NEVADA BUREAU OF MINES

VERNON E. SCHEID, DIRECTOR

REPORT 10

ISOTOPIC AGE DETERMINATIONS OF NEVADA ROCKS

By JOHN H. SCHILLING

MACKAY SCHOOL OF MINES

UNIVERSITY OF NEVADA

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STATE OF NEVADA

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NEVADA BUREAU OF MINES

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Inexact as the radioactive methods may be at the present time, there is tremendous comfort in the thought that almost all rocks are endowed with little radioactive clocks of some sort, ticking away and storing up time records which we shall probably one day be able to interpret much more exactly than now.

Hedberg (1961)

ISOTOPIC AGE DETERMINATIONS OF NEVADA ROCKS

By JOHN H. SCHILLING

ABSTRACT

More than 158 isotopic age determinations have been made on Nevada rocks by various workers. These determinations are listed individually, accompanied by available pertinent data.

Ages have been determined for 92 intrusive, 54 volcanic, 8 metamorphic, 3 sedimentary rock samples, and 1 example of alteration-mineralization. The potassium-argon method of dating was used 111 times; more than half these determinations were run on biotite, the other determinations utilized hornblende, sanidine, muscovite, plagioclase, and the whole rock. The lead-alpha method was used to date 37 samples; all determinations were on zircon. Eight dates were determined by the rubidium-strontium method using K-feldspar, lepidolite, biotite, and muscovite.

Many lead-alpha determinations of Nevada rocks have not proven individually reliable. Where both lead-alpha and potassium-argon dates are available for given intrusive bodies, approximately half of the pairs substantially agree, however a quarter differs grossly. In three-fourths of the cases of gross discrepancy, the lead-alpha date can be shown to be too old on geologic grounds. Furthermore, multiple lead-alpha dates from the same intrusive do not agree with one another. In contrast, the potassium-argon and rubidium-strontium dates of Nevada intrusive rocks, in most cases, agree with other geologic evidence and with one another, and can be used to reach certain tentative conclusions.

Intrusive activity in the Great Basin is not distributed randomly in time -- more intrusives were emplaced at certain times than at others. These maximas of igneous activity appear to have moved southeastward with time across the Great Basin in pulses or waves.

Four volcanic provinces can be outlined in the State on the basis of age: (1) one, 6 to 14 million years old extending along the California line from west-central to southern Nevada; (2) another 14 to 23 million years old in west-central and northwest Nevada; (3) the "ignimbrite region" in southeastern Nevada which is 23 to 26 million years old; and (4) another 27 to 41 million years old in east-central and northeast Nevada. More dating is needed before the limits of these provinces can be established completely.

Although too few intrusives have been dated by the K-Ar (potassium-argon) method to draw definite conclusions, a comparison of the ages of dated intrusives and their associated ore deposits does suggest that generally in Nevada no more ore can be expected around an intrusive body of a particular age than around those of any other age. This also appears to hold true for each type of ore deposit (tungsten contact metasomatic, lead-zinc-silver limestone replacements, copper-contact, lead-silver veins, and porphyry-copper) for which there are sufficient data for even a tentative conclusion.

All the metamorphic rocks in Utah and northeastern Nevada dated by the K-Ar method give mid-Tertiary (57-18 m.y.) ages, although the metamorphic fabric apparently

was formed in Jurassic or Early Cretaceous time. The "too-young" K-Ar ages probably are due to argon loss during deep burial of the rocks in mid-Tertiary time.

INTRODUCTION

Purpose and Scope

This report lists pertinent available data for all known isotopic age determinations of Nevada rocks, bringing together much scattered information published and unpublished, not readily available elsewhere. The author and the Bureau will appreciate receiving information about other determinations on Nevada rocks, as well as additional data or corrections for the dates described here. Any information acquired after the publication of this report will be placed on file at the Nevada Bureau of Mines, where it will be available for examination.

Although no attempt has been made to evaluate the reliability of each determination, the limitations of the various methods are discussed briefly. Some tentative conclusions are given about the age of igneous activity and associated ore deposits in the Great Basin.

The support of the Atomic Energy Commission and several mining companies has enabled the Nevada Bureau of Mines to undertake a modest program of age dating aimed at helping to fill in the gaps; the eight determinations done so far are included in this report.

Previous Work

This compilation of isotopic dates, and the tentative conclusions reached, are based on determinations run by many different individuals and laboratories (see Appendix A, B, C and D). However, only a few individuals and organizations have contributed the bulk of the dates listed in this report.

R. L. Armstrong (1963) dated 40 eastern Nevada rocks by the potassium-argon method. He made a major contribution toward dating intrusive rocks in the State, as well as an important contribution toward volcanic dating. His technique was unique in that he analyzed the argon content by neutron activation.

The University of California at Berkeley has dated 29 Nevada rocks by the potassium-argon method. Most of these dates are from western Nevada and are of Tertiary volcanic rocks. Studies by Evernden and others (1964), and Evernden and James (1964) have contributed greatly to an understanding of the reliability of plant and mammal fossils (and the K-Ar method) in dating Tertiary rocks.

The U. S. Geological Survey has dated 47 of the Nevada rocks listed in this report, 35 by the lead-alpha method (Jaffe and others, 1959) and 14 by the potassium-argon method. Unfortunately many of the lead-alpha dates are unreliable. However, it should be remembered that these lead-alpha dates were the first to suggest the length and complexity of intrusive activity in Nevada -- a picture which the potassium-argon dating has clarified and refined.

Geochron Laboratories has run potassium-argon determinations on at least 13 Nevada rocks submitted by various geologists. Nine of these were determined for the Nevada Bureau of Mines.

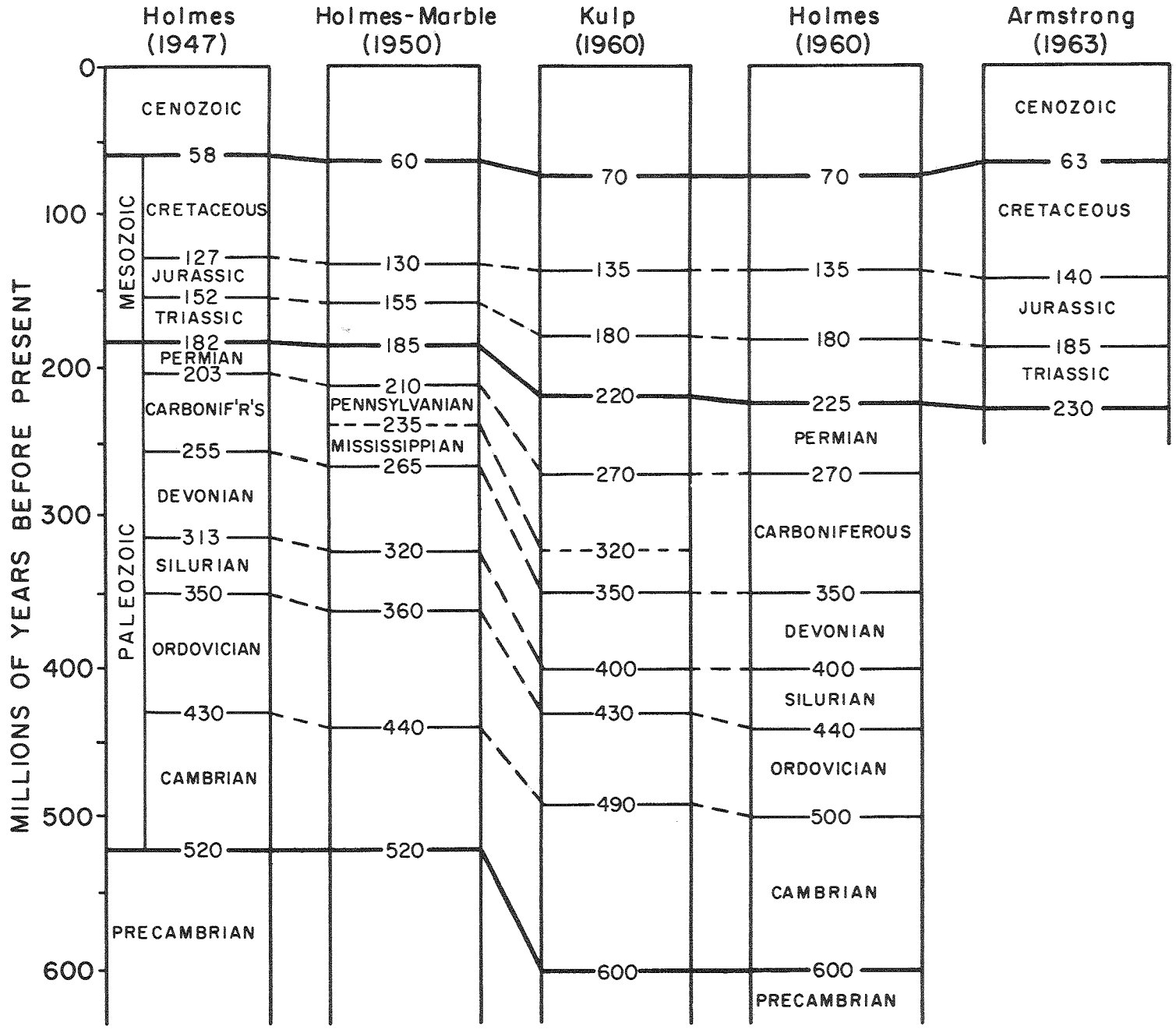

FIGURE 1. Comparison of various geological time scales.

Acknowledgements

So many persons have supplied information about the age determinations listed in this report that it would be difficult to properly credit every contribution; the help of each is gratefully acknowledged. Richard L. Armstrong, Daniel I. Axelrod, Laurence H. Beal, H. F. Bonham, Chester R. Longwell, Edwin H. McKee, and R. C. Speed were particularly helpful.

The report has benefited greatly from the constructive comments and interest of H. F. Bonham, S. E. Jerome, and Ira Lutsey. Helen Mossman and Laurietta James have done a fine job in turning the rough draft of the manuscript into final copy, as have Roland V. Wilson and Richard Paul in drafting the plates and figures.

METHODS

Early in this century it was discovered that certain elements found in rocks are continuously disintegrating radioactively to form other elements or isotopes, and that this decay takes place at a constant rate -- rapid enough to be measurable. This discovery opened up exciting new possibilities for absolute dating of rocks (fig. 1 & 2).

An absolute age can be determined if: (1) the rate of decay of the given radioactive isotope is known; (2) the initial concentrations of the radioactive isotope and one of its stable decay products are known; (3) the present concentration of the radioactive isotope or decay product is known; and (4) the mineral being dated has remained a closed chemical system since its formation -- that is, has not lost or gained some of the radioactive parent or its decay product. Because condition (4) is not especially common in the earth's crust due to weathering, chemical alteration, metamorphism, and other factors, great care must be taken in selecting samples (and the mineral actually used) for determinations. In nearly all cases, it also is necessary to select samples which can be assumed to have had none of the decay product present at the time of formation; otherwise it is difficult to meet condition (2). Finally the decay rates (condition 1) for some systems have not always been (or are not now) accurately known and the assumed values have been changed several times; it is thus useful to know the actual value of the decay constant used in calculating the age of a given sample.

It is important always to remember that isotopic age dating does not give a simple direct rock age, but only indicates how much time has elapsed since certain minerals in the rock were formed, and this only if the basic assumptions and allowances are correct. These methods give the date of crystallization of a granite, not the date of its intrusion; the age of metamorphism of a crystalline schist, not the age of the sedimentary rock from which it was derived; and the maximum age of a sandstone when a detrital mineral from the rock is dated.

Four geochronometric methods have been used to date Nevada rocks: lead-alpha, potassium-argon, rubidium-strontium, and carbon-14. These four methods have been the most commonly used to date rocks elsewhere in the world (Kulp, 1963; Zeller, 1965). The carbon-14 method is useful only up to about fifty thousand years, and is not covered in this report.

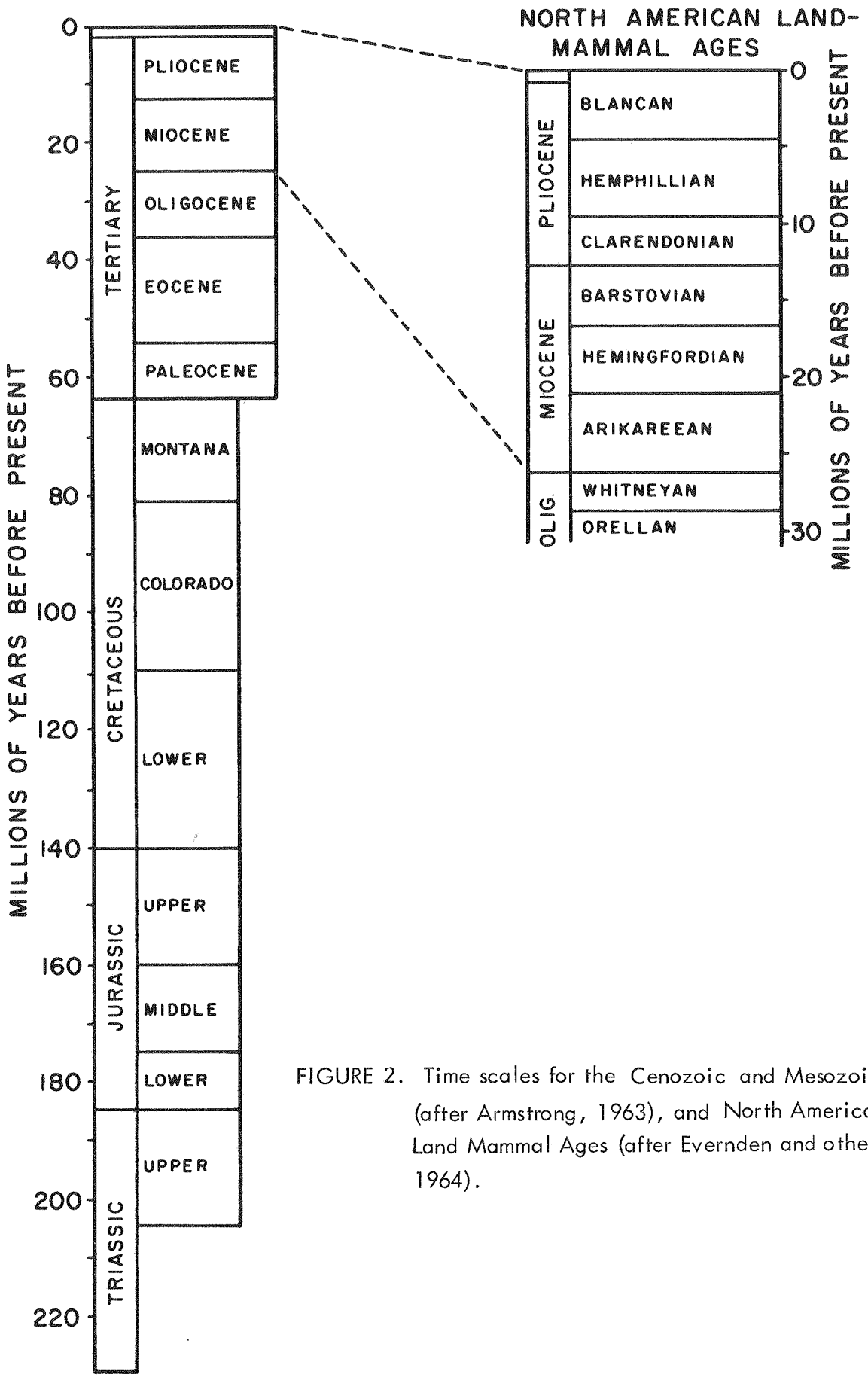

FIGURE 2. Time scales for the Cenozoic and Mesozoic (after Armstrong, 1963), and North American Land Mammal Ages (after Evernden and others, 1964).

Potassium-Argon Method

The decay of K^{40} to Ar^{40} has been widely used in dating rocks and minerals (102 of the 146 determinations run on Nevada rocks utilized this method). It is a particularly useful method because potassium-bearing minerals are common in most rocks; the necessary measurements can be made with relative ease, and with an analytical error that need not exceed ± 2 percent. The decay constant presently used probably is accurate to ± 3 percent. The formula for calculating K-Ar ages is:

$$\text{Age (in m.y.)} = 1885 \ln (1 + 9.10\, Ar^{40}/K^{40})$$

The method can be used to date material ranging in age from oldest geologic time (about 3500 m.y.) to ages of less than 30,000 years (using special techniques).

The method always gives reliable minimum ages (that is, does not give dates that are too old), except for minerals of extremely low potassium content. Its greatest limitation is argon loss, particularly at elevated temperatures, resulting in ages younger than the date of crystallization. Materials that retain their argon over long periods of geologic time at near-surface temperatures include biotite, muscovite, sanidine, normal hornblende, certain fine-grained volcanic rocks, and in most cases glauconite and pyroxene. However, even these minerals and rocks lose argon if heated to several hundred degrees for a short time or to lower temperatures for millions of years. Fifty-eight of the K-Ar determinations run on Nevada rocks used biotite, 10 biotite-hornblende mixtures, 8 sanidine, 6 plagioclase, 4 biotite-muscovite mixtures, 3 muscovite, 3 whole rock, and 1 each hornblende and orthoclase.

TABLE 1. Comparison of Different Potassium-Argon Ages from the Same Nevada Intrusives

Intrusive Body	County	Different...				Dates (m.y.)		Ratio Oldest/Youngest	Difference (m.y.)
		Labs	Locations	Minerals	Samples				
Sylvania	Esmeralda	X	X		X	153	155	1.01	2
Nevada Scheelite	Mineral				X	84	88	1.05	4
Sand Springs Range	Churchill		X		X	76	80	1.05	4
Mill Canyon	Eureka	X	X		X	124	147	1.18	23
White Pine Mts.	Nye		X		X	29	36	1.25	7
Harrison Pass	Elko	X	X		X	26	35	1.35	9
						Averages		1.15	8

Rubidium-Strontium Method

The decay of Rb^{87} to Sr^{87} also has been used for isotopic dating (8 of the 146 determinations run on Nevada rocks utilized this method). These elements can be analyzed with an error of less than 2 percent; the decay constant now used probably has an uncer-

tainty of less than ± 2 percent (Kulp, 1963). These values are comparable to those for the K-Ar method. The formula for calculating Rb-Sr ages is:

$$\text{Age (in m.y.)} = 6.78 \times 10^4 \ln (1 + Sr^{87}/Rb^{87})$$

The method can be used to date material ranging in age from oldest geologic time to 100 million years, and under special conditions to as young as 10 million years.

At elevated temperatures considerable diffusion of strontium can take place from the strontium-rich minerals, and the Rb-Sr ages of these minerals then will be younger than the time of crystallization. However if the minerals have been cooled slowly, the Rb-Sr age will be closer to the true age than will the K-Ar age. Microcline and muscovite normally show lower diffusion rates than cogenetic biotite; therefore concordant Rb-Sr ages for these minerals indicate a rapid cooling history, discordant Rb-Sr ages indicate slow cooling.

Unfortunately, base exchange effects due to groundwater action can lower the Rb-Sr age obtained from biotites, but does not affect the K-Ar age; the Rb-Sr age of muscovite apparently is not changed by this type of alteration.

Thus comparisons of the K-Ar and Rb-Sr ages of a rock, and the Rb-Sr ages of different minerals in the rock, are particularly useful in establishing a reliable absolute age as well as providing information about the metamorphic history of the rock.

TABLE 2. Comparison of Different Lead-Alpha Ages from the Same Nevada Intrusives

Intrusive Body	County	Different ... Labs	Locations	Minerals	Samples	Dates (m.y.)		Ratio Oldest/Youngest	Difference (m.y.)
Unionville	Pershing		X		X	230	290	1.26	60
Copper Canyon	Lander		X		X	38	49	1.29	11
Climax	Nye		X		X	230	330	1.44	100
Mountain City	Elko		X		X	70	110	1.57	40
						Averages		1.39	53

Biotite, muscovite, microcline, and lepidolite can give reliable dates. Four of the Rb-Sr determinations run on Nevada rocks used K-feldspar, 2 lepidolite, and 1 each biotite and muscovite.

Lead-Alpha Method

The uranium-lead geochronometric system is based on the decay of U^{238} to Pb^{206} and U^{235} to Pb^{207}. The lead-alpha (Pb α) method measures the total lead present and the alpha radiation. The formulas used for calculating the lead-alpha ages of Nevada rocks were (Jaffe and others, 1959):

(0-200 m.y.) $$\text{Age (in m.y.)} = t = \frac{c \times Pb\ (ppm)}{\alpha\ /mg/hr}$$

(200-1700 m.y.) $$\text{Age (in m.y.)} = \frac{c \times Pb\ (ppm)}{\alpha/mg/hr} - 1/2\ k \left[\frac{c \times Pb\ (ppm)}{\alpha\ /mg/hr}\right]^2$$

The constants, c and k, are functions of the ratio of thorium to uranium in the mineral being dated. Values used were:

Xenotime: $c = 2550;\ k = 1.71 \times 10^{-4}$
Zircon: $c = 2485;\ k = 1.56 \times 10^{-4}$
Monazite: $c = 2085;\ k = 0.65 \times 10^{-4}$

Zircon is the most satisfactory mineral for lead-alpha dating -- all Nevada determinations were on this mineral; monazite and xenotime have been used elsewhere to date rocks by the Pb α method.

Unfortunately, many lead-alpha determinations of Nevada rocks have not proven reliable. Where Pb α and K-Ar ages for the same intrusive are available (see table 3), approximately half the pairs substantially agree, however a quarter differ grossly. In three-fourths of the cases of gross discrepancy, the lead-alpha date can be shown to be too old on geologic grounds and does not agree with other lead-alpha dates from the same intrusive (see table 2). These high Pbα dates probably are due to inherited radiogenic or common lead. In contrast, the K-Ar (see table 1) and Rb-Sr dates agree with other geologic evidence and with one another.

TABLE 3. Comparison of Lead-Alpha and Potassium-Argon Ages of Nevada Intrusives

Intrusive Body	Pb α (m.y.)	K-Ar (m.y.)	Pbα/K-Ar	Difference (m.y.)
Austin, Lander Co.	44	140	.32	96
Mountain City, Elko Co.	70	81[2]	.86	11
Heuser Peak, White Pine Co.	30	32	.94	2
Eureka, Eureka Co.	64	64	1.00	0
Harrison Pass, Elko Co.	40[1]	35	1.14	5
Siligman, White Pine Co.	128	110	1.16	18
Kingsley, White Pine Co.	41	35	1.17	6
Ruth-Kimberly, White Pine Co.	160	123	1.30	35
Mountain City, Elko Co.	110	81[2]	1.36	29
Harrison Pass, Elko Co.	40[1]	26	1.40	14
Knob Hill, Clark Co.	38	26	1.45	12
Osceola, White Pine Co.	170	115	1.48	55
Wheeler Peak, White Pine Co.	145	95	1.52	50
Climax, Clark Co.	230	93[2]	2.5	137
Boulder City, Clark Co.	53	17	3.1	36
Lexington Creek, White Pine Co.	225	64	3.5	161
Climax, Clark Co.	330	93[2]	3.6	237

1/ Same Pbα determination compared with two different K-Ar determinations.

2/ Same K-Ar determination compared with two different Pbα determinations.

However, the uranium-lead system as a whole is an attractive one, since any chemical alteration of a sample will cause discordance between the uranium-lead ages based on the different isotopic ratios (Pb206/U238, Pb207/U235, and Pb207/Pb206). And if a series of zircons of different concentration can be extracted from the same rock complex, an absolute age can be determined using a Concordia diagram (Kulp, 1963, p. 3).

AGE OF GREAT BASIN METAMORPHIC ROCKS

All the metamorphic rocks in Utah and northeastern Nevada dated by the K-Ar method (Armstrong, 1963, p. 127; Thorman, 1965) give mid-Tertiary (57-18 m.y.) dates, although it is believed that the metamorphic fabric (and mineral suite) was formed in Jurassic or Early Cretaceous time. The "too young" K-Ar dates probably are due to argon loss caused by "postmetamorphic" heating in (or continuing till) mid-Tertiary time.

Oligocene volcanics throughout much of this area are only in depositional contact with upper Paleozoic rocks, indicating that the metamorphic rocks were deeply buried as late as Oligocene (22-28 m.y.) time, which in turn implies that the rocks were subjected to temperatures of several hundred degrees -- more than adequate to cause continuous and complete argon loss. The widespread igneous activity at the same time in this area probably contributed additional heat, at least locally.

In contrast, all the Precambrian rocks of southern Nevada that have been dated by K-Ar and Rb-Sr methods gave Precambrian ages, indicating that mid-Tertiary heating was not prevalent in that part of the Great Basin.

AGE OF GREAT BASIN INTRUSIVE ROCKS

Most of the potassium-argon dates of Nevada and Utah (Armstrong, 1963) intrusives appear to represent reliable ages of crystallization (and thus roughly also of intrusion). The potassium-argon dates in nearly all cases agree with other geologic evidence and with each other. And although many of the lead-alpha dates are individually unreliable, as a group they do tend to support the reliability of the potassium-argon dates.

The mid-Tertiary heating of the metamorphic rocks throughout Utah and eastern Nevada (see above) suggests the possibility of argon loss, and "too-young" K-Ar ages, for any older intrusive rocks that might have been present in this region. In eastern Nevada the intrusives have "older", as well as mid-Tertiary, K-Ar ages indicating that some (shallow-emplaced?), if not all, intrusives escaped being exposed to elevated temperatures. In contrast, in Utah no intrusives with older K-Ar ages have been dated indicating either that few, if any, intrusives were emplaced before mid-Tertiary time, or that all older intrusives were subjected to elevated temperatures during the mid-Tertiary.

However, several lines of evidence suggest that although a few intrusive dates in Utah and eastern Nevada might be "too-young", most (if not all) are not. Obviously many intrusives in the region are mid-Tertiary in age, some can be shown to be so because of their stratigraphic relationship to units of known age, while others similarly are at least post-Cretaceous. And few, if any of the K-Ar ages disagree with stratigraphic or other direct geologic evidence of age. Armstrong (1963, p. 97) points out that in this region there is no correlation of depth of intrusion with K-Ar dating as there should be if later heating had caused argon loss, and that none of the intrusives dated came from zones as deep as the metamorphic rocks with "too-young" ages. Further the concordance of lead-alpha and potassium-argon dates from a number of intrusives suggest negligible heating and "true" ages; lead-alpha dates from some intrusives are older than K-Ar dates,

but this is not unusual even where the K-Ar dates are known to be correct.

This does not mean that every date should be accepted unquestionably as ages of emplacement. Each date should be considered individually suspect unless supporting evidence is available. It does indicate a consensus that the probability of a given date being "too-young" is small. As has been emphasized elsewhere, cross-checking both by dating more than one mineral from each rock and by using other isotopic methods, could do much to clarify the picture of what has happened to the metamorphic and intrusive rocks since their genesis.

The apparent reliability of most of the potassium-argon dates of Nevada (and Utah) rocks does make it possible to come to tentative conclusions about the distribution in time and space of intrusive rocks of the Great Basin, although more determinations are needed to clarify the picture, particularly in western Nevada. Plate 1 shows the locations and ages of Nevada intrusives that have been dated by the potassium-argon method. Figure 3 shows the distribution in time of all Great Basin intrusives dated by the K-Ar method, and compares this distribution with that of the Sierra Nevada and Coast Ranges to the west and the Rocky Mountains to the east. Figure 4 compares the distribution in time, of intrusives (dated by the K-Ar method) from the eastern, central, and western parts of the Great Basin.

It is immediately obvious from these illustrations that intrusive activity is not distributed randomly in time in the western United States. The Sierra Nevada, Great Basin, and Rocky Mountains each are characterized by intrusives of certain ages (fig. 3) even though the overall picture for the West is one of a continuum of dates; this same pattern holds true when parts of the Great Basin are compared with the Basin as a whole (figs. 3 and 4).

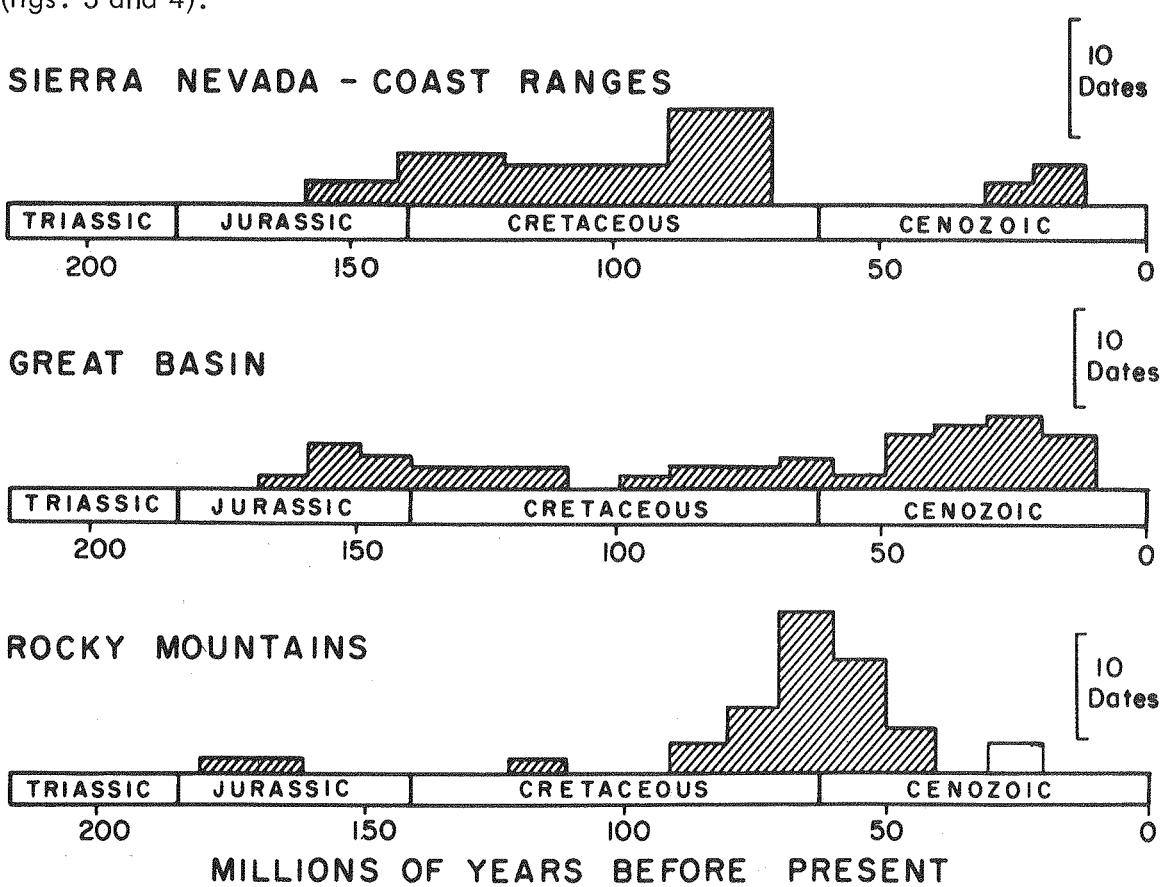

FIGURE 3. Potassium-argon ages of Cordilleran intrusive rocks (data for states other than Nevada from Armstrong, 1963).

Armstrong (1963) points out that in the eastern half of the Great Basin for the two "major (intrusive) age groups [13-64 m.y. and 93-182 m.y.], there is a trend toward younger ages southeastward within the group", supporting the theory that intrusive activity moved eastward with time across the Great Basin in pulses or waves. This same trend is apparent for the Basin as a whole (fig. 5). The younger wave appears to have moved more slowly, causing the two waves to converge eastward with time.

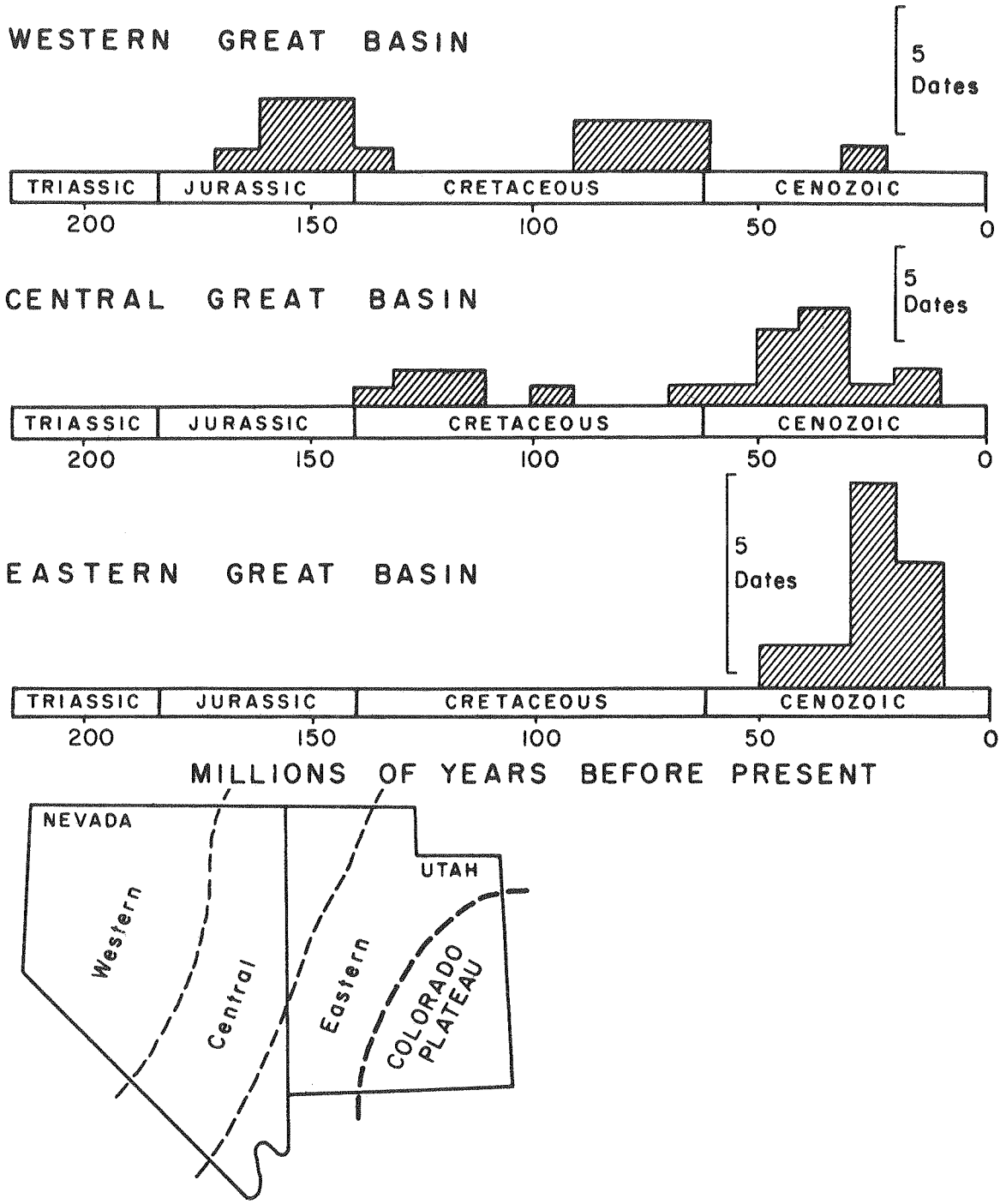

FIGURE 4. Potassium-argon ages of Great Basin intrusive rocks (data for Utah from Armstrong, 1963).

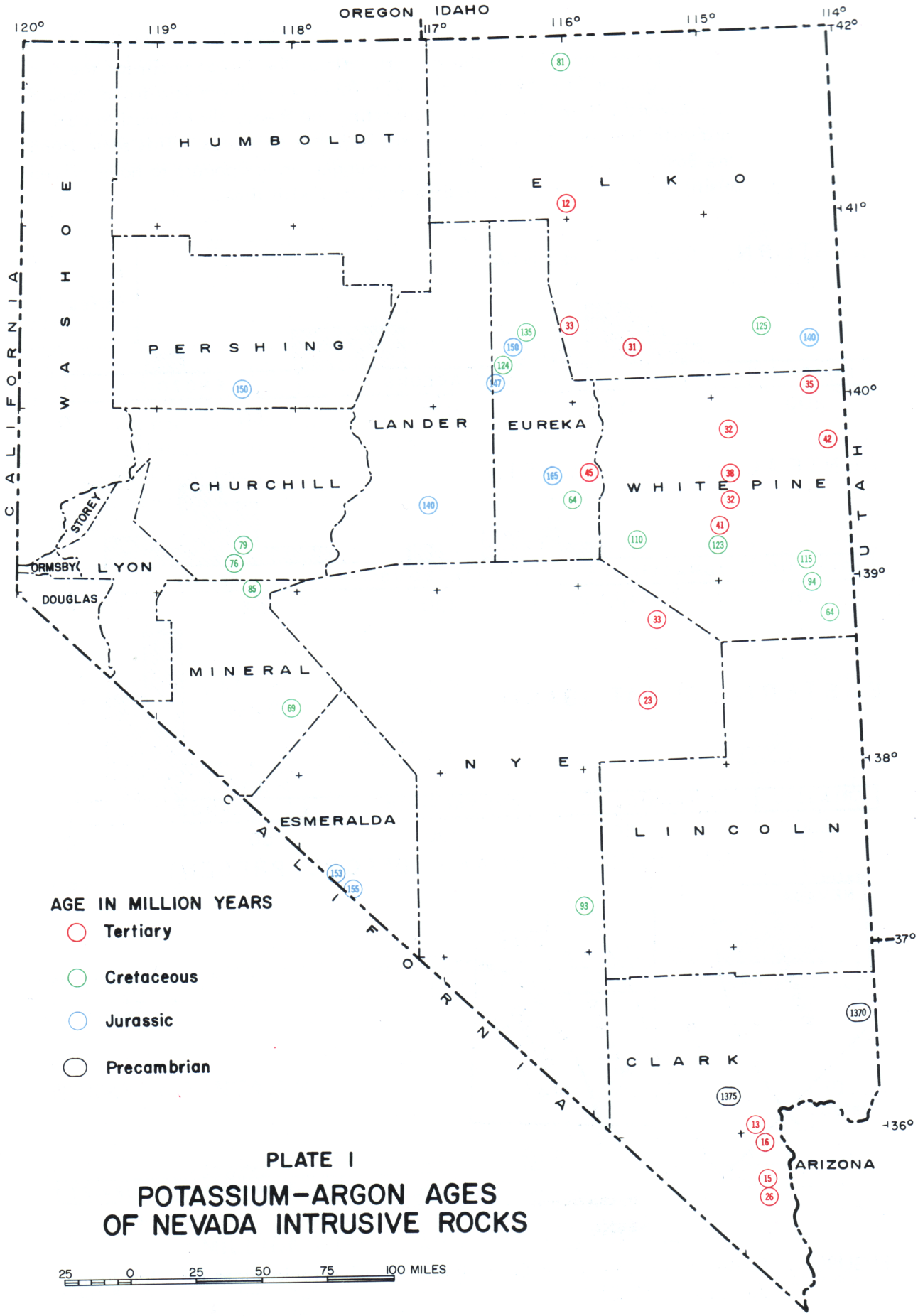

PLATE I

POTASSIUM-ARGON AGES OF NEVADA INTRUSIVE ROCKS

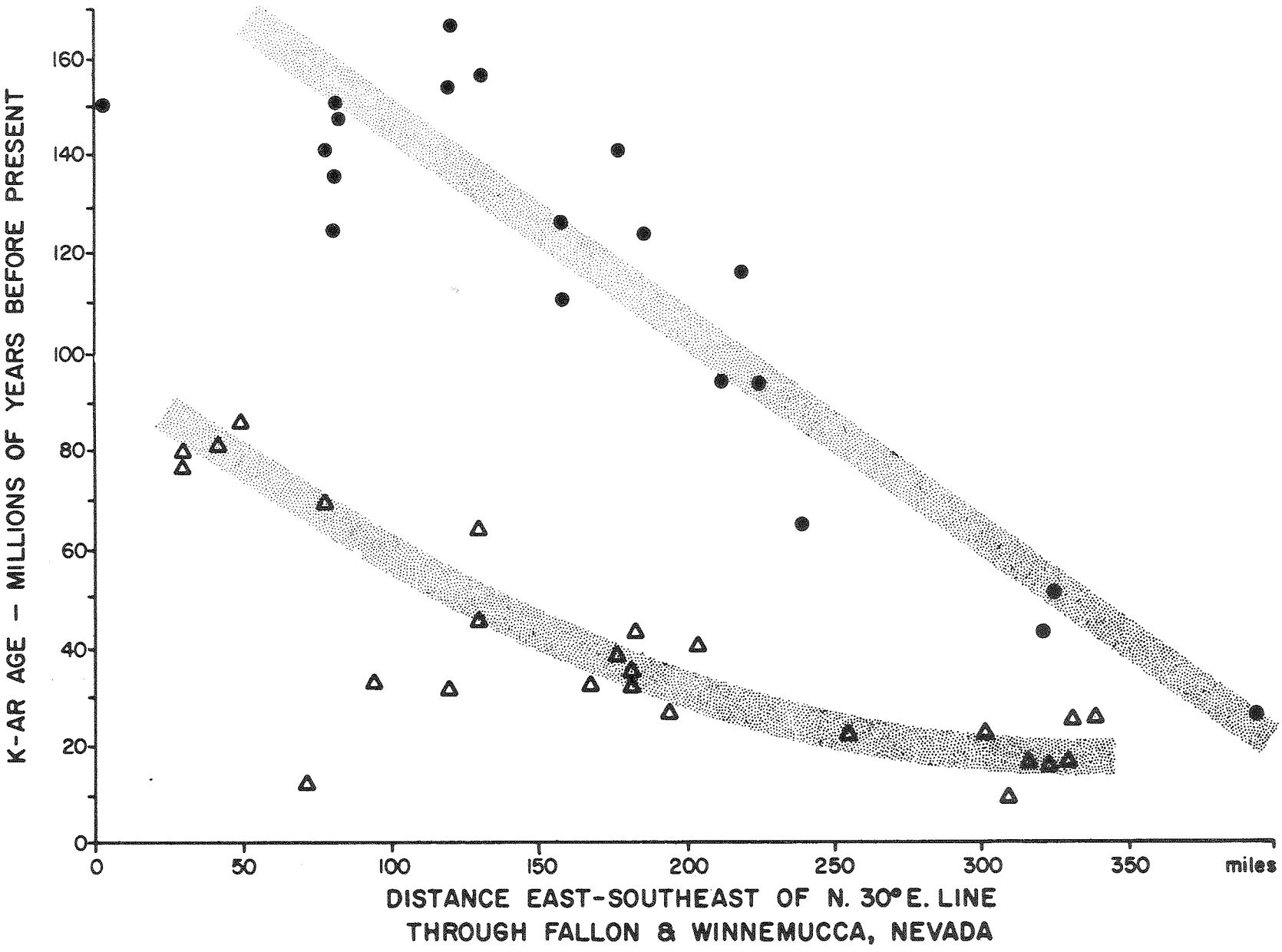

FIGURE 5. Variation of the potassium-argon age of intrusive rocks from northwest to southeast in the Great Basin (data for Utah from Armstrong, 1963).

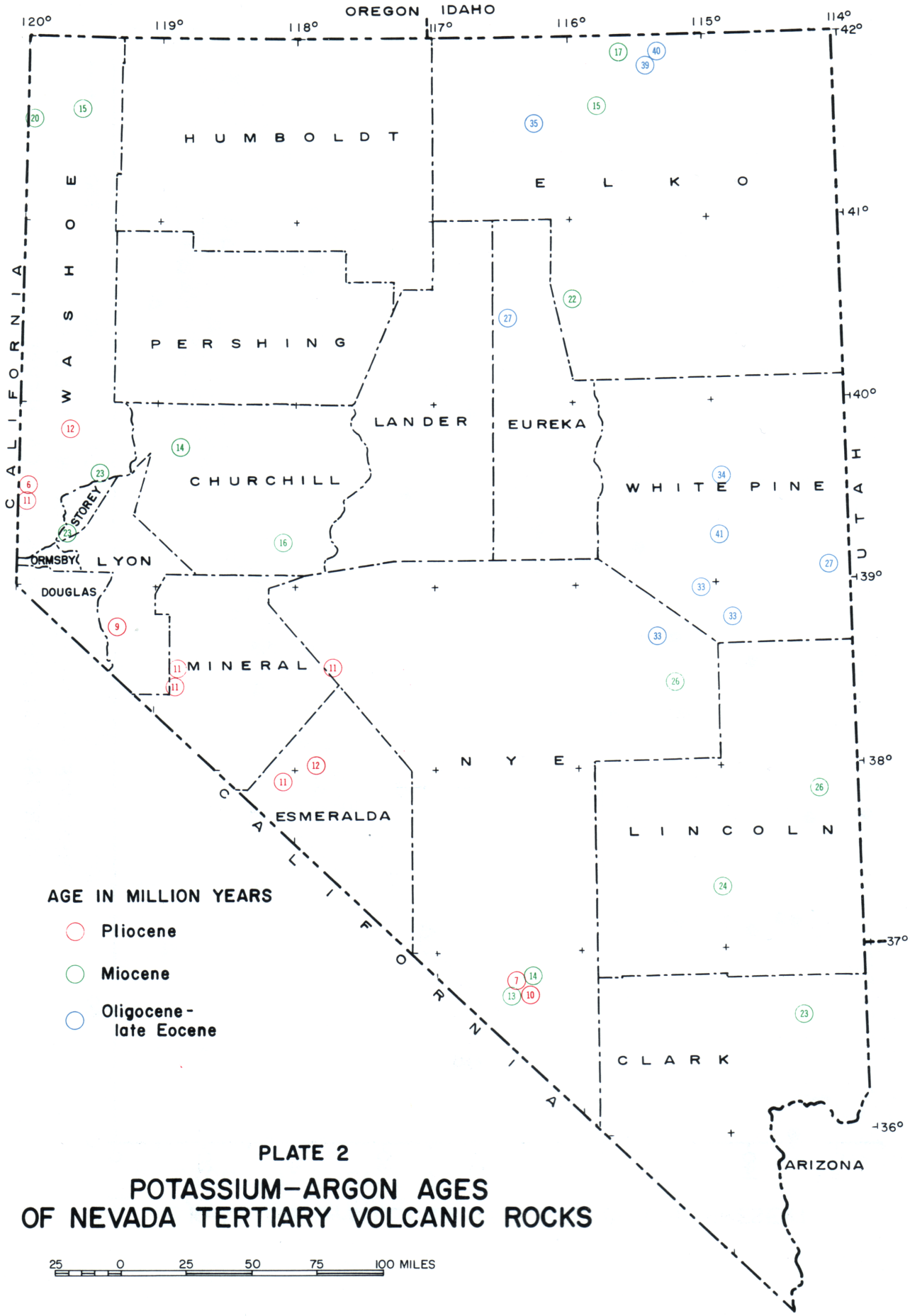

PLATE 2

POTASSIUM-ARGON AGES
OF NEVADA TERTIARY VOLCANIC ROCKS

AGE OF NEVADA VOLCANIC ROCKS

Although the volcanic rocks have not been isotopically dated in large areas of the State (see plate 2), four volcanic provinces can be tentatively outlined on the basis of age: (1) one, 6 to 14 million years old extending along the California-Nevada line from west-central to southern Nevada; (2) another 14 to 23 million years old in west-central and northwest Nevada; (3) another 23 to 26 million years old -- the "ignimbrite region" (Armstrong, 1963, p. 69) -- in southeastern Nevada; and (4) one 27 to 41 million years old in east-central and northeast Nevada. More dates are needed before the geographical limits of these provinces can be established. Further dating may also extend the time limits somewhat. However, volcanic dates that fall outside the above time limits are absent or extremely rare within a particular province.

AGE OF NEVADA ORE DEPOSITS ASSOCIATED WITH INTRUSIVES

The only mineralization that has been directly dated by isotopic methods is that of the Ely (Ruth) porphyry-copper deposits. Here the dates indicate that the mineralization-alteration (121 m.y.) and the quartz monzonite porphyry (123 m.y.) probably are genetically related. In order to reach any conclusions about the age of other hydrothermal mineralization in the State, it is necessary to assume that the mineralization in each case is of the same age as the associated intrusive rocks. Many ore deposits and their associated intrusives can be shown to be related genetically, and thus are of about the same age. And where the ore deposits are within an intrusive, the intrusive's age is the maximum age of the mineralization.

Unfortunately, only a small fraction of the associated intrusives have been dated by the K-Ar method, thus many important ore deposits can not be dated isotopically, even indirectly. Because the data are so incomplete, the following conclusions are at best tentative.

The relatively few dates that are available suggest that, in Nevada, individual intrusives of any one age group do not have more associated ore than do intrusives of any other age. This appears to hold true for each genetic type of ore deposit (and each metal) for which adequate K-Ar data are available (dates enclosed in parentheses indicate major production [more than $10,000,000]; underlined dates indicate production valued at $1,000,000 to $10,000,000): tungsten contact metasomatic deposits are associated with 12, 23, 31, 35, 64, 78, (85), 93, and 153 m.y. old intrusives; lead-zinc-silver limestone replacement bodies with 23, 33, (64), (110), 123, (124), and 125 m.y. intrusives; copper-contact deposits with 33, (81), 110, 124, and 125 m.y. intrusives; lead-silver veins with 23, 81, 115, and 153 m.y. intrusives; and porphyry-copper deposits with 70, 81, and (123) m.y. (Bingham Canyon, Utah, with (45) m.y.) intrusives.

The above also appears to hold true in a general way if the total production of all types of hydrothermal ore from districts in Nevada with K-Ar dated intrusives is compared to the age of the intrusives (fig. 6). One "super" district, Ely, has produced considerably more ore than all the other "dated" districts combined. If Ely's production is "averaged" with other production of the same age, the 120 to 130-million-year-old intrusives individually appear to have more associated ore, giving an obviously distorted picture. To minimize this effect a logarithmic scale was used to show production in figure 6.

In conclusion, the limited data do not point out any one age of intrusives that individually have more associated ore, or more ore of a particular type. This would seem to indicate that the periods of maximum igneous activity -- those having the largest number of intrusive bodies -- are the periods of maximum ore genesis. However many more intrusives must be isotopically dated before definite conclusions can be reached.

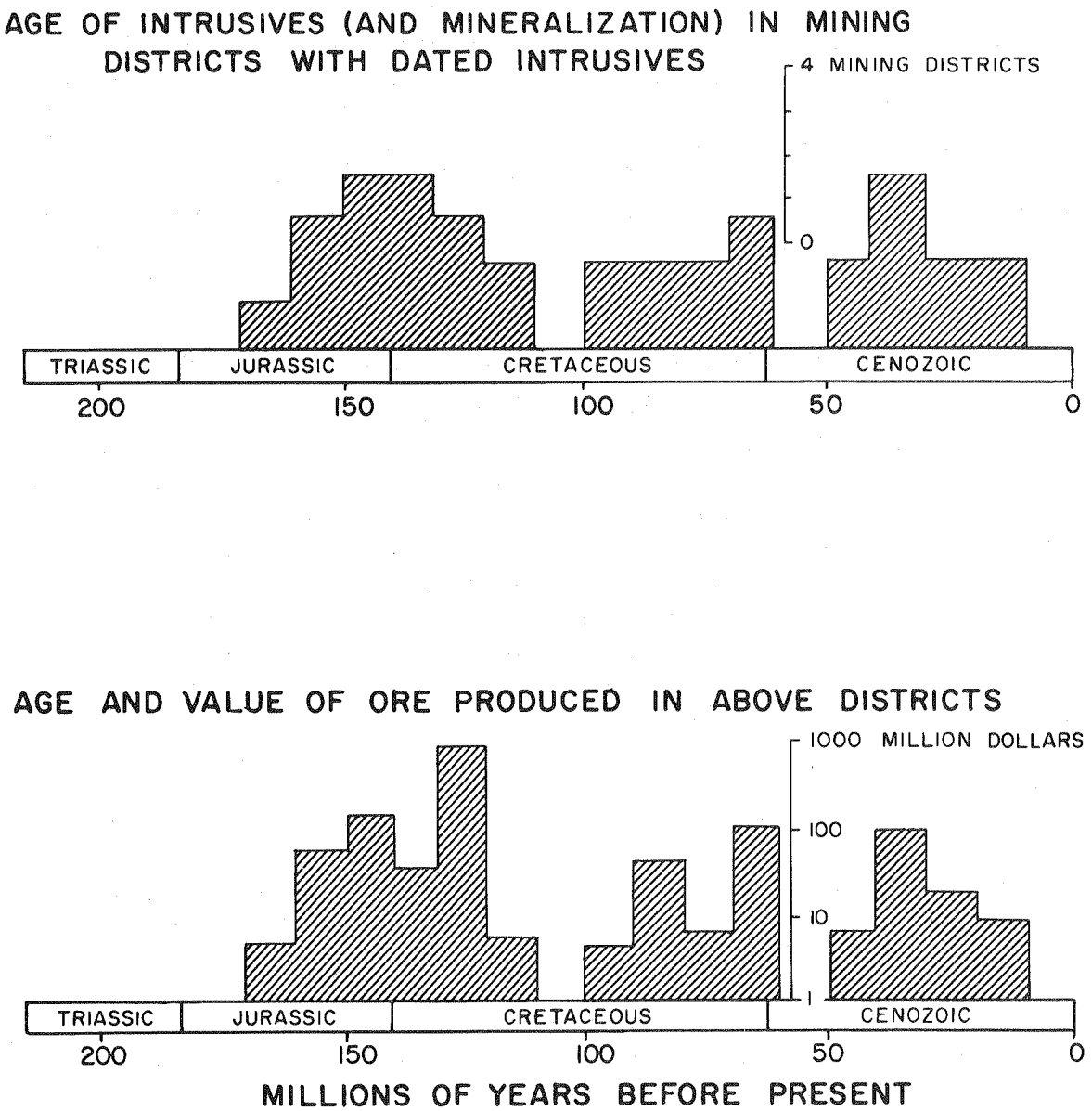

FIGURE 6. Potassium-argon age of ore deposits in Nevada (assuming that the mineralization is of the same age as the associated intrusive rocks).

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APPENDICES

Individual determinations are listed in Appendix A (intrusive rocks), B (volcanic rocks), C (metamorphic rocks), D (sedimentary rocks), and E (alteration and mineralization). Under each date the age, rock type and petrography, location, method used, mineral used, collector, analyst, analytical data and constants used to calculate the age, geologic setting, "geologic" age, associated ore deposits, and sources of information about the determination and geology are given if known.

The uncertainty factor or error is given in parenthesis after the age: unfortunately the various workers have used different criteria in calculating this figure -- for some it is the variation between replicate analyses, for others the supposed analytical accuracy or the maximum total error based on the analytical error plus the uncertainty of the decay constant.

The "geologic" age given is based on geologic evidence other than the rock's isotopic age. A star in front of a reference cited indicates that the reference mentions the isotopic age determination, not just the geology of the rock. If more than one date is available for a given intrusive or rock unit, they are listed consecutively. The published references to many dates do not give the constants used (or analytical data), mineral used, what laboratory ran the determination, location, etc. This information is essential in comparing dates and establishing their reliability. It is hoped that these data will be presented in all future publications.

The locations at which all analysed rock samples were collected, are shown in figure 7.

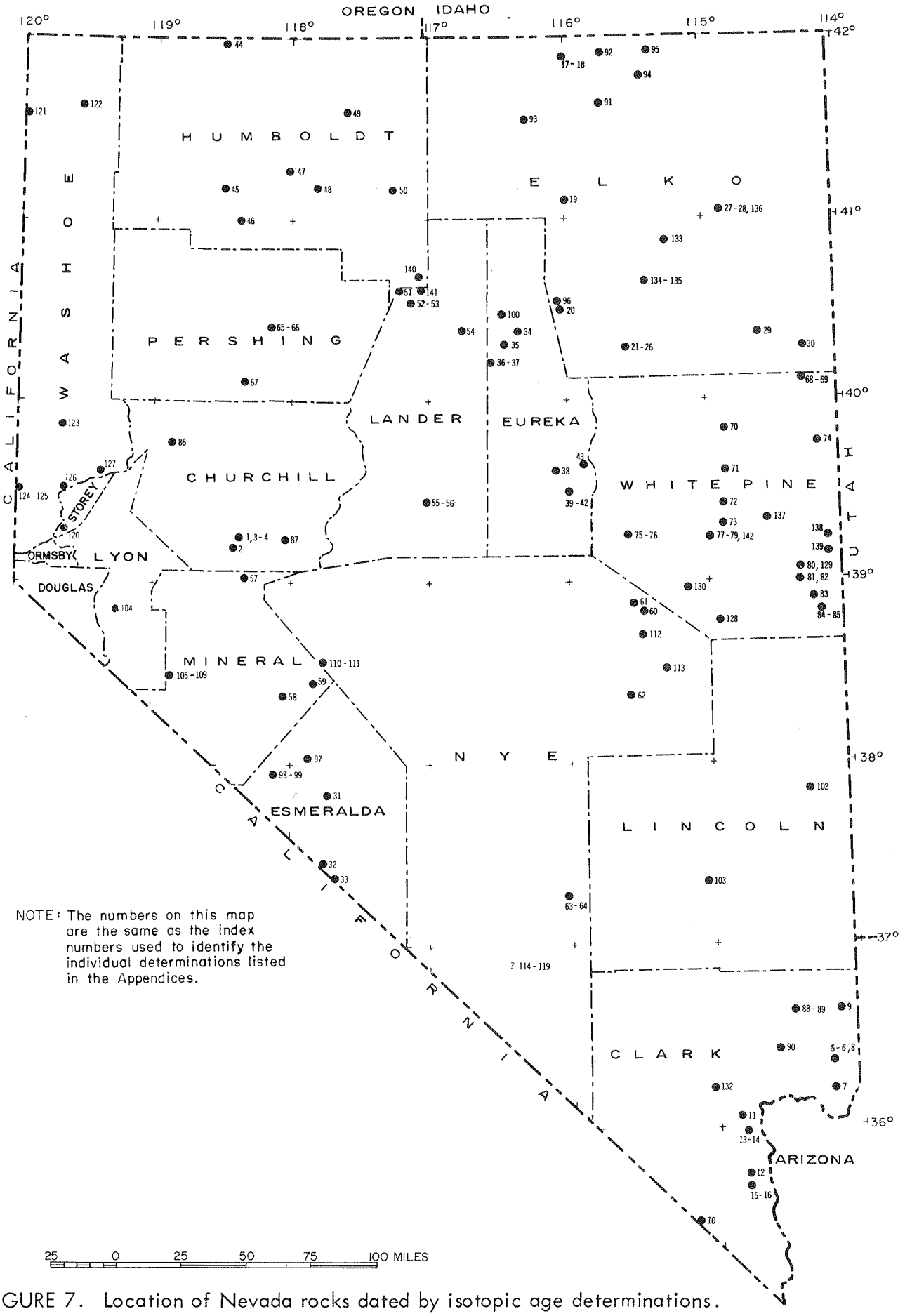

FIGURE 7. Location of Nevada rocks dated by isotopic age determinations.

APPENDIX A

INTRUSIVE ROCKS

CHURCHILL COUNTY

Index No: 1
GRANITE
79.6 m.y. ($\pm$ 2.0 m.y.)

Location: Sec. 34, T. 16 N., R. 32 E.; in the Sand Springs Range; from a prominent outcrop, about 200 feet east-southeast of the Shoal shaft and 1230 feet N. 60° E. of the southwest corner of Sec. 34 (see Pl. 6, Univ. Nev., 1962).

Method: POTASSIUM-ARGON.

Mineral: BIOTITE. Separated by J. B. Murphy, Nevada Bureau Mines, 1962. Grain size: 0.006 to 0.033 in. Fresh, with minor chlorite in separate grains as contaminent.

Collected by: S. E. Jerome and John H. Schilling, Nevada Bureau Mines, 1962. (NBM no. AD-1).

Determined by: Geochron Laboratories, Inc., 1962. (Geochron no. B-0188).

Constants: K^{40}: $\lambda_\beta = 4.72 \times 10^{-10}$/year; $\lambda_\varepsilon = 0.585 \times 10^{-10}$/year.
$K^{40} = 1.22 \times 10^{-4}$ gm/gm total K.

Data: K = 5.47%; radiogenic Ar^{40} = 0.0317 ppm; Ar^{at}_{40} = 47%.

Geology of Intrusive: From the center of a granitic body 10 miles long and over 5 miles wide that intrudes Triassic(?) metamorphic rocks, has been deeply eroded, and is partially covered by Tertiary and Quaternary volcanic rocks. The body consists of two distinct rock types: granite and granodiorite. Field relationships suggest that the granodiorite (see no. 2) is somewhat younger than the granite (this determination). (Univ. Nev. 1962, p. 16).

Petrography: Porphyritic, with abundant large microcline phenocrysts in a medium- to coarse-grained groundmass of strongly- zoned plagioclase, (An_{10-25}) quartz, microcline, and (5-10%) biotite. Typical of granite in the granitic body.

Cited Age: Cretaceous(?) (Univ. Nev., 1962).

Associated Ore Deposits: Tungsten (scheelite) contact deposits.

References: *Krueger, H. W. (July 31, 1962) written communication: Geochron Laboratories.
*Schilling (1965).

Index No: 2
GRANODIORITE
76.0 m.y. ($\pm$ 2.0 m.y.)

Index No: 2 (Continued)

Location: SW 1/4 Sec. 11, T. 15 N., R. 31 1/2 E.; in the canyon separating the Sand Springs Range from the Cocoon Mountains to the west; from the southwest wall of Four Mile Canyon where the canyon trends southeast, is narrow, and has vertical walls.

Method: POTASSIUM-ARGON.

Mineral: BIOTITE. Separated by J. B. Murphy, Nevada Bureau Mines, 1962. Grain size: 0.004-0.012 in. Fresh, with some hornblende and minor chlorite in separate grains as contaminents.

Collected by: S. E. Jerome and John H. Schilling, Nevada Bureau Mines, 1962. (NBM no. AD-3).

Determined by: Geochron Laboratories, Inc., 1962. (Geochron no. B-0189).

Constants: Same as no. 1.

Data: K = 2.66%; radiogenic Ar^{40} = 0.0147 ppm; Ar_{40}^{at} = 48%.

Geology of Intrusive: From the same granitic body as no. 1, from a point at least several hundred feet from the contact.

Petrography: Equigranular, medium-grained; consisting of plagioclase (An_{20-35}), microcline, quartz, hornblende, and (1-5%) biotite. Typical of granodiorite in the granitic body.

Cited Age: Cretaceous(?), slightly younger than no. 1 (Univ. Nev., 1962).

Associated Ore Deposits: Tungsten (scheelite) contact deposits.

References: *Krueger, H. W. (July 31, 1962) written communication: Geochron Laboratories.

*Schilling (1965).

Index No: 3

PEGMATITE

31.5 m.y. (± 3.0 m.y.)

Note: This age is suspect; the considerable alteration of the biotite could have caused a younger age.

Location: Sec. 33, T. 16 N., R. 32 E.; in the Sand Springs Range; from a trench 1505 feet N. 3° W. of the southeast corner of Sec. 33 (see Pl. 6, Univ. Nev., 1962).

Method: POTASSIUM-ARGON.

Mineral: BIOTITE. Separated by J. B. Murphy, Nev. Bur. Mines, 1962. Partially altered to abundant chlorite.

Collected by: S. E. Jerome and John H. Schilling, Nevada Bureau Mines, 1962. (NBM no. AD-2).

Determined by: Geochron Laboratories, Inc., 1962. (Geochron no. B-0202).

Constants: Same as no. 1.

Data: K = 2.74%; radiogenic Ar^{40} = 0.0062 ppm; Ar_{40}^{at} = 80%.

Geology of Intrusive: From a pegmatitic portion of a 1- to 2-foot-wide dike, one of the numerous aplite-pegmatite dikes (see also no. 4) that fill joints most commonly striking N. 60° W. and dipping steeply in the large granitic body (see nos. 1 & 2). Field relationships suggest that the dikes are a late stage differentiate from the still plastic portions of the granitic body (Univ. Nev., 1962, p. 17-18).

Petrography: Pegmatitic; coarse microcline, pods of quartz, and abundant large, thin biotite flakes. Not typical of most of the dikes in that it contains abundant biotite rather than little to none.

Cited Age: Late Cretaceous to Early Tertiary, slightly younger than the granitic body (Univ. Nev., 1962, p. 18).

Associated Ore Deposits: None.

References: *Krueger, H. W. (July 31, 1962) written communication: Geochron Laboratories.

*Schilling (1965).

Index No: 4
PEGMATITE
66 m.y. ($\pm$ 4 m.y.)

Location: Sec. 4, T. 15 N., R. 32 E.; in the Sand Springs Range; from a trench 790 feet S. 24° E. of the southeast corner of Sec. 33, T. 16 N., R. 32 E.

Method: POTASSIUM-ARGON.

Mineral: BIOTITE. Hand-picked from rock. Slightly altered to chlorite.

Collected by: S. E. Jerome and John H. Schilling, Nev. Bur. Mines, 1963 (NBM no. AD-6.

Determined by: Geochron Laboratories, Inc., 1964 (Geochron no. B-0368).

Constants: Same as no. 1.

Data: K = 5.54%; radiogenic Ar^{40} = 0.0264 ppm; Ar_{40}^{at} = 53%.

Geology of Intrusive: From the pegmatitic portion of a 2- to 3-foot wide dike belonging to the same group of aplite-pegmatite dikes as no. 3.

Petrography: Same as no. 3 except biotite books are thicker.

Cited Age: Same as no. 3.

Associated Ore Deposits: None.

References: *Krueger, H. W. (March 31, 1964) written communication: Geochron Laboratories.

*Schilling (1965)

CLARK COUNTY

Index No: 5
GRANITE
1,090 m.y.

Location: T. 18 S., R. 70 E.; one-quarter mile northeast of Gold Butte (see Volborth, 1962, pl. 1).

Method: RUBIDIUM-STRONTIUM.

Mineral: K-FELDSPAR.

Collected by: A. Volborth, Nev. Mining Analytical Laboratory, Univ. Nevada. (no. N-29).

Determined by: M. A. Lanphere and G. J. Wasserburg, Calif. Institute of Technology.

Geology of Intrusive: From same body as no. 6.

Index No: 5 (Continued)
Petrography: Rapakivi-type granite.
Cited Age: Precambrian (Volborth, 1962).
Reference: *Volborth (1962).

Index No: 6A & 6B
GRANITE
(A) 1,060 m.y.
(B) 830 m.y.

Note: A and B are separate determinations run on two different minerals from the same sample.

Location: T. 18 S., R. 70 E.; at the Gold Butte mine, 1/2 mile southeast of Gold Butte.
Method: RUBIDIUM-STRONTIUM.
Mineral: (A) K-FELDSPAR.
(B) BIOTITE.
Collected by: A. Volborth, Nev. Mining Analytical Laboratory, Univ. Nevada. (no. N-6).
Determined by: M. A. Lanphere and G. J. Wasserburg, Calif. Institute of Technology.
Geology of Intrusive: From the same body as no. 5.
Petrography: Rapakivi-type granite.
Cited Age: Precambrian (Volborth, 1962).
Reference: *Volborth (1962).

Remarks: Although in thin section the feldspar and biotite appear fresh, the age may have been affected by the weathered condition of the rock. It is known that biotite may suffer extensive loss of radiogenic strontium, but it is believed that this effect is less pronounced in K-feldspar.

Index No: 7
PEGMATITE
1,700 m.y.

Location: Sec. 18, T. 20 S., R. 70 E.; at the Nevada Mica mine.
Method: RUBIDIUM-STRONTIUM.
Mineral: K-FELDSPAR. A single large crystal.
Collected by: A. Volborth, Nev. Mining Analytical Laboratory, Univ. Nevada. (no. N-25).
Determined by: M. A. Lanphere and G. J. Wasserburg, Calif. Institute of Technology.
Geology of Intrusive: From a large pegmatite (similar to no. 8) that intrudes gneissic Precambrian rocks.
Cited Age: Precambrian (Volborth, 1962).
Associated Ore Deposits: Pegmatite minerals.
Reference: *Volborth (1962).

Index No: 8A & 8B
PEGMATITE
(A) 1,630 m.y.
(B) 1,700 m.y.

Note: A and B represent different determinations run on two different minerals from the same sample.

Location: T. 18 S., R. 70 E.; at the Snowflake mine, 2 1/2 miles east of Gold Butte.
Method: RUBIDIUM-STRONTIUM.
Mineral: (A) MUSCOVITE. From a 3-inch-square book.
(B) K-FELDSPAR. From the graphic granite zone.
Collected by: A. Volborth, Nev. Mining Analytical Laboratory, Univ. Nevada. (no. N-10).
Determined by: M. A. Lanphere and G. J. Wasserburg, Calif. Institute of Technology.
Geology of Intrusive: From a large lens-shaped pegmatite (see also no. 7) crosscutting Precambrian hornblende-garnet and biotite-garnet gneiss.
Petrography: Crudely zoned with a quartz core surrounded by coarse graphic granite which contains large books of muscovite and biotite.
Cited Age: Precambrian (Volborth, 1962).
Associated Ore Deposits: Pegmatite minerals.
Reference: *Volborth (1962).

Index No: 9
PEGMATITE
1,370 m.y. ($\pm$ 140 m.y.)

Location: NE 1/4 Sec. 9, T. 15 S., R. 71 E.; at the Talgo prospect.
Method: POTASSIUM-ARGON.
Mineral: MUSCOVITE. About 20 mesh.
Collected by: L. H. Beal, Nevada Bureau of Mines, 1960.
Determined by: Geochron Laboratories, Inc., 1961.
Data: K = 7.42%; radiogenic Ar^{40} = 1.07 ppm.
Geology of Intrusive: From the wall zone of a zoned pegmatite dike.
Associated Ore Deposits: Pegmatite minerals (beryl, mica, etc.).
Reference: *Beal (1965).

Index No: 10
GRANITE
927 m.y. ($\pm$ 90 m.y.)

Location: T. 28 S., R. 61 E.; at Crescent Peak.
Method: LEAD-ALPHA.
Mineral: ZIRCON. Metamict. Grain size: -60 + 200 mesh.
Collected by: R. J. Roberts, U. S. Geological Survey. (no. 11).
Determined by: U. S. Geological Survey. (no. 361).
Constants: c = 2485; k = 1.56×10^{-4}.
Data: Pb = 240 ppm; α = 593/mg/hr.
Geology of Intrusive:
Cited Age: Precambrian.
References: *Jaffe and others (1959), p. 130.

Index No: 11
ANDESITE
13 m.y. ($\pm$ 2 m.y.)

Location: SW 1/4 Sec. 20, T. 22 N., R. 64 E.; north of Boulder City.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 1% chlorite as contaminent.
Collected by: R. L. Armstrong, Yale Univ., and C. R. Longwell, U. S. Geol. Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 29).
Data: K = 6.62%; radiogenic $Ar^{40} = 3.30 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 65\%$.
Geology of Intrusive: From the River Mountain pluton.
Petrography: Medium- to fine-grained biotite andesite porphyry.
Reference: *Armstrong (1963), p. 158.

Index No: 12
ANDESITE
15 m.y. ($\pm$ 2 m.y.)

Location: SW 1/4 Sec. 27, T. 25 S., R. 64 E.; 2 miles north of Nelson.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. Less than 2% impurities.
Collected by: R. L. Armstrong, and C. R. Longwell, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ., (no. YAG 26).
Data: K = 5.01%; radiogenic $Ar^{40} = 2.88 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 63\%$.
Geology of Intrusive: From a dike related to the Mount Davis Volcanics.
Petrography: Phenocrysts (10%) of sanidine, oligoclase, biotite, pyroxene, and magnetite in a groundmass of oligoclase, and some K-feldspar and quartz.
Cited Age: Miocene (Longwell, 1963).
References: *Armstrong (1963), p. 151.
Longwell (1963), p. 24-29.

Index No: 13
GRANODIORITE
16 m.y. ($\pm$ 2 m.y.)

Location: NW 1/4 Sec. 4, T. 23 S., R. 64 E.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE-HORNBLENDE mixture. 10% quartz and feldspar as contaminent.
Collected by: R. L. Armstrong, and C. R. Longwell, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 23).
Data: K = 2.41%; radiogenic $Ar^{40} = 1.45 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 73\%$.
Geology of Intrusive: From the Boulder City laccolith (see also no. 14) which intrudes Tertiary volcanic rocks.

Petrography: Fine-grained biotite-hornblende granodiorite porphyry. Calcic andesine (phenocrysts to 3 mm), sanadine(?), hornblende, biotite, magnetite, and minor quartz, apatite, and zircon.

Cited Age: Eocene, approximate time equivalent to late Golden Door Volcanics (Longwell, 1963).

References: *Armstrong (1963), p. 157.
Longwell (1963), p. 17.

Index No: 14
MONZONITE
53 m.y. ($\pm$ 10 m.y.)

Location: NE 1/4 Sec. 4, T. 23 S., R. 64 E.; about 1 1/2 miles northeast of the center of Boulder City.
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: E. H. Pampeyan, U. S. Geol. Survey. (no. P-2-cc).
Determined by: U. S. Geological Survey. (no. 34).
Constants: Same as no. 10.
Data: Pb = 2.7 ppm; = 120/mg/hr.
Geology of Intrusive: From same laccolith as no. 13.
Cited Age: Late Cretaceous to early Tertiary (E. H. Pampeyan).
Reference: *Jaffe and others (1959), p. 74.

Index No: 15
GRANITE
26 m.y. ($^{+4}_{-2}$ m.y.)

Location: NE 1/4 Sec. 28, T. 26 S., R. 64 E.; 3 1/2 miles south of Nelson.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 2% chlorite as contaminent.
Collected by: R. L. Armstrong, and C. R. Longwell, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 25).
Data: K = 6.17%; radiogenic $Ar^{40} = 7.81 \times 10^{-6}$ cc/gm; $Ar^{at}_{40} = 44\%$.
Geology of Intrusive: From the Knob Hill pluton (see also no. 16) which intrudes Precambrian metamorphic rocks.
Petrography: Medium- to fine-grained porphyritic biotite granite. K-feldspar (phenocrysts to 5 mm), quartz, oligoclase, and biotite.
References: *Armstrong (1963), p. 158-159.
Longwell (1963), p. 18.

Index No: 16
GRANITE
38 m.y. ($\pm$ 10 m.y.)

Location: S 1/2 Sec. 24 and N 1/2 Sec. 25, T. 26 S., R. 64 E.; head of Aztec Wash, 4 miles southeast of Nelson.

Index No: 16 (Continued)
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: E. H. Pampeyan, U. S. Geological Survey. (no. P-3-cc).
Determined by: U. S. Geological Survey. (no. 33).
Constants: Same as no. 10.
Data: Pb = 5.75 ppm; α = 394/mg/hr.
Geology of Intrusive: From the Knob Hill pluton (see also no. 15).
Cited Age: Late Cretaceous to early Tertiary (E.H. Pampeyan).
Reference: *Jaffe and others (1959), p. 74.

ELKO COUNTY

Index No: 17A & 17B
GRANITE
(A) 81 m.y. ($\pm$ 5 m.y.)
(B) 70 m.y. ($\pm$ 20 m.y.)

Note: A and B represent two different determinations run on different minerals from same sample.

Location: From Mountain City stock.
Method: (A) POTASSIUM-ARGON.
(B) LEAD-ALPHA.
Mineral: (A) BIOTITE.
(B) ZIRCON.
Determined by: U. S. Geological Survey. (no. 60 NC 175).
Data: (B) Pb = 10 ppm; α = 341/mg/hr.
Geology of Intrusive: From Mountain City stock (see also no. 18).
Associated Ore Deposits: Same as no. 18.
References: *Decker (1962), p. 42.
U. S. Geol. Survey (1962), p. 94.

Index No: 18
GRANITE
110 m.y. ($\pm$ 15 m.y.)

Location: From road-cut on north side of State Highway 11A, 1.5 miles west of Duck Valley (Western Shoshone) Indian Reservation boundry; SE 1/4 T. 46 N., R. 53 E.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Collected by: R. W. Decker, Dartmouth College.
Determined by: U. S. Geological Survey. (USGS no. Elko-2).
Data: Pb = 31 ppm; α = 683/mg/hr.
Geology of Intrusive: From Mountain City stock (see also no. 17).
Associated Ore Deposits: Porphyry-copper deposit. Massive copper (chalcopyrite) replacement bodies. Lead-silver veins. Uranium (autunite) veins.
Reference: *Decker (1962), p. 42.

Index No: 19
QUARTZ MONZONITE
12 m.y. ($\pm$ 20 m.y.)

Location: T. 37 N., R. 53 E.; at the Lone Wolf mine.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Determined by: L. E. Long, Lamont Geological Observatory, Columbia Univ.
Geology of Intrusive: Sample is from the Nannie's Peak pluton, an arcuate, dikelike body 4 miles long (north-south) and up to 1800 feet wide, exposed along the crest of Lone Mountain. Intrudes Devonian(?) limestone of the McClellan Creek sequence.
Petrography: Pink, fine- to coarse-grained, hypidiomorphic-porphyritic quartz monzonite consisting of andesine, quartz, K-feldspar, augite, biotite, and hornblende.
Associated Ore Deposits: Tungsten (scheelite) contact deposits. Lead-copper limestone-replacement bodies.
Reference: *Lovejoy (1959), p. 553.

Index No: 20
QUARTZ MONZONITE
33 m.y. ($^{+5}_{-2}$ m.y.)

Location: NE 1/4 Sec. 5, T. 30 N., R. 53 E.; Pinon Range; Railroad mining district.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. Almost pure.
Collected by: R. L. Armstrong, Yale Univ., and K. Ketner, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 109).
Data: K = 7.00%; radiogenic $Ar^{40} = 9.19 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 37\%$.
Geology of Intrusive: From the Railroad District stock.
Petrography: Medium-grained andesine, K-feldspar, quartz, and biotite.
Associated Ore Deposits: Silver-lead-copper limestone-replacement bodies. Gold-quartz veins.
Reference: *Armstrong (1963), p. 164.

Index No: 21
PEGMATITE
140-175 m.y.

Location: In the southern Ruby Mountains.
Method: RUBIDIUM-STRONTIUM.
Mineral: LEPIDOLITE.
Determined by: P. A. Bailly, Department of Geology, Stanford University.
Constants: Same as no. 31.
Geology of Intrusive: From a lepidolite-bearing pegmatite, a number of which are found in the southern Ruby Mountains.

Index No: 21 (Continued)

Cited Age: Pre-Miocene and post-Carboniferous (Sharp, 1942).

Associated Ore Deposits: Pegmatite minerals (beryl, mica, etc.).

References: *Bailly (1951), p. 85-86, 90-91, 152-171.
Sharp (1942), p. 647-690.

Index No: 22
QUARTZ MONZONITE
26 m.y. ($^{+4}_{-2}$ m.y.)

Location: NE 1/4 Sec. 13, T. 28 N., R. 57 E.; 3 miles east of Harrison Pass in the Ruby Mountains.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. Pure.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 130).
Data: K = 6.94%; radiogenic $Ar^{40} = 7.12 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 42\%$.
Geology of Intrusive: From the Harrison Pass stock (see also nos. 23-26).
Petrography: Medium-grained andesine to oligoclase, biotite, K-feldspar, quartz, and sphene.
Associated Ore Deposits: Tungsten (scheelite) contact deposits.
Reference: *Armstrong (1963), p. 166-167).

Index No: 23
QUARTZ MONZONITE
29-36 m.y.** ($\pm$ 10%) **Range of determinations run on 4 samples.

Location: Harrison Pass, Ruby Mountains.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Determined by: U. S. Geological Survey.
Geology of Intrusive: From the Harrison Pass stock (see also nos. 22, 24-26).
Associated Ore Deposits: Tungsten (scheelite) contact deposits.
Reference: *Willden and others (1965).

Index No: 24A & 24B
QUARTZ MONZONITE
(A) 35 m.y.
(B) 40 m.y.

Location: Harrison Pass, Ruby Mountains.
Method: (A) POTASSIUM-ARGON.
(B) LEAD-ALPHA.
Mineral: (A) BIOTITE.
(B) ZIRCON.
Collected by: R. R. Coats, U. S. Geological Survey.

Determined by: U. S. Geological Survey.
Geology of Intrusive: From the Harrison Pass stock (see also nos. 22, 23, 25, 26).
Associated Ore Deposits: Tungsten (scheelite) contact deposits.
Reference: *U. S. Geological Survey (1964), p. 105.

Index No: 25
QUARTZ MONZONITE
30 m.y. (± 10%)

Location: Harrison Pass, Ruby Mountains.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Determined by: U. S. Geological Survey.
Geology of Intrusive: From the Harrison Pass stock (see also nos. 22-24, 26).
Petrography: Coarse-grained.
Associated Ore Deposits: Tungsten (scheelite) contact deposits.
Reference: *Willden and others (1965).

Index No: 26
QUARTZ MONZONITE
40 m.y. (± 10%)

Location: Harrison Pass, Ruby Mountains.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Determined by: U. S. Geological Survey.
Geology of Intrusive: From the Harrison Pass stock (see also nos. 22-25).
Petrography: Coarse-grained.
Associated Ore Deposits: Tungsten (scheelite) contact deposits.
Reference: *Willden and others (1965).

Index No: 27
PEGMATITE
41.5 m.y.

Location: Wood Hills.
Method: POTASSIUM-ARGON.
Geology of Intrusive: From a pegmatite (see no. 28 for date on a second pegmatite).
Reference: *Thorman (1965).

Index No: 28
PEGMATITE
29.8 m.y.

Location: Wood Hills.
Method: POTASSIUM-ARGON.
Geology of Intrusive: From a pegmatite (see no. 27 for date on a second pegmatite).
Reference: *Thorman (1965).

Index No: 29
SYENITE
125 m.y. ($^{+19}_{-6}$ m.y.)

Location: SW 1/4 Sec. 36, T. 29 N., R. 65 E.; west side Dolly Varden Mountains.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE-HORNBLENDE. Almost pure.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 87).
Data: K = 2.67%; radiogenic $Ar^{40} = 13.5 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 13\%$.
Geology of Intrusive: Sample is from the Dolly Varden Stock.
Petrography: Coarse-grained biotite-sphene-hornblende syenite consisting of K-feldspar, andesine, hornblende, quartz, sphene, and magnetite.
Associated Ore Deposits: Copper contact deposits. Silver-lead limestone-replacement deposits.
Reference: *Armstrong (1963), p. 161.

Index No: 30
QUARTZ MONZONITE
140 m.y. ($^{+21}_{-7}$ m.y.)

Location: SE 1/4 Sec. 21, T. 28 N., R. 68 E.; south end of Whitehorse Mountain.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE, 10% HORNBLENDE. 9% chlorite as contaminent.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 91).
Data: K = 4.61%; radiogenic $Ar^{40} = 26.9 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 32\%$.
Geology of Intrusive: From the Whitehorse stock.
Petrography: Medium-grained biotite quartz monzonite consisting of oligoclase, K-feldspar, quartz, and biotite.
Associated Ore Deposits:
Reference: *Armstrong (1963), p. 161.

ESMERALDA COUNTY

Index No: 31
PEGMATITE
620-700 m.y.

Location: 2500 feet N. 70 E. of the Custer Gulch mine on Mineral Ridge; about 5 miles northwest of Silver Peak.
Method: RUBIDIUM-STRONTIUM.
Mineral: LEPIDOLITE.

Collected by: P. A. Bailly, Department of Geology, Stanford University.
Determined by: P. A. Bailly, Department of Geology, Stanford University.
Constants: Rb^{87}: $\lambda_\beta = 1.19 \times 10^{-11}$/year; $Rb^{87} = 0.272$ gm/gm total Rb.
Geology of Intrusive: Lepidolite-potash feldspar-oligoclase-quartz center of a pegmatite body 100 feet long and 30 feet wide in "Proterozoic" dolomite marble. The outer part of the pegmatite is muscovite-potash feldspar-quartz. Although numerous other pegmatites occur in the area none contain lepidolite.
Cited Age: Precambrian(?).
Associated Ore Deposits: None.
Reference: *Bailly (1951), p. 85-86, 90-91, 152-171.

Index No: 32
QUARTZ MONZONITE
153 m.y. ($\pm$ 5 m.y.)

Location: NW 1/4 Sec. 34, T. 5 S., R. 38 E.; along Palmetto Wash, just south of State Highway 3.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. Separated by J. B. Murphy, Nevada Bureau Mines, 1963.
Collected by: John H. Schilling, and others, Nevada Bureau Mines, 1963. (NBM no. AD-5).
Determined by: Geochron Laboratories, Inc., 1963. (Geochron no. B-0321).
Constants: Same as no. 1.
Data: K = 6.61%; radiogenic Ar^{40} = 0.0751 ppm; Ar_{40}^{at} = 10%.
Geology of Intrusive: From within 20 feet of the northeast contact of a quartz monzonite intrusive body that forms the core of the Sylvania Mountains (no. 33 is from this same body). This unit has been called the Sylvania Adamellite (McKee, 1962) and the "Uncle Sam" quartz monzonite porphyry (Schilling, 1962). It is believed to be part of the Inyo batholith (McKee, 1962).
Petrography: Inequigranular, with coarse-grained orthoclase (35%) in a "groundmass" of medium-grained plagioclase (35%), quartz (20%), biotite (5%), hornblende, sphene, apatite, and magnetite.
Associated Ore Deposits: Tungsten (scheelite) contact deposits. Talc contact deposits. Galena-silver veins.
References: *Krueger, H. W. (Sept. 24, 1963) written communication: Geochron Laboratories.
McKee (1962), p. 73-82.
Schilling (1962), p. 17.

Index No: 33
QUARTZ MONZONITE
155 m.y. ($\pm$ 8 m.y.)

Location: Southern part of Sylvania Mountains.
Method: POTASSIUM-ARGON.

Index No: 33 (Continued)
Mineral: BIOTITE.
Collected by: E. H. McKee, Univ. Calif. (Berkeley).
Determined by: Univ. California (Berkeley).
Geology of Intrusive: From the typical porphyritic quartz monzonite body that forms the core of the Sylvania Mountains (see also no. 32 which is from this same body). This unit has been called the Sylvania Adamellite (McKee, 1962) and the "Uncle Sam" quartz monzonite porphyry (Schilling, 1962). It is believed to be part of the Inyo batholith (McKee, 1962).
Petrography: Porphyritic, with 35% orthoclase phenocrysts, 40% plagioclase (An_{25}), 15% quartz, 0-5% hornblende, 0-5% biotite, 0-3% sphene, apatite, and magnetite.
Associated Ore Deposits: Tungsten (scheelite) contact deposits. Talc contact deposits. Galena-silver veins.
References: *McKee (1962), p. 73-82.
Schilling, (1962), p. 17.

EUREKA COUNTY

Index No: 34A & 34B
QUARTZ MONZONITE
(A) 125 m.y. ($^{+19}_{-6}$ m.y.)
(B) 145 m.y. ($^{+22}_{-7}$ m.y.)

Note: A and B are separate determinations run on the same mineral concentrate from the same sample.

Location: SW 1/4 Sec. 21, T. 29 N., R. 50 E.; Cortez Range.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 3% chlorite and montmorillonite as contaminent.
Collected by: R. L. Armstrong, Yale Univ., and L. J. P. Muffler, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 132).
Data: K = 5.84%.
(A) radiogenic $Ar^{40} = 29.5 \times 10^{-6}$ cc/gm; $Ar^{at}_{40} = 9\%$.
(B) radiogenic $Ar^{40} = 35.4 \times 10^{-6}$ cc/gm; $Ar^{at}_{40} = 23\%$.
Geology of Intrusive: From the Frenchie Creek intrusive complex (see also no. 35).
Petrography: Medium- to fine-grained, porphyritic; K-feldspar, andesine, and quartz.
Reference: *Armstrong (1963), p. 166.

Index No: 35
DIORITE
150 m.y. ($^{+23}_{-8}$ m.y.)

Location: NW 1/4 Sec. 11, T. 28 N., R. 49 E.; Cortez Range.
Method: POTASSIUM-ARGON.
Mineral: HORNBLENDE. 25% quartz and feldspar.

Collected by: R. L. Armstrong, Yale Univ., and L. J. P. Muffler, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 130).
Data: K = 0.618%; radiogenic $Ar^{40} = 3.91 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 55\%$.
Geology of Intrusive: Sample is from the Frenchie Creek intrusive complex (see also no. 34).
Petrography: Very-fine-grained, porphyritic; andesine, K-feldspar(?), hornblende-pyroxene, and quartz.
Reference: *Armstrong (1963), p. 165-166.

Index No: 36
GRANODIORITE
124 m.y. **($^{+18}_{-6}$) m.y.)

**Note: Age is average of 4 determinations of same sample, ranging from 115 to 140 m.y.

Location: SW 1/4 Sec. 21, T. 27 N., R. 48 E.; in the Cortez Range.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 15% chlorite as contaminent.
Collected by: R. L. Armstrong, Yale Univ., and H. Masursky, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 115).
Data: K = 5.51%; radiogenic Ar^{40} = 26.1, 27.2. 30.8, 27.0 $\times 10^{-6}$ cc/gm; Ar_{40}^{at} = 11 - 24%.
Geology of Intrusive: From the Mill Canyon stock (see also no. 37).
Petrography: Medium-grained andesine-oligoclase, quartz, K-feldspar, and biotite.
Associated Ore Deposits: Silver-lead-zinc-copper limestone-replacement bodies.
Reference: *Armstrong (1963), p. 165.

Index No: 37
GRANODIORITE
147 m.y.

Location: From same stock as no. 36; in the Cortez Range.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Determined by: Univ. California (Berkeley).
Geology of Intrusive: From the Mill Canyon stock (see also 36).
Reference: *Armstrong (1963), p. 165.

Index No: 38
QUARTZ MONZONITE
165 m.y. ($^{+25}_{-8}$ m.y.)

Location: NW 1/4 Sec. 1, T. 20 N., R. 52 E.; east side Whistler Mountain, 4 miles north of Devils Gate.
Method: POTASSIUM-ARGON.
Mineral: MUSCOVITE, 10% BIOTITE. Chlorite, quartz, and feldspar as contaminents.

Index No: 38 (Continued)
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 107).
Data: K = 6.44%; radiogenic $Ar^{40} = 43.9 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 16\%$.
Geology of Intrusive: From the Whistler Mountain stock.
Petrography: Very-fine-grained andesine, quartz, K-feldspar, and muscovite.
Reference: *Armstrong (1963), p. 163.

Index No: 39
GRANODIORITE
64 m.y. ($^{+10}_{-3}$) m.y.)

Location: SW 1/4 Sec. 22, T. 19 N., R. 53 E.; southwest of Eureka.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 20% chlorite and montmorillonite as contaminents.
Collected by: R. L. Armstrong.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 108).
Data: K = 4.65%; radiogenic $Ar^{40} = 11.8 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 25\%$.
Geology of Intrusive: From same intrusive body as no. 40; intrudes Upper Cambrian rocks.
Petrography: Medium-grained, porphyritic, with phenocrysts of andesine, quartz, and biotite in a groundmass of quartz and K-feldspar.
Cited Age: Same as no. 40.
Associated Ore Deposits: Lead-silver limestone-replacement deposits.
References: *Armstrong (1963), p. 164.
Nolan (1962), p. 13.

Index No: 40
QUARTZ DIORITE[1]
64 m.y. ($\pm$ 10 m.y.)[2]

Location: Sec. 22, T. 19 N., R. 53 E.; from the dump of the Rogers (Richmond ?) tunnel, Eureka mining district.
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: T. B. Nolan, U. S. Geol. Survey. (no. TN-3).
Determined by: U. S. Geological Survey. (no. 28).
Constants: Same as no. 10.
Data: Pb = 5.0 ppm; α = 193/mg/hr.
Geology of Intrusive: A small intrusive plug of quartz diorite with extensive alteration around its margins. (see also no. 39).
Petrography: Fine-grained quartz, andesine, some hornblende and biotite, and minor orthoclase.
Cited Age: Archean (Hague, 1892, p. 220). Cretaceous, post-Newark Canyon Formation (Nolan 1962).

Associated Ore Deposits: Lead-silver limestone-replacement deposits.

References: Hague (1892), p. 220.
*Jaffe and others (1959), p. 73.
*Nolan (1962), p. 13.

[1]Rock called quartz monzonite in Jaffe (1959).
[2]An age of 62 m.y. (± 12 m.y.) is given for this determination in Nolan (1962).

Index No: 41
RHYOLITE
39 m.y. (± 10 m.y.)[1]

Location: Sec. 23, T. 19 N., R. 53 E.; south end of Target Hill, Eureka mining district.
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: T. B. Nolan, U. S. Geological Survey. (no. TN-4).
Determined by: U. S. Geological Survey. (no. 26).
Constants: Same as no. 10.
Data: Pb = 8.0 ppm; α = 503/mg/hr.
Geology of Intrusive: From a small intrusive body.
Petrography: Phenocrysts of quartz, some sanadine, and locally oligoclase, and sparse biotite flakes, in a microcrystalline to glassy groundmass.
Cited Age: Tertiary, (T. B. Nolan). Miocene, (based on diatom flora in closely related rhyolite tuff).
References: *Jaffe and others (1959), p. 73.
*Nolan (1962), 78 p.
[1]An age of 38 m.y. (± 5 m.y.) is given for this determination in Nolan (1962, p. 16).

Index No: 42
ANDESITE
52 m.y. (± 10 m.y.)

Location: From the dump of a shaft 1400 feet S. 15° W. of the old Windfall Mill, in Windfall Canyon, Eureka mining district.
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: T. B. Nolan, U. S. Geological Survey. (no. TN-1).
Determined by: U. S. Geological Survey (no. 27).
Constants: Same as no. 10.
Data: Pb = 3.3 ppm; α = 158/mg/hr.
Geology of Intrusive and extrusive hornblende andesite.
Petrography: Phenocrysts of andesine-labradorite, thoroughly-altered hornblende, and some quartz and biotite, in a holocrystalline to hypocrystalline groundmass of quartz and feldspar.

Index No: 42 (Continued)
Cited Age: Tertiary (Nolan, 1962). Pliocene (Hague, 1892).
References: Hague, Arnold (1892), p. 232.
*Jaffe and others (1959), p. 73.
*Nolan (1962), p. 15.

Index No: 43
GRANITE(?)
45 m.y. (± 10 m.y.)

Location: Near Jacobs Peak in the Diamond Range.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Collected by: R. J. Roberts, U. S. Geological Survey.
Determined by: U. S. Geological Survey.
Reference: *Adair and Stringham (1960), p. 231.

HUMBOLDT COUNTY

Index No: 44
GRANODIORITE
120 m.y. (± 15 m.y.)

Location: Northwest corner Sec. 28, T. 47 N., R. 31 E.; northwest part of Kings River Range.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Determined by: U. S. Geological Survey, 1959.
Data: Pb = 8.4 ppm; α = 177/mg/hr.
Reference: *Willden (1965), p. 16.

Index No: 45
DIORITE
135 m.y.** (± 15 m.y.)

**Age also indicates the maximum age of the conglomerate in which the boulders of diorite occurred.

Location: West center Sec. 18, T. 38 N., R. 31 E.; crest of Jackson Mountains.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Determined by: U. S. Geological Survey, 1959.
Geology of Sedimentary Rock: From diorite boulders in the basal conglomerate of the King Lear Formation.
Reference: *Willden (1963), p. 16.

Index No: 46
GRANODIORITE
65 m.y. (± 10 m.y.)

Location: South center Sec. 24, T. 36 N., R. 32 E.; southeast side Donna Schee Peak.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Determined by: U. S. Geological Survey, 1959.
Data: Pb = 6.0 ppm; α = 222/mg/hr.
Reference: *Willden (1965).

Index No: 47
GRANODIORITE
50 m.y. ($\pm$ 10 m.y.)

Location: North center Sec. 26, T. 39 N., R. 35 E.; west side of Slumbering Hills.
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: R. Willden, U. S. Geological Survey. (no. 55-W-35).
Determined by: U. S. Geological Survey. (no. 36).
Constants: Same as no. 10.
Data: Pb = 9.5 ppm; α = 468/mg/hr.
Geology of Intrusive:
Cited Age: Post-Late Cretaceous, pre-Miocene (R. Willden).
Reference: *Jaffe and others (1959), p. 75.

Index No: 48
GRANODIORITE
53 m.y. ($\pm$ 10 m.y.)

Location: Northwest corner Sec. 17, T. 38 N., R. 37 E.; east side of Bloody Run Peak.
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: R. Willden, U. S. Geological Survey. (no. 55-W-70).
Determined by: U. S. Geological Survey. (no. 37).
Constants: Same as no. 10.
Data: Pb = 4.95 ppm; α = 468/mg/hr.
Geology of Intrusive:
Cited Age: Post-Late Cretaceous, pre-Miocene (R. Willden).
Associated Ore Deposits: Tungsten (scheelite)-quartz veins. Epithermal gold-silver veins.
Reference: *Jaffe and others (1959), p. 75.

Index No: 49
GRANODIORITE
37 m.y. ($\pm$ 10 m.y.)

Location: Extreme southwest corner Sec. 32, T. 43 N., R. 39 E.; east side of Santa Rosa Peak.

Index No: 49 (Continued)
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: R. Willden, U. S. Geological Survey. (no. 55-W-100).
Determined by: U. S. Geological Survey. (no. 35).
Constants: Same as no. 10.
Data: Pb = 5.4 ppm; α = 365/mg/hr.
Geology of Intrusive:
Cited Age: Post-Late Cretaceous, pre-Miocene (R. Willden).
Reference: *Jaffe and others (1959), p. 74.

Index No: 50
GRANODIORITE
69 m.y. ($\pm$ 10 m.y.)

Location: North center Sec. 17, T. 38 N., R. 42 E.; north side of Julian Creek.
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: P. E. Hotz, U. S. Geological Survey. (no. 54-W-48).
Determined by: U. S. Geological Survey. (no. 77).
Constants: Same as no. 10.
Data: Pb = 10.5 ppm; α = 378/mg/hr.
Geology of Intrusive: From the Osgood Mountains stock, which is exposed over an area of 7.7 square miles.
Petrography: Medium-grained, equigranular granodiorite consisting of andesine, orthoclase, quartz, biotite, hornblende, and minor magnetite and sphene.
Cited Age: Post-Early Permian, pre-Late Miocene (Hotz and Willden, 1964).
Associated Ore Deposits: Contact (scheelite) tungsten deposits. Epithermal gold-arsenic stockwork deposits.
References: *Jaffe and others (1959), p. 82.
*Hotz and Willden (1964), p. 41-49.

LANDER COUNTY

Index No: 51
GRANODIORITE
47 m.y. ($\pm$ 10 m.y.)

Location: Sec. 24 or 25, T. 32 N., R. 42 E.; in Trenton Canyon.
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: R. J. Roberts, U. S. Geol. Survey. (no. RJR-2-56).
Determined by: U. S. Geological Survey. (no. 30).
Constants: Same as no. 10.
Data: Pb = 3.75 ppm; α = 199/mg/hr.
Geology of Intrusive: From a small stock having an area of about 1 mile.

Cited Age: Jurassic(?) (R. J. Roberts).
Associated Ore Deposits: None.
Reference: *Jaffe and others (1959), p. 74.

Index No: 52
QUARTZ MONZONITE
38 m.y. (± 10 m.y.)

Location: South-central T. 31 N., R. 43 E.; at Copper Canyon
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: R. J. Roberts, U. S. Geological Survey
Determined by: U. S. Geological Survey
Constants: Sames as no. 10.
Data: Pb = 8.0 ppm; α = 520/mg/hr.
Geology of Intrusive: From a hydrothermally altered and mineralized part of a nearly circular body of Copper Canyon quartz monzonite porphyry exposed over 1/2 mile square area (same as no. 53).
Petrography: Quartz (40%), andesine (30%), orthoclase (25%), and several percent biotite. Sixty percent of rock generally is phenocrysts of all above minerals.
Associated Ore Deposits: Porphyry copper-molybdenum deposits. Copper-gold veins and bodies. Lead-zinc-silver bodies.
References: *Jaffe and others (1959), p. 74.
Clement (1961), 32 p.

Index No: 53
QUARTZ MONZONITE
49 m.y. (± 10 m.y.)

Location: South-central T. 31 N., R. 43 E.; at Copper Canyon.
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: R. J. Roberts, U. S. Geological Survey. (no. RJR-3-56).
Determined by: U. S. Geological Survey. (no. 31).
Constants: Same as no. 10.
Data: Pb = 7.6 ppm; α = 387/mg/hr.
Geology of Intrusive: From same body as no 52, but from unaltered and unmineralized part.
Reference: *Jaffe and others (1959), p. 74.

Index No: 54
QUARTZ DIORITE
50 m.y. (± 10 m.y.)

Location: Sec. 12, 13, 14, or 24, T. 29 N., R. 46 E., or Sec. 19, T. 29 N., R. 47 E.

Index No: 54 (Continued)
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: J. Gilluly and Olcott Gates. (no. 851).
Determined by: U. S. Geological Survey. (no. 41).
Constants: Same as no. 10.
Data: Pb = 6.7 ppm; α = 331/mg/hr.
Geology of Intrusive: From a pluton exposed over an area of about 2 square miles. Intrudes Ordovician and Devonian sedimentary rocks.
Associated Ore Deposits: Gold-silver-copper-lead (sulfide) veins. Bedded barite deposits.
Reference: *Jaffe and others (1959), p. 75.

Index No: 55
QUARTZ MONZONITE
140 m.y. ($^{+21}_{-7}$ m.y.)

Location: 0.5 mile west of Austin.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 7% chlorite as contaminent.
Collected by: R. L. Armstrong.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 216).
Data: K = 6.38%; radiogenic Ar^{40} = 36.5 X 10^{-6} cc/gm; Ar^{at}_{40} = 23%.
Geology of Intrusive: From same intrusive as no. 56; intrudes Cambrian(?) rocks.
Petrography: Medium-grained; plagioclase (andesine), quartz, K-feldspar, and biotite.
Cited Ages: Cretaceous (Lincoln, 1923). Jurassic (Ross, 1953).
Associated Ore Deposits: See no. 56.
References: Ross (1953), p. 17.
*Armstrong (1963), p. 173.

Index No: 56
QUARTZ MONZONITE
44 m.y. ($\pm$ 10 m.y.)

Location: Austin.
Method: LEAD-ALPHA.
Mineral: ZIRCON. Grain size: -80 + 400 mesh.
Collected by: R. J. Roberts, U. S. Geological Survey. (no. RJR-1-56).
Determined by: U. S. Geological Survey. (no. 29).
Constants: Same as no. 10.
Data: Pb = 6.75 ppm; α = 382/mg/hr.
Geology of Intrusive: A large, deeply eroded body. (See also no. 55).
Cited Age: Cretaceous (Lincoln, 1923).
Associated Ore Deposits: Silver-gold veins. Uranium (autunite) veins. Tungsten (scheelite) contact deposits.

References: Lincoln (1923), p. 116.
*Jaffe and others (1959), p. 73.

MINERAL COUNTY

Index Nos: 57A & 57 B
GRANODIORITE
(A) 87.5 m.y. (± 1.0 m.y.)
(B) 83.6 m.y. (± 3.5 m.y.)

Note: A and B represent determinations of biotite concentrates from two separate rock samples taken within several feet of each other.

Location: Sec. 1, T. 13 N., R. 32 E.; in the hills at the south end of the Sand Springs Range; from the north edge of the wash in the canyon containing the main road from the Nevada Scheelite mine to U. S. Highway 50, 1/2 mile east of the mine.

Method: POTASSIUM-ARGON.

Mineral: BIOTITE. Separated by J. B. Murphy, Nevada Bureau Mines. Grain size A: 0.006-0.012 in.; grain size B: 0.007-0.010 in. Both concentrates were fresh, with minor chlorite in separate grains as contaminent.

Collected by: (A) S. E. Jerome and John H. Schilling, Nev. Bur. Mines, 1962. (NBM no. AD-4).
(B) John H. Schilling, Nev. Bur. Mines, 1963.(NBM no. AD-7).

Determined by: (A) Geochron Laboratories, Inc., 1962.(Geochron no. B-0203).
(B) Geochron Laboratories, Inc., 1964.(Geochron no. B-0388).

Constants: Same as no. 1

Data: (A) K = 6.42%; radiogenic Ar^{40} = 0.0410 ppm; Ar_{40}^{at} = 33%.
(B) K = 7.21%; radiogenic Ar^{40} = 0.0440 ppm; Ar_{40}^{at} = 25%.

Geology of Intrusive: Together, 10 to 20 feet from northeast contact of a granodiorite stock about a mile in diameter that intrudes Triassic(?) rocks of the Excelsior(?) Formation. The granodiorite resembles the granodiorite (see no. 2) in the large granitic body several miles to the north.

Petrography: Equigranular, medium-grained; plagioclase (An_{25-35}), microcline, quartz, (5-15%) biotite, and hornblende.

Cited Age: Cretaceous(?) (Ross, 1961, pl. 2).

Associated Ore Deposits: Tungsten (scheelite) contact deposits.

References: *Krueger, H. W. (July 31, 1963) written communication: Geochron Laboratories.
*Krueger, H. W. (May 12, 1964) written communication: Geochron Laboratories.
*Schilling (1965).

Index No: 58
QUARTZ MONZONITE
68.7 m.y. (± 1.8 m.y.)

Location: 100 yards east of the frontal fault, in a small draw 1/4 mile south of Spearmint Canyon in the Pilot Mountains; Sec. 23(?), T. 6 N., R. 35 E.

Index No: 58 (Continued)
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. Separated by J. B. Murphy, Nevada Bureau Mines, (1964). Fresh, with minor chlorite intermixed with the biotite as contaminent.
Collected by: R. L. Nielsen, University of Nevada; H. F. Bonham, Jr. and S. E. Jerome, Nevada Bureau Mines, 1964. (NBM no. AD-8).
Determined by: Geochron Laboratories, Inc., 1964. (Geochron no. B-0426).
Constants: Same as no. 1.
Data: K = 5.59%; radiogenic Ar^{40} = 0.0279 ppm; Ar_{40}^{at} = 46%.

Geology of Intrusive: From within 150 feet of the contact of a stock of Sodaville quartz monzonite intruding (Permian) Excelsior and (Triassic) Gold Range Formations. The stock is a mile long and over 2000 feet wide (the width is limited by overlapping alluvium along the western side of the body. The rock is massive, light pinkish-gray, and of uniform composition.
Petrography: Medium grained except along contact, where it is porphyritic. Consists of orthoclase and microcline (30%), oligoclase (35%), quartz (25%), biotite (5%), magnetite, apatite, and sphene.
Cited Age: Late Jurassic-Cretaceous (Nielson, 1963, p. 119).
Associated Ore Deposits: Copper-molybdenum (chalcopyrite-molybdenite) deposits.
References: *Krueger, H. W. (Sept. 1, 1964) written communication: Geochron Laboratories.
Nielsen (1963), p. 109-119.

Index No: 59
QUARTZ MONZONITE
40 m.y. ($\pm$ 10 m.y.)

Location: SW 1/4, T. 8 N., R. 37 E.; about 5 miles southeast of the site of Simon, on Cedar Mountain.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Determined by: U. S. Geological Survey.
Geology of Intrusive: From a granitic mass.
Associated Ore Deposits: Tungsten (scheelite) contact deposits.
Reference: *Ross (1961), p. 36.

NYE COUNTY

Index No: 60A & 60B
QUARTZ MONZONITE
(A) 27 m.y. ($^{+4}_{-2}$ m.y.)
(B) 31 m.y. ($^{+5}_{-2}$ m.y.)

Note: A and B are separate determinations run on the same sample.

Location: SE 1/4 Sec. 5, T. 11 N., R. 58 E.; in the southwest White Pine Mountains.
Method: POTASSIUM-ARGON.

Mineral: BIOTITE, 15% HORNBLENDE. 8% chlorite as contaminent.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 154).
Data: K = 5.10%.
(A) radiogenic $Ar^{40} = 5.35 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 27\%$.
(B) radiogenic $Ar^{40} = 6.28 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 52\%$.
Geology of Intrusive: From same intrusive as no. 61.
Petrography: Medium-grained quartz monzonite consisting of quartz, K-feldspar, labradorite, and biotite.
Reference: *Armstrong (1963), p. 168.

Index No: 61
QUARTZ MONZONITE
36 m.y. ($^{+5}_{-2}$ m.y.)

Location: Sec. 36, T. 12 N., R. 57 E.; in the southwest White Pine Mountains.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 6% chlorite and montmorillonite as contaminent.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 155).
Data: K = 5.90%; radiogenic $Ar^{40} = 8.39 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 48\%$.
Geology of Intrusive: From same intrusive as no. 60.
Petrography: Medium-grained quartz monzonite consisting of quartz, oligoclase, K-feldspar, biotite.
Reference: *Armstrong (1963), p. 169.

Index No: 62
QUARTZ MONZONITE
23 m.y. ($^{+4}_{-2}$ m.y.)

Location: SW 1/4 Sec. 29, T. 6 N., R. 57 E.; Troy Canyon, Grant Range.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 3% chlorite as contaminent.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 74).
Data: K = 6.52%; radiogenic $Ar^{40} = 5.79 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 33\%$.
Geology of Intrusive: Sample is from the Troy stock.
Petrography: Medium-grained biotite-muscovite quartz monzonite consisting of oligoclase, quartz, microcline, and muscovite.
Associated Ore Deposits: Gold-silver-lead-zinc veins and limestone-replacement bodies. Tungsten (scheelite) contact deposits.
Reference: *Armstrong (1963, p. 160).

Associated Ore Deposits: Silver-gold-lead-copper limestone-replacement deposits. Antimony (stibnite) veins.

Reference: *Wallace, Tatlock, and Silberling (1960), p. 291-293.

Index No: 66
RHYOLITE
290 m.y. (± 45 m.y.)

Location: Sec. 3, T. 29 N., R. 34 E.; about 2 miles south of Unionville.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Determined by: U. S. Geological Survey.
Geology of Intrusive: From same stock of rhyolite porphyry as no. 65. The rhyolite intrusive bodies probably represent direct feeders for the extrusive Weaver Rhyolite which is Permian(?) and Early Triassic in age.
Petrography: Phenocrysts of quartz and K-feldspar in extremely fine-grained groundmass.
Associated Ore Deposits: Silver-gold-lead-copper limestone-replacement deposits. Antimony (stibnite) veins.
Reference: *Wallace, Tatlock, and Silberling (1960), p. 291-293.

Index No: 67
GABBRO
150 m.y. (± 3 m.y.)

Location: Near sample 2 (Speed, 1963, fig. 2); NW 1/4 SW 1/4 SW 1/4 Sec. 24, T. 26 N., R. 32 E.; in the West Humboldt Range.
Method: POTASSIUM-ARGON.
Mineral: TITANOBIOTITE. Mesh size: > 50 mesh.
Collected by: R. C. Speed, Jet Propulsion Lab., Calif. Institute Tech., 1963.
Determined by: J. L. Kulp, Lamont Geol. Observatory, Columbia Univ., 1964.
Constants: K^{40}: $\lambda_\beta = 4.72 \times 10^{-10}$ /year; $\lambda_\varepsilon = 0.585 \times 10^{-10}$ /year.
$K^{40} = 1.19 \times 10^{-4}$ gm/gm/ total K.
Data: K = 5.83%; radiogenic $Ar^{40} = 3.61 \times 10^{-5}$ cc/gm; $Ar^{at}_{40} = 14\%$.
Geology of Intrusive: From the middle (at about the equivalent stratigraphic position of chemical & modal analysis no. 2, Speed, 1963) of the picrite layer of a two-layer tabular intrusive body that is exposed over a 1/2 square mile area. The body is composed of 240 feet of hornblende picrite (gabbro) overlain by at least 100 feet of anorthosite, and is part of a gabbroic complex which has a known maximum extent of over 35 miles.
Petrography: Foliated hornblende picrite consisting of 35 percent olivine, 28 percent plagioclase (An_{55-60}), 15 percent clinopyroxene, 10 percent kaersutite, 6 percent chlorite, and 2 percent each of titanobiotite, magnetite, and bronzite. Deuteric alteration is common.
Cited Age: Lower Jurassic to Upper Tertiary (Speed, 1963, p. 69).

Index No: 63
QUARTZ MONZONITE
93 m.y.** **Average of 6 determinations.

Location: T. 8 S., R. 53 E.; Oak Springs mining district, on the Atomic Energy Commission Nevada Test Site.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Determined by: U. S. Geological Survey.
Geology of Intrusive: From the quartz monzonite portion (see also no. 64) of the Climax composite stock.
Associated Ore Deposits: Tungsten (scheelite) contact deposits.
Reference: *Armstrong (1963), p. 1-t and 96-t.

Index No: 64A & 64B
QUARTZ MONZONITE
(A) 330 m.y. (± 35 m.y.)
(B) 230 m.y. (± 25 m.y.)**

**This age is thought to be more nearly correct because it was substantiated by replicate determinations, and falls within the age limits established by field relationships.

Location: T. 8 S., R. 53 E.; Oak Springs mining district, on Atomic Energy Commission Nevada Test Site.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Determined by: U. S. Geological Survey.
Geology of Intrusive: Medium-grained quartz monzonite (see also no. 63) from the Climax composite stock which is composed of an older granodiorite intrusive and a younger quartz monzonite intrusive.
Associated Ore Deposits: Tungsten (scheelite) contact deposits.
Reference: *Houser and Poole (1960), p. 177.

PERSHING COUNTY

Index No: 65
RHYOLITE
230 m.y. (± 40 m.y.)

Location: Sec. 3, T. 29 N., R. 34 E.; about 2 miles south of Unionville.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Determined by: U. S. Geological Survey.
Geology of Intrusive: From a stock of rhyolite porphyry exposed over an area of about 1/2 square mile. See no. 66.
Petrography: Phenocrysts of quartz (less than 2 mm) and K-feldspar (1-5 mm) in vitreous-appearing groundmass.
Cited Age: Early Triassic (Wallace, Tatlock, and Silberling, 1960).

Index No: 67 (Continued)
References: Speed (1963), p. 69-77.
*Speed, R. C. (May 5, 1964) written communication: Jet Propulsion Lab., Calif. Institute Tech.

WHITE PINE COUNTY

Index No: 68
QUARTZ MONZONITE
35 m.y. ($^{+5}_{-2}$ m.y.)

Location: SW 1/4 Sec. 18, T. 26 N., R. 68 E.; south end of Kingsley Mountains.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE, 10% HORNBLENDE. 3% chlorite as contaminent.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 93).
Data: K = 5.17%; radiogenic Ar^{40} = 7.14 X 10^{-6} cc/gm; Ar_{40}^{at} = 48%.
Geology of Intrusive: From the Kingsley stock (see also no. 69).
Petrography: Medium-grained hornblende-biotite quartz monzonite consisting of andesine, K-feldspar, quartz, biotite, and hornblende.
Associated Ore Deposits: Tungsten (scheelite) contact deposits.
Reference: *Armstrong (1963), p. 162.

Index No: 69
QUARTZ MONZONITE
41 m.y.

Location: Kingsley Mountains.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Determined by: Univ. Utah.
Geology of Intrusive: From the Kingsley stock (see also no. 68).
Reference: *Armstrong (1963), p. 162.

Index No: 70
QUARTZ MONZONITE
32 m.y. ($^{+5}_{-2}$ m.y.)

Location: NW 1/4 Sec. 31, T. 23 N., R. 63 E.; 5 1/2 miles south of Cherry Creek.
Method: POTASSIUM-ARGON
Mineral: BIOTITE. Pure.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 82).
Data: K = 6.30%; radiogenic Ar^{40} = 8.07 X 10^{-6} cc/gm; Ar_{40}^{at} = 43%.

Geology of Intrusive: From a dike cutting the Cherry Creek stock.
Petrography: Fine-grained porphyritic leucoadamellite consisting of microcline, quartz, oligoclase.
Reference: *Armstrong (1963), p. 160.

Index No: 71
GRANITE
38 m.y. ($^{+6}_{-2}$ m.y.)

Location: NW 1/4 Sec. 9, T. 20 N., R. 63 E.; northern Egan Range.
Method: POTASSIUM-ARGON
Mineral: BIOTITE. 3% chlorite as contaminent.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 52).
Data: K = 6.51%; radiogenic $Ar^{40} = 9.91 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 59\%$.
Geology of Intrusive:
Petrography: Coarse- to medium-grained biotite granite porphyry consisting of K-feldspar, quartz, oliogoclase, and biotite.
Reference: *Armstrong (1963), p. 159.

Index No: 72
QUARTZ MONZONITE
32 m.y. ($^{+5}_{-2}$ m.y.)

Location: NE 1/4 Sec. 27, T. 18 N., R. 63 E.; 5 miles west of McGill.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 7% chlorite and montmorillonite as contaminent.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 37).
Data: K = 6.19%; radiogenic $Ar^{40} = 7.81 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 44\%$.
Geology of Intrusive: From the Heuser Peak pluton (see also no. 73).
Petrography: Medium- to coarse-grained andesine, quartz, K-feldspar, and biotite.
Reference: *Armstrong (1963), p. 158.

Index No: 73
QUARTZ MONZONITE
30 m.y. ($\pm$ 10 m.y.)

Location: East slope of Heuser Peak, south end of the North Egan Range.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Collected by: R. J. Roberts, U. S. Geological Survey.
Determined by: U. S. Geological Survey.
Geology of Intrusive: From the Heuser Mountain pluton (see also no. 72).
Reference: *Adair and Stringham (1960), p. 231.

Index No: 74
QUARTZ MONZONITE
42 m.y. ($^{+6}_{-2}$ m.y.)

Location: SE 1/4 Sec. 33, T. 22 N., R. 69 E.; Kern Mountains.
Method: POTASSIUM-ARGON.
Mineral: MUSCOVITE, 10% BIOTITE. 10% quartz and feldspar.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 98).
Data: K = 7.30%; radiogenic $Ar^{40} = 12.2 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 56\%$.
Geology of Intrusive: From the Kern Mountain pluton. This pluton is unusual petrographically and appears to have been emplaced as a solid mass. It is surrounded by mylonized rock and lacks normal intrusive contacts.
Pet ography: Pegmatitic (cataclastic?) quartz monzonite; coarse feldspar (oligoclase and microcline) and mica with interstital medium- to fine-grained quartz, feldspar, and mica, all anhedral.
Reference: *Armstrong (1963), p. 163.

Index No: 75
QUARTZ MONZONITE
110 m.y. ($^{+17}_{-6}$ m.y.)

Location: SE 1/4 Sec. 16, T. 16 N., R. 57 E.; Silver Bell Canyon, Mount Hamilton.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE, 10% QUARTZ, FELDSPAR, and HORNBLENDE. Biotite is 30% altered to chlorite.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 53).
Data: K = 3.19%; radiogenic $Ar^{40} = 13.4 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 41\%$.
Geology of Intrusive: From the Seligman stock (see also no. 76).
Petrography: Medium-grained andesine, quartz, K-feldspar, and biotite.
Associated Ore Deposits: Lead-silver limestone replacement bodies. Copper contact-deposits.
Reference: *Armstrong (1963), p. 159.

Index No: 76
QUARTZ MONZONITE
128 m.y. ($\pm$ 15 m.y.)

Location: T. 16 N., R. 57 E.; near Hoppe Spring near Seligman Canyon on the west slope of the White Pine Range.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Collected by: R. J. Roberts, U. S. Geological Survey.
Determined by: U. S. Geological Survey.

Geology of Intrusive: From the Seligman stock (see also no. 75).
Reference: *Adair and Stringham (1960), p. 231.

Index No: 77
QUARTZ MONZONITE
123 m.y. (± 12 m.y.)

Location: One-quarter mile west of Kimberly in the Ely mining district.
Method: POTASSIUM-ARGON.
Mineral: ORTHOCLASE.
Collected by: L. H. Beal, 1955.
Determined by: Univ. California (Berkeley), 1956.
Geology of Intrusive: From a quartz monzonite porphyry body (see also nos. 78, 79, 142).
Associated Ore Deposits: Porphyry-copper deposits. Lead-zinc-silver limestone replacement bodies. Manganiferous silver-lead bodies (in the oxidized portions of the lead-zinc-silver bodies).
References: *Beal (1956).
Bauer, Cooper, and Breitrick (1960), p. 220-228.

Index No: 78
QUARTZ MONZONITE
160 m.y. (± 20 m.y.)

Location: No. 13 bench, west end of the Liberty Pit, Ruth.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Collected by: R. J. Roberts, U. S. Geological Survey.
Determined by: U. S. Geological Survey.
Geology of Intrusive: From a quartz monzonite porphyry body (see also nos. 77, 79, 142).
Petrography: Variety known locally as the "ore porphyry".
Associated Ore Deposits: Same as no. 70.
Reference: *Adair and Stringham (1960), p. 231.

Index No: 79
RHYOLITE
41 m.y. (± 5 m.y.)

Location: Ely mining district.
Geology: The post-ore rhyolite occurs as plugs, dikes, sills, diatremes, flows, and tuffs. (See also nos. 77,78).
Reference: *Bauer (1963), p. 5.

Index No: 80A & 80B
QUARTZ MONZONITE

(A) 125 m.y. ($^{+19}_{-6}$ m.y.)
(B) 105 m.y. ($^{+16}_{-5}$ m.y.)

Note: A and B represent separate determinations run on the same mineral concentrate.

Location: SW 1/4 Sec. 28, T. 14 N., R. 68 E.; 3 1/2 miles south-southeast of Osceola, southern Snake Range.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 30% chlorite as contaminent.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (YAG-180).
Data: K = 4.49%.
(A) radiogenic $Ar^{40} = 23.1 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 19\%$.
(B) radiogenic $Ar^{40} = 19.3 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 35\%$.
Geology of Intrusive: From the Osceola stock (see also no. 81).
Petrography: Medium-grained andesine, quartz, K-feldspar, and biotite.
Associated Ore Deposits: See no. 81.
Reference: *Armstrong (1963), p. 170-171.

Index No: 81
QUARTZ MONZONITE
170 m.y. ($\pm$ 20 m.y.)

Location: Sec. 7, T. 13 N., R. 68 E.; 1/4 mile north of Shingle Creek on the west side of the Snake Range.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Collected by: A. B. Griggs and D. H. Whitebread, U. S. Geological Survey.
Determined by: U. S. Geological Survey.
Geology of Intrusive: From the Osceola stock (see also no. 80).
Associated Ore Deposits: Gold-quartz veins. Lead-silver veins. Tungsten (scheelite) quartz veins.
Reference: *Adair and Stringham (1960), p. 231.

Index No: 82A & 82B
QUARTZ MONZONITE

(A) 89 m.y. ($^{+13}_{-4}$ m.y.)
(B) 100 m.y. ($^{+15}_{-5}$ m.y.)

Note: A and B represent separate determinations run on the same concentrate.

Location: Center Sec. 28, T. 13 N., R. 68 E.; southern Snake Range.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 9% chlorite and montmorillonite, and 3% garnet as contaminent.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 190).

Data: K = 5.62%.

(A) radiogenic $Ar^{40} = 20.3 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 20\%$.

(B) radiogenic $Ar^{40} = 22.9 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 19\%$.

Geology of Intrusive: From the Wheeler Peak pluton (see also no. 83).

Petrography: Medium-grained quartz (50%), microcline, andesine, and minor muscovite-biotite.

Associated Ore Deposits: See no. 83.

Reference: *Armstrong (1963), p. 171-172.

Index No: 83

QUARTZ MONZONITE

145 m.y. ($\pm$ 20 m.y.)

Location: T. 12 N., R. 69 E.; 750 feet southwest of Snake Creek on the east side of the Snake Range, at an elevation of 8,200 feet.

Method: LEAD-ALPHA.

Mineral: ZIRCON.

Collected by: A. B. Griggs and D. H. Whitebread, U. S. Geological Survey.

Determined by: U. S. Geological Survey.

Geology of Intrusive: From the Wheeler Peak pluton (see also no. 82).

Associated Ore Deposits: Tungsten (huebnerite and/or scheelite) quartz veins. Lead-silver veins. Beryllium (bertrandite and phenacite)-fluorite veins.

Reference: *Adair and Stringham (1960), p. 231.

Index No: 84

QUARTZ MONZONITE

64 m.y. ($^{+10}_{-3}$ m.y.)

Location: NW 1/4 Sec. 2, T. 11 N., R. 69 E.; southeast part of Southern Snake Range.

Method: POTASSIUM-ARGON.

Mineral: MUSCOVITE. Almost pure.

Collected by: R. L. Armstrong, Yale Univ.

Determined by: R. L. Armstrong, Yale Univ. (no. YAG 187).

Data: K = 7.99%; radiogenic $Ar^{40} = 20.4 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 25\%$.

Geology of Intrusive: From the Lexington Creek stock (see also no. 85).

Petrography: Coarse- to medium-grained quartz, microcline, andesine, and muscovite.

Cited Age: Middle Tertiary (Drewes, 1958).

Associated Ore Deposits: Tungsten (scheelite) contact deposits.

References: *Armstrong (1963), p. 171.
Drewes (1958), p. 221-240.

Index No: 85
QUARTZ MONZONITE
225 m.y. ($\pm$ 25 m.y.)

Location: T. 11 N., R. 69 E.; south side of Lexington Creek on the east side of the Snake Range, at an altitude of about 7,400 feet.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Collected by: A. B. Griggs and D. H. Whitebread, U. S. Geological Survey.
Determined by: U. S. Geological Survey.
Geology of Intrusive: From the Lexington Creek stock (see also no. 84).
Reference: *Adair and Stringham (1960), p. 231.

APPENDIX B

VOLCANIC ROCKS

CHURCHILL COUNTY

Index No: 86
TUFF
13.9 m.y.

Location: UCMP loc. P-4134, Hotsprings Mountains.
Method: POTASSIUM-ARGON.
Mineral: PLAGIOCLASE.
Collected by: G. T. James, Univ. California (Berkeley).
Determined by: Univ. California (Berkeley). (UC no. KA-1261).
Constants: Same as no. 1.
Data: K = 0.933%; Ar_{40}^{at} = 33%.
Geology of Extrusive: Sample is from andesitic tuff interbedded with leaf-bearing tuffaceous shales containining Chloropagus flora.
Cited Age: Early Clarendonian (North American Land Mammal Age).
Reference: *Evernden and James (1964), p. 970.
Axelrod (1956), p. 1-322.

Index No: 87
TUFF
15.9 m.y.

Location: 2 miles south of UCMP loc. P-5101, near Middlegate.
Method: POTASIUM-ARGON.
Mineral: PLAGIOCLASE.
Collected by: G. T. James, Univ. California (Berkeley).
Determined by: Univ. California (Berkeley). (UC no. KA-1264).
Constants: Same as no. 1.
Data: K = 0.538%; Ar_{40}^{at} = 30%.

Geology of Extrusive: Sample is from dacite tuff (unit M of Axelrod, 1956) interbedded with leaf-bearing tuffaceous shales containing Middlegate flora. Hemphillian mammals have been recovered from overlying Monarch Hill Formation and are approximately 3 miles southeast of UCMP loc. V 5200. Fragmentary mammal remains have been found in Middlegate Formation about 100 feet stratigraphically above the fossil plant occurrences but are too fragmentary for an accurate age assignment and could be anything from Barstovian to Hemphillian in age.

Cited Age: Early Clarendonian (North American Land-Mammal Age).

Reference: *Evernden and James (1964), p. 970.
Axelrod (1956), p. 1-322.

CLARK COUNTY

Index No: 88
TUFF
23 m.y. ($\pm$ 3 m.y.)

Location: SW 1/4 Sec. 8, T. 15 S., R. 67 E.; at Muddy River narrows.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE-HORNBLENDE mixture. 10% pyroxene as contaminent.
Collected by: R. L. Armstrong, Yale Univ., and C. R. Longwell, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 32).
Data: K = 3.11%; radiogenic $Ar^{40} = 2.79 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 75\%$.

Geology of Extrusive: From tuff in Horse Spring Formation at a point about 200 feet above the Overton Fanglomerate and about 80 feet below the lowest Horse Spring limestone. See also no. 89.

Petrography: Consists mostly of glass shards cemented by calcite, a few percent lithic fragments, 20% andesine, 2% biotite, 2% hornblende, and less than 1% pyroxene.

Reference: *Armstrong (1963), p. 152.

Index No: 89
TUFF
23 m.y.

Location: Sec. 17, T. 15 S., R. 67 E.; north side of the narrows of the Muddy River.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: D. W. Weaver, Univ. Calif. at Santa Barbara, 1958.
Determined by: Univ. California (Berkeley), 1958.

Geology of Extrusive: From a tuff (in part waterlaid, in part massive) interbedded with limestone of the Horse Spring Formation (see also no. 88).

Petrography: Fresh ash, whitish groundmass, abundant biotite.

Index No: 89 (Continued)
Cited Age: Cretaceous or early Tertiary (Tschanz, 1960).
Reference: *Tschanz (1960), p. 293-295.
*Longwell, C. R. (Dec. 25, 1964) written communication: Dept. Geol., Stanford University.

Index No: 90
TUFF
90.4 m.y. (± 1 m.y.)

Location: S 1/2 Sec. 36, T. 17 S., R. 66 E.; Valley of Fire, short distance north of Valley of Fire road, southwest of Atlatl Rock.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Determined by: U. S. Geological Survey.
Geology of Extrusive: From volcanic ash in the Willow Tank Formation.
Cited Age: Late Lower Cretaceous, based on fossil tree fern.
Reference: *Longwell (Jan. 4, 1965) written communication: Stanford Univ.

ELKO COUNTY

Index No: 91
RHYOLITE
15.4 m.y.

Location: One-quarter mile north of Wildhorse; Sec. 4, T. 43 N., R. 55 E.; Wildhorse 15' quadrangle grid coordinates 2,524,900' N/445,400'E.
Method: POTASSIUM-ARGON.
Mineral: SANIDINE.
Collected by: R. R. Coats, U. S. Geol. Survey.
Determined by: Univ. California (Berkeley). (UC no. KA-1380).
Constants: Same as no. 1.
Data: K = 8.59%; Ar_{40}^{at} = 3%.
Geology of Extrusive: From the basal phase of the Jarbidge Rhyolite (see also no. 92) stratigraphically above an undescribed Barstovian mammal assemblage (Rizzi Ranch Fauna).
Petrography: Rhyolite.
Cited Age: Miocene (Coats, 1964). Barstovian (North American Land-Mammal Age), (Evernden, 1964).
Associated Ore Deposits: Contains epithermal gold-silver veins.
References: Coats (1964).
*Evernden, Savage, Curtis, and James (1964), p. 194.

Index No: 92
RHYOLITE
16.8 m.y. (± 0.5 m.y.)

Location: Along Meadow Creek in the Rowland 15' quadrangle, north-central Elko County.
Method: POTASSIUM-ARGON.
Mineral: SANIDINE.
Collected by: D. I. Axelrod, Univ. California at Los Angeles.
Determined by: Geochron Laboratories, Inc.
Constants: Same as no. 1.
Geology of Extrusive: From the Jarbidge Rhyolite (see also no. 91) which includes flows, tuffs, and welded tuffs of rhyolitic composition.
Petrography: Phenocrysts of quartz, sanidine, and rarer oligoclase-andesine.
Cited Age: Miocene (Coats, 1964).
Associated Ore Deposits: Contains epithermal gold-silver veins.
Reference: *Coats (1964), p. 11.

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Index No: 93
TUFF
35.2 m.y. (± 1 m.y.)

Location: Sec. 11, T. 42 N., R. 51 E.; north side of State Highway 11 at road turn.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. Grain size: -40 + 80 mesh. Over 95% pure.
Collected by: D. I. Axelrod, Univ. Calif. Los Angeles, 1961.
Determined by: Geochron Laboratories, Inc., 1962.
Constants: Same as no. 1.
Geology of Extrusive: From Chicken Creek Formation, some 600 feet above Bull Run flora. No alteration.
Petrography: Biotite rhyolite ash.
Cited Age: Eocene (Axelrod, 1964, p. 77).
References: *Axelrod, D. I. (Oct. 23, 1964) written communication: Univ. Calif. Los Angeles.
*Axelrod (1964), p. 77.

xxxxxx

Index No: 94A & 94B
TUFF
(A) 39 m.y. (± 1 m.y.)
(B) 40 m.y. (± 1 m.y.)

Location: South edge Sec. 30, T. 45 N., R. 58 E.
Method: POTASSIUM-ARGON.
Mineral: (A) BIOTITE.
(B) SANIDINE. Grain size: -20 + 80 mesh.

Index No: 94A & 94B (Continued)
Collected by: D. I. Axelrod, Univ. Calif. Los Angeles, 1961.
Determined by: Geochron Laboratories, Inc., 1962.
Constants: Same as no. 1.
Geology of Extrusive: From the Deadhorse Tuff, about 150 feet above Copper Basin flora (see also no. 95). No alteration.
Petrography: Biotite-hornblende rhyolite lapilli tuff.
Cited Age: Eocene (Axelrod, 1964, p. 77).
References: *Axelrod, D. I. (Oct. 23, 1964) written communication: Univ. Calif. Los Angeles.
*Axelrod (1964), p. 77.

Index No: 95
TUFF
39.9 m.y.

Location: From(?) the Jarbidge 15' quadrangle, north-central Elko County.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: D. I. Axelrod, Univ. California at Los Angeles, 1961.
Determined by: Geochron Laboratories, Inc., 1962.
Constants: Same as no. 1.
Geology of Extrusive: From the Dead Horse Tuff (see also no. 94) which is the oldest Tertiary formation in the Jarbidge quadrangle. It is overlain conformably by the Meadow Fork Formation.
Petrography: Crystal-vitric tuff ranging in composition from biotite-hornblende dacite through biotite-hornblende quartz latite to biotite rhyolite.
Cited Age: Tertiary (pre-Miocene) (Coats, 1964).
Associated Ore Deposits: None.
Reference: *Coats (1964), p. 7.

Index No: 96
TUFF
22 m.y. ($^{+3}_{-2}$ m.y.)

Location: SE 1/4 Sec. 34, T. 31 N., R. 53 E.; in the Railroad mining district.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 2% montmorillonite as contaminent.
Collected by: R. L. Armstrong, and Keith Ketner, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 111).
Data: K = 7.04%; radiogenic $Ar^{40} = 6.12 \times 10^{-6}$ cc/gm; $Ar^{at}_{40} = 66\%$.
Geology of Extrusive:
Petrography: Highly-welded, crystal-vitric tuff consisting of glass shards, 20% sanidine, 15% oligoclase, and 1% biotite.
Reference: *Armstrong (1963), p. 154.

ESMERALDA COUNTY

Index No: 97
TUFF
12.7 m.y.

Location: At Darmes coal mine, near Coaldale Junction; near UCMP loc. P-3924.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: G. T. James, Univ. California (Berkeley).
Determined by: Univ. California (Berkeley). (UC no. KA-1268).
Constants: Same as no. 1.
Data: K = 6.853%; Ar_{40}^{at} = 31%.
Geology of Extrusive: Sample from biotite tuff interbedded with fossil plant-bearing tuffaceous shale and lignite seam of the Esmeralda Formation (see also nos. 98, 99, 110, 111).
Cited Age: Clarendonian (North American Land-Mammal Age).
Associated Ore Deposits: Lignite coal.
References: *Evernden and James (1964), p. 971.
Axelrod (1940), p. 163-174.

Index No: 98
TUFF
11.1 m.y.

Location: T. 1 N., R. 35 E.; northeast corner of White Mountain USGS 30' quadrangle, 3/4 mile south of hill 6061, in the vicinity of UCMP loc. V-2804, Fish Lake Valley.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: G. H. Curtis and D. E. Savage.
Determined by: Univ. California (Berkeley). (UC no. KA-480).
Constants: Same as no. 1.
Data: K = 4.64%; Ar_{40}^{at} = 36%.
Geology of Extrusive: From the Esmeralda Formation (see also nos. 97, 99, 110, 111), 25 feet above micro-mammal level.
Petrography: Crystal, vitric, biotite tuff.
Cited Age: Early Clarendonian (North American Land-Mammal Age) (Stirton, 1939).
Associated Ore Deposits: Contains mercury (cinnabar) deposits.
References: *Evernden, Savage, Curtis, and James (1964), p. 177.
Stirton (1939).

Index No: 99
TUFF
11.4 m.y.

Location: T. 1 N., R. 35 E.; northeast corner of White Mountain USGS 30' quadrangle, 3/4 mile south of hill 6061, in the vicinity of UCMP loc. V-2804, Fish Lake Valley.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: G. H. Curtis and D. E. Savage.
Determined by: Univ. California (Berkeley). (UC no. KA-499).
Constants: Same as no. 1.
Data: K = 6.12%; Ar_{40}^{at} = 31%.
Geology of Extrusive: From the Esmeralda Formation (see also nos 98, 99, 110, 111), just below micro-mammal level (UCMP loc. V-2804).
Petrography: Crystal, vitric, biotite tuff.
Cited Age: Early Clarendonian. Considered to be younger than Coal Valley fauna by Stirton (1936, p. 635) because of supposed absence of Nannippus tehonensis, but several specimens of this horse have been found in the collection from this locality. Equal to Coal Valley and Cedar Mtn. fauna on basis of fossil materials.
Associated Ore Deposits: Contains mercury (cinnabar) deposits.
References: *Evernden, Savage, Curtis, and James (1964), p. 179.
Stirton (1939).

EUREKA COUNTY

Index No: 100
TUFF
27 m.y. ($^{+4}_{-2}$ m.y.)

Location: SW 1/4 Sec. 23, T. 30 N., R. 49 E.; in the Granite Hills.
Method: POTASSIUM-ARGON
Mineral: BIOTITE-5% HORNBLENDE. 8% chlorite as contaminent.
Collected by: L. J. P. Muffler, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 208).
Data: K = 6.18%; radiogenic Ar^{40} = 6.73 X 10^{-6} cc/gm; Ar_{40}^{at} = 60%.
Geology of Extrusive: From the Frenchie Creek Quadrangle Volcanics.
Petrography: Highly-welded, crystal-vitric tuff consisting of unaltered glass shards, 18% andesine, 15% sanidine, 10% quartz, 5% biotite, 2% lithic fragments, and a trace of hornblende.
Reference: *Armstrong (1963), p. 156.

LINCOLN COUNTY

Index No: 101
TUFF
37 m.y.

Location: "eastern Nevada".
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Reference: *Masursky (1960), p. 282.

Index No: 102
TUFF
26 m.y. ($^{+4}_{-2}$ m.y.)

Location: NE 1/4 Sec. 27, T. 1 S., R. 68 E.; base of section in Condor Canyon, near Panaca.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. Less than 2% impurities.
Collected by: R. L. Armstrong.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 63).
Data: K = 6.14%; radiogenic $Ar^{40} = 6.20 \times 10^{-6}$ cc/gm; $Ar^{at}_{40} = 68\%$.
Geology of Extrusive: From Needles Range Formation (see also no. 113).
Petrography: Moderately-welded, crystal-vitric tuff consisting of devitrified glass shards, 40% andesine, 6% quartz, and 2% biotite.
Reference: *Armstrong (1963), p. 153.

Index NO: 103
TUFF
24 m.y. ($^{+4}_{-2}$ m.y.)

Location: SE 1/4 Sec. 6, T. 7 S., R. 62 E.; east of Alamo.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE-HORNBLENDE mixture. 2-5% impurities.
Collected by: R. L. Armstrong, and Paul Williams, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 44).
Data: K = 3.93%; radiogenic $Ar^{40} = 3.74 \times 10^{-6}$ cc/gm; $Ar^{at}_{40} = 59\%$.
Geology of Extrusive: From Hiko Tuff.
Petrography: Moderately welded, crystal-vitric tuff composed of glass shards, 40% andesine, 3% quartz, 3% sanidine, 2% biotite, and 1% each of hornblende and magnetite.
Reference: *Armstrong (1963), p. 152.

LYON COUNTY

Index No: 104
TUFF
9.3 m.y.

Location: Eastern edge of Smith Valley.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: G. H. Curtis and D. E. Savage.
Determined by: Univ. California (Berkeley). (UC no. KA-485).
Constants: Same as no. 1.
Data: K = 4.47%; Ar_{40}^{at} = 64%.

Geology of Extrusive: From Smith Valley "beds", Morgan Ranch Formation.
Petrography: Crystal vitric biotite dacite tuff.
Cited Age: Hemphillian (North American Land-Mammal Age), (MacDonald, 1959).
Associated Ore Deposits: None.

References: *Evernden, Savage, Curtis, and James (1964), p. 178.
MacDonald (1959).
Axelrod (1956), p. 1-322.
Wilson (1936).

MINERAL COUNTY

Index No: 105
TUFF
11.2 m.y.

Location: Sec. 6, T. 7 N., R. 28 E.; approximately 2000 feet west of Aldrich Station, Coal Valley, at UCMP loc. V-4706. (See also nos. 105-109).
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: G. H. Curtis and D. E. Savage.
Determined by: Univ. California (Berkeley). (UC no. KA-414).
Constants: Same as no. 1.
Data: K = 6.37%; Ar_{40}^{at} = 52%.

Geology of Extrusive: From near top of unit A6 of Aldrich Station Formation.
Petrography: Biotite rhyolite tuff.
Cited Age: Early Clarendonian (North American Land-Mammal Age) (Stirton, 1939).

References: *Evernden, Savage, Curtis, and James (1964), p. 176.
Axelrod (1956).
Stirton (1939).

Index No: 106
TUFF
11.0 m.y.

Location: Coal Valley.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: G. H. Curtis and D. E. Savage.
Determined by: Univ. California (Berkeley). (UC no. KA-552).
Constants: Same as no. 1.
Data: K = 6.65%; Ar_{40}^{at} = 91%.
Geology of Extrusive: From tuff in unit A6 of Aldrich Station Formation below tuff of nos. 107 & 108.
Cited Age: Early Clarendonian (see nos. 105, 107-109).
References: *Evernden, Savage, Curtis, and James (1964), p. 180.

Index No: 107
TUFF
10.6 m.y.

Location: Coal Valley, on ridge east of UCMP loc. V-3939.
Method: POTASSIUM-ARGON.
Mineral: GLASS.
Collected by: G. H. Curtis and D. E. Savage.
Determined by: Univ. California (Berkeley). (UC no. KA-500).
Constants: Same as no. 1.
Data: K = 5.37%; Ar_{40}^{at} = 67%.
Geology of Extrusive: From top of unit A6 (same as no. 108), Aldrich Station Formation (see also nos. 105, 106, 108, 109). Since 1951, a number of specimens of Nannippus tehonensis have been found at UCMP locs. V-3939, 4705, and 4706 in the upper part of the Aldrich Station Formation. Mammalian fossils collected from the lower two-thirds of the overlying Coal Valley Formation are similar to those in the Aldrich Station Formation and may be only slightly younger, especially those from the lower 800' of the Coal Valley Formation. Specimens from the Aldrich Station and Orinda Formations could be equal in age. Barstovo-Clarendonian age given by Axelrod is for underlying plants of the Aldrich Station Formation.
Petrography: Biotite crystal vitric tuff.
Cited Age: Early Clarendonian (Stirton, 1939).
References: *Evernden, Savage, Curtis, and James (1964), p. 179.
Axelrod (1956).
Stirton (1939).

Index Nos: 108A & 108B
TUFF
(A) 10.5 m.y. Note: A and B represent two separate determinations.
(B) 11.2 m.y.

Location: Coal Valley, near UCMP loc. V-4707.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: G. H. Curtis and J. F. Evernden.
Determined by: Univ. California (Berkeley). (UC no. KA-482).
Constants: Same as no. 1.
Data: (A) K = 6.76%; Ar_{40}^{at} = 89%.
(B) K = 6.76%; Ar_{40}^{at} = 90%.
Geology of Extrusive: From top of unit A6 (same as no. 107), Aldrich Station Formation (see also nos. 105-107,109).
Petrography: Biotite crystal vitric tuff.
Cited Age: Early Clarendonian (North America Land-Mammal Age) (see no. 107).
References: *Evernden, Savage, Curtis, and James (1964), p. 178.
Axelrod (1956).
Stirton (1939).

Index No: 109
TUFF
10.8 m.y.

Location: Coal Valley, near UCMP loc. V-4707.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: G. H. Curtis and D. E. Savage.
Determined by: Univ. California (Berkeley). (UC no. KA-551).
Constants: Same as no. 1.
Data: K = 6.54%; Ar_{40}^{at} = 36%.
Geology of Extrusive: From tuff approximately 200 feet above base of unit 1 of Coal Valley Formation (see also nos. 105-108,124).
Petrography: Biotite crystal vitric tuff.
Cited Age: Early Clarendonian. The fossil mammal specimens listed by Axelrod (1956 , p. 33) are not complete enough for an age assignment of more than Clarendonian. Additional specimens collected by the University of California Museum in 1951 and since include a number of specimens of Nannippus tehonensis, and an age assignment of early Clarendonian is in order. These specimens are similar to those from the Aldrich Station Formation, and there appears to be no difference in the two collections from the two formations.
References: *Evernden, Savage, Curtis, and James (1964), p. 179.
Axelrod (1956).
Stirton (1939).

Index No: 110
TUFF
11.5 m.y.

Location: Cedar Mountain area, approximately 1 mile northwest of "Tedford Pocket".
Method: POTASSIUM-ARGON.
Mineral: SANIDINE.
Collected by: G. H. Curtis and D. E. Savage.
Determined by: Univ. California (Berkeley). (UC no. KA-577).
Constants: Same as no. 1.
Data: K = 5.94%; Ar_{40}^{at} = 33%.
Geology of Extrusive: From tuff approximately 50 feet higher in Esmeralda Formation than nos.97-99,111.
Cited Age: Early Clarendonian (North American Land-Mammal Age).
Associated Ore Deposits: Diatomaceous earth.
References: *Evernden, Savage, Curtis, and James (1964), p. 180.
Stirton (1939), p. 627-40.

Index No: 111
TUFF
10.7 m.y.

Location: Cedar Mountain area, about 1 mile north of "Tedford Pocket".
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: G. H. Curtis and D. E. Savage.
Determined by: Univ. California (Berkeley). (UC no. KA-452).
Constants: Same as no. 1.
Data: K = 7.05%; Ar_{40}^{at} = 64%.
Geology of Extrusive: From tuff of the Esmeralda Formation, 200 feet above fossil mammal-bearing beds of early Clarendonain age (see also nos. 97-99, 110).
Petrography: Biotite crystal vitric tuff.
Cited Age: Early Clarendonian (North American Land-Mammal Age). Considered to be younger than Coal Valley fauna by Stirton (1939, p. 635) because of supposed absence of Nannippus tehonensis, but several specimens of teeth of this horse have been collected since from this locality (UCMP loc. 1984). Equal to Coal Valley and Fish Lake Valley fauna on basis of fossil materials.
Associated Ore Deposits: Diatomaceous earth.
References: *Evernden, Savage, Curtis, and James (1964), p. 177.
Stirton (1939).

Index No: 112
TUFF
(A) 30 m.y. ($^{+5}_{-2}$ m.y.)
(B) 36 m.y. ($^{+5}_{-2}$ m.y.)

Note: A and B are separate determinations run on the same biotite concentrate.

Location: Center Sec. 34, T. 10 N., R. 58 E.; Ragged Ridge, northern Grant Range.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. Less than 2% impurities.
Collected by: R. L. Armstrong, Yale Univ.; R. Scott, Rice Univ.; and J. C. Taylor, Shell Oil Co.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 150).
Data: (A) K = 6.54%; radiogenic $Ar^{40} = 7.62 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 54\%$.
(B) K = 6.54%; radiogenic $Ar^{40} = 9.23 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 30\%$.
Geology of Extrusive: From flow above Sheep Pass Formation.
Petrography: Dacite(?) consisting of 8% oligoclase, 6% quartz, and 1% biotite as phenocrysts in a very-fine-grained groundmass.
Reference: *Armstrong (1963), p. 154.

Index No: 113
TUFF
26 m.y. ($^{+4}_{-2}$ m.y.)

Location: NW 1/4 Sec. 4, T. 8 N., R. 59 E.; Red Ridge, Grant Range.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. Less than 2% impurities.
Collected by: R. L. Armstrong.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 81).
Data: K = 7.44%; radiogenic $Ar^{40} = 7.81 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 32\%$.
Geology of Extrusive: From Needles Range Formation (see also no. 102).
Petrography: Highly-welded, crystal-vitric tuff consisting of glass shards, 30% sanadine, 15% plagioclase (totally altered to sericite and calcite), and 3% biotite.
Reference: *Armstrong (1963), p. 153.

Index No: 114
TUFF
7.5 m.y.

Location: Southern Nye County.
Method: POTASSIUM-ARGON.
Mineral: SANIDINE.
Determined by: U. S. Geological Survey.
Geology of Extrusive: From the lower part of the Spearhead Member of the Thirsty Canyon Tuff. (See also no. 115).
Reference: *Noble and others (1964A), p. 25.

Index No: 115
TUFF
6.5-7.5 m.y.**

**Age of unit; based on determinations run on more than one sample.

Location: Southern Nye County.
Method: POTASSIUM-ARGON.
Determined by: U. S. Geological Survey.
Geology of Extrusive: From the Thirsty Canyon Tuff (and associated lavas ?). (See also no. 114).
Petrography: Unit contains comendite, trachytic soda rhyolite, trachyte, and pantellite.
Reference: *Noble and others (1964B).

Index No: 116
TUFF
10.5-11.5 m.y.**

**Age of unit; based on determinations run on more than one sample.

Location: Southern Nye County.
Method: POTASSIUM-ARGON.
Determined by: U. S. Geological Survey.
Geology of Extrusive: From the Timber Mountain Tuff (and associated lavas ?).
Petrography: Unit contains rhyolite, quartz latite, trachyandesite, and trachy-basalt.
Reference: *Noble and others (1964B).

Index No: 117
TUFF
12.5-13.5 m.y.**

**Age of unit; based on determinations run on more than one sample.

Location: Southern Nye County.
Method: POTASSIUM-ARGON.
Determined by: U. S. Geological Survey.
Geology of Extrusive: From the Paintbrush Tuff (and associated lavas ?).
Petrography: Unit contains rhyolite and quartz latite.
Reference: *Noble and others (1964B).

Index No: 118
TUFF
13-14 m.y.**

**Age of units; based on determinations run on more than one sample.

Location: Southern Nye County.
Method: POTASSIUM-ARGON.
Determined by: U. S. Geological Survey.
Geology of Extrusive: From the Wahmonie and Salyer Formations.
Petrography: Units contain quartz latite, rhyodacite, and dacite lavas breccia flows, and tuffs.
Reference: *Noble (1964B).

Index No: 119
TUFF
13.5-14.5 m.y.**

**Age of unit; based on determinations run on more than one sample.

Location: Southern Nye County.
Method: POTASSIUM-ARGON.
Determined by: U. S. Geological Survey.
Geology of Extrusive: From the Belted Range Tuff (and associated lavas and tuffs ?).
Petrography: Unit contains comendite, trachytic soda rhyolite, and trachyte.
Reference: *Noble and others (1964B).

STOREY COUNTY

Index No: 120
RHYOLITE
22.7 m.y.

Location: NW 1/4 Sec. 31, T. 17 N., R. 21 E.; 3 miles northwest of Sutro flora locality at Silver City.
Method: POTASSIUM-ARGON.
Mineral: SANIDINE.
Collected by: R. Rose, San Jose State College.
Determined by: Univ. California (Berkeley). (UC no. KA-1267).
Constants: Same as no. 1.
Data: K = 7.597%; Ar_{40}^{at} = 7%.
Geology of Extrusive: Sample is from Hartford Hill Rhyolite (see also no. 127) conformably underlying Alta Andesite in which shales containing Sutro flora are interbedded; from approximately 300 to 500 feet stratigraphically below plant-bearing beds.
Cited Age: Orellan (North American Land-Mammal Age).
Associated Ore Deposits: Contains epithermal silver-gold veins.
References: *Evernden and James (1964), p. 971.
Axelrod (1957).

WASHOE COUNTY

Index No: 121
TUFF
19.8 m.y.**

**Reportedly, tuffs are not welded and contain detrital feldspar from older rocks (H. F. Bonham, personal communication) thus true age may be younger.

Location: NE 1/4 Sec. 35, T. 43 N., R. 18 E.; at UCMP loc. 97, at 49er Camp.
Method: POTASSIUM-ARGON.
Mineral: PLAGIOCLASE.
Collected by: G. T. James, Univ. California (Berkeley).
Determined by: Univ. California (Berkeley). (UC no. KA-1273).
Constants: Same as no. 1.

Data: K = 0.149%; Ar_{40}^{at} = 52%.

Geology of Extrusive: Sample is from welded tuff interbedded with leaf-bearing diatomite and tuffaceous shales containing upper Cedarville flora from upper 200 feet of formation.

Cited Age: Late Hemingfordian-early Barstovian (North American Land-Mammal Age).

References: *Evernden and James (1964), p. 971.
Chaney and Axelrod (1959).

Index No: 122
PUMICITE
15.2 m.y.

Location: Massacre Lake, east side of Long Valley near Vya.
Method: POTASSIUM-ARGON.
Mineral: SANIDINE.
Collected by: G. T. James.
Determined by: Univ. California (Berkeley). (UC no. KA-1017).
Constants: Same as no. 1.
Data: K = 4.72%; Ar_{40}^{at} = 10%.

Geology of Extrusive: Pumicite one foot above fossil mammal-bearing tuff at UCMP localities V-6160 and V-6161. Tentative faunal list from this tuff: Merychippus, Parahippus cf. brevidontus, Hypohippus or Anchitherium, chalicothere, tayassuid, Ticholeptus or Merychyrus, cf. Cranioceras, rhinocerotid, Mylagaulus, Liodontia, Arctomyoides, Peromyscus, Tomarctus cf. rurestris.

Cited Age: Early Barstovian (North American Land-Mammal Age), (Everndon, 1964).

Reference: *Evernden, Savage, Curtis, and James, (1964), p. 189.

Index No: 123
TUFF
12.4 m.y.

Location: South-central Sec. 4, T. 23 N., R. 21 E.; south of Pyramid Lake.
Method: POTASSIUM-ARGON.
Mineral: PLAGIOCLASE.
Collected by: H. Bonham and J. Gimlett, Nev. Bur. Mines, D. Slemmons, Univ. Nev.
Determined by: Univ. California (Berkeley). (UC no. KA-1244).
Constants: Same as no. 1.
Data: K = 0.5358%; Ar_{40}^{at} = 8%.

Geology of Extrusive: Sample from welded dacitic tuff immediately above Pyramid flora.

Cited Age: Late Hemingfordian to early Barstovian (North American Land-Mammal Age).

References: *Evernden and James (1964), p. 969.
Axelrod (1957).

Index No: 124
TUFF
5.7 m.y.

Location: From UCMP loc. P-102, near Verdi, Nevada.
Method: POTASSIUM-ARGON.
Mineral: PLAGIOCLASE.
Collected by: G. T. James, Univ. California (Berkeley).
Determined by: Univ. California (Berkeley). (UC no. KA-1286).
Constants: Same as no. 1.
Data: K = 0.388%; Ar_{40}^{at} = 51%.
Geology of Extrusive: Sample is from andesitic tuff in the Coal Valley Formation (see also no. 109) interbedded with leaf-bearing tuffaceous shale containing Verdi flora. Fragmentary remains of fossil mammals of possible Clarendonian age have been collected approximately 600 feet stratigraphically below the leaf-bearing shales at Mogul, Nevada, 1 mile east of sample locality.
Cited Age: Hemphillian (North American Land-Mammal Age).
References: *Evernden and James (1964), p. 972.
Axelrod (1958).

Index No: 125
BASALT
11.0 m.y.

Location: At Mogul, near Verdi, and 1 mile east of UCMP loc. P-102.
Method: POTASSIUM-ARGON.
Mineral: WHOLE ROCK.
Determined by: Univ. California (Berkeley). (UC no. KA-1259).
Geology of Extrusive: Sample from an olivine basalt flow which occurs 400 feet below a fossil mammal horizon of possible Clarendonian age (see also no. 124).
Reference: *Evernden and James (1964), p. 972.

Index No: 126
BASALT
1.14 m.y. (± 0.04 m.y.)

Location: At Mustang, 7 miles east of Sparks.
Method: POTASSIUM-ARGON.
Mineral: WHOLE ROCK.
Collected by: G. B. Dalrymple, U. S. Geological Survey.
Geology of Extrusive: From the McClellan Peak Basalt, which flowed down Long Valley, entered the Truckee River Canyon above Mustang, and flowed 3 miles downstream.
Cited Age: Pleistocene.
Reference: *Birkeland, P. W. (1965) Mustang, Nevada: unpublished manuscript.

Index No: 127A & 127B
RHYOLITE
(A) 22.8 m.y.
(B) 22.7 m.y.

Note: A and B are separate determinations run on concentrates of different minerals from the same sample.

Location: SW 1/4 NE 1/4 Sec. 14, T. 20 N., R. 23 E.; just north of U. S. Highway 40 (Interstate 80), 5 miles west of Wadsworth.
Method: POTASSIUM-ARGON.
Mineral: (A) SANIDINE.
(B) PLAGIOCLASE.
Collected by: R. Rose, San Jose State College.
Determined by: Univ. California (Berkeley). (A is UC no. KA-1288; B is UC no. KA-1289).
Constants: Same as no. 1.
Data: (A) K = 8.225%; Ar_{40}^{at} = 20%.
(B) K = 0.862%; Ar_{40}^{at} = 29%.
Geology of Extrusive: Sample is from a rhyolite which is similar to or equivalent to the Hartford Hill Rhyolite (see also no. 120).
Reference: *Evernden and James (1964), p. 972.

WHITE PINE COUNTY

Index No: 128
TUFF
33.4 m.y.

Location: Sec. 32, T. 11 N., R. 63 E.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: H. Williams
Determined by: Univ. California (Berkeley). (UC no. KA-175).
Constants: Same as no. 1.
Data: K = 6.38%; Ar_{40}^{at} = 50%.
Geology of Extrusive: Welded tuff from Summit Tuff unit of Sheep Pass section (see no. 112), 375 ft. above base of Tertiary volcanic sequence.
Cited Age: Oligocene, based on limited fossil control on fresh-water molluscs.
Reference: *Evernden, Savage, Curtis, and James (1964), p. 175.

Index No: 129
TUFF
27 m.y. ($^{+4}_{-2}$ m.y.)

Location: SW 1/4 Sec. 3, T. 14 N., R. 69 E.; east of Sacramento Pass, Snake Range.
Method: POTASSIUM-ARGON.
Mineral: HORNBLENDE, 5% BIOTITE, 40% QUARTZ, FELDSPAR, and GLASS.
Collected by: R. L. Armstrong.

Index No: 129 (Continued)
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 183B).
Data: K = 2.28%; radiogenic $Ar^{40} = 2.40 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 85\%$.
Geology of Extrusive: From the Sacramento Pass Volcanics.
Petrography: Highly-welded, crystal-vitric tuff, consisting of devitrified glass shards, 25% andesine, 2% biotite, 1% hornblende, and traces of sanidine and quartz.
Reference: *Armstrong (1963), p. 155.

Index No: 130
TUFF
32.8 m.y.

Location: Windous Butte, southwest of Ely; SW 1/4 Sec. 31, T. 13 N., R. 61 E.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Collected by: H. Williams.
Determined by: Univ. California (Berkeley). (UC no. KA-145).
Constants: Same as no. 1.
Data: K = 6.1%; $Ar_{40}^{at} = 29\%$.
Geology of Extrusive: From a series of welded tuffs.
Cited Age: Oligocene, based on very limited fossil control on fresh-water molluscs.
Reference: *Evernden, Savage, Curtis, and James (1964), p. 175.

Index No: 131
TUFF
34 m.y.

Location: Egan Range.
Method: POTASSIUM-ARGON.
Geology of Extrusive: From a welded tuff in the lower portion of the Garrett Ranch volcanic group which is underlain by the Sheep Pass Formation.
Cited Age: Post-Eocene, (Winfrey, 1960).
Reference: *Winfrey (1960), p. 128.

APPENDIX C

METAMORPHIC ROCKS

CLARK COUNTY

Index No: 132A & 132B
SCHIST
(A) 1450 m.y. ($^{+220}_{-70}$ m.y.)
(B) 1300 m.y. ($^{+200}_{-70}$ m.y.)
Note: A and B are separate determinations run on the same concentrate.

Location: SW 1/4 Sec. 24, T. 20 S., R. 62 E.; Frenchman Mountain.
Method: POTASSIUM-ARGON.

Mineral: BIOTITE. Pure.
Collected by: R. L. Armstrong, Yale Univ., and C. R. Longwell, U. S. Geological Survey.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 31).
Data: K = 7.17%.
(A) radiogenic $Ar^{40} = 613 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 6\%$.
(B) radiogenic $Ar^{40} = 532 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 2\%$.
Geology of Metamorphic: From the Frenchman Mountain Schist.
Petrography: From a biotite-rich inclusion in pegmatitic microcline granite. Consists of equal amounts of oligoclase and quartz, and 15% biotite.
Reference: *Armstrong (1963), p. 174.

ELKO COUNTY

Index No: 133
METASEDIMENT
18.6 m.y.

Location: North end of Ruby-East Humboldt Range.
Method: POTASSIUM-ARGON.
Geology of Metamorphic Rock: From Precambrian metasedimentary sequence (see also nos. 134, 135).
Cited Age: (of metamorphism) Late Jurassic-Early Cretaceous (Thorman, 1965).
Reference: *Thorman (1965).

Index No: 134
GNEISS
25 m.y. ($^{+4}_{-2}$ m.y.)

Location: SE 1/4 Sec. 9, T. 32 N., R. 58 E.; near Lamoille Camp, Lamoille Canyon, Ruby Mountains.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 1% chlorite and montmorillonite as contaminents.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 136).
Data: K = 7.46%; radiogenic $Ar^{40} = 7.40 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 45\%$.
Geology of Metamorphic: See also nos. 133, 135.
Petrography: Medium- to fine-grained biotite granodiorite gneiss; andesine, quartz, K-feldspar, and biotite; strong foliation (banded and mica orientation), extensive recrystallization.
Reference: *Armstrong (1963), p. 176.

Index No: 135
GNEISS
29 m.y. ($^{+4}_{-2}$ m.y.)

Location: NE 1/4 Sec. 1, T. 31 N., R. 58 E.; head of Lamoille Canyon, Ruby Mountains.
Method: POTASSIUM-ARGON.
Mineral: BIOTITE. 8% chlorite as contaminent.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 135).
Data: K = 6.68%; radiogenic $Ar^{40} = 7.66 \times 10^{-6}$ cc/gm; $Ar^{at}_{40} = 37\%$.

Geology of Metamorphic: See also nos. 133, 134.
Petrography: Medium- to fine-grained biotite quartz monzonite gneiss; quartz, oligoclase, microcline, and biotite; equigranular, banded, mica oriented, extensively recrystallized.
Refrence: *Armstrong (1963), p. 176.

Index No: 136
METASEDIMENT
42.4 m.y.

Location: Wood Hills.
Method: POTASSIUM-ARGON.
Geology of Metamorphic Rock: From metamorphosed Cambrian Dunderburg Shale.
Cited Age: (of metamorphism) Late Jurassic-Early Cretaceous (Thorman, 1964).
Reference: *Thorman (1965).

WHITE PINE COUNTY

Index No: 137
SLATE
39 m.y. ($^{+6}_{-2}$ m.y.)

Location: NW 1/4 Sec. 3, T. 17 N., R. 66 E.; McCoy Creek, Schell Creek Range.
Method: POTASSIUM-ARGON.
Mineral: MUSCOVITE-BIOTITE. Over 45% quartz, feldspar, and chlorite; rock too fine-grained for proper separation.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 192B).
Data: K = 2.84%; radiogenic $Ar^{40} = 4.42 \times 10^{-6}$ cc/gm; $Ar^{at}_{40} = 33\%$.

Geology of Metamorphic:
Petrography: Very-fine-grained carbonaceous phyllitic slate; quartz, muscovite, and biotite(?); strong planar foliation due to shears, shear bands alternating with bands of more randomly oriented minerals.
Reference: *Armstrong (1963), p. 177.

Index No: 138A & 138B
SCHIST

(A) 27 m.y. ($^{+4}_{-2}$ m.y.)
(B) 34 m.y. ($^{+5}_{-2}$ m.y.)

Note: A and B are separate determinations run on the same concentrate.

Location: NW 1/4 Sec. 28, T. 16 N., R. 70 E.; Hendrys Creek, central Snake Range.
Method: POTASSIUM-ARGON.
Mineral: MUSCOVITE. 2% chlorite and 1% staurolite as contaminents.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 39).
Data: K = 6.38%.
(A) radiogenic $Ar^{40} = 6.92 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 38\%$.
(B) radiogenic $Ar^{40} = 8.78 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 28\%$.

Geology of Metamorphic: See also no. 139.
Petrography: Staurolite-garnet mica schist; groundmass mostly quartz and muscovite with a few percent biotite; strong mica foliation crumpled, minerals annealed.
Reference: *Armstrong (1963), p. 174.

Index No: 139A & 139B
GNEISS

(A) 40 m.y. ($^{+6}_{-2}$ m.y.)
(B) 34 m.y. ($^{+5}_{-2}$ m.y.)

Note: A and B are separate determinations run on the same concentrate.

Location: NW 1/4 Sec. 11, T. 15 N., R. 70 E.; south of Hendrys Creek, central Snake Range.
Method: POTASSIUM-ARGON.
Mineral: MUSCOVITE-BIOTITE. 40% quartz, feldspar, minor garnet and epidote.
Collected by: R. L. Armstrong, Yale Univ.
Determined by: R. L. Armstrong, Yale Univ. (no. YAG 40).
Data: K = 4.27%.
(A) radiogenic $Ar^{40} = 6.80 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 40\%$.
(B) radiogenic $Ar^{40} = 6.02 \times 10^{-6}$ cc/gm; $Ar_{40}^{at} = 25\%$.

Geology of Metamorphic: See also no. 138.
Petrography: Granite mylonite gneiss; large augen of microcline and andesine in ground-up quartz, plagioclase, with biotite and muscovite; extreme lineation, less distinct foliation.
Reference: *Armstrong (1963), p. 175.

APPENDIX D

SEDIMENTARY ROCKS

HUMBOLDT COUNTY

Index No: 140
DETRITAL ZIRCON
680 m.y.**

**Age of the zircon only; indicates maximum age of the rock.

Location: On Battle Mountain.
Method: LEAD-ALPHA.
Mineral: ZIRCON.
Determined by: U. S. Geological Survey.
Geology of Sedimentary Rock: From the Harmony Formation, which is dominantly arkose, felspathic sandstone, and grit.
Cited Age: Mississippian(?) (Roberts, 1951). Late Cambrian, based mainly on trilobite fossils (Roberts and others, 1958).
References: Roberts (1951).
*Roberts and others (1958), p. 2828.

LANDER COUNTY

Index No: 141
DETRITAL ZIRCON
958 m.y. (± 100 m.y.)**

**Age of the zircon only; indicates maximum age of the sandstone.

Location: Sec. 15, T. 31 N., R. 43 E.
Method: LEAD-ALPHA.
Mineral: Detrital ZIRCON. Grain size: -60 + 200 mesh.
Collected by: R. J. Roberts, U. S. Geol. Survey. (no. HF-1).
Determined by: U. S. Geological Survey. (no. 362).
Constants: Same as no. 10.
Data: Pb = 54.5 ppm; = 130/mg/hr.
Geology of Sedimentary Rock: From sandstone in the Harmony Formation.
Cited Age: Late Cambrian (R. J. Roberts).
Reference: *Jaffe and others, (1959).

APPENDIX E

ALTERATION AND MINERALIZATION

WHITE PINE COUNTY

Index No: 142
HYDROTHERMAL ALTERATION
121 m.y.

Location: At Kimberly in the Ely mining district.

Method: POTASSIUM-ARGON.
Mineral: BIOTITE.
Determined by:
Constants: K^{40}: $\lambda_{\varepsilon} = 4.72 \times 10^{-10}$/yr; $\lambda_{\varepsilon} = 0.585 \times 10^{-10}$/yr.
Data: K = 6.94%; radiogenic $Ar^{40} = 0.00348 \times 10^{-3}$ cc/gm.
Geology of Alteration: Secondary brown mica (biotite) occurs in the hydrothermal alteration accompanying porphyry-copper mineralization. (See also nos. 77-79).
Associated Ore Deposits: Porphyry-copper deposits.
Reference: *Schwartz (1959), p. 180.

The Mackay School of Mines is one of the several colleges of the University of Nevada. The School consists of three divisions: the academic Departments of Instruction, the Nevada Bureau of Mines, and the Nevada Mining Analytical Laboratory. The Mackay School of Mines is thus the State of Nevada's educational, research, and public service center for the mineral industry.

The Nevada Bureau of Mines and the Nevada Mining Analytical Laboratory serve the public as State agencies to assist in developing Nevada's mineral resources. They identify, analyze, and evaluate minerals, rocks, and ores found in Nevada. They conduct field studies on Nevada geology and mineral deposits, including metallic and industrial minerals as well as oil and gas. They pursue laboratory and library research in mineral beneficiation, extractive metallurgy, and economic problems connected with the mineral industry of Nevada.

For information concerning the mineral resources and mineral industry of Nevada, write to: Director, Nevada Bureau of Mines, University of Nevada, Reno, Nevada.