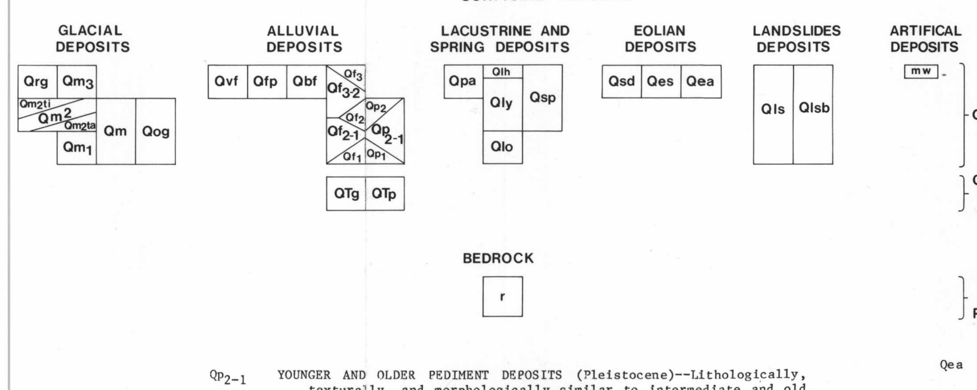
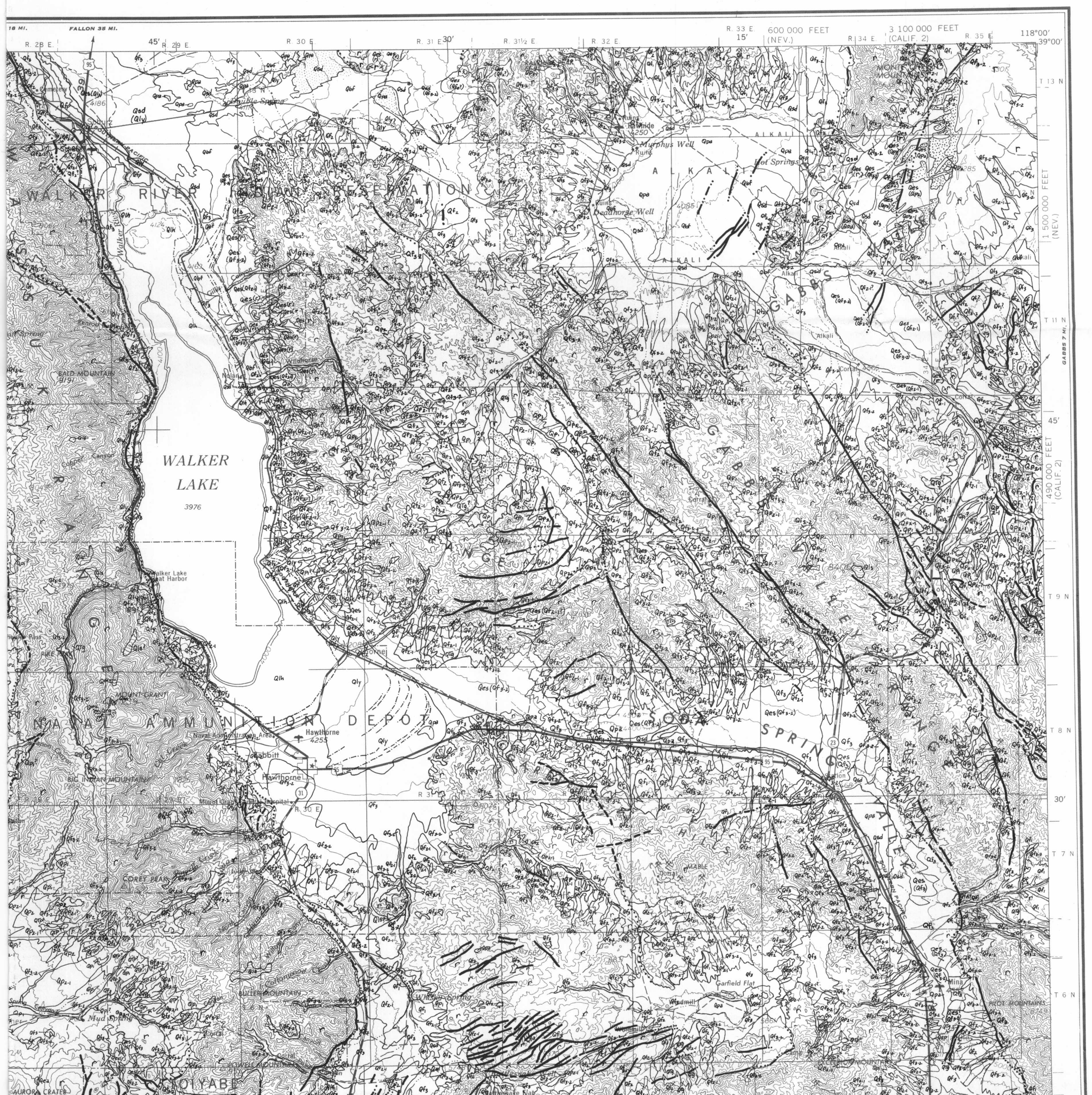
MISCELLANEOUS FIELD STUDIES
MAP MF - 1382 - C

CORRELATION OF MAP UNITS

SURFICIAL DEPOSITS





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Geology mapped 1979-81.

QUADRANGLE LOCATION

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15. Dohrenwend, J. C., 1981, Reconnaissance surficial geologic map of the Gabbs-Luning area, Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF-1374, scale 1:62,500.
16. Unpublished surficial geologic map of the Dardanelles Cone quadrangle, California, by J. C. Dohrenwend, scale 1:62,500.
17. Unpublished surficial geologic map of the Sonora Pass quadrangle, California, by J. C. Dohrenwend, scale 1:62,500.
18. Clark, M. M., 1967, Pleistocene glaciation of the drainage of the West Walker River, Sierra Nevada, California: Stanford, Calif., Stanford University, Ph. D. thesis, 130 p. Modified by J. C. Dohrenwend.
19. Unpublished geologic map of the Fales Hot Springs quadrangle, California and Nevada, by G. F. Brem, scale 1:62,500.
20. Dohrenwend, J. C., and Brem, G. F., 1982, Reconnaissance surficial geologic map of the Bridgeport quadrangle, California and Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF-1371, scale 1:62,500.
21. Dohrenwend, J. C., 1982, Reconnaissance surficial geologic map of the Aurora quadrangle, California and Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF-1373, scale 1:62,500.
22. Stewart, J. H., and Johannesen, D. C., 1981, Geologic map of the Powell Mountain quadrangle, Mineral County, Nevada, with Surficial geology by J. C. Dohrenwend: U.S. Geological Survey Miscellaneous Field Studies Map MF-1268, scale 1:62,500.
23. Dohrenwend, J. C., 1982, Surficial geologic map of the Excelsior Mountains area, Nevada: U.S. Geological Survey Miscellaneous Field Studies Map MF-1372, scale 1:62,500.
24. Unpublished geologic map of the Pincrest quadrangle, California, by N. K. Huber and B. E. John, scale 1:62,500. Surficial geology modified by J. C. Dohrenwend.
25. Unpublished geologic map of the Tower Peak quadrangle, California, by Clyde Wahrhaftig, scale 1:62,500.
26. Chesterman, C. W., 1975, Geology of the Matterhorn Peak quadrangle, Mono and Tuolumne Counties, California: California Division of Mines and Geology Map 22, scale 1:48,000. Surficial geology modified by J. C. Dohrenwend.
27. Chesterman, C. W., and Gray, C. H., Jr., 1975, Geology of the Bodie quadrangle, Mono County, California: California Division of Mines and Geology Map 21, scale 1:48,000. Surficial geology modified by J. C. Dohrenwend.
28. Dohrenwend, J. C., 1981, Reconnaissance surficial geologic map of the Trench Canyon quadrangle, Nevada: U.S. Geological Survey Open-File Report 81-1155, scale 1:62,500.
29. Stewart, J. H., Kleinhampl, F. J., Johannesen, D. C., Speed, R. C., and Dohrenwend, J. C., 1981, Geologic map of the Huntoon Valley quadrangle, Nevada: U.S. Geological Survey Open-File Report 81-274, scale 1:62,500.

2° QUADRANGLE, NEVADA — CALIFORNIA

DESCRIPTION OF MAP UNITS

GLACIAL DEPOSITS

Qrg ROCK-GLACIERS (Holocene)--Unsorted, angular boulders; unweathered to very slightly weathered. Includes and closely associated with abundant coarse blocky talus. Characterized by distinct lobate morphology with steep, commonly unstable marginal slopes. Nearly 90 percent of the more than 40 rock glaciers identified in the quadrangle occur in north- to northeast-facing cirques at elevations between 2,925 and 3,350 m (9,600 and 11,000 ft). Individual rock glaciers are typically less than 0.15 km^2 in area and are generally restricted to within 0.5 km of cirque headwalls. Thickness 15 to 30 m

Qm_3 YOUNG GLACIAL MORAINES (Holocene)--Generally unsorted sandy to clayey, boulder to cobble till. Commonly associated with rock glacier deposits. Forms undissected moraines. Unweathered with little to no soil development or vegetation. Includes some talus and alluvial fan deposits which are closely associated with the glacial drift. Of the 72 Holocene glacial moraine deposits identified and mapped in the quadrangle, 69 occur in north to northeast facing cirques at elevations between 2,800 and 3,260 m (9,200 and 10,700 ft). Typically individual deposits are less than 0.25 km^2 in area and extend no more than 0.5 km from cirque headwalls or extant glaciers. The largest Holocene glacial moraine covers an area of approximately 0.8 km^2 and is approximately 2 km long

Qm_2 INTERMEDIATE GLACIAL MORAINES (Upper Pleistocene)--Unsorted to very poorly sorted, slightly compacted, sandy to clayey, boulder to cobble till. Lateral moraines are undissected to slightly dissected, sharp crested; terminal moraines are slightly to moderately dissected. Granitic boulders on moraine surfaces are slightly to moderately weathered, and soils are typically weakly developed. Includes some talus, colluvium, valley fill, outwash and alluvial fan deposits where these deposits are intimately associated with the glacial drift. In the Sierra Nevada, the minimum elevations of source areas for north-facing cirques associated with late Pleistocene moraines are as low as 2,590 m (8,500 ft) in the vicinity of Lake Tahoe in the northwest corner of the quadrangle and as low as 2,860 m (9,400 ft) in northern Yosemite National Park in the south-central part of the quadrangle. Terminal moraines of late Pleistocene glaciers in the larger valleys occur as low as 1,770 m (5,800 ft) near Markleeville in the northwest corner of the quadrangle and as low as 2,010 m (6,600 ft) in the Bridgeport Valley in the south-central part of the quadrangle. Lateral moraines of the larger valley glaciers typically rise to between 300 and 450 m above valley floors within 8 to 10 km upstream from associated terminal moraines. Small late Pleistocene glacial moraines also occur in north-facing valleys and cirques of the Sweetwater Mountains at elevations above 2,925 m (9,600 ft) and on Mt. Grant in the Wassuk Range at elevations above 3,020 m (9,900 ft). The two regionally correlatable late Pleistocene glaciations of the Sierra Nevada, were first recognized by Blackwelder (1931). Deposits of these two glaciations have been described and mapped in the Lake Tahoe area by Burnett (1971); in the Sonora Pass area by Clark (1967); and in the Bridgeport Valley-Mono Basin area by Burke and Birkeland (1979), Chesterman (1975), Chesterman and Gray (1975) and Sharp (1972). As mapped, intermediate glacial moraines include:

Qm_2ti Deposits of Tioga glaciation--Unsorted to very poorly sorted, slightly compacted, boulder to cobble till. Moraines are generally well preserved and sharp crested. Terminal moraines are only slightly eroded. Nearly all subsurface clasts are relatively fresh and soils on morainal surfaces are weakly developed. Surface weathering characteristics typical of unforested Tioga moraines include: less than 30 percent of granitic boulders are weathered, less than 50 percent of granitic boulders are pitted, pitting is subtle with depths generally less than 20 mm, and mafic inclusions in granitic boulders are weathered in relief to less than 50 mm (Burke and Birkeland, 1979)

Qm_2ta Deposits of Tahoe Glaciation--Unsorted to very poorly sorted, slightly compacted, boulder to cobble till. Moraines are generally well preserved and sharp crested, but somewhat less well preserved and more broadly crested than Tioga moraines. Terminal moraines are moderately eroded. Soils on morainal surfaces are weakly developed, but subsurface granitic clasts are generally grusified and oxidized to some extent. Surface weathering characteristics typical of unforested Tahoe moraines include: 50 percent or more of granitic boulders are weathered, more than 50 percent of granitic boulders are pitted, pitting is obvious with depths generally exceeding 25 mm, and mafic inclusions in granitic boulders are commonly weathered in relief in excess of 100 mm (Burke and Birkeland, 1979)

Qm_1 OLDER GLACIAL MORAINES (Middle and lower Pleistocene)--Deeply weathered, moderately well to well compacted, sandy to clayey, unsorted boulder to cobble till. Moraines are dissected and generally associated with hummocky topography and only local preservation of constructional form. Buried granitic clasts are typically decomposed to grus. Constructional surfaces are capped by moderately to strongly developed soils. Includes some older glacial outwash deposits too small to map separately. Only mapped beyond the limits of intermediate glacial moraine deposits. Where preserved and identified, older glacial moraines extend up to 2 km downstream beyond the termini of small late Pleistocene valley glaciers and as much as 10 km downstream from the limits of the larger late Pleistocene valley glaciers. Thickness 0 to 100 m

Qm MORAINAL DEPOSITS (Pleistocene)--Unsorted to very poorly sorted, sandy to clayey, boulder to cobble till. Includes some talus and colluvium where these materials are intimately associated with the glacial drift. Generally lacks diagnostic constructional form. Typically occurs as patchy veneer on bedrock in forested valleys of the Sierra Nevada. Thickness 0 to 30+ m

Qog OUTWASH-GRAVEL DEPOSITS (Pleistocene)--Poorly to moderately sorted, rounded boulder to cobble gravel, sandy gravel and gravelly sand. Preserved as discontinuous terrace remnants along several of the major streams draining the Sierra Nevada: the Upper Truckee River at South Lake Tahoe, the East Fork of the Carson River, the Middle and Clark Forks of the Stanislaus River and the Little Walker River. Also occurs as dissected outwash fans and aprons downstream from Pleistocene terminal moraines at the south end of Carson Valley, near the confluence of the Little Walker and West Walker Rivers, and at the south end of Bridgeport Valley. Thickenss 0 to 90 m

ALLUVIAL DEPOSITS

Qvf VALLEY-FILL DEPOSITS (Holocene)--Undifferentiated alluvium underlying low-gradient floors of alpine valleys. Includes stream-channel and flood-plain alluvium, low-gradient alluvial fan deposits, glacial outwash deposits and lacustrine deposits. Commonly associated with glacial drift. Contacts between valley-fill deposits and alluvial fan or outwash deposits are characteristically gradational and poorly defined. Mapped only in the alpine valleys of the Sierra Nevada

Qfp FLOOD-PLAIN ALLUVIUM (Holocene)--Moderately to poorly sorted gravelly to silty sand and sandy to clayey silt. Stream channel and overbank deposits along low-gradient perennial streams (the East and West Walker Rivers and the East and West Forks of the Carson River). Characterized by the flat topography typical of flood-plains along braided and meandering streams: point bars, mid-channel bars, sloughs and levees

Qbf BASIN-FILL DEPOSITS (Holocene)--Undifferentiated eolian, lacustrine, flood-plain and distal alluvial fan deposits. Mostly medium to fine grained sand, silt and clay with some interbedded coarser sand and gravel. Underlies large areas within many of the larger basins of the quadrangle. In basins with integrated through-flowing drainage, forms broad, very gently sloping (less than 0.5°) alluvial plains between the distal fringes of alluvial fans and the margins of active flood-plains (Carson, Antelope and Mason Valleys). In closed basins, occurs as either broad, gently sloping alluvial plains between the distal fringes of alluvial fans and the margins of playas (Gabbs Valley) or as narrow, discontinuous fringes around playas (Teels Marsh, Rhodes Salt Marsh, Columbus Salt Marsh). Contacts betwen basin-fill deposits and distal alluvial fan deposits, flood-plain deposits, lacustrine deposits or sand sheets are typically gradational and poorly defined. Thicknesses of Holocene basin-fill deposits are generally unknown. However, water wells in Carson, Smith, Mason, Rhodes, Soda Spring, Teels, and Walker Lake Valleys have penetrated as much as 200 m of alluvium without encountering bedrock and Neogene fill thicknesses in excess of 1,000 m are likely in these basins (Everett and Rush, 1967; Glancy and Katzer, 1975; Huxel, 1969; Rush and Schroer, 1976; VanDenburgh and Glancy, 1970)

Qf_3 YOUNG ALLUVIAL FAN DEPOSITS (Holocene)--Poorly sorted deposits of boulders, cobbles, pebbles, sand, and silt. Clast lithologies vary according to the rock types that crop out in the drainage basins associated with each fan. Clast size generally decreases and sorting generally improves downfan towards distal margins. Difficult to consistently distinguish from basin-fill deposits or valley-fill deposits where distal fan limits are gradational and poorly defined. Fan surfaces are undissected to slightly dissected with few, if any, well-defined drainage channels. Drainage is distributary, radiating from the fan apex. Constructional surfaces are generally unweathered with very weak, if any, soil development. Occurs throughout the valleys and basins of the quadrangle, including the alpine valleys of the Sierra Nevada. Particularly extensive in the lower piedmont areas of Antelope, Smith and Mason Valleys and in all of the larger closed basins east of the Wassuk Range

Qf_{3-2} YOUNG AND INTERMEDIATE ALLUVIAL FAN DEPOSITS (Holocene and upper Pleistocene)--Lithologically and texturally similar to young alluvial fan deposits. Morphologically intermediate and gradational between young and intermediate alluvial fan deposits. Includes fan-delta deposits around the margins of Walker and Mono Lakes (Pleistocene Lakes Lahontan and Russell). Also includes areas where young and intermediate age fan surfaces are too complexly interrelated to be mapped separately or where age relations are uncertain. This unit is the most abundant and widespread surficial unit mapped in the quadrangle. Occurs extensively thoughout the valleys and basins east of the Sierra Nevada

Qf_2 INTERMEDIATE ALLUVIAL FAN DEPOSITS (Upper Pleistocene)--Lithologically and texturally similar to young alluvial fan deposits. Contacts between intermediate and young alluvial fan deposits are commonly gradational and poorly defined. Intermediate alluvial fan surfaces are slightly to moderately dissected with numerous well-defined drainage channels. Drainage is predominantly distributary, but some drainage channels head on fan surfaces. Relief due to dissection is generally less than 5 m. Constructional surfaces are slightly to moderately weathered with weak to moderate soil development and distinct desert pavement. Typically concentrated along the upper or proximal parts of bajadas adjacent to mountain fronts. Occurs throughout the valleys and basins east of the Sierra Nevada but is most abundant and extensive fringing the closed basins east of the Wassuk Range. Includes some fan-delta deposits around the margins of the Walker and Mono Lakes (Pleistocene Lakes Lahontan and Russell)

Qf_{2-1} INTERMEDIATE AND OLD ALLUVIAL FAN DEPOSITS (Pleistocene)--Lithologically and texturally similar to young alluvial fan deposits. Morphologically intermediate and gradational between intermediate and old alluvial fan deposits. Also mapped in areas where intermediate and old alluvial fan deposits are complexly interrelated and difficult to map separately or where age relations are uncertain. Includes some fan-delta deposits around the margins of Walker and Mono Lakes (Pleistocene Lakes Lahontan and Russell). Typically underlies the upper or proximal parts of bajadas adjacent to mountain fronts, but is rarely exposed along tectonically active mountain fronts except where uplifted and protected from burial by faulting. Also occurs as intricately upfaulted fan remnants at the southern ends of Antelope Valley, Smith Valley and Whiskey Flat. Particularly extensive fringing the closed basins east of the Wassuk Range

Qf_1 OLD ALLUVIAL FAN DEPOSITS (Middle and lower Pleistocene)--Lithologically and texturally similar to intermediate and young alluvial fan deposits. Fan surfaces are deeply dissected by well-developed subparallel drainage that heads on the fan surface. Relief due to dissection is typically 10 to 30 m. Commonly separated from younger depositional surfaces by abrupt erosional scarps. Constructional fan surfaces are strongly weathered with moderately well to very well developed soils and distinct to well-developed desert pavement. Typically underlies the upper or proximal parts of bajadas adjacent to mountain fronts, but is rarely exposed along tectonically active mountain fronts except where uplifted and protected from burial by faulting. Occurs throughout the valleys and basins east of the Sierra Nevada but is particularly extensive fringing the closed basins east of the Wassuk Range

Qp_2 YOUNGER PEDIMENT DEPOSITS (Upper Pleistocene)--Lithologically, texturally, and morphologically similar to intermediate alluvial fan deposits except that the younger pediment deposits occur as veneers on erosion surfaces cut into bedrock and older alluvium. Contacts between younger pediment deposits and intermediate and young alluvial fan deposits are commonly gradational and poorly defined. Probably includes some intermediate alluvial fan deposits in areas of slight dissection. A component of most major pediment areas in the quadrangle. Occurs in any part of the piedmont from range front to alluvial flat. Adjacent to numerous widely scattered bedrock surfaces where pediment deposits have been removed by erosion. Occurs extensively along the west flank of the Wassuk Range and in several interior valleys of the Gillis and Gabbs Valley Ranges. Not present along tectonically active mountain fronts. Thickness 0 to 15 m

Qp_{2-1} YOUNGER AND OLDER PEDIMENT DEPOSITS (Pleistocene)--Lithologically, texturally, and morphologically similar to intermediate and old alluvial fan deposits, except that the pediment deposits occur as veneers on erosion surfaces cut into bedrock and older alluvium. Probably includes some intermediate and old alluvial fan deposits in areas of slight dissection. Adjacent to numerous widely scattered bedrock pediment surfaces where pediment deposits have been removed by erosion. A major component of almost all pediment areas in the quadrangle. May occur in any area of the piedmont from mountain front to alluvial flat. Occurs extensively along the west flank of the Singatse Range, the west flank of the Wassuk Range, the west and north flanks of the Pine Grove Hills (Pine Grove Summit) and in several interior valleys of the Gillis and Gabbs Valley Ranges. Not present along tectonically active mountain fronts. Thickness 0 to 25 m

Qp_1 OLDER PEDIMENT DEPOSITS (Middle and lower Pleistocene)--Lithologically, texturally, and morphologically similar to old alluvial fan deposits except that older pediment deposits occur as veneers on erosion surfaces cut into bedrock and older alluvium. Adjacent to bedrock pediment surfaces where pediment deposits have been removed by erosion. Occurs in any area of the piedmont from mountain front to alluvial flat. Difficult to distinguish from old alluvial fan deposits in aras of eroded alluvium, and probably includes some old fan deposits in areas of slight to moderate dissection. The most extensive and widespread of the pediment units mapped in the quadrangle. Occurs along the western flanks of the Pine Nut Mountains, the Wellington Hills, the Singatse Range and the Wassuk Range; along the west, north, and east flanks of the Pine Grove Hills; and within several interior valleys of the Gillis Range, the Gabbs Vallley Range, the Garfield Hills and the Excelsior Mountains. Not present along tectonically active mountain fronts. Thickness 0 to 25 m

QTg OLD ALLUVIAL GRAVEL AND SAND (Quaternary and (or) Tertiary)--Boulder to pebble gravel, sandy gravel, gravelly sand and sand. Gravel clasts are mostly subangular to subrounded. Loosely to moderately indurated matrix, predominantly sand and silt. Locally cemented by caliche. Local preservation of constructional form. Covers large areas along the crest of the Sweetwater Mountains. Also occurs extensively where the West Walker River cuts between the Pine Nut Mountains and the Wellington Hills and along the East Walker River from Bridgeport Valley to Sweetwater Flat. Elsewhere, typically occurs in uplifted blocks near or immediately adjacent to young faults. Thickness 0 to 100+ m

QTp PEDIMENT DEPOSITS (Quaternary and (or) Tertiary)--Boulder to pebble gravel, sandy gravel, and gravelly sand. Sandy matrix includes some silt and clay. Poorly to moderately sorted. Gravel clasts are subangular to subrounded. Occurs as veneers on bedrock erosion surfaces of deeply dissected piedmonts, typically on that part of the piedmont adjacent to the mountain front. Dominates the intensively faulted piedmont on the west flank of the Pine Nut Mountains. Also caps numerous scattered remnants of at least two erosion surfaces along the southeast, east, north and west flanks of the Pine Grove Hills, along the north, and northeast flanks of the Bodie Hills, and along the southwest flank of the Wassuk Range between Aldrich Station and Mud Spring. No other significant occurrences have been identified in the quadrangle. The highest of these surfaces, the Lewis Terrace of Axelrod (1956), stands approximately 250 m above the present level of the East Walker River where that stream cuts across the southeast flank of the Pine Grove Hills in the vicinity of Aldrich Station. Thickness 0 to 30 m

LACUSTRINE AND SPRING DEPOSITS

Qpa PLAYA DEPOSITS (Holocene)--Brownish- to grayish-white clay, silt, and fine sand with associated evaporite salt. Interbedded lenses of sand and gravel near playa margins. Deposited in ephemeral lakes occupying the central parts of closed basins. Thirty-two playas are mapped in the quadrangle but only seven of these playas are greater than 6 km^2 in area. Six of these larger playas are located in the closed basins of the eastern quarter of the quadrangle: Gabbs Valley playa, Soda Spring Valley playa, Garfield Flat playa, Rhodes Salt Marsh, Teels Marsh and Columbus Salt Marsh. Rhodes Salt Marsh, Teels Marsh and Columbus Salt Marsh are moist playas; the water table is typically within 3 m of the playa surface and saline mineral concentrations occur as surface crusts or as dispersed layers within the upper few meters of the playa deposits. Near-surface accumulations of borates (mostly borax and ulexite) occur locally and were mined from these playas in the latter part of the 19th century (Papke, 1976). Gabbs Valley, Garfield Flat and Soda Spring Valley playas are clay-pan dry playas with compact clayey surfaces and giant subparallel to polygonal dessication cracks. Giant dessication cracks are thought to result from the long term lowering of a relatively deep water table (Neal and Motts, 1967; Neal and others, 1968).
Three of these larger playas, Columbus Salt Marsh, Rhodes Salt Marsh, and Garfield Flat, were sites of small pluvial lakes during late Pleistocene time. According to Mifflin and Wheat (1979), the maximum depths of these lakes were: 171 ft (52 m) at Columbus Salt Marsh, 66 ft (20 m) at Rhodes Salt Marsh, and 23 ft (7 m) at Garfield Flat. Shoreline development associated with these lakes is generally poor and not well preserved and mappable occurrences of lacustrine deposits are rare. However, a series of four shorelines is preserved on a small late Pleistocene alluvial fan remnant on the northwest margin of Columbus Salt Marsh approximately 60 to 105 ft (18-33 m) above the present surface of that playa. In addition, shorelines on the northwest and east margins of Gabbs Valley playa at approximately 1,260 m (4,140 ft) elevation suggest the possibility of a shallow (less than 10 m deep) Pleistocene lake in that valley, although these shorelines have been suggested as an indication of Holocene tilting in that area (Ekren and Byers, 1978)

Qlh HISTORIC LACUSTRINE DEPOSITS (Upper Holocene)--Shoreline and lake-bottom deposits of Walker and Mono Lakes. At Walker Lake these deposits occur below a prominent nearly continuous strandline at approximately 1,255 m (4,120 ft) elevation. According to Rush (1970), the elevation of the lake was approximately 1,245 m (4,080 ft) in 1882. The Walker Lake deposits are characterized by prominent strandlines of well-sorted well-rounded sand and gravel; recessional littoral deposits of gravel, sand, and sandy silt; and lithoid tufa rinds on bouldery fan-delta deposits. At Mono Lake historic lacustrine deposits occur below a prominent, nearly continuous strandline at approximately 1,960 m (6,430 ft) elevation. According to Hardy (1942), the level of Mono Lake was approximately 1,945 m (6,375 ft) in the 1850's and rose to a high of 1,960 m (6,428 ft) in 1919. Lake level has since declined to a present elevation of approximately 1,942 m (6,370 ft). The Mono Lake deposits include a few recessional strandlines and near-shore lake-bottom deposits of alkali-rich clay, silt, and sand. Because of the continuing decline of both lakes, lacustrine deposits are now exposed as much as two km beyond the 1957 shorelines shown on this map. No significant vegetation, weathering, or soil development occurs on these deposits in either area

Qly YOUNGER PLUVIAL LAKE DEPOSITS (Holocene and upper Pleistocene)--Littoral and lake bottom deposits of Walker Lake (Pleistocene Lake Lahontan), Mono Lake (Pleistocene Lake Russell), Artesia Lake (Pleistocene Lake Wellington) and Lake Tahoe (late Pleistocene high strands of Lake Tahoe).
At Walker Lake, these deposits occur below the prominent Lake Lahontan high shoreline at approximately 1,330 m (4,370 ft) elevation. Characterized by strandlines and beach ridges of well-sorted well-rounded beach sand that are especially prominent and well developed on the lacustrine plain southeast of the present shoreline of Walker Lake. Near-shore deposits of medium sand to sandy silt occur between these strandlines. Lithoid tufa rinds are abundant on bouldery alluvial deposits and fan-deltas; and prominent accumulations of both lithoid and dendritic tufa characterize deposits near and along the high Lake Lahontan shoreline, particularly as tufa cemented conglomerates along narrow lacustrine terraces on the steep western shore of Walker Lake. Lacustrine deposits commonly veneer fan-deltas but locally have been buried by young alluvial fan deposits.
At Mono Lake, younger pluvial lake deposits occur below the Lake Russell high shoreline at approximately 2,190 m (7,190 ft) elevation, and significant thicknesses of these deposits are mostly limited to elevations below 2,135 m (7,000 ft). These deposits consist of laminated lacustrine silt with layers of intercalated volcanic ash locally overlain by sand and gravel of small alluvial fans and by numerous beach ridges and strandlines of medium sand to sandy silt. They are largely covered by sand dunes and sand sheets derived from the lacustrine deposits themselves and from the air-fall tuffs of Mono Craters immediately south of Mono Lake. Lithoid tufa rinds and coatings occur on littoral and alluvial deposits, and lithoid tufa towers associated with fresh-water springs from a prominent landscape element at elevations below 2,040 m (6,700 ft).
At Artesia Lake, younger pluvial lake deposits occur below the high Pleistocene Lake Wellington shoreline (approximately 1,460 m (4,790 ft) elevation). This high shoreline is well defined along the north shore of the lake by a series of narrow wave-cut bedrock benches, truncated intermediate and old alluvial fans, and a prominent beach ridge. Elsewhere, however, indicators of the former high shoreline are obscure and poorly preserved. The lacustrine deposits consist of distinctly bedded fine sand, silt, and clay with interbedded layers and channels of alluvial sand and gravel.
At the south end of Lake Tahoe, younger pluvial lake deposits are dominated by silt, sand, and gravel of the Pleistocene outwash delta of the upper Truckee River. These deposits also include small fan deltas and lacustrine terraces of gravelly coarse grus sand and an arcuate, 2 to 3 m high, beach ridge of moderately sorted sand. Significant thicknesses of all of these deposits occur within 100 ft (30 m) of the present level of Lake Tahoe

Qlo OLDER PLUVIAL LAKE DEPOSITS (Middle and lower Pleistocene)--Exposed in only two areas of the quadrangle, Smith Valley and the eastern shore of Walker Lake. In Smith Valley, these deposits consist of distinctly bedded, lacustrine sand, silt, and silty clay with occasional interbedded layers and channels of coarse sand and fine gravel. These sedimentary deposits underlie a broad lacustrine plain ranging from 1,460 m (4,800 ft) to approximately 1,510 m (4,960 ft) elevation across central Smith Valley. Sand sheets and younger pluvial lake deposits veneer large areas of this plain; and exposures of older pluvial lake deposits are restricted to deflation hollows southeast of Artesia Lake and to bluffs, gullies and small canyons along the flood plain of the West Walker River, entrenched 5 to 40 m below the plain's surface. On the eastern shore of Walker Lake, these deposits consist of well-sorted gravel and sandy gravel with occasional tufa fragments and tufa rinds on gravel clasts. Limited to a single pre-Lake Lahontan(?) point bar remnant between elevations of 1,335 m (4,380 ft) and 1,370 m (4,500 ft) on the east shore of the Walker Lake (Mifflin and Wheat, 1979), immediately above and adjacent to a large prominent and well-preserved point bar deposit of Lake Lahontan age

Qsp SPRING DEPOSITS (Holocene and upper Pleistocene)--Mounds, ridges, terracettes, platforms, and towers of travertine and tufa deposited by mineral springs. Also includes fringing deposits of alkali-rich silt and clay. Occurs in several small, widely scattered areas of the quadrangle: Soda Spring at the south end of Soda Spring Valley; German Spring and Rock House Spring approximately 10 km south of Teels Marsh, Travertine Hot Springs east of Bridgeport, and Fales Hot Springs west of Devil's Gate. Also includes the lithoid tufa towers of Mono Lake. Lithoid tufa towers are assoicated with fresh-water springs, and they are formed at or near lake level by algal activity in areas of fresh spring water-lake water mixing (Lajoie, 1968)

EOLIAN DEPOSITS

Qsd SAND DUNES (Holocene)--Well-sorted medium to fine sand. Forms barchanoid ridge dunes and longitudinal dunes, 1 to 15 m high. Typically occurs leeward of pluvial lake plains, playas and distal fringes of large young alluvial fans. At least partly stabilized by sparse to moderately dense stands of sagebrush and bitterbush. By far the largest dunefield in the quadrangle covers an irregular area of approximately 115 km^2 on the lacustrine plain northeast of Mono Lake. This dune field is derived from lacustrine deposits of Mono Lake and Pleistocene Lake Russell and from the air-fall tuffs of Mono Craters. The largest dunes in this field are mobilized beach ridges of Lake Russell. Other large dune fields include: barchanoid ridge and longitudinal dunes veneering the lacustrine plain and piedmont east and northeast of Artesia Lake and east of the Walker River flood-plain and fan-delta at the north end of Walker Lake; narrow fields of barchanoid ridge dunes surrounding Gabbs Valley playa, fringing the east and north margins of the Soda Spring Valley playas, the southwest margin of Rhodes Salt Marsh, and the south, east, and northeast margins of Teels Marsh; a small field of complex dunes northeast of Garfield Flat; and an approximately 10 km long belt of longitudinal dunes veneering alluvial fans and bedrock northeast from Teels Marsh to Belleville. Sand dune orientations and dune field distribution indicate dominant southwest to west-southwest wind directions in this region. Symbols for units covered by sand dune deposits are shown in parentheses. Thickness 0 to 15 m

Qes EOLIAN SAND DEPOSITS (Holocene)--Well to moderately well sorted sand and silt. Occurs as thin sand sheets that veneer other surficial deposits and bedrock leeward of and largely derived from lacustrine plains, playas, and the distal fringes of large young alluvial fans. Extensive sand sheet veneers occur at the following locations: the lacustrine plain of central Smith Valley; the alluvial plain and piedmont east and northeast of Mason Valley; the west and southwest flanks of the Gillis Range and the bajada along the north flank of Soda Spring Valley; extensive areas of alluvium and bedrock east and southeast of Gabbs Valley; the piedmonts and lower mountain slopes east of Rhodes Salt Marsh, Teels Marsh, and the Soda Spring Valley playa; and extensive areas of the lacustrine plain and uplands northeast of Mono Lake. The systematic distribution of these sand sheets indicates dominant west to southwest wind directions only locally modified by northwest topographic trends. Symbols for units veneered by eolian sand sheets are shown in parentheses. Thickness 0 to 5 m

Qea EOLIAN AND ALLUVIAL DEPOSITS (Holocene)--Eolian sand and young alluvial fan deposits in small fault-bounded depressions in the intensively faulted uplands east and northeast of Mono Lake. Predominantly reworked late Pleistocene and Holocene air-fall tuff from Mono Craters south of Mono Lake. Thickness 0 to 30 m

LANDSLIDE DEPOSITS

Qls LANDSLIDE DEPOSITS (Holocene and Pleistocene)--Chaotic masses of unsorted angular boulder- to clay-size debris. Includes some talus and colluvium where these materials overlap or are intermixed with landslide debris. Typically forms hummocky lobate masses in moderately to steeply sloping upland terrain. Two hundred and nine large landslides (area greater than 0.1 km^2) have been identified and mapped in the quadrangle. The individual areas of these landslides follows an exponential distribution ranging from 96 slides with areas less than 0.3 km^2 to one slide with an approximate area of 12.0 km^2. Thirty-five landslides exceed areas of 1.0 km^2. The total area of all of these slides is approximately 160 km^2, almost 0.8 percent of the total area of the quadrangle. Eighty-one percent (170) of these landslides involve Tertiary volcanic rocks, predominantly andesitic and latitic lahars, ash flows, air fall tuff and lava flows. An additional 15 percent (32) involve Mesozoic granitic rocks. Most of these landslides are rotational slump-block debris flow or glide-block debris flow complexes that have formed on 25 to 60 percent (14-31°) slopes along or within 10 km of tectonically active mountain fronts

Qlsb LANDSLIDE BLOCKS (Holocene and Pleistocene)--Coherent gravity faulted bedrock blocks, as much as to 1.5 km in maximum dimension, that occur at the heads of large landslides. Arcuate faulting and backward rotation of these blocks demonstrate their genetic relationship with the adjacent landslides

ARTIFICIAL DEPOSITS

mw MINING WASTES (Upper Holocene)--Boulder- to clay-size fragments of fractured, crushed, and pulverized rock dumped in large spoil piles and tailings ponds. Large dumps of mining waste in the quadrangle occur at the Yerington copper mines on the east flank of the Singatse Range, the Leviathan sulfur mine northwest of Monitor Pass, and the Bodie gold and silver mines in the southeast Bodie Hills

BEDROCK

r BEDROCK (Quaternary and (or) pre-Quaternary)--Igneous, metamorphic, and sedimentary rocks of Precambrian through Quaternary age. In the west and southwest parts of the quadrangle, the Sierra Nevada is predominantly underlain by Mesozoic granitic rocks intruding pre-Tertiary metasedimentary rocks and unconformably overlain by Tertiary lahars, flows, and ash flows of silicic to intermediate composition. East of the Sierra Nevada, several of the fault-block ranges in the north central part of the quadrangle (the Pine Nut Mountains, the Wellington Hills, the Sweetwater Mountains and the Singatse Range) possess a similar geology except that the Tertiary volcanic rocks are overlain by late Tertiary terrigenous sedimentary rocks. South and southeast of these ranges, the Bodie and Anchorite Hills north and east of Mono Lake are dominated by Tertiary and Quaternary volcanic rocks of basaltic through rhyolitic compositions. Farther east, the upfaulted and westward-tilted Wassuk Range is composed primarily of Mesozoic granitic rocks intruding slightly to moderately metamorphosed Mesozoic volcanic and sedimentary rocks. East of the Wassuk Range, the bedrock geology of the eastern third of the quadrangle becomes somewhat more complex and varied. In the Gillis Range east of Walker Lake, Mesozoic intrusive, volcanic, and sedimentary rocks predominate, whereas father northeast the Gabbs Valley Range is mostly composed of middle and late Tertiary andesitic lahars, tuffs and flows and silicic nonwelded to welded ash-flow tuffs. The southeast part of the quadrangle is underlain by a variety of slightly to moderately metamorphosed Paleozoic and Mesozoic volcanic and sedimentary rocks, Mesozoic plutonic rocks, and middle and late Cenozoic volcanic rocks. Throughout the quadrangle pre-Tertiary rocks are extensively folded and faulted. In contrast, deformation of the middle and late Tertiary volcanic and terrigenous sedimentary rocks is essentially limited to high-angle faulting (Stewart, 1982)

CONTACT

FAULT--Mapped faults are limited to those faults which by stratigraphic evidence can be shown to be Quaternary or by geomorphic evidence can be inferred to be Quaternary and (or) late Tertiary. In Quaternary deposits, fault traces are shown as solid lines only where offset of Quaternary deposits can be demonstrated. Fault traces forming contacts between bedrock and Quaternary units are shown as solid lines only where offset of the Quaternary deposits can be demonstrated or where Quaternary movement is suggested by the morphology of the bedrock scarp. Elsewhere, fault traces in or bounding Quaternary deposits are shown as dotted lines. In bedrock, faults are mapped where the morphology of the fault trace suggests Quaternary and (or) late Tertiary movement or where fault traces can be related to faults that offset or bound Quaternary deposits. Fault traces in bedrock are solid where known, dashed where inferred

HISTORIC HIGH SHORELINES--Delineates contacts between historic lacustrine deposits and pluvial lake deposits

YOUNGER PLUVIAL LAKE SHORELINES

m GLACIAL MORAINE CRESTS

BEDROCK PEDIMENT SURFACE WHERE PEDIMENT DEPOSITS HAVE BEEN REMOVED BY EROSION--Typically well dissected

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Interior—Geological Survey, Reston, Va.—1982
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