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NEVADA BUREAU OF MINES AND GEOLOGY

REPORT 22

GUIDEBOOK TO THE QUATERNARY GEOLOGY ALONG THE WESTERN FLANK OF THE TRUCKEE MEADOWS, WASHOE COUNTY, NEVADA

(Prepared in conjunction with Geological Society of America Cordilleran Section Meeting, Las Vegas, Nev., March 1975)

BY E.C. BINGLER

A road log and trip guide to glacial, alluvial fan, and basin deposits: City of Reno south via US 395 to the Mount Rose fan complex.

MACKAY SCHOOL OF MINES
UNIVERSITY OF NEVADA · RENO
1975

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GUIDEBOOK TO THE QUATERNARY GEOLOGY ALONG THE WESTERN FLANK OF THE TRUCKEE MEADOWS, WASHOE COUNTY, NEVADA

E.C. Bingler

INTRODUCTION

This report briefly describes the stratigraphy and physical features of Quaternary deposits that underlie the western half of the Truckee Meadows from Reno south to the Mount Rose fan complex. Much of the information presented is taken from stratigraphic, sedimentologic, and detailed field studies in progress, and supported jointly by the Nevada Bureau of Mines and Geology and by Federal funds provided through U. S. Geological Survey Earthquake Hazard Reduction Grant No. 14-08-0001-G-78-73. This work is aimed at providing a more detailed stratigraphic framework to use in dating last movement of faults and determining the history of fault movements in the Reno area. Although many details of the Quaternary geologic history in this area have emerged during these studies, the regional patterns of Quaternary stratigraphy had been established by the mapping of Thompson and White (1964) in the Mount Rose quadrangle, and especially the reconnaissance mapping of Birkeland (1966, 1968) along the Truckee River system.

REGIONAL SETTING

The term Truckee Meadows as used in this report refers in a broad regional sense to the area occupied by the structural basin bounded by the Virginia Range on the east, the Carson Range on the west, Steamboat Hills to the south, and the eastern part of the uplifted Peavine Mountain block to the north. These marginal blocks include Mesozoic metavolcanic and plutonic rocks overlain by a thick sequence of Tertiary volcanic and epiclastic rocks made up largely of andesite and andesite porphyry flow rock, hypabyssal intrusives, and minor siliceous welded tuff. Large volumes of propylitically altered volcanic rock are exposed in the extensive foothill and mountain drainages that rim the valley. Tilted beds of conglomerate, sandstone, and diatomite of Miocene to late Pliocene age are exposed along the western margin of the Truckee Meadows and to the north and west along and in the Truckee River drainage basin, and mark the early initiation of basin sediment accumulation. The extensive Quaternary deposits exposed in the Truckee Meadows represent the continuation of long-established patterns of basin sediment accumulation.

Three major categories of Quaternary deposits are recognized:

1. Main stream gravel deposits of the Truckee River, almost entirely represented by extensive bouldery outwash assigned to Illinoian and Wisconsinan glacial activity in the Sierran province.
2. A long and complex history of alluvial fan deposition along the margins of the Truckee Meadows and extending in time from early Quaternary into the Holocene.
3. Reworking of older deposits and deposition of relatively fine-grained clastic debris throughout the central part of the Truckee Meadows by low-gradient streams during the Holocene and continuing to the present.

THE DEPOSITS

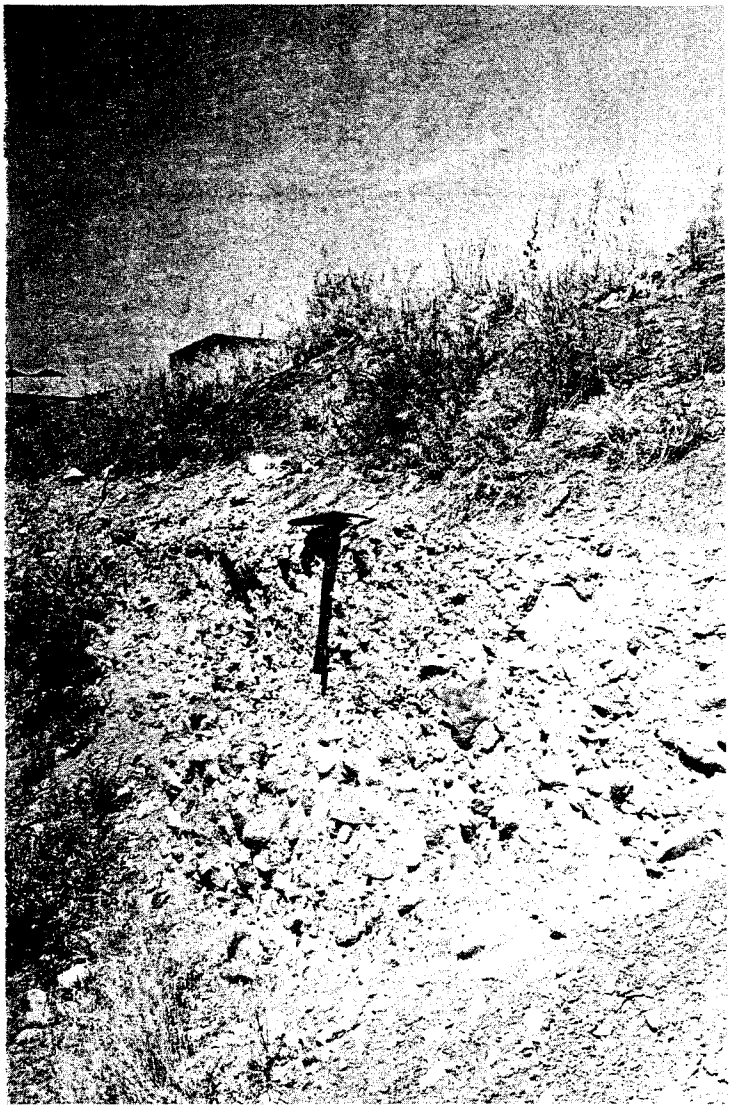
Tertiary

Sandstone of Hunter Creek (Th): Intercalated pale gray to gray or greenish-brown siltstone and fine sandstone, with diatomite and diatomaceous fine sandstone, and moderately well sorted, texturally mature medium pebble to small cobble gravelly sand. Lowermost 800 to 1000 feet is very gravelly, and mean size of large clasts increases toward the basal contact with volcanic bedrock. Lowermost beds include much volcanic detritus and local thin tuff beds and mudflows. A 1000- to 3000-foot-thick medial member is almost entirely diatomite and diatomaceous sandstone. The uppermost few hundred feet of the sandstone of Hunter Creek is a complex sequence of diatomaceous sandstone, volcanic arenite, and thin but areally extensive dune deposits. Information on the age of this informal stratigraphic unit is sparse; parts of it may be as old as 10 m.y. and uppermost beds may be as young as Blancan. In the past this formation has been correlated with the Truckee Formation.

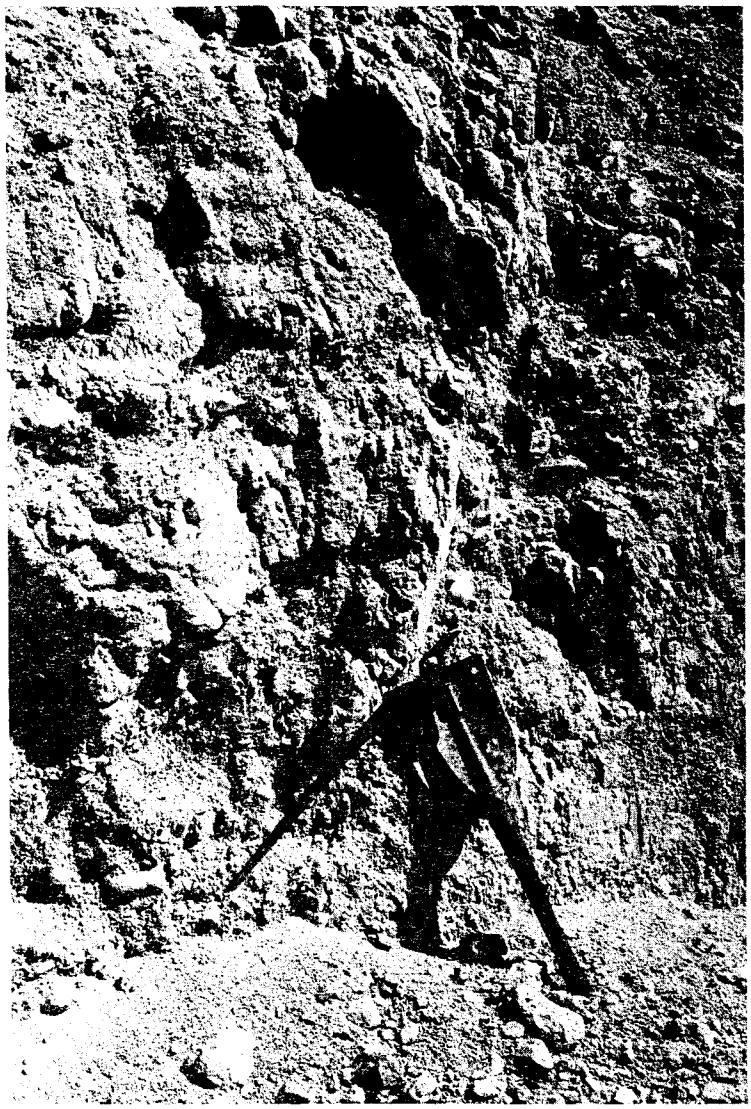
Pleistocene

Siliceous sinter (Qs): Deposits of siliceous sinter shown on the map (fig. 1) were mapped by White and others (1964) as part of a very detailed study of the Steamboat Springs thermal area. Older chalcedonic sinter was assigned a middle Pleistocene age; opaline sinter is inferred to range in age from middle Pleistocene to the present. The reader interested in these deposits is referred to the detailed and extensive discussion presented by White and others (1964).

Alluvial fan deposits of Peavine Mountain (Qpf): This informal stratigraphic unit includes the earliest recognizable alluvial fan deposits of Quaternary age in the Truckee Meadows. Weakly defined beds of yellowish-brown gravel to gravelly muddy sand unconformably overlie steeply dip-



Well developed soil on poorly sorted alluvial fan deposits of Peavine Mountain.



Minor fault plane cutting weakly bedded gravelly sand of the alluvial fan deposits of Peavine Mountain (Qpf).

ping strata of the sandstone of Hunter Creek throughout most of northwest and southwest Reno. About 2 miles south of Windy Hill the fan deposits thin very rapidly under distal pediment gravels (Qdm) of the Mount Rose fan complex.

In north and northwest Reno large areas are underlain by beds of poorly to moderately sorted gravelly muddy sand comprised of angular pebbles to small cobble-sized clasts of andesite and white bleached andesite in a matrix of muddy sand in which the principal clay mineral is montmorillonite. Textural parameters and sedimentologic features indicate that these deposits were formed by deposition from moderately high energy streams of debris that was rapidly being stripped from the volcanic and altered volcanic foothill belt. Deposits of the fan complex underlie southwest Reno and are similar except for an increase in highly rounded clasts that appear to be derived from beds of highly rounded pebble gravel present within the Kate Peak Formation in the foothill belt south and west of Reno. The alluvial fan deposits of Peavine Mountain underlie all known glacial deposits in the Truckee River system and are tentatively regarded as early Pleistocene in age. For the sake of simplicity in this report gravel mapped informally as the Gravel of Reno by Birkeland (1968) and shown on the geologic map of Reno (Bonham and Bingler, 1973) was included in the alluvial fan deposits of Peavine Mountain. Birkeland indicated the age of the Gravel of Reno to be greater than flows of Lousetown Formation ranging in age from 1.2 to 2.3 m.y. but younger than 2.4 m.y. Our mapping in the Reno quadrangle suggests a partly disconformable and partly intertonguing relationship between the Gravel of Reno and fan deposits, and leads us to favor an early Quaternary (1 to 2 m.y.) age assignment for the fan gravel.

Pediment and alluvial fan gravel (Qp): This unit includes thin veneers of moderately to poorly sorted medium pebble to cobble gravel found partly as a thin alluvial fan at the mouth of Evans Creek and as gravel sheets distributed across pedimented bedrock and fan deposits south of Evans Creek and in extreme northwest Reno. Clast content is dominantly volcanic with only a few percent plutonic types represented. Gravel ranging in age from pre-Illinoian to

Deeply weathered pediment gravel (Qp) resting on sandstone of Hunter Creek in northwest Reno.

late Illinoian is included in the map unit as shown on figure 1.

Donner Lake outwash deposits (Qd; Qdm): Deposits of Donner Lake outwash of Illinoian age are shown on figure 1 underlying much of south and southwest Reno. Along the western margin of the map in the Truckee River valley, deposits of bouldery outwash (about 30 feet thick) form strath terraces capping bedrock; further east under the city of Reno similar deposits form an extensive mantle that thickens gradually eastward to a maximum of several hundred feet. Similar outwash extends as far east and south as the Colosseum site in south Reno. All of the Donner Lake outwash that was examined is deeply weathered, with well-marked soil horizons extending to depths of 6 to 8 feet.

Deposits of Donner Lake outwash are composed principally of unconsolidated small cobble gravel and interbedded coarse sand. Sandy horizons are discontinuous and grade rapidly into sandy gravel laterally. The gravel component is characterized by a high degree of rounding of individual clasts, the presence of very large boulders (>5 feet in diameter) of basalt or quartz monzonite, and the absence of altered andesite clasts. Unusually large boulders, 12 to 16 feet in diameter, are common in Donner Lake outwash, and are attributed to transport by catastrophic flooding of the Truckee River during glacial stages. Birkeland (1968) describes the process of ice damming of Lake Tahoe during glacial intervals and subsequent breaching with the generation of catastrophic floods (Jökulhlaups).

Pediment and thin fan deposits in the Mount Rose fan complex are here regarded as formed during Illinoian time (Donner Lake glaciation) by major mountain front streams that reached the western edge of the Truckee Meadows and transported debris from alpine glacial environments high in the Carson Range. The large area of gravel in the southern part of the map (fig. 1) represents material transported down Thomas and White's Creek drainages. These deposits disconformably overlie early Pleistocene alluvial fan deposits and are overlain in part by deposits believed to be of Wisconsinan age. There is no direct stratigraphic link between Truckee River outwash and these pediment and fan deposits. Thompson and White (1964) include the pediment and fan gravel described here within their pre-Lake Lahontan unit, and indicate a Kansan (Sherwin glaciation; Hobart glaciation) age. Lacking direct evidence this older age assignment must remain a possibility.

These deposits consist largely of brown to brownish gray, poorly sorted, muddy sandy pebble gravel. Cobbles and small boulders are common. Clasts are dominantly volcanic; porphyritic andesite and latite are the principal rock types. Plutonic rock types are present in the deposits but are not common at the surface because of decomposition in the thick soil horizon.

Tahoe outwash deposits (Qt; Qtn): Mainstream deposits of sandy boulder to large cobble gravel deposited by the Truckee River during Wisconsinan time underlie much of Reno and Sparks. The large area underlain by these unconsolidated and weakly weathered deposits is marked by low relief, a gentle gradient of about 30 feet per mile eastward, and a surface litter of highly rounded cobbles and small boulders of gray andesite and pinkish white quartz monzonite and aplite. In embankments and excavations Tahoe outwash is recognized by an overall gray to brownish-gray color, highly rounded gravel clasts, and clast content of approximately 55 percent gray andesite, 30 percent basalt, 6 percent metavolcanics, 5 percent rhyolite, and 4 percent plutonic rocks. Clast content by rock type varies from place to place within the outwash and prominent white quartz monzonite cobbles are more abundant locally. Tahoe outwash, like the older Donner Lake outwash, characteristically includes giant boulders deposited as part of gravel beds during periods of catastrophic flood-

Bouldery Tahoe outwash overlain by a thin veneer of Holocene gravelly sand reworked locally from the alluvial fan deposits of Peavine Mountain. Excavation for Interstate 80

ing. Boulders of quartz monzonite up to 16 feet in diameter were removed during excavation for Interstate 80 just south of the University campus, and boulders of similar size have been encountered in many excavations for large commercial buildings in the Reno area.

In the Reno-Sparks area, Tahoe outwash forms an extensive alluvial wedge, thickening eastward, that represents rapid filling of an extensive river valley and the basinal downwarp of the northern Truckee Meadows. This wedge of coarse clastic debris ranges in thickness from about 300 feet in west Reno to over 1000 feet under the city of Sparks.

At the southern margin of the map area a thin veneer of gravel, rich in fresh quartz monzonite boulders, forms the upper surface of the Mount Rose fan complex from the mouth of White's Canyon and along White's Creek to north and east of the Steamboat Hills. These deposits can be distinguished from the older pediment and fan gravel immediately to the north by virtue of their greater content of plutonic rock clasts and by the weakly weathered upper fan surface. The age of this deposit is not known; it is here tentatively regarded as Wisconsinan in age and inferred to be outwash derived from alpine glaciers in the White Canyon drainage basin high in the Carson Range.

Holocene

Holocene deposits in the Truckee Meadows include bajada complexes of low gradient fans around the valley margin, several distinct alluvial fans at the mouths of substantial drainages, and an areally extensive but thin sheet of interbedded silt, fine sand, and peat deposited in a complex floodplain-swamp-lacustrine environment.

Alluvial fan-bajada-floodplain complex (Qa; Qf): These map units include extensive fluviatile deposits of low-gradient streams that reworked older gravelly outwash and alluvial fan deposits along the west and south margins of the Truckee Meadows. Sand and mud removed from older deposits have been redeposited in a thin but areally extensive mantle extending from the Mount Rose fan complex north and northeastward toward the axis of the basin. These deposits are very weakly weathered and largely undissected. Locally, as at Windy Hill, material transported down the large Evans Creek drainage area has built a fan eastward that has engulfed high-standing remnants of Donner Lake outwash south of Virginia Lake and the faulted west margin of Windy Hill. These fan deposits intertongue with and become an integral part of the large bajada mantle represented by the map unit Qa.

Floodplain-swamp sequence (Qfl): Interbedded gray to pale grayish-yellow silt and fine sand deposits cover much of the eastern and central parts of the Truckee Meadows. Maximum thickness of the unit east of Sparks is about 20 feet, and it thins to a feather edge along its western edge in and south of the city of Reno. Thin lenses of peat 1 to 2 feet thick are common as interbeds as are clay-rich horizons suggestive of local ponding conditions. The position of this sequence along the frontal lobate margin of the Tahoe outwash alluvial plain, the uniform gray color, and the mineral content of the sands (rich in fresh black biotite and clear feldspar) all suggest that much of the sequence was derived by winnowing of the outwash plain.

Samples of interbedded peat have yielded a C^{14} age of 2130±165 years B.P. making these the youngest deposits outside of presently forming mainstream gravel in the Truckee River channel. These dated beds directly overlie and marginally intertongue with the alluvial fan and floodplain deposits of the Qa map unit; hence the Qa beds are regarded as middle to late Holocene in age.

QUATERNARY FAULTING

Quaternary faults are common and widespread throughout the Truckee Meadows. Nearly all the faults shown on figure 1 display Pleistocene movement, but very few fault planes transect known Holocene deposits. Most faults in the map area are normal faults, a few notably in northwest and southwest Reno have reverse displacements. Cordova's (1969) study of fault patterns in the Mount Rose fan complex has been the standard reference on the distribution and structural style of fault traces in the southern part of the Truckee Meadows. In addition to mapping on air photos, he examined individual traces carefully in the field and recorded scarp heights and attitudes. He found that most scarps do not exceed 20 feet in height; a few are up to 50 feet high. Using scarp slope angles he inferred episodic movement on at least 25 percent of the scarps measured.

The impression one gets from the geologic map of a swarm of relatively short fault traces is accurate; no single fault can be traced for more than a mile or two, and even zones of high fault density are tenuous and ambiguous when one attempts to draw domain boundaries. Several regional patterns emerge from examination of figure 1. A cluster or swarm of faults beginning just north of Steamboat Hills trends slightly east of north and extends into the Huffaker Hills. A narrower network of faults extends north beginning within the northwestern spur of the Steamboat Hills, trending a few degrees west of north across the Mount Rose fan complex, merging with basement faults west of Windy Hill, and extending discontinuously northward into downtown Reno. A third zone of faults marks the boundary between bedrock and the Mount Rose fan complex at the canyon of White's Creek and extends northward through and into the highly fragmented and disarticulated mountain margin west of Windy Hill. This pattern suggests, but by no means proves, that patterns of dislocation in the bedrock areas continue within and similarly affect younger basin deposits, and it would seem that much of what we now see of the spatial distribution of Quaternary faults may well result from the continuing release of strain in and around this basin along patterns that have been effective over a long period of time.

Displacement on Quaternary faults in the map area, based on present scarp heights, ranges from a few feet up to 30 to 40 feet on a few traces. Scarps at the upper limit of this range are present in Reno along the west edge of Virginia Lake, in the hills southwest of the Centennial Colosseum, along the basin margin in the Thomas Creek drainage and at the mouth of White's Creek, and at the northwest margin of the Steamboat Hills. At the other extreme many of the faults in the Mount Rose fan complex display only a few feet of displacement (only about 50 percent of the fault traces are shown within the area of the Mount Rose fan complex; the deleted faults are all of very minor displacement. If the deleted faults were shown on figure 1, the density would increase but the regional patterns would not change.)

The spatial distribution of faults and the time sequence of movement of faults within the Mount Rose fan complex is extremely involved. There is little evidence to suggest that there was fault movement during the main period of fan growth; instead most of the faults in the fan area transect fan and pediment gravel without noticeable change in depositional pattern across individual faults or fault zones. There are examples of minor stream piracy, stream course disruption, and small local fan building within drainages established on the dissected fan surface. Most of these features seem to be of middle to late Holocene age.

Some faults appear to have a history of slow, post-Wisconsinan movement. Geomorphic evidence for the development of White's Creek just north of Steamboat Hills along State Route 27 is significant in this respect. White's Creek is a consequent drainage developed on the upper surface of the Mount Rose fan complex, and is part of a larger regional set of consequent drainages distributed radially on the fan. Just north of Steamboat Hills a horst block of faulted gravel transects the White's Creek drainage, and within that elevated block White's Creek forms an antecedent canyon. One explanation for this pattern is that slow movement over a long period of time on the bounding faults (high scarps) permitted slow entrenchment of White's Creek to its present level. Had movement been abrupt and extensive on the bounding faults, White's Creek would have been locally dammed and diverted to the north down the sloping fan surface.

The complex relationships between faulting and Quaternary stratigraphic patterns are only now beginning to be better understood for the Truckee Meadows. Much is owed to the earlier mapping that provided a regional overview and insight into the major problems to be solved. The brief treatment offered here is intended as a partial presentation and review of new data and our approach to the problems. It is not a review of research completed and conclusions reached, but is intended as a stimulus to discussion of the problems presented by the Quaternary in the Truckee Meadows.

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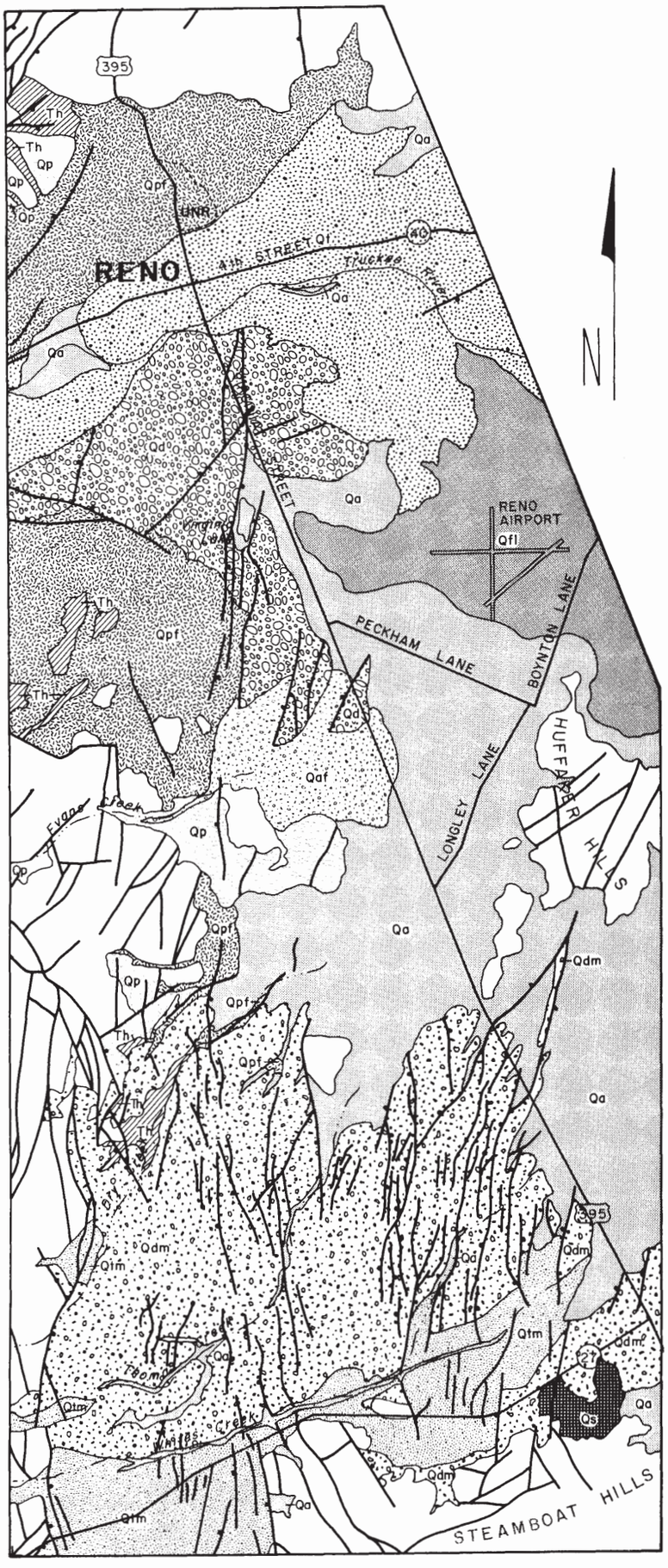


QUATERNARY GEOLOGY:

UNIVERSITY OF NEVADA RENO CAMPUS–
VIRGINIA STREET (395 SOUTH) – STEAMBOAT HILLS

Compiled by E. C. Bingler

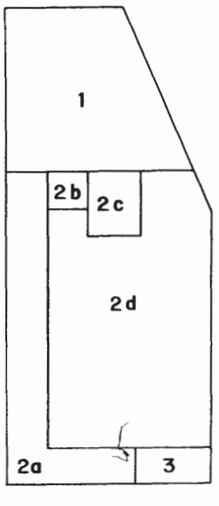
QUATERNARY
- Holocene
  - Qfl — Fluviatile and lacustrine silt and fine sand.
  - Qa / Qaf — Alluvium. (Qa): *thin sheet-like aprons of fine- to medium-grained clayey sand and intercalated pebble gravel.* (Qaf): *Windy Hill alluvial fan.*
- Pleistocene
  - Wisconsinan
    - Qt / Qtm — Tahoe outwash. (Qt): *cobble gravel and sand in the Truckee River drainage.* (Qtm): *boulder to cobble gravel in the Mt. Rose area.*
  - Illinoian
    - Qd / Qdm — Donner Lake outwash. (Qd): *cobble gravel and sand in the Truckee River drainage.* (Qdm): *Donner Lake outwash in the Mt. Rose area; bouldery pediment gravel locally grading into fan deposits.*
  - Early Quaternary
    - Qp — Pediment gravel.
    - Qpf — Alluvial fan deposits of Peavine Mountain.
    - Qs — Siliceous sinter in the Steamboat Hills.

TERTIARY
- Th — Sandstone of Hunter Creek.
- Basement rocks.

SCALE 1: 62,500

0 1 2 3 MILES

0 1 2 3 4 KILOMETERS



SOURCES OF GEOLOGIC DATA

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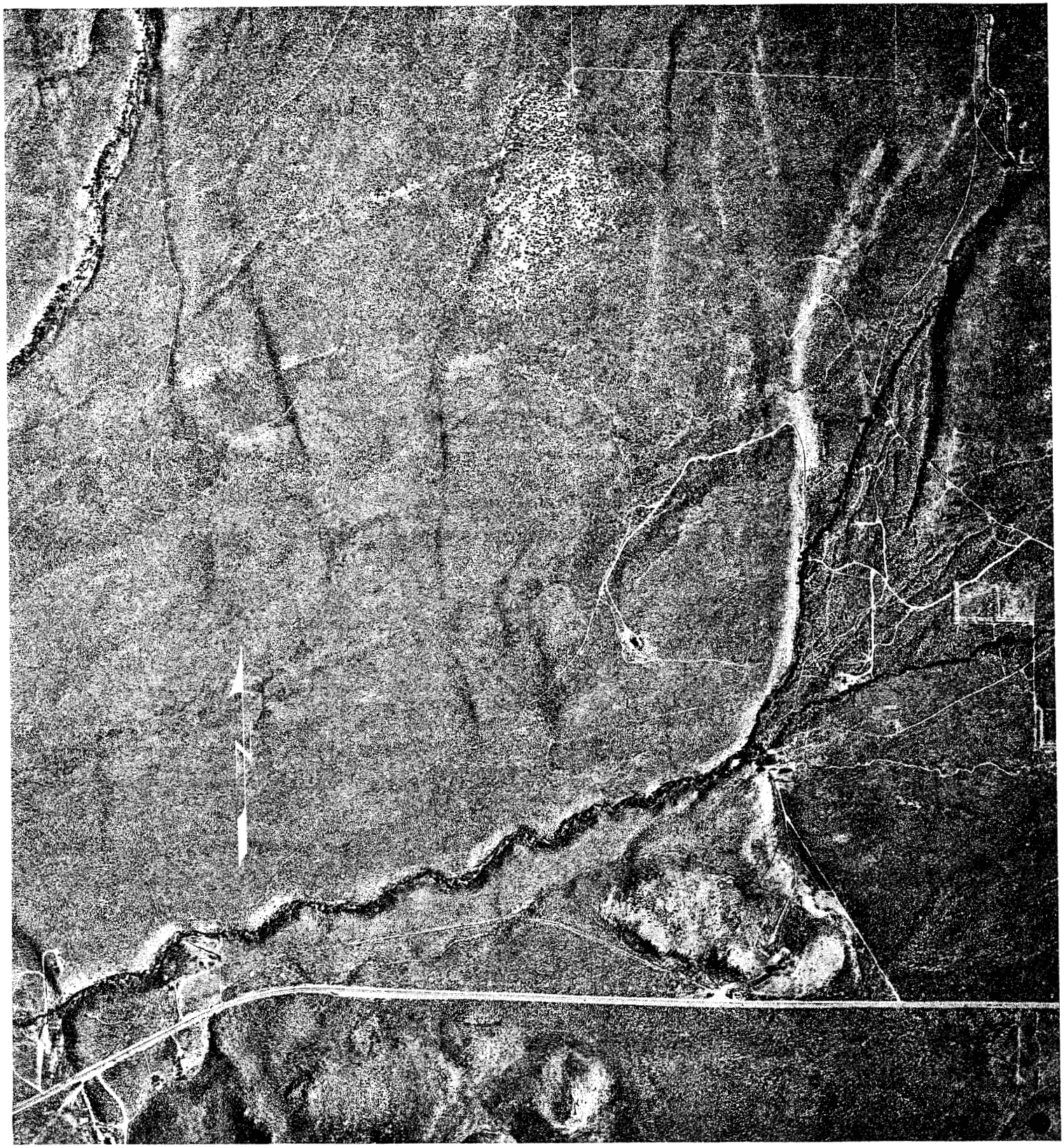


Antecedent drainage of Whites Creek crossing a horst block of outwash fan gravel. Nevada Highway 27 is seen at the bottom of the photograph. The area shown is at the northwest edge of the Steamboat Hills.

ROAD LOG

This road log describes exposures of Quaternary surficial deposits from the University campus south through Reno, across the Truckee River valley through the alluvial fan and basin fill sequence of the southern Truckee Meadows to the Steamboat Hills.

0.0 Distance **0.0 Cumulative mileage**

University of Nevada-Reno heating plant. At the assembly point we are in a steep-walled drainageway cut in partially cemented alluvial fan deposits of Peavine Mountain (early Quaternary). This drainage is only one of several cut deeply into a bajada complex that mantles the altered bedrock foothills north and west of Reno. Most of the incision that produced the old channels appears to have taken place during and subsequent to the Wisconsin glacial stage, because nearly all of the channel floors are coincident with the upper surface of the Tahoe outwash floodplain within the Truckee River valley.

Leave parking lot by temporary exit. Turn left onto University connecting road and climb the hill up to large parking lot. Keep to the left and continue west up the grade, past the gymnasium to North Virginia Street. Exposure of yellowish-brown small cobble to medium pebble sandy gravel containing numerous light-colored, altered volcanic clasts is typical of the fan deposits. The gravel matrix contains about 5 percent montmorillonite, probably largely transported from the volcanic provenance, and is the reason for local foundation problems associated with some residential dwellings in north and northwest Reno.

0.2 Distance **0.2 Cumulative mileage**

Turn right onto North Virginia Street (U.S. Highway 395 north). Use extreme caution—dangerous intersection. From this point north to the large University parking lot the highway traverses an intermediate bench cut on fan gravel and related to the very wide drainage visible on the right. Approaching the parking lot entrance the drainage is to our right and trends northwest passing under Virginia Street and sloping gently upward to the left toward the accretionary top of the old bajada. Transport of material was from northwest to southeast down this drainage and ultimately reaching the Tahoe outwash floodplain. Many of the modern University buildings are constructed in this wash, but because of light annual precipitation in the Reno area, no major flooding problems are encountered.

0.3 Distance **0.5 Cumulative mileage**

Turn right into University parking lot. Excellent exposures of alluvial fan deposits of Peavine Mountain in the cut face on the south-facing bluff. The Recreation Building, a large new brick structure on the east bluff was recently constructed, and foundation studies for this structure revealed a highly variable degree of lithification reflected in erratic blow count totals. The deposits exposed here are finer-grained than the average for the unit. Gravel beds thicken and become more frequent northwest of this site.

Turn around and retrace route to North Virginia. Turn left and head south on North Virginia Street.

0.4 Distance **0.9 Cumulative mileage**

University west entrance on the left. The road now passes across an old channel, then down an intermediate grade marking the sloping eroded southeast-facing front of the bajada complex. The low-gradient surface from Interstate 80 south marks the north margin of the Tahoe outwash floodplain.

0.5 Distance **1.4 Cumulative mileage**

Cross Interstate 80. Highway cuts on the right expose gray-brown unconsolidated and interbedded cobble gravel and coarse sand, part of Tahoe outwash, to within approximately 10 to 12 feet of the surface. Above the outwash is fine to medium pebbly sand of Holocene age, derived by reworking of the alluvial fan deposits of Peavine Mountain and spread as a thin veneer over the Wisconsinan outwash. The south-facing escarpment north and nearly parallel to the course of Interstate 80 marks the eroded south margin of the old bajada and the depositional edge of the Tahoe outwash floodplain. Proceed south on Virginia Street across the floodplain. Fine-grained Holocene sediments thin rapidly to a feather edge south of Interstate 80.

0.2 Distance **1.6 Cumulative mileage**

West Fifth Street. An excavation for an addition to Saint Marys Hospital a few blocks to our right, exposed about 8 feet of Holocene pebbly sand (altered volcanic provenance, very weak soil) overlying a weak soil developed on bouldery Tahoe outwash (Sierran provenance) that contains scattered boulders 6 to 10 feet in diameter.

Note the numerous unreinforced masonry false fronts and parapets on older buildings in this part of Reno. These facades are a significant hazard in this area of wide-spread Quaternary faulting and known high seismic risk.

0.1 Distance **1.7 Cumulative mileage**

Fourth and Virginia Streets. Virginia Street continues down a gentle slope largely underlain by artificial fill that locally reaches depths of about 12 feet, resting on bouldery Tahoe outwash. On the left is Harrah's new high-rise hotel. A seismic safety element was incorporated in the design and construction of this building.

0.4 Distance **2.1 Cumulative mileage**

Cross the Truckee River. This perennial stream drains Lake Tahoe and other valleys to the north, and flows through a largely antecedent drainage over a hundred miles long to empty into Pyramid Lake. The Truckee River is incised into Wisconsinan outwash and Holocene silt and fine sand throughout most of the Truckee Meadows. Local floodplain deposits associated with the incised channel are probably largely Holocene, but some late Wisconsinan deposits of Tioga outwash may be present. The surface rising ahead of us as we cross the river is cut on Donner Lake bouldery outwash of Illinoian age.

0.1 Distance **2.2 Cumulative mileage**

Courthouse on the right. For the next few blocks we will climb a moderately dissected slope on Donner Lake outwash, cross a small summit, and then proceed down an erosional slope that is part of one of several well-marked, but not deeply incised, east-trending drainages. Excavations in this area, reveal strongly weathered bouldery outwash made up of highly rounded clasts of andesite, metavolcanics, and plutonic rocks. Plutonic clasts are typically almost completely decomposed within the soil horizon, and volcanic clasts exhibit thick weathering rinds. Giant boulders are common.

0.4 Distance **2.6 Cumulative mileage**

Thoma Street. Cross a post-Illinoian fault that defines the northwestern margin of a north-trending, elongate graben in Donner Lake outwash. This graben is floored with a thin Holocene veneer of pebbly sand and silt reworked from the outwash.

0.5 Distance **3.1 Cumulative mileage**

Approaching Vassar Street. On the left, Donner Lake outwash is exposed in an embankment along Holcomb Street. The steep slope along Holcomb Street is inferred to be a fault scarp, part of the eastern margin of the graben, that trends north in this area. Ahead, the nearly flat surface is underlain by the western feather-edge of a thin but very extensive veneer of Holocene fine silt and sand that occupies much of the central Truckee Meadows.

0.2 Distance **3.3 Cumulative mileage**

Turn right on Mount Rose Street and proceed up the deeply weathered upper depositional surface of the Donner Lake outwash floodplain. This surface is inferred to be oversteepened by Quaternary faulting and basin warping.

0.1 Distance **3.4 Cumulative mileage**

Turn left on Lakeside Drive, which for the next few blocks parallels an inferred fault that separates Donner Lake outwash to our right, from reworked outwash of Holocene(?) age underlying the gentle slope to our left. (Note the lag of highly rounded cobbles and boulders and some smaller versions of the giant boulders common in these deposits.)

0.3 Distance **3.7 Cumulative mileage**

Cross Plumb Lane. Lakeside Drive continues to parallel the post-Illinoian fault (hanging wall to the right) that in the next few blocks becomes more obvious where defined by the bluff (Donner Lake outwash) forming the west margin of Virginia Lake.

0.2 Distance **3.9 Cumulative mileage**

Continue along the west shore of Virginia Lake. Caution: Duck crossing, and 15 mph speed limit strictly enforced. Across the lake to our left the east shore is composed of Donner Lake outwash in the hanging wall of a down-to-the-west fault. Virginia Lake thus occupies a small graben, arranged, in plan, en echelon to the graben earlier crossed in downtown Reno.

0.2 Distance **4.1 Cumulative mileage**

Fork in the road. Continue left along Virginia Lake. Good exposures of Donner Lake outwash are seen in the embankment to the right as we approach the fork in the road. These materials are relatively stable in such embankments, but would be subject to slumping during an earthquake event that generated local strong ground motion.

0.2 Distance **4.3 Cumulative mileage**

Continue along Lakeside Drive up the slight slope. This southern end of the Virginia Lake graben is structurally complex and is made up of several branching post-Illinoian faults. Much of the topography in this local area is fault-controlled.

0.1 Distance **4.4 Cumulative mileage**

Fault scarp on the left and paralleling Lakeside Drive exposes Donner Lake outwash just north of the Monterey Manor apartments.

0.4 Distance **4.8 Cumulative mileage**

Moana Lane. Four-way stop. Most of the gentle slopes to the right are underlain by alluvial fan deposits of Peavine Mountain. In this area the fans grew outward from the northeastern margin of the Carson Range block (high mountainous area to the right and ahead), and incorporate much altered andesite, and abundant very highly rounded pebbles reworked from intra-formational gravel beds in the Kate Peak Formation

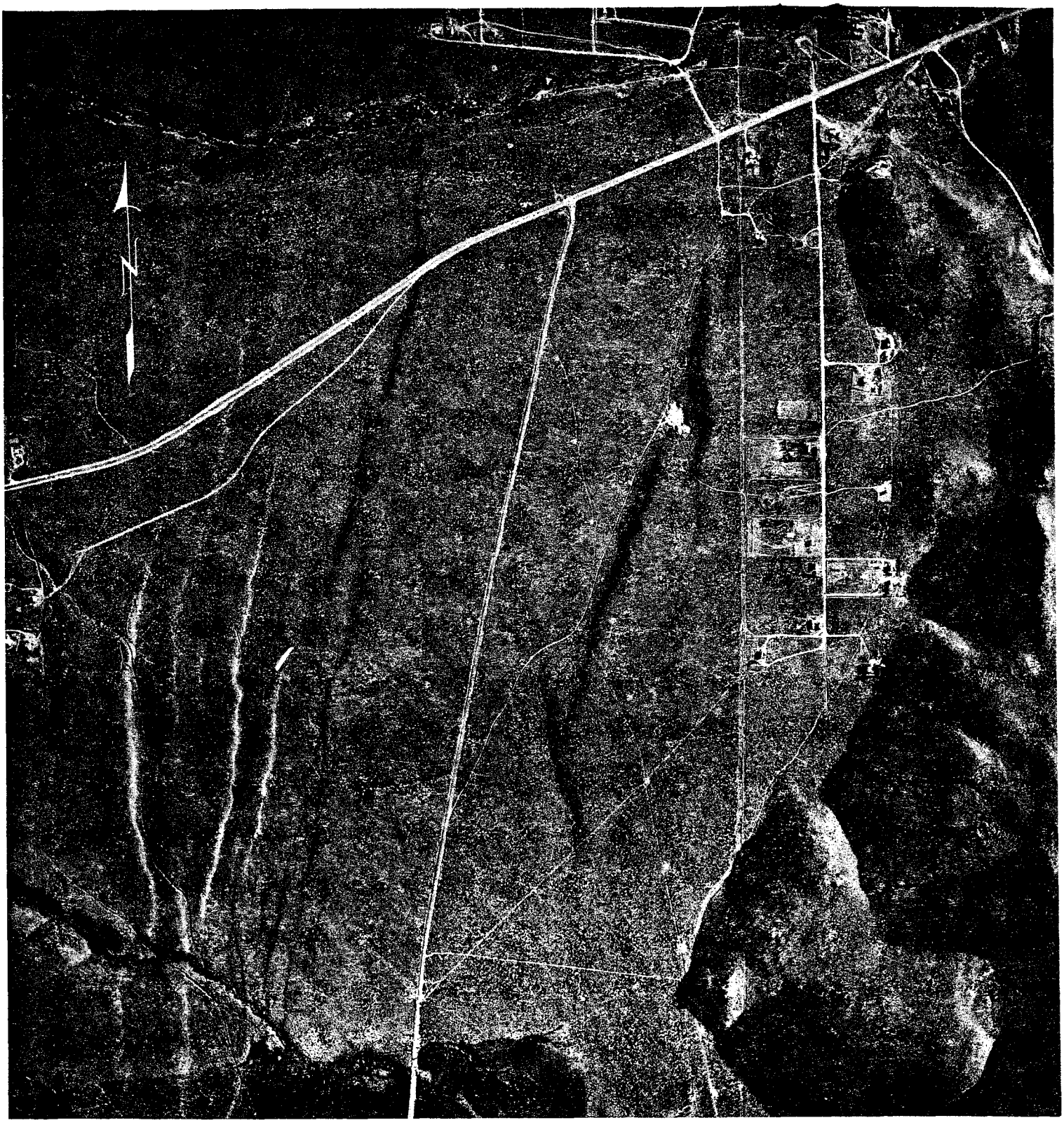
Ahead and to the left are elongate, low-lying, fault-bounded hillocks of Donner Lake outwash that to the south are buried by a Holocene fan built outward from the mouth of Evans Creek. Most of the hills are bounded on the west by down-to-the-west faults that do not disturb the Holocene Evans Creek fan deposits.

Turn left onto Moana Lane. Cross a fault escarpment and climb to the top of a hill underlain by Donner Lake outwash. Cross the summit and proceed down the oversteepened depositional slope of the Donner Lake floodplain. Irregularities on this slope are partly due to post-Illinoian faulting and partly to slight dissection of the surface by minor post-Illinoian consequent streams draining this surface.

0.7 Distance **5.5 Cumulative mileage**

Virginia Street. This is the approximate boundary between the area of outwash we have just traversed, and the large Holocene floodplain-swamp-lacustrine complex that lies directly ahead and occupies much of the central and eastern Truckee Meadows.

Turn right on South Virginia Street (U.S. Highway 395 south). The extensive area to the east is underlain by



Faulted fan gravel of possible Wisconsinan age. The northwest margin of Steamboat Hills is at the right. Low-sun-angle photograph taken in morning.

Densely faulted northeast margin of the Mount Rose fan complex. Here faults transect a thin veneer of Illinoian (?) pediment gravel resting on diatomaceous siltstone beds (sandstone of Hunter Creek). A landslide complex, seen as a light-colored patch along the left margin, includes both bedrock and pediment gravel.

fine-grained pebbly silt and sand deposited by low-gradient streams draining to the northeast.

0.5 Distance **6.0 Cumulative mileage**

Outwash and alluvial fan terrain are seen to the right (west).

0.2 Distance **6.2 Cumulative mileage**

Cross a low hill that strikes northeast across South Virginia. This hill is composed of Donner Lake outwash, largely cobble gravel, bounded on the northwest by a down-to-the-north fault. From the top of this hill, one can view the very large low gradient plain extending to the east underlain by Holocene silt and fine sand. These deposits, derived from fan material to the west, interlayer with deposits containing peat dated at 2130±165 years B.P.

0.5 Distance **6.7 Cumulative mileage**

Cross into Holocene fan material deposited by streams issuing from the Evans Creek drainage. The apex of this fan lies off to the right at the north end of Windy Hill.

0.7 Distance **7.4 Cumulative mileage**

Cross the approximate boundary between the Evans Creek fan and a large area of Holocene silt and sand. Huffaker Hills, made up of Kate Peak andesite, emerge prominently from the very gently north-dipping Holocene depositional surface. These prominent hills of Tertiary andesite, aligned in a north northeast direction, reflect down-to-the-west faults in the basement that do not transect the Holocene deposits.

0.3 Distance **7.7 Cumulative mileage**

On the right at about 2:00 o'clock the steep north face of a dark-colored hill is underlain by Kate Peak andesite. In line with, but beyond this hill, highly faulted pediment gravels of the Mount Rose fan complex rise prominently towards the mountain front. These deposits, deeply weathered and highly faulted, are inferred to be Illinoian in age—the pediment and alluvial fan time-equivalents of Truckee River mainstream outwash—but may be as old as Kansan. For the next mile and a half the highway crosses pebbly, low-gradient fan deposits of Holocene age.

1.6 Distance **9.3 Cumulative mileage**

Pass by the southern extremity of the Huffaker Hills on the left. Low hills of fan gravel on the right represent the distal margin of the Mount Rose fan complex buried by Holocene alluvium.

0.4 Distance **9.7 Cumulative mileage**

Cross a fault.

0.1 Distance **9.8 Cumulative mileage**

The road rises up onto fan deposits.

0.5 Distance **10.3 Cumulative mileage**

Cross a fault scarp that controls this small drainage. This fault appears to disrupt Holocene alluvium along its trace.

0.8 Distance **11.1 Cumulative mileage**

Steamboat Hills at 2:00 o'clock. U.S. Highway 395 continues across alternating low-gradient surfaces underlain by Holocene deposits, and lobes of the Mount Rose fan complex for the next mile.

1.0 Distance **12.1 Cumulative mileage**

Cross fault-controlled drainage.

0.4 Distance **12.5 Cumulative mileage**

Turn right at the intersection and proceed west on the Mount Rose Highway, (Nevada Highway 27) up the fan surface.

At 12:30 o'clock the high peak of Mount Rose is prominent on the skyline, and to the right the Carson block, partially tree- and snow-covered, extends around to about 2 o'clock. In the far distance, at about 2:30 is the Peavine Mountain block, which rises on the north side of the Truckee River valley. In the middle ground at 12:00 o'clock, low hills form the northwest spur of the Steamboat Hills, and merge downward with the upper surface of the Mount Rose fan complex. Much of the material in and around the northwest spur of the Steamboat Hills in this area is bouldery fan debris containing considerable granodiorite and quartz monzonite (seen as scattered boulders remaining along the side of the road in this area from the construction of Nevada Highway 27). These fan deposits are inferred to be Tahoe equivalent, Wisconsinan in age. To the left, from 10:00 o'clock around to about 9:00 o'clock, are light-colored exposures of siliceous sinter and altered gravel in the Steamboat Springs area. Steam is venting at the surface both here and further down to the extreme left, at the base of the foothills. At 2:00 o'clock in the middle-ground, the low swales and small hills are all fault-controlled. Most of the west and northwest facing embankments are fault scarps.

1.1 Distance **13.6 Cumulative mileage**

Cross fault-controlled drainage. Fan gravels to the left. Small area of reddened material mapped as a mud volcano by White and others (1964).

0.8 Distance **14.4 Cumulative mileage**

Road climbs steep fan surface (tectonically oversteepened?), and numerous fresh quartz monzonite boulders are visible among the sagebrush; also a few scattered very large boulders of basalt and basaltic andesite are seen. This is the Wisconsinan part of the fan. About 100 to 200 yards to the right of the road is the approximate area of the contact between this younger fan material which has filled in around the volcanic foothills in the northern part of the Steamboat Hills, and the older (Illinoian?) fan material.

0.6 Distance **15.0 Cumulative mileage**

To the right, the Lancers Hill. East face of this bedrock knob is mantled with colluvial debris and bordered at the base by a post-Wisconsinan fault downdropped to the east. On the right are bouldery outcrops of Alta andesite with platy jointing.

0.2 Distance **15.2 Cumulative mileage**

Cross a small bypass area of fan between Lancers Hill and the northern margin of the Steamboat Hills.

0.3 Distance **15.5 Cumulative mileage**

Large unweathered quartz monzonite boulders off to the right mark the area of the Wisconsinan fan.

0.6 Distance **16.1 Cumulative mileage**

Fault scarp. West margin of a Quaternary horst block to our right.

0.6 Distance **16.7 Cumulative mileage**

Callahan Ranch Road. Turn left on Callahan Ranch Road. The embankment 150 to 200 yards to the left with the prominent quartz monzonite boulders on the steep face is a compound fault scarp, one of the major fault scarps in this area. At the base of that escarpment is a small ponded drainage filled with Holocene alluvium (largely colluvial reworked debris derived from the fan surface). The fault does not break the Holocene alluvium, but it does transect Wisconsinan age fan material.

0.6 Distance **17.3 Cumulative mileage**

Road passes over a divide. Ahead is a new subdivision built in and around a large number of inferred post-Wisconsinan fault traces.

0.5 Distance **17.8 Cumulative mileage**

Turn right on Wildwood. Road climbs up the depositional surface of the Tahoe fan. Continue past Willow Brook down into a small drainage which is entirely fault controlled. Many strands of very young faults pass through this low area.

0.3 Distance **18.1 Cumulative mileage**

Cross two east-sloping fault scarps.

0.1 Distance **18.2 Cumulative mileage**

Turn left on Tannerwood. The exposure in the low road cut indicates the nature of weathering on this material. There is a weakly developed color B horizon and no CCA horizon present in this material. Rock fragments are fresh right up to the surface, with little if any development of rinds. Litter of large quartz monzonite boulders on the left.

Continue straight ahead. The very large embankment directly ahead of us and visible to the right and left is a major fault scarp, one of the largest of the small group we have been crossing.

0.3 Distance **18.5 Cumulative mileage**

Turn around at Wintergreen and return to U.S. Highway 395 south via Wintergreen, left on Callahan Ranch Road, right at Mount Rose Highway (Nevada Highway 27) to U.S. Highway 395.

End of road log.