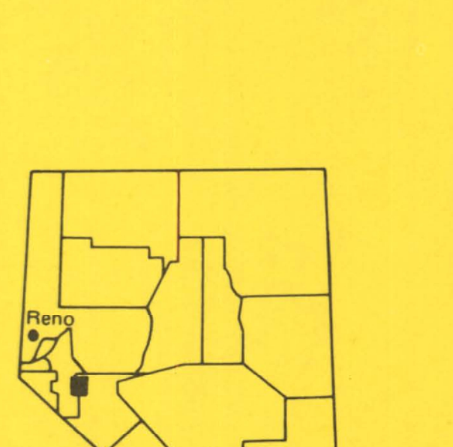
E. C. BINGLER

1978

GEOLOGIC MAP OF THE SCHURZ QUADRANGLE

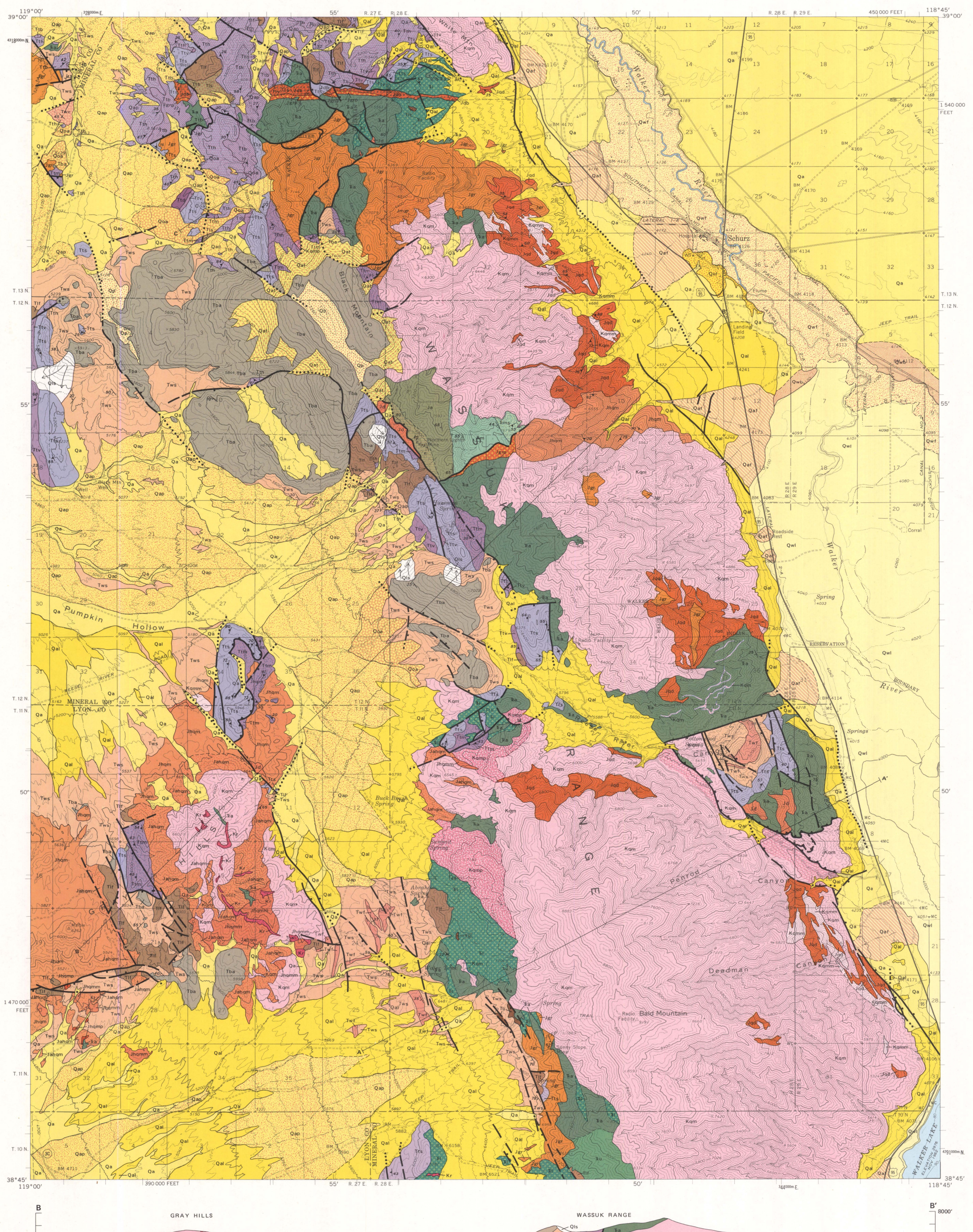
NEVADA BUREAU OF MINES
AND GEOLOGY

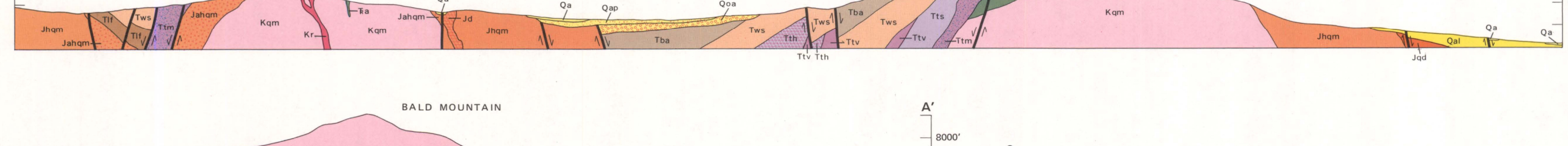
MAP 60

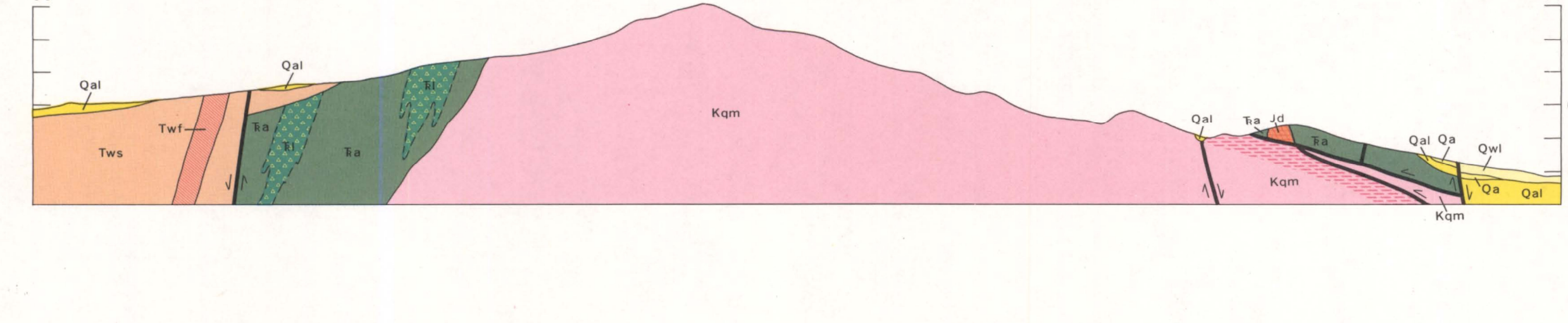


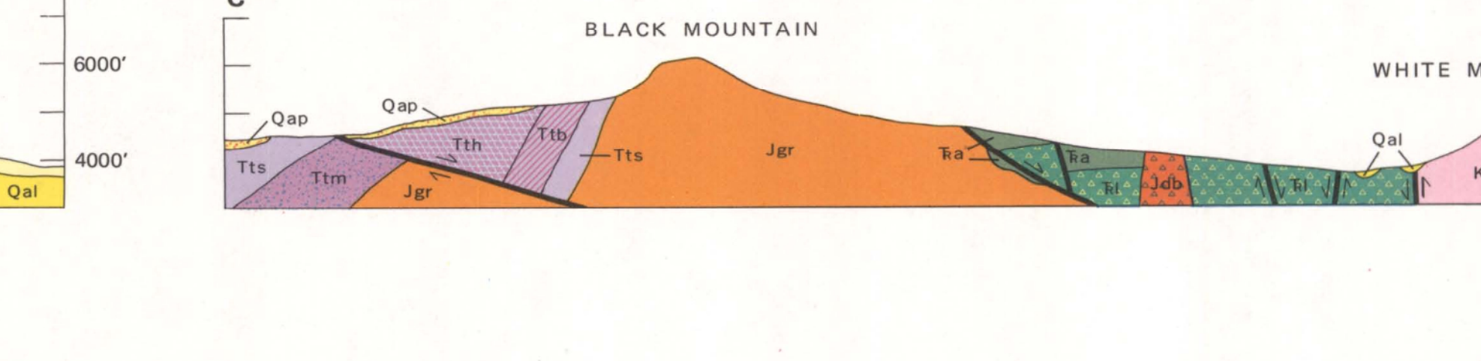
A 1:48,000-scale geologic map of the Schurz 15' quadrangle; cross sections; and text describing 47 geologic units, and structures.

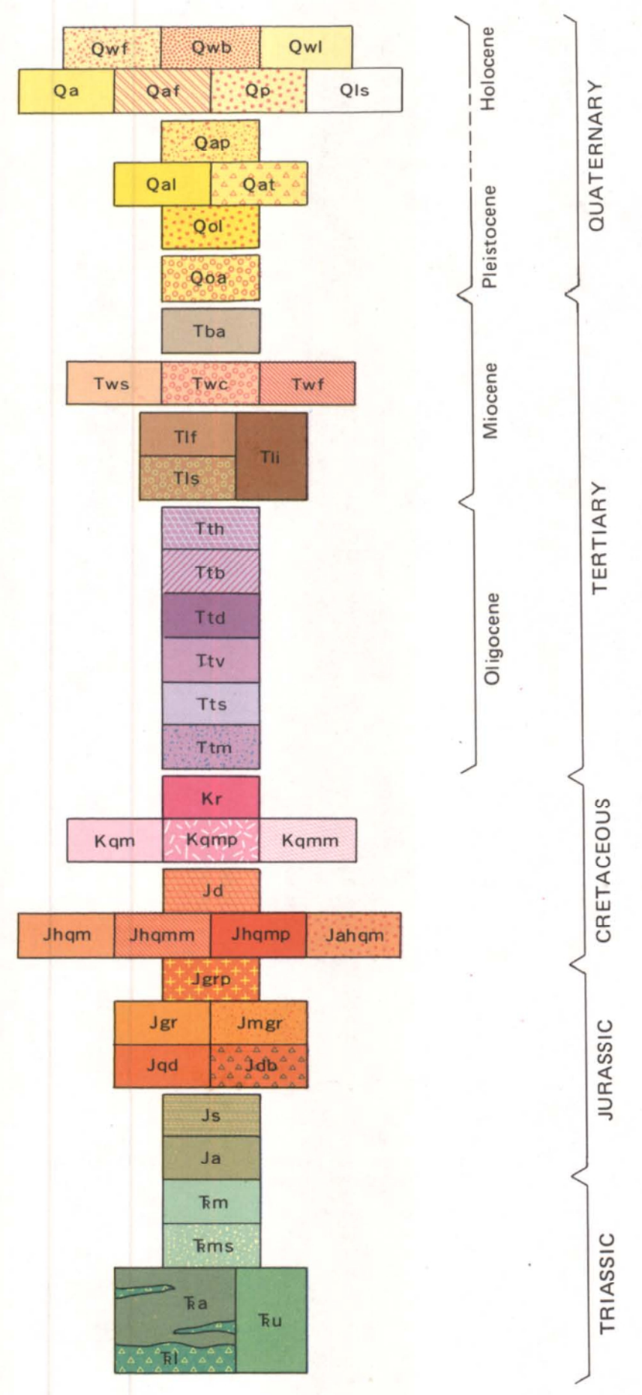
NEVADA BUREAU OF MINES AND GEOLOGY
UNIVERSITY OF NEVADA
RENO, NEVADA 89557
ORDER MAP NO. 60 – [redacted]

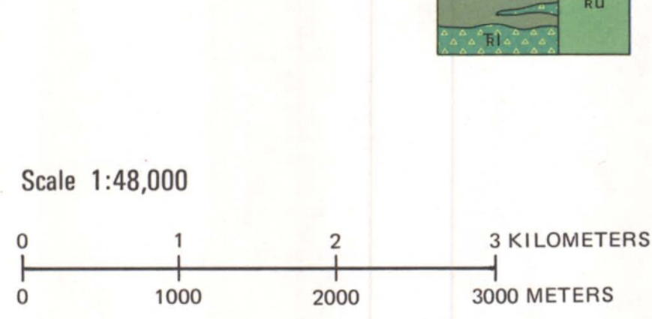












CONTOUR INTERVAL 80 FEET
DOTTED LINES ARE 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

Contact. Short dashes where transitional; dotted where concealed.

Fault. Long dashes where inferred or approximately located; Dotted where concealed. Ball on downthrown side.

25
Bedding.

35
Foliation. Schistosity in metamorphic rocks; compaction foliation in ash-flow tuffs.

Mylonite and breccia.

LITHOLOGY

Rocks and unconsolidated deposits exposed in the Schurz quadrangle range in age from Late Triassic to latest Holocene and include such diverse types as metamorphosed volcanic and sedimentary rocks, a wide variety of intrusive rocks that range in composition from quartz diorite to sodic quartz monzonite, andesitic to rhyolitic flow rock and ash-flow tuffs, and many types of Quaternary clastic rocks. Bedrock underlies about 40 percent of the quadrangle area and the majority of these bedrock exposures are Jurassic or Cretaceous intrusive rocks typical of the Sierran Province.

Quaternary Deposits

MIDDLE TO LATE QUATERNARY DEPOSITS

Unconsolidated and largely unweathered deposits in this age category include flood-plain alluvium (Qwf), beach (Qwb), and lacustrine (Qwl) deposits which together form the deposits of the Walker River system; landslide debris (Qls) in three small isolated areas; minor playa deposits (Qp); and sediment (Qap), alluvial-fan (Qaf), and undifferentiated alluvial deposits, all of which formed as a vast apron of generally thin but laterally continuous fan-bajada-pediment complexes marginal to the bedrock highs in the Wassuk Range and Gray Hills.

Qwf Qwb Qwl **Deposits of the Walker River system. Qwf:** Flood-plain alluvium. Gray to lavender-tan moderately well-sorted fine sandy to clayey silt and fine sand, formed as channel and over-bank deposits, comprise the late Holocene to modern flood plain of the Walker River. **Qwb:** Pale yellowish-tan, well-sorted, fine pebbly to coarse arkosic, well-rounded beach sand deposited during an intermediate late Holocene stand of Walker Lake at approximately 4120 feet. This deposit is a relic beach–beach-ridge complex and its position is related to wave action generated by late Holocene prevailing southwesterly winds. **Qwl:** Thin recessional littoral lacustrine deposits of light grayish-tan, well-sorted, medium to fine arkosic sand and silty sand. Includes calcareous tufa rinds on bouldery alluvial-fan deposits and prominent strand-line beach gravel deposits along the eastern front of the Wassuk Range.

Qls **Landslide deposits.** Small block slides of basaltic andesite (Tba) and fine-grained, weakly consolidated Tertiary sediment (Tws) locally formed where flows overlie the structurally weak sediment and erosion has removed lateral support.

Qp **Playa deposits.** Local accumulations of grayish-white to pale brownish-white, clayey silt in small, structurally controlled, closed depressions.

Qaf **Alluvial-fan deposits.** Unconsolidated, poorly sorted, bouldery and sandy cobble to pebble gravel in small fans along the eastern front of the Wassuk Range. Composed of angular to subrounded fragments of plutonic and metavolcanic bedrock types. Poorly bedded and unweathered. Fan surfaces are generally littered with large angular boulders. These deposits grade laterally at the distal margin of the fans into finer-grained sandy, gravelly alluvial-plain deposits (Qa).

Qa **Alluvial-plain and undifferentiated alluvial deposits.** Unconsolidated, unweathered to weakly weathered, poorly sorted, pebble to cobble, muddy-sandy gravel in late Holocene to modern channels and washes or forming broad low-gradient alluvial plains.

Qap **Pediment deposits.** Poorly sorted, bouldery and muddy, uncemented gravel in slightly eroded, thin pediment veneers deposited on bedrock and older alluvial deposits, and underlying broad low-gradient surfaces along the western flank of the Wassuk Range. Weakly weathered upper surface is marked by incipient to weakly developed desert pavement composed largely of pebble-size clasts with slight desert varnish.

EARLY TO MIDDLE QUATERNARY DEPOSITS

Unconsolidated, moderately to strongly weathered, alluvial, lacustrine(?), and colluvial deposits that unconformably overlie all Tertiary and older rocks. Most of these deposits are moderately to deeply eroded and largely buried under thin deposits of Holocene alluvium.

Qal **Alluvial-fan and bajada deposits.** Uncemented to weakly cemented, poorly sorted, tan to gray-brown, bouldery, muddy-sandy cobble to pebble gravel composed of subangular clasts of resistant volcanic, plutonic, and metamorphic bedrock types. Deposits from a few meters to several hundred meters thick form slightly to deeply eroded alluvial-fan and bajada complexes flanking the Wassuk Range. The upper constructional surfaces on these deposits are weakly to moderately weathered and marked by distinct desert pavement.

Qat **Talus deposits.** Extensive thin deposits of bouldery, stabilized talus sheets and cones of angular basaltic andesite fragments mantling the summit of Black Mountain. These deposits form distinctive stone stripes on the west flank of Black Mountain; similar stripes at the Reese River Canyon divide are not shown separately on the map.

Qol **Older fluvial-lacustrine deposits.** Thin- to medium-bedded, pale purplish-brown to very light-tan, well-sorted, sandy to pebbly silt interbedded locally with gray, poorly sorted, pebbly to cobbly coarse arkosic sand and sandy pebble gravel. Two miles north-northwest of Schurz, similar beds exposed in bluffs forming the east margin of the Walker River flood plain consist of grayish- to brownish-white well-sorted sandy silt and minor intercalated lenses of pebble gravel.

Qoa **Older alluvial-fan deposits.** Extensively eroded and deeply weathered alluvial-fan remnants. Western flank of Reese River Canyon divide: Bouldery and sandy, very poorly sorted cobble gravel composed principally of subangular to subrounded clasts of basaltic andesite and lesser metavolcanic rock types set in a grayish-tan to reddish-brown muddy-sandy matrix. Well-developed calcium carbonate caliche forms prominent rinds on clasts and a nodular caliche horizon about 0.5 m below the upper boulder-strewn surface. Northwest of Black Mountain: Uncemented, poorly sorted, bouldery cobble to coarse pebble gravel. Most clasts are angular to subangular fragments of basement intrusive and metavolcanic rocks. Well-developed nodular caliche horizon.

Tertiary Rocks

MIOCENE VOLCANIC AND SEDIMENTARY ROCKS

Tertiary rocks exposed in the Schurz quadrangle are dominantly of volcanic origin and are subdivided into five groups based on relative stratigraphic position, mode of origin, and overall composition. Silicic ash-flow tuffs form the oldest group and everywhere rest unconformably on Mesozoic plutonic or metavolcanic rocks. These ash flows range in age from 28 to 22 m.y. (Oligocene to Miocene) and are part of a similar sequence of siliceous calc-alkaline tuffs exposed throughout much of central western Nevada. The ash-flow tuff sequence is unconformably overlain by a thin, 14 m.y. old succession of hornblende latite flows and very locally deposited fine-grained volcaniclastic sediments. A third group of rocks consisting of fine to coarse volcaniclastic sediments and minor andesitic flows (Wassuk Group) formed about 12 million years ago as local basin-fill deposits. The youngest group of Tertiary rocks are 8 m.y. old basaltic andesite flows that formed a widespread veneer over the Wassuk Group sediments, but are now exposed only in isolated remnants along the western flank of the Wassuk Range and in the Gray Hills.

Tba **Basaltic andesite flows.** Extensive exposures of homogeneous, rubbly-weathering flows of medium- to dark-gray, fine-grained sparsely porphyritic, hornblende-bearing basaltic andesite underlie the summit of Black Mountain and the Reese River Canyon divide; isolated remnants of thin flows ((10 m thick) of similar composition are exposed along the south flank of the Gray Hills. The basaltic andesite consists of 60 to 80 percent microphenocrysts of stubby subhedral laths of andesine (0.1–1 mm), 10 percent equant augite crystals, and a trace of olivine set in an extremely fine-grained matrix of brown glass, augite needles, plagioclase microlites, and opaque iron minerals. Nearly all samples contain from 1 to 5 percent resorbed phenocrysts of green-brown hornblende up to 0.5 cm long. The chemical composition of two typical samples is given in columns 1 and 2 of the table. Major element percentages are very similar to average andesite cited by Nockolds (1954). Nearly all outcrops exhibit surface weathering that forms a dull gray-brown to brownish-black varnish. Some joint surfaces on outcrops at the Reese River Canyon divide display characteristic gray-white opaline silica films and selvages a few millimeters thick presumably deposited from late stage exhalations accompanying final cooling of the flows. K-Ar age determinations on whole rock and plagioclase samples of fresh basaltic andesite yielded Miocene ages of 7.3 ± 0.4 m.y. and 9.7 ± 7.5 m.y., respectively. The very large analytical uncertainty of the second date is the result of high atmospheric argon in the plagioclase.

Tws Twc Twf **Wassuk Group.** Thin-bedded pale-gray to pale greenish-gray and pinkish-gray, tuffaceous and diatomaceous, weakly cemented fine silty sandstone to sandy siltstone (Tws). Locally includes cross-bedded horizons, very thin ((2 cm) discontinuous beds of reworked 1–2 cm white tuff fragments, discontinuous thin beds of poorly sorted pebble conglomerate transitional laterally and vertically into fine sandstone, and rare boulder beds containing clasts greater than 1 m diameter. Near the mouth of Reese River Canyon, and in the broad saddle between the Wassuk Range and the Gray Hills, these sedimentary rocks are interbedded with thin mafic flows and flow breccias of gray to gray-black plagioclase andesite to olivine basalt (Twf) and locally intruded by small dikes of similar composition. A fresh sample of porphyritic olivine basalt interbedded with volcanic sandstone (Tws) collected from the C S/2 NE/4 S24,R27E,T11N yielded a K-Ar age of 13.7 ± 2.2 m.y. on plagioclase. This is in good agreement with ages of older andesite flows and dikes in the Wassuk Group reported by Gilbert and Reynolds (1973). In the northwest corner of the map area sedimentary rocks of this group (Twc) consist of well-bedded, poorly to strongly cemented, pale reddish- to yellowish-brown, sandy pebble to cobble conglomerate and pebbly sandstone containing highly rounded clasts of white quartz, metavolcanic rocks, and Tertiary tuff and flow rock. Locally contains minor very thin interbeds of sandy oolitic freshwater limestone.

Tlf Tli Tls **Hornblende latite volcanic rocks. Tlf:** Thin flows and minor flow breccia of very pale pinkish- to bluish-gray, very fine-grained, porphyritic hornblende latite. Rock weathers a characteristic pale orangish brown; fresh surfaces display small (1–3 mm long) laths of oxidized remnants of hornblende needles, rare small plagioclase phenocrysts, and sparse clots (2–3 mm long) of fine-grained cristobalite. In thin section, pseudomorphous aggregates of extremely fine-grained opaque iron oxide and pyroxene granules rim and largely replace hornblende phenocrysts set in a trachytic matrix of subhedral sodic plagioclase (Ab$_{60-70}$) laths ((0.1 mm) and dustlike alkali feldspar. Aggregates of anhedral cristobalite fill small veinlets and vugs in the rock. Shown in column 3 of the table is a partial chemical analysis of typical samples of the hornblende latite flow rock. Erosional remnants of thick (20–50 m) accumulations of homogeneous latite flows are exposed in fault blocks west of White Mountain, near the Northern Lights Mine, in the central part of the Gray Hills, and along the southwest flank of Bald Mountain. The flows rest unconformably on Oligocene–Miocene ash-flow tuffs or Mesozoic rocks, and disconformably underlie basal sedimentary beds of the Wassuk Group. **Tli:** Small feeder dikes and plugs of fresh, medium-gray, fine-grained hornblende latite porphyry. Typical rock is texturally and compositionally similar to related flows (Tlf) except that hornblende phenocrysts are fresh and exhibit no reaction rims. Only the larger intrusive masses are shown on the map, but many small masses intrude the Tertiary ash flows and Mesozoic rocks; these are most common along the contact between the older basement rocks and the ash-flow tuff sequence. Hornblende separated from samples of a small plug (NW/4 SW/4 SE/4 S13, T13N,R27E) yielded a K-Ar age of 13.9 ± 0.4 m.y. or middle Miocene. This date is consistent with field evidence for widespread erosion following eruption of the last of the early Miocene ash-flow tuffs within the quadrangle. **Tls:** Local accumulation several tens of meters thick of medium greenish-brown, very poorly sorted and weakly lithified andesitic volcaniclastic sediment consisting of mudflow breccia, clayey sand, and muddy gravel containing angular clasts of latite, rhyolite, and fine-grained andesite. Unconformably overlies the uppermost tuffs of the Hu-Pwi Rhyodacite and disconformably underlies hornblende latite flows. Present only northwest of Black Mountain.

OLIGOCENE AND MIOCENE ASH-FLOW TUFFS

Silicic calc-alkaline ash-flow tuffs ranging in composition from rhyolite to rhyodacite and in age from 28 to approximately 23 m.y. are subdivided and mapped as 4 formations and two informal rock-stratigraphic units. These rocks form a distinctive and very widespread sequence that intervenes between Mesozoic plutonic and metamorphic basement rocks and the middle Miocene and younger dominantly andesitic volcanic and volcaniclastic rocks associated with early Basin-and-Range volcanism.

Tth **Hu-Pwi Rhyodacite.** Over 300 meters of reddish to orangish brown-weathering, gray augite rhyodacite crystal-rich ash-flow tuff, minor flow rocks and agglomerate, and tuffaceous sediment which is correlated with the Hu-Pwi Rhyodacite named in the Gillis Range (Ekren and others, 1978). Basal sequence about 10 m thick exposed north of Black Mountain and west of White Mountain includes gray-brown, well-indurated, poorly sorted pebbly sandstone and tuffaceous sandstone. These sediments are overlain by a distinctive interval, 0 to 15 m thick, of gray-black, flow-banded augite rhyodacite vitrophyre agglomerate and breccia containing angular to rounded, cobble- to boulder-size clasts of flow-banded vitrophyre in a medium-gray, glassy to partially devitrified matrix. Vitrophyre agglomerate grades upward into dense and flinty, locally flow-banded gray- to brownish-gray devitrified augite rhyodacite flows(?) with a total thickness of 10 to 20 m. Most of the formation throughout the map area is a compound cooling unit of devitrified, moderately to densely welded, medium- to coarse-grained biotite-augite rhyodacite crystal tuff, composed of gray-white, glassy plagioclase tablets (2–5 mm), subhedral to euhedral biotite books (2–3 mm), and stubby prisms of dark- to light-green diopsidic augite set in a crystallized and mottled matrix of yellowish-white to gray to lavender fine ash. In most exposures the tuff is crumbly- to powdery-weathering and the augite phenocrysts are partially to completely altered to a fine-grained clay aggregate. In the lower part of the tuff sequence, slightly flattened grayish-purple pumice lapilli and lava fragments make up about 1 percent of the rock. In thin section typical augite rhyodacite ash-flow tuff is vitroclastic and consists of about 50 percent plagioclase crystals, 5 to 10 percent combined biotite and augite, plus a trace of green-brown hornblende set in a devitrified matrix (generally spherulitic) of fine-grained moderately to strongly deformed shards. Plagioclase phenocrysts include intact euhedral, complexly twinned and discontinuously zoned sodic andesine and many smaller broken fragments of similar type. The total population of plagioclase grains ranges in size from greater than 7 mm to less than 0.01 mm in diameter.

Chemical composition of typical devitrified tuff is shown in column 4 of the table. The oxide values are similar to rhyodacite (Nockolds, 1954) except for the anomalously high K_2O which may be the result of local alteration. An analysis of pumice from this same formation by Proffett and Proffett (1976, p. 18) is very similar to dacite. K-Ar age determination on biotite separated from two samples of the Hu-Pwi Rhyodacite yielded dates of 25.2 ± 1.0 and 22.0 ± 0.5 m.y. The average of these two samples is close to the 23.1 m.y. average of six dates reported for the Hu-Pwi Rhyodacite by Proffett and Proffett (1976) and Ekren and others (1978).

Ttb **Blue Sphinx Tuff.** A relatively thin sequence of nonwelded, largely crystallized, fine-grained rhyolite crystal-vitric tuffs exposed in the northwest quarter of the Schurz quadrangle where it intervenes between the Hu-Pwi Rhyodacite and a thin interval of undifferentiated vitric tuffs, is tentatively correlated with the Blue Sphinx Tuff named in the Gabbs Valley Range (Ekren and others, 1978).

The Blue Sphinx Tuff in the northern Wassuk Range consists of an upper part several tens of meters thick made up of lithic-rich lapilli tuff containing from 10 to 50 percent undeformed gray-white pumice (2–3 cm long) and about 10 percent dark-colored felsite lithic fragments set in a fine- to medium-grained pale gray-brown to pinkish-brown matrix of crystal fragments (20–30 percent) and unflattened glass shards. Phenocrysts include from a few to 10 percent quartz, 5 to 10 percent sodic plagioclase, 12 percent sanidine, a few percent reddish-brown biotite, and a trace of hornblende; the matrix of these ash flows is generally glassy to partially devitrified. The pumice-rich, hornblende-bearing ash flows included here in the upper part of the Blue Sphinx Tuff disconformably overlie a locally thick (nearly 100 m) sequence of fine-grained, dense, pumice-poor, highly crystallized, pale gray-white, pale-lavender, and reddish-white rhyolite crystal-vitric tuffs which comprise the bulk of the Blue Sphinx. These rocks are composed of about 30 percent phenocrysts, principally small ((2 mm) broken crystal fragments in a ratio of 3:2:1 sanidine:plagioclase:quartz, set in a crystallized ash matrix. The unusually dense and indurated character of these tuffs is the result of pervasive vapor-phase crystallization that converted the glass matrix to a fine-grained felsitic aggregate of anhedral tridymite and alkali feldspar.

All of the rhyolitic ash-flow tuffs included in the Blue Sphinx contain very distinctive and characteristic ovoid phenocrysts of "sieve-textured" vermicular quartz that owe their texture to the presence of amoeboid inclusion of devitrified glass. Most of these grains are rounded and display circular or oval cross-sections on broken rock surfaces; average diameter of these quartz phenocrysts is 3–5 mm. Most of the vermicular phenocrysts are single crystals, but in some samples composite quartz grains with straight-line contacts and different optic orientation comprise a single phenocryst.

The age of the Blue Sphinx Tuff is approximately 25 m.y. or latest Oligocene based on its stratigraphic position beneath the Hu-Pwi Rhyodacite (23 m.y.) and above the tuff of Gabbs Valley (25.5 m.y.) (Ekren and others, 1978).

Ttd **Dacite crystal tuff.** A simple cooling unit of biotite dacite crystal-vitric tuff with an exposed thickness of about 100 m forms a small northeast-trending ridge approximately 2 miles northwest of Black Mountain. The tuff is disconformable on a thin cooling unit of vitric tuff (Ttv) and appears to be overlain by ash-flow tuff of the Hu-Pwi Rhyodacite although the contact area is completely covered by pediment gravel. The non-welded base of the cooling unit rests on a thin ((2 m) boulder to cobble gravel containing conspicuous red oxidized boulders of Singatse Tuff and the immediately underlying vitric tuff. A few meters above the base the tuff grades into a thin and discontinuous dark purplish-brown devitrified tuff containing sparse, nearly black fiamme of weakly flattened pumice 2 to 5 cm long and about 1 cm thick. All of the tuff above this zone is devitrified, light lavender-tan to yellowish-white crystal-rich tuff made up of 30 to 40 percent gray, glassy, subhedral to euhedral, plagioclase tablets or fragments (up to 6 mm, average 3 mm) and 5 to 10 percent black biotite crystals a few millimeters in diameter set in a fine-grained, weakly welded-ash matrix.

Biotite dacite tuff was not found elsewhere in the Schurz quadrangle but erosional remnants of identical tuff have been mapped in the Virginia Range a few miles north of Carson City, Nevada (Bingler, 1977; 1978) and east of Walker Lake in the Gillis Range (R. Hardyman, 1976, oral commun.). In the Gillis Range 20 m-thick biotite dacite crystal tuff is interlayered with thin vitric cooling units and overlain by the Blue Sphinx Tuff. Based on its stratigraphic position the dacite tuff is about 25 m.y. old.

Ttv **Vitric tuff, undifferentiated.** Thin ash-flow cooling units of pale-gray, purplish-white, pale-orange, and light pinkish-red, crystal-poor, rhyolite to quartz latite vitric tuff and minor interbedded tuffaceous sediment that disconformably overlie the Singatse Tuff and are overlain by the Blue Sphinx Tuff, the Hu-Pwi Rhyodacite, or by the biotite dacite tuff. Most of the vitric tuffs are non-welded, devitrified, fine-grained, shard tuffs containing a few percent small (1–2 cm) white pumice lapilli and less than 5 percent phenocrysts of sanidine, sodic plagioclase, and quartz (3:2:1) and a trace of biotite. Average grain size of the phenocrysts is about 1 mm. Some exposures of vitric tuff are a distinctive medium-gray color, contain 5 to 10 percent prominent white pumice lapilli in random orientation, and are entirely glassy. Exposures of pumice-rich devitrified and densely welded vitric tuff beneath biotite dacite tuff northwest of Black Mountain are typical of one of the lower ash flows in the vitric tuff map unit. This cooling unit contains highly flattened to stretched pumice fragments with length-width ratios approaching 20 to 1. Very similar distinctive highly welded vitric tuff is present in the Gillis Range (R. Hardyman, 1976, oral commun.) and in the Carson City area where it has been recently named the Nine Hill Tuff (Bingler, 1978).

Undifferentiated vitric tuffs in the Wassuk Range include ash flows correlative with the Bluestone Mine Tuff (Proffett and Proffett, 1976), the tuff of Gabbs Valley (Ekren and others, 1978), and the Nine Hill and Eureka Canyon Tuffs (Bingler, 1977). No age determinations were made on these vitric tuffs in the Schurz quadrangle, but dates of 25.0 ± 1 and 26.1 ± 0.8 m.y. obtained by Ekren and others (1978) on sanidine from the tuff of Gabbs Valley and 26.1 ± 0.2 m.y. on sanidine in the Eureka Canyon Tuff (Bingler and others, 1978), establish the late Oligocene age of the equivalent vitric tuff in the Wassuk Range.

Tts **Singatse Tuff.** The Singatse Tuff is a distinctive, coarse-grained, hornblende-biotite quartz latite crystal tuff named for exposures on Singatse Peak (Proffett and Proffett, 1976, p. 19). This tuff is the most widely exposed cooling unit of the Oligocene–Miocene ash-flow sequence in the Wassuk Range, where it forms bold, rubbly- to blocky-weathering ridges flanking the basement rock core of the range. The thickest and best exposed sections of the Singatse Tuff are northwest of Black Mountain, north of Black Mountain Well, and at Hussman Spring; maximum exposed thickness is about 700 m. In the northern, southern, and east-central part of the quadrangle the Singatse Tuff rests disconformably on Mesozoic rocks, whereas in the central and west-central areas of the map it rests on the Mickey Pass Tuff. Where the Singatse Tuff disconformably overlies the Mickey Pass, the contact is generally marked by thin pebble beds and light-gray to white opalized wood fragments indicative of forestation of the land surface just prior to eruption of the first ash flows of the Singatse Tuff.

In the Wassuk Range the Singatse Tuff is a multiple ash flow, compound cooling unit made up of a basal, generally glassy and lithic-rich, horizon several tens of meters thick transitional upward into dense devitrified tuff that comprises the bulk of the map unit, and an uppermost bleached and crystallized vapor-phase zone from zero to about 15 m thick. A partial cooling break marked by changes in the degree of devitrification and a break in slope in ridge profile occurs locally above the lowermost lithic-rich horizon. The lower lithic-rich zone consists of light-gray to medium pinkish-gray, brown to red brown-weathering, coarse-grained, moderately welded crystal tuff containing 10 to 15 percent pebble-size accidental lithic fragments and a few percent moderately flattened black glassy fiamme up to a few centimeters long. Phenocrysts, ranging from extremely small fragments up to individual crystals more than 0.5 cm in diameter, include 20 to 25 percent plagioclase, 15 to 20 percent sanidine, 3 to 5 percent quartz, 5 percent biotite, and a few percent hornblende. Most of the Singatse Tuff is medium-gray to dark grayish-lavender, brown-weathering, devitrified slightly to moderately welded hornblende quartz latite crystal tuff. Large (up to 0.5 cm) yellow-stained (limonite) quartz and "parallel fracturing" sanidine are distinctive phenocrysts in hand specimen; coarse very fresh, black biotite flakes and stubby greenish-black hornblende prisms are characteristic and helpful in identifying the Singatse Tuff in the field. The phenocryst population includes 10 to 12 percent quartz, 25 percent plagioclase, 10 percent sanidine and about 8 percent biotite plus hornblende. In thin section, the rock displays prominent vitroclastic texture and is crowded with broken fragments of plagioclase, quartz, and sanidine. Crystals of euhedral plagioclase range up to 5 mm in maximum dimension; large quartz and sanidine grains are generally highly fractured. Reddish-brown biotite and green-brown hornblende are slightly to pervasively oxidized and rimmed with fine-grained aggregates of opaque iron oxide granules and chlorite. The matrix is composed of fine-grained moderately deformed shards and submicroscopic dust thoroughly devitrified to very fine-grained felty aggregates of alkali feldspar and cristobalite(?).

A chemical analysis of devitrified but otherwise unaltered Singatse Tuff is given in column 5 of the table. Values of individual oxides compare closely with those of average quartz latite (dellenite) cited by Nockolds (1954). This analysis is also very similar to analyses of Singatse Tuff listed by Proffett and Proffett (1976) for rock from the type section except that the sample from the Wassuk Range has slightly higher silica and lower lime and magnesia. K-Ar age determinations on biotite and hornblende yielded concordant ages of 25.9 ± 0.8 and 25.6 ± 0.8 m.y. respectively that clearly establish the late Oligocene age of the Singatse Tuff.

Ttm **Mickey Pass Tuff.** A locally very thick accumulation of crystal-rich ash-flow tuff ranging in composition from rhyodacite to rhyolite that rests on Mesozoic basement rocks and is disconformably overlain by the Singatse Tuff was described in the Singatse Range (Yerington Mining district) and named the Mickey Pass Tuff (Proffett and Proffett, 1976, p. 8). Subsequent to its naming, exposures of the Mickey Pass have been mapped as far north and west as the Virginia City area (Bingler, 1977) and as far east and south as the Gabbs Valley Range (Ekren and others, 1978). Thick sections of Mickey Pass Tuff are exposed in the Wassuk Range from north of Black Mountain south to Hussman Spring and in the central and northern parts of the Gray Hills. Rapid lateral thickness changes from more than 400 m to zero where the Mickey Pass thins against basement highs indicate that the ash flows of the Mickey Pass filled topographic lows on the middle Oligocene basement surface in and around the Wassuk Range in much the same way as in the Singatse Range (Proffett and Proffett, 1976, p. 7). Exposures of the Mickey Pass Tuff at the northwest margin of Black Mountain are typical of the formation throughout the quadrangle and are the basis for the description below.

The Mickey Pass Tuff is a multiple ash flow, composite sheet of light pinkish-red to medium reddish-brown, pumiceous, largely devitrified, coarse-grained vitric-crystal tuff composed of subhedral to euhedral phenocrysts of sanidine (15 percent), quartz (10 percent), sodic plagioclase (5 percent), and a trace of biotite all set in a fine-grained matrix of moderately to strongly deformed devitrified glass shards. Compacted white pumice lapilli are conspicuous throughout the formation and range from a trace near the base of the ash-flow sheet to more than 25 percent of the rock near the top of the unit; most of the cooling units in the Mickey Pass contain 5 to 10 percent pumice. A few percent of small-pebble size, angular dark-red felsite fragments are scattered throughout the tuff near the base of the sheet. Dense, glassy, crystal-rich black rhyodacite vitrophyre is characteristic of the basal few meters of the Mickey Pass Tuff and in addition to the essential quartz, plagioclase, and sanidine phenocrysts, it contains trace amounts of green-brown hornblende and dark-green hypersthene. Total phenocryst content, percentage of quartz, and the sanidine: plagioclase ratio all increase regularly upward through the ash-flow sheet. The upper part of the Mickey Pass contains abundant subhedral, partially amoeboid and vermicular, pale rose-colored equant quartz phenocrysts that impart a distinctive, somewhat "graphic" texture to the tuff in hand specimen.

Chemical analyses for the basal and uppermost part of the Mickey Pass Tuff reproduced from Proffett and Proffett (1976, table 2) are shown in columns 6 and 7 in the table. These analyses document the upward change in composition from rhyodacite (col. 6) to rhyolite (col. 7) typical of the Mickey Pass. K-Ar age dates on biotite, sanidine, and plagioclase (Bingler, 1978; Ekren and others, 1978; Proffett and Proffett, 1976) indicate that ash flows comprising this sheet were erupted during the late Oligocene from 28 to 26 m.y. ago.

Mesozoic Rocks

INTRUSIVE ROCKS

Plutonic and hypabyssal crystalline rocks ranging in age from Middle Jurassic(?) to Late Cretaceous are exposed over 20 to 30 percent of the area of the Schurz quadrangle and form the core of all the principal mountain masses. These rocks range in composition from quartz diorite to sodic quartz monzonite; progressively younger intrusives are increasingly more granitic and present in greater volume. This sequence of rocks is divided into four major groups of rocks of distinctive chemical and modal composition. The first group, the oldest recognizable intrusive activity, is made up entirely of hornblende quartz diorite which is locally metamorphosed to amphibolite. The second group of probably Middle to Late Jurassic age is principally equigranular and medium-grained granodiorite but also includes distinctive hypabyssal porphyritic granodiorite and locally more mafic hybrid rocks. The third group is largely restricted to the Gray Hills and is made up of coarse-grained, locally porphyritic hornblende-biotite quartz monzonite and local mafic varients. The youngest and most areally extensive group of intrusives is composed of leucocratic and sodic biotite quartz monzonite stocks and related hypabyssal porphyry phases, and fine-grained porphyry dikes.

Kr **Rhyolite porphyry dikes.** Thin, discontinuously exposed dikes of bright-white rhyolite porphyry form an arcuate, north-northwest-trending trace across the central part of the Gray Hills. These dikes, which range in thickness from less than a meter up to several tens of meters thick, intrude biotite quartz monzonite or older Mesozoic rocks but were nowhere found to intrude Tertiary ash-flow tuffs. The dikes and smaller pod-like masses are nearly vertical or dip steeply east or northeast; one hook-shaped mass plunges very steeply to the north.

The dikes consist of very homogeneous, sparsely porphyritic rhyolite that contains less than 1 percent small phenocrysts of quartz and feldspar in a dense and flinty aphanitic matrix. The rock is closely jointed and typically weathers to a rubble of small equant blocks. Many joint surfaces are stained by orangish- to reddish-brown limonite formed from the oxidation of less than 1 percent very small pyrite grains scattered throughout the rock. In thin section typical rhyolite consists of scattered subhedral to euhedral grains of quartz, sodic plagioclase, and alkali feldspar from 1 to 2 mm in diameter set in an anhedral matrix of quartz, albite, alkali feldspar, myrmekite, and scattered flecks of opaque iron oxide. Matrix grain size ranges from 0.1 to 0.01 mm except for patches of myrmekite that range up to 0.5 mm in diameter. Rare very thin veinlets of fine-grained white mica (sericite?) transect the rock and together with the patchy to feathery texture of the matrix suggest that the rhyolite has undergone extensive deuteric or epigenetic alteration.

The close spatial association of the rhyolite dikes with the sodic quartz monzonite and the absence of these dikes cutting any nearby Tertiary rocks suggests that they are of Late Cretaceous age.

Kqm Kqmp Kqmm **Bald Mountain pluton.** Included within this category is a vast volume of equigranular medium-grained sodic biotite quartz monzonite (Kqm); porphyritic roof, margin, and dike phases (Kqmp) of the main pluton; and a hybrid mafic varient (Kqmm) that presumably originated by partial assimilation of metavolcanic and quartz dioritic wallrocks by the primary quartz monzonite magma. The main mass of the Bald Mountain pluton is the most widely exposed of all the bedrock types mapped in the Schurz quadrangle, underlies over 25 square miles of the Schurz quadrangle, and forms the intrusive core of the Wassuk Range and the Gray Hills. The relative proportion of porphyritic marginal facies and mafic hybrid rocks is quite small ((2 sq mi); these rock types are restricted to the range front area southwest of Schurz, the Reese River Canyon, and the foothills northeast of Bald Mountain.

Kqm: The lithology of the main mass of the Bald Mountain pluton is homogeneous, medium-grained, equigranular to seriate sodic biotite quartz monzonite composed, on the average, of 35 percent quartz, 37 percent sodic plagioclase, 25 percent orthoclase perthite, and a few percent green-brown biotite. The quartz monzonite typically forms rounded to craggy outcrops and weathers to pale yellowish to grayish white. In hand specimen the absence of hornblende together with the abundant clots of quartz serve to distinguish this rock from other major plutonic types. In thin section the rock displays hypidiomorphic-granular texture; subhedral grains of discontinuously zoned oligoclase(?) are partially enclosed by orthoclase patch or string perthite and watery clear, generally highly fractured quartz. Grain-size of the felsic minerals ranges from about 0.1 to 5 mm and averages 2 to 3 mm. Flakes of green-brown biotite up to several millimeters across are partially to completely chloritized. Accessory minerals in order of decreasing abundance include magnetite-ilmenite, sphene, blue-green hornblende, allanite, apatite, and zircon.

Areally minor but distinctive rock types associated with the biotite quartz monzonite include aplite and quartz monzonite porphyry dikes that intrude older wallrocks around the periphery of the Bald Mountain pluton, and a graphic quartz monzonite marginal facies that is transitional into typical biotite quartz monzonite in the contact zone with metasedimentary rocks east of the Northern Lights Mine area. Typical aplite dikes extensively exposed at White Mountain range from less than a meter to several meters thick and are made up of equal proportions of fine- to medium-grained quartz, plagioclase, orthoclase perthite plus minor myrmekite and a trace of shredded and chloritized biotite. Quartz monzonite porphyry dikes are pinkish tan to pinkish gray and contain up to 10 percent tabular plagioclase phenocrysts and rounded quartz eyes up to 1 cm in diameter set in a fine-grained (0.1 mm) matrix of quartz, plagioclase, quartz, and biotite. Many of these dikes are extensively altered and converted to aggregates of epidote, chlorite, albite, and sericite. Outcrops of the graphic quartz monzonite marginal facies are distinguished from average biotite quartz monzonite by near absence of biotite, smaller grain size and equigranular texture, and patches of graphic texture visible under the hand lens.

Kqmp: Extensive exposures of porphyritic biotite quartz monzonite are shown separately on the map at the northwest margin of Bald Mountain in the NW/4 T11N,R28E. This rock type on fresh surfaces is medium gray to pale greenish gray and very distinctive in outcrop or hand specimen due to scattered pink, equant to tabular, euhedral phenocrysts of potash feldspar 1 to 2 cm in diameter set in a porphyritic matrix containing 1 to 5 mm-diameter euhedra of gray to white plagioclase, rounded gray to white quartz, and euhedral books of biotite all enclosed by a very fine-grained aggregate of anhedral quartz and feldspar. Plagioclase tablets comprise about 60 percent of the rock; biotite, quartz, and potash feldspar phenocrysts make up less than 10 percent of the rock. This distinctive porphyry grades, laterally and downward into the main pluton by an increase in matrix grain size and gradual disappearance of euhedral phenocrysts.

Kqmm: This map category includes hybrid rock composed of xenoliths from a few centimeters up to several meters of Jurassic and Triassic wallrock types intimately intruded by biotite quartz monzonite. In many exposures along the front of the Wassuk Range there appears to have been interaction, assimilation, and chemical exchange between the volatile-rich quartz monzonite magma and generally more mafic xenoliths from the wallrock pendants and screens with the result that most xenoliths display various degrees of conversion to coarse-grained feldspathic hornfels, schist, or gneiss. Enclosing quartz monzonite is darker gray, finer grained, and more biotite-rich than typical quartz monzonite (Kqm) of the main plutons. This facies of mixed intrusives and contact metamorphic rock is transitional into the main biotite quartz monzonite map unit over distances of a few meters to tens of meters through decreasing abundance of inclusions and increasing felsic constituents of the intrusive rock.

Chemical analyses of medium-grained biotite quartz monzonite and quartz monzonite aplite appear in columns 8 and 9 in the table. The plutonic sample in column 8 is very similar to average adamellite cited by Nockolds (1954) except for slightly lower silica and higher alumina. Combined alkalis are similar but the ratio of soda to potash is much higher in the Bald Mountain rocks. Analytical data for the aplite (col. 9) are typically higher in silica and lower in magnesia and lime as expected for these more highly evolved rocks, but the high soda:potash ratio parallels that of the parent quartz monzonite.

Jd **Dacite porphyry.** Small dacite porphyry plugs of probable Late Jurassic age intrude Late Triassic metavolcanic rocks and Jurassic quartz monzonite (Jhqm). The most extensive exposures are in a fault block at the Northern Lights Mine, near the mouth of Reese River Canyon, and in the northeastern part of the Gray Hills. Dacite porphyry in these widely separated exposures is very similar in appearance. Fresh surfaces of the rock are greenish to pale lavender gray; surficial weathering enhances the green tones of the matrix. White stubby plagioclase crystals comprise 30 to 50 percent of the rock and form complex intergrown clots that produce a glomeroporphyritic texture. Distinctive rounded and enlarged individual and composite grains of quartz up to 1 cm in diameter, and chlorite pseudomorphs after 1 to 5 mm-diameter biotite books make up about 5 percent of the rock. The matrix is aphanitic, dense, and typically breaks with subconchoidal fracture. In thin section, plagioclase (oligoclase?) phenocrysts are complexly twinned and unzoned. The matrix is an anhedral aggregate of extremely fine-grained quartz and feldspar. Cobaltinitrite-stained plugs of the dacite porphyry indicate that the rock matrix consists of from a few percent to as much as 50 percent alkali feldspar, thus the actual rock composition ranges from quartz latite to dacite. Samples from the Reese River Canyon area are little altered, but most specimens collected elsewhere in the quadrangle are moderately metamorphosed to a greenschist assemblage of decussate green-brown biotite (replaces original biotite) plus sericite, calcite, and epidote.

Jhqm Jhqmm Jhqmp **Gray Hills pluton.** Included in this category is a large stock of hornblende-biotite quartz monzonite to granodiorite which forms much of the bedrock exposed in the Gray Hills, a coarsely porphyritic phase exposed over a 2 square-mile area in the Wassuk Range, an equigranular coarse-grained and very mafic varient that underlies small areas in the southern part of the Gray Hills and west of Bald Mountain, and a few small exposures of porphyry compositionally similar to the main plutonic mass (Jhqm). In most exposures these rocks are readily distinguished from biotite quartz monzonite of the Bald Mountain pluton by darker color, substantially higher mafic mineral content, and the presence of essential hornblende. Large areas of the main Gray Hills pluton are bleached and altered to fine-grained albite + epidote ± chlorite ± tremolite – actinolite apparently related to intrusion of one of the Bald Mountain biotite quartz monzonite plutons.

Jhqm: The principal hornblende-biotite quartz monzonite intrusive consists of homogeneous, medium-gray, equigranular to slightly porphyritic rock composed of about 30 percent plagioclase tablets, 30 percent anhedral microcline perthite, 20 percent interstitial quartz, and 20 percent hornblende plus biotite subhedra. Individual plagioclase grains range from less than 1 mm to more than 5 mm long and they commonly are arranged in small clots or clusters 0.5 to 2.0 mm in diameter. Biotite and hornblende are generally present in about equal proportions although some samples contain only trace amounts of biotite. Outcrops of the quartz monzonite rapidly weather to spheroidal forms and aprons of colluvial grus. Typical quartz monzonite grades locally into granodiorite containing as little as 10 percent alkali feldspar. In these samples the tabular, subhedral plagioclase is more apparent and cobaltinitrite-stained slabs reveal that the alkali feldspar is present as coarse phenocrysts slightly larger than the largest plagioclase, or as millimeter-size interstitial grains. Most of the exposures of hornblende-biotite quartz monzonite in the Gray Hills are made up of equigranular to slightly porphyritic rocks. In the Wassuk Range exposures, however, nearly all of the rock contains large subhedral to euhedral concentrically zoned alkali feldspar phenocrysts ranging in maximum diameter from a few millimeters to 5 cm; most average 2 to 3 cm.

In thin section, specimens of equigranular quartz monzonite consist of large subhedral to euhedral laths of sodic plagioclase displaying complex combinations of combined Carlsbad-albite and pericline twins set in an intergranular matrix of anhedral quartz and poikilitic microcline perthite. Euhedral to subhedral green-brown to brown biotite and blue-green hornblende crystals form discontinuous clots molded around large feldspars or as individual interstitial grains in the granular matrix. Accessory sphene, magnetite, and traces of apatite and zirca are present in all sections examined; myrmekite forms a few percent of the matrix in several samples.

Jhqmm: Along the southern margin of the Gray Hills several small outcrop areas totaling about one square mile are underlain by more mafic hornblende-biotite quartz monzonite and were mapped separately. These rocks typically are equigranular, medium- to coarse-grained, and contain 50 to 60 percent mafic minerals. Average mafic quartz monzonite consists of 20 to 30 percent sodic plagioclase, 5 to 10 percent microcline perthite, and a few percent small interstitial grains of quartz; the remainder of the rock is subhedral hornblende and a few percent magnetite, biotite, and sphene. These hornblende-rich rocks grade into Jhqm with decreasing hornblende content.

Jhqmp: Small outcrop areas of hornblende quartz monzonite porphyry exposed south of the Gray Hills are included here as part of the Gray Hills pluton because of their similarity in mineral composition and their proximity to the main pluton. These rocks are pale gray-white to pinkish-white porphyry of which about 50 percent of the rock is euhedral phenocrysts of sodic plagioclase (25 percent), microcline (20 percent), and green-brown hornblende (5 percent). Feldspars are sericitized and range in size from less than 1 mm to nearly 0.5 cm, hornblende averages 1 mm. The matrix is a very fine-grained (aphanitic) aggregate of anhedral quartz and alkali feldspar.

Jahqm **Altered quartz monzonite.** Hornblende quartz monzonite is extensively altered over large areas in the Gray Hills. The distribution of these altered rocks is spatially related to biotite quartz monzonite (Kqm) intrusives, and it appears that the alteration was the result of circulating late stage magmatic fluids and local heating of wallrock during magma emplacement.

Altered quartz monzonite is marked in hand specimen by the appearance of chalky-white plagioclase and pale bluish-green mafic minerals; increasingly pervasive alteration results in a proportionately lighter-colored rock. In weakly altered rock, quartz and microcline are unaffected, all of the biotite and some of the hornblende is converted to pale blue-green chlorite and nearly colorless epidote, and plagioclase is crowded with small flakes and granules of sericite and epidote. In more strongly altered samples mafic minerals are completely replaced by nearly colorless hornblende and aggregates of epidote; plagioclase grains are crowded with high relief granules of epidote and ragged flakes of sericite. Thoroughly altered rock is nearly white albite consisting of coarse anhedral albite, quartz, patches of pale blue-green chlorite, and irregular veinlets of anhedral epidote.

Jgr Jmgr Jgrp **Black Mountain pluton.** This assemblage of Late Jurassic plutonic and hypabyssal intrusive rocks includes fine-grained, equigranular hornblende granodiorite extensively exposed north and west of Black Mountain (Jgr); granodiorite porphyry (Jgrp) largely confined to an east-west belt of faulting and intrusive activity; and a locally developed mafic phase (Jmgr) of the main granodiorite pluton mapped separately northeast of Black Mountain. These rocks are part of a batholith exposed as far west as the Singatse Range, but generally not further south than the T12–13N boundary.

Jgr: The main intrusive of the Black Mountain pluton is homogeneous, medium-gray to slightly greenish-gray, equigranular, fine-grained, hornblende granodiorite composed of about 50 percent plagioclase, 10 to 30 percent orthoclase, 10 to 20 percent hornblende, 10 to 20 percent quartz, and accessory amounts of biotite, augite, sphene, and magnetite. In nearly all exposures the granodiorite is partially replaced by pale-green to greenish-yellow, fine-grained epidote concentrated along intersecting joints; locally these joint-controlled epidote concentrations coalesce to form irregular webs and clots of episodite. This pervasive epidotization together with the uniform fine-grained equigranular texture of the granodiorite serves to distinguish it from the other major plutonic types mapped in the quadrangle. In thin section, typical fresh hornblende granodiorite consists of largely equant to tabular, subhedral, discontinuously zoned and complexly twinned calcic oligoclase averaging about 1 mm in diameter, similar-sized subhedral to anhedral blue-green hornblende prisms poikilitically enclosing cores of colorless augite, and interstitial anhedral to subhedral grains of orthoclase (slightly perthitic) and quartz. Accessory green-brown biotite, colorless sphene, and opaque iron oxide (magnetite) occur as individual small anhedral crystals (0.1 mm) and clots up to 1 mm diameter.

Jmgr: Dark greenish gray rocks of this map unit are gradational into equigranular granodiorite. These rocks are more nearly quartz diorite than granodiorite in composition, coarser-grained than the main pluton (average grain size 2 to 3 mm), and slightly porphyritic. It is possible that these rocks are part of a compositionally altered pendant of older hornblende quartz diorite described below (Jqd), or the crystallization product of locally contaminated, more mafic granodiorite magma.

Jgrp: Granodiorite porphyry nearly identical in composition (columns 10 and 11 of the table) to equigranular hornblende granodiorite forms part of a four-mile-long, east-west composite dike system discontinuously exposed from the south end of White Mountain westward, and a fault-bounded dike-like mass just south and east of the Northern Lights Mine. The rock is very homogeneous except for small (1–2 cm) fine-grained inclusions of greenish gray meta-andesite and displays a distinctive "spotted" fine-grained granular texture on light-gray weathered surfaces due to the somewhat rounded or bead-like gray-white plagioclase phenocrysts that occupy about 50 percent of the rock. Under the microscope these phenocrysts are made up of single plagioclase subhedral or composite grains consisting of from two to five individual crystals intergrown to form a single clot of mutually perpendicular prisms. Plagioclase composition is calcic oligoclase to sodic andesine, prominently discontinuously zoned, and complexly twinned. Average plagioclase phenocryst size is approximately 5 mm; the largest phenocryst noted is about 1.5 cm in diameter. Euhedral to subhedral blue-green to green-brown hornblende prisms range in size from a maximum of 0.5 cm down to less than 0.1 cm. Matrix grain size ranges from 0.1 to 0.05 mm and includes anhedral orthoclase and quartz in approximately equal amounts, subhedral hornblende and plagioclase, ragged flakes of darker brown biotite, and granules of magnetite and sphene 1 mm or less in diameter.

Chemical analyses of representative samples of hornblende granodiorite (Jgr) and granodiorite porphyry (Jgrp) are given in columns 10 and 11 of the table. These rocks are nearly identical except for slightly higher potash and lower combined lime and magnesia in the hornblende granodiorite. Both these rocks are similar in composition to granodiorite or quartz monzonite (Nockolds, 1954) except for anomalously high lime and magnesia contents which are more like those of average quartz diorite.

Jqd Jdb **Hornblende quartz diorite and quartz diorite breccia. Jqd:** Includes equigranular medium-grained biotite-hornblende quartz diorite and medium- to coarse-grained epidote amphibolite in isolated septa, pendants, and wallrock associated with younger Jurassic and Cretaceous plutonic rocks. Along the northeast and east flank of the northern Wassuk Range, quartz diorite forms many thin dikes and veinlets intimately intruding amphibolite and metavolcanic rocks and larger intrusive masses containing numerous wallrock inclusions. There is a complete transition from unequivocal quartz diorite containing sparse inclusions through mixed igneous-metamorphic rock into amphibolite containing only a few small quartz diorite dikes. Along the north flank of Bald Mountain, the large inclusion mapped as quartz diorite in biotite quartz monzonite (Kqm) is thoroughly metamorphosed to amphibolite and the nature of the parent rock is uncertain.

Exposures of biotite-hornblende quartz diorite that still retain some igneous characteristics consist of medium- to dark-gray, equigranular, slightly foliated to homogeneous rock with a weakly mottled or "gabbroic" texture. Felsic constituents include gray to gray-white plagioclase tablets up to a few millimeters in diameter plus very fine-grained quartz and orthoclase not visible under the hand lens. Mafic minerals are primary hornblende partially to completely replaced by fine-grained aggregates of metamorphic hornblende and biotite. Under the microscope subhedral plagioclase laths are discontinuously zoned and partially enclosed by anhedral grains of quartz and orthoclase. Plagioclase size ranges up to 1 to 2 mm long; quartz and orthoclase grains average about 0.2 mm. Primary hornblende subhedra up to 0.5 cm long are partially to completely replaced by decussate aggregates of nearly equant dark green-brown biotite and blue-green hornblende grains from 0.5 to several millimeters in diameter. Small anhedral granules of opaque iron oxide and sphene occur adjacent to the mafic minerals. The average mineral mode of these rocks is 40 to 50 percent plagioclase, 10 to 20 percent combined quartz and orthoclase, 20 percent hornblende, 10 percent biotite, and accessory amounts of sphene, magnetite, and apatite. In most sections, plagioclase and biotite are partially replaced by fine-grained sericite, epidote, and albite; hornblende and biotite are partially replaced by pale-green chlorite.

The chemical composition of hornblende quartz diorite (column 12 in the table) is very similar to Nockolds (1954) average mangerite or low-silica granodiorite. However, modal variation among many specimens of the quartz diorite suggests that most of the map unit contains more silica and less soda and potash than the analysed sample.

Amphibolite typical of much of the rock included in this map unit is crystalloblastic to porphyro-blastic, medium- to coarse-grained, medium to very dark gray, massive, and composed of roughly equal proportions of plagioclase and hornblende. Prominent prisms of blue-green hornblende from less than 1 mm to more than 1 cm long are randomly oriented and occur evenly distributed throughout the rock or as dark patchy aggregates of many crystals. Subhedral weakly and continuously zoned andesine exhibits prominent albite and combined Carlsbad-albite twinning. Small anhedral grains of quartz, epidote, alkali feldspar, apatite, sphene, and magnetite form intergranular mosaics partially enclosing hornblende and plagioclase and comprise about 10 percent of the rock.

Jdb: Rock mapped separately in this category is confined to an east-west belt about 4 miles long north of Black Mountain and consists of an intimate mixture of hornblende quartz diorite described above and xenoliths of sheared and partially assimilated angular to subangular blocks of porphyritic meta-andesite (Ꞧa) and more siliceous metavolcanic rocks (Ꞧl). Individual blocks range in size from a few centimeters to several meters; many of the blocks are veined and criss-crossed by small dikelets of hornblende quartz diorite. Locally within the map unit this mafic intrusive breccia is cut by dikes and irregular pod-like masses of granodiorite porphyry (Jgrp) and light pinkish-gray quartz monzonite to granite aplite dikes from less than a meter to several meters thick apparently related to the latest intrusive episode represented by the Bald Mountain plutons.

Pluton ages. K-Ar ages of biotite and hornblende separates prepared from the four major plutonic rock types cluster at 80 to 100 m.y. and 140 to 150 m.y. These episodes correspond to intrusive epochs A and B respectively as described by Lanphere and Reed (1973, p. 3777). All dated mineral pairs from the same rock sample are discordant with biotite yielding the younger age in all instances. Biotite separated from equigranular quartz monzonite of the Bald Mountain pluton gave an age of 80 ± 3.0 m.y. (Bingler, 1972). Hornblende from the main Black Mountain pluton (Jgr) gave an age of 144 ± 4 m.y.; two hornblende dates from granodiorite porphyry were 143 ± 4 m.y. (Bingler, 1972) and 114 ± 5 m.y., and biotite from the same sample yielded a 79 ± 2.4 m.y. age. Two hornblende dates from the Gray Hills pluton (Jhqm) were 140 ± 4 m.y. and 154 ± 5 m.y.; biotite from the second sample yielded a 100 ± 3 m.y. age. Dates obtained from hornblende quartz diorite (Jqd) were 135 ± 4 m.y. and 79.7 ± 2.4 m.y. on hornblende and biotite respectively. From these data it is apparent that biotite in all the plutons has been reset by the 80 m.y. Bald Mountain intrusive event, and it is quite likely that the quartz diorite ages have both been reset by later Jurassic and Cretaceous plutonism. Hornblende ages for the Black Mountain and Gray Hills pluton average 139 m.y. or Late Jurassic.

METASEDIMENTARY AND METAVOLCANIC ROCKS

Mesozoic metasedimentary rocks are extensively exposed in the central northern part of the Wassuk Range in a roof pendant at the Northern Lights Mine. Nearly 7000 feet of stratigraphic section includes Late Triassic volcaniclastic and carbonate rocks near the base overlain by siliceous argillite, tuffaceous siltstone, and interbedded limestone all of Jurassic age.

Metavolcanic rocks of Triassic age are widely exposed throughout the northern Wassuk Range. Porphyritic flow rocks of intermediate composition ranging from andesite to latite form the bulk of the exposed rock types. Locally interlayered with these flows are thick sections of latitic to rhyolitic pyroclastic rocks ranging from lapilli-tuff breccia to fine-grained ash-flow tuffs.

All of the metasedimentary and metavolcanic rocks are completely recrystallized to very fine-grained aggregates of quartz, feldspar, mica, epidote, and calcite as a result of regional thermal metamorphism. Because of the very fine grain size of the metamorphic products and the lack of deformation during recrystallization, nearly all the Mesozoic rocks retain primary textures and structures in outcrop and hand specimen. Only locally near intrusive contacts have the metasedimentary and metavolcanic rocks undergone conversion to coarse-grained foliated rocks lacking primary texture.

Js Ja Ꞧm Ꞧms **Metasedimentary rocks.** The Jura-Triassic metasedimentary section is exposed in a wedge-shaped pendant immediately south of Black Mountain. The pendant is bounded on the north and east by an intrusive contact with biotite quartz monzonite, on the south by a major pre-Tertiary fault that juxtaposes granodiorite porphyry and metavolcanic rocks against the metasedimentary section, and on the west by a gently east-dipping named fault that passes under the Northern Lights Mine. Within the pendant the metasedimentary rocks strike north to northwest, and dip steeply west. About 40 percent of the exposed section is carbonate rock and the remainder is fine-grained volcaniclastic sediment; all of the rocks are of marine origin. Thermal metamorphism has converted the carbonate rocks to fine-grained tremolite marble and nearly all of the fine-grained volcaniclastic rocks to dense and flinty siliceous argillite.

Js: Light- to medium-gray, very thin-bedded, platy-weathering fine-grained tuffaceous siltstone and interbedded gray, yellowish-tan, and bluish-gray fine-grained limestone and limestone breccia. Near the Northern Lights Mine the platy gray siltstone includes two prominent ledge-forming limestone beds 5 to 10 m thick and separated stratigraphically by 20 to 30 m of siltstone. In general, interbedded limestone consists of thin, recrystallized, gray-brown nodular beds a few centimeters to several tens of centimeters thick irregularly distributed through homogeneous gray siltstone. Except for the thick carbonate beds noted above, the map unit contains about 10 percent limestone. Where the siltstone beds are most intensely metamorphosed the rock is a darker gray color, resistant to weathering, dense and compact, breaks along subconchoidal fracture surfaces across bedding, and generally contains 1 to 2 mm long, randomly oriented bluish-black tremolite needles. In thin section these rocks consist of poorly sorted detrital angular grains of plagioclase(?) and sparse quartz ((0.01 mm in diameter) in a matrix of metamorphic calcite, very small tremolite prisms, a trace of biotite, and recrystallized very fine silt. Calcite forms ragged anhedral patches about 0.1 mm in diameter scattered uniformly throughout the rock.

The siltstone unit has an exposed thickness of about 200 m. The top of the unit is bounded by a fault and the base is a gradational contact, marked by the presence of thin chert and limestone beds, with underlying siliceous argillite. Platy-weathering beds 10 to 20 m above the base of the map unit contain sparse, thin-shelled and poorly preserved pelecypod remains that could not be identified. Arietitid ammonoite impressions ranging in diameter from 2 to about 6 cm collected from gray siltstone at the top of the map unit immediately above the bounding fault are of Early Jurassic, probably Sinemurian, age (N. J. Silberling, written comm., 1971). Rocks of very similar age and lithology were mapped in the New Empire quadrangle as calcareous argillite (Bingler, 1977) and included within the Gardnerville Formation of Noble (1962).

Ja: Thick sequence of thin- to medium-bedded, yellowish to orangish brown-weathering, dark bluish-black, dense, very fine-grained siliceous argillite containing less than 1 percent blue-gray, thin fine-grained tremolite marble interbeds. Weakly metamorphosed beds are aphanitic, flinty, and composed of a submicroscopic aggregate of quartz, feldspar, calcite, and opaque black dust. Sparse coarser-grained beds contain 10 to 20 percent scattered silt-size very angular grains of plagioclase and quartz floating in a similar submicroscopic matrix. Throughly recrystallized beds include a few percent of acicular tremolite prisms, scabby sericite flakes, and zoisite(?) in a very fine-grained xenomorphic quartzo-feldspathic matrix. Near the top of the unit, beds a few centimeters to a few tens of centimeters thick display paper-thin graded bedding which is most apparent on weathered joint surfaces; most beds throughout the sequence show no internal structure. The map unit is conspicuously lacking in outcrop exposures because of the characteristic chippy weathering of the rock.

The siliceous argillite unit is nearly 600 m thick and very homogeneous throughout. It conformably overlies and is apparently transitional downward into fine-grained tremolite marble. Because the primary lithology of individual siliceous argillite beds is quite similar to the overlying gray siltstone, it is quite likely that much of the physical dissimilarity between the argillite and overlying siltstone unit is the result of thermal metamorphism. No fossils were found in the siliceous argillite beds, but they are believed to be of Early Jurassic age and largely equivalent to the lower part of the Gardnerville Formation of Noble (1962).

Ꞧm: Medium-gray, fine-grained, thin- to medium-bedded, homogeneous, weakly foliated tremolite marble. Typical specimens consist of anhedral matrix calcite grains from 0.01 to 0.05 mm in diameter and from less than 1 percent up to about 10 percent randomly oriented acicular porphyroblasts of tremolite. Many of the tremolite grains are arranged in sheafs and form characteristic "bow-tie" texture. Most of the tremolite grains are 2 to 3 mm long, but in a few samples, elongate clusters on bedding planes are up to 2 cm long.

Nearly 1000 m of tremolite marble is exposed in the pendant at the Northern Lights Mine, however, these rocks have undergone considerable internal deformation by flowage and it is not known how closely this thickness approximates original depositional thickness. No fossils were found in these rocks but the uniform carbonate lithology and the stratigraphic position of the beds beneath Gardnerville-type sediments indicates that they are probably correlative with the massive limestone beds in the upper part of the Oreana Peak Formation of Noble (1962) and are Norian in age.

Ꞧms: The tremolite marble unit is conformably underlain by a few hundred meters of very fine-grained, thin- to medium-bedded, siliceous volcaniclastic and pyroclastic rocks. The contact between the overlying tremolite marble and these volcaniclastic rocks is transitional over a few meters of section where carbonate beds a few tens of centimeters thick are intercalated with metavolcanic strata, and the base of the unit is an intrusive contact with biotite quartz monzonite. The intervening rocks are poorly exposed and largely covered by colluvium on a steep east-facing slope. Rocks typical of this unit are metamorphosed, dense and flinty, gray to bluish- and pale greenish-gray felsites. Massive, light-colored beds a few centimeters to more than a meter thick alternate with thin beds that display a fine grading in which aphanitic cherty material grades vertically into siliceous very fine silt. Locally the thick massive beds display fragmental texture, somewhat masked by recrystallization, in which angular, centimeter-size light-colored fragments, float in a fine matrix. The thick, poorly sorted fragmental beds alternating with thin cherty graded beds, coupled with the siliceous to intermediate composition of these rocks, suggests that much of this unit is of subaqueous pyroclastic origin. Similar rocks exposed about 1 mile north of the divide on the Schurz highway are interbedded with limestone containing abundant Anatropite and assigned to the Macrolobatus Zone (Latest Karnian) by Silberling (1976, written comm.). These rocks are correlative with similar beds in the Upper Volcanic Member of the Oreana Peak Formation mapped by Noble (1962) in the southern Pine Nut Mountains and by Bingler (1977) in the New Empire quadrangle.

Ꞧa Ꞧl Ꞧu **Metavolcanic rocks.** Thick sections of porphyritic flow rocks, hypabyssal intrusives, and silicic pyroclastic rocks comprise the oldest rocks mapped in the Schurz quadrangle. All of these rocks are completely recrystallized as a result of thermal metamorphism and nearly all the major blocks of exposed metavolcanic rocks are clearly remnants of roof and wall rocks peripheral to, and engulfed by the large intrusive masses of the Bald Mountain plutonic complex. No direct evidence for the age of these rocks is available, but the compositional and textural similarity they bear to the thick sequence of mafic to silicic metavolcanics that underlie Late Triassic metasediments at McConnel Canyon in the Singatse Range strongly suggests a Late Triassic age for the metavolcanic rocks in the Wassuk Range.

Ꞧa: Largely homogeneous, pale bluish- to greenish-gray, and greenish-black, hard and dense, prominently porphyritic, fine-grained meta-andesite flow rock consisting of 10 to 20 percent plagioclase and 5 to 10 percent pyroxene phenocrysts set in an aphanitic black matrix. Plagioclase phenocrysts range in size from about 0.5 to 5 mm and average 1 to 2 mm, are euhedral to subhedral, and pale grayish to greenish white. The greenish color of the plagioclase is characteristic of these rocks and the result of partial to complete replacement by very fine-grained granular epidote. Pyroxene phenocrysts average less than 1 mm in diameter, are apparent only on weathered surfaces, and in most specimens are completely replaced by very fine-grained biotite. In thin section, primary mineral phases are largely replaced by extremely fine-grained (0.01 to 0.1 mm) flakes of green-brown biotite, granules of epidote, plagioclase, opaque iron-oxide dust, and sparse quartz. Pyroxene (augite?) phenocrysts are partially to completely replaced by decussate stubby flakes of biotite, and granular epidote plus opaque iron oxide. Primary porphyritic rock texture is still apparent in most sections beneath the metamorphic overprint, but patchy extinction and weakly defined twinning suggests that these grains have largely recrystallized. The matrix of the rock is entirely recrystallized to a fine-grained aggregate of anhedral plagioclase, quartz, and minute biotite flakes.

The meta-andesite mapped within the block exposed north of Reese River Canyon (Cottonwood Spring) contains numerous small hypabyssal dikes and plugs of coarsely porphyritic rock of similar composition to average meta-andesite but of strikingly different texture. In most of these dikes plagioclase phenocrysts, largely epidotized, form distinctive dime-size plates, 1 to 5 mm thick and more than 1 cm across that comprise 30 to 50 percent of the rock. Stubby mafic phenocrysts, originally primary pyroxene but now replaced by blue-green hornblende, make up about 10 percent of the rock, and the matrix is a very fine-grained aggregate of randomly oriented hornblende needles, anhedral plagioclase and granular epidote.

A chemical analysis of average fine-grained meta-andesite is given in column 13 of the table. All oxide values are very similar to those cited for average rhyodacite by Nockolds (1954). Apparently all of the potash originally in the primary matrix of the rock is incorporated in biotite, for no alkali feldspar was detected in any samples.

Ꞧl: Meta-latite pyroclastic rocks. Dense, homogeneous fine- to coarse-grained, fragmental, pyroclastic rocks and minor hypabyssal intrusives ranging in composition from latite to rhyolite. These rocks underlie meta-andesite flows in the area immediately southwest of White Mountain and are interlayered with meta-andesite along the west flank of Bald Mountain. A complete section of pyroclastic rocks is nowhere exposed, but the map unit is at least 500 m thick and possibly as much as 1000 m thick.

Much of the map unit consists of dense, very fine-grained, pale gray to lavender gray-weathering, sparsely porphyritic rock containing 5 to 20 percent conspicuous white to pinkish-white, equant, euhedral phenocrysts of alkali feldspar. On fresh fracture surfaces the matrix is dark gray to brownish black and aphanitic, fragmental texture is poorly defined on these fresh surfaces but apparent on weathered joint surfaces. Near Bald Mountain this unit includes thin and local unwelded pyroclastic flows containing angular blocks of felsite porphyry up to several meters in diameter and thin (a few tens of meters) densely welded ash flows containing up to 20 percent centimeter-long, highly flattened and partially stretched fiamme. Under the microscope, relic euhedral phenocrysts of Carlsbad-twinned alkali feldspar comprise more than 90 percent of the phenocrysts with complexly twinned plagioclase and small rounded and embayed quartz grains forming the remainder. In most sections the matrix is completely recrystallized to a very fine ((0.01 mm) xenomorphic aggregate of plagioclase, quartz, and biotite. Near White Mountain rocks of similar composition are thoroughly recrystallized and schistose within 1 mile of the quartz monzonite pluton, yet fragmental texture is still well preserved and apparent in outcrop. Original phenocrysts in these rocks are ragged and recrystallized; the matrix is lepidoblastic and average grain size is 0.07 mm.

More silicic rhyodacite lapilli tuff containing abundant pumice is exposed immediately beneath meta-andesite in the canyon that crosses the NE/4 S24,T13N,R27E. These light- to medium-gray crystal tuffs include from 10 to more than 50 percent angular blocks of indurated tuff and irregularly shaped white pumice fragments in a matrix composed of 30 to 50 percent broken cognate crystals of plagioclase (10 to 15 percent) and quartz (about 20 percent) set in recrystallized fine ash. A chemical analysis of this tuff (column 14 in the table) indicates the rock is intermediate in composition between quartz latite and rhyodacite.

Ꞧu: Includes scattered poor exposures of meta-andesite and meta-latite pervasively intruded by equigranular biotite quartz monzonite (Kqm) and porphyritic granodiorite to quartz monzonite dikes. Much of the meta-volcanic float may represent fragments of xenoliths near the roof-margin rocks of the Bald Mountain pluton.

Chemical Composition (weight percent)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SiO_2	54.92	54.93	59.4	60.76	69.16	64.63	73.07	67.25	76.04	60.53	59.80	58.11	63.60	70.61
Al_2O_3	17.32	17.23	16.4	16.19	14.39	16.25	12.38	16.17	12.88	15.50	16.43	16.47	16.14	14.10
Fe_2O_3	4.67	3.61	6.6	3.58	2.35	2.31	—	1.47	0.40	3.34	3.49	3.45	1.71	0.88
FeO	3.05	4.25	NA	1.25	0.50	1.18	0.15	1.23	0.51	2.77	3.33	4.37	3.68	2.75
MgO	3.53	4.24	2.1	1.53	0.39	1.12	0.09	0.76	0.10	2.62	2.93	3.81	1.84	1.43
CaO	8.32	7.37	5.4	3.15	1.97	3.06	1.11	3.05	1.23	5.28	5.50	6.08	3.40	1.83
Na_2O	3.92	3.75	3.9	2.81	3.49	4.00	3.56	5.30	4.62	4.24	3.86	3.81	4.28	3.43
K_2O	1.53	1.95	2.1	7.37	4.42	4.01	4.35	2.89	2.90	3.48	2.47	2.01	3.63	3.43
H_2O+	0.12	0.42	NA	0.62	0.55	2.62	0.64	0.34	0.05	0.32	0.76	1.05	0.56	0.56
H_2O-	0.33	0.34	NA	0.43	0.91	0.76	NA	0.22	0.19	0.19	0.28	0.32	0.22	0.24
TiO_2	0.96	1.04	NA	0.61	0.34	0.58	0.20	0.49	0.09	0.95	0.74	0.84	0.60	0.33
P_2O_5	0.25	0.40	NA	0.15	0.11	0.16	NA	0.16	0.00	0.33	0.20	0.18	0.20	0.07
MnO	0.09	0.09	NA	0.12	0.03	0.07	0.05	0.03	0.01	0.07	0.07	0.04	0.08	0.06
Total	99.01	99.62	95.9	98.57	98.61	100.75	95.60	99.36	99.02	99.62	99.86	100.54	100.14	99.72

1. Basaltic andesite, E edge Black Mountain, S36,T13N,R27E. 2. Basaltic andesite, S30,T12N,R28E. 3. Hornblende latite, W C NE/4 S13, T12N,R27E. 4. Hu-Pwi Rhyodacite, W C S18,T13N,R28E. 5. Singatse Tuff, W C S18,T13N,R28E. 6 and 7. Proffett and Proffett (1976, p. 18). 8. Biotite quartz monzonite, S29,T13N,R28E. 9. Quartz monzonite aplite, C S17,T13N,R28E. 10. Hornblende granodiorite, NE/4 NE/4 S30,T13N,R28E. 11. Hornblende granodiorite porphyry, NE/4 S24,T13N,R27E. 12. Hornblende quartz diorite, NE/4 S34, T13N,R27E. 13. Meta-andesite, NE/4 S24,T13N,R27E. 14. Meta-latite tuff, NE/4 S24,T13N,R27E.
Sample 3 analysed by XRF; for all others, SiO_2 and H_2O gravimetrically; K_2O, Na_2O, MgO, and CaO by AA; Al_2O_3 by CDTA; FeO by Dichromate; TiO_2 and P_2O_5 by colorimetry. Analyst: Patrick Beaulieu, Nevada Mining Analytical Laboratory.

STRUCTURE

The structural framework of the northern Wassuk Range is dominated by regional patterns of normal faulting along east-west, northeast, and northwest trends. North- to northwest-trending faults, active from Miocene to Holocene time during regional Basin-and-Range extension, resulted in thousands of meters of normal offset, 60- to 80-degree westward rotation of range-forming basement blocks, and the present basin-and-range topography in the quadrangle. Very low-angle faults on which the hanging-wall block has moved eastward are presumably early formed east-dipping normal faults progressively rotated westward by subsequent faulting (Proffett, 1977). Although the northern Wassuk Range forms the western margin of the Walker Lane, only a few faults appear to be related to strike-slip movement.

Normal Faults

The eastern front of the Wassuk Range is marked by a northwest-trending series of slightly *en echelon*, high-angle normal faults extending from White Mountain to the southeast corner of the quadrangle. Most of these traces form east-facing scarps several meters high in late Pleistocene alluvial fan and bajada deposits, but do not cut Holocene deposits. The great normal offset of several thousand meters between the bedrock core of the range on the west and the Walker Lake basin on the east probably occurred on faults of similar trend and orientation now buried by alluvium along the range margin. Normal faults of similar style bound the east edge of the Gray Hills, but these lack the large offsets of the range-front system.

Originally horizontal Tertiary rocks are systematically rotated westward throughout the quadrangle. In general, there is a proportional relationship between geologic age of the unit and the amount of westward dip suggesting generally continuous down-to-the-east normal faulting from Middle Tertiary to the present. The many low-angle faults with curved traces in plan view north of Black Mountain and the low-angle fault at the Northern Lights Mine are believed to be the result of progressive westward tilting of Middle to Late Tertiary normal faults by younger normal faults now buried under alluvial-fan and sediment gravel. The present trough- or scoop-shaped form of these faults is the result of westward rotation of originally arcuate plan-view traces of steep-dipping normal faults. Another important feature of the widespread rotation of bedrock masses is that the map or plan view of the mountain ranges is in fact nearly a cross-sectional view. Thus, supracrustal metavolcanic and metasedimentary rocks and roof-margin porphyritic phases of individual plutons tend to crop out along the western flank of the Wassuk Range just as the younger Tertiary rocks form north- or northwest-trending outcrop bands along the western margin of the range. This cross-sectional geometry in map view is particularly apparent east of the Northern Lights Mine and along the northwest flank of Bald Mountain.

A few Late Tertiary to Quaternary normal faults formed at a high angle to the dominant northwest pattern and trend east to about N70E. Principal among these are the faults forming an elongate graben at the southwest edge of the Gray Hills, the down-to-the-southeast faults at the northwest edge of Bald Mountain and north of Cottonwood Spring, and the down-to-the-north fault at the north edge of the hogback along the northwest edge of the map area. All of these are post-early Miocene–pre-Quaternary faults.

Strike-slip, Thrust, and Detachment Faults

Faults mapped along the western margin of White Mountain and in the northern part of the Gray Hills, and the zone of pervasive mylonitization and thrusting in the Reese River–Penrod Canyon area differ in structural style from the numerous normal faults in the quadrangle.

The low-angle fault separating Singatse Tuff from underlying Mickey Pass Tuff, was mapped in the northern part of the Gray Hills where it is nearly horizontal or dips gently westward. Compaction foliation in the underlying tuff also dips westward or gently eastward, but compaction foliation in the overlying sheet strikes north-south and dips 60 to 80 degrees to the west. Additionally, the cooling-zone boundaries in the Singatse Tuff parallel the plane of the fault and are also at a high angle to compaction foliation. Since the nearly horizontal contact between Mickey Pass Tuff and basement rocks precludes substantial westward rotation of the mountain block, it seems likely that a large block of Singatse Tuff slid downslope prior to final cooling but after emplacement and came to rest in its present position. Thus the mapped low-angle fault is a type of detachment fault related to gravity sliding during Middle Tertiary time.

Northwest-trending faults of possible strike-slip origin were mapped in the Gray Hills (S2 and 3,T11N,R27E) and along the west edge of White Mountain. The fault in the Gray Hills appears to offset a small dacite porphyry plug (Jd) intruded into hornblende quartz monzonite; at least a part of the trace cuts Singatse Tuff. Right lateral separation of the porphyry plug across the fault is approximately 2 km, but any dip-slip component that may be present is indeterminate. No unusual amount of brecciation or gouge was noted along the trace. The fault that bounds White Mountain to the west is notable for the tens of meters of gouge and broken rock along the trace. Normal down-to-the-west separation of several hundred meters and left lateral separation of at least 2 km is present in this fault.

The Reese River–Penrod Canyon fault zone is marked by a 50 to 80 m thick, northeast-dipping tabular zone of mylonite and pervasively brecciated biotite quartz monzonite. At Penrod Canyon the upper boundary of the mylonite is marked by imbricate low-angle faults (thrusts?) striking west to northwest. The uppermost fault truncates meta-andesite (Ꞧa) intruded by dacite porphyry (Jd); both these lithologies are relatively fresh and undeformed unlike the mylonite and breccia immediately beneath the fault. Both the faults and the mylonite zone dip 12 to 30 degrees north or northeast. Just south of Cottonwood Spring, well-developed mylonite grades both upward and downward through breccia into relatively intact rock. Although this zone of intense deformation is very well developed from Cottonwood Spring southeast to the range front, it could not be traced to the northwest where it is concealed under alluvial-fan deposits. The present geometry of the fault zone is that of a northwest-trending thrust sheet. It is possible that westward rotation of the range has also rotated the fault zone from an initial near vertical and northwest-trending zone that was a regional strike-slip fault zone part of the Walker Lane system. This interpretation is consistent with the anomalous amount of penetrative deformation indicative of high directed stress generally associated with strike-slip faults.

Pre-Tertiary Faults

Included in this category is the northeast-trending fault that bounds the pendant of Triassic rocks southeast of the Northern Lights Mine, and the east-west zone of faults and dikes southwest of White Mountain. The pendant-boundary fault near the Northern Lights Mine originally was a down-to-the-north normal fault with northeast strike prior to extreme westward tilting of the range block. This fault dropped Jurassic sediments more than 2.5 km down against Late Triassic metavolcanic rocks, and served as a locus for intrusion of Jurassic granodiorite porphyry. Further north, the east-west zone of granodiorite porphyry and quartz diorite mega-breccia formed no later than Late Jurassic, and is overlain by Oligocene ash flows that pass across the zone without interruption.

ACKNOWLEDGMENTS

Many geologists have aided my understanding of this complex area by giving freely of their local knowledge of the Wassuk Range and neighboring parts of the Yerington district. I wish especially to thank Jeff Hulen formerly with Bear Creek Mining Co., John Proffett and Ken Howard of the Anaconda Co., and Bob Gloin of Getty Oil Co. George Stathis of ASARCO provided me with the first large-scale color photography of the northern Wassuk Range for which I thank him. H. F. Bonham, Jr. critically reviewed the manuscript, Susan Nichols edited the text and prepared the map copy, and Georgianna Trexler typed and composed the text.

REFERENCES

Bingler, E. C. (1972) K-Ar dates from volcanic and plutonic rocks of the northern Wassuk Range, central western Nevada: Isochron/West, no. 3, p. 31–32.

______(1977) New Empire geologic map: Nevada Bur. Mines and Geology Map 59.

______(1978) Abandonment of the Hartford Hill Rhyolite Tuff and new formation names for Middle Tertiary ash-flow tuffs in the Carson City–Silver City area, Nevada: Contributions to Stratigraphy, U.S. Geol. Survey Bull. (in press).

Bingler, E. C., Silberman, M. L., and McKee, E. H. (1978) K-Ar ages of Tertiary ash-flow tuffs in the Carson City–Silver City area, central western Nevada: Isochron/West, no. 22, p. 23–24.

Ekren, E. B., Byers, F. M., Jr., Hardyman, R. F., Marvin, R. F., and Silberman, M. L. (1978) Stratigraphy, geochronology, and preliminary petrology of Tertiary volcanic rocks in the Gillis and Gabbs–Valley Ranges, Mineral County, Nevada: U.S. Geol. Survey Bull. (in press).

Gilbert, C. M., and Reynolds, M. W. (1973) Character and chronology of basin development, western margin of the Basin and Range Province: Geol. Soc. America Bull., v. 84, p. 2489–2510.

Lanphere, M. A., and Reed, B. L. (1973) Timing of Mesozoic and Cenozoic plutonic events in circum-Pacific North America: Geol. Soc. America Bull., v. 84, p. 3773–3782.

Noble, D. (1962) Mesozoic geology of the southern Pine Nut Range, Douglas County, Nevada: Ph.D. thesis, Stanford Univ., Stanford, Calif.

Nockolds, S. R. (1954) Average chemical compositions of some igneous rocks: Geol. Soc. America Bull., v. 65, p. 1007–1032.

Proffett, J. M., Jr. (1977) Cenozoic geology of the Yerington district, Nevada, and implications for the nature and origin of Basin and Range faulting: Geol. Soc. America Bull., v. 88, p. 247–266.

Proffett, J. M., Jr., and Proffett, Beth (1976) Stratigraphy of the Tertiary ash-flow tuffs in the Yerington district, Nevada: Nevada Bur. Mines and Geology Rept. 27, 28p.

Topographic base from U. S. Geological Survey
Schurz 15' quadrangle, 1964
First edition, first printing, 1978: 2000 copies
Printed by Williams and Heintz Map Corp.,
Washington, D. C.
Cartography by Susan L. Nichols
Composition by Georgianna Trexler