New K-Ar ages of hydrothermal minerals and igneous rocks from the western Virginia Range, Washoe and Storey counties, Nevada

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NEW K-Ar AGES OF HYDROTHERMAL MINERALS AND IGNEOUS ROCKS FROM THE WESTERN VIRGINIA RANGE, WASHOE AND STOREY COUNTIES, NEVADA

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Thirty-two new K-Ar ages for hydrothermal minerals and rocks from the western part of the Virginia Range, Nevada, were obtained under a cooperative program between the U.S. Geological Survey and the Nevada Bureau of Mines and Geology. This program supports chronological studies of stratigraphy and ore deposits in Nevada. Locations for dated samples are given in figure 1, and analytical data follow this text.

Age determinations were done in the laboratories of the U.S. Geological Survey, Menlo Park, California, using standard isotope-dilution procedures as described by Dalrymple and Lanphere (1969). The analyses were performed on mineral concentrates prepared by heavy liquid, magnetic, electrostatic, and hand-picking procedures. Potassium was analyzed by lithium metaborate flux fusion-flame photometry techniques, the lithium serving as an internal standard (Ingamells, 1970). Argon analyses were conducted using a 60° sector, 15.2 cm-radius, Nier-type mass spectrometer or on a five-collector mass spectrometer (Stacey and others, 1981). The precision of the data, shown as the ± value, is the estimated analytical uncertainty at one standard deviation (σ). It represents uncertainty in the measurement of radiogenic ^{40}Ar and K_2O in the sample and is based on experience with replicate analyses in the Menlo Park laboratories. The decay constants used for ^{40}K and the $^{40}K/K$ abundance ratio are those adopted by the International Union of Geological Sciences Subcommission on Geochronology (Steiger and Jager, 1977).

Samples from which the K-Ar ages for hydrothermal minerals were determined have been grouped into two assemblages. Quartz-alunite-bearing rock and quartz + sulfide ± muscovite ± K-feldspar veins that were mined for precious metals at Virginia City include the Comstock lode, Flowery lode, and the Silver City veins. K-Ar ages for these veins and a vein in Cedar Hill range from 14.0 ± 0.4 to 12.9 ± 0.4 m.y. (samples 1-6), in general agreement with K-Ar ages determined for the Occidental lode and Comstock lode by others (Bonham and Papke, 1969; Whitebread, 1976). K-Ar ages for alunite and muscovite from widely separated altered areas in the vicinity and north of Virginia City range from 16.3 ± 0.5 to 9.3 ± 0.5 m.y. (samples 7-15).

K-Ar ages for Miocene intrusive and extrusive rocks are similar to those determined by Bonham and Papke (1969), Silberman and McKee (1972), Whitebread (1976), Morton and others (1977), Silberman and others (1979), and R. Ashley (pers. commun.). Stratigraphy of Miocene rocks in the area is given by Gianella (1936), Calkins (1944), Calkins and Thayer (1945), and Thompson (1956). Two K-Ar ages for Davidson Granodiorite are 13.4 ± 0.4 and 11.6 ± 0.4 (samples 28-29). K-Ar ages for Alta Formation rocks range from 20.1 ± 1.4 to 16.6 ± 0.6 m.y. (samples 21-23), for Knickerbocker Andesite range from 14.3 ± 0.5 to 10.6 ± 0.4 m.y. (samples 24-27), and for Kate Peak intrusive rocks range from 15.0 ± 1.6 to 13.3 ± 0.6 m.y. (samples 16-18). The "black dike" encountered in Comstock lode mines has a K-Ar age of 8.6 ± 0.3 m.y. (sample 30). Metavolcanic rocks at the north end of the Comstock lode, that are considered to be older than Miocene, have K-Ar ages of 13.7 ± 0.5 and 13.5 ± 0.4 m.y. (samples 19-20) and have apparently been reset.

SAMPLES DESCRIPTIONS

1. K-Ar
Vein material (Cedar Hill Canyon; NW/4 S20,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 6.70 wt. %; $^{40}Ar^*$ = 1.30866 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.426.
(muscovite) 13.5 ± 0.4 m.y.

2. K-Ar
Cedar Hill vein (Cedar Hill Canyon; SW/4 S20,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 4.50 wt. %; $^{40}Ar^*$ = 9.0879 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.432.
(muscovite) 14.0 ± 0.4 m.y.

3. K-Ar
Vein material (2340 level, Ward Mine; NW/4 S32,T17N,R21E; Storey Co., NV) from Comstock Lode. *Analytical data:* K_2O = 8.65 wt. %; $^{40}Ar^*$ = 1.70092 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.676.
(muscovite) 13.6 ± 0.4 m.y.

4. K-Ar
Vein material (Keystone Mine; SW/4 S5,T16N,R21E; Storey Co., NV) from Silver City fault zone. *Analytical data:* K_2O = 6.80 wt. %; $^{40}Ar^*$ = 1.3452 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.782.
(muscovite) 13.7 ± 0.4 m.y.

5. K-Ar
Vein material (Sixmile Canyon; SW/4 S24,T17N,R21E; Storey Co., NV) from Flowery Lode. *Analytical data:* K_2O = 12.62 wt. %; $^{40}Ar^*$ = 2.34525 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.542.
(adularia) 12.9 ± 0.4 m.y.

6. K-Ar
Vein material (Sixmile Canyon; SE/4 S23,T17N,R21E; Storey Co., NV) from Flowery Lode. *Analytical data:* K_2O = 13.39 wt. %; $^{40}Ar^*$ = 2.53129 × 10^{-10} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.589.
(adularia) 13.1 ± 0.4 m.y.

7. K-Ar
Quartz-alunite alteration (Orleans Hill; SW/4 S17,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 1.08 wt. %; $^{40}Ar^*$ = 2.47579 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.161.
(alunite-quartz) 15.9 ± 1.0 m.y.

8. K-Ar
Quartz-sericite alteration (Mt. Davidson; SW/4 S30,T17N,R20E; Storey Co., NV). *Analytical data:* K_2O = 3.20 wt. %; $^{40}Ar^*$ = 6.9160 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.579.
(sericite-quartz) 14.9 ± 0.6 m.y.

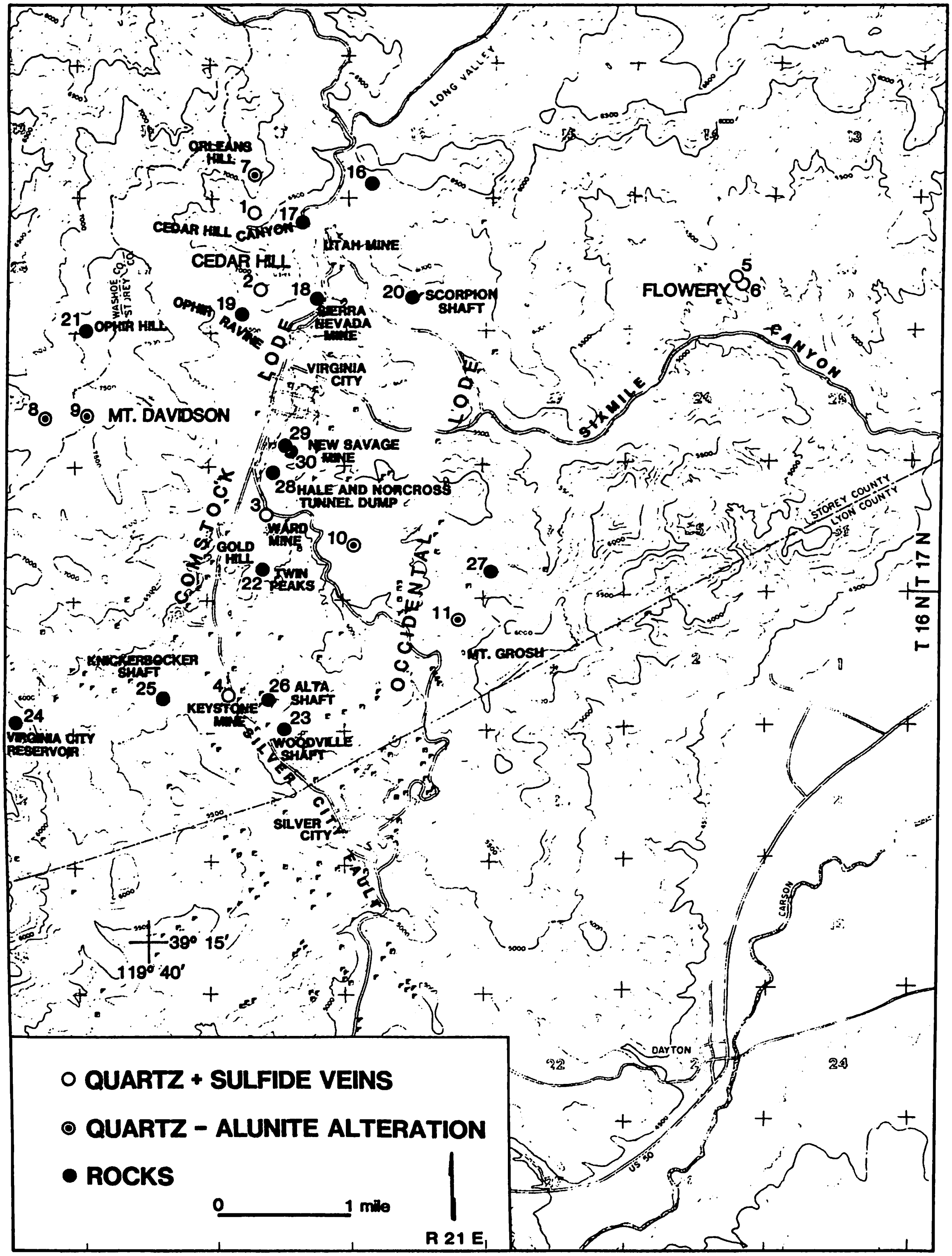

FIG. 1A

FIGURE 1. Sample location map.

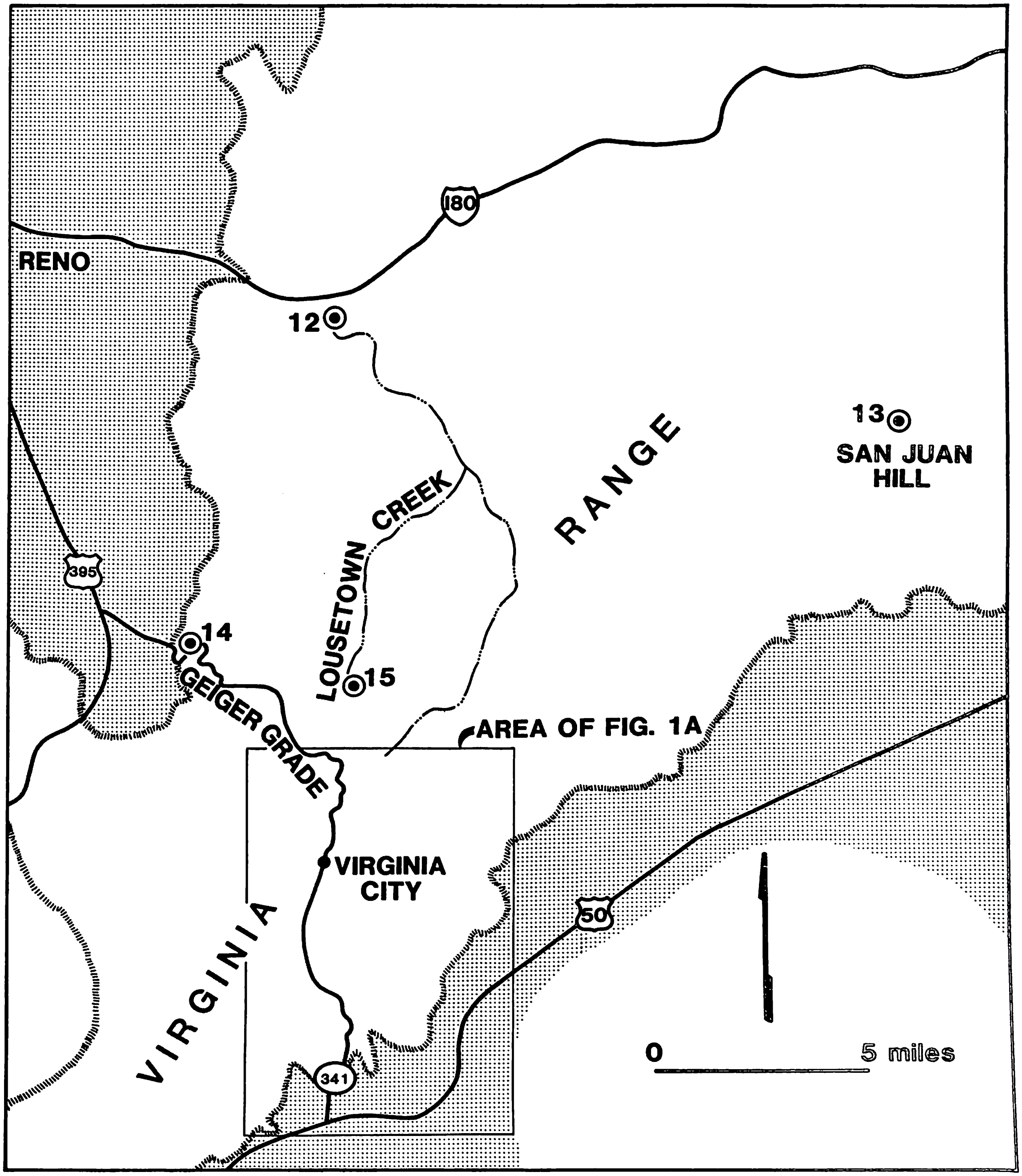
RENO
180
12
13
SAN JUAN
HILL
RANGE
CREEK
LOUSETOWN
395
14
15
GEIGER GRADE
AREA OF FIG. 1A
VIRGINIA
CITY
VIRGINIA
50
341
0
5 miles

FIG. 1B

9. K-Ar
Quartz-alunite alteration (1 mile W of Mt. Davidson; SE/4 S25,T17N,R20E; Washoe Co., NV). *Analytical data:* K_2O = 1.29 wt. %; $^{40}Ar^*$ = 3.04818 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.192.
(alunite-quartz) 16.3 ± 0.5 m.y.

10. K-Ar
Quartz-alunite alteration (Ward shaft; SW/4 S33,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 0.33 wt. %; $^{40}Ar^*$ = 7.32135 × 10^{-12} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.048.
(alunite-quartz) 15.4 ± 1.0 m.y.

11. K-Ar
Quartz-alunite alteration (Mt. Grosh; NE/4 S4,T16N,R21E; Storey Co., NV). *Analytical data:* K_2O = 1.24 wt. %; $^{40}Ar^*$ = 2.69638 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.177.
(alunite-quartz) 15.0 ± 0.6 m.y.

12. K-Ar
Quartz-alunite alteration (Long Valley; NW/4 S21,T19N,R21E; Storey Co., NV). *Analytical data:* K_2O = 1.18 wt. %; $^{40}Ar^*$ = 1.69680 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.151.
(alunite-quartz) 10.0 ± 0.8 m.y.

13. K-Ar
Quartz-alunite alteration (San Juan Hill, Ramsey district; SE/4 S33,T19N,R23E; Storey Co., NV). *Analytical data:* K_2O = 5.04 wt. %; $^{40}Ar^*$ = 6.78792 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.259.
(alunite-quartz) 9.3 ± 0.5 m.y.

14a. K-Ar
Quartz-alunite alteration (base of the Geiger Grade; NW/4 S35,T18N,R20E; Washoe Co., NV). *Analytical data:* K_2O = 4.12 wt. %; $^{40}Ar^*$ = 5.59477 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.118.
(alunite-quartz) 9.4 ± 0.8 m.y.

14b. K-Ar
Quartz-alunite alteration (base of the Geiger Grade; NW/4 S35,T18N,R20E; Washoe Co., NV). *Analytical data:* K_2O = 3.47 wt. %; $^{40}Ar^*$ = 8.05487 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.285.
(alunite-quartz) 16.0 ± 1.6 m.y.

15a. K-Ar
Quartz-alunite alteration (upper Lousetown Creek; SW/4 S4,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 1.33 wt. %; $^{40}Ar^*$ = 2.65348 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.234.
(alunite-quartz) 13.8 ± 0.4 m.y.

15b. Quartz-alunite alteration assemblage (upper Lousetown Creek; SW/4 S4,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 0.86 wt. %; $^{40}Ar^*$ = 1.75649 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.131.
(alunite-quartz) 14.1 ± 0.7 m.y.

16. K-Ar
Intrusive rock (quarry at Utah shaft; SW/4 S16,T17N,R21E; Storey Co., NV) from Kate Peak Formation. *Analytical data:* K_2O = 0.47 wt. %; $^{40}Ar^*$ = 9.68358 × 10^{-12} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.248.
(plagioclase) 14.3 ± 0.5 m.y.

17. K-Ar
Intrusive rock (Utah Mine; NE/4 S20,T17N,R21E; Storey Co., NV) from Kate Peak Formation. *Analytical data:* K_2O = 0.513 wt. %; $^{40}Ar^*$ = 1.14875 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.21.
(plagioclase) 15.0 ± 1.6 m.y.

18. K-Ar
Intrusive rock (Sierra Nevada Mine; SE/4 S20,T17N,R21E; Storey Co., NV) from Kate Peak Formation. *Analytical data:* K_2O = 4.21 wt. %; $^{40}Ar^*$ = 8.5775 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.43.
(alkali feldspar) 13.3 ± 0.6 m.y.

19. K-Ar
Extrusive rock (Ophir Ravine; SW/4 S20,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 1.150 wt. %; $^{40}Ar^*$ = 2.95361 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.451.
(whole rock) 13.5 ± 0.4 m.y.

20. K-Ar
Extrusive rock (Scorpion shaft; SE/4 S21,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 1.167 wt. %; $^{40}Ar^*$ = 2.3062 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.167.
(whole rock) 13.7 ± 0.5 m.y.

21. K-Ar
Alta Formation (Ophir Hill; SW/4 S19,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 0.535 wt. %; $^{40}Ar^*$ = 1.2826 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.144.
(hornblende) 16.6 ± 0.6 m.y.

22. K-Ar
Alta Formation (Twin Peaks, Gold Hill; SW/4 S32,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 0.755 wt. %; $^{40}Ar^*$ = 2.2688 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.26.
(hornblende) 20.1 ± 1.4 m.y.

23. K-Ar
Alta Formation (Woodville shaft; NE/4 S8,T16N,R21E; Storey Co., NV). *Analytical data:* K_2O = 0.618 wt. %; $^{40}Ar^*$ = 1.62029 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.103.
(hornblende) 18.1 ± 0.8 m.y.

24. K-Ar
Knickerbocker Andesite (Virginia City reservoir; SE/4 S1,T16N,R20E; Washoe Co., NV). *Analytical data:* K_2O = 0.617 wt. %; $^{40}Ar^*$ = 1.21373 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.109.
(plagioclase) 13.6 ± 0.6 m.y.
K_2O = 1.27 wt. %; $^{40}Ar^*$ = 1.93549 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.256.
(whole rock) 10.6 ± 0.4 m.y.

25. K-Ar
Knickerbocker Andesite (Knickerbocker shaft; SE/4, S6,T16N,R21E; Storey Co., NV). *Analytical data:* K_2O = 0.29 wt. %; $^{40}Ar^*$ = 5.5469 × 10^{-12} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.083.
(plagioclase) 13.2 ± 1.3 m.y.
K_2O = 1.70 wt. %; $^{40}Ar^*$ = 3.51083 × 10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.618.
(whole rock) 14.3 ± 0.5 m.y.

26. K-Ar

Knickerbocker Andesite (Alta shaft; SW/4 S5,T16N,R21E; Storey Co., NV). *Analytical data:* K_2O = 0.317 wt. %; $^{40}Ar^*$ = 6.0784×10^{-12} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.097.

(plagioclase) 13.3 ± 0.7 m.y.

27. K-Ar

Knickerbocker Andesite (N slope Mt. Grosh; SW/4 S34,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 0.635 wt. %; $^{40}Ar^*$ = 1.2459×10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.081.

(plagioclase) 13.6 ± 0.8 m.y.

28. K-Ar

Davidson Granodiorite (Hale and Norcross tunnel dump; SW/4 S29,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 2.286 wt. %; $^{40}Ar^*$ = 4.418×10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.303.

(feldspar) 13.4 ± 0.4 m.y.

29. K-Ar

Davidson Granodiorite (365 level, New Savage Mine; SW/4 S29,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 2.75 wt. %; $^{40}Ar^*$ = 4.6097×10^{-11} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.379.

(feldspar) 11.6 ± 0.4 m.y.

30. K-Ar

"Black dike" (365 level, New Savage Mine; SW/4 S29,T17N,R21E; Storey Co., NV). *Analytical data:* K_2O = 0.725 wt. %; $^{40}Ar^*$ = 8.9946×10^{-12} mol/gm; $^{40}Ar^*/\Sigma^{40}Ar$ = 0.432.

(whole rock) 8.6 ± 0.3 m.y.

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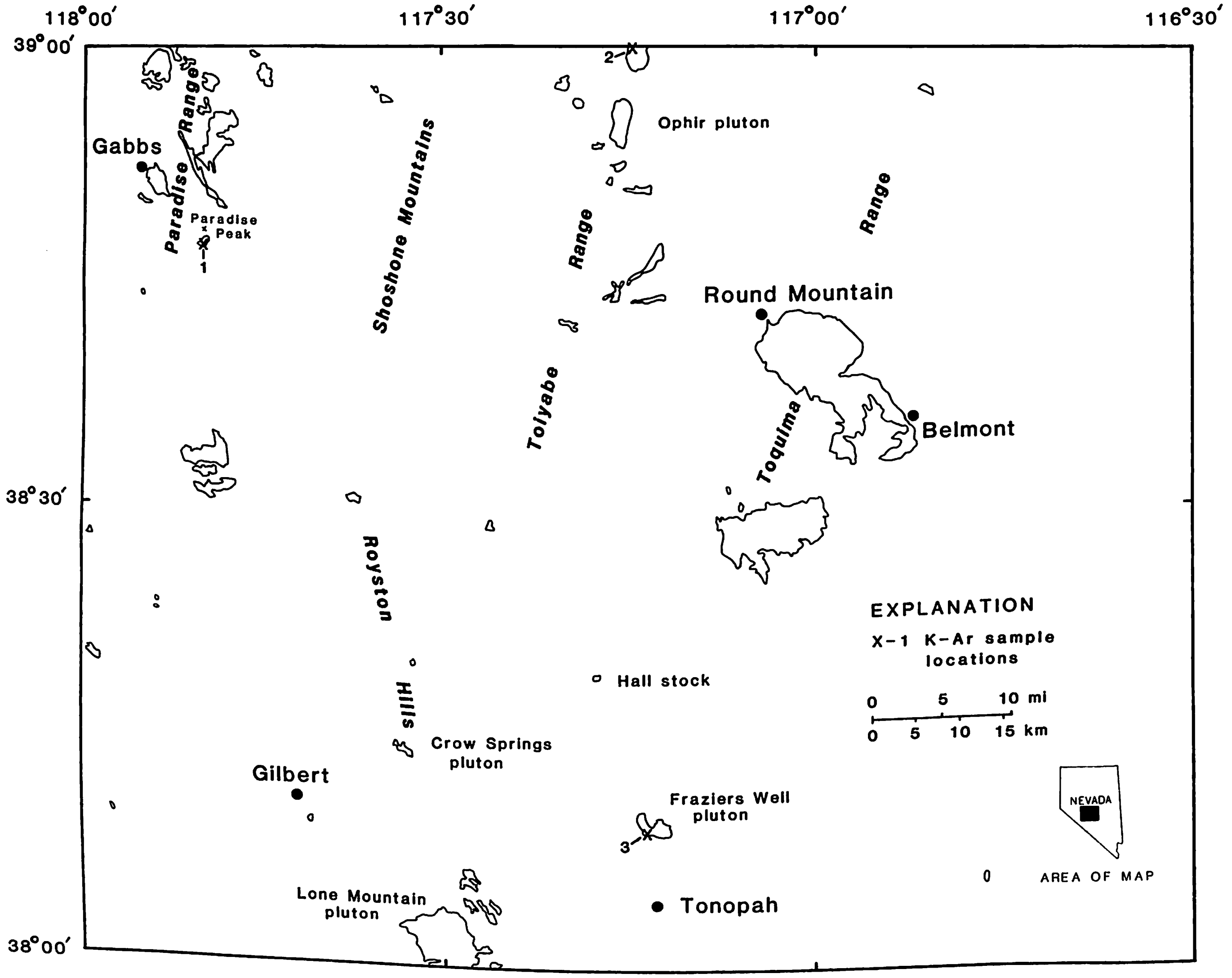

FIGURE 1. Map showing the distribution of granitic plutons in the western part of the Tonopah 1 × 2° quadrangle, Nevada.