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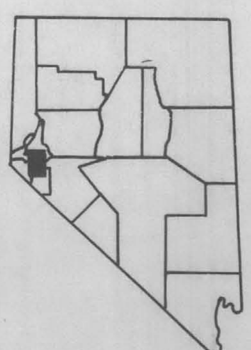
YERINGTON AREA GRAVITY

NEVADA BUREAU OF MINES
MAP 39

GRAVITY MAP OF THE YERINGTON COMO, WABUSKA, AND WELLINGTON QUADRANGLES, NEVADA

By John W. Erwin

Douglas, Lyon & Mineral Cos.



MACKAY SCHOOL OF MINES
UNIVERSITY OF NEVADA
1970

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NEVADA BUREAU OF MINES MAP 39

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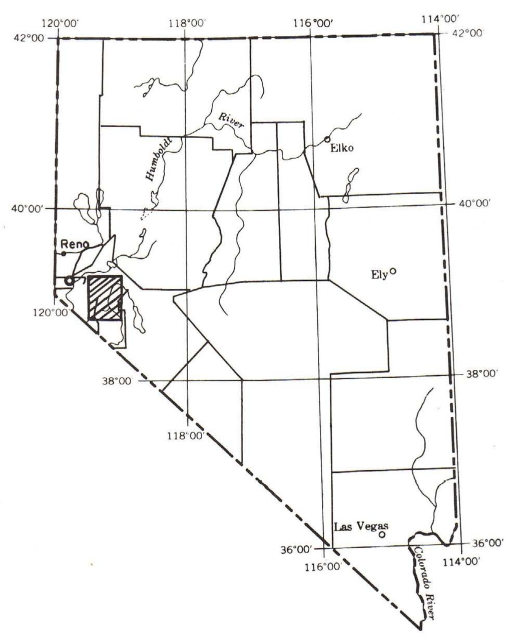
GRAVITY MAP OF THE YERINGTON, COMO, WABUSKA, AND WELLINGTON QUADRANGLES, NEVADA

By John W. Erwin

INTRODUCTION

This map is a compilation of gravity data obtained by the Nevada Bureau of Mines for an area of about 475 square miles bounded by latitudes 38° 45' and 39° 15'N., and longitudes 119° and 119°30'W., which will be referred to as the Yerington area in this report. The survey covers parts of Douglas, Lyon, and Mineral Counties, Nevada. A total of 231 gravity stations were occupied during the course of the work, which was confined primarily to the valleys and flanks of the ranges.



The field work was done by the author during the period 1967-1969 with the assistance of Ralph G. Mock, graduate student of the Mackay School of Mines, University of Nevada. Previous gravity work in western Nevada is by Woollard (1958), Thompson (1958), Gimlett (1967), and Wahl (1965).

This project is part of a continuing program dealing with problems of mineral exploration and the gathering of basic data for the further understanding of the Nevada portion of the Basin and Range province. Alluvial-covered pediments peripheral to known mineralized areas are important potential target areas for mineral exploration, and gravity is of aid in locating and defining these pediments. Also, the thickness and distribution of low-density Tertiary volcanic and sedimentary rocks and Quaternary alluvium overlying relatively dense pre-Tertiary rocks may be determined by gravity. Knowledge of the distribution and thickness of the Tertiary rocks is useful in exploration for mineral deposits in both Tertiary and pre-Tertiary rocks.

FIELD METHODS AND DATA REDUCTION

Standard geophysical methods for gravity surveys as described by Nettleton (1940) were used throughout the work. A Worden gravimeter with a sensitivity of 0.4655 milligals per scale division was used in the survey. Gravity data were referenced to the bench mark at the northwest corner of sec. 10, T. 14 N., R. 25 E., which in turn was tied to a gravity station at the Reno International Airport. The absolute value of gravity at the Reno airport station was established by Woollard (1958) and Chapman (1966). A value of 979.6844 mgals was obtained, yielding a simple Bouguer value of -183.4.

Stations were established at bench marks, section corners, and other existing controls shown on U. S. Geological Survey topographic maps. Elevations of stations were established by altimeter where other control was not available. All precautions were taken to minimize error due to altimeter use. Altimeter stations were not used as bases for establishing other gravity points.

The data were reduced to sea-level datum by using a combined elevation factor of 0.06 mgal/foot, which corresponds to a density of 2.67 g per cm³ for rocks above sea level. A standard latitude correction was made (Nettleton, 1940). Terrain corrections were not applied, but a number of stations were examined for terrain effects. The terrain corrections would be small in the valleys where the great majority of the stations are located. They do not exceed 1 to 2 mgals. Stations in the same general vicinity are, in general, equally affected by an equal terrain correction. Consequently, the 5 mgal contours used in this map would not be substantially altered if terrain corrections were applied.

The estimated error of the gravity survey is ±1.0 mgal. Principal sources of error are observation, instrument drift, elevation and horizontal control, and improper selection of the density used in the combined elevation correction. On existing control, most error is minimal. Altimeter stations are subject to an error of about ± 0.6 mgal because these elevations could be in error by as much as ± 10 feet.

TOPOGRAPHY AND GENERAL GEOLOGY

The area of gravity coverage includes the Pine Nut Mountains bounding Smith Valley on the west. The West Walker River flows through Smith Valley entering the valley near Wellington. At the extreme north end of Smith Valley is Artesia Lake. Thermal springs are found at Nevada Hot Springs and elsewhere along the west side of Smith Valley. The Singatse Range, Buckskin Range, and Pine Grove Hills occupy the central part of the map, and the Wassuk Range and Cambridge Hills are on the eastern edge of the map. The Desert Mountains bound the northern edge of the map. The West Walker River cuts the Singatse Range, flows north through Mason Valley and swings around the northern Wassuk Range. The East Walker River joins the West Walker River south of Yerington.

The present topography is the result of faulting and erosion during late Tertiary and Quaternary time. With the exception of the Desert Mountains, the ranges in this map area are north-trending fault blocks, typical of the Basin and Range province. The Desert Mountains trend eastward and probably were formed by upwarping (Moore, 1969). North-south range-front faults generally flank the eastern fronts of the principal ranges, with displacements of up to several thousands of feet. Narrow flanking pediments locally pass laterally into the valleys, where not truncated by the range-front faults. The west sides of the Singatse and Wassuk Ranges are alluviated back slopes of westward-tilted blocks that probably are cut by many normal faults (Moore, 1969).

The oldest rocks in the Yerington area are metavolcanics and metasediments of Mesozoic age (Moore, 1969). These rocks generally occur as roof pendants surrounded by younger granitic rocks. Metavolcanic rocks are the more abundant within the map area and originally consisted mainly of andesite breccia, tuffs, flows, basalt, and rhyolite with interbedded sedimentary rocks (Moore, 1969). The metavolcanics are exposed in T. 15 N., R. 26 E. and T. 12 N., R. 26 E. and in the Buckskin and Singatse Ranges, and are generally of low to medium grade. Metasedimentary rocks, originally composed mainly of shale, siltstone, sandstone, and graywacke with some limestone, are exposed in T. 14 N., R. 26 E., and on the west slope of the Singatse Range. Intense metamorphism of these rocks adjacent to intrusive contacts is locally present (Knopf, 1918).

Cretaceous intrusive rocks are exposed throughout the Yerington area. These rocks vary in composition from granite to quartz monzonite, but are predominately granodiorite and quartz monzonite (Moore, 1969).

Tertiary volcanic and sedimentary rocks are widespread over the Yerington area. The rhyolite tuff of the Yerington area is widespread and considered to have been originally continuous with the Hartford Hill Rhyolite Tuff in its type locality near Silver City, Nev. (Moore, 1969). Younger andesitic rocks are exposed in the northern Singatse Range and the Cambridge Hills. Tertiary sedimentary rocks with interbedded tuffaceous rocks, lava flows, and breccias are exposed in T. 12 N., R. 26 E. and in the Pine Grove Hills.

Quaternary alluvium overlies both pre-Tertiary and Tertiary rocks, and may be several thousands of feet thick in the basins of the area.

Many normal faults displace the Mesozoic and Cenozoic rocks, which are in fault contact in several areas. The basin is separated from the ranges in part by normal faults or fault zones that trend northerly in a typical basin-and-range pattern. Major east-west structural features are noteworthy in the Buckskin, northern Singatse, and northern Wassuk Ranges.

The economic geology of the Yerington district and vicinity has been described by Knopf (1918), by Reeves, Shawe, and Kral (1958), and Moore (1969). The Anaconda Co.'s Yerington open-pit mine is a major producer of copper. Other copper production from the Singatse Range has been substantial. Iron ore is produced from The Standard Slag Co.'s open-pit mine in the Buckskin Range. Copper, gold, and tungsten mineralization has been noted throughout the district. A large tonnage of contact-metamorphic iron-copper mineralization was discovered southeast of Yerington in 1960 by Columbia-Geneva Steel Co.

ROCK DENSITIES AND INTERPRETATION

Various workers have presented data on densities of rock units in Nevada. Healey and Miller (1962) discussed the results of 500 bulk density determinations on rocks from the Nevada Test Site. They pointed out that the densities of Quaternary alluvium and Tertiary tuffaceous rocks are quite similar and may be grouped into one unit for interpretation purposes. Cook's (1965) determinations in eastern Nevada illustrate the variable density of the Tertiary rocks. Many sections of Tertiary rocks with considerable tuffaceous or vesicular material have quite a low composite density.

The density of Quaternary alluvium is difficult to measure, but an acceptable estimate to many workers is about 2.0 to 2.2 g per cm³. Because of the variable density of Tertiary rocks, a range of values is more valid. Light unwelded Tertiary tuffs may have a density of 1.4 to 1.6 g per cm³ whereas welded tuffs may have a density of 2.4 to 2.5 g per cm³. Andesites range from about 2.4 to 2.7 g per cm³, while basalts may range from 1.9 to 2.9 g per cm³, depending on whether they are vesicular or massive. Older pre-Tertiary rocks of the Yerington area are in general more dense than the Tertiary rocks. Cretaceous acidic to intermediate intrusives have densities of 2.7 to 2.9 g per cm³. Mesozoic metavolcanics were found to be quite dense; samples yielded densities of 2.9 to 3.0 g per cm³. Mesozoic metasedimentary rocks are estimated to be somewhat less dense, having a density of about 2.6 to 2.8 g per cm³. The density of the Mesozoic metamorphics depend to some extent on the degree of metamorphism.

The most obvious density contrast in the Yerington area is between pre-Tertiary and Tertiary rocks. A density of about 2.2 g per cm³ seems to be a reasonable estimate for the Tertiary-Quaternary sequence. Pre-Tertiary rock densities probably have a composite density of about 2.6 to 2.7 g per cm³. Consequently, for interpretation purposes it is assumed that the density contrast between these two major units is 0.5 g per cm³. Of course, local geological conditions have to be considered when an interpretation is made. Tabulated below are data on rock densities based on field samples in the Yerington area and composite data from other workers.

Rock Type	Density g per cm³
Quaternary Alluvium	2.0 - 2.2
Quaternary Volcanics (basalt, vesicular to massive.)	1.9 - 2.9
Tertiary:	
Tuff (unwelded to welded)	1.4 - 2.5
Andesite	2.4 - 2.7
Mesozoic:	
Intrusives (acidic to intermediate)	2.5 - 2.7
Metavolcanics	2.8 - 3.0
Metasediments	2.6 - 2.8

In general, several combinations of local density contrasts, hence local gravity anomalies, are possible. Pre-Tertiary rocks in contact with Quaternary-Tertiary rocks are the probable cause of the large local gravity lows that are coincident with the basins in Smith Valley and Mason Valley. These basins are underlain by the relatively low density Quaternary-Tertiary sequence which in turn overlies the more dense pre-Tertiary rocks. The basins are generally separated from the more dense rocks of the ranges by normal Tertiary and Quaternary range-front faulting. The presence of range-front faults is indicated by steep gravity gradients along the range fronts, whereas more gentle gradients probably indicate pediments and alluviated backslopes of fault-block ranges. Steeply dipping pre-Tertiary bedrock surfaces underlying Quaternary alluvium could also cause steep gravity gradients.

Thick sections of Tertiary volcanic or sedimentary rocks are associated with local gravity lows. Low density volcanics or sedimentary sections in contact with pre-Tertiary rocks causes gravity anomalies similar to alluvial filled basins. The rather high density Mesozoic metavolcanics particularly, may yield local gravity highs dependent somewhat on the degree of metamorphism. The same reasoning holds for intrusive rocks but probably on a more subtle basis.

Consequently, an approximation of the thickness of alluvial-filled valleys can be determined by gravity. The presence of pediments and range-front faults may also be determined with accompanying quantitative interpretations. Thicknesses of Tertiary volcanic and sedimentary sections may be approximated. Also the presence of Mesozoic metamorphics and intrusives may be determined under the proper geological conditions.

GRAVITY ANOMALIES

A gravity contour interval of 5 mgal was established. The contour magnitude is the simple Bouguer value referenced to the international gravity formula. Interpretation is primarily qualitative, although depth estimates were made using simple geometric forms or a two-dimensional graticule.

Four prominent anomalies are shown on the map. They are: (1) the northern Smith Valley low and the southern Smith Valley low, (2) the central and south Mason Valley lows, (3) a gravity high in T. 12 S., R. 26 E. of Mason Valley, and (4) two gravity lows in northern Mason Valley. In addition, there are embayments and areas of low gravity relief indicating pediments or areas of thin Tertiary cover. There also are three gravity lows in the Wassuk Range and Pine Grove Flat which are associated with Tertiary volcanics or sediments.

The determination of a regional trend in gravity is difficult because of local variation in rock densities, particularly the Mesozoic metamorphics. However, there is probably a regional increase northeastward which may be due in part to the uplifted Desert Mountains.

Smith Valley

The north-trending low extending over Smith Valley can be considered to be divided into a northern and southern low with a subtle saddle between them. The maximum relief of the two lows is about 20 to 25 mgals. Although the data is sparse a steep gravity gradient suggestive of normal faulting is indicated along the west side of the valley. The gradient would be steeper if the terrain correction were applied, since the gravity values would be increased for stations nearer the range. East of this fault there are about 3,000 to 3,500 feet of alluvial fill, assuming a density contrast of 0.5 g per cm³ between fill material and bedrock. The embayment northwest of Artesia Lake probably indicates a pediment or gradual thinning of the alluvial cover toward the range. Again the steepening gravity gradient out in the valley indicates normal faulting east of this embayment.

The southeasterly trending gravity nose extending from the Buckskin Range probably delineates a small pediment of Mesozoic metavolcanic rocks extending out towards the valley. The embayment between the Buckskin Range and the Singatse Range in T. 13 N., R. 24 E. probably results from the thinning of the Tertiary-Quaternary sequence northward. A rapid thickening of the Tertiary-Quaternary sequence towards the valley along the east side of Smith Valley at T. 12-13 N., R. 24 E. is indicated by the steep gradients. Local normal faulting may be involved here. The south-trending gravity nose in T. 12 N., R. 24 E. probably indicates a pediment of Cretaceous intrusive rock which extends out into the center of Smith Valley. The steep gradients which correlate with exposed fault evidence are probably caused by normal faults that cut into the pediment. There is a suggestion of a saddle between the north and south gravity lows that may represent the projection of the intrusive at depth. The northern gravity low may outline a graben structure complicating the westward-tilted Singatse Range fault block.

The embayment east of this pediment in T. 12 N., R. 24 E. can be interpreted as a northward thinning of the Quaternary-Tertiary sequence. The presence of Tertiary sedimentary rocks in the southeastern part of Smith Valley probably obscures the pre-Tertiary and Quaternary-Tertiary sequence density contrasts in that area.

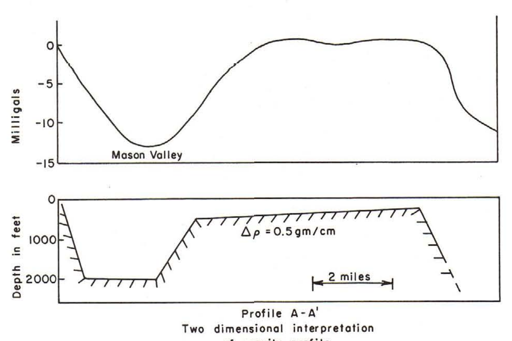
Mason Valley

A narrow north-trending gravity low extends northward from the southern edge of Mason Valley to the town of Yerington. Steep gravity gradients flank both sides of this anomaly south to the Cambridge Hills, where a thick section of the Quaternary-Tertiary sequence obscures the pre-Tertiary density contrast. A graben structure can be inferred from the gravity data for Mason Valley. Narrow pediments may be developed on the west flank of the Singatse Range, but are cut by range-front faults coincident with the steep gravity gradients.

The maximum relief of about 15 mgal in the northern part of the anomaly is probably caused by 2,000 to 2,500 feet of valley fill. The gravity relief increases southward to about 25-30 mgals, due either to thickening of the Quaternary-Tertiary sequence or to an increase in the density contrast. However, assuming a density contrast of 0.5 g per cm³ the low is probably due to 3,500 to 4,000 feet of Quaternary alluvium and Tertiary sedimentary rocks.

Just east of the Mason Valley low within T. 12-13 N., R. 26 E. are several anomalies of interest. A narrow north-south gravity high correlates with the exposed Cretaceous granite in the southwest corner of T. 12 N., R. 26 E. This is probably due to the more dense intrusive which probably extends south under the Tertiary cover in T. 11 N., R. 26 E. A gravity high correlates with outcrops of Cretaceous granite at Luhr Hill just east of Yerington.

Southeast of Luhr Hill in T. 12 N., R. 26 E. is a gravity high which overlies exposed Mesozoic metavolcanic and intrusive rocks, here partially concealed by Tertiary cover. With the delineation possible at this station spacing, the anomaly appears to be due to the dense Mesozoic metavolcanic (2.9-3.0 g per cm³) and Cretaceous intrusive rocks underlying the area. Known mineralization in this area also may contribute to this gravity anomaly. Immediately west of this high is a 5 mgal low which is probably caused by an alluvial basin with about 500 feet of valley fill. To the south of this gravity high (southwest corner T. 12 N., R. 26 E.) is a 15 mgal low which probably represents about 2,000 feet of Tertiary sediments. To the east (T. 12 N., R. 26 E.) a 10 to 15 mgal low in the Wassuk Range overlies Tertiary volcanics; this low is probably due to a volcanic pile including unwelded tuff with a thickness of 1,500 to 2,000 feet. An east-west profile (A-A') across Mason Valley and south of Luhr Hill through this area with an accompanying interpretation is shown below.



Profile A-A'
Two dimensional interpretation of gravity profile

North of Yerington in Mason Valley there are several prominent gravity lows. Immediately north of the Anaconda Copper pit in T. 13 N., R. 25 E. is a gravity low of 2 to 3 mgals magnitude. This probably is a basin containing about 500 feet of alluvial material.

The large gravity low northeast of Yerington in T. 14 N., R. 26 E. has a magnitude of about 10 mgals. This area is covered by a probable thickness of 1,500 feet of alluvial fill. Flanking this low to the northwest in the vicinity of Wabuska there is a circular low, probably caused by the presence of about 1,500 feet of low density material in an alluvial-filled basin. Separating these two lows is a northeast-trending high which correlates with the Cretaceous intrusive rock at Mason Butte (T. 14 N., R. 25 E.). The small gravity low to the southeast in T. 13 N., R. 26 E. is also separated from the central low by a subtle gravity high. These three gravity lows separated by northeast-trending highs form an interesting en echelon pattern. The lows are possibly down-dropped blocks that contain Tertiary sediments overlain by alluvium; the separating highs are probably thinly covered areas of Mesozoic rocks.

Other Anomalies

Some rather high bedrock gravity values are indicated in the northeastern part of the map. These values are associated with the northwest trending belt of Mesozoic metavolcanic rocks that have a density of about 3.0 g per cm³. Although the data are sparse, the few gravity points in the area indicate the extreme northeast Quaternary alluvium basin is associated with a gravity low.

The traverse along Churchill Canyon shows a correlation between pre-Tertiary and Tertiary rocks. Gravity values increase in the extreme northeastern end of the traverse, suggesting that the Tertiary cover is thin and overlies dense metamorphic rocks. A gravity increase is also associated with the Cretaceous intrusive in the northeast corner of T. 14 N., R. 23 E. The gravity pattern in Lincoln Flat suggests some thickening of the Tertiary in this area.

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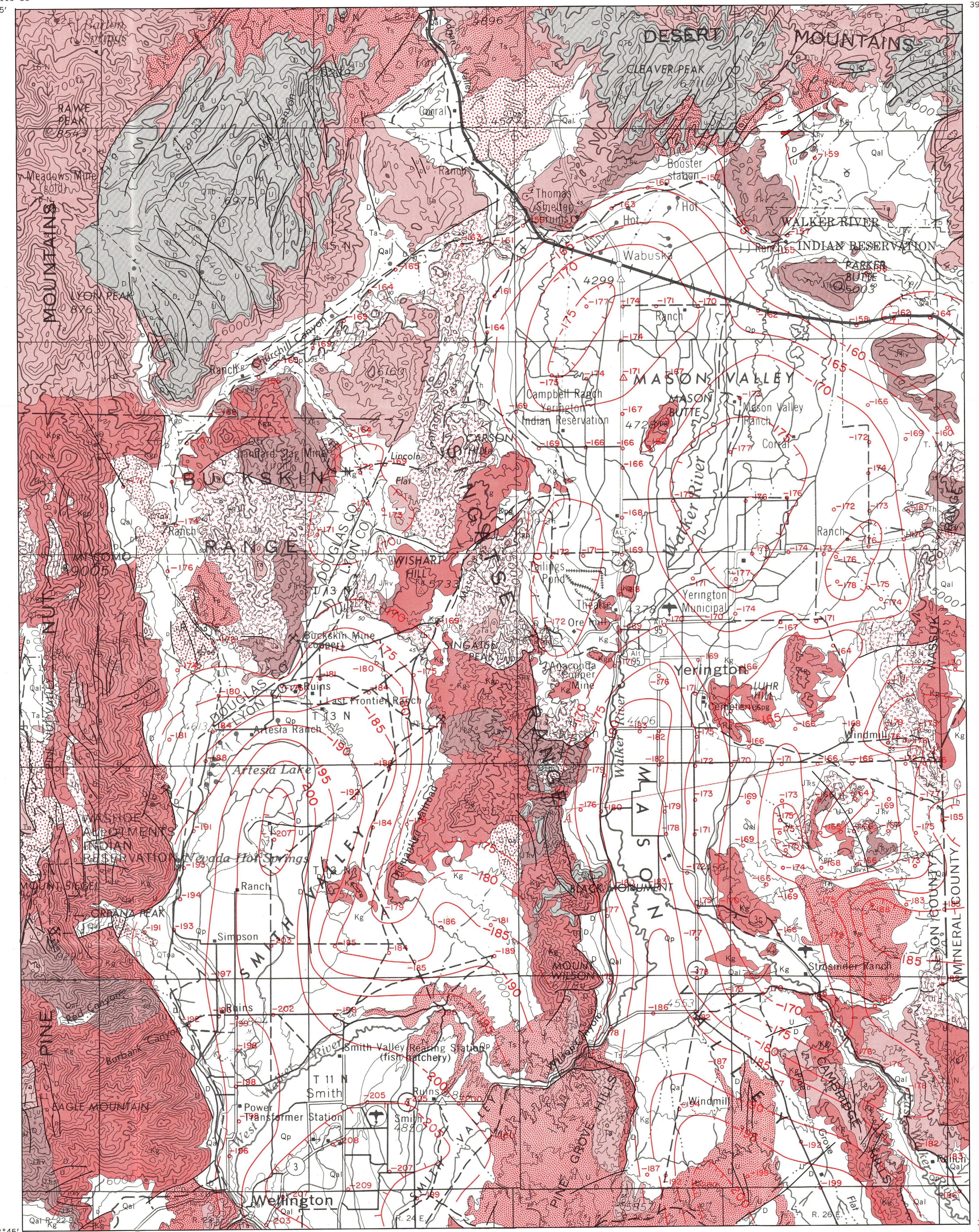

Topographic base enlarged and modified from U.S. Geological Survey 1:250,000 scale map, Reno (NJ-11-1) and Walker Lake (NJ-11-4) sheets.

SCALE 1:125,000

Geology after Moore (1969).

1970

EXPLANATION

QUATERNARY — Pleistocene and Recent

Qal | Qp

Alluvium

Qal, mainly alluvial fan gravel, stream-laid gravel, sand, and silt, some talus material, and dune sand

Qp, fine sand, silt, and clay of river flood plains, and playa clay and sand

TERTIARY AND QUATERNARY

QToa

Older alluvium

Predominantly fanglomerate and pediment gravel, but includes terrace gravel and late Pleistocene lake beds. Pediment gravel commonly caps poorly consolidated Tertiary sediments

TERTIARY OR QUATERNARY — Pliocene or Pleistocene

QTb

Basalt

Predominantly thin lava flows with interbeds of scoriaceous basalt breccia and diatomaceous sediments. Includes McClellan Peak and Lousetown Formations. In part younger than older alluvium

TERTIARY — Miocene or Pliocene

Ta

Andesitic rocks

Flow breccias, lava flows, and agglomerates with interbedded sediments. Locally includes basaltic and rhyolitic rocks. Includes Alta and Kate Peak Formations, and Chloropagus Formation of Axelrod (1956).

Ts

Sedimentary rocks

Lacustrine and fluvatile sediments. Sandstone, mudstone, shale, marl, diatomite, limestone, and calcareous tufa. Interbedded tuffaceous rocks, lava flows, and breccias. Includes Truckee Formation and Aldrich Station, Coal Valley, and Morgan Ranch Formations of Axelrod (1956)

Miocene

Th

Hartford Hill Rhyolite Tuff

Widespread biotite rhyolite pumice tuff-breccia and welded tuff. Welded, black, glassy basal layer is locally present

CRETACEOUS

Kgp | Kpg | Kg

Granitic rocks

Kgp, *granite porphyry*

Kpg, *porphyritic quartz monzonite*

Kg, *undivided, nonporphyritic quartz monzonite, granodiorite, and hybrid mafic rocks. In general, porphyritic quartz monzonite is younger than undivided granitic rocks and older than granite porphyry*

TRIASSIC AND JURASSIC

JTRs | JTRv

Metamorphic rocks

JTRs *Shale, slate, tuffaceous siltstone, sandstone, and graywacke largely derived from volcanic rocks. Interbeds of conglomerate, limy shale, limestone, dolomite, and gypsum*

JTRv *Andesite breccias, tuffs, and flows; basalt; and rhyolite; with interbedded volcanic-derived sedimentary rocks and limestones. Metamorphosed to greenschist or higher metamorphic facies*

Contact
Dashed where approximately located

U D
Fault, showing dip
Dashed where approximately located
U, *upthrown side;* D, *downthrown side*

60
Strike and dip of beds
Estimated when shown with no dip number

Strike of vertical beds

Hot Spring

-190
Gravity contours
Contour interval 5 millegals. Hachured contours indicate areas of low gravity closure. Dashed where data is incomplete.

Gravity stations

-182
U.S. Geological Survey elevation control and altimeter elevation control

Base station