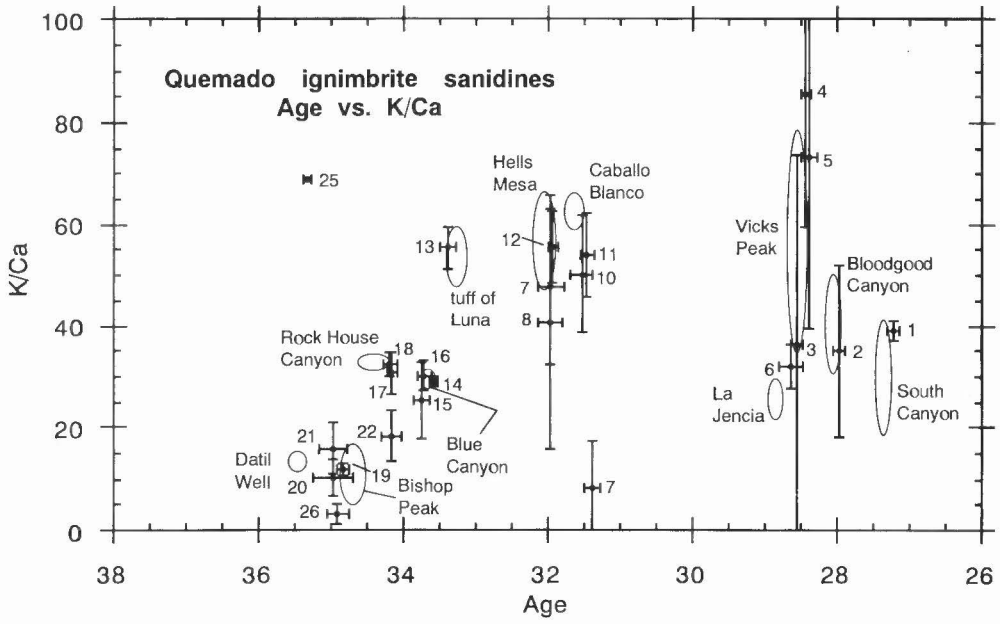


FIGURE 4. Plot comparing results from this study (points with 1 σ error bars, numbers keyed to Appendix 1 and Table 1) with published K/Ca and $^{40}Ar/^{39}Ar$ ages of regional Mogollon-Datil ignimbrites (ovals approximate ±1 σ error envelopes, after McIntosh et al., 1991, 1992).

31.4 Ma. On the basis of age and K/Ca values (Fig. 4), the 32.0-Ma sanidines are interpreted as xenocrysts derived from Hells Mesa Tuff. The 31.4-Ma sanidines are also probably xenocrysts, but their origin is less certain. They overlap in age with the Caballo Blanco Tuff, but their K/Ca values are considerably lower (Fig. 4).

Plagioclase phenocrysts from pumice in the lower ignimbrite member of the tuff of South Crosby Peak (sample 9) gave a mean age of 29.67 ±0.86 Ma. This relatively low-precision age determination is currently the best available estimate of eruption age for the lower tuff of South Crosby Peak.

La Jencia Tuff

The La Jencia Tuff is a well-known regional ignimbrite erupted at 28.85 ±0.07 Ma from the Sawmill-Magdalena cauldron west of Socorro. The crystal-poor outflow sheet is widely exposed throughout much of the northern Mogollon-Datil volcanic field (McIntosh et al., 1991, 1992). A thin ignimbrite interbedded with the South Crosby Peak Formation in the Crosby Mountains (sample 6; Fig. 2) apparently represents the northwestern distal fringe of the La Jencia Tuff outflow sheet. The 28.64 ±0.18-Ma age of sample 6 overlaps at 1 σ with the published age (Fig. 3) of the La Jencia Tuff, and the sanidine K/Ca value precludes correlation with the Vicks Peak Tuff, which has sanidine with higher and more variable K/Ca values (Fig. 4).

Vicks Peak Tuff

The Vicks Peak Tuff is one of the most voluminous (1200 km^3) and widespread ignimbrites in the northern Mogollon-Datil volcanic field. Erupted at 28.56 ±0.06 Ma from the Nogal cauldron in the southern San Mateo Mountains, its crystal-poor outflow sheet extends west nearly to the New Mexico-Arizona border (McIntosh et al., 1991, 1992). Its sanidine phenocrysts have distinctive K/Ca values that are generally high and quite variable among samples (Fig. 4). Age and K/Ca results from a thin, crystal-poor ignimbrite sheet with outcrops distributed across much of the southern study area (samples 4-6; Fig. 2) confirm correlation with the Vicks Peak Tuff (Figs. 3, 4). K/Ca results (Fig. 4) indicate that grain-to-grain variations in sanidine K/Ca values are even greater than previously established sample-to-sample variations.

Bloodgood Canyon Tuff

The Bloodgood Canyon Tuff is the most voluminous (1000 km^3) and widespread (15,000 km^2) ignimbrite in the southern Mogollon-Datil volcanic field (Ratté et al, 1984). It erupted at 28.05 ±0.06 Ma from the Bursum cauldron in the Mogollon Mountains and its outflow sheet is known to extend to the area immediately south of the present study area (McIntosh et al., 1991, 1992). Age and K/Ca results from sample 2 support identification of a thin, moderately-welded ignimbrite in the Escondido Mountain quadrangle as Bloodgood Canyon Tuff (Fig. 4).

South Canyon Tuff

The South Canyon Tuff is the youngest regional ignimbrite that is widely exposed in the northern Mogollon-Datil volcanic field. It erupted at 27.37 ±0.07 Ma from the Mount Withington cauldron in the northern San Mateo Mountains and its outflow sheet extends into the western part of the study area (McIntosh et al., 1991, 1992). Age and K/Ca data from a thin, poorly welded ignimbrite mapped as A-L Peak Rhyolite by Lopez and Bornhorst (1979) in the Crosby Mountains support its identification as the distal fringe of the South Canyon outflow sheet (Figs. 3, 4). Because of its crystal-poor lithology, this distal outflow sheet could easily be confused with La Jencia or Vicks Peak Tuff.

Systematic differences between single-crystal and bulk-sample $^{40}Ar/^{39}Ar$ ages

One striking feature of this data set is that the $^{40}Ar/^{39}Ar$ ages determined from Quemado area ignimbrites tend to be younger than published data from regional units (Fig. 3, Table 1). In two cases, Datil Well Tuff and Rock House Canyon Tuff, the published ages are significantly (0.25-0.5 Ma) older than this study's age determinations. As discussed above, these discrepancies probably reflect small amounts of incompletely degassed xenolithic feldspar in the bulk samples analyzed for the published ages. In these two cases the single-crystal laser fusion ages are probably the best estimate of eruption age. For most of the ignimbrites, however, this study's single-crystal ages are 0.05 to 0.2 Ma younger than the published bulk-sample ages, and the ages determined by the two methods overlap at the 1 σ level. This small but systematic difference in age may reflect minor xenocrystic contamination in the bulk samples, but is probably actually due to difference in technique

(single crystal laser fusion vs. resistance furnace step heating) or to inexact interlaboratory calibration between the New Mexico Tech laboratory, where the single-crystal work was performed, and the U.S.G.S. laboratory in Reston, Va., where the published bulk-sample analyses were accomplished. Further single-crystal analyses of Mogollon-Datil ignimbrites will help resolve the source of these small but systematic discrepancies between dating techniques.

Age and provenance of volcaniclastic units

Volcaniclastic units were analyzed in this study in order to help constrain depositional age and provenance. Two units were studied: the volcaniclastic unit of Cañon del Leon and Dog Springs Formation.

Volcaniclastic unit of Cañon del Leon

Samples of phenocrysts hand picked from pumice clasts in pumiceous muddy siltstone samples of the volcaniclastic unit of Cañon del Leon yielded three sanidine and numerous plagioclase grains for analysis. One sanidine grain, from the uppermost pumice-rich bed (sample 22, Appendix 1), gave an age (34.17 ±0.13 Ma) and K/Ca value (Fig. 4) that suggest that the grain was derived from Rock House Canyon Tuff, and provides a relatively precise maximum depositional age for the upper part of the unit of Cañon del Leon. More abundant plagioclase grains from the same sample yielded a mean age of 33.21 ±0.50 Ma, providing a younger but less precise maximum depositional age for the bed. Samples of middle and basal beds of the unit of Cañon del Leon (sample 23-25; Appendix 1), yielded plagioclase with mean ages ranging from 35.19 ±0.42 Ma to 35.59 ±0.87 Ma and in general agreement with stratigraphic order (Table 1). Sample 23 represents a thin (5 cm), rhyolitic, ash-fall approximately 12 m above the base of the unit of Cañon del Leon. Because the ash bed is not reworked, its relatively imprecise age (35.19 ±0.42 Ma) is representative of the depositional age of the unit. Two sanidine grains from the basal pumiceous bed at Castle Rock (sample 25, Appendix 1) have a mean age of 35.33 ±0.06 Ma and a K/Ca value distinctly higher than any of the regional ignimbrites erupted near 35 Ma in the northern Mogollon-Datil volcanic field (Fig. 4). These were probably derived from a rhyolitic dome or flow, or possibly from reworked pyroclastic fall material from a distant rhyolitic ignimbrite. In any case, the age of these sanidines represents a reasonably precise maximum depositional age for the basal part of this unit. Age data from the unit of Cañon del Leon, together with the sedimentological interpretation of this unit as the product of distal reworked volcanic ejecta derived from rhyolitic to intermediate volcanism, are consistent with deposition of the unit ranging approximately from 35 to 33 Ma.

Dog Springs Formation

The two samples from the Dog Springs Formation (samples 26 and 27, Appendix 1) yielded plagioclase grains with relatively imprecise mean ages of 37.57 ±1.29 Ma and 38.70 ±1.18 Ma, and a single sanidine grain at 36.94 ± 0.07 Ma. Also present were unusual low-potassium K-feldspars with a stratigraphically unreasonable age of 34.92 ±0.15 Ma; as discussed above, these grains are believed to be authigenic and therefore only provide a minimum depositional age. Given the interpretation of the Dog Springs Formation as debris flows shed from the flanks of stratovolcanoes, the best estimate for the depositional age of sampled beds in the Dog Springs Formation is approximately 37 Ma, based on the age of the one sanidine grain analyzed.

Age of Cerrito Viejo intrusion

Plagioclase grains from the single sample of the Cerrito Viejo intrusion, a small dacitic stock near the southeastern corner of the study area (sample 28, Appendix 1), yielded a mean age of 30.56 ±1.42 Ma. This age represents a reasonable but imprecise estimate of the timing of intrusion and cooling of the stock. These data suggest that Cerrito Viejo was not related to the stratovolcano sources for the lithologically similar Dog Springs Formation; the location of these source volcanoes remains unknown. It is possible, however, that this intrusion is related to volcanism that supplied volcanic and volcaniclastic material preserved in the tuffs of South Crosby Peak.

Age of mafic lavas

The five samples of mafic lava analyzed in this study address two separate goals. The two samples of Pliocene lava from Blue Mesa (samples 29 and 30, Appendix 2) were collected to provide age control on faulting and deposition of gravels along the Red Lake fault zone. Three samples of Oligocene mafic lavas were collected to better constrain the timing of basaltic andesite volcanism. None of the samples of mafic lavas yield ages as precise or reliable as data from sanidine-bearing units. As discussed above, age spectra from these samples are not flat, indicating complexities in $^{40}Ar/^{39}Ar$ systematics that are not uncommon when analyzing multimineralic materials such as the groundmass concentrates obtained from these samples (e.g., McIntosh and Cather, this volume). The isochron ages are considered the best estimate for eruptive ages for these samples, although calculated analytical errors (Tables 1; Appendix 2) probably under-represent geological errors for these age determinations.

The two samples of alkali basalt from Blue Mesa (samples 29 and 30; Appendix 2) yielded isochron ages of 4.48 ±0.02 and 5.71 ±0.25 Ma; these data are consistent with stratigraphic order. Of these age determinations, the younger (sample 29) is considered more reliable, because the age spectrum is less complex and the radiogenic yields are higher (Appendix 2,4).

Stratigraphy and sedimentation in the Quemado area

The $^{40}Ar/^{39}Ar$ results from this study, together with recent mapping (Chamberlin et al., 1994a), provide significant new age and correlation constraints for understanding stratigraphy in the Quemado area, as follows:

1. The stratigraphically lowest andesitic volcaniclastic interval, which includes the Dog Springs Formation and volcaniclastic unit of Largo Creek (new name; Chamberlin and Harris, this volume), was deposited near 37 Ma.

2. Upper Eocene pumiceous sandstones and ash beds of the volcaniclastic unit of Cañon del Leon (new name; Chamberlin and Harris, this volume) were deposited in the Quemado area from approximately 35 to 33 Ma and are in part laterally equivalent to the Pueblo Creek Formation in the Reserve area, and to the Chavez Canyon and Rincon Windmill Formations in the Datil area.

3. The andesite of Dry Leggett Canyon in the Fox Mountain area is bracketed by the underlying 34.9 Ma tuff of Bishop Peak and the overlying 33.4 Ma tuff of Luna.

4. The eolian sandstone of Escondido Mountain (new name; Chamberlin and Harris, this volume) contains three regional ignimbrites as lenticular paleovalley fills; these include the 31.6-Ma Caballo Blanco Tuff, the 28.6-Ma Vicks Peak Tuff and the 28.0-Ma Bloodgood Canyon Tuff.

5. Fluviatile conglomeratic sandstones of the South Crosby Peak Formation are bracketed by the 32.0-Ma Hells Mesa Tuff and the 27.4-Ma South Canyon Tuff, and also contain the tuff of South Crosby Peak (ca. 29.7 Ma), the 28.9-Ma La Jencia Tuff and the 28.6-Ma Vicks Peak Tuff.

6. The Squirrel Springs Canyon Andesite is bracketed by the 28.6-Ma Vicks Peak Tuff and the 28.0-Ma Bloodgood Canyon Tuff.

7. Basaltic andesite lavas assigned to the Bearwallow Mountain Andesite began to be erupted from the Mangas Mountain center about 26.1 Ma.

Using constraints provided by $^{40}Ar/^{39}Ar$ results, the upper Eocene to Oligocene (ca. 40-26 Ma) volcanogenic strata of the Quemado-Datil area can be divided in four regional composite stratigraphic units shown on the generalized geologic map (Fig. 1). From oldest to youngest these composite units and their approximate depositional ages are (1) andesitic debris-flow deposits and andesitic sandstones of the lower Spears Group, ca. 39.6 to 36.9 Ma; (2) epiclastic basaltic andesite to rhyolitic conglomeratic and tuffaceous sandstones of the middle Spears Group intercalated with 35.0 to 31.5-Ma ignimbrites of the Datil Group; (3) epiclastic basaltic andesite to rhyolitic conglomeratic sandstones and eolian volcaniclastic sandstones of the upper Spears Group intercalated with 28.9 to 27.4-Ma ignimbrites of the

Mogollon Group; and (4) Mogollon Group basaltic andesite lavas of the Squirrel Springs Canyon Andesite and Bearwallow Mountain Andesite (ca. 28.5 and 26.1, Ma, respectively) interbedded with and overlying 28.6 to 28.0-Ma ignimbrites. Additional lithologic variations in the above regional units include the presence of eolian sandstones below the Hells Mesa Tuff (Datil Group) in the Datil area (Osburn and Chapin, 1983) and intertonguing of middle Spears Group tuffaceous sandstones with thick flows of the andesite of Dry Leggett Canyon (approximately 34 Ma) at Fox Mountain.

Additional details of Quemado area stratigraphy, as well as implications for sedimentation and tectonics, are presented in companion articles (Chamberlin et al.; Chamberlin and Harris; Armstrong and Chamberlin, this volume).

Displacement history of the Red Lake fault zone

Field relationships and $^{40}Ar/^{39}Ar$ results from basalts (samples 29 and 30, Table 1) in the Blue Mesa area of the Red Lake fault zone, north of Datil (Fig. 2), indicate most of the down-to-the-east displacement is of late Oligocene to Miocene age. Only 100 m of the total 600 m of apparent normal displacement postdates the Pliocene (4.5 Ma) basalt of Blue Mesa.

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APPENDIX 1

Sample	Lab #	40/39	37/39	36/39	39K moles	K/Ca	%40*	Age	±1 σ
IGNIMBRITES									
1)	**South Canyon Tuff, ANDSNMTN-5, Crosby Springs quad, sanidine, J=0.0006644 ±0.000002**								
	1220-02	23.03	1.41E-02	7.45E-04	1.4E-13	36.2	99.0	27.11	0.07
	1220-06	23.39	1.31E-02	1.87E-03	1.5E-13	39.0	97.5	27.15	0.06
	1220-10	23.14	1.30E-02	9.48E-04	1.4E-13	39.4	98.7	27.17	0.04
	1220-08	23.43	1.27E-02	1.89E-03	7.8E-14	40.0	97.5	27.18	0.06
	1220-03	22.95	1.31E-02	2.38E-04	1.5E-13	38.8	99.6	27.19	0.06
	1220-04	23.52	1.24E-02	2.03E-03	1.5E-13	41.1	97.4	27.24	0.05
	1220-05	24.65	1.30E-02	5.69E-03	1.5E-13	39.2	93.1	27.30	0.07
	1220-01	23.38	1.36E-02	1.37E-03	4.7E-13	37.4	98.2	27.30	0.04
	1220-07	23.12	1.21E-02	4.15E-04	1.3E-13	42.1	99.4	27.34	0.04
	1220-09	23.81	1.43E-02	2.68E-03	1.8E-13	35.8	96.6	27.35	0.05
	mean age						n=10	**27.23**	**0.09**
	isnchron age		40Ar/36Ar=309.7 ±19.1		MSWD=3.2		n=10	27.22	0.09
2)	**Bloodgood Canyon Tuff, nm1t10, Escondido Mt quad, sanidine, J=0.000909 ±0.000001**								
	753-08	17.27	1.17E-02	3.25E-04	4.1E-15	43.6	99.3	27.91	0.06
	753-07	17.37	1.20E-02	6.42E-04	3.0E-15	42.7	98.8	27.92	0.07
	753-05	17.38	3.65E-02	6.39E-04	4.5E-15	14.0	98.8	27.95	0.07
	753-01	17.24	1.07E-02	1.19E-04	7.6E-15	47.6	99.7	27.96	0.06
	753-06	17.66	4.06E-02	1.51E-03	5.0E-15	12.6	97.4	27.98	0.07
	753-02	17.37	1.04E-02	1.83E-04	3.3E-15	49.1	99.6	28.15	0.08
	753-03	20.39	2.89E-02	1.03E-02	3.3E-15	17.7	84.9	*28.18*	0.09
	753-04	20.96	3.26E-02	1.20E-02	4.4E-15	15.7	83.0	*28.32*	0.10
	mean age						n=6	**27.98**	**0.09**
	isnchron age		40Ar/36Ar=311.8 ±4.4		MSWD=1.2		n=8	27.95	0.07
3)	**Vicks Peak Tuff, nm1102, Escondido Mt quad, sanidine, J=0.0009079 ±0.000001**								
	752-03	18.04	5.01E-02	1.66E-03	1.2E-15	10.2	97.2	28.49	0.10
	752-08	17.65	4.18E-02	3.22E-04	8.0E-16	12.2	99.4	28.49	0.13
	752-05	17.57	5.52E-03	5.01E-05	1.6E-15	92.4	99.8	28.50	0.09
	752-01	17.70	5.75E-03	3.67E-04	1.9E-15	88.7	99.3	28.55	0.09
	752-02	17.71	4.01E-02	3.82E-04	1.7E-15	12.7	99.3	28.56	0.09
	752-04	17.69	3.67E-02	2.65E-04	1.3E-15	13.9	99.4	28.59	0.09
	752-06	17.69	2.12E-02	-6.36E-05	2.2E-15	24.1	100.0	28.75	0.07
	752-07	18.00	7.75E-01	1.70E-04	3.2E-16	0.7	99.9	*29.23*	0.25
	mean age						n=7	**28.56**	**0.09**
	isnchron age		40Ar/36Ar=241.1 ±41.4		MSWD=1.2		n=7	28.61	0.08
4)	**Vicks Peak Tuff, nm1080, Mangas quad, sanidine, J=0.000761 ±0.000002**								
	989-08	21.28	5.20E-03	1.62E-03	1.2E-13	98.0	97.6	28.30	0.07
	989-01	21.38	2.16E-02	1.82E-03	2.9E-13	23.6	97.4	28.36	0.07
	989-11	21.59	5.48E-03	2.52E-03	2.2E-13	93.2	96.5	28.36	0.06
	989-09	21.49	6.97E-03	2.09E-03	2.8E-13	73.2	97.0	28.40	0.05
	989-03	21.19	5.25E-03	1.06E-03	2.8E-13	97.2	98.4	28.41	0.06
	989-06	21.57	5.40E-03	2.26E-03	1.4E-13	94.4	96.8	28.45	0.09
	989-07	21.14	4.55E-03	7.30E-04	1.9E-13	112.1	98.9	28.47	0.06
	989-10	21.86	5.56E-03	3.14E-03	1.5E-13	91.8	95.7	28.49	0.08
	989-02	22.30	5.58E-03	4.57E-03	1.5E-13	91.4	93.8	28.50	0.08
	989-05	22.02	9.40E-03	3.56E-03	2.8E-13	54.3	95.1	28.53	0.05
	989-04	21.26	4.64E-03	9.71E-04	3.3E-13	110.1	98.5	28.53	0.05
	mean age						n=11	**28.44**	**0.08**
	isochron age		40Ar/36Ar=307.9 ±16.8		MSWD=2.0		n=11	28.40	0.09
5)	**Vicks Peak Tuff, ANDSNMTN-6, Crasby Springs quad, sanidine , J=0.0006614 ±0.000002**								
	1219-05	25.50	1.27E-02	5.46E-03	2.2E-13	40.3	93.6	28.26	0.07
	1219-02	26.35	4.83E-03	8.29E-03	2.5E-13	105.6	90.6	28.27	0.07
	1219-07	26.53	4.95E-03	8.82E-03	1.1E-13	103.0	90.1	28.30	0.06
	1219-09	31.56	4.25E-03	2.56E-02	1.1E-13	120.1	75.9	28.37	0.10
	1219-01	27.52	5.83E-03	1.19E-02	1.6E-13	87.5	87.1	28.37	0.07
	1219-08	24.26	1.83E-02	8.39E-04	2.0E-13	27.9	98.9	28.41	0.04
	1219-03	25.87	9.82E-03	6.24E-03	1.8E-13	51.9	92.8	28.42	0.07
	1219-10	24.56	5.19E-03	1.71E-03	2.3E-13	98.4	97.8	28.46	0.05
	1219-04	24.63	1.47E-02	1.71E-03	1.3E-13	34.7	97.9	28.54	0.05
	1219-06	25.30	8.28E-03	3.74E-03	2.8E-13	61.6	95.5	28.61	0.05
	mean age						n=10	**28.40**	**0.12**
	isnchron age		40Ar/36Ar=288.4 ±5.6		MSWD=4.4		n=10	28.46	0.10
6)	**La Jeacia Tuff, ESGLFMT-1, Crosby Springs quad, sanidine, J=0.0007585 ±0.000002**								
	991-01	22.79	2.27E-02	6.66E-03	4.3E-13	22.5	91.3	28.25	0.10
	991-08	21.00	1.65E-02	1.07E-04	1.8E-13	30.9	99.8	28.45	0.07
	991-02	21.99	1.63E-02	3.35E-03	2.6E-13	31.4	95.4	28.47	0.09
	991-03	27.22	1.62E-02	2.08E-02	3.0E-13	31.5	77.3	28.57	0.12
	991-06	21.59	1.42E-02	1.70E-03	2.8E-13	36.0	97.6	28.60	0.05
	991-09	21.21	1.46E-02	3.87E-04	2.4E-13	34.9	99.4	28.61	0.06
	991-07	21.21	1.35E-02	2.84E-04	3.0E-13	37.9	99.5	28.65	0.08
	991-05	21.77	1.58E-02	2.01E-03	4.5E-13	32.3	97.2	28.72	0.09
	991-13	21.25	1.96E-02	1.39E-04	1.1E-13	26.0	99.7	28.76	0.07
	991-04	21.81	1.40E-02	2.01E-03	2.9E-13	36.5	97.2	28.78	0.10
	991-14	21.22	1.75E-02	1.43E-05	1.1E-13	29.1	99.9	28.78	0.07
	991-11	21.28	1.47E-02	8.98E-05	1.7E-13	34.8	99.8	28.82	0.08
	991-12	21.32	1.71E-02	1.13E-04	2.0E-13	29.8	99.7	28.87	0.06
	991-10	22.40	1.28E-02	9.39E-05	1.5E-13	39.8	99.8	*30.33*	0.07
	mean age						n=13	**28.64**	**0.18**
	isochron age		40Ar/36Ar=285.3 ±8.6		MSWD=5.2		n=13	28.68	0.09
7)	**tuff nf South Crosby Peak, upper ignimbrite member, ANDSNMTN-4, Crosby Springs quad, sanidine, J=0.0006609 ±0.000002**								
	1221-06	26.72	2.74E-02	8.78E-04	1.5E-13	18.6	99.0	31.25	0.06
	1221-10	27.50	1.26E-01	3.00E-03	1.5E-13	4.1	96.7	31.45	0.06
	1221-08	27.81	2.58E-01	4.02E-03	7.3E-14	2.0	95.7	31.46	0.09
	1221-04	27.07	8.21E-03	4.73E-04	1.8E-13	62.2	99.4	31.80	0.05
	1221-05	27.25	4.93E-02	1.08E-03	2.5E-13	10.4	98.8	31.81	0.05
	1221-03	27.25	8.01E-03	8.71E-04	1.4E-13	63.7	99.0	31.88	0.08
	1221-07	27.46	1.10E-02	1.12E-03	1.2E-13	46.3	98.7	32.03	0.06
	1221-02	28.08	5.95E-02	3.14E-03	1.4E-13	8.6	96.6	32.06	0.07
	1221-01	27.78	9.56E-03	1.69E-03	1.5E-13	53.3	98.1	32.22	0.06
	1221-09	29.82	2.20E-01	7.67E-03	1.8E-13	2.3	92.4	*32.56*	0.06
	mean age						n=10	31.85	0.39
	meao graias 06 to 08 - Caballo Blanco Tuff xenocrysts						n=3	**31.39**	**0.12**
	mean grains 04 to 01 - Hells Mesa Tuff xenocrysts						n=6	**31.97**	**0.17**
	isochron age 04-01		40Ar/36Ar=428.6 ±69.7		MSWD=6.4		n=6	31.75	0.15

APPENDIX 1 continued

Sample	Lab #	40/39	37/39	36/39	39K moles	K/Ca	%40*	Age	±1 σ
8)	**tuff of South Crosby Peak, middle ignimbrite member, ANDSNMTN-3, Crosby Springs quad, sanidine and plagioclase, J=0.0006589 ±0.000002**								
	1218-02	60.87	1.95E+00	1.22E-01	1.1E-14	0.3	41.0	*29.49*	0.61
	1218-04	36.66	1.59E+00	3.66E-02	1.5E-14	0.3	70.8	*30.62*	0.30
	1218-09	27.27	1.07E-02	9.94E-04	2.6E-13	47.5	98.8	31.76	0.05
	1218-08	28.72	2.65E-02	5.90E-03	1.4E-13	19.2	93.9	31.76	0.08
	1218-01	27.26	9.10E-03	4.37E-04	1.8E-13	56.0	99.4	31.94	0.05
	1218-05	27.60	1.13E-02	1.23E-03	1.0E-13	45.3	98.6	32.06	0.07
	1218-03	27.47	9.05E-03	5.67E-04	1.9E-13	56.4	99.3	32.14	0.07
	1218-06	27.35	8.26E-03	1.58E-04	2.2E-13	61.8	99.8	32.14	0.06
	1218-07	34.92	2.74E+00	2.28E-02	7.6E-15	0.2	81.3	*33.48*	0.50
	1218-10	33.44	3.74E-02	1.21E-02	6.7E-14	13.6	89.2	*35.12*	0.12
	mean age - Hells Mesa Tuff xenocrysts						n=6	**31.97**	**0.18**
	isochron age		40Ar/36Ar=256.7 ±37.4		MSWD=11.2		n=6	31.99	0.13
9)	**tuff nf South Crosby Peak, lower ignimbrite member, ANDSNMTN-2, Crosby Springs quad, plagioclase, J=0.0009107 ±0.000001**								
	743-06	18.33	1.29E+00	3.09E-03	2.8E-16	0.4	95.4	28.54	0.26
	743-03	18.50	1.39E+00	3.51E-03	1.0E-16	0.4	94.8	28.62	0.60
	743-07	18.31	1.37E+00	1.69E-03	7.2E-17	0.4	97.7	29.19	0.86
	743-04	18.53	1.31E+00	1.34E-03	4.0E-16	0.4	98.3	29.70	0.23
	743-08	18.30	1.51E+00	3.97E-04	8.8E-17	0.3	99.9	29.81	0.79
	743-01	18.37	1.55E+00	2.74E-04	5.7E-16	0.3	100.1	29.99	0.16
	743-05	20.39	1.77E+00	5.84E-03	3.1E-17	0.3	92.1	30.63	2.13
	743-02	18.41	1.39E+00	-1.56E-03	1.7E-16	0.4	103.0	30.90	0.43
	mean age						n=8	**29.67**	**0.86**
	isochron age		40Ar/36Ar=89.2 ±39.8		MSWD=4.0		n=8	29.84	0.17
10)	**Caballo Blanco Tuff, nm1078, Mangas quad, sanidine, J=0.000763 ±0.000002**								
	995-05	23.92	9.66E-03	2.97E-03	4.1E-13	52.8	96.2	31.41	0.05
	995-06	23.64	8.52E-03	1.99E-03	5.5E-13	59.9	97.4	31.42	0.11
	995-02	25.31	1.11E-02	7.58E-03	7.0E-13	45.8	91.1	31.45	0.11
	995-01	23.56	9.89E-03	1.63E-03	5.6E-13	51.6	97.9	31.46	0.07
	995-08	23.36	9.30E-03	8.05E-04	4.9E-13	54.9	98.9	31.53	0.08
	995-03	23.28	7.88E-03	4.52E-04	6.7E-13	64.7	99.3	31.55	0.10
	995-07	24.71	1.14E-02	5.02E-03	3.7E-13	44.9	93.9	31.66	0.07
	995-04	23.65	1.89E-02	9.16E-04	5.6E-13	27.0	98.8	31.87	0.06
	mean age						n=8	**31.54**	**0.15**
	isochron age		40Ar/36Ar=279.9 ±24.9		MSWD=7.1		n=8	31.61	0.14
11)	**Caballo Blanco Tuff, nm1079, Mangas Quad, sanidine, J=0.0007625 ±0.000002**								
	996-03	25.85	9.02E-03	9.74E-03	5.7E-13	56.5	88.8	31.30	0.17
	996-01	24.79	7.74E-03	5.96E-03	3.3E-13	65.9	92.8	31.37	0.10
	996-05	23.67	7.80E-03	2.07E-03	5.6E-13	65.4	97.3	31.42	0.13
	996-12	25.44	1.06E-02	8.01E-03	4.5E-13	48.0	90.6	31.44	0.11
	996-04	23.52	9.50E-03	1.51E-03	5.1E-13	53.7	98.0	31.44	0.05
	996-10	24.78	9.24E-03	5.72E-03	4.1E-13	55.2	93.1	31.46	0.06
	996-09	23.57	1.25E-02	1.61E-03	6.1E-13	40.9	97.9	31.47	0.08
	996-06	23.59	1.09E-02	1.61E-03	6.3E-13	46.9	97.9	31.48	0.07
	996-07	27.23	8.26E-03	1.40E-02	6.2E-13	61.8	84.8	31.48	0.12
	996-11	23.65	9.31E-03	1.81E-03	5.0E-13	54.8	97.6	31.49	0.07
	996-08	24.85	8.86E-03	5.87E-03	4.2E-13	57.6	92.9	31.49	0.07
	996-02	23.87	1.22E-02	2.04E-03	5.5E-13	41.9	97.4	31.70	0.08
	mean age						n=12	**31.46**	**0.09**
	isochron age		40Ar/36Ar=291.7 ±5.5		MSWD=1.1		n=12	31.50	0.09
12)	**Hells Mesa Tuff, ANDSNMT-1, Crosby Springs quad, sanidine, J=0.000759 ±0.000002**								
	1041-04	23.60	7.88E-03	5.35E-04	4.3E-13	64.8	99.2	31.79	0.05
	1041-01	23.81	8.78E-03	1.08E-03	3.9E-13	58.1	98.6	31.85	0.05
	1041-10	23.61	8.44E-03	2.14E-04	4.6E-13	60.4	99.6	31.93	0.05
	1041-08	23.79	8.59E-03	8.06E-04	3.5E-13	59.4	98.9	31.94	0.06
	1041-02	23.69	1.11E-02	4.18E-04	4.6E-13	45.8	99.4	31.96	0.04
	1041-03	24.49	1.10E-02	3.10E-03	3.3E-13	46.3	96.2	31.97	0.05
	1041-09	25.99	1.01E-02	8.16E-03	3.7E-13	50.8	90.6	31.97	0.05
	1041-05	23.73	1.04E-02	5.13E-04	2.6E-13	49.0	99.3	31.98	0.06
	1041-06	23.63	8.05E-03	1.66E-04	3.9E-13	63.4	99.7	31.98	0.05
	1041-07	24.13	8.84E-03	1.85E-03	3.6E-13	57.7	97.7	31.99	0.05
	mean age						n=10	**31.93**	**0.07**
	isochron age		40Ar/36Ar=300.7 ±6.6		MSWD=2.1		n=10	31.92	0.09
13)	**tuff of Luna, LGMSA-1,Largo Mesa quad, sanidiae, J=0.0007555 ±0.000002**								
	1040-07	25.36	9.51E-03	2.55E-03	2.5E-13	53.6	96.9	33.21	0.06
	1040-02	24.77	1.02E-02	4.17E-04	3.4E-13	50.2	99.4	33.26	0.05
	1040-10	25.68	7.75E-03	3.50E-03	1.5E-13	65.8	95.9	33.26	0.06
	1040-04	24.86	9.00E-03	4.29E-04	3.2E-13	56.7	99.4	33.37	0.05
	1040-06	24.86	9.17E-03	4.15E-04	2.8E-13	55.6	99.4	33.38	0.06
	1040-01	25.76	9.02E-03	3.39E-03	3.7E-13	56.5	96.0	33.41	0.06
	1040-09	27.18	9.67E-03	8.05E-03	3.1E-13	52.8	91.2	33.46	0.06
	1040-05	24.98	9.33E-03	6.09E-04	2.4E-13	54.7	99.2	33.46	0.07
	1040-03	24.95	9.68E-03	2.84E-04	1.7E-13	52.7	99.6	33.55	0.06
	1040-08	25.11	9.26E-03	8.06E-04	3.4E-13	55.1	99.0	33.56	0.06
	mean age						n=10	**33.39**	**0.12**
	isochron age		40Ar/36Ar=295.5 ±12.7		MSWD=5.6		n=10	33.38	0.10
14)	**Blue Canyon Tuff, nm1098, Cox Peak quad, saaidine, J=0.000909 ±0.000001**								
	738-04	20.65	1.67E-02	1.24E-04	8.3E-15	30.5	99.7	33.46	0.06
	738-08	20.81	1.73E-02	5.14E-04	6.7E-15	29.5	99.2	33.53	0.07
	738-02	20.78	1.75E-02	3.23E-04	3.7E-15	29.1	99.4	33.58	0.08
	738-05	20.73	1.72E-02	8.98E-05	5.1E-15	29.7	99.8	33.61	0.07
	738-03	20.99	1.86E-02	9.26E-04	5.9E-15	27.4	98.6	33.62	0.08
	738-01	21.16	1.88E-02	1.51E-03	4.7E-16	27.2	97.8	33.62	0.19
	738-07	20.80	1.75E-02	2.71E-04	5.3E-15	29.1	99.5	33.63	0.07
	738-06	20.81	1.75E-02	2.34E-04	1.1E-14	29.2	99.6	33.66	0.07
	mean age						n=8	**33.59**	**0.06**
	isochron age		40Ar/36Ar=329.3 ±53.1		MSWD=1.2		n=8	33.56	0.08
15)	**Blue Canyon Tuff, nm1077, Mangas quad, sanidine, J=0.00076 ±0.000002**								
	1037-01	24.82	1.92E-02	2.38E-04	4.9E-13	26.5	99.6	33.59	0.07
	1037-07	24.95	1.62E-02	5.42E-04	5.1E-13	31.5	99.3	33.65	0.08
	1037-05	25.45	5.05E-02	2.11E-03	1.9E-13	10.1	97.5	33.70	0.07
	1037-06	24.98	1.77E-02	4.19E-04	4.0E-13	28.8	99.4	33.74	0.08
	1037-10	24.89	1.73E-02	5.97E-05	4.7E-13	29.5	99.8	33.75	0.06
	1037-08	24.90	1.78E-02	3.40E-05	3.9E-13	28.7	99.9	33.78	0.07

APPENDIX 1 continued

Sample	Lab #	40/39	37/39	36/39	39K moles	K/Ca	%40*	Age	±1 σ
	1037-02	24.92	1.74E-02	6.63E-05	3.8E-13	29.3	99.8	33.79	0.07
	1037-04	24.98	1.79E-02	1.84E-04	4.6E-13	28.4	99.7	33.83	0.06
	1037-09	25.70	3.56E-02	2.36E-03	1.4E-13	14.3	97.2	33.93	0.06
	1037-03	27.17	1.73E-02	3.63E-04	5.0E-13	29.4	99.5	*36.70*	0.08
	mean age						n=9		**33.75**	**0.10**
	isochron age		40Ar/36Ar=330.2 ±27.3		MSWD=2.6		n=9		33.73	0.10
16)	**Blue Canyon Tuff, nm-1076, Mangas quad, sanidine, J=0.000755 ±0.000002**									
	1039-10	25.05	1.34E-02	6.11E-04	3.0E-13	38.1	99.2	33.54	0.05
	1039-04	25.05	1.78E-02	5.75E-04	1.7E-13	28.7	99.2	33.55	0.06
	1039-02	25.02	1.80E-02	1.37E-04	6.1E-13	28.4	99.8	33.69	0.05
	1039-08	25.06	1.71E-02	1.80E-04	4.7E-13	29.8	99.7	33.72	0.06
	1039-09	25.05	1.75E-02	7.60E-05	5.2E-13	29.1	99.8	33.74	0.06
	1039-06	25.08	1.73E-02	1.23E-04	4.2E-13	29.6	99.8	33.77	0.06
	1039-07	25.07	1.73E-02	4.86E-05	3.6E-13	29.5	99.9	33.78	0.06
	1039-05	25.09	1.80E-02	7.62E-05	5.4E-13	28.4	99.8	33.80	0.06
	1039-03	25.27	1.73E-02	6.06E-04	6.4E-13	29.4	99.2	33.83	0.06
	1039-01	26.03	8.89E-03	1.21E-03	3.9E-13	57.4	98.5	*34.61*	0.05
	mean age						n=9		**33.71**	**0.10**
	isochron age		40Ar/36Ar=124.8 ±42.7		MSWD=3.3		n=9		33.77	0.10
17)	**Rockhouse Canyon Tuff, nm1097, Cox Peak quad, sanidine and plagioclase, J=0.0009085 ±0.000001**									
	736-07	21.03	1.48E-02	7.97E-05	1.3E-14	34.4	99.8	34.07	0.08
	736-08	21.22	5.64E-01	8.43E-04	2.9E-15	0.9	98.9	34.09	0.15
	736-02	21.11	1.73E-02	2.53E-04	1.1E-14	29.6	99.5	34.12	0.07
	736-04	21.09	1.59E-02	1.34E-04	1.2E-14	32.1	99.7	34.14	0.08
	736-03	21.11	1.49E-02	1.83E-04	9.2E-15	34.2	99.6	34.15	0.11
	736-06	21.18	1.63E-01	2.58E-04	2.8E-15	3.1	99.6	34.25	0.10
	736-05	21.15	1.58E-02	8.15E-05	1.1E-14	32.3	99.8	34.27	0.08
	736-01	21.23	1.79E-02	1.77E-04	1.2E-14	28.6	99.7	34.35	0.06
	mean age						n=8		34.18	0.10
	mean age - sanidines						n=6		**34.18**	**0.10**
	isochron age		40Ar/36Ar=227.0 ±85.8		MSWD=2.3		n=8		34.22	0.11
18)	**Rockhouse Canyon Tuff, nm1096, Cox Peak quad, sanidine and plagioclase, J=0.0009107 ±0.000001**									
	737-02	21.44	2.25E+00	3.95E-03	8.0E-16	0.2	95.3	33.30	0.48
	737-03	21.02	2.07E-02	2.16E-04	6.2E-15	24.6	99.6	34.08	0.12
	737-01	20.99	1.65E-02	2.39E-05	5.8E-15	31.0	99.9	34.11	0.07
	737-04	21.05	1.69E-02	8.83E-05	9.6E-15	30.1	99.8	34.18	0.10
	737-05	21.26	1.64E-02	7.72E-04	1.1E-14	31.2	98.8	34.19	0.09
	737-06	21.10	8.05E-01	4.78E-04	5.9E-16	0.6	99.5	34.20	0.17
	737-08	21.06	1.42E-02	-4.15E-05	5.6E-15	36.0	100.0	34.25	0.07
	737-07	21.45	6.74E-01	1.73E-04	1.3E-15	0.8	99.9	34.88	0.11
	mean age						n=8		34.15	0.43
	mean age - sanidines						n=5		**34.16**	**0.07**
	isochron age		40Ar/36Ar=294.3 ±71.6		MSWD=0.7		n=6		34.17	0.08

Bishop Peak Tuff

19)	**tuff of Bishop Peak,nm1112, Gallo Mts West quad, sanidine and plagioclase, J=0.0007575 ±0.000002**								
	992-12	26.25	7.63E-02	2.24E-03	7.1E-14	6.7	97.4	34.62	0.09
	992-01	25.76	3.87E-02	2.08E-04	1.8E-13	13.2	99.7	34.75	0.08
	992-05	26.23	3.85E-02	1.80E-03	1.4E-13	13.3	97.9	34.76	0.08
	992-04	26.59	3.00E-01	3.06E-03	9.8E-14	1.7	96.6	34.77	0.08
	992-13	26.02	4.05E-02	9.66E-04	1.4E-13	12.6	98.8	34.81	0.08
	992-09	26.07	4.60E-02	9.95E-04	1.5E-13	11.1	98.8	34.87	0.08
	992-11	26.11	4.58E-02	1.07E-03	1.1E-13	11.2	98.7	34.89	0.08
	992-08	26.19	4.85E-02	1.18E-03	9.6E-14	10.5	98.6	34.95	0.08
	992-10	27.17	2.07E-01	4.54E-03	7.0E-14	2.5	95.0	34.96	0.13
	992-07	26.23	2.67E-01	7.82E-04	4.9E-14	1.9	99.1	35.19	0.12
	992-03	46.79	1.14E+00	7.06E-02	2.4E-14	0.4	*55.6*	*35.22*	0.39
	992-02	27.43	6.07E-01	4.83E-03	3.6E-14	0.8	94.9	*35.24*	0.16
	992-06	49.74	1.25E+00	7.77E-02	3.5E-14	0.4	*54.0*	*36.36*	0.32
	meaa age						n=11		34.89	0.19
	meaa age - plagioclase						n=3		35.61	0.66
	mean age - sanidines						n=6		**34.84**	**0.08**
	isochron age		40Ar/36Ar=282.0 ±32.0		MSWD=3.0		n=10		34.86	0.12
20)	**tuff of Bishop Peak, GMW-1-93, Gallo Mts West quad, sanidine, J=0.004019 ±0.00001**									
	291-05A	4.85	4.06E-02	7.97E-05	7.6E-17	12.6	99.1	34.56	0.10
	291-04A	4.87	4.10E-02	1.02E-04	8.2E-17	12.4	99.0	34.61	0.10
	291-06A	4.88	4.67E-02	5.09E-05	1.1E-16	10.9	99.3	34.83	0.08
	291-03A	4.92	4.58E-02	6.78E-05	1.0E-16	11.1	99.2	35.07	0.08
	291-01A	4.93	4.42E-02	8.28E-05	4.9E-17	11.5	99.1	35.10	0.11
	291-08A	4.95	2.54E-01	2.10E-04	7.9E-17	2.0	98.7	35.12	0.09
	291-02A	4.93	5.40E-02	6.08E-05	8.3E-17	9.5	99.3	35.17	0.08
	291-07A	4.95	4.44E-02	3.52E-05	2.1E-16	11.5	99.4	35.31	0.08
	mean age						n=8		**34.97**	**0.28**
	isochron age		40Ar/36Ar=601.6 ±280.7		MSWD=12.1		n=8		34.68	0.22
21)	**Datil Well Tuff, nm1095, Cox Peak quad, sanidine, J=0.0009068 ±0.000001**									
	1072-02	25.95	4.23E+00	2.28E-02	7.7E-15	0.1	75.2	*31.73*	0.35
	1072-04	21.66	2.49E-03	3.21E-03	4.3E-15	205.1	95.5	*33.54*	0.64
	741-02	21.77	3.84E-02	1.22E-03	3.5E-15	13.3	98.3	34.66	0.09
	741-03	21.56	3.30E-02	-8.67E-05	4.8E-16	15.5	100.0	34.95	0.19
	1072-05	22.01	3.72E-02	1.42E-03	1.5E-14	13.7	98.0	34.96	0.21
	1072-03	21.79	3.29E-02	6.70E-04	1.3E-14	15.5	99.0	34.96	0.21
	1072-07	21.81	4.13E-02	3.86E-04	5.7E-14	12.4	99.4	35.13	0.08
	1072-06	22.03	2.00E-02	9.31E-04	1.6E-14	25.5	98.7	35.20	0.20
	1072-01	23.56	4.18E-02	4.38E-03	7.3E-14	12.2	94.4	*36.03*	0.07
	mean age						n=6		**34.98**	**0.19**
	isochron age		40Ar/36Ar=195.9 ±88.7		MSWD=3.4		n=6		35.09	0.17

VOLCANICLASTIC UNITS

22)	**volcaniclastic unit of Canon del Leon, CDL 10/2-4, Escondido Mt quad, upper, pumice clasts from siltstone, sanidine and plagioclase, J=0.0009106 ±0.000001**								
	744-05	21.69	1.18E+00	5.82E-03	1.2E-15	0.4	92.4	32.65	0.13
	744-02	20.97	1.48E+00	1.97E-03	7.0E-16	0.3	97.7	33.37	0.14
	744-01	22.12	1.60E+00	5.40E-03	1.4E-16	0.3	93.2	33.61	0.45
	744-04	20.93	2.79E-02	-3.09E-04	8.3E-16	18.3	100.3	34.17	0.13

APPENDIX 1 continued

Sample	Lab #	40/39	37/39	36/39	39K moles	K/Ca	%40*	Age	±1 σ
	744-03	34.29	2.15E+00	1.28E-02	2.3E-15	0.2	89.4	49.74	0.21
	mean age						n=5		36.71	7.31
	mean age - plagioclase						n=3		33.21	0.50
	meaa age - sanidine						n=1		**34.17**	**0.13**
	isochron age		40Ar/36Ar=160.1 ±41.4		MSWD=7.2		n=4		33.95	0.25
23)	**volcaniclastic unit of Canon del Leon, CDL 10/2-9B, Escondido Mt quad, lower, ash bed, plagioclase, L#754: J=0.0009091 ±0.000001; L#756: J=0.0009076 ±0.000001**									
	754-01	22.71	1.64E+00	5.27E-03	1.9E-15	0.3	93.6	34.57	0.23
	754-02	27.62	1.50E+00	2.14E-02	9.1E-16	0.3	77.4	34.76	0.23
	754-04	24.12	1.75E+00	8.89E-03	8.5E-16	0.3	89.6	35.14	0.17
	754-03	22.37	1.75E+00	2.75E-03	1.4E-15	0.3	96.9	35.23	0.11
	754-05	24.00	1.95E+00	8.17E-03	1.5E-15	0.3	90.5	35.31	0.13
	754-06	23.85	1.80E+00	7.18E-03	5.0E-16	0.3	91.6	35.51	0.25
	756-02	22.78	1.95E+00	3.85E-03	1.1E-15	0.3	95.6	35.35	0.14
	756-01	23.52	1.85E+00	5.73E-03	1.0E-15	0.3	93.3	35.62	0.16
	mean age						n=8		**35.19**	**0.36**
	isochron age		40Ar/36Ar=280.8 ±12.6		MSWD=3.4		n=8		35.40	0.17
24)	**volcaniclastic unit of Canoa del Leon, CDL 10/2-11B, Escondido Mt quad, basal, pumice clasts from siltstoae, sanidine and plagioclase, J=0.0009058 ±0.000001**									
	742-02	23.39	1.59E+00	6.46E-03	1.5E-15	0.3	92.3	35.07	0.13
	742-01	22.84	1.82E+00	4.44E-03	3.4E-16	0.3	94.8	35.20	0.23
	742-03	22.02	1.75E+00	1.35E-03	2.1E-15	0.3	98.7	35.33	0.11
	742-07	23.26	2.63E+00	5.14E-03	2.3E-16	0.2	94.2	35.64	0.36
	742-06	23.29	2.77E+00	4.28E-03	7.9E-16	0.2	95.4	36.13	0.16
	742-04	36.74	3.97E+00	9.98E-03	1.5E-16	0.1	92.7	*55.17*	0.53
	mean age						n=5		**35.48**	**0.42**
	isochron age		40Ar/36Ar=290.2 ±64.8		MSWD=13.2		n=5		35.47	0.42
25)	**volcaniclastic unit of Canon del Leon, CR-93-1-XR, Largo Mesa quad, basal, pumice clasts from siltstone, plagioclase, J=0.0009088 ±0.000001**									
	746-08	23.96	1.23E+00	8.80E-03	2.6E-15	0.4	89.4	34.72	0.24
	746-03	22.75	1.77E+00	4.09E-03	2.6E-15	0.3	95.2	35.08	0.09
	746-07	24.38	1.83E+00	9.44E-03	1.5E-15	0.3	89.0	35.17	0.15
	746-02	22.17	1.60E+00	1.84E-03	1.8E-15	0.3	98.0	35.20	0.11
	746-05	22.09	7.38E-03	9.00E-04	1.5E-14	69.1	98.7	35.29	0.07
	746-04	21.90	7.44E-03	4.81E-05	1.5E-14	68.5	99.8	35.38	0.06
	746-06	23.95	2.96E+00	4.97E-03	8.0E-16	0.2	94.7	36.78	0.17
	746-01	31.49	1.81E+00	2.94E-02	2.4E-15	0.3	72.8	37.14	0.39
	mean age						n=8		35.59	0.87
	mean age - sanidines						n=2		**35.33**	**0.06**
	isochron age		40Ar/36Ar=316.6 ±26.9		MSWD=21.1		n=8		35.28	0.19
26)	**Dog Springs Fm, nm1115, tuff layer, Madre Mt quad, plagioclase and anorthoclase, L#751: J=0.0009068 ±0.000001; L#1254: J=0.0006689 ±0.000002**									
	751-06	22.23	1.74E-01	2.89E-03	4.5E-15	2.9	96.1	34.63	0.10
	751-01	23.93	7.53E-02	8.22E-03	3.3E-15	6.8	89.8	34.82	0.18
	751-03	21.79	2.89E-01	8.06E-04	2.4E-15	1.8	98.9	34.93	0.09
	751-04	21.69	1.44E-01	4.07E-04	5.9E-15	3.5	99.4	34.94	0.08
	751-05	22.78	1.29E-01	4.00E-03	3.0E-15	4.0	94.8	34.98	0.18
	751-08	22.04	2.43E-01	1.39E-03	4.3E-15	2.1	98.1	35.04	0.13
	751-02	22.32	5.36E-01	2.36E-03	2.6E-15	1.0	97.0	35.08	0.09
	751-07	24.45	9.52E-02	3.93E-03	4.5E-15	5.4	95.2	*37.67*	0.13
	1254-03	69.62	3.07E+00	1.30E-01	3.3E-14	0.2	45.1	37.57	0.34
	1254-08	78.22	1.62E+00	1.58E-01	4.2E-14	0.3	40.6	37.98	0.36
	1254-06	57.05	1.84E+00	8.53E-02	2.3E-14	0.3	56.0	38.23	0.39
	1254-07	41.57	1.87E+00	3.27E-02	3.4E-14	0.3	77.1	38.30	0.16
	1254-04	77.68	3.25E+00	1.55E-01	2.5E-14	0.2	41.3	38.37	0.44
	1254-02	58.63	1.65E+00	8.91E-02	5.5E-14	0.3	55.3	38.74	0.23
	1254-01	60.55	1.86E+00	9.50E-02	4.0E-14	0.3	53.9	38.98	0.30
	1254-05	112.78	3.20E+00	2.65E-01	1.4E-14	0.2	30.7	41.42	1.07
	meaa age - authigenic K-spar ?						n=7		34.92	0.15
	mean age - plagioclase						n=8		**38.70**	**1.18**
	isochron age - plag		40Ar/36Ar=294.4 ±3.2		MSWD=2.9		n=7		38.48	0.35
27)	**Dog Springs Fm, nm1121, tuff breccia, Crosby Springs quad, plagioclase and sanidine, J=0.0009061 ±0.000001**									
	740-06	26.04	3.21E+00	1.36E-02	2.8E-16	0.2	85.4	36.06	0.32
	740-07	27.75	2.71E+00	1.80E-02	1.7E-16	0.2	81.5	36.64	0.58
	740-08	22.95	4.82E-03	3.29E-04	8.5E-15	105.9	99.5	36.94	0.07
	740-01	25.61	2.99E+00	8.61E-03	2.8E-16	0.2	90.9	37.73	0.35
	740-03	27.97	2.91E+00	1.49E-02	2.6E-16	0.2	85.0	38.55	0.37
	740-02	25.12	3.07E+00	3.20E-03	1.1E-16	0.2	97.1	39.51	0.79
	mean age						n=6		37.57	1.29
	mean age - sanidine						n=1		**36.94**	**0.07**
	isochron age		40Ar/36Ar=322.5 ±36.9		MSWD=14.0		n=6		36.94	0.28

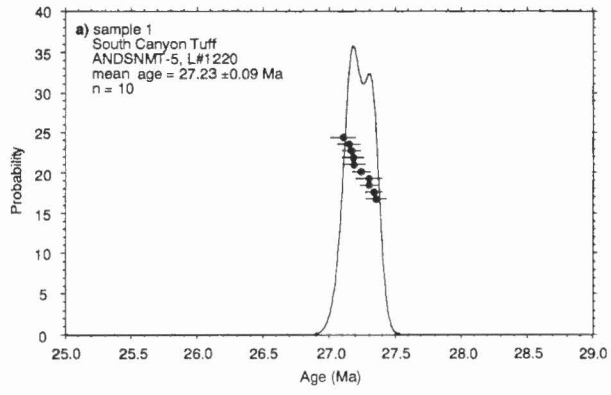
Intrusion

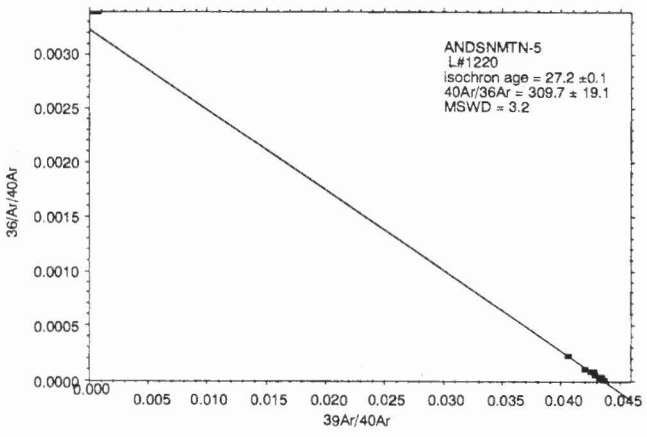
28)	**Cerrito Viejo, nm1114, quartz diorite intrusion, Sugarloaf Mt quad, plagioclase, J=0.0006652 ±0.000002**								
	1253-07	399.83	3.33E+00	1.27E+00	2.6E-14	0.2	5.9	27.96	2.15
	1253-01	40.83	4.65E+00	5.65E-02	1.4E-14	0.1	59.9	29.21	0.34
	1253-03	169.62	3.60E+00	4.90E-01	3.7E-14	0.1	14.7	29.80	0.82
	1253-04	159.68	3.75E+00	4.54E-01	2.5E-14	0.1	16.2	30.91	0.86
	1253-08	163.48	2.97E+00	4.65E-01	1.9E-14	0.2	16.2	31.49	1.33
	1253-06	98.81	3.04E+00	2.46E-01	2.6E-14	0.2	26.7	31.50	0.52
	1253-02	37.69	4.25E+00	3.84E-02	1.0E-14	0.1	70.7	31.79	0.42
	1253-05	59.32	4.43E+00	1.12E-01	1.8E-14	0.1	44.9	31.79	0.43
	mean age						n=8		**30.56**	**1.42**
	Isochron age		40Ar/36Ar=295.5 ±2.7		MSWD=7.3		n=8		30.75	0.65

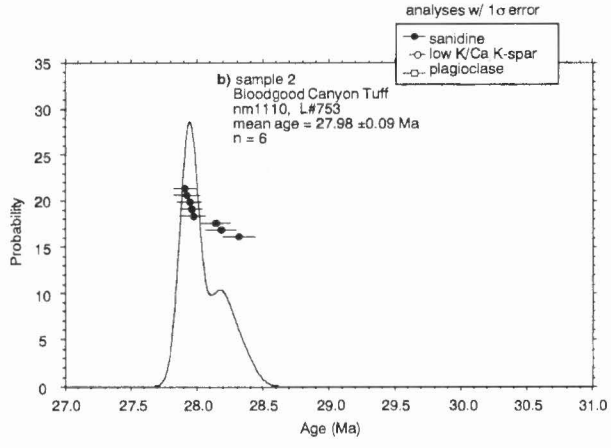
APPENDIX 2 - $^{40}Ar/^{39}Ar$ step-heating results from Quemado area samples are given below.

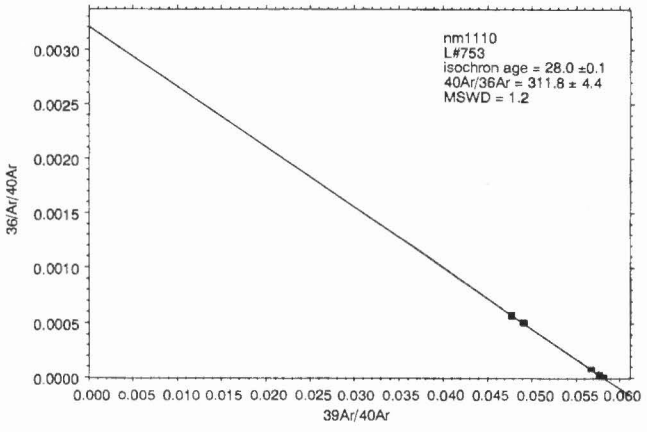
Sample	Lab #	Temp	40/39	37/39	36/39	39K moles	K/Ca	Cl/K	%40*	%39Ar	Age	± 1σ
29)	**basalt of Blue Mesa, BLUMSA-2, upper flow, D-Cross Mt quad, groundmass concentrate, J=0.0007612 ±0.000002**											
	1007-01A	550	1.47E+02	8.00E-01	4.82E-01	2.2E-14	6.4E-01	1.9E-01	3.0	1.9	6.02	1.08
	1007-01B	625	2.71E+01	6.96E-01	8.00E-02	8.1E-14	7.3E-01	1.5E-01	12.9	8.8	4.79	0.20
	1007-01C	725	6.08E+00	5.75E-01	9.24E-03	2.2E-13	8.9E-01	8.6E-02	55.5	28.1	4.63	0.03
	1007-01D	775	4.17E+00	6.04E-01	2.88E-03	1.3E-13	8.4E-01	5.3E-02	80.2	39.4	4.59	0.03
	1007-01E	800	4.08E+00	7.46E-01	2.42E-03	6.1E-14	6.8E-01	4.1E-02	83.4	44.6	4.67	0.05
	1007-01F	850	4.10E+00	8.59E-01	2.62E-03	5.1E-14	5.9E-01	5.0E-02	82.2	49.0	4.62	0.06
	1007-01G	900	4.26E+00	8.85E-01	2.51E-03	4.6E-14	5.8E-01	7.7E-02	83.6	53.0	4.89	0.07
	1007-01H	1000	4.26E+00	8.83E-01	2.93E-03	9.7E-14	5.8E-01	6.5E-02	80.8	61.3	4.73	0.04
	1007-01I	1200	4.45E+00	2.78E+00	4.34E-03	1.3E-13	1.8E-01	2.3E-02	75.4	72.6	4.61	0.04
	1007-01J	1400	4.43E+00	5.44E-01	5.23E-03	3.1E-13	9.4E-01	3.3E-02	65.5	99.6	3.98	0.10
	1007-01K	1625	7.72E+01	3.06E+01	2.52E-01	4.5E-15	1.7E-02	-2.3E-02	6.4	100.0	6.93	1.76
	total gas age					1.2E-12				n=11	4.52	0.09
	mean age of near-plateau steps									B to I	4.65	0.03
	isochron age						40Ar/36Ar=297.7 ±1.1		MSWD=71.8		**4.48**	**0.02**
29)	**basalt of Blue Mesa, BLUMSA-1, lower flow, D-Cross Mt quad, groundmass concentrate, J=0.0007643 ±0.000002**											
	1008-01A	550	3.58E+02	1.80E+00	1.20E+00	6.9E-15	2.8E-01	8.3E-02	1.0	0.9	4.91	4.71
	1008-01B	625	1.10E+02	1.57E+00	3.59E-01	2.2E-14	3.3E-01	6.3E-02	3.3	3.9	4.95	1.11
	1008-01C	725	4.29E+01	1.10E+00	1.34E-01	6.7E-14	4.6E-01	5.8E-02	7.9	13.0	4.66	0.32
	1008-01D	775	3.30E+01	8.91E-01	9.97E-02	5.6E-14	5.7E-01	4.6E-02	10.9	20.7	4.95	0.24
	1008-01E	800	3.85E+01	9.73E-01	1.16E-01	4.0E-14	5.2E-01	3.2E-02	11.0	26.1	5.84	0.31
	1008-01F	850	5.03E+01	1.17E+00	1.56E-01	4.6E-14	4.4E-01	4.7E-02	8.7	32.3	6.04	0.39
	1008-01G	900	3.58E+01	1.34E+00	1.07E-01	5.5E-14	3.8E-01	2.5E-02	11.9	39.8	5.87	0.28
	1008-01H	1000	2.11E+01	1.44E+00	5.81E-02	1.1E-13	3.5E-01	3.3E-03	19.0	55.1	5.52	0.15
	1008-01I	1200	1.16E+01	1.36E+00	2.72E-02	1.4E-13	3.8E-01	1.7E-03	31.2	73.8	4.97	0.07
	1008-01J	1400	1.14E+01	1.66E+01	2.80E-02	1.8E-13	3.1E-02	7.1E-03	38.2	97.7	6.05	0.08
	1008-01K	1636	3.69E+01	1.11E+01	1.14E-01	1.7E-14	4.6E-02	6.7E-03	10.7	100.0	5.48	0.43
	total gas age					7.3E-13				n=11	5.48	0.25
	disturbed spectrum									no plateau		
	isochron age						40Ar/36Ar=293.8 ±0.9		MSWD=19.4		**5.71**	**0.06**
31)	**Bearwallow Mt Andesite, STLRMS-2, basal lava, Slaughter Mesa quad, groundmass concentrate, J=0.0007656 ±0.000002**											
	1011-01A	550	5.69E+01	3.21E-01	1.35E-01	7.5E-14	1.6E+00	5.1E-02	29.8	4.6	23.3	0.3
	1011-01B	625	3.45E+01	5.12E-01	5.45E-02	1.5E-13	1.0E+00	3.9E-02	53.4	13.9	25.3	0.1
	1011-01C	725	2.39E+01	7.77E-01	1.58E-02	2.5E-13	6.6E-01	1.8E-02	80.6	29.1	26.4	0.1
	1011-01D	775	2.11E+01	8.51E-01	5.99E-03	1.8E-13	6.0E-01	6.2E-03	91.8	40.3	26.6	0.1
	1011-01E	800	2.02E+01	7.68E-01	3.36E-03	1.4E-13	6.6E-01	2.5E-03	95.3	49.0	26.4	0.1
	1011-01F	850	1.95E+01	7.05E-01	2.03E-03	1.8E-13	7.2E-01	1.3E-03	97.1	59.9	26.0	0.1
	1011-01G	900	1.93E+01	6.77E-01	1.42E-03	1.7E-13	7.5E-01	9.1E-04	98.0	70.2	26.0	0.1
	1011-01H	1000	1.93E+01	7.25E-01	1.50E-03	2.0E-13	7.0E-01	1.2E-03	97.9	82.5	26.0	0.1
	1011-01I	1200	1.99E+01	7.91E-01	4.19E-03	1.9E-13	6.4E-01	3.1E-03	94.0	94.2	25.7	0.1
	1011-01J	1400	2.19E+01	7.35E+00	1.21E-02	7.1E-14	6.9E-02	6.3E-03	86.1	98.6	26.0	0.1
	1011-01K	1626	3.81E+01	6.37E+00	6.64E-02	2.2E-14	8.0E-02	7.2E-03	49.8	100.0	26.1	0.3
	total gas age					1.6E-12				n=11	25.9	0.1
	mean age of near-plateau steps									C to J	26.1	0.1
	isochron age						40Ar/36Ar=286.1±1.1		MSWD=24.6		**26.1**	**0.1**
32)	**Squirrel Springs Canyon Andesite, STLRMS-1, Slaughter Mesa quad, groundmass concentrate, J=0.0007618 ±0.000002**											
	1012-01A	550	2.39E+02	8.65E-01	7.34E-01	1.7E-14	5.9E-01	5.0E-03	9.3	1.0	30.2	2.1
	1012-01B	625	5.72E+01	9.21E-01	1.18E-01	5.3E-14	5.5E-01	1.4E-03	39.2	4.3	30.6	0.3
	1012-01C	726	2.60E+01	7.62E-01	1.25E-02	1.9E-13	6.7E-01	5.8E-04	85.9	16.3	30.4	0.1
	1012-01D	775	2.20E+01	6.28E-01	1.56E-03	1.9E-13	8.1E-01	3.4E-04	98.0	28.3	29.4	0.1
	1012-01E	800	2.15E+01	5.31E-01	1.27E-03	1.6E-13	9.6E-01	4.4E-04	98.3	38.2	28.9	0.1
	1012-01F	850	2.13E+01	4.71E-01	1.28E-03	2.2E-13	1.1E+00	4.5E-04	98.3	52.1	28.5	0.1
	1012-01G	900	2.12E+01	4.31E-01	1.44E-03	2.2E-13	1.2E+00	6.4E-04	98.0	65.6	28.3	0.1
	1012-01H	1000	2.16E+01	4.00E-01	2.10E-03	2.4E-13	1.3E+00	1.8E-03	97.2	80.4	28.6	0.1
	1012-01I	1200	2.29E+01	6.01E-01	7.03E-03	2.0E-13	8.5E-01	4.1E-03	91.0	93.1	28.4	0.1
	1012-01J	1400	3.77E+01	1.29E+01	5.89E-02	3.4E-14	4.0E-02	4.5E-03	56.4	95.2	29.2	0.2
	1012-01K	1631	2.83E+01	7.56E+00	2.70E-02	7.7E-14	6.7E-02	2.2E-03	73.9	100.0	28.7	0.1
	total gas age					1.6E-12				n=11	29.0	0.1
	mean age of near-plateau steps									F-I	28.5	0.1
	isochron age						40Ar/36Ar=305.1 ±1.2		MSWD=54.43		**28.8**	**0.1**
33)	**andesite of San Antone Canyon, MNGSMT-1, Mangas Mt quad, groundmass concentrate, J=0.0007652 ±0.000002**											
	1013-01A	550	1.93E+02	5.23E-01	5.86E-01	3.1E-14	9.8E-01	6.3E-03	10.4	2.0	27.6	1.6
	1013-01B	625	5.53E+01	5.24E-01	1.11E-01	7.0E-14	9.7E-01	2.4E-03	40.8	6.5	30.8	0.3
	1013-01C	725	2.74E+01	4.71E-01	1.76E-02	2.2E-13	1.1E+00	7.8E-04	81.1	20.4	30.4	0.1
	1013-01D	775	2.27E+01	3.93E-01	2.53E-03	2.2E-13	1.3E+00	3.8E-04	96.7	34.7	30.1	0.1
	1013-01E	800	2.20E+01	3.47E-01	1.74E-03	1.7E-13	1.5E+00	4.5E-04	97.7	45.4	29.4	0.1
	1013-01F	850	2.18E+01	3.56E-01	1.34E-03	2.1E-13	1.4E+00	7.0E-04	98.2	58.9	29.3	0.1
	1013-01G	900	2.15E+01	3.85E-01	1.30E-03	2.0E-13	1.3E+00	1.0E-03	98.3	72.0	28.9	0.1
	1013-01H	1000	2.15E+01	5.60E-01	1.78E-03	2.5E-13	9.1E-01	3.1E-03	97.6	87.7	28.8	0.1
	1013-01I	1200	2.21E+01	1.02E+00	5.67E-03	1.2E-13	5.0E-01	8.3E-03	92.7	95.3	28.1	0.1
	1013-01J	1400	2.57E+01	7.00E+00	2.00E-02	3.2E-14	7.3E-02	2.1E-02	79.0	97.3	27.9	0.2
	1013-01K	1628	3.19E+01	6.25E+00	4.04E-02	4.2E-14	8.2E-02	2.6E-02	63.9	100.0	28.0	0.2
	total gas age					1.6E-12				n=11	29.3	0.1
	disturbed spectrum									no plateau		
	isochron age						40Ar/36Ar=300.3 ±1.2		MSWD=81.84		**29.2**	**0.1**

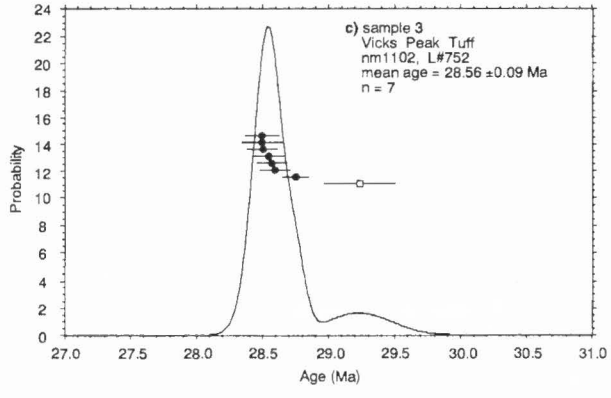
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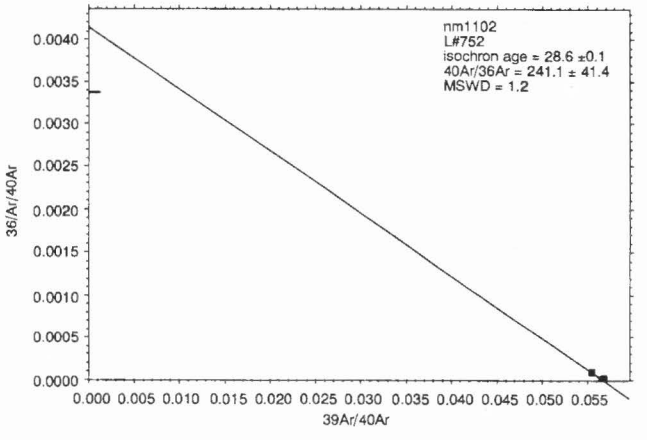

a) sample 1
South Canyon Tuff
ANDSNMT-5, L#1220
mean age = 27.23 ±0.09 Ma
n = 10
Probability
Age (Ma)

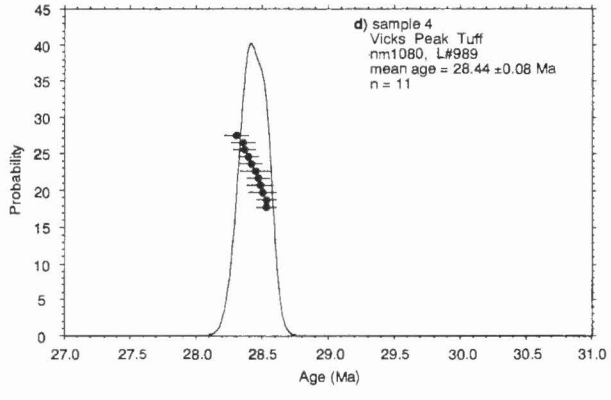

ANDSNMTN-5
L#1220
isochron age = 27.2 ±0.1
40Ar/36Ar = 309.7 ± 19.1
MSWD = 3.2
36/Ar/40Ar
39Ar/40Ar

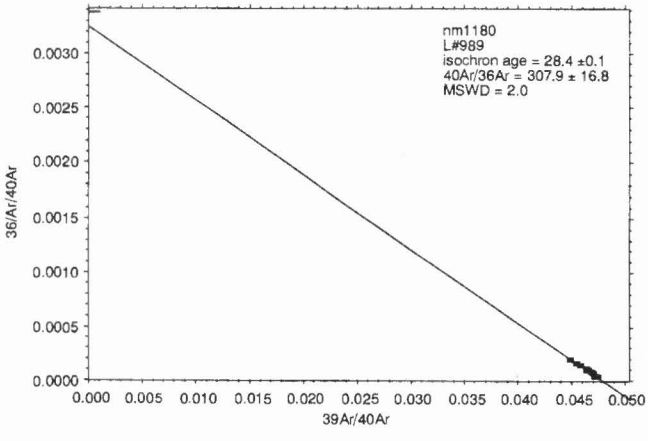

analyses w/ 1σ error
sanidine
low K/Ca K-spar
plagioclase
b) sample 2
Bloodgood Canyon Tuff
nm1110, L#753
mean age = 27.98 ±0.09 Ma
n = 6
Probability
Age (Ma)


nm1110
L#753
isochron age = 28.0 ±0.1
40Ar/36Ar = 311.8 ± 4.4
MSWD = 1.2
36/Ar/40Ar
39Ar/40Ar

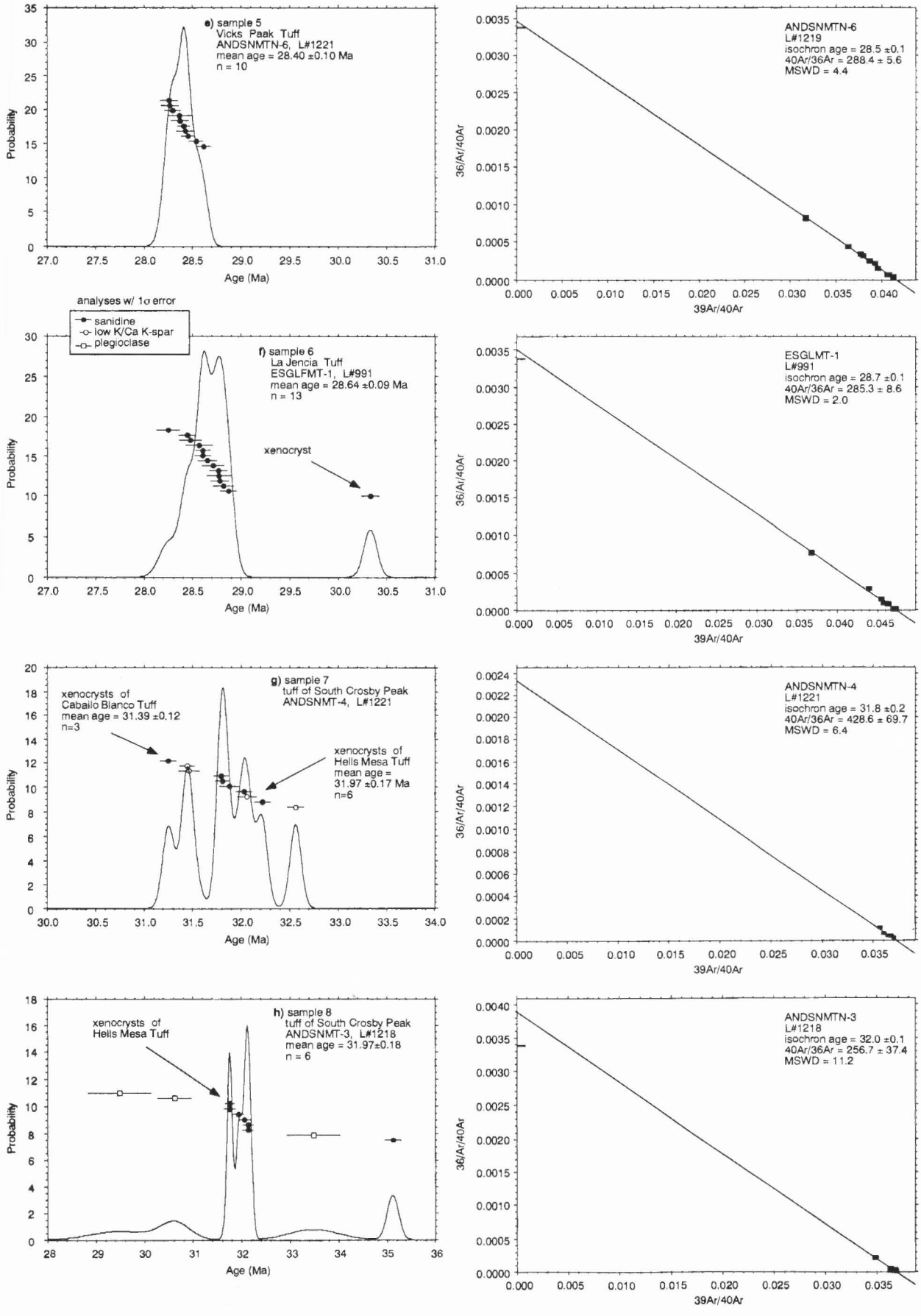

c) sample 3
Vicks Peak Tuff
nm1102, L#752
mean age = 28.56 ±0.09 Ma
n = 7
Probability
Age (Ma)


nm1102
L#752
isochron age = 28.6 ±0.1
40Ar/36Ar = 241.1 ± 41.4
MSWD = 1.2
36/Ar/40Ar
39Ar/40Ar

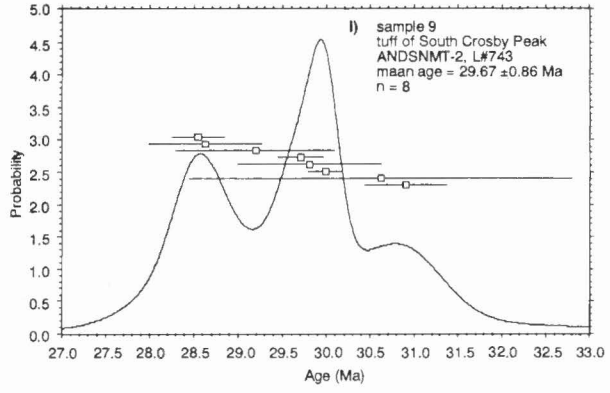

d) sample 4
Vicks Peak Tuff
nm1080, L#989
mean age = 28.44 ±0.08 Ma
n = 11
Probability
Age (Ma)

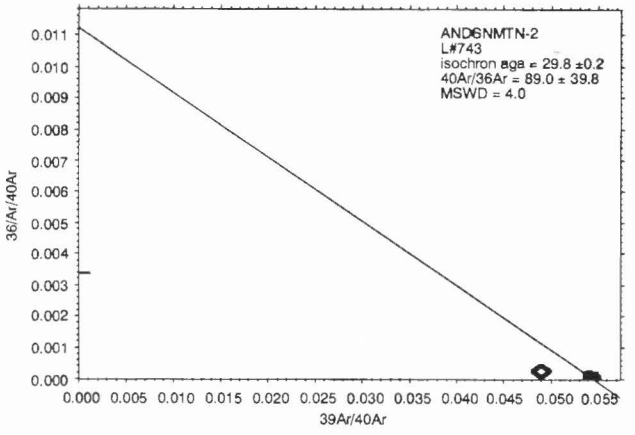

nm1180
L#989
isochron age = 28.4 ±0.1
40Ar/36Ar = 307.9 ± 16.8
MSWD = 2.0
36/Ar/40Ar
39Ar/40Ar

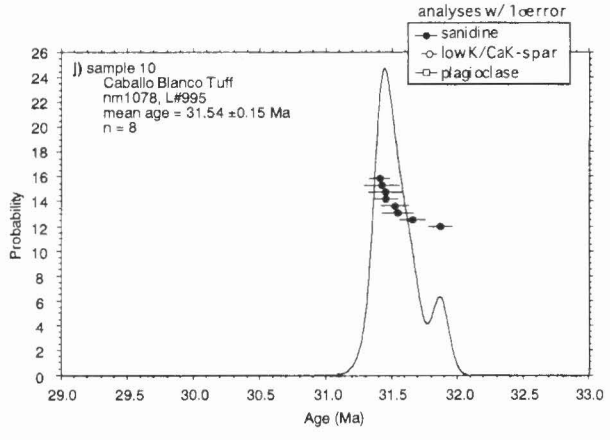
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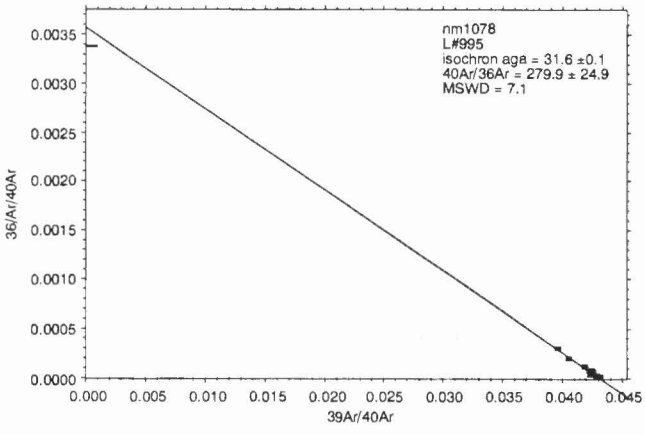


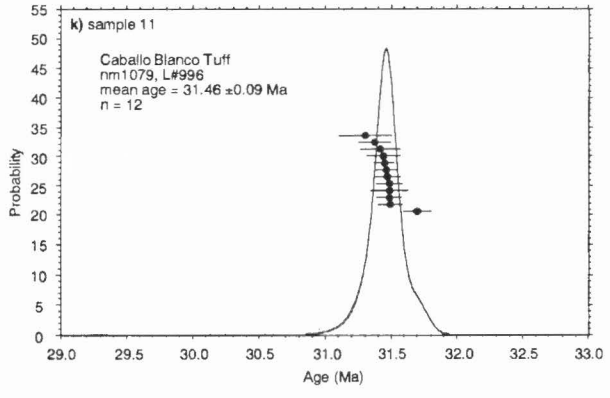
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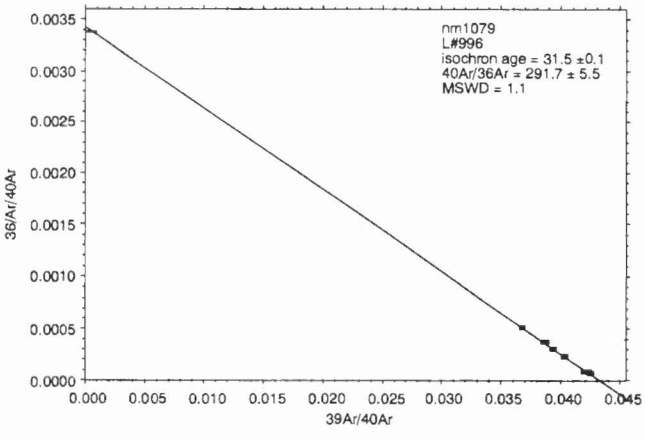


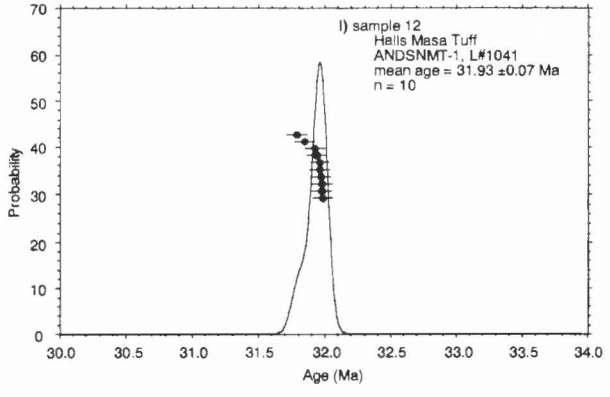


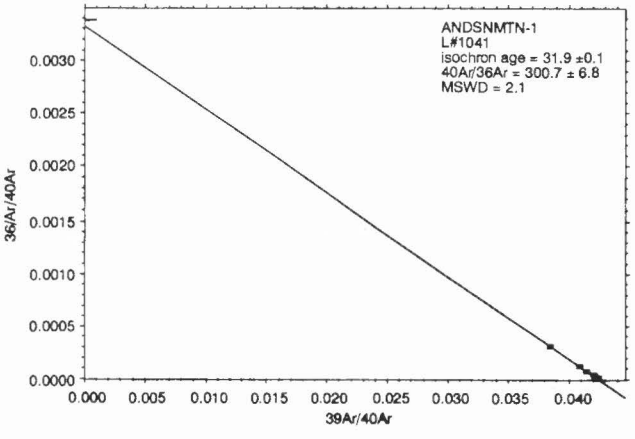




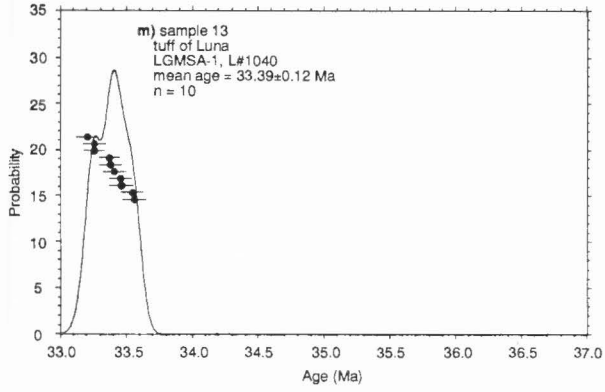


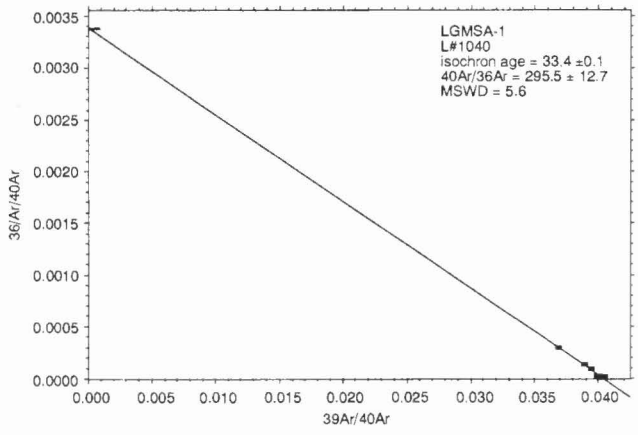


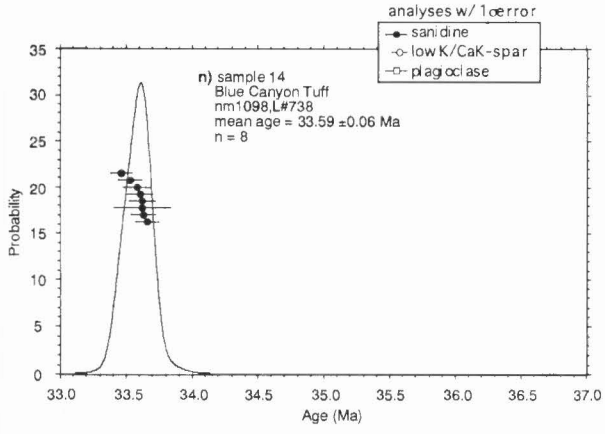


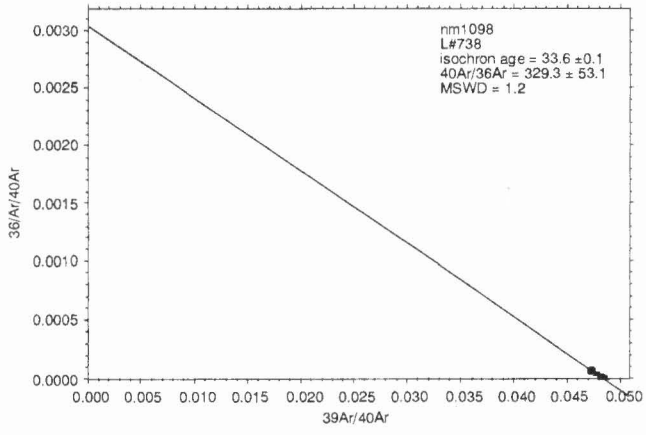


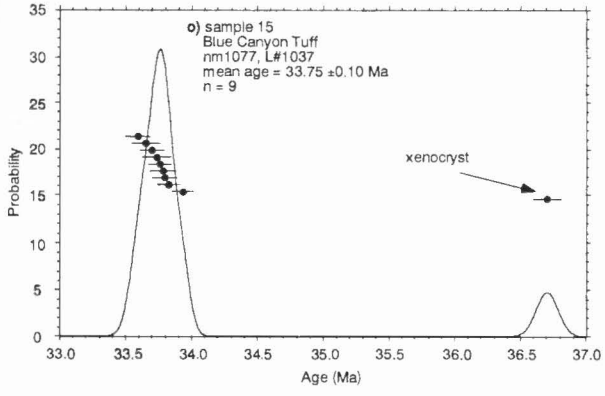
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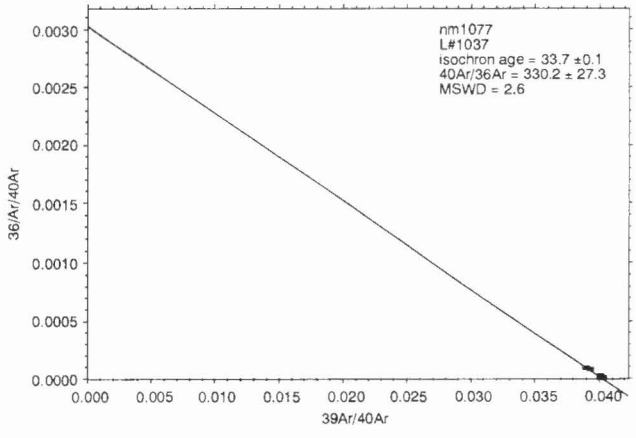


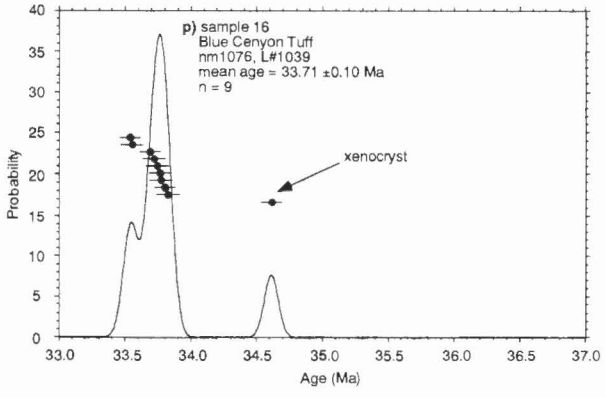


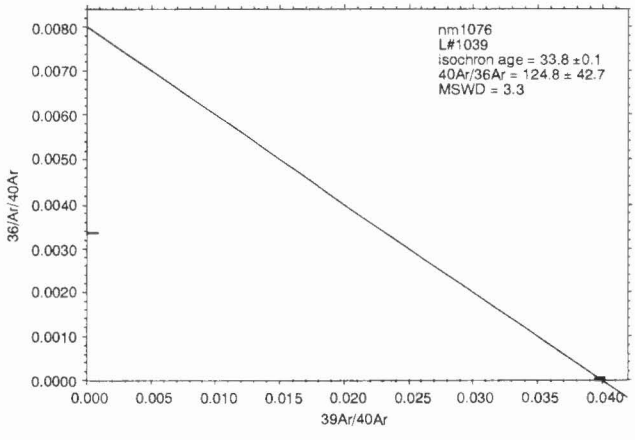




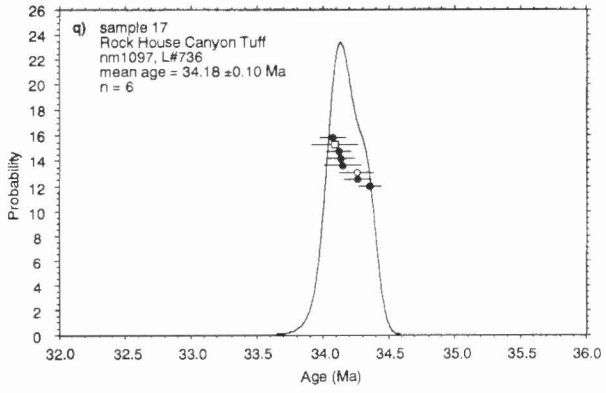


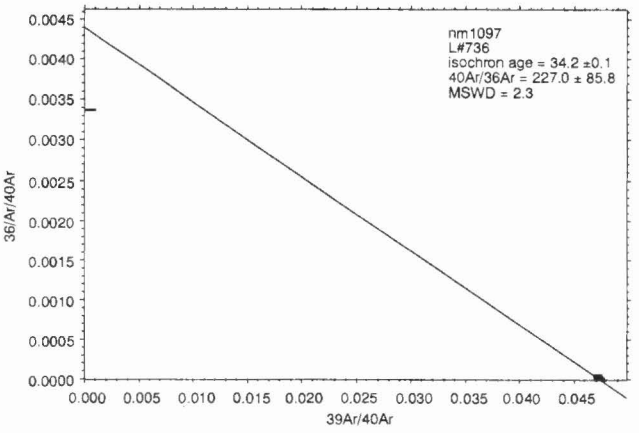


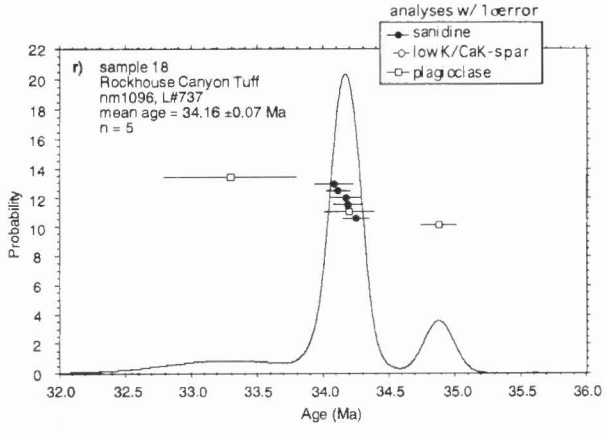


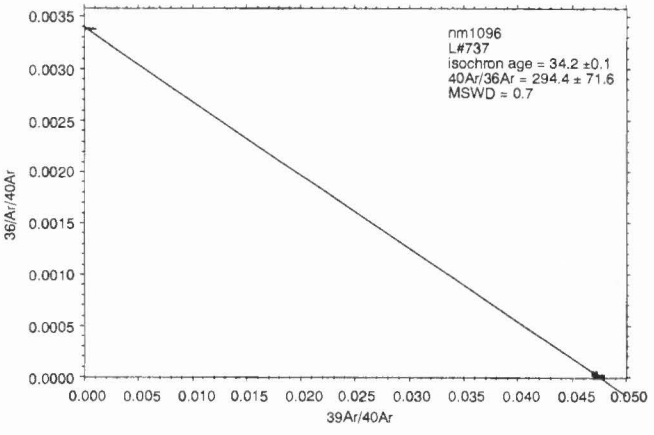


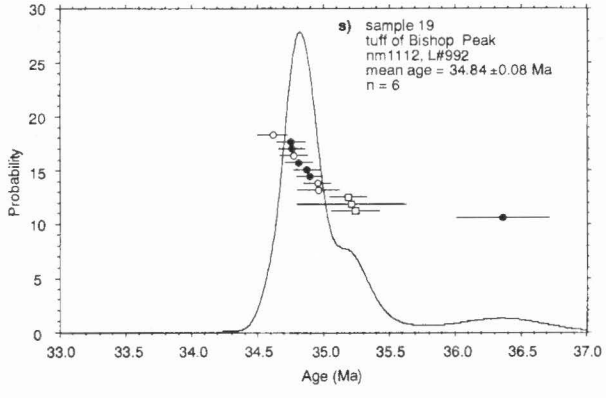
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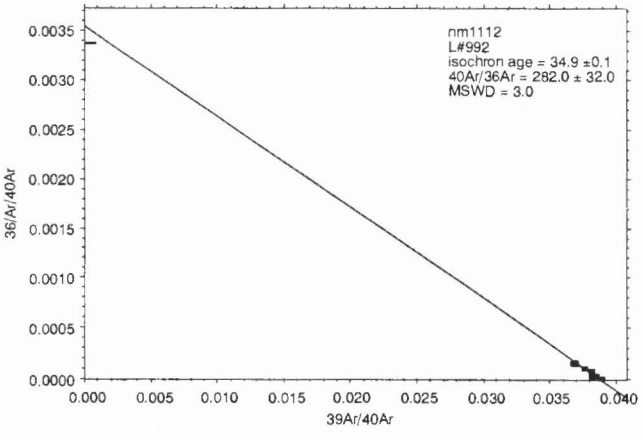


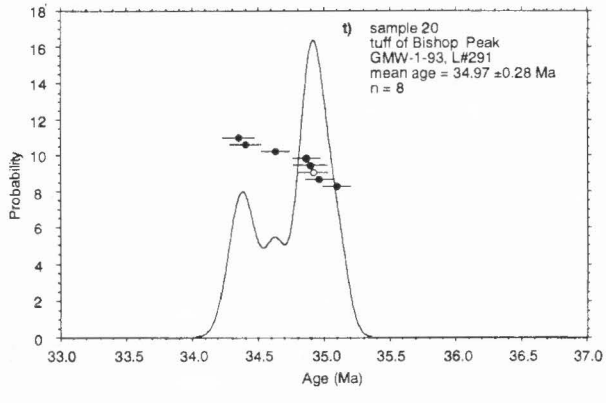


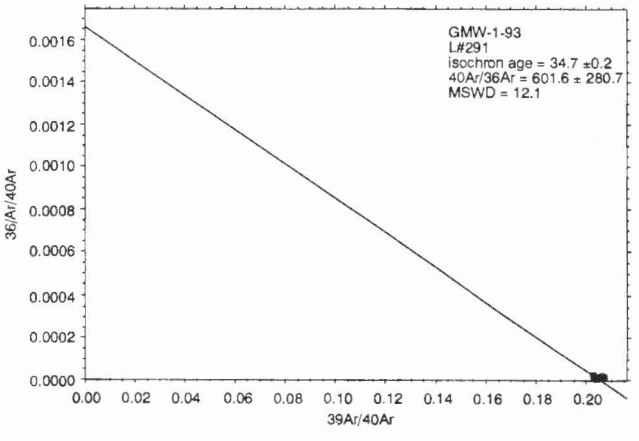




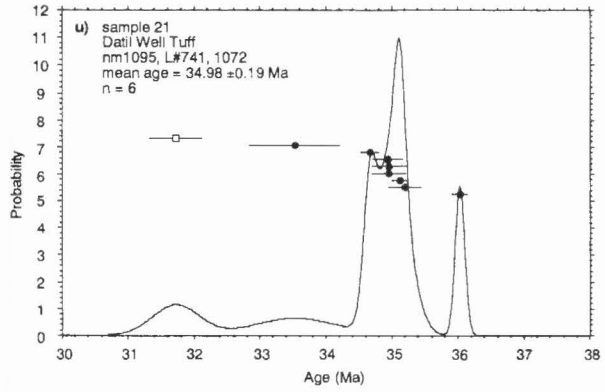


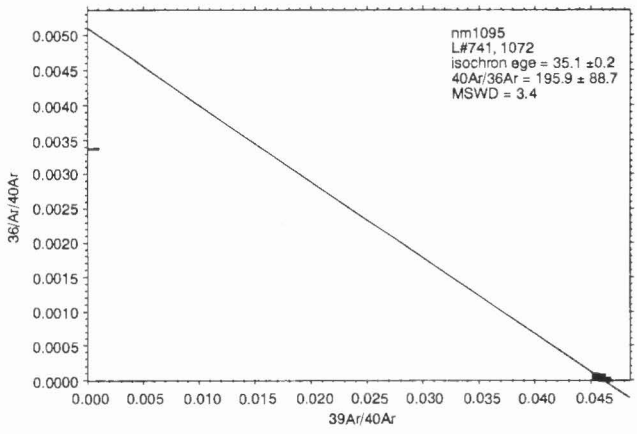


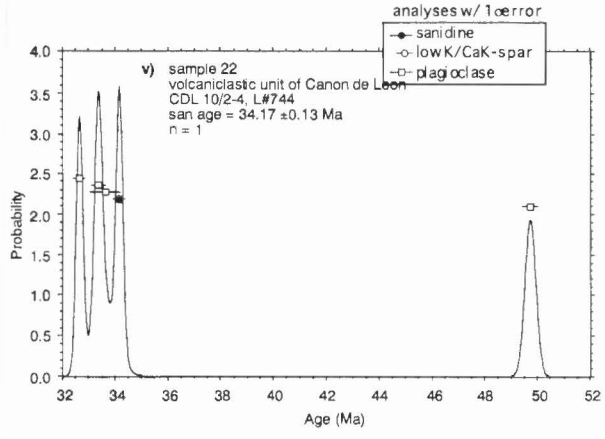


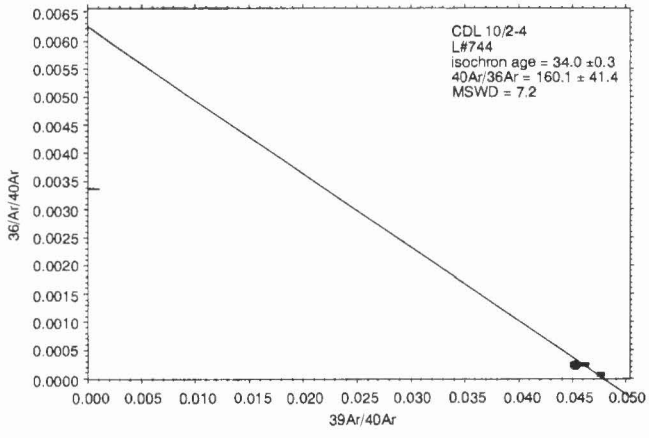


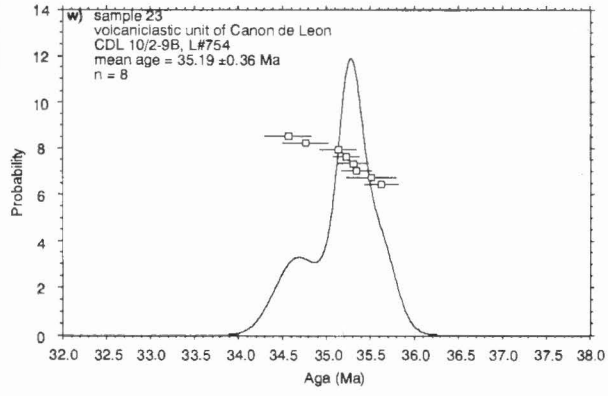
APPENDIX 3 continued

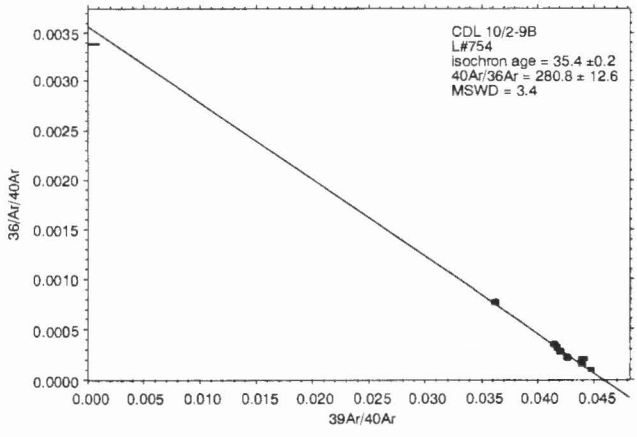


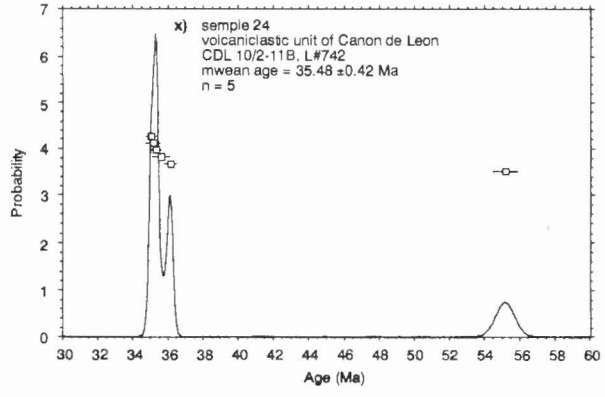


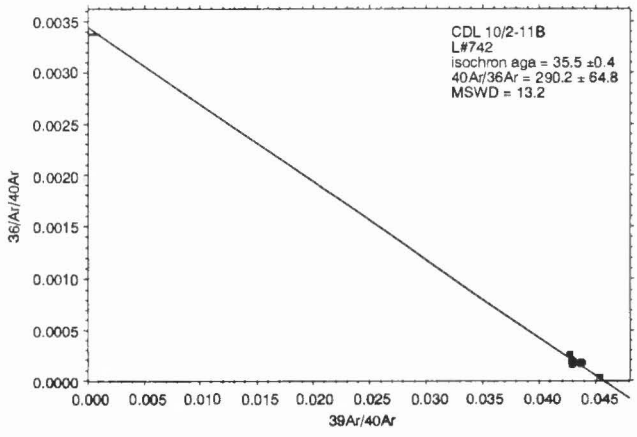




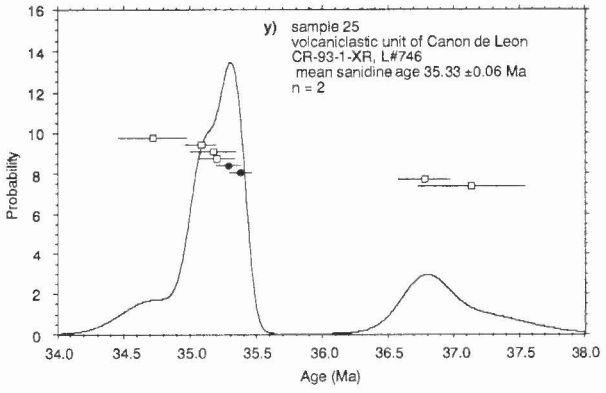


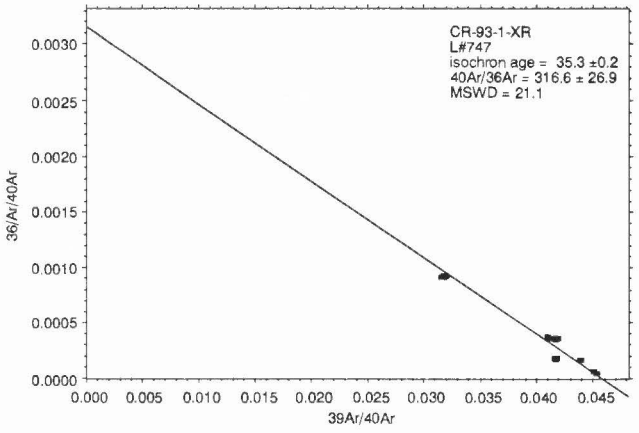


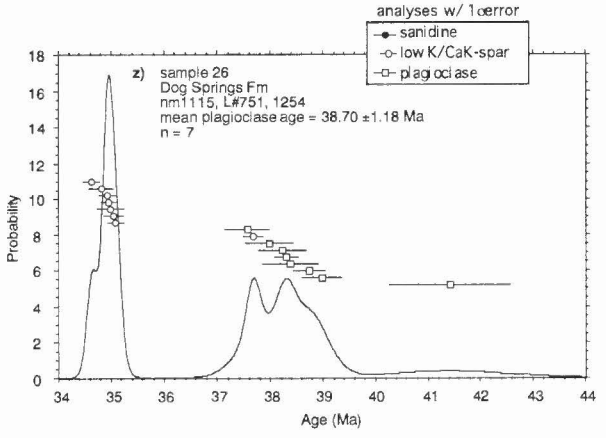


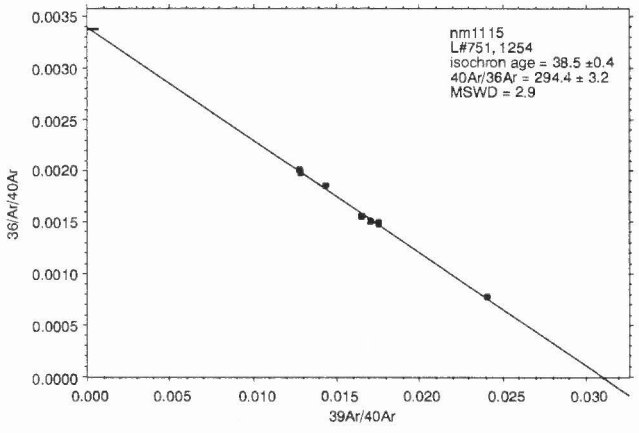


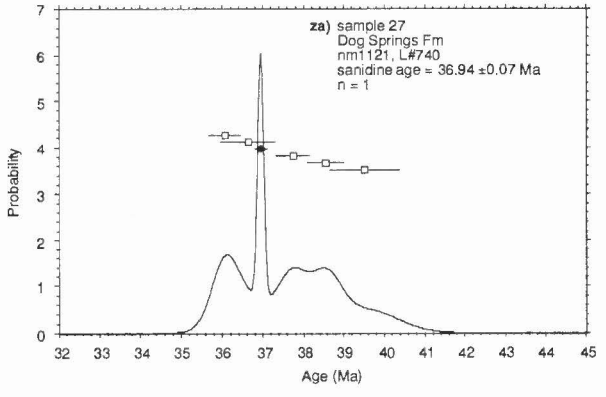
APPENDIX 3 continued

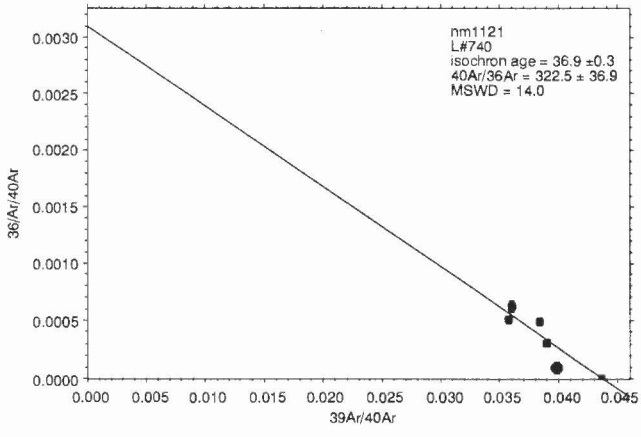


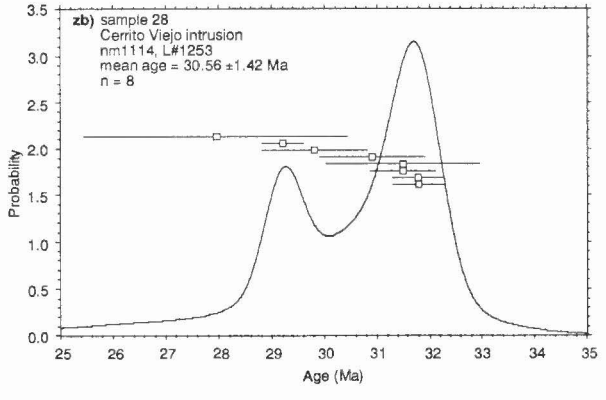


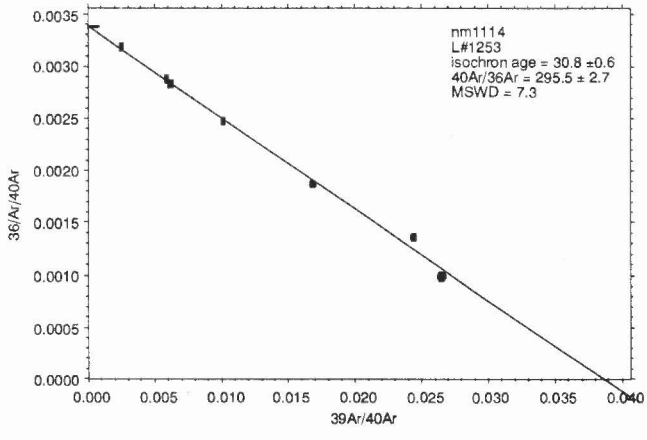




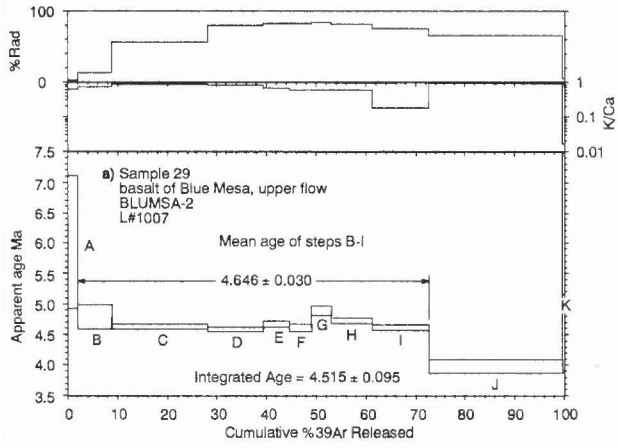


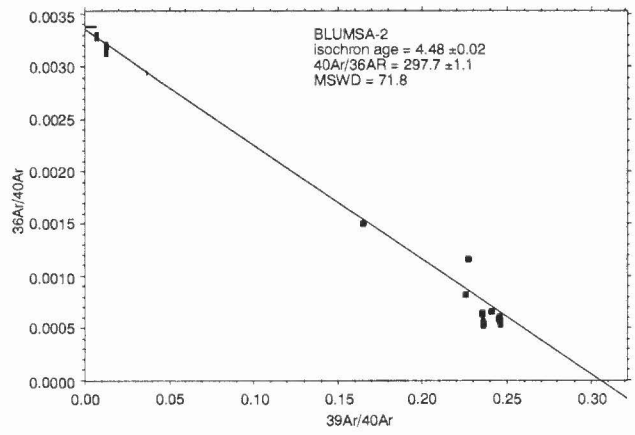


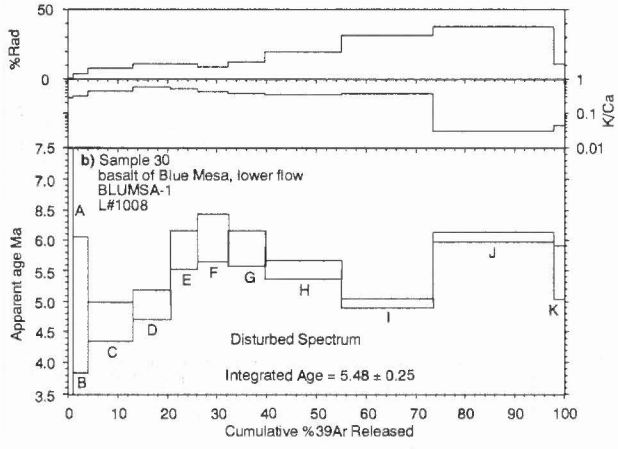


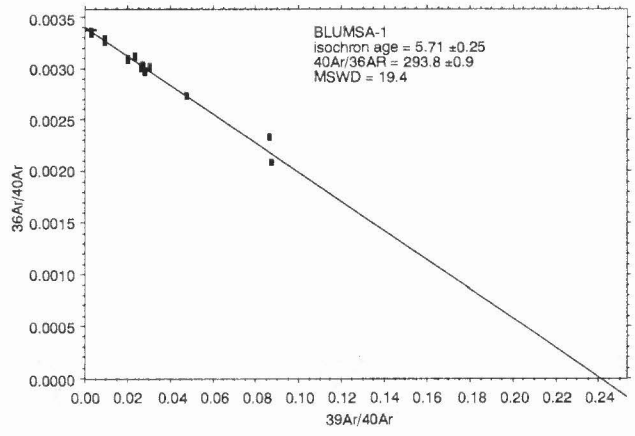


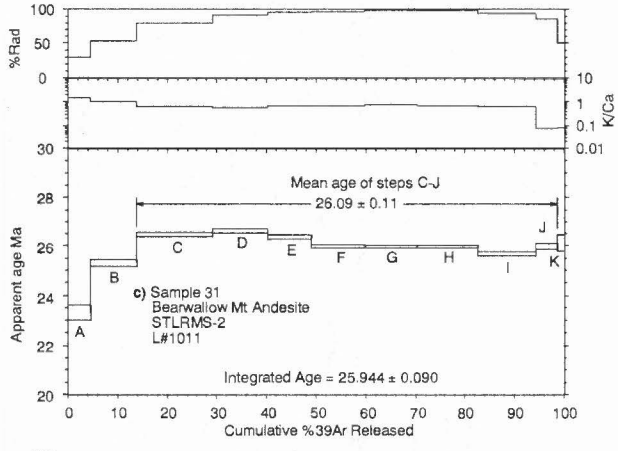
APPENDIX 4

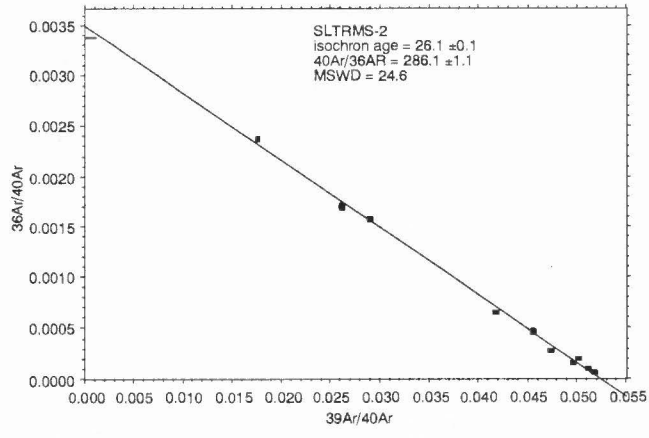

%Rad
K/Ca
Apparent age Ma
a) Sample 29
basalt of Blue Mesa, upper flow
BLUMSA-2
L#1007
Mean age of steps B-I
4.646 ± 0.030
Integrated Age = 4.515 ± 0.095
Cumulative %39Ar Released

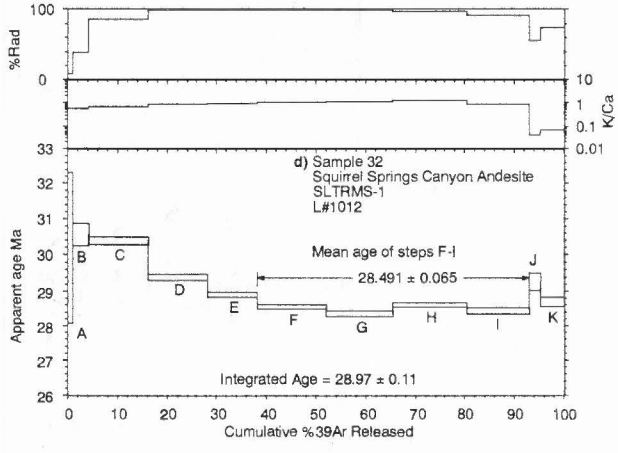

BLUMSA-2
isochron age = 4.48 ±0.02
40Ar/36AR = 297.7 ±1.1
MSWD = 71.8
36Ar/40Ar
39Ar/40Ar

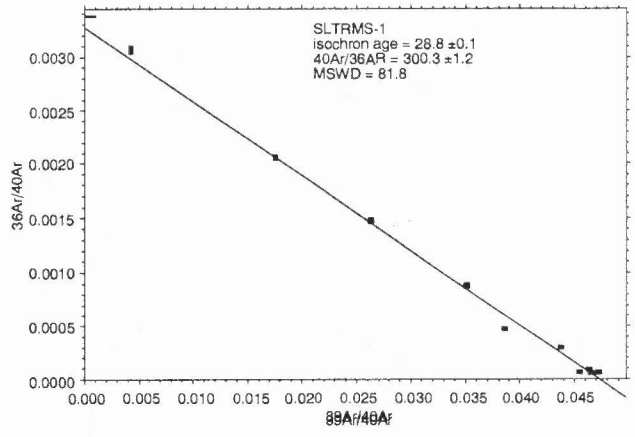

%Rad
K/Ca
Apparent age Ma
b) Sample 30
basalt of Blue Mesa, lower flow
BLUMSA-1
L#1008
Disturbed Spectrum
Integrated Age = 5.48 ± 0.25
Cumulative %39Ar Released


BLUMSA-1
isochron age = 5.71 ±0.25
40Ar/36AR = 293.8 ±0.9
MSWD = 19.4
36Ar/40Ar
39Ar/40Ar

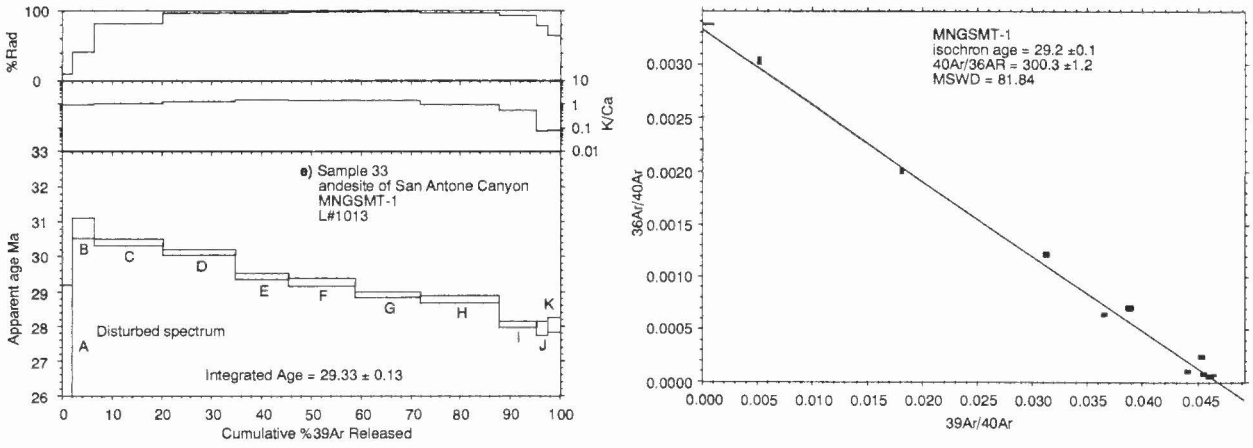

%Rad
K/Ca
Apparent age Ma
Mean age of steps C-J
26.09 ± 0.11
c) Sample 31
Bearwallow Mt Andesite
STLRMS-2
L#1011
Integrated Age = 25.944 ± 0.090
Cumulative %39Ar Released

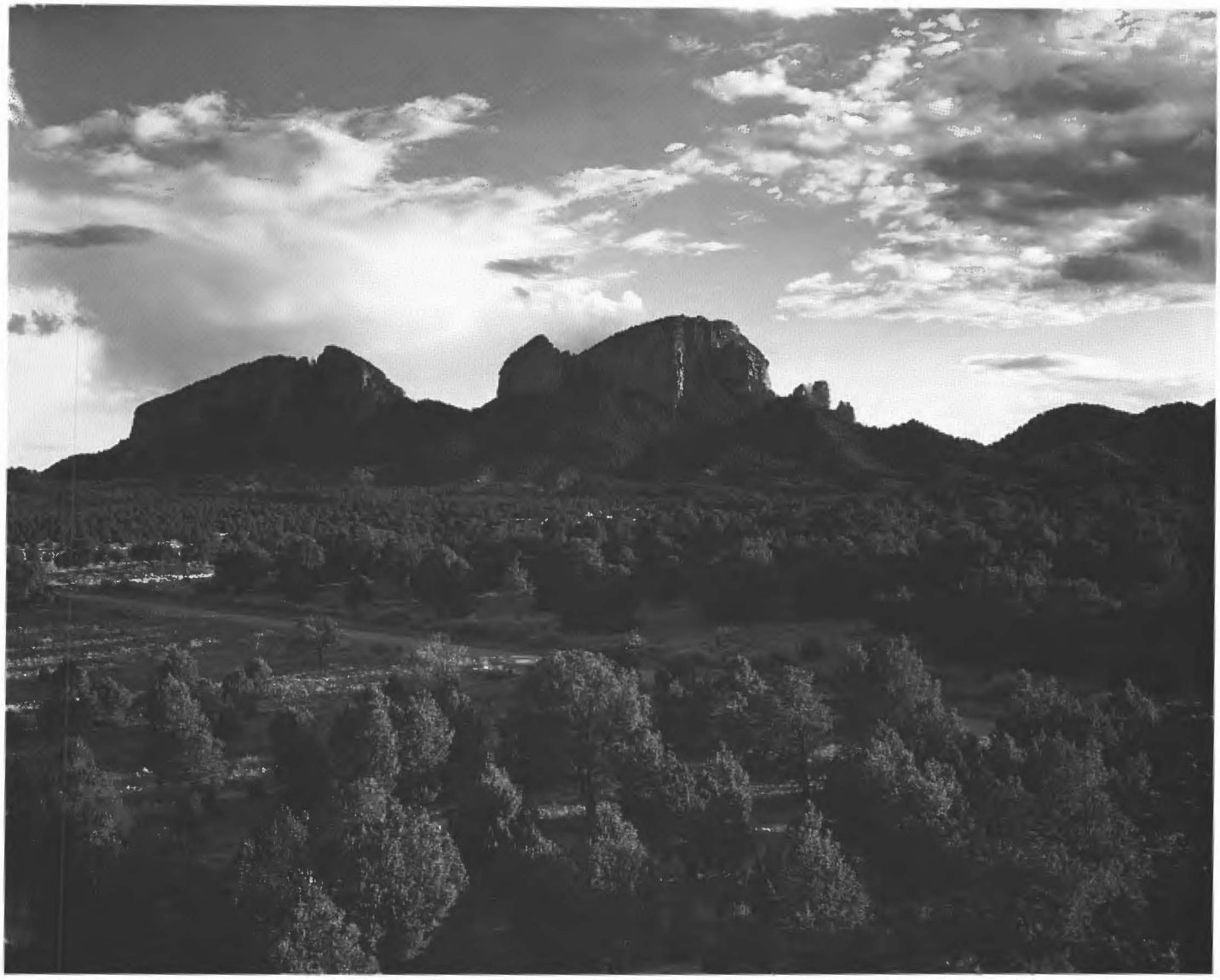

SLTRMS-2
isochron age = 26.1 ±0.1
40Ar/36AR = 286.1 ±1.1
MSWD = 24.6
36Ar/40Ar
39Ar/40Ar


%Rad
K/Ca
Apparent age Ma
d) Sample 32
Squirrel Springs Canyon Andesite
SLTRMS-1
L#1012
Mean age of steps F-I
28.491 ± 0.065
Integrated Age = 28.97 ± 0.11
Cumulative %39Ar Released


SLTRMS-1
isochron age = 28.8 ±0.1
40Ar/36AR = 300.3 ±1.2
MSWD = 81.8
36Ar/40Ar
39Ar/40Ar

APPENDIX 4 continued





Monoliths in central Sawtooth Mountains approximately 27 km northwest of Datil, New Mexico. View is S25°W. Forest Road 6 (Cibola National Forest) is in foreground. Cliff-forming unit is the Dog Springs Formation (upper Eocene) that consists of dacitic debris-flow deposits and sandstones. Lower slopes and flats covered by piñon-juniper woodland are underlain by the Baca Formation (middle Eocene). Camera station is in NE ¼ sec. 4, T1N, R11W, Wayne Lambert photograph No. 93L52. August 11, 1993, 7:12 p.m. MDT.