U.S. Geological Survey radiometric ages—compilation "C" Part three: California and Nevada

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Isochron/West was published at irregular intervals from 1971 to 1996. The journal was patterned after the journal *Radiocarbon* and covered isotopic age-dating (except carbon-14) on rocks and minerals from the Western Hemisphere. Initially, the geographic scope of papers was restricted to the western half of the United States, but was later expanded. The journal was sponsored and staffed by the New Mexico Bureau of Mines *(now Geology)* & Mineral Resources and the Nevada Bureau of Mines & Geology.

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U.S. GEOLOGICAL SURVEY RADIOMETRIC AGES—COMPILATION "C"
Part three: California and Nevada

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This is part three of the third compilation of a planned series of age determinations by the U.S. Geological Survey appearing in Isochron/West. It contains both unpublished and published dates. However, the latter ages lacked either a specific sample location, petrologic information, or analytical data in their published form. Such specifics are often needed for evaluation and utilization of an isotopic age. That, we believe, is the value of this compilation—it supplies such information for most of the listed samples. Users are warned to use these ages with discretion as they constitute only a part of the total geologic picture in any particular area. For ease of reference, samples are grouped together by state.

Some of the listed ages are spurious due to the presence of xenocrystic material, excess radiogenic argon, mineral alteration, diffusion of radiogenic argon, etc. If the age is recognized as being spurious, this fact is mentioned. In a number of cases, we have insufficient information, geologic or otherwise, to accurately evaluate the listed age. The spurious mineral ages are of value in that they may indicate to future geochronologists and geologists that there are potential problems in dating certain rocks in that sampled locality.

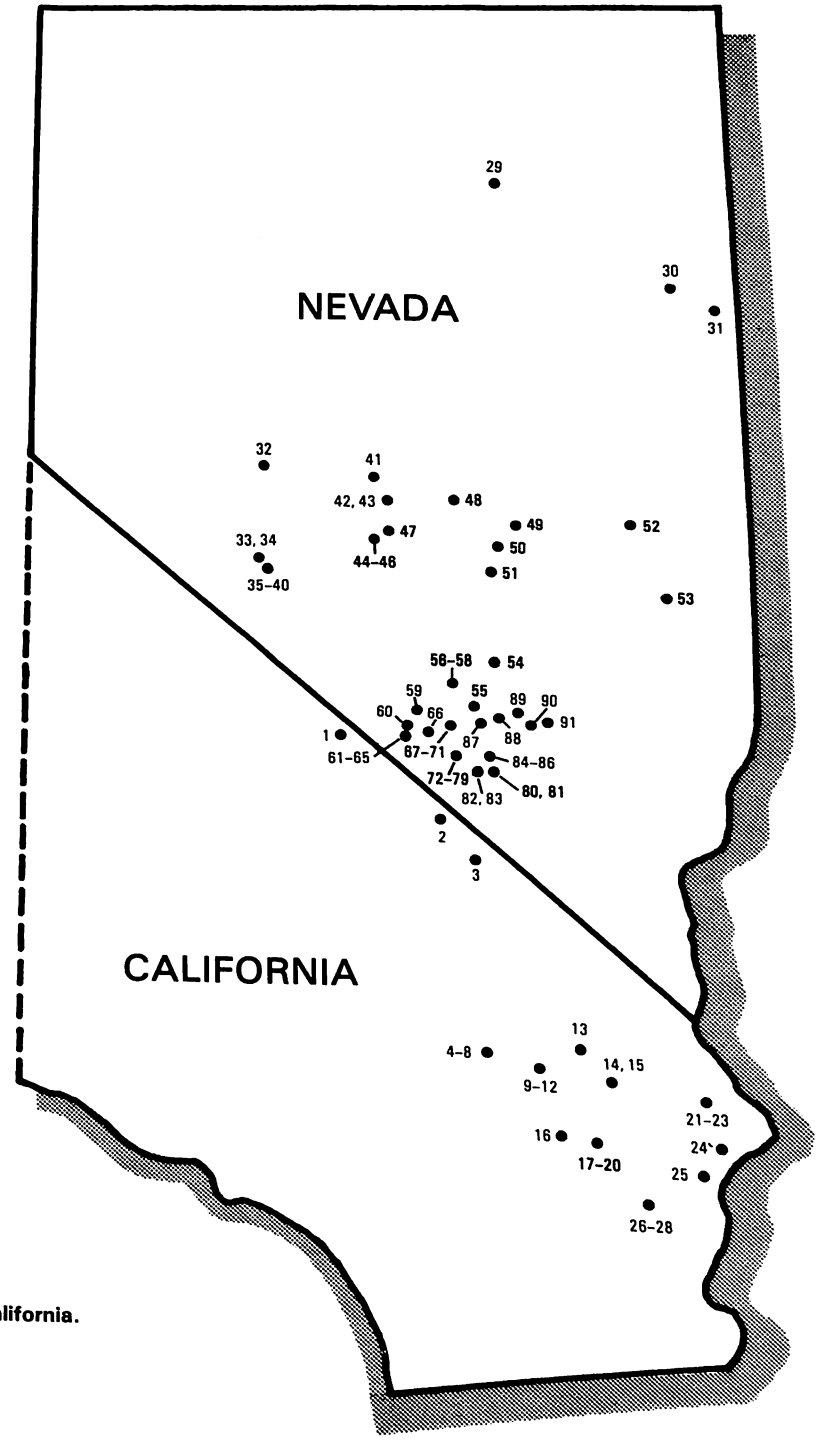
All the ages were determined by U.S. Geological Survey personnel in Denver, Colorado. Analysts are R. F. Marvin, H. H. Mehnert, and E. A. Brandt for K-Ar ages; C. E. Hedge and K. Futa or R. E. Zartman and W. T. Henderson for Rb-Sr ages; R. E. Zartman and M. D. Gallego or L. M. Kwak for U-Th-Pb ages; and C. W. Naeser for fission-track ages. Analytical techniques are not described as these dating methods are fairly common knowledge to most geologists.

The following decay constants, recommended by the IUGS Subcommission on Geochronology were used.

Potassium-40: $\lambda\epsilon = 0.581 \times 10^{-10}$/yr, $\lambda\beta = 4.962 \times 10^{-10}$/yr; atomic abundance is 0.01167 atomic percent

Rubidium-87: $\lambda\beta = 1.42 \times 10^{-11}$/yr

Fission-track: $\lambda = 7.03 \times 10^{-17}$/yr for U^{238}



Geographic index to sample localities in Nevada and southeastern California.

SAMPLE DESCRIPTIONS

CALIFORNIA

1. *USGS(D)TSV-228-79* K-Ar
Olivine basalt (37°00'35"N, 117°27'W; NW¼ S18,T11S,R42E; S rim of Ubehebe Crater, Ubehebe Crater 15' quad., Inyo Co., CA). *Analytical data:* K_2O = 2.33, 2.34%; $^*Ar^{40}$ = 0.00358 × 10^{-10} mol/gm, $^*Ar^{40}/\Sigma Ar^{40}$ = 1%. *Collected by:* W. J. Carr. *Comments:* A vesicular olivine basalt which is part of a large basalt block in the south rim of Ubehebe Crater.
whole-rock 1.1 ± 0.1 Ma

2. *USGS(D)TSV-399-82* K-Ar
Ash-flow tuff (36°35'20"N, 116°44'50"W; Lees Camp 7.5' quad., Inyo Co., CA). *Analytical data:* K_2O = 8.13, 8.15%; $^*Ar^{40}$ = 1.752 × 10^{-10} mol/gm, $^*Ar^{40}/\Sigma Ar^{40}$ = 38%. *Collected by:* W. J. Carr. *Comments:* An isolated ash-flow tuff composed of about 20% phenocrysts (quartz, sanidine, plagioclase, biotite, etc.).
biotite 14.9 ± 0.5 Ma

3. *USGS(D)TSV-383-81* K-Ar
Basalt (36°21'12"N, 116°38'48"W; T26N,R3E; old railroad cut about 2 miles SE of Travertine Point, Ryan 15' quad., Inyo Co., CA). *Analytical data:* K_2O = 1.50, 1.49%; $^*Ar^{40}$ = 0.08562 × 10^{-10} mol/gm, $^*Ar^{40}/\Sigma Ar^{40}$ = 20%. *Collected by:* W. J. Carr. *Comments:* A fine-grained, subophitic, olivine basalt from one of a series of basalt flows in the upper part of Funeral Formation. Calculated age is a minimum age.
whole-rock 4.0 ± 0.1 Ma

4. *28-7* (Glazner, 1986) K-Ar
Dacite(?) (34°48'N, 116°18'W; S13,T8N,R6E; Sleeping Beauty area of southern Cady Mountains, Cady Mountains 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 1.15, 1.12%; $^*Ar^{40}$ = 0.3257 × 10^{-10} mol/gm, $^*Ar^{40}/\Sigma Ar^{40}$ = 64%. *Collected by:* A. F. Glazner. *Comments:* Dacite(?) specimen from the andesite of Sleeping Beauty Ridge. Calculated age represents age of formation. The decay constants for potassium-40 that were published with this K-Ar age are in error; the age was calculated using the revised decay constants proposed by Steiger and Jager (1977).
plagioclase 19.8 ± 1.4 Ma

5. *11-1A* (Glazner, 1986) K-Ar
Tuff (34°46'N, 116°16'W; S30,T8N,R7E; Sleeping Beauty area of southern Cady Mountains, Cady Mountains 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 6.39, 6.46%; $^*Ar^{40}$ = 1.862 × 10^{-10} mol/gm, $^*Ar^{40}/\Sigma Ar^{40}$ = 56%. *Collected by:* A. F. Glazner. *Comments:* Tuff is a western phase of the Peach Springs Tuff. Calculated age represents age of formation. The decay constants for potassium-40 that were published with this K-Ar age are in error; the age was calculated using the revised decay constants proposed by Steiger and Jager (1977).
sanidine 20.0 ± 1.0 Ma

6. *12-3* (Glazner, 1986) K-Ar
Basalt (34°47'N, 116°15'W; S16,T8N,R7E; Sleeping Beauty area of southern Cady Mountains, Broadwell Lake 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 1.60, 1.57%; $^*Ar^{40}$ = 0.4562 × 10^{-10} mol/gm, $^*Ar^{40}/\Sigma Ar^{40}$ = 64%. *Collected by:* A. F. Glazner. *Comments:* Basalt flow from the formation of Argos Siding. Calculated age represents age of formation. The decay constants for potassium-40 that were published with this K-Ar age are in error; the age was calculated using the revised decay constants proposed by Steiger and Jager (1977).
whole-rock 19.9 ± 0.7 Ma

7. *AG-3* (Glazner, 1986) K-Ar
Dacite (34°47'N, 116°15'W; S21,T8N,R7E; Sleeping Beauty area of southern Cady Mountains, Broadwell Lake 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 3.52, 3.43%; $^*Ar^{40}$ = 1.0145 × 10^{-10} mol/gm, $^*Ar^{40}/\Sigma Ar^{40}$ = 69%. *Collected by:* A. F. Glazner. *Comments:* Dacite of Cady Mountains—an extrusive. Calculated whole-rock age is age of formation. The decay constants for potassium-40 that were published with this K-Ar age are in error; the age was calculated using the revised decay constants proposed by Steiger and Jager (1977).
whole-rock 20.2 ± 1.3 Ma

8. *USGS(D)A3-38* K-Ar
Altered dacite (34°47'N, 116°15'W; S21,T8N,R7E; Sleeping Beauty area of southern Cady Mountains, Broadwell Lake 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 13.78, 13.85%; $^*Ar^{40}$ = 2.219 × 10^{-10} mol/gm, $^*Ar^{40}/\Sigma Ar^{40}$ = 59%. *Collected by:* A. F. Glazner. *Comments:* A potassium metasomatized dacite which is equivalent to unaltered dacite dated at 20.3 Ma (sample A6-3). The calculated whole-rock age is anomalously young.
whole-rock 11.1 ± 0.3 Ma

9. *USGS(D)H80GM-227* K-Ar
Granodiorite (34°46'37"N, 115°44'38"W; NE¼ S20,T8N,R12E; Budweiser Spring in SW part of Granite Mountains, Flynn 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 8.40, 8.46%; $^*Ar^{40}$ = 8.810 × 10^{-10} mol/gm, $Ar^{40}/\Sigma Ar^{40}$ = 80%. *Submitted by:* K. A. Howard. *Comments:* A granodiorite pluton. The calculated age is probably a reduced age (cooling age) and may represent a period of tectonic uplift in the Granite Mountains.
biotite 71.2 ± 2.6 Ma

10. *USGS(D)H80GM-225* K-Ar
Biotite monzogranite pluton (34°44'08"N, 115°40'57"W; boundary line between S35 and 36,T7N,R12E; S end of Sheep Coral area, south of Granite Mountains, Cadiz 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 8.82, 8.92%; $^*Ar^{40}$ = 9.231 × 10^{-10} mol/gm, $^*Ar^{40}/\Sigma Ar^{40}$ = 85%. *Submitted by:* K. A. Howard. *Comments:* The calculated age is probably a reduced age (cooling age) and may represent a period of tectonic uplift in the Granite Mountains.
biotite 70.9 ± 2.6 Ma

11. *USGS(D)H80GM-435* K-Ar
Diorite (34°50'42"N, 115°39'28"W; S30, T9N,R13E; eastern Granite Mountains, Flynn 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O

= 0.86, 0.87%; $*Ar^{40}$ = 0.9427 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 70%. *Submitted by:* K. A. Howard. *Comments:* A hornblende-biotite diorite (gabbro?) pluton that is probably Jurassic in age. Calculated age is therefore a reduced age, representing subsequent uplift and cooling of the pluton.

hornblende 74.2 ± 4.5 Ma

12. *USGS(D)H80MM-223* K-Ar
Hornblende-biotite diorite pluton (34°38'22"N, 115°36'26"W; S3,T6N,R13E; near Castle Mine in Marble Mountains, Cadiz 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 0.99, 0.98%; $*Ar^{40}$ = 2.579 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 81%. *Submitted by:* K. A. Howard. *Comments:* Calculated age indicates that pluton was emplaced during the Jurassic. A K-Ar age of 152 Ma has been obtained on coexisting biotite (personal commun., M. A. Pernokas, 1986).

hornblende 173 ± 10 Ma

13. *USGS(D)H80Co-424* K-Ar
Biotite monzogranite pluton (34°56'02"N, 115°25'45"W; NE¼ S29,T10N,R15E; Colton Hills, Colton Well 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 8.94, 8.98%; $*Ar^{40}$ = 21.38 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 91%. *Submitted by:* K. A. Howard. *Comments:* Pluton is Jurassic (or older).

biotite 159 ± 6 Ma

14. *USGS(D)KH78-47* K-Ar
(Miller and others, 1982; Glazner and others, 1986) Tuff (34°46'10"N, 115°07'29"W; SW¼NW¼ S20,T8N,R18E; central Piute Mountains, Fenner 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 8.39, 8.34%; $*Ar^{40}$ = 2.253 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 81%. *Collected by:* K. A. Howard. *Comments:* A crystal-lithic rhyodacite tuff (possible equivalent to the Peach Springs Tuff).

sanidine 18.6 ± 0.6 Ma

15. *USGS(D)K478-62* (Miller and others, 1982) K-Ar
Pegmatite (34°44'12"N, 115°06'21"W; NW¼ SW¼ S33,T8N,R18E; south Piute Mountains, Essex 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 10.87, 10.83%; $*Ar^{40}$ = 31.73 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 85%. *Collected by:* K. A. Howard. *Comments:* Precambrian pegmatite is cut by a Cambrian unconformity. Calculated muscovite age is a reduced age.

muscovite 192 ± 5 Ma

16. *USGS(D)H80Cal-147* (Howard and John, 1984) K-Ar
Vitrophyre (34°17'37"N, 115°33'04"W; NE¼ S6,T2N,R14E; S Calumet Mountains, Bristol Lake 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 0.88, 0.83, 0.82%; $*Ar^{40}$ = 0.2596 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 35%. *Submitted by:* K. A. Howard. *Comments:* Biotite-hornblende dacite vitrophyre is the oldest volcanic rock in the region. Calculated age represents the age of formation.

hornblende 21.3 ± 1.7 Ma

17. *USGS(D)H79IM-270* K-Ar
(Howard and others, 1982; Miller and others, 1982; Howard and John, 1984; Miller and Howard, 1985)
Aplite (34°08'57"N, 115°11'33"W; NE¼SE¼ S27,T1N,R17E; Ranger Canyon in southern Iron Mountains, Iron Mountains 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 10.78, 10.83%; $*Ar^{40}$ = 9.696 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 79%. *Submitted by:* K. A. Howard. *Comments:* Calculated muscovite age is a minimum age for the aplite intrusive that cuts mylonite gneisses in the Iron Mountains.

muscovite 61.3 ± 1.4 Ma

18. *USGS(D)KH78-30b* (Miller and others, 1982) K-Ar
Gneissic-layered pegmatite (34°16'50"N, 115°11'29"W; NW¼NW¼ S10,T2N,R17E; S end of Old Women Mountains, Milligan 15' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 9.12, 9.13%; $*Ar^{40}$ = 8,951 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 87%. *Collected by:* K. A. Howard. *Comments:* The calculated age is not the age of crystallization, but probably approximates the time of regional uplift and cooling.

biotite 66.9 ± 2.3 Ma

19. *USGS(D)PS78-9* (Miller and others, 1982) K-Ar
Schist (34°21'31"N, 115°17'58"W; SE¼ S9,T3N,R16E; Kilbeck Hills, Chubbuck 7.5' quad., San Bernardino Co., CA). *Analytical data:* (biotite) K_2O = 9.02, 9.12%; $*Ar^{40}$ = 9.455 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 88%; (muscovite) K_2O = 10.46, 10.58%; $*Ar^{40}$ = 11.18 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 85%. *Submitted by:* K. A. Howard. *Comments:* Biotite schist is metamorphosed Bright Angel Shale of Cambrian age. Calculated ages suggest Late Cretaceous metamorphic event.

biotite 71.0 ± 2.6 Ma
muscovite 72.3 ± 1.7 Ma

20. *USGS(D)OW79(CM)* (Miller and others, 1982) K-Ar
Phyllitic schist (34°32'N, 115°10'W; Old Women Mountains, Essex 15' quad., San Bernardino Co., CA). *Analytical data:* (biotite) K_2O = 9.16, 9.19%; $*Ar^{40}$ = 9.245 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 90%; (muscovite) K_2O = 10.44, 10.40%; $*Ar^{40}$ = 10.47 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 89%. *Submitted by:* K. A. Howard. *Comments:* The schist is metamorphosed Bright Angel Shale of Cambrian age. Calculated ages suggest Late Cretaceous metamorphic event. Exact sample collection site is not known.

biotite 68.7 ± 2.5 Ma
muscovite 68.5 ± 1.6 Ma

21. *USGS(D)KH78-10* (John, 1982) K-Ar
Monzogranite (34°31'05"N, 114°38'50"W; S14-15,T5N,R22E; small hill on E side of U.S. 95 in the Chemehuevi Valley; Chemehuevi Peak 7.5' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 8.87, 8.91%; $*Ar^{40}$ = 8.351 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 94%. *Collected by:* K. A. Howard. *Comments:* Medium-grained biotite monzogranite intrusive (granite of Chemehuevi) intrudes mylonitic gneisses in the Chemehuevi Mountains. Calculated biotite age is a minimum age for the intrusive.

biotite 64.1 ± 2.2 Ma

22. *USGS(D)BJ80Ch-199* K-Ar
Latite (34°39'00"N, 114°35'03"W; S4,T6N,R23E; Chemehuevi Mountains Whale Mountain 7.5' quad., San Bernardino Co., CA). *Analytical data:* (biotite) K_2O = 8.31, 8.30%; $*Ar^{40}$ = 2.155 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 66%; (hornblende) K_2O =

0.68, 0.67%; $*Ar^{40}$ = 0.2022 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 23%. *Submitted by:* K. A. Howard. *Comments:* Biotite-hornblende latite dike, part of a dike swarm. The calculated ages are probably reduced ages.

biotite 17.9 ± 0.6 Ma
hornblende 20.7 ± 1.3 Ma

23. *USGS(D)H80Ch-307* K-Ar
Granodiorite (34°40'04"N, 114°34'12"W; SW¼ S27,T7N,R23E; Chemehuevi Mountains, Whale Mountain 7.5' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 8.87, 8.90%; $*Ar^{40}$ = 2.217 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 59%. *Submitted by:* K. A. Howard. *Comments:* Granodiorite is part of a plutonic complex. The calculated age is probably a reduced age.

biotite 17.2 ± 0.6 Ma

24. *USGS(D)WWM-300* (Ridenour and others, 1982) K-Ar
Altered quartz monzonite (34°16'15"N, 114°16'30"W; NW¼SW¼ S8,T2N,R26E; Whipple Mountains, Whipple Mountain 7.5' quad., San Bernardino Co., CA). *Analytical data:* K_2O = 8.317% (isotope dilution, K. Futa, analyst, USGS), $*Ar^{40}$ = 2.956 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 51%. *Submitted by:* K. A. Howard. *Comments:* Sericite was obtained from an altered and mineralized quartz monzonite which is highly fractured and in fault contact with Tertiary volcanics. Calculated age probably reflects the time of mineralization and is a minimum age for the quartz monzonite pluton.

sericite 24.5 ± 0.7 Ma

25. *USGS(D)MWC-43-76* K-Ar
Gneiss (34°03'N, 114°30'W; S31,T1S,R24E; Riverside Mountains, Parker SW 7.5' quad., Riverside Co., CA). *Analytical data:* K_2O = 6.78, 6.68%; $*Ar^{40}$ = 4.677 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 82%. *Submitted by:* W. J. Carr. *Comments:* A fine-grained, banded quartz-feldspathic gneiss with 1-cm "augen" K-feldspar in a matrix of quartz, altered feldspar, calcite, micas, chlorite, and epidote. Analyzed material is a mixture of K-feldspar and plagioclase.

K-feldspar ± plagioclase 47.6 ± 1.1 Ma

26. *USGS(D)BJ80LM-119* K-Ar
Gneiss (33°55'21"N, 114°59'39"W; SW¼ S9,T3S,R19E; NW area of Little Maria Mountains, Midland 15' quad., Riverside Co., CA). *Analytical data:* K_2O = 9.40, 9.39%; $*Ar^{40}$ = 8.489 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 87%. *Submitted by:* K. A. Howard. *Comments:* Biotite augen gneiss (metamorphosed granite). Calculated age reflects uplift and cooling of rocks in this area.

biotite 61.7 ± 2.2 Ma

27. *USGS(D)H80LM-374* K-Ar
Epidotized porphyritic granite pluton (33°51'02"N, 114°52'04"W; Little Maria Mountains, Midland 15' quad., Riverside Co., CA). *Analytical data:* K_2O = 9.05, 9.05%; $*Ar^{40}$ = 8.749 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 89%. *Submitted by:* K. A. Howard. *Comments:* Calculated age is probably a reduced age (cooling age) as other geologic information suggests that the pluton is probably Jurassic in age.

biotite 65.9 ± 2.4 Ma

28. *USGS(D)H79BM-6* K-Ar
Pegmatite (33°48'49"N, 114°41'04"W; Big Maria Mountains, Big Maria Mountains SW 7.5' quad., Riverside Co., CA). *Analytical data:* K_2O = 10.58, 10.58%; $*Ar^{40}$ = 8.679 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 85%. *Submitted by:* K. A. Howard. *Comments:* Pegmatite cuts isoclinally folded Paleozoic and Mesozoic strata.

muscovite 56.1 ± 1.3 Ma

NEVADA

29. *80FP-69* (Poole and Claypool, 1984) K-Ar
Diorite (41°06'05"N, 116°01'06"W; NE¼NW¼ S16,T37N,R53E; near head of Lone Mountain Creek on S shoulder of dirt road in canyon Blue Basin 7.5' quad., Elko Co., NV). *Analytical data:* K_2O = 8.40, 8.38%; $*Ar^{40}$ = 9.201 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 89%. *Collected by:* F. G. Poole. *Comments:* Diorite sill in the Vinini Formation (Ordovician).

biotite 74.6 ± 2.7 Ma

30. *USGS(D)363-DL-64* K-Ar
Granitoid (40°20'55"N, 114°34'W; Dolly Varden District, Sharp Peak 7.5' quad., Dolly Varden Mountains, Elko Co., NV). *Analytical data:* (biotite) K_2O = 9.22%, $*Ar^{40}$ = 21.63 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 92%; (amphibole) K_2O = 0.57%, $*Ar^{40}$ = 1.434 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 41%. *Collected by:* D. E. Lee. *Comments:* Potassium values supplied by D. E. Lee. The intrusive granitoid probably crystallized about 155 Ma ago, in agreement with the ages of other intrusives in this region.

biotite 156 ± 6 Ma
amphibole 167 ± 11 Ma

31. *USGS(D)345-DL-66* K-Ar
Granitoid (40°15'55"N, 114°17'10"W; SE¼ S27,T28N,R68E; Goshute Mountains, White Horse Mountains 7.5' quad., Elko Co., NV). *Analytical data:* K_2O = 7.70, 7.48%; $*Ar^{40}$ = 17.91 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 95%. *Collected by:* D. E. Lee. *Comments:* This age is a minimum age for the White Horse Pass pluton. Sample locality listed above is questionable.

biotite 157 ± 6 Ma

32. *USGS(D)75FB144* (Ekren and Byers, 1978) K-Ar
Obsidian (38°56'N, 118°04'W; Mount Annie NE 7.5' quad., Nye Co., NV). *Analytical data:* K_2O = 4.80, 4.84%; $*Ar^{40}$ = 1.085 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 79%. *Collected by:* F. M. Byers. *Comments:* Obsidian sample was collected several inches above the base of the Esmeralda Formation. Published age of 15.2 Ma has been recalculated with revised potassium-40 decay constants (Steiger and Jager, 1977).

glass 15.6 ± 0.5 Ma

33. *USGS(D)Tr* K-Ar
Tuff (38°13'31.1"N, 118°10'01"W; Belleville 7.5' quad., Mineral Co., NV). *Analytical data:* K_2O = 7.57, 7.50%; $*Ar^{40}$ = 2.758 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 53%. *Collected by:* P. P. Orkild.

biotite 25.2 ± 0.9 Ma

34. *USGS(D)Tg-hbl* K-Ar
Gilbert andesite (38°14'12"N, 118°09'44.4"W;

S end of the Excelsior Mountains, Mina region, Belleville 7.5′ quad., Mineral Co., NV). *Analytical data:* (plagioclase) K_2O = 2.33, 2.31%; $*Ar^{40}$ = 0.5980 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 80%; (hornblende) K_2O = 0.73, 0.72%; $*Ar^{40}$ = 0.1856 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 57%. *Collected by:* P. P. Orkild.

plagioclase 17.8 ± 0.6 Ma
hornblende 17.7 ± 1.1 Ma

35. *USGS(D)TV-8* K-Ar
Andesite (38°08′30″N, 118°05′18″W; 1.2 miles S of Candelaria, Candelaria Hills, Candelaria 7.5′ quad., Mineral Co., NV). *Analytical data:* K_2O = 2.44, 2.46, 2.52, 2.45%; $*Ar^{40}$ = 0.5741 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 76%. *Collected by:* P. P. Orkild.

whole-rock 16.1 ± 0.6 Ma

36. *USGS(D)Candelaria #12* K-Ar
Welded tuff (38°08′30″N, 118°05′48″W; 1 mile S of Candelaria, Candelaria Hills, Candelaria 7.5′ quad., Mineral Co., NV). *Analytical data:* K_2O = 8.08, 8.08%; $*Ar^{40}$ = 2.908 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 62%. *Collected by:* P. P. Orkild.

biotite 24.8 ± 0.9 Ma

37. *USGS(D)Candelaria #1* K-Ar
Welded tuff (38°09′24″N, 118°04′32″W; 1 mile E of Candelaria, Candelaria Hills, Candelaria 7.5′ quad., Mineral Co., NV). *Analytical data:* K_2O = 7.93, 7.96%; $*Ar^{40}$ = 2.913 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 38%. *Collected by:* P. P. Orkild.

biotite 25.3 ± 0.9 Ma

38. *USGS(D)Qb-1* K-Ar
Basalt (38°09′30″N, 118°04′36″W; 1 mile E of Candelaria, Candelaria Hills, Candelaria 7.5′ quad., Mineral Co., NV). *Analytical data:* K_2O = 2.64, 2.63%; $*Ar^{40}$ = 0.1072 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 35%. *Collected by:* P. P. Orkild.

whole-rock 2.8 ± 0.1 Ma

39. *USGS(D)Qb-2* K-Ar
Basalt (38°09′24″N, 118°03′30″W; 1.75 miles E of Candelaria, Candelaria Hills, Candelaria 7.5′ quad., Mineral Co., NV). *Analytical data:* K_2O = 2.56, 2.52%; $*Ar^{40}$ = 0.1074 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 34%. *Collected by:* P. P. Orkild.

whole-rock 2.9 ± 0.1 Ma

40. *USGS(D)Candelaria #20* K-Ar
Welded tuff (38°09′36″N, 118°03′21″W; 2 miles E of Candelaria, Candelaria Hills, Candelaria 7.5′ quad., Mineral Co., NV). *Analytical data:* K_2O = 6.85, 6.85%; $*Ar^{40}$ = 2.262 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 29%. *Collected by:* P. P. Orkild.

biotite 22.8 ± 0.8 Ma

41. *USGS(D)77FP-109* K-Ar
Quartz monzonite dike (38°50′42″N, 117°12′58″W; SW¼NW¼ S1,T11N,R42E; N side of Belcher Canyon on E flank of Toiyabe Range, Carver 7.5′ quad., Nye Co., NV). *Analytical data:* K_2O = 7.98, 7.87%, $*Ar^{40}$ = 3.042 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 86%. *Collected by:* F. G. Poole. *Comments:* Quartz monzonite dike cuts the Darrough Felsite.

biotite 26.5 ± 0.9 Ma

42. *USGS(D)84DJ43* K-Ar
Vein (38°46′24″N, 117°02′39″W; S33, T11N,R44E; Toquima Range, Carvers SE 7.5′ quad., Nye Co., NV). *Analytical data:* K_2O = 15.7, 15.5%; $*Ar^{40}$ = 6.050 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 94%. *Collected by:* D. W. Jones. *Comments:* Age of adularia vein in the Mount Jefferson Tuff; vein is part of the ring fracture system of the Mount Jefferson caldera.

adularia 26.8 ± 1.0 Ma

43. *USGS(D)84DJ33* K-Ar
Rhyolite (38°46′N, 117°02′W; S3,T10N,R44E; Toquima Range, Carvers SE 7.5′ quad., Nye Co., NV). *Analytical data:* K_2O = 8.30, 8.28%; $*Ar^{40}$ = 3.154 × $^{10-10}$ mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 66%. *Collected by:* D. W. Jones. *Comments:* Age of a rhyolite porphyry plug that intrudes the margin of the Mount Jefferson caldera.

biotite 26.2 ± 0.9 Ma

44. *USGS(D)77FP-83* K-Ar
Mafic lava (38°28′24″N, 117°10′58″W; SW¼ SW¼ S8,T7N,R43E; 0.5-km NW of Willow Spring on SW side of Toquima Range, Baxter Spring 15′ quad., Nye Co., NV). *Analytical data:* (hornblende) K_2O = 0.92, 0.93, 0.97, 0.94%; $*Ar^{40}$ = 2.166 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 82%; (pyroxene) K_2O = 1.28, 1.27%; $*Ar^{40}$ = 1.868 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 86%. *Collected by:* F. G. Poole. *Comments:* The mafic nonvesicular greenstone (lava) has a minimum age of 153 Ma (Late Jurassic) according to the hornblende K-Ar age but the greenstone is actually Cambrian to Ordovician in age. Cretaceous or Tertiary igneous activity probably reset the K-Ar isotopic system in the pyroxene. Oddly enough, the pyroxene crystals apparently have a higher potassium content than the hornblende crystals.

hornblende 153 ± 9 Ma
pyroxene 99.1 ± 3.4 Ma

45. *USGS(D)77FP-85* K-Ar, Fission-track
Gabbro (38°28′23″N, 117°10′23″W; SW¼SE¼ S8,T7N,R43E; 0.7-km NE of Willow Springs on SW side of Toquima Range, Baxter Spring 15′ quad., Nye Co., NV). *Analytical data:* (kaersutite) K_2O = 0.90, 0.91%; $*Ar^{40}$ = 2.147 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 89%; (zircon—5 grains) Ps = 4.18 × 10^6 tracks/cm² (552), Pi = 8.87 × 10^6 tracks/cm² (586), 0 = 1.02 × 10^{15} n/cm², U = 250 ppm. *Collected by:* F. G. Poole. *Comments:* Dated minerals were obtained from the coarse-grained interior of a gabbroic dike cutting Cambrian to Ordovician greenstone and Cambrian argillite. The kaersutite K-Ar age suggests a Late Jurassic age for the dike and the zircon fission-track age suggests an Oligocene age. The older age is tentatively accepted as the more valid intrusion age; the zircon age represents an Oligocene thermal overprint.

K-Ar: kaersutite 158 ± 9 Ma
Fission-track: zircon 28.7 ± 3.6 Ma

46. *USGS(D)77FP-86* K-Ar
Gabbro (38°28′23″N, 117°10′23″W; SW¼SE¼ S8,T7N,R43E; 0.7 km NE of Willow Springs on SW side of Toquima Range, Baxter Spring 15′ quad., Nye Co., NV). *Analytical data:* K_2O = 1.19, 1.17%; $*Ar^{40}$ = 2.082 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ =

87%. *Collected by:* F. G. Poole. *Comments:* The hornblende-pyroxene concentrate was obtained from a gabbroic dike that cuts the Cambrian to Ordovician greenstone and Cambrian argillite. The K-Ar age is probably a reduced age; the dike probably formed during the Late Jurassic.

hornblende-pyroxene 119 ± 4 Ma

47. *USGS(D)78FP-23* K-Ar
Coarse-grained granite, Pipe Spring plugon (38°29'50"N,117°01'10"W; NW¼NW¼ S2,T7N,R44E; 0.75 mile NNE of Elephant Rock, Baxter Spring 15' quad., Nye Co., NV). *Analytical data:* K_2O = 5.27, 5.28%, $*Ar^{40}$ = 38.01 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 96%. *Collected by:* F. G. Poole.

biotite 442 ± 16 Ma

48. *USGS(D)VH-1-126* K-Ar
Olivine basalt (38°47'N, 116°33'W; drill hole VH-1, SE of Red Cone in Crater Flat, Bare Mountain 15' quad., Nye Co., NV). *Analytical data:* K_2O = 1.53, 1.55%; $*Ar^{40}$ = 0.08086 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 31%. *Submitted by:* W. J. Carr. *Comments:* Drill core of holocrystalline olivine basalt (olivine slightly altered) from a buried lava flow.

whole-rock 3.6 ± 0.1 Ma

49. *USGS(D)LC12-8-2* K-Ar
Basalt (38°29'N, 115°58'W, volcano cone, The Wall 7.5' quad., Nye Co., NV). *Analytical data*: K_2O = 1.63, 1.61%; $*Ar^{40}$ = 0.01329 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 5%. *Submitted by:* W. J. Carr. *Comments*: Sample is from the interior of a volcanic bomb found on a volcano cone associated with the informal Black Rock flows (basalt of Lunar Crater Field).

whole-rock 0.57 ± 0.03 Ma

50. *USGS(D)LC12-11-20v* K-Ar
Porphyritic basalt, basalt of Lunar Crater Field (38°23'N, 116'W; S end of Pancake Range, Lunar Crater 7.5' quad., Nye Co., NV). *Analytical data*: K_2O = 0.41, 0.39, 0.37, 0.38%; $*Ar^{40}$ = 0.02361 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 6%. *Submitted by:* W. J. Carr.

plagioclase 4.2 ± 0.5 Ma

51. *USGS(D)RE9-28-2* K-Ar
Basalt dike (38°10'N, 116°07'W; eroded cinder cone about 0.5 mile N of Nevada Highway 25, Echo Canyon 7.5' quad., Nye Co., NV). *Analytical data*: K_2O = 1.36, 1.34%; $*Ar^{40}$ = 0.1033 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 51%. *Submitted by:* W. J. Carr. *Comments*: Basalt, as a whole, is only slightly altered but olivine phenocrysts are altered.

whole-rock 5.3 ± 0.2 Ma

52. *USGS(D)SP-4-84* K-Ar
Rhyodacite porphyry (38°32'30"N, 114°59'45"W; NW¼ S22,T8N,R62E; 2 miles E of Shingle Spring in Egan Range, Shingle Pass 7.5' quad., Lincoln Co., NV). *Analytical data*: K_2O = 8.28, 8.29%; $*Ar^{40}$ = 4.225 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 83%. *Collected by:* D. C. Hedlund. *Comments*: A medium- to coarse-grained, hornblende-biotite rhyodacite-prophyry plug intruding Paleozoic limestone.

biotite 35.1 ± 1.3 Ma

53. *USGS(D)F-78-15* K-Ar
Basalt (37°59'N, 114°41'W; ½ mile N of Black Rock Knoll, Ely Springs 7.5' quad., Lincoln Co., NV). *Analytical data*: K_2O = 2.88, 2.87%; $*Ar^{40}$ = 1.135 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 74%. *Collected by:* F. Maldonado. *Comments*: A minimum age for the basalt flow.

whole-rock 27.2 ± 1.0 Ma

54. *USGS(D)GR-1* K-Ar
Granite (37°27'N, 116°16'W; S end of Kawich Range, Silent Canyon 15' quad., Nye Co., NV). *Analytical data*: K_2O = 8.92, 8.98%; $*Ar^{40}$ = 13.02 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 81%. *Collected by:* F. Maldonado. *Comments*: The apparent age of the granite pluton.

biotite 98.4 ± 3.3 Ma

55. *USGS(D)TSV-413-82* K-Ar
Basalt (37°08"N, 116°23'W; N side of Scrugham Peak, Scrugham Peak 7.5' quad., Nye Co., NV). *Analytical data*: K_2O = 2.07, 2.02%; $*Ar^{40}$ = 0.07987 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 20%. *Collected by:* W. J. Carr. *Comments*: A holocrystalline, seriate-textured, olivine basalt from a basalt flow (basalt of Buckboard Mesa).

whole-rock 2.7 ± 0.2

56. *USGS(D)TSV-166* Fission-track
Rhyolite (37°14'30'30"N, 116°35'42"W; Thirsty Canyon in Paiute Mesa area, Thirsty Canyon 7.5' quad., Nye Co., NV). *Analytical data*: (6 grains) Ps = 0.402 × 10^6 tracks/cm² (93), Pi = 3.22 × 10^6 tracks/cm² (373), 0 = 1.0 × 10^{15} n/cm². *Submitted by:* W. J. Carr. *Comments*: A rhyolite lava associated with the Black Mountain volcanic center. This calculated age is young in comparison with a K-Ar age of 9.4 ± 0.3 Ma obtained by R. F. Fleck (USGS, Menlo Park) (V. A. Frizzell, written commun., 1986).

zircon 7.5 ± 1.2 Ma

57. *USGS(D)TSV-167-79* K-Ar, Fission-track
Rhyolite (37°14'42"N, 116°36'00"W, Thirsty Canyon 7.5' quad., Nye Co., NV). *Analytical data*: (whole-rock) K_2O = 4.49, 4.46%; $*Ar^{40}$ = 0.5650 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 84%; (zircon—6 grains) Ps = 1.43 × 10^6 tracks/cm² (231), Pi = 9.95 × 10^6 tracks/cm² (806), 0 = 1.0 × 10^{15} n/cm²; (apatite—50 grains) Ps = 0.018 × 10^6 tracks/cm² (37), Pi = 0.112 × 10^6 tracks/cm² (234), 0 = 1.02 × 10^{15} n/cm². *Submitted by:* W. J. Carr. *Comments*: Sample collected near the base of the upper flow of the rhyolite lava of Pillar Spring.

K-Ar: whole-rock 8.9 ± 0.3 Ma
Fission-track: zircon 8.6 ± 0.6 Ma
apatite 9.6 ± 4.3 Ma

58. *USGS(D)TSV-7* Fission-track
Syenite lava of Yellow Cleft (37°16'00"N, 116°37'12"W; SE of Black Mountain, Trail Ridge 7.5' quad., Nye Co., NV). *Analytical data*: (6 grains) Ps = 0.819 × 10^6 tracks/cm² (182), Pi = 6.26 × 10^6 tracks/cm² (695), 0 = 1.05 × 10^{15} n/cm². *Submitted by:* W. J. Carr. *Comments*: Syenite lava of Yellow Cleft is stratigraphically older than the lava of Pillar Spring. Thus the calculated age is somewhat young and is considered to be a minimum age for the syenite.

zircon 8.2 ± 0.9 Ma

59. *USGS(D)TSV-65A* K-Ar
Vitrophyre (37°05'30"N, 116°48'W; N end of hill

with NASA tracking station, Springdale 15′ quad., Nye Co., NV). *Analytical data*: (biotite) K_2O = 7.76, 7.90%; $*Ar^{40}$ = 1.170 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 44%; (sanidine) K_2O = 5.23, 5.23%; $*Ar^{40}$ = 0.7271 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 64%. *Collected by:* W. J. Carr. *Comments*: A trachyitic rhyolite vitrophyre at base of a lava unit in the middle of a lava pile. Apparent age is around 10 Ma.

biotite 10.4 ± 0.4 Ma
sanidine 9.6 ± 0.3 Ma

60. *USGS(D)BF-380A* K-Ar
Basalt (36°57′45″N, 116°55′25″W; Bullfrog Hills, Bullfrog 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.25, 1.28%; $*Ar^{40}$ = 0.1478 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 37%. *Collected by:* F. Maldonado. *Comments*: A medium-grained olivine basalt flow overlying the tuff of Pahute Mesa(?), in the Thirsty Canyon Tuff. The calculated age is apparently a bit too old for the flow's stratigraphic position.

whole-rock 8.1 ± 0.4 Ma

61. *USGS(D)BF-383* K-Ar
Basalt (36°50′35″N, 116°56′25″W; S boundary line of S33,T12S,T45E; NE of Grapevine Mountains, Bullfrog 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.78, 1.78%; $*Ar^{40}$ = 0.2317 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 60%. *Collected by:* F. Maldonado. *Comments*: The apparent age of a vesicular basalt flow overlying a local ash-flow tuff that is stratigraphically above the Ammonia Tanks Member, Timber Mountain Tuff.

whole-rock 9.0 ± 0.3 Ma

62. *USGS(D)BF-380* K-Ar
Basalt (36°48′45″N, 116°55′45″W; NE flank of Grapevine Mountains, Bullfrog 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.29, 1.29%; $*Ar^{40}$ = 0.1912 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 29%. *Collected by:* F. °Maldonado. *Comments*: A fresh-looking vesicular basalt flow overlying the Ammonia Tanks Member of the Timber Mountain Tuff. In thin-section, the basalt contained a minor amount of carbonate. Calculated age is the apparent age of the basalt flow.

whole-rock 10.3 ± 0.4 Ma

63. *USGS(D)BF-379* K-Ar
Basalt (36°46′15″N, 116°51′15″W; Bullfrog 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 2.35, 2.33%; $*Ar^{40}$ = 0.2538 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 53%. *Collected by:* F. Maldonado. *Comments*: The apparent age of an olivine basalt flow, slightly vesicular.

whole-rock 7.5 ± 0.3 Ma

64. *USGS(D)BF-522* K-Ar
Metadiorite (36°53′54″N, 116°53′14″W; S13,T12S,R45E; S of Bullfrog Hills, Bullfrog 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 0.88, 0.86%; $*Ar^{40}$ = 0.1839 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 36%. *Collected by:* F. Maldonado. *Comments*: A metadiorite dike outcrops in the metamorphic core of the Bullfrog Hills. The calculated age is almost certainly a reduced age and probably reflects a time of Miocene volcanism.

hornblende 14.6 ± 0.9 Ma

65. *USGS(D)TSV-296-80* K-Ar
Gneiss (36°53′30″N, 116°53′W; S13,T12S,R45E; Bullfrog Hills, Bullfrog 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 10.65, 10.62%; $*Ar^{40}$ = 2.510 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 64%. *Collected by:* W. J. Carr. *Comments*: A Precambrian coarse-grained, quartz-muscovite gneiss; calculated K-Ar age is a reduced age.

muscovite 16.3 ± 0.4 Ma

66. *USGS(D)BF-591* K-Ar
Latite (36°55′20″N, 116°48′00″W; SW¼ S2,T12S,R46E; E of Black Peak, Bullfrog 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 7.50, 7.49%; $*Ar^{40}$ = 1.080 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 54%. *Collected by:* F. Maldonado. *Comments*: Tentatively accepted as the age of a latite lava flow overlying a succession of rhyolite lavas.

biotite 10.0 ± 0.4 Ma

67. *USGS(D)TSV-262-79* (Carr and others, 1986) K-Ar
Vitophyre (36°58′N, 116°38′30″W; Beatty Wash, Bare Mountain 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 8.54, 8.54%; $*Ar^{40}$ = 1.712 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 54%. *Collected by:* W. J. Carr. *Comments:* Biotite-bearing vitrophyre (quartz latite lava); sample TSV-260-79 (Entry 67) was collected from a similar outcrop only meters away.

biotite 13.9 ± 0.5 Ma

68. *USGS(D)TSV-260-79* (Carr and others, 1986) K-Ar
Vitrophyre (36°58′N, 116°38′30″W; Beatty Wash, Bare Mountain 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 8.39, 8.39%; $*Ar^{40}$ = 1.683 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 57%. *Collected by:* W. J. Carr. *Comments*: Biotite-bearing vitrophyre (rhyolite lava); sample TSV-262-79 (Entry 68) was collected from a similar outcrop only meters away.

biotite 13.9 ± 0.5 Ma

69. *USGS(D)TSV-305-80* (Carr and others, 1986) K-Ar
Quartz latite dike—border phase (36°52′N, 116°38′W; first dike W of mouth of Tarantula Canyon, Bare Mountain 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 8.34, 8.36%; $*Ar^{40}$ = 1.674 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 68%. *Collected by:* W. J. Carr.

biotite 13.9 ± 0.5 Ma

70. *UGS(D)TSV-128-78* K-Ar
(Carr, 1982; Vaniman and others, 1982)
Olivine basalt (36°52′N, 116°33′W; NE Crater Flat area, Bare Mountain 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.72, 1.74%; $*Ar^{40}$ = 0.02667 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 5%. *Collected by:* W. J. Carr. *Comments*: Olivine basalt from the northern most basalt flow in Crater Flat.

whole-rock 1.07 ± 0.04 Ma

71. *USGS(D)TSV-168-79* (Carr and Parrish, 1985) K-Ar
Basalt (36°52′24″N, 116°28′06″W; Yucca Mountain, Topopah Springs SW 7.5′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.97, 1.97%; $*Ar^{40}$ = 0.2835 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 70%. *Collected by:* W. J. Carr. *Comments*: Microporphyritic basalt from a dike intruding a hinge-line fault.

whole-rock 10.0 ± 0.4 Ma

72. *USGS(D)VH-2-1200* (Carr and Parrish, 1985) K-Ar
Basalt (36°48′15″N, 116°34′40″W; drill hole

VSW-VH-2 between Red Cone and Black Cone in west-central Crater Flat, Bare Mountain 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.59, 1.60%; $*Ar^{40}$ = 0.2605 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 76%. *Collected by:* W. J. Carr. *Comments*: Drill core of somewhat altered basalt containing 5% olivine phenocrysts. The calculated age may be slightly too old according to volcano-stratigraphic relationships (Carr and Parrish, 1985).

whole-rock 11.3 ± 0.4 Ma

73. *USGS(D)TSV-378-81* K-Ar
(Vaniman and others, 1982)
Fine-grained olivine basalt flow (36°47′30″N, 116°34′30″W; SE slope of Red Cone in Crater Flat, Bare Mountain 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.66, 1.62%; $*Ar^{40}$ = 0.03520 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 12%. *Collected by:* W. J. Carr.

whole-rock 1.5 ± 0.1 Ma

74. *USGS(D)CF79-24-8* K-Ar
(Vaniman and others, 1982)
Olivine-augite basalt flow (36°47′N, 116°33′W; SE Crater Flat area, Bare Mountain 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.57, 1.60%; $*Ar^{40}$ = 0.08786 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 25%. *Submitted by:* W. J. Carr. *Comments*: Carr (1982) listed the age of this flow as 3.75 Ma.

whole-rock 3.85 ± 0.13 Ma

75. *USGS(D)CF79-26-1* K-Ar
(Vaniman and others, 1982)
Olivine-augite basalt flow (36°45′N, 116°33′W; SE Crater Flat area, Bare Mountain 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.77, 1.76%; Ar^{40} = 0.09248 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 39%. *Submitted by:* W. J. Carr. *Comments*: Carr (1982) listed the age of this flow as 3.75 Ma.

whole-rock 3.64 ± 0.13 Ma

76. *USGS(D)TSV-250-79* (Carr and others, 1986) K-Ar
Tuff boulder (36°41′30″N, 116°32′30″W; T14S,R49E; 0.5 mile NNE of U.S. Highway 95, Big Dune 7.5′ quad., Nye Co., NV). *Analytical data*: K_2O = 7.04, 7.01%; $*Ar^{40}$ = 1.380 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 82%. *Collected by:* W. J. Carr. *Comments*: A large boulder of welded porphyritic tuff (Grouse Canyon Member of the Belted Range Tuff) exposed near the base of a conglomerate bed underlying a porphyritic welded ash-flow tuff which is correlated with the Crater Flat Tuff.

sanidine 13.6 ± 0.5 Ma

77. *USGS(D)TSV-283-80* K-Ar
(Vaniman and others, 1982)
Basalt (36°41′N, 116°31′W; T14S,R49E; W side of a cinder cone, Big Dune 7.5′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.80, 1.81%; $*Ar^{40}$ = 0.005861 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 3%. *Collected by:* W. J. Carr. *Comments*: Basalt is from the interior of a volcanic bomb. Vaniman and others (1982) state that the sample is from the Lathrop Wells cone.

whole-rock 0.23 ± 0.04 Ma

78. *USGS(D)TSV-129-78* K-Ar
(Maldonado, 1985; Vaniman and others, 1982)
Olivine basalt (36°41′30″N, 116°30′30″W; summit crater of a cinder cone, Big Dune 7.5′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.88, 1.86%; $*Ar^{40}$ = 0.007552 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 25%. *Collected by:* W. J. Carr. *Comments*: A somewhat scoriaceous olivine basalt. Vaniman and others (1982) state that this sample is from the Lathrop Wells cone. R. J. Fleck (U.S. Geological Survey) obtained an age of 0.29 Ma for a similar whole-rock sample from the Lathrop Wells cone (Vaniman and others, 1982).

whole-rock 0.30 ± 0.10 Ma

79. *USGS(D)SW-9-79* K-Ar
Ash (36°44′N, 116°26′30″W; Lathrop Wells 7.5′ quad., Nye Co., NV). *Analytical data*: K_2O = 8.54, 8.60%; $*Ar^{40}$ = 0.3911 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 30%. *Submitted by:* W. J. Carr. *Comments*: Silicic ash-bed in alluvium.

biotite 3.2 ± 0.1 Ma

80. *USGS(D)SW-6-79* K-Ar
Fine-grained, white vitric ash (36°35′N, 116°18′W; NE¼NW¼ S13,T16S,R50E; Lathrop Wells 15′ quad., Nye Co., NV). *Analytical data*: K_2O = 8.65, 8.63%; $*Ar^{40}$ = 1.255 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 81%. *Collected by:* W. C. Swadley.

biotite 10.1 ± 0.3 Ma

81. *USGS(D)83-3-19A* K-Ar, Fission-track
Ash (36°29′24″N, 116°15′12″W; SW¼ S8,T17S,R51E; N part of Carson Slough, Ash Meadow 15′ quad., Nye Co., NV). *Analytical data*: (biotite) K_2O = 8.85, 8.87%; $*Ar^{40}$ = 0.4863 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 43%; (sanidine) K_2O = 9.40, 9.59%; $*Ar^{40}$ = 0.4405 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 76%; (zircon—6 grains) Ps = 0.817 × 10^6 tracks/cm² (140), Pi = 14.78 × 10^6 tracks/cm² (1266), 0 = 0.963 × 10^{15} n/cm². *Submitted by:* W. J. Carr. *Comments*: A white ash bed in the "lake beds" (playa) of Ash Meadows. The presence of detrital minerals is a factor that must be considered in evaluating these ages.

K-Ar: biotite 3.81 ± 0.14 Ma
sanidine 3.22 ± 0.12 Ma
Fission-track: zircon 3.20 ± 0.4 Ma

82. *USGS(D)TSV-282* Fission-track
Ash (36°32′12″N, 116°22′36″W; "Ewing" bentonite pit on eastern edge of Amargosa Desert, Lathrop Wells 15′ quad., Nye Co., NV). *Analytical data*: (6 grains) Ps = 0.654 × 10^6 tracks/cm² (109), Pi = 13.91 × 10^6 tracks/cm² (1159), 0 = 1.05 × 10^{15} n/cm². *Submitted by:* W. J. Carr. *Comments*: Ash is interbedded with lacustrine beds.

zircon 2.95 ± 0.42 Ma

83. *USGS(D)TSV-391* Fission-track
Ash (36°27′48″N, 116°22′48″W; Rock Valley wash, Ash Meadows area, Amargosa Desert; Ash Meadows 15′ quad., Nye Co., NV). *Analytical data*: (12 grains) Ps = 0.215 × 10^6 tracks/cm² (66), Pi = 6.05 × 10^6 tracks/cm² (927), 0 = 0.971 × 10^{15} n/cm². *Submitted by:* W. J. Carr. *Comments*: Ash is at top of lacustrine beds that are overlain uncomfortably by fluvial sediments.

zircon 2.1 ± 0.4 Ma

84. *USGS(D)TSV-382-81* K-Ar
Olivine basalt (36°44′N, 116°14′30″W; NE end of

Little Skull Mountain, Spector Range NW 7.5′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.37, 1.37, 1.31, 1.33%; $*Ar^{40}$ = 0.2183 and 0.2219 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 29, 31%. *Collected by:* W. J. Carr. *Comments*: A fine- to medium-grained, porphyritic olivine basalt (somewhat altered); the youngest of several basalt flows.

whole-rock 11.2 ± 0.5 Ma
11.4 ± 0.5 Ma

85. *USGS(D)TSV-372-81* K-Ar
Medium-grained, holocrystalline, nearly aphyric, olivine basalt (36°47′08″N, 116°19′22″W; SE corner of hill in Jackson Flats area, Jackass Flats 7.5′ quad., Nye Co., NV). *Analytical data*: K_2O = 1.98, 1.97, 1.90, 1.96%; $*Ar^{40}$ = 0.3130 and 0.2708 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 19, 41%. *Collected by:* W. J. Carr. *Comments*: The two K-Ar ages determined for this sample on different sample splits are in considerable disagreement. The more valid age appears, from an analytical point-of-view, to be the 9.6 Ma age.

whole-rock 11.1 ± 0.5 Ma
9.6 ± 0.4 Ma

86. *USGS(D)TSV-370-81* K-Ar
Fine-grained, holocrystalline basalt (36°51′30″N, 116°13′W; near the top and at NW end of Kiwi Mesa, NE of Jackass Flats; Skull Mountain 7.5′ quad., Nye Co., NV). *Analytical data:* K_2O = 2.76, 2.71, 2.67, 2.65%; $*Ar^{40}$ = 0.3847 and 0.3880 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 55, 58%. *Collected by:* W. J. Carr.

whole-rock 9.9 ± 0.4 Ma
10.0 ± 0.4 Ma

87. *USGS(D)TSV-214-79* K-Ar
Rhyolite (36°59′30″N, 116°19′W; tributary canyon to Fortymile Canyon, Topopah Spring 7.5′ quad., Nye Co., NV). *Analytical data:* K_2O = 5.06, 5.07%; $*Ar^{40}$ = 0.6819 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 26%. *Collected by:* W. J. Carr. *Comments:* Sample is from the base of the rhyolite lava of Shoshone.

whole-rock 9.3 ± 0.3 Ma

88. *USGS(D)Velh-784* K-Ar
Basalt (37°00′N, 116°03′30″W; drill hole in SW Yucca Flat, Yucca Flat 7.5′ quad., Nye Co., NV). *Analytical data:* K_2O = 1.36, 1.35%; $*Ar^{40}$ = 0.1590 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 58%. *Submitted by:* W. J. Carr. *Comments:* The basalt or microdiabase is interbedded with alluvium at 784 ft below the surface of Yucca Flat.

whole-rock 8.1 ± 0.3 Ma

89. *USGS(D)TSV-309-80* K-Ar
Basalt (37°06′N, 115°57′30″W; 0.5 mile SE of Slanted Buttes, Paiute Ridge 7.5′ quad., Nye Co., NV). *Analytical data:* K_2O = 1.88, 1.85%; $*Ar^{40}$ = 0.2290 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 41%. *Collected by:* W. J. Carr. *Comments:* A seriate porphyritic basalt with olivine and plagioclase microphenocrysts.

whole-rock 8.5 ± 0.3 Ma

90. *USGS(D)TSV-293-80* K-Ar
Porphyritic basalt flow (36°59′N, 115°49′30″W; hill 4905, Aysees Peak 7.5′ quad., Lincoln Co., NV). *Analytical data:* K_2O = 1.30, 1.28%; $*Ar^{40}$ = 0.1180 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 42%. *Collected by:* W. J. Carr.

whole-rock 6.3 ± 0.2 Ma

91. *USGS(D)TSV-381-81* K-Ar
Basalt (37°01′N, 115°46′30″W; S side of hill 4935, 2.5 miles SSE of Kelly Mine, Papoose Lake 15′ quad., Lincoln Co., NV). *Analytical data:* K_2O = 1.24, 1.25%; $*Ar^{40}$ = 0.2491 and 0.2399 × 10^{-10} mol/gm, $*Ar^{40}/\Sigma Ar^{40}$ = 40, 43%. *Submitted by:* W. J. Carr. *Comments:* Medium-grained olivine-bearing basalt dike cuts Tertiary colluvium.

whole-rock 13.8 ± 0.5 Ma
13.3 ± 0.5 Ma

REFERENCES

Carr, W. J. (1982) Volcano tectonic history of Crater Flat, southwestern Nevada, as suggested by new evidence from drill hole USW-VH-1 and vicinity: U.S. Geological Survey Open-file Report 82-457, 23 p.

Carr, W. J., Byers, F. M., Jr., and Orkild, P. P. (1986) Strtigraphic and volcano-tectonic relations of Crater Flat Tuff and some older volcanic units, Nye County, Nevada: U.S. Geological Survey Professional Paper 1323, 28 p.

Carr, W. J., and Parrish, L. D. (1985) Geology of drill hole USW VH-2, and structure of Crater Flat, southwestern Nevada: U.S. Geological Survey Open-file Report 85-475, 41 p.

Ekren, E. B., and Byers, F. M., Jr. (1978) Preliminary geologic map of the Luning NE quadrangle, Mineral and Nye Counties, Nevada: U.S. Geological Survey Open-file Report 87-915.

Glazner, A. F. (1986) Stratigraphy, structure, and potassic alteration of Miocene volcanic rocks, in the Sleeping Beauty area, central Mojave Desert, California: Geological Society of America, Cordilleran Section, 82nd Annual Meeting, March 25–28, 1986, Los Angeles, California, Guidebook and Volume—Trips 5 and 6, p. 51–63.

Glazner, A. F., Nielson, J. E., Howard, K. A., and Miller, D. M. (1986) Correlation of the Peach Springs Tuff, a large volume Miocene ignimbrite sheet in California and Arizona: Geology, v. 14, p. 840–843.

Howard, K. A., and John, B. E. (1984) Geologic map of the Sheep Hole-Cadiz Wilderness Study Area (CDCA-305), San Bernardino County, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1615A.

Howard, K. A., Miller, D. M., and John, B. E. (1982) Regional character of mylonitic gneiss in the Cadiz Valley area, southeastern California: Cordilleran Publishers, San Diego, p. 441–447.

John, B. E. (1982) Geologic framework of the Chemehuevi Mountains, southeastern California: Cordilleran Publishers, San Diego, p. 317–325.

Maldonado, F. (1985) Geologic map of the Jackass Flats area, Nye County, Nevada: U.S. Geological Survey Miscellaneous Geological Investigation Map I-1519.

Miller, C. F., Howard, K. A., and Hoisch, T. D. (1982) Mesozoic thrusting, metamorphism, and plutonism, Old Woman-Piute Range, southeastern California: Cordilleran Publishers, San Diego, p. 561–581.

Miller, D. M., and Howard, K. A. (1985) Bedrock geologic map of the Iron Mountains quadrangle, San Bernardino and Riverside Counties, California: U.S. Geological Survey Miscellaneous Field Studies Map MF-1736.

Poole, F. G., and Claypool, G. E. (1984) Petroleum, source-rock potential and crude-oil correlation in the Great Basin: Rocky Mountain Assoc. of Geologists, Denver, Colorado, p. 179–229.

Ridenour, J., Moyle, P. R., and Willet, S. L. (1982) Mineral occurrences in the Whipple Mountains Wilderness Study Area, San Bernardino County, California: Cordilleran Publishers, San Diego, p. 69–76.

Steiger, R. H., and Jager, E. (1977) Subcommission on Geochronology—Convention on the use of decay constants in geo- and cosmochronology: Earth Planetary Science Letters, v. 36, p. 359–362.

Vaniman, D. T., Crowe, B. M., and Gladney, E. S. (1982) Petrology and geochemistry of hawaiite lavas from Crater Flat, Nevada: Contributions to Mineralogy and Petrology, v. 80, p. 341–357.

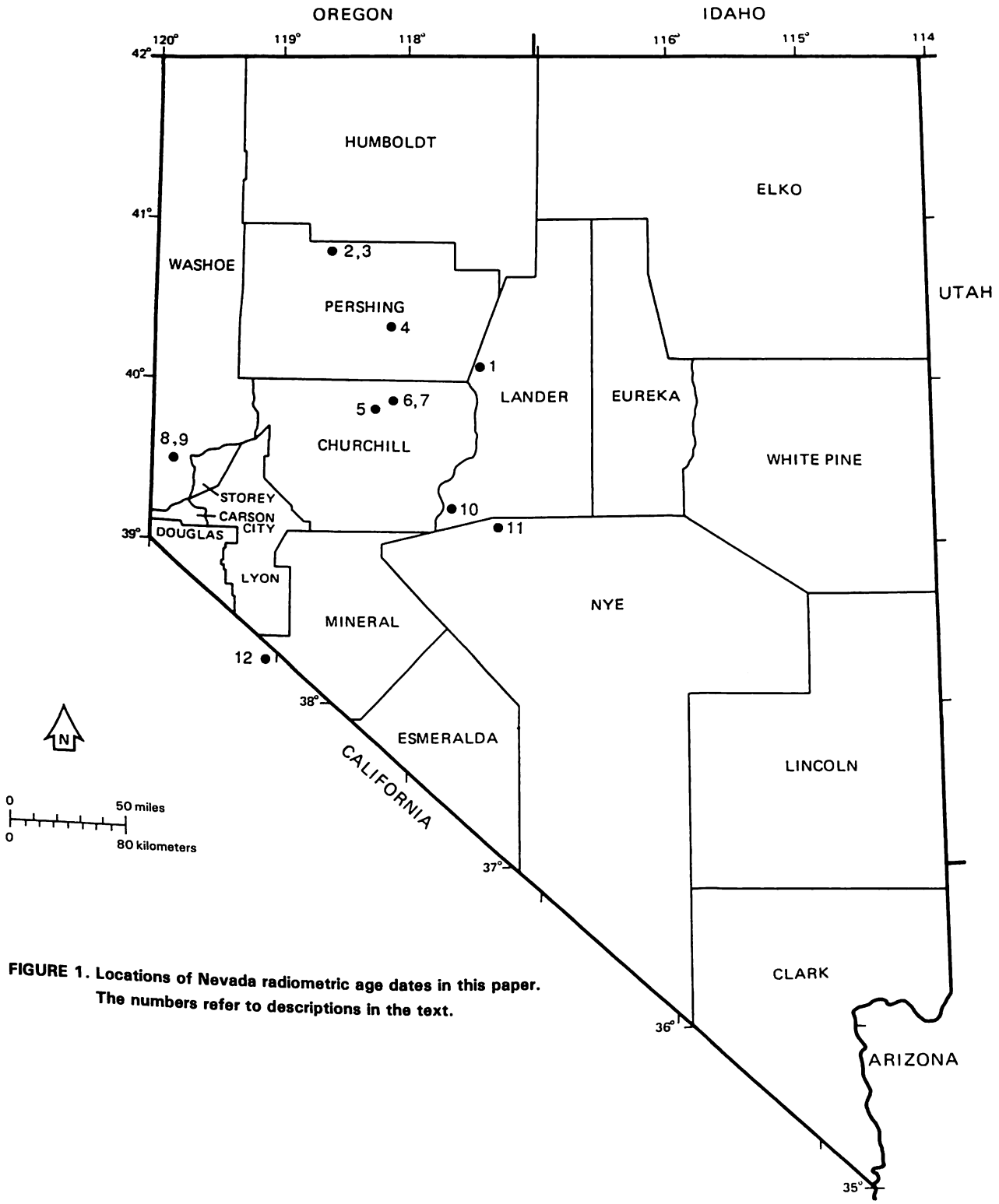


FIGURE 1. Locations of Nevada radiometric age dates in this paper. The numbers refer to descriptions in the text.