**UTAH GEOLOGICAL SURVEY**
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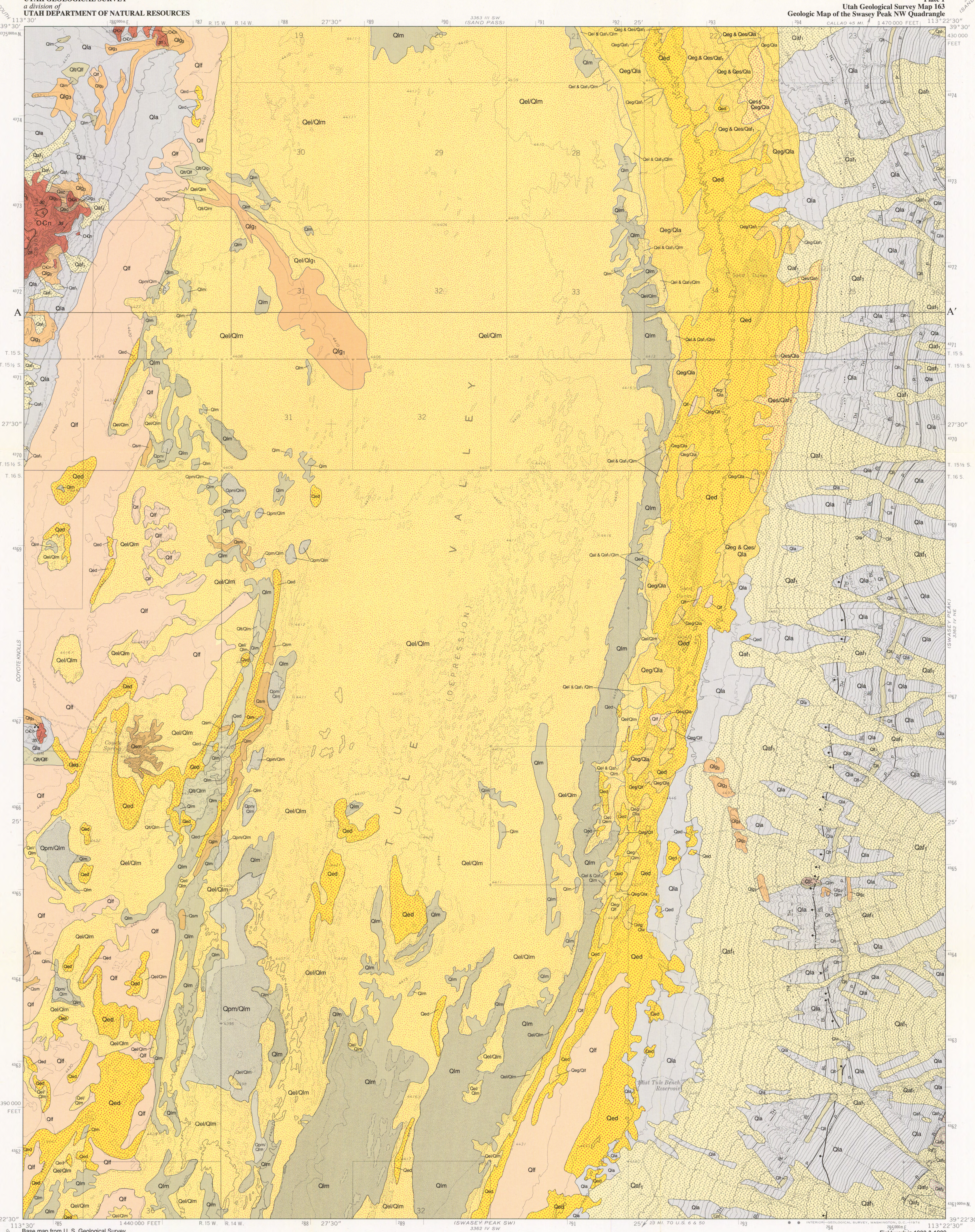
**UTAH DEPARTMENT OF NATURAL RESOURCES**

**Plate 1**
**Utah Geological Survey Map 163**
**Geologic Map of the Swasey Peak NW Quadrangle**




Base map from U. S. Geological Survey
Swasey Peak N.W. 7.5' Quadrangle, 1972

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
DOTTED LINES REPRESENT 5-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

1994 MAGNETIC NORTH
DECLINATION AT CENTER OF SHEET

QUADRANGLE LOCATION

Field work in 1988 & 1989
Lori J. Douglas, Cartographer

# GEOLOGIC MAP OF THE SWASEY PEAK NW QUADRANGLE, MILLARD COUNTY, UTAH

by

Dorothy Sack

1994

## DESCRIPTION OF MAP UNITS

**Qac** Undifferentiated alluvium and colluvium (late Pleistocene and Holocene) - *poorly sorted, coarse- to fine-grained sediments consisting of fluvially reworked colluvium or alluvium with a significant colluvial component; unit occurs at or above the piedmont junction separating other Quaternary deposits below from bedrock above; estimated maximum thickness is 15 feet (4.6 m).*

**Qaf$_1$** Young alluvial-fan deposits (late Pleistocene and Holocene) - *coarse- to fine-grained alluvium and debris-flow sediments deposited on piedmont slopes since regression of Lake Bonneville from the Bonneville shoreline; Qaf$_1$ deposits are generally finer toward the distal portion of alluvial fans, where they may be locally overlain by eolian sediments; approximately 0.5 to 25 feet ( 0.2 to 7.6 m) thick.*

**Qaf$_2$** Intermediate alluvial-fan deposits (middle (?) to late Pleistocene) - *dominantly coarse-grained alluvium and debris-flow deposits found on the piedmont of the House Range above the Bonneville shoreline; Qaf$_2$ consists of alluvial fans that were abandoned when Lake Bonneville regressed from the Bonneville shoreline; thin accumulations of loess occur on the surface of the unit, which is from a few to tens of feet thick.*

**Qaf$_3$** Old alluvial-fan deposits (early (?) to middle (?) Pleistocene) - *bouldery alluvial-fan deposits comprising steep spurs which project basinward from the front of the House Range; Qaf$_3$ lies adjacent to and above outcrops of Qaf$_2$; overlain by fine-grained weathering products and loess; the unit is over 100 feet (30 m) thick.*

**Qed** Eolian dunes (late Pleistocene and Holocene) - *well-sorted sand to very poorly sorted mixtures of sand, silt, and clay; composition varies from mostly gypsum, to mixed, to mostly nongypsum minerals; forms include parabolic, transverse, dome, shrub-coppice, and lunette dunes; approximately 1.5 to 15 feet (0.5 to 4.6 m) thick.*

**Qeg** Gypsiferous eolian sheet sand (late Pleistocene and Holocene) - *primarily sand-sized gypsum deposited as a sand sheet rather than in well-developed dunes; the source of the gypsum is the saline marl flats of the basin floor; thickness varies from 0.5 to 10 feet (0.2 to 3 m).*

**Qel** Eolian-reworked lacustrine fines (Holocene) - *dominantly marly but locally gypsiferous, lacustrine fine-grained sediments entrained from the valley floor and redeposited downwind on the valley floor in small shrub-coppice dunes; Qel deposits are typically less than 3 feet (0.9 m) thick.*

**Qes** Nongypsiferous eolian sheet sand (late Pleistocene and Holocene) - *primarily nongypsum sand deposited as a sheet rather than in well-developed dunes; moderately well sorted to well sorted; found downwind of sandy, ephemeral stream channels which drain areas of Prospect Mountain Quartzite in the House Range; 0.5 to 5 feet (0.2 to 1.5 m) thick.*

**Qla** Undifferentiated lacustrine and alluvial deposits (late Pleistocene and Holocene) - *generally poorly sorted, coarse- to fine-grained sediments composed of lake-reworked alluvial-fan deposits, fan-reworked lake deposits, and areas where lake and fan deposits are not distinguishable at the map scale; lake-reworked fan deposits consist of pre-Bonneville alluvial fans etched by shorelines; Qla becomes finer grained in the downslope direction; generally less than 10 feet (3 m) thick.*

**Qlf** Fine-grained lacustrine deposits (late Pleistocene) - *poorly sorted sand, silt, clay, and marl found between the basin-floor marl flats and the piedmont; locally saline; locally reworked by fluvial or eolian processes; in many places the contact between Qlf and the marl flats is marked by a Holocene bluff; generally less than 10 feet (3 m) thick.*

**Qlg$_1$** Young lacustrine gravel (Holocene) - *sand and pebbles, which include clasts of lithified Lake Bonneville marl and tufa; found in coastal landforms created by low-level Tule Valley lakes after the valley was reisolated from Lake Bonneville; locally overlain by eolian sediments; approximately 10 feet (3 m) thick.*

**Qlg$_2$** Intermediate lacustrine gravel (late Pleistocene) - *primarily pebble- to cobble-sized clasts deposited in coastal landforms by Lake Bonneville between about 19,500 and 14,000 years ago; estimated maximum thickness is 6 feet (1.8 m).*

**Qlg$_3$** Old lacustrine gravel (late Pleistocene) - *sandy to well-sorted pebbles and cobbles deposited by transgressive Lake Tule between about 30,000 and 19,500 years ago; found in shoreline features below an elevation of 4,582 feet (1347 m); maximum thickness about 30 feet (9 m).*

**Qlm** Lacustrine marl (late Pleistocene and Holocene) - *includes Lake Bonneville pristine white marl and sandy marl reworked by Lake Bonneville and regressive Lake Tule; contains abundant ostracodes and occasional gastropods; locally displays efflorescing salts; commonly overlain by Qel; thickness varies from a few inches to at least 12 feet (3.7 m).*

**Qls** Lacustrine sand (late Pleistocene) - *pebbly, marly sand deposited over Qlm just offshore from the Provo shoreline during Provo shoreline time; carbonate-coated gastropod shells are common; about 25 feet (7.6 m) thick.*

**Qlt** Lacustrine tufa (late Pleistocene and Holocene) - *calcium carbonate precipitated during Provo shoreline time and during the subsequent regressive phases of Lakes Bonneville and Tule; forms a shelf which lies about 40 to 60 feet (12 to 18 m) below the Provo shoreline on the House Range piedmont and includes broken, reworked tufa found at lower elevations; from 0.1 to approximately 1.5 feet (0.3 to 0.45 m) thick.*

**Qpm** Playa mud (Holocene) - *thin deposits of clay, silt, and marl, with small amounts of sand, overlying basin-floor marl (Qlm); chloride rich; typically flooded.*

**Qsm** Marsh deposits (Holocene) - *fine-grained sediments and marl found in association with springs and related high-ground-water surfaces on the basin floor; generally saline and organic rich; thickness not determined.*

**OꞒn** Notch Peak Formation (Upper Cambrian to Lower Ordovician) - *cliff-forming, massive limestone and dolomite; primarily medium-gray, very fine-grained, slightly cherty limestone; flat limestone pebble conglomerate and coarse-grained detrital limestone found locally; approximately 1,400 feet (430 m) thick.*

Units in cross section only

**Qu** Undifferentiated Quaternary deposits (early to late Quaternary) - *alluvial, eolian, lacustrine, playa, and spring deposits forming the upper part of the basin fill; estimated maximum thickness 300 feet (90 m).*

**Tu** Undifferentiated Tertiary deposits (middle to late Tertiary) - *basin fill; estimated maximum thickness is 6,500 feet (2,000 m) (see Allmendinger and others, 1983).*

**Ꞓou** Upper member of the Orr Formation (Upper Cambrian) - *gray interbedded shale and limestone; 600-700 feet (180-215 m) thick.*

**Ꞓob** Big Horse Member of the Orr Formation (Upper Cambrian) - *medium-gray, thick-bedded, bioclastic limestone that contains oolites and indistinct biohermal structures; 715 feet (218 m) thick.*

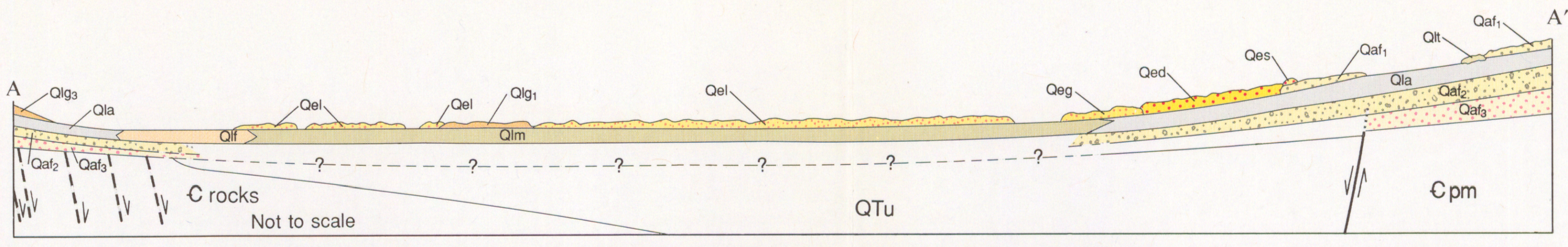
**Ꞓpm** Prospect Mountain Quartzite (Lower Cambrian) - *pinkish-gray to light-brown-gray quartzite; approximately 4,000 feet (1,200 m) thick.*

**pꞒs** Undifferentiated Precambrian sedimentary rocks (Precambrian) - *thickness greater than 3,900 feet (1,200 m) (see Allmendinger and others, 1983).*

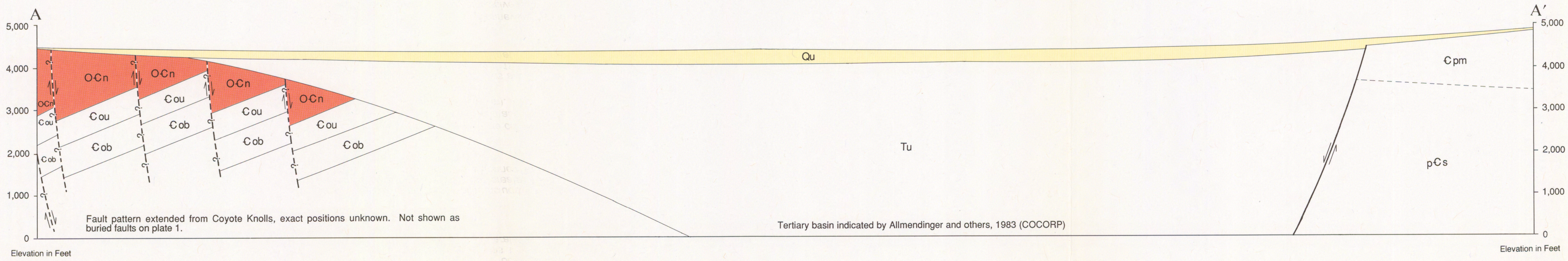
## MAP SYMBOLS

- Contact
- Piedmont Scarp Fault - *dotted where concealed, bar and ball on downthrown side*
- B — Bonneville shoreline of Lake Bonneville
- P — Provo shoreline of Lake Bonneville
- BL — Lowest shoreline of Lake Bonneville in Tule Valley
- TH — Highest shoreline of Lake Tule (pre-Lake Bonneville)
- 12 — Strike and dip of bed
- Borrow pit
- Qes/Qaf — Younger deposits thinly distributed over older deposits

## CORRELATION OF MAP UNITS

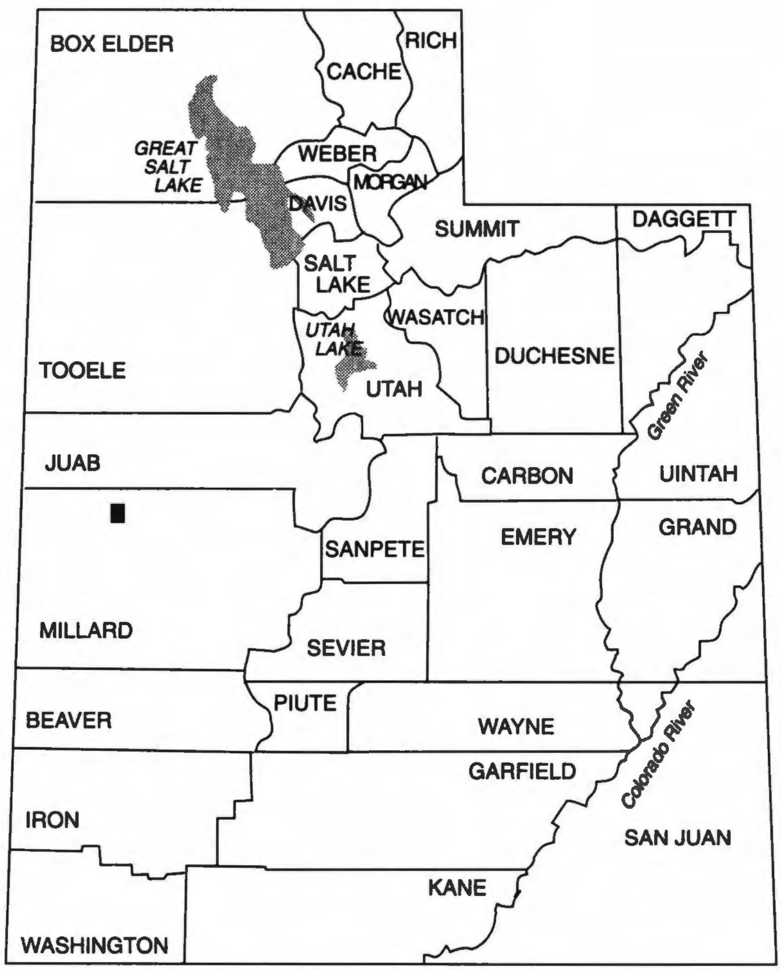




This schematic cross section follows the line of cross section A-A′ and shows the relationship of the Quaternary deposits. QTu represents undifferentiated Quaternary-Tertiary basin-fill deposits.



# GEOLOGIC MAP OF THE SWASEY PEAK NW QUADRANGLE, MILLARD COUNTY, UTAH

*by*
*Dorothy Sack*
*Department of Geography*
*Ohio University*




**Map 163** **1994**
**UTAH GEOLOGICAL SURVEY**
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*Athens OH 45701-2979*

## ABSTRACT

The Swasey Peak NW quadrangle is located in east-central Tule Valley, about 45 miles (72 km) west of Delta, Utah. It covers portions of the Tule Valley basin floor, the adjacent piedmonts of both the House Range and the Coyote Knolls, and a small part of the Coyote Knolls. The geologic map of the quadrangle portrays bedrock, Quaternary deposits, fault scarps, and preserved segments of paleolake shorelines.

Pre-Quaternary bedrock in the quadrangle consists only of the Upper Cambrian to Lower Ordovician Notch Peak Formation, which occupies less than 1 square mile (2.6 sq km) of the map area. The extensive Quaternary sediments were deposited from early (?) Pleistocene through Holocene time in alluvial, eolian, lacustrine, playa, and spring environments. The Quaternary sediments are divided into 18 map units. Relative ages of these units are determined from geomorphic, stratigraphic, and geochronometric evidence primarily related to the late Quaternary paleolake history of Tule Valley. Tule Valley contained an embayment of Lake Bonneville from about 19,500 to shortly after 14,000 years ago. Before and after that interval, Tule Valley contained an isolated paleolake, Lake Tule.

Young alluvial-fan deposits and mixed lacustrine and alluvial deposits dominate the House Range piedmont on the east side of the map area. The most extensive map unit, eolian-reworked lacustrine fines, covers the marly, wind-swept Tule Valley basin floor, which occupies the central and much of the western part of the map area. Eolian dunes, gypsiferous sheet sand, nongypsiferous sheet sand, and lacustrine fines are concentrated along the toe of the House Range piedmont between it and the basin floor. Large exposures of lacustrine fine-grained sediments also lie along the western margin of the basin floor. The comparatively small areas of lacustrine gravel, represent coastal deposits of Lakes Bonneville and Tule.

Regional relationships show that the study area was subjected to compressive forces sometime between Late Jurassic and Oligocene time; basin-and-range extensional tectonics have affected the region since Oligocene time. This extensional tectonism is responsible for the House Range normal fault, which crosses that range's piedmont in the eastern part of the quadrangle. Geologic hazards include debris flows, flash floods, blowing sand and dust, and earthquake hazards related to the House Range fault. Gravel, sand, gypsum, and marl constitute the most valuable economic resources in the quadrangle.

## INTRODUCTION

The Swasey Peak NW quadrangle is located in west-central Utah approximately 45 miles (72 km) west of the town of Delta. The map area lies about 3 miles (5 km) west of the House Range and 9 miles (14 km) east of the Confusion Range in east-central Tule Valley (figure 1). Smaller north-south-trending hills, called the Coyote Knolls, lie adjacent to the quadrangle's western margin near the center of Tule Valley.

The geology of the Swasey Peak NW quadrangle largely reflects the late Quaternary geologic history of Tule Valley. The Tule Valley basin is approximately 50 miles (80 km) long, 19 miles (31 km) wide, and covers 545 square miles (1,412 sq km) (figure 1). It is a structural basin of interior drainage in the Great

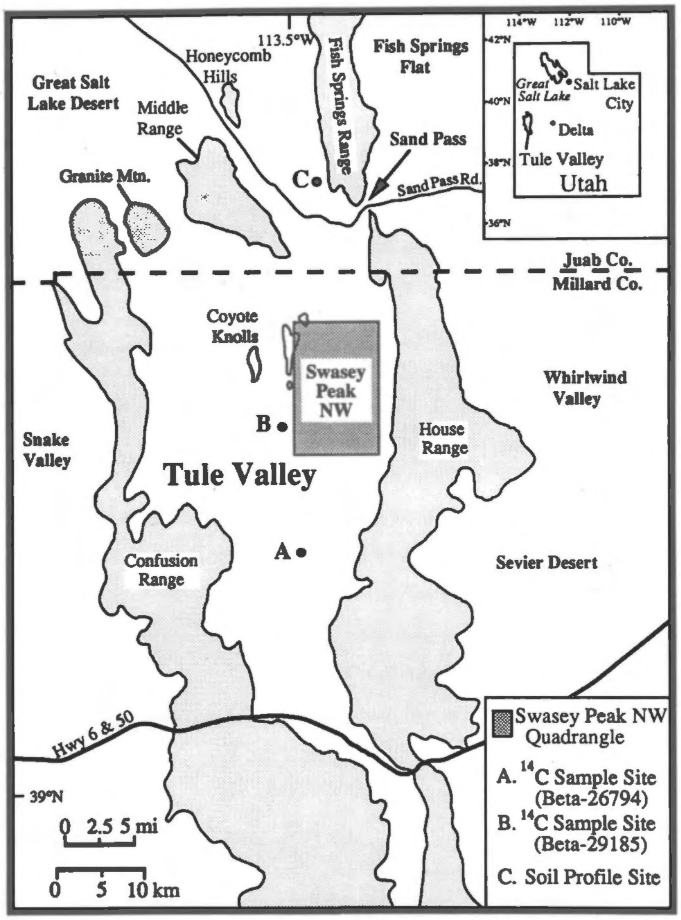


***Figure 1.** Location map of the Swasey Peak NW quadrangle and other sites mentioned in the text.*

Basin section of the Basin and Range physiographic province. During the Quaternary, the climate of this region consisted of long arid intervals separated by periods of greater effective moisture (Gilbert, 1890; Scott and others, 1983; Oviatt and Currey, 1987; Oviatt and others, 1987). As in the present period of aridity, deposition in Tule Valley during past arid times was probably dominated by alluvial-fan, eolian, and playa processes. The last major period of greater effective moisture occurred from about 30,000 to 13,000 years ago (Currey and Oviatt, 1985; Currey, 1990) and caused large lakes to form throughout the Great Basin, including in Tule Valley (Sack, 1990). Lacustrine deposits from that interval are still widespread in Tule Valley, but have been reworked to some extent by fluvial, eolian, and playa processes (Sack, 1992).

This geologic map portrays Quaternary deposits, pre-Quaternary bedrock, fault scarps, and prominent remnants of late Quaternary paleolake shorelines. In western Utah, Quaternary deposits its merit being mapped in the detail traditionally reserved for pre-Quaternary rocks because the Quaternary deposits are extensive, of possible economic value, useful in identifying geologic hazards, and important to regional paleoenvironmental reconstructions.

## Physical Geography and Land Use

The Swasey Peak NW quadrangle covers portions of the Tule Valley basin floor, the adjacent piedmonts of both the House Range and the Coyote Knolls, and a small part of the Coyote Knolls (figures 1 and 2). Approximately 99.6 percent of the map area consists of Quaternary deposits; Paleozoic bedrock of the Coyote Knolls is found only at the northwest and west edge of the quadrangle, and accounts for the remaining 0.4 percent of the map area (table 1). The western and central portions of the map area are dominated by Tule Valley's low-relief, basin floor. The lowest point in Tule Valley, which has an elevation of 4,395 feet (1,340 m), is located in the southwestern part of the Swasey Peak NW quadrangle. Toward the east, elevations within the quadrangle gradually increase to a maximum of 5,345 feet (1,629 m) in the upper piedmont of the House Range.

The climate of the study area is mid-latitude dry, consisting of cold winters, hot summers, low average-annual precipitation, and high average-annual potential evapotranspiration. Mean temperatures are approximately 50°F (10°C) for the year, 27°F (-2.8°C) in January, and 76°F (24.4°C) in July (Stephens, 1977; Stevens and Brough, 1987; Sack, 1990, table 1). Mean annual precipitation is about 7.0 inches (18 cm) (Stephens, 1977; Stevens and Brough, 1987; Sack, 1990, table 1).

Vegetation in the study area varies with drainage and soil-salinity factors. Marsh bulrush (*Scirpus paludosis*) and salt grass (*Distichlis stricta*) grow in and around the springs and marshes. Large tracts of the basin floor lie at or near the ground-water table and consist of unvegetated saline mudflats, whereas pickleweed (*Allenrolfea occidentalis*) and greasewood (*Sarcobatus vermiculatus*) are found on those parts of the basin floor where the ground-water table is somewhat deeper. The lower piedmont zone, which has moderately well-drained, slightly saline soils, is dominated by greasewood, shadscale (*Atriplex confertifolia*), halogeton (*Halogeton glomeratus*), and winterfat (*Eurotia lanata*). The middle and upper piedmont zones consist of well-drained soils of low salinity. Sagebrush (*Artemesia tridentata*), Mormon tea (*Ephedra nevadensis*), shadscale, and rabbitbrush (*Chrysothamnus* sp.) dominate the vegetation in those areas.

The quadrangle area is owned by the state and federal governments, and much of it is administered by the Bureau of Land Management. There are no permanent residents, but sheep and cattle herders sometimes camp there during the winter grazing season. Coyote Springs, in the west-central part of the map area, is an important source of water for livestock operations in all of northern Tule Valley.

## Previous Work

Some previous geologic mapping projects have involved the Swasey Peak NW quadrangle. Morris's (1978) preliminary geologic map of the 1:250,000-scale Delta quadrangle includes the study area. That map, however, does not differentiate Quaternary and Tertiary sedimentary deposits. The bedrock portion of the present map is only a slight modification of Hintze's (1981) work, which detailed pre-Quaternary rocks in the Swasey Peak NW quadrangle at the scale of 1:24,000 but portrayed the

***Figure 2.** Photograph showing the lower piedmont of the House Range in the foreground, the Tule Valley basin floor and part of the Coyote Knolls in the middle ground, and the Confusion Range in the background. The view is to the west across the northern part of the Swasey Peak NW quadrangle.*

***Table 1.***
*Map units as percentage of quadrangle surface area.*

| | | |
|---|---|---|
| 40.5% | Qel | Eolian-reworked lacustrine fines |
| 13.9% | $Qaf_1$ | Young alluvial-fan deposits |
| 12.6% | Qla | Undifferentiated lacustrine and alluvial deposits |
| 8.7% | Qed | Eolian dunes |
| 8.3% | Qlf | Fine-grained lacustrine deposits |
| 7.8% | Qlm | Lacustrine marl |
| 3.2% | Qeg | Gypsiferous eolian sheet sand |
| 1.4% | Qpm | Playa mud |
| 0.7% | Qlt | Lacustrine tufa |
| 0.7% | $Qlg_1$ | Young lacustrine gravel |
| 0.6% | $Qlg_3$ | Old lacustrine gravel |
| 0.5% | Qes | Nongypsiferous eolian sheet sand |
| 0.4% | Qac | Undifferentiated alluvium and colluvium |
| 0.4% | OCn | Notch Peak Formation |
| 0.3% | Qsm | Marsh deposits |
| < 0.1% | $Qaf_2$ | Intermediate alluvial-fan deposits |
| < 0.1% | $Qaf_3$ | Old alluvial-fan deposits |
| < 0.1% | $Qlg_2$ | Intermediate lacustrine gravel |
| < 0.1% | Qls | Lacustrine sand |

rest of the map area as a single unit of undivided Quaternary alluvium and Lake Bonneville deposits. Compared with the 1:24,000-scale quadrangle map presented here, Sack's (1990) 1:100,000-scale Quaternary geologic map of Tule Valley is more generalized. Piedmont fault scarps along the eastern margin of the study area were mapped as part of previous regional-scale projects by Bucknam and Anderson (1979), Piekarski (1980), and Sack (1990).

## Map-Unit Symbols

The extensive Quaternary sediments in the Swasey Peak NW quadrangle unconformably overlie Paleozoic rocks and were deposited in alluvial, eolian, lacustrine, playa, and spring environments. As shown in table 2, the first lower-case letter after the Q in a Quaternary map-unit symbol indicates one of these five depositional environments. The second lower-case letter in a map-unit symbol provides additional information about material texture, composition, or depositional subenvironment. For example, eolian sediments that occur in well-developed dunes are symbolized by Qed. Two depositional subenvironments, alluvial fan (Qaf) and lacustrine gravel (Qlg), are further subdivided on the basis of relative age using numeric subscripts.

In some parts of the Swasey Peak NW quadrangle one relatively thin Quaternary unit covers a different map unit. These areas are represented on the map by stacking the appropriate material symbols. For stacked units, the designation for the surficial unit is written above the designation for the underlying material (Varnes and Van Horn, 1951; Hunt and others, 1953; Robison and McCalpin, 1987; Oviatt, 1989; Sack, 1990). For example, where playa mud (Qpm) overlies lacustrine marl (Qlm), the area is labelled Qpm/Qlm. Locations on the map that consist of stacked units are colored according to the material at the surface. Computation of the areal extent of the various map units (table 1) is also based on overlying units.

Some areas of the quadrangle are not adequately portrayed by simply stacking two map units because they consist of two surficial deposits overlying a third type of material. In these places the two surficial units are listed in the numerator of the stacked symbol and the underlying material appears as usual in the denominator. The surface sediment type that occurs in the larger amount is listed as the first symbol of the numerator. For example, where interfingering eolian-reworked lacustrine fines (Qel) and young alluvial-fan deposits ($Qaf_1$) overlie lacustrine marl (Qlm), the symbol ($Qel+Qaf_1$)/Qlm indicates that the eolian-reworked lacustrine fines cover a greater area than the young alluvial-fan deposits.

*Table 2.*
*Symbols used for Quaternary map units.*

| | | |
|---|---|---|
| First Letter, Temporal Designation: | | |
| | | Q = Quaternary deposits |
| Second Letter, General Depositional Environment: | | |
| | | a = alluvial |
| | | e = eolian |
| | | l = lacustrine |
| | | p = playa |
| | | s = spring |
| Third Letter, Subenvironment Indicator: | | |
| | Alluvial: | c = colluvium |
| | | f = alluvial fan |
| | Eolian: | d = dunes |
| | | g = gypsum |
| | | l = lacustrine |
| | | s = sheet-like |
| | Lacustrine: | a = alluvial |
| | | f = fine-grained |
| | | g = gravel |
| | | m = marl |
| | | s = sand |
| | | t = tufa |
| | Playa: | m = mud |
| | Spring: | m = marsh |
| Numeric Subscript, Relative-Age Indicator: | | |
| | | 1 = young |
| | | 2 = intermediate |
| | | 3 = old |

## RELATIVE-AGE CONTROL

Approximate ages of Quaternary map units in the Swasey Peak NW quadrangle are determined from geomorphic, stratigraphic, and geochronometric evidence primarily related to the late Quaternary paleolake history of Tule Valley (Sack, 1990). At the beginning and end of the most recent Quaternary deep-lake cycle, which lasted from about 30,000 to 13,000 years ago (Currey and Oviatt, 1985; Currey, 1990), Tule Valley contained an isolated paleolake, called Lake Tule (Sack, 1988). Between those two phases of independent Lake Tule, Tule Valley was occupied by an arm of Lake Bonneville (Gilbert, 1890; Currey and others, 1984; Sack, 1990), the largest late Pleistocene paleolake in western North America. During that period of Bonneville integration, Tule Valley was an embayment in the southwestern portion of Lake Bonneville (figure 3).

Independent Lake Tule probably originated about 30,000 years ago (figure 4) when climatic conditions were also causing Lake Bonneville to expand. This transgressive phase of Lake Tule (TLT on figure 4) lasted until about 19,500 years ago. At approximately that time, Pleistocene Lake Tule became the Tule Valley arm of Lake Bonneville when the transgressing Lake Bonneville spilled over Sand Pass, which is the lowest point on the divide between the two basins (figure 1) (Currey and Oviatt, 1985; Sack, 1990). Inflow from Lake Bonneville (I on figure 4) caused the water level in Tule Valley to rise rapidly to the Sand Pass threshold elevation, at which point the Tule Valley water body achieved full integration with Lake Bonneville (Sack, 1990).

When Lake Bonneville stood at the brink of overflow at Sand Pass, it occupied the highest level it had yet attained in the lake cycle. By analogy, at the same time Lake Tule must also have occupied its highest level in the lake cycle (Sack, 1990). This Lake Tule level is marked in Tule Valley by a conspicuous shoreline, which lies about 100 feet (30 m) below the modern elevation of Sand Pass. The fact that the shoreline is a Lake Tule feature is apparent from its substantial elevation below Sand Pass. It is known to be from the transgressive, that is, pre-Bonneville integration, phase of Lake Tule because it is overlain by the distinctive white marl deposit of Lake Bonneville. The shoreline is interpreted as the highest transgressive Lake Tule level because little shoreline evidence is found between it and the elevation of Sand Pass. In this quadrangle, remnants of this highest, transgressive Lake Tule shoreline extend across the lower to middle piedmont of the House Range at elevations ranging from 4,636 feet (1,413 m) at the south to 4,644 feet (1,415 m) at the north. This variation in shoreline elevation is due primarily to differential hydroisostatic rebound caused by Lake Bonneville.

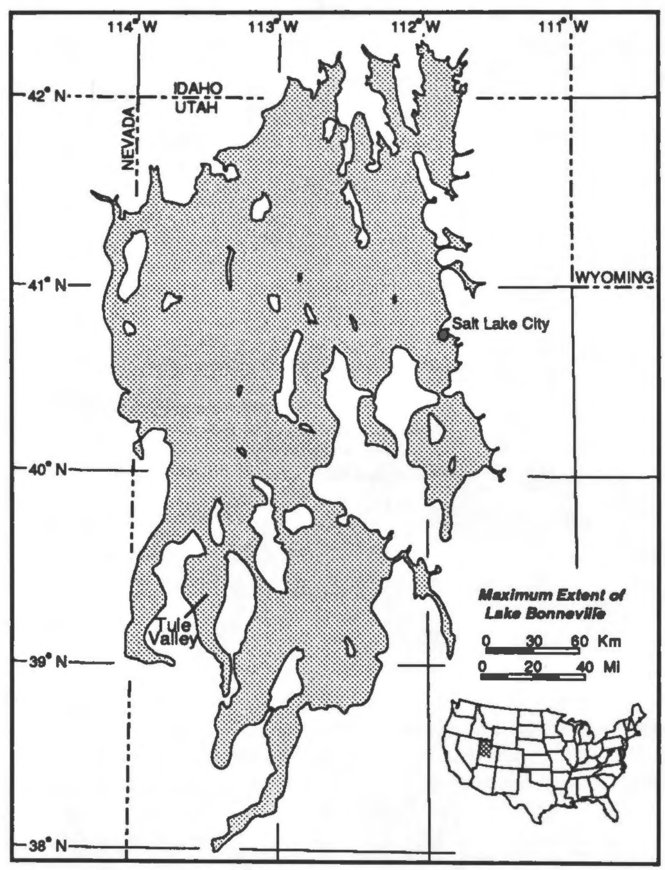


*Figure 3. The Tule Valley arm of Lake Bonneville (Sack, 1992).*

Tule Valley was integrated with Lake Bonneville for less than 6,000 years (Sack, 1990) (figure 4). This interval, however, spans the most dramatic part of Lake Bonneville history. During this period Lake Bonneville completed its transgressive phase (TLB on figure 4) when it reached the lowest elevation on its divide and began overflowing into the Snake-Columbia River system. Under this external threshold control, Lake Bonneville constructed its highest shoreline, called the Bonneville shoreline (BS on figure 4). A few remnants of the Bonneville shoreline are found at an elevation of approximately 5,165 feet (1,574 m) in the southeast corner of the map area, high on the House Range piedmont. When alluvial material at Lake Bonneville's threshold failed about 14,500 years ago, the water level rapidly fell 340 feet (104 m) from the Bonneville shoreline in the catastrophic Bonneville flood (BF on figure 4) (Gilbert, 1890; Malde, 1968; Jarrett and Malde, 1987; Burr and Currey, 1988). Discharge eroded the outlet down to a bedrock sill, where the water level restabilized (Gilbert, 1890). At this level, Lake Bonneville constructed the geomorphically prominent Provo shoreline (PS on figure 4). Preserved portions of the Provo shoreline extend across the House Range piedmont along the eastern edge of the quadrangle and are found in the northwest corner of the map area in the Coyote Knolls. Elevation of the Provo shoreline ranges from 4,799 to 4,812 feet (1,463 to 1,467 m).

Burr and Currey (1988) estimated that Lake Bonneville began its rapid, climatically induced regression from the Provo shoreline about 14,200 years ago (RLB on figure 4). Because the Sand Pass threshold is only 73 feet (22 m) below the local elevation of the Provo shoreline, Tule Valley was probably reisolated from Lake Bonneville soon after Provo shoreline time, perhaps by shortly after 14,000 years ago (RI on figure 4). A

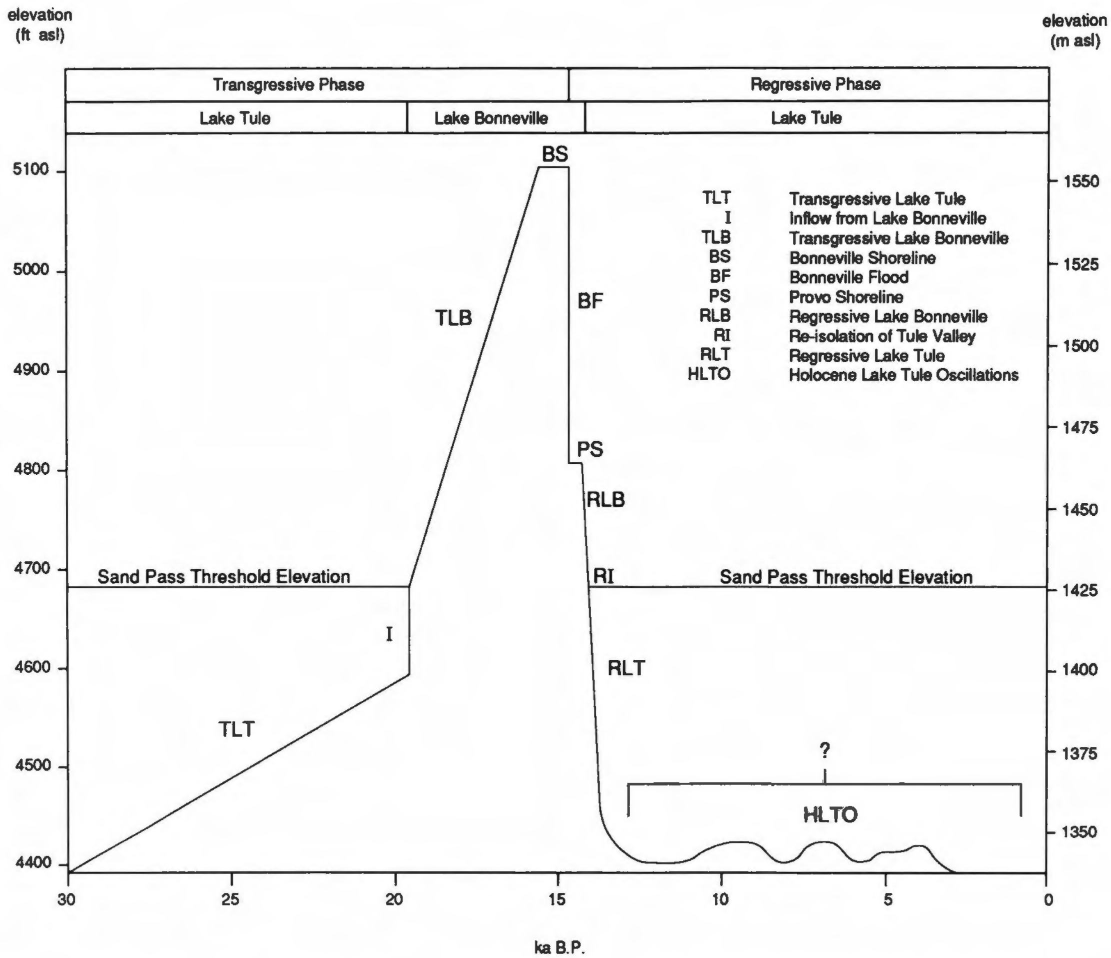


***Figure 4.*** *Schematic time-altitude diagram of late Quaternary lakes in Tule Valley. Late Pleistocene water-level elevations depicted on the diagram are corrected for hydroisostatic rebound according to the formula of Currey and Oviatt (1985). The Sand Pass threshold is the lowest point on the divide between Tule Valley and the main part of the Bonneville basin. Transgressive Lake Tule (TLT) became the Tule Valley arm of Lake Bonneville about 19,500 years ago when Lake Bonneville spilled over the Sand Pass threshold. The water level in Tule Valley rapidly rose to equilibrate with the level of Lake Bonneville (I). At water-level elevations above Sand Pass, the Tule Valley arm oscillated in unison with the rest of Lake Bonneville. This included the remainder of the Bonneville transgressive stages (TLB), Bonneville shoreline time (BS), the Bonneville flood (BF), Provo shoreline time (PS), and the early part of the climatically induced regression of Lake Bonneville from the Provo shoreline (RLB). Tule Valley became reisolated from Lake Bonneville shortly after 14,000 years ago (RI). Small Holocene water bodies subsequently rose and fell within Tule Valley (HLTO). The upper extent of those water-level oscillations are depicted with some confidence, however, their minimum levels and ages are conjectural.*

shoreline that extends around Tule Valley at the approximate elevation of the Sand Pass threshold is interpreted as a post-Provo Lake Bonneville shoreline because no sites have yet been found where it is overlain by white marl or any other lacustrine deposit. It was apparently formed just before reisolation of Tule Valley, and is therefore interpreted as the lowest and youngest Lake Bonneville shoreline in Tule Valley. Remnants of it are found in the lower piedmont zone of the House Range along the eastern edge of the Swasey Peak NW quadrangle at an elevation of approximately 4,723 feet (1,440 m). The shoreline's elevation in the quadrangle is lower than at Sand Pass due to differential hydroisostatic rebound.

Post-Bonneville, or regressive, Lake Tule (RLT on figure 4) apparently desiccated very rapidly to very low levels and later rose a couple of times to modest levels. The rapid desiccation is inferred by analogy with the precipitous contemporaneous drop of Lake Bonneville (Currey and Oviatt, 1985) and from a radiocarbon age of 13,790 ± 130 yr B.P. (Beta-26794; $^{13}C$ adjusted) from a tufa sample collected from a Tule Valley locality south of the study area (NE¼ SE¼, section 35, T. 17 S., R. 15 W.; A on figure 1) (Sack, 1990). The sampled tufa deposit is believed to reflect a Lake Tule water level of approximately 4,490 feet (1,369 m) (Sack, 1990). At this level, the lake was 254 feet (77 m) below the elevation of Sand Pass, yet still sizeable, having a maximum depth of about 95 feet (29 m).

Subsequent Holocene-age oscillations of the water level (HLTO in figure 4) are inferred from geochronometric and morphostratigraphic evidence from Tule Valley. The geochronometric evidence comes from the adjacent Coyote Knolls quadrangle (Sack, 1994) to the west. A radiocarbon age of 9,140 ± 90 yr B.P. (Beta-29185; $^{13}C$ adjusted) was obtained from gastropod shells collected at an elevation of 4,426 feet (1,349 m) from a site in the eastern portion of the Coyote Knolls quadrangle (NE¼ SW¼ section 22, T. 16 S., R. 15 W.; B on figure 1) (Sack, 1994). Although the sampled shells were collected from the neighboring quadrangle, the same gastropod-rich unit is widely exposed around Tule Valley, including this quadrangle, at an elevation of 4,426 feet (1,349 m). The gastropods are freshwater types (*Lymnaea* and *Helisoma*) that probably lived in a marsh adjacent to the lake. At that level, the lake would have been approximately 31 feet (9 m) deep. It is not known whether this Holocene lake was a stillstand in the regression of Lake Tule, or whether it marked a slight readvance of the water level in Tule Valley from very low levels.

The gastropod-rich unit is exposed in a bluff that is continuous around Tule Valley. It is present on both the Coyote Knolls and Swasey Peak NW quadrangles (figure 5). Because the shoreline bluff may have resulted from coastal erosion, it could mark a rise in the water level after a regression from the level of the gastropod-rich unit. Neither the extent nor the timing of the hypothesized oscillation is known; its depiction on figure 4 is hypothetical.

The occurrence of even later low-level oscillations of the lake is indicated by morphostratigraphic evidence from the Swasey Peak NW quadrangle. A large compound spit is located in the northwest portion of the map area between elevations of 4,406 and 4,416 feet (1,343 and 1,346 m). The upper surface of one segment of the compound spit lies at an elevation of approximately 4,410 feet (1,344 m); this segment is overlain by a smaller spit, whose upper surface is about 6 feet (1.8 m) higher. Both parts of the compound feature consist primarily of pebbles and sand, including reworked, pebble-sized clasts of Lake Bonneville tufa and lithified Lake Bonneville marl. These components indicate that both parts of the compound spit are of post-Bonneville age. Furthermore, the spit is well preserved despite the fact that its two segments lie only 10 to 20 feet (3 to 6 m) below the bluff that exposes the gastropod unit. If the bluff was created by coastal processes, the spit was probably constructed later. Moreover, because in the Bonneville basin transgressive coastal landforms are typically better developed than

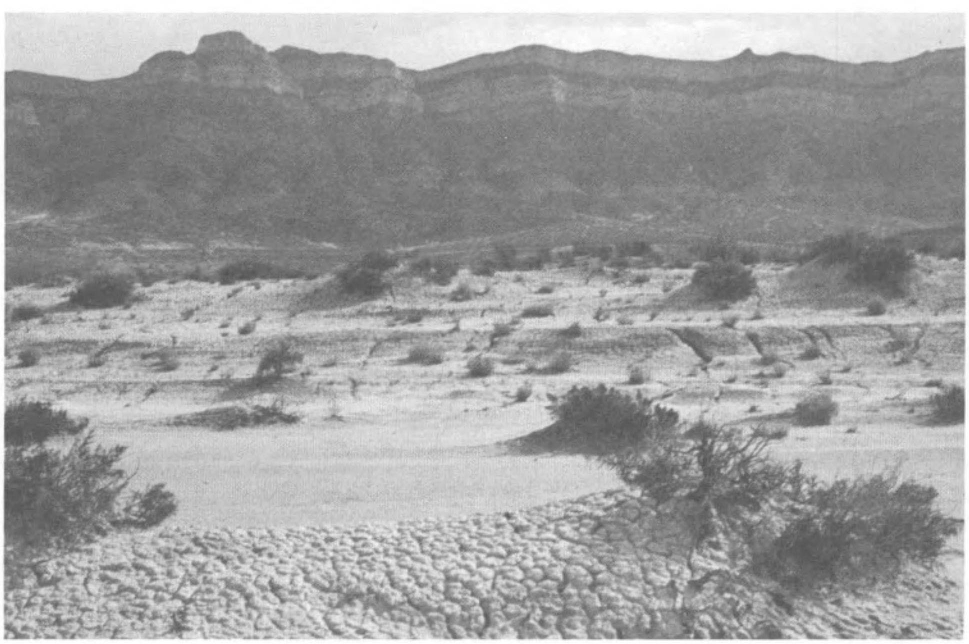

*Figure 5. The Holocene-age bluff and the gastropod-rich unit that it exposes (dark band in bluff). Eolian deposits have accumulated on top of the bluff. The view is to the east and includes the House Range in the background.*

regressive coastal landforms, the compound spit is interpreted as marking two readvances of the Holocene water level after its regression from the shoreline bluff (figure 4). It is believed that the lake level fell from the prominent shoreline bluff to low levels then readvanced to approximately 4,410 feet (1,344 m), where it constructed the larger of the two compound-spit segments. Sometime later the water level rose an additional 6 feet (1.8 m) and constructed the smaller component of the compound spit. A spit composed of similar, late Holocene coastal gravel occurs in the neighboring Coyote Knolls quadrangle between about 4,415 and 4,420 feet (1,346 and 1,347 m) (Sack, 1989).

# PALEOZOIC STRATIGRAPHY

## Cambrian-Ordovician

### Notch Peak Formation (OCn)

Less than 1 square mile (2.6 sq km) of the Swasey Peak NW quadrangle has exposed bedrock, all of it is the Notch Peak Formation, which here is cut by many faults of small displacement. Hintze and others (1988) defined three members of the Notch Peak Formation in western Utah. In ascending order, these are the Hellnmaria, Red Tops, and Lava Dam Members. All members are limestone and dolomite; the Red Tops consists of thin-bedded, bioclastic lime grainstone, whereas the other members are more massive, finer textured, and commonly include large hemispherical stromatolites.

According to Lehi F. Hintze (personal communication, 1992) the portion of the Notch Peak Formation that is exposed in this quadrangle includes the top part of the Hellnmaria Member, the entire Red Tops Member, and all but the top of the Lava Dam Member. The upper part of the Hellnmaria Member here consists of about 480 feet (145 m) of medium-gray, medium- to thick-bedded limestone, interbedded with brownish-gray and grayish-orange-pink, medium- to thick-bedded dolomite. The dolomite is finely to coarsely crystalline and locally includes as much as 5 percent brown chert as bedded nodules. The Red Tops Member is a reddish-gray, thin-bedded lime grainstone about 110 feet (33 m) thick. The Lava Dam Member is medium-dark-gray and brownish-gray, medium-grained lime mudstone and dolomitic limestone. About 240 feet (73 m) of Lava Dam beds were measured above the Red Tops, but the upper part of the Lava Dam Member has not been preserved in surface exposures in this quadrangle. In nearby areas the Lava Dam Member is about 400 feet (120 m) thick (Hintze and others, 1988).

# QUATERNARY STRATIGRAPHY

## Description of Quaternary Map Units

### Introduction

Because of the extensive overlap in ages of the Quaternary map units, they are discussed in alphabetical rather than chronological order. The presentation is alphabetized by map-unit symbol.

### Alluvial Deposits

**Undifferentiated alluvium and colluvium (Qac):** Poorly sorted, coarse- and fine-grained sediments consisting of fluvially reworked colluvium or alluvium with a significant colluvial component are mapped as Qac. This unit occurs at and above the piedmont junction, which separates exposures of bedrock upslope from topographically lower Quaternary deposits. Its maximum thickness is estimated to be 15 feet (4.6 m). Small map areas of undifferentiated alluvium and colluvium are found at the piedmont junction of the Coyote Knolls in the northwest corner of the quadrangle and along its southwestern margin. The latter exposure represents undifferentiated alluvium and colluvium shed from a bedrock outcrop west of the map area. In the Swasey Peak NW quadrangle Qac is not found above the elevation of Sand Pass (4,744 feet [1,446 m]), therefore it postdates the reisolation of Tule Valley from Lake Bonneville. The age of this unit ranges from very late Pleistocene to present.

**Young alluvial-fan deposits ($Qaf_1$):** $Qaf_1$ is composed of poorly sorted, coarse- to fine-grained alluvium and debris-flow sediments deposited on piedmont slopes of the House Range and Coyote Knolls since regression of Lake Bonneville from the Bonneville shoreline (figure 6). These deposits generally become increasingly fine grained toward the distal portion of the alluvial fans, where they may be locally overlain by eolian sediments. The unit's thickness ranges from about 0.5 feet to at least 25 feet (0.2 to 7.6 m). $Qaf_1$ covers 13.9 percent of the quadrangle, making it the second most extensive map unit. Young alluvial-fan deposits are of late Pleistocene through recent age.

**Intermediate alluvial-fan deposits ($Qaf_2$):** Alluvial-fan deposits of intermediate age are dominantly coarse-grained alluvium and debris-flow deposits. This unit occupies four small areas in the southeastern corner of the quadrangle. Intermediate alluvial-fan deposits occur on upper piedmont slopes of the House Range above the Bonneville shoreline. $Qaf_2$ is found in alluvial fans that were abandoned when Lake Bonneville regressed from its highest shoreline during the Bonneville flood. Thin accumulations of loess generally overlie intermediate alluvial-fan deposits. The thickness of this map unit ranges from a few to tens of feet. Figure 7 contains a soil profile description for an abandoned fan of intermediate alluvial-fan material from a location in northern Tule Valley (SE¼ SE¼ section 25, T. 13 S., R. 15 W.; C on figure 1). The II+ stage of carbonate morphology (Gile and others, 1966; Machette, 1985), together with the Lake Bonneville relationships, suggest a middle (?) to late Pleistocene age for this map unit.

**Old alluvial-fan deposits ($Qaf_3$):** Old alluvial-fan deposits lie in small map areas near and above outcrops of intermediate alluvial-fan deposits ($Qaf_2$) in the southeastern corner of the quadrangle. $Qaf_3$ consists of bouldery alluvium and debris-flow sediments comprising steep ridges which are elongated approximately perpendicular to the House Range mountain front. These

*Figure 6. View to the east up the House Range piedmont illustrating the nature of young alluvial-fan deposits (Qaf$_1$).*

| Depth (in.) | Horizon | Depth (cm) | Description |
|---|---|---|---|
| 0–2 | A | 0–5 | Gravelly silt loam, vesicular A, subangular blocky, calcareous. |
| 2–4 | AB | 5–10 | Gravelly clay loam, medium subangular blocky, slightly calcareous. |
| 4–10 | Bk1 | 10–25 | Gravelly sandy clay loam, medium subangular blocky, moderately calcareous. |
| 10–19 | Bk2 | 25–48 | Gravelly sandy clay loam, coarse angular blocky, calcareous. |
| 19–45 | Bk3 | 48–114 | Gravelly sandy loam, angular blocky, calcareous to very calcareous, stage II+ carbonate accumulation. |

*Figure 7. Soil profile description of intermediate alluvial-fan deposits (Qaf$_2$) from a site in the Sand Pass NW quadrangle of northern Tule Valley (SE¼ SE¼ section 25, T. 13 S., R. 15 W.; C on figure 1). The soil's II+ stage of carbonate morphology and the fan's abandonment due to the Bonneville flood suggest a middle (?) to late Pleistocene age for Qaf$_2$. Note that the scale on the vertical axis is diagrammatic and not constant.*

ridges, or spurs, are remnants of old alluvial fans, which are much steeper than the intermediate alluvial-fan remnants. Surface and near-surface fines are abundant, and probably result from in situ rock weathering as well as accumulation of loess. Old alluvial-fan deposits are at least 100 feet (30 m) thick. This unit may be of early (?) to middle (?) Pleistocene age.

## Eolian Deposits

**Eolian dunes (Qed):** Eolian dunes occupy 8.7 percent of the map area. Most of the dunes occur in the eastern part of the quadrangle near the contact between the basin floor and the distal edge of the piedmont (figure 8). The dunes range in texture from well-sorted sand to poorly sorted mixtures of sand, silt, and clay. Composition of dune sediments varies from primarily gypsum, through mixed gypsum and nongypsum constituents, to mostly nongypsum minerals. Common dune types include barchanoid, dome, parabolic, blowout, and shrub-coppice. In addition, irregular lunettes, which have poorly sorted but generally fine-grained material, are common on top of valley-floor bluffs. Varying stages of dune activity are present, from stabilized to currently active. Dune morphologies reflect a dominant northeasterly direction of eolian transportation. Thickness estimates for eolian-dune deposits range from 1.5 to 15 feet (0.5 to 4.6 m). Dunes probably started forming in the very late Pleistocene, but most are of Holocene age.

**Gypsiferous eolian sheet sand (Qeg):** Wind-blown gypsum deposited in sand sheets rather than in well-formed dunes is mapped as Qeg. Areas of Qeg are found near the eolian dunes (Qed) east and northeast of the basin floor. Deflation of the primarily sand-sized gypsum grains from the floor of Tule Valley began with desiccation of the sulfate-rich, closed-basin lake in the very late Pleistocene and continues today. Gypsiferous eolian sheet sand occurs only as a stacked unit in the Swasey Peak NW quadrangle. Qeg overlies young alluvial-fan deposits (Qaf$_1$), mixed lacustrine and alluvial deposits (Qla), lacustrine fines (Qlf), and lacustrine marl (Qlm). In some areas, a mixture of Qeg and nongypsiferous eolian sheet sand (Qes) overlies an alluvial or lacustrine unit. Qeg deposits cover 3.2 percent of the quadrangle and are approximately 0.5 to 10 feet (0.2 to 3 m) thick. They are late Pleistocene and Holocene in age.

**Eolian-reworked lacustrine fines (Qel):** Qel covers 40.5 percent of the Swasey Peak NW quadrangle, and is the most extensive map unit (table 1). Eolian-reworked lacustrine fines consist of predominantly marly, locally gypsiferous lacustrine fines that were entrained by the wind from the Tule Valley basin floor and redeposited on the basin floor a short distance to the northeast (downwind). Qel is deposited primarily in small shrub-coppice dunes, which are typically less than 3 feet (0.9 m) thick (figure 9). In this quadrangle Qel always occurs as a stacked unit. Qel/Qlm is found mainly north and northeast of

***Figure 8.*** *Active sand dunes along the lower House Range piedmont. View is to the southeast toward the House Range.*

the barren marl flats (Qlm). The large region of Qel/Qlm in the central portion of the map may be described as a wind-swept plain. These sediments are transported by the wind mainly as salt-bound marl pellets. Laboratory analyses of a Qel sample show that eolian-reworked lacustrine fines are rich in chloride salts and contain over 40 percent calcium carbonate. Eolian-reworked lacustrine fines are of Holocene age.

**Nongypsiferous eolian sheet sand (Qes):** Sheets of moderately to well-sorted, nongypsum sand are deposited on the lower sector of the House Range piedmont in the northeast part of the quadrangle. Areas of Qes accumulation lie downwind (northeast) of ephemeral piedmont streams whose loads are dominated by quartzite sand. Sometime after fluvial deposition, loose, dry sand from the stream channels is entrained by the wind and transported over the piedmont. The quartzite sand is derived from the Prospect Mountain Quartzite, which crops out in the adjacent House Range. Like gypsum sheet sand (Qeg) and eolian-reworked lacustrine fines (Qel), Qes is only found as a stacked unit on the geologic map. Qes, in some areas mixed with Qeg, overlies young alluvial-fan deposits ($Qaf_1$) and mixed lacustrine and alluvial deposits (Qla). Thickness of Qes is estimated to be 0.5 to 5 feet (0.2 to 1.5 m). Qes is late Pleistocene and Holocene in age.

## Lacustrine Deposits

**Undifferentiated lacustrine and alluvial deposits (Qla):** Undifferentiated lacustrine and alluvial deposits are poorly sorted, coarse- to fine-grained sediments found in the piedmont zone of both the House Range and the Coyote Knolls. Grain size generally decreases in the downslope direction. In the upper and middle piedmont, Qla consists mainly of alluvial-fan sediments that were deposited before the last deep-lake cycle and which were only moderately reworked by lacustrine processes so that the lacustrine gravel layer is thin. In these areas the unit is expressed geomorphically as prelake alluvial fans etched by Lake Tule and Lake Bonneville shorelines. Qla sediments are commonly fine grained in the lower piedmont sector because the prelake fan material there was more fine grained than in higher zones. In the lower piedmont sector, undifferentiated lacustrine and alluvial deposits typically consist of lacustrine deposits that have been slightly reworked by postlake alluvial-fan processes. Areas mapped as Qla also include places where lacustrine and alluvial sediments intertongue at unmappable scales. Undifferentiated lacustrine and alluvial deposits are generally less than 10 feet (3 m) thick. The Qla map unit covers 12.6 percent of the Swasey Peak NW quadrangle, and is late Pleistocene and Holocene in age.

**Fine-grained lacustrine deposits (Qlf):** Approximately 8.3 percent of the Swasey Peak NW quadrangle is covered by fine-grained lacustrine deposits. Qlf typically consists of a poorly sorted mixture of sand, silt, clay, and marl (figure 10). Locally, it contains gypsum, displays effloresing salts, or is reworked by fluvial or eolian processes. In this quadrangle, fine-grained lacustrine deposits are not found above an elevation of 4,450 feet (1,356 m). The unit lies just above the basin floor, which is dominated by Qel and Qlm, and in many places the contact between Qel or Qlm and Qlf is marked by the Holocene bluff at an approximate elevation af 4,426 feet (1,349 m). Qlf is generally less than 10 feet (3 m) thick and is of late Pleistocene age.

**Young lacustrine gravel ($Qlg_1$):** A large compound spit in the northwest part of the quadrangle is composed of young lacustrine gravel. $Qlg_1$ consists of sand and pebbles. Some of the pebbles are broken and reworked clasts of Lake Bonneville tufa and lithified marl. Young lacustrine gravel is generally overlain by

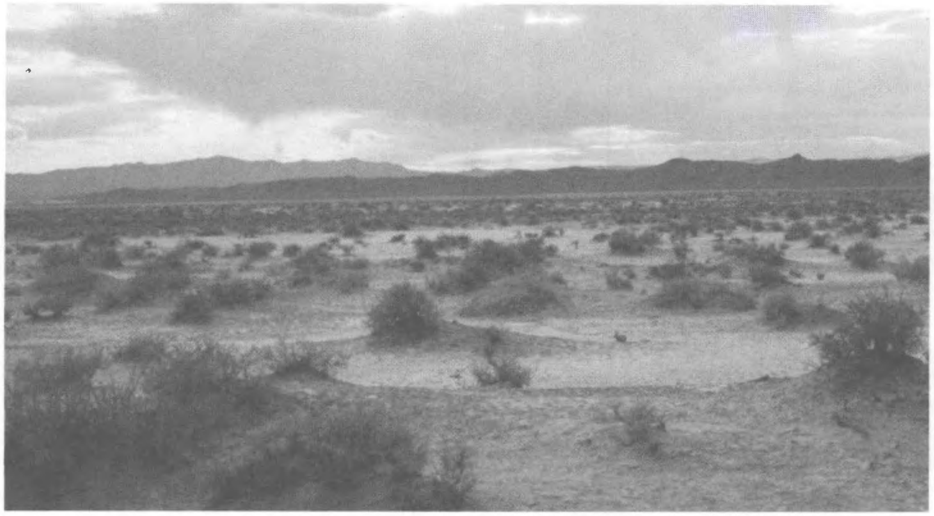

*Figure 9. Eolian-reworked lacustrine fines (Qel) deposited in small shrub-coppice dunes near the center of the study area. The dunes overlie lacustrine marl (Qlm), which is exposed between the coppices. The view is to the west across the basin floor to the Coyote Knolls, with the Confusion Range on the skyline.*

thin accumulations of eolian deposits (Qeg or Qel). $Qlg_1$ was deposited by low-level Tule Valley lakes after the basin was again isolated from Lake Bonneville. In addition to being younger, $Qlg_1$ is found at lower elevations and is finer grained than the intermediate and old lacustrine-gravel units ($Qlg_2$ and $Qlg_3$). Outcrops of $Qlg_1$ are found below an elevation of about 4,426 feet (1,349 m) on the valley floor. Maximum thickness is approximately 10 feet (3 m). Young lacustrine gravel is the most extensive of the coastal gravel units, but accounts for less than 1 percent of the map area. Mappable exposures of $Qlg_1$ are Holocene in age.

**Intermediate lacustrine gravel ($Qlg_2$):** Coastal gravel deposited by Lake Bonneville constitutes $Qlg_2$. $Qlg_2$ contains primarily subrounded pebbles and cobbles. Although Lake Bonneville gravels are common in Tule Valley as a whole, only two small areas of the map unit are found in the Swasey Peak NW quadrangle. These areas lie on the House Range piedmont above 4,723 feet (1,440 m), which is the local elevation of the lowest Lake Bonneville shoreline in Tule Valley. Intermediate lacustrine gravel is a relatively thin unit and has an estimated maximum thickness of 6 feet (1.8 m). $Qlg_2$ is intermediate in age between $Qlg_1$ and $Qlg_3$, and was deposited by Lake Bonneville in the interval from about 19,500 years ago to shortly after 14,000 years ago (figure 4).

**Old lacustrine gravel ($Qlg_3$):** Approximately 0.6 percent of the map area consists of coastal gravel deposited by Lake Tule before Tule Valley was integrated with Lake Bonneville. This unit typically contains pebble- through cobble-sized clasts, and is sandy to well sorted. Old lacustrine gravel is locally overlain by unmappable amounts of lacustrine marl (Qlm) and fine-grained lake deposits (Qlf). $Qlg_3$ is found between 4,430 and 4,582 feet (1,350 and 1,397 m) and has an estimated maximum thickness of 30 feet (9 m). $Qlg_3$ was deposited between about 30,000 and 19,500 years ago (figure 4).

**Lacustrine marl (Qlm):** Lacustrine marl includes Lake Bonneville pristine white marl (Gilbert, 1890) and sandy, reworked

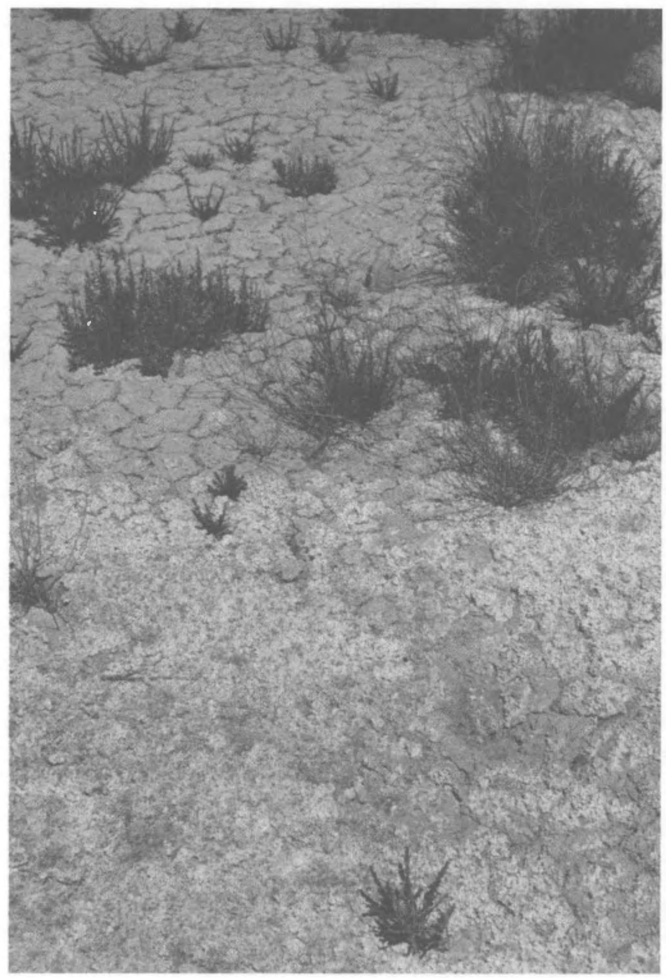

*Figure 10. Typical field appearance of the fine-grained lacustrine deposits (Qlf).*

marl. The latter includes white marl reworked by Lake Bonneville and by post-Bonneville Tule Valley lakes and playas, as well as marl that was washed basinward by postlacustrine fluvial processes. Lacustrine marl in the Swasey Peak NW quadrangle is generally calcareous silt or calcareous sandy silt. An analyzed sample of marl from the Tule Valley basin floor consisted of 64.3 percent calcium carbonate. Ostracodes are abundant and gastropods are occasionally found in the marl. Qlm may locally display effloressing salts or be reworked by fluvial processes. Lacustrine marl accounts for 7.8 percent of the map area. Most of the basin floor in the quadrangle consists of extensive, barren marl flats (Qlm) (figure 11), or marl flats overlain by eolian (Qel/Qlm) or playa deposits (Qpm/Qlm). Although these flats probably functioned as playas sometime in the Holocene, distinguishable playa deposits are not common except in those areas mapped as playa mud overlying lacustrine marl (Qpm/Qlm). Pristine Lake Bonneville white marl is typically 2.8 feet (0.9 m) thick, but may be eroded to a very thin layer. Deposits consisting of both pristine and reworked marl in the center of the basin are at least 12 feet (3.7 m) thick (Tinl and Pierce, 1984), and may be much thicker. Lacustrine marl is of late Pleistocene and Holocene age.

**Lacustrine sand (Qls):** Lacustrine sand consists of pebbly, marly sand that overlies Qlm just offshore from the Provo shoreline in one location along the House Range piedmont. Ostracodes, gastropods, and carbonate-coated reworked gastropods occur within the lacustrine sand, which is about 25 feet (7.6 m) thick. This unit was deposited when Lake Bonneville occupied the Provo shoreline, and therefore is of very late Pleistocene age (figure 4).

**Lacustrine tufa (Qlt):** Lacustrine tufa is a calcium carbonate deposit precipitated from the lake water during Provo shoreline time and during the subsequent regressive phases of Lakes Bonneville and Tule. Qlt covers about 0.7 percent of the map area, mostly as a prominent shelf lying about 40 to 60 feet (12 to 18 m) below the Provo shoreline. Included within this map unit are tufa gravels deposited in the very late Pleistocene and Holocene when fluvial and lacustrine processes eroded and reworked the shelf and other massive tufa deposits. Qlt ranges in thickness from 0.1 to about 1.5 feet (0.03 to 0.45 m) and is of late Pleistocene and Holocene age.

### Playa Deposits

**Playa mud (Qpm):** Playa mud consists of clay, silt, and marl, with small amounts of sand. These sediments are chloride-rich and occur as thin deposits over basin-floor marl (Qlm). They are late Holocene in age and are typically flooded in wet years.

### Spring Deposits

**Marsh deposits (Qsm):** Marsh deposits are associated with modern springs and related areas of high water table on the basin floor. This material generally consists of organic and marly fines, which are locally saline. Thickness was not determined. Marsh deposits are very late Holocene in age.

## STRUCTURE

The Coyote Knolls form the east flank of a curved but roughly north-south-striking syncline, whose west flank extends to the west edge of the Confusion Range (figure 1). One or more compressive events that created the syncline occurred sometime between Late Jurassic and Oligocene time (Hose, 1977). A later period of extensional tectonism formed the approximately north-south-trending tilted fault-block structure that dominates the topography of the region today. That period of basin-and-range tectonics may have started as early as the Oligocene Epoch and continues through the present (Nolan, 1943). It caused the relative uplift and eastward tilting of the House Range, and the relative downdropping of the Tule Valley basin, which also dips

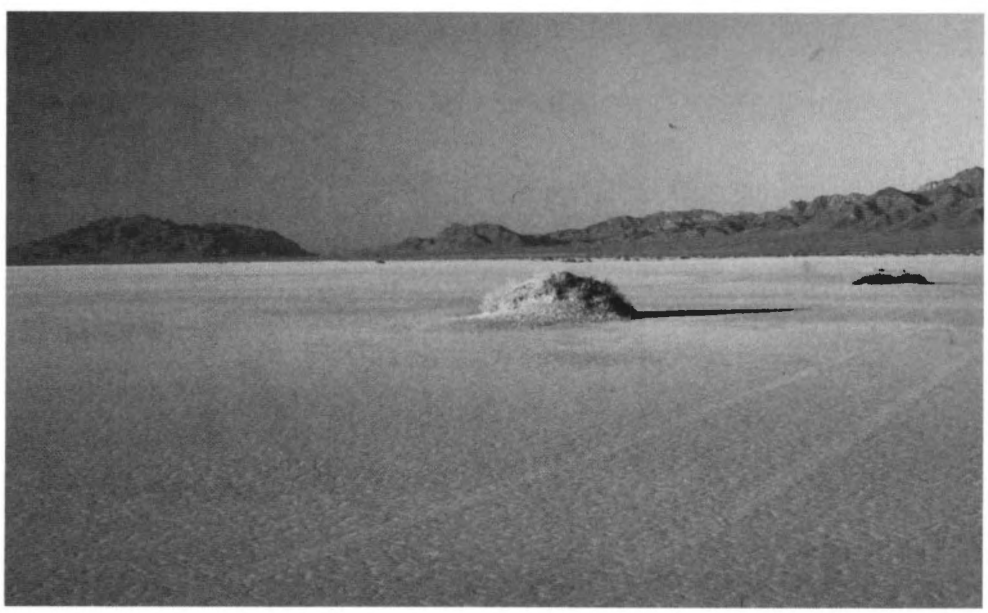

*Figure 11. Marl flats (Qlm) on the Tule Valley basin floor in the central part of the Swasey Peak NW quadrangle. View is to the northeast and includes the northern part of the House Range.*

to the east (Gilbert in Hunt, 1982; Allmendinger and others, 1983; Hunt, 1987). In the map area, the House Range piedmont is crossed by scarps of the high-angle, normal House Range fault, along which the House Range was elevated relative to Tule Valley. An estimated 9,000 feet (2,700 m) of displacement has occurred along that fault (Powell, 1958), which soles into a Mesozoic thrust that was reactivated as a normal fault (Allmendinger and others, 1983).

The structure of the Swasey Peak NW quadrangle is interpreted with the aid of published geological and geophysical data and is portrayed on the accompanying geologic cross section (A-A′). Gravity data from southern Tule Valley was used by Crosson (1964) to infer the presence there of a deep graben that is filled with more than 5,000 feet (1,500 m) of Tertiary and Quaternary alluvial-fan, lake, playa, and eolian sediments. Crosson (1964, p. 18) interpreted gravity data from northern Tule Valley, in the vicinity of the Swasey Peak NW quadrangle, as indicating less deep valley fill than in southern Tule Valley, although "with adequate data, graben features, similar to that found in the southern White [Tule] Valley, may be discovered." Crosson (1964) used the exposed Coyote Knolls tilted fault blocks (figure 1) to support his view that tilted fault blocks and grabens probably exist in the northern Tule Valley subsurface. Likewise, Hose (1963) depicted subsurface tilted fault blocks in the geologic cross section of the adjacent Coyote Knolls (formerly Cowboy Pass NE) quadrangle. More recent gravity data show a prominent negative anomaly along the eastern side of the Swasey Peak NW quadrangle (Bankey and Cook, 1989). These data reveal the existence of a linear trough with a depth between 1.5 and 2.5 miles (2.5 and 4 km), depending on the estimated relative density difference between bedrock of the House Range and Tule Valley basin fill. Seismic data collected in Tule Valley south of the quadrangle indicate that the gravity anomaly coincides with a prominent 2-mile (3.2-km) deep graben filled with Pliocene- through Quaternary-age sediment (Allmendinger and others, 1983). The subsurface units appearing on the geologic cross section (A-A′) and their approximate thicknesses are determined from geologic maps of adjacent quadrangles (Hose, 1963; Hintze, 1981; Sack, 1994), and from Allmendinger and others (1983, figure 3).

## LATE QUATERNARY GEOLOGIC HISTORY

The late Quaternary history of the Swasey Peak NW quadrangle is interpreted from the nature and distribution of its deposits, shorelines, and fault scarps, and from knowledge about the late Quaternary histories of Tule Valley (Sack, 1990) and the Bonneville basin (Scott and others, 1983; Currey and Oviatt, 1985; McCoy, 1987; Burr and Currey, 1988; Oviatt, 1989; Currey, 1990). Assuming that the topography of Tule Valley has been approximately constant over the Quaternary, the study area would likely have been at least partially inundated during the lake cycles which are known to have preceded the Bonneville lacustral cycle: the pre-Pokes Point (greater than 600,000 years ago), Pokes Point (about 200,000 years ago), Little Valley (about 140,000 years ago), and Cutler Dam (about 50,000 years ago) lake cycles. Only one of those water bodies, the Little Valley cycle lake, rose high enough in the Bonneville basin to have integrated Tule Valley like Lake Bonneville did (McCoy, 1987; Oviatt and others, 1987; Sack, 1990). Tule Valley likely contained isolated lakes early and late in the Little Valley lake cycle and during the other pre-Bonneville lake cycles. However, direct physical evidence for only the Bonneville lake cycle has been observed in the study area.

Before the start of the Bonneville lacustral cycle, the study area, along with the rest of the Bonneville basin, experienced a long period of aridity (Gilbert, 1890). This is evident from the large size of pre-Bonneville alluvial fans which are only superficially reworked into Lake Bonneville coastal landforms (Gilbert, 1890). Inferring from the present arid geomorphology of the quadrangle area, this long pre-Bonneville epoch of aridity fostered development of alluvial fans on the piedmont, dunes and eolian sheet sand on the lower piedmont, and playas, springs, dunes, and eolian sheet sand on the valley floor.

As Lake Tule rose in its transgressive phase (TLT on figure 4), it reworked the pre-Bonneville subaerial deposits at least to some extent. Sand, silt, and clay on the valley floor and lowest part of the piedmont were entrained and transported by coastal waves and currents. They were probably deposited lakeward of their initial position. With the continued transgression of Lake Tule, coastal waves and currents eventually reached coarse-grained alluvial-fan sediments somewhat higher on the piedmont. Coastal reworking of these deposits created gravel beaches, barriers, spits, and tombolos of transgressive Lake Tule ($Qlg_3$), and left a portion of the quadrangle's lower and middle piedmont etched by numerous shorelines (Qla). Some lake-reworked alluvial fans (Qla), but no significant coastal gravel deposits (Qlg), exist between the highest transgressive Lake Tule shoreline, at an average elevation of 4,640 feet (1,414 m), and the lowest Lake Bonneville shoreline in the quadrangle, at approximately 4,723 feet (1,440 m). This reflects the rapid inflow of Lake Bonneville, which occurred about 19,500 years ago (I on figure 4). Coastal reworking of pre-Bonneville alluvial fans continued as the water level rose during the subsequent transgressive phase of Lake Bonneville (TLB on figure 4). Beach sediments ($Qlg_2$) were deposited and accumulation of lacustrine marl (Qlm) began during that phase.

While stabilized at the threshold-controlled Bonneville shoreline from about 15,350 to 14,500 years ago (Burr and Currey, 1988; Currey, 1990), Lake Bonneville cut a substantial bluff into the upper piedmont of the House Range. When the lake fell from the Bonneville to the Provo shoreline during the Bonneville flood (BF on figure 4), alluvial-fan processes resumed on the upper piedmont, depositing young alluvial-fan sediments ($Qaf_1$). The height and steepness of the Bonneville shoreline's erosional scarp, however, caused the fan-building channels to incise and abandon those alluvial-fan deposits above the Bonneville shoreline ($Qaf_2$). Remnants of even older abandoned alluvial fans ($Qaf_3$) lie above those that were abandoned because of Lake Bonneville. Relative age of the old alluvial-fan deposits is inferred from their steeper slopes and larger accumulations of loess and fine-grained regolith.

As depicted in figure 4, Lake Bonneville dropped rapidly from the Provo shoreline beginning about 14,200 years ago (Burr and Currey, 1988). Shortly thereafter, Tule Valley was reisolated from Lake Bonneville (RI in figure 4), and regressive Lake Tule continued the rapid fall to very low levels (RLT in figure 4). Deposition of lacustrine tufa (Qlt) began in Provo shoreline time and persisted during the regressive phase of Lake Tule. As the water level fell, subaerially exposed, fine-grained lake and alluvial-fan sediments started to be reworked by eolian processes into dunes (Qed) and sand sheets (Qes). As sulfates precipitated out of the mineral-rich desiccating water body, sand-sized gypsum crystals were blown to the northeast and redeposited in dunes (Qed) and gypsiferous sand sheets (Qeg). During the Holocene, the water level in the basin has remained at comparatively low levels, enabling the continued deposition of alluvial-fan ($Qaf_1$) and eolian sediments (Qed, Qeg, Qes). Subaerially exposed marl on the basin floor has been blown downwind (northeast) as salt-bound marl pellets and reworked into shrub-coppice dunes (Qel). The presence of small, isolated playas (Qpm) and springs (Qsm) on the basin floor during the Holocene have resulted in limited deposition of those sediments.

## ECONOMIC GEOLOGY

Gravel, sand, gypsum, and marl constitute the most valuable economic resources in the Swasey Peak NW quadrangle. The only gravel pit that currently exists in the quadrangle is found in an area of old lacustrine gravel ($Qlg_3$) along the west-central margin of the map (NE¼ SW¼ SE¼ section 11, T. 16 S., R. 15 W.). Gravel from that pit is used to surface nearby unpaved roads. Because it is locally well sorted, old lacustrine gravel ($Qlg_3$) has the best resource potential of the three lacustrine gravel units. None of the lacustrine gravel units, however, is very extensive (table 1). Many areas of undifferentiated lacustrine and alluvial deposits (Qla) consist predominantly of gravel, and could be exploited for this resource. Borrow pits have been dug in Qla elsewhere in Tule Valley. Although significant quantities of well-sorted gravel may be located in areas of Qla, the long distance to present major construction sites probably precludes economically feasible, large-scale recovery, at least for some time.

The extensive deposits of eolian sand make this material potentially exploitable. Active eolian dunes constitute the best source of clean, well-sorted sand. Gypsum sand has been removed from dune areas elsewhere in Tule Valley, but not in the Swasey Peak NW quadrangle. Besides agricultural uses, gypsum is a component of cement, plaster, and sheetrock (Reeves, 1978). Because the nondunal gypsum sand (Qeg) is typically mixed with or overlies other units, the best source of extractable gypsum in the map area is sand dunes. However, many dunes in the study area also consist of mixtures of gypsum and nongypsum sand. In general, dunes with a large gypsum content are those located close to the marl flats.

Lacustrine marl deposits (Qlm) are also considered an economic resource. The high calcium carbonate content of the marl makes it potentially useful as agricultural lime. Tinl and Pierce (1984) described marl from a Tule Valley core as being diatomaceous.

## WATER RESOURCES

Coyote Spring (figure 12) is the only perennial water resource within the quadrangle. It is classified as a thermal artesian spring by Wilberg and Stolp (1985), who reported figures for the spring's discharge and water quality from measurements made between 1974 and 1984. Six water-temperature measurements made over this ten-year period ranged from 82.4 to 84.2°F (28.0-29.0°C). Discharge was an estimated 10 gallons per minute (40 l/min) in September 1974 and 400 gallons per minute (1500 l/min) on July 31, 1984. Specific conductance of the water measured between 2,000 and 2,500 microsiemens/cm, and pH ranged between 7.3 and 8.2. These values are within the maximum allowable limits for human consumption. Millard County maintains a graded gravel road leading to Coyote Spring, which is used for watering sheep and cattle during the winter grazing season.

## GEOLOGIC HAZARDS

Geologic hazards within the quadrangle include debris flows, flash floods, earthquakes, and blowing sand and dust. The greatest danger from debris flows exists along the eastern margin of the quadrangle in the upper piedmont zone of the House Range. The Swasey Peak NW quadrangle lies on the windward side of the House Range, which has peaks rising to 9,678 feet (2,950 m). The height, steepness, and relatively sparse vegetation of the western House Range render its upper piedmont susceptible to thunderstorm- or snowmelt-induced, mass-wasting events. Recent debris-flow deposits on the upper piedmont of the House Range indicate that this hazard will likely occur again.

Flood hazards in the Swasey Peak NW quadrangle consist of stream floods and sheetfloods. Both types of flood are most likely to occur along the House Range piedmont because of the presence of ephemeral stream channels there and because of orographically enhanced precipitation. Stream floods are caused by rapid snowmelt or intense rainfall. They may develop after debris flows (Beaty, 1968) or occur independently of mass-wasting events. Intense rainfall generally triggers sheetfloods.

The size and extent of House Range piedmont fault scarps indicate the seismic hazard of the study area (Bucknam and Anderson, 1979; Piekarski, 1980; Sack, 1990). Approximately 2.6 miles (4.2 km) of piedmont fault scarps have been mapped along the House Range piedmont in the Swasey Peak NW quadrangle. Although most of the fault-scarp traces cross undifferentiated lacustrine and alluvial deposits (Qla) that predate the Bonneville shoreline, some are visible on alluvial fans that postdate the Bonneville shoreline ($Qaf_1$). Fault-scarp traces mapped in areas of $Qaf_1$, however, are not necessarily much younger than those mapped in areas of Qla. Air photo interpretation reveals that many of the traces mapped in young alluvial-fan deposits ($Qaf_1$) are only visible because they exist where fan deposits are unusually thin. That is, the scarps may be much older features draped with a superficial layer of $Qaf_1$. Neverthe-

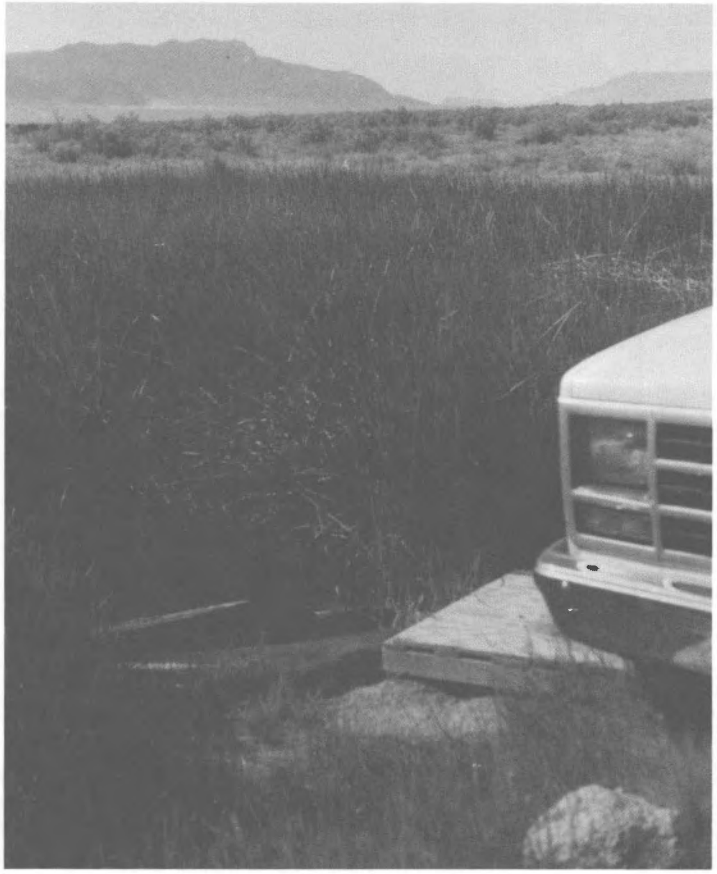

*Figure 12. Coyote Spring outflow is just left of the wooden platform near the bottom left of this photograph, taken on August 9, 1992. The House Range is on the distant skyline. Photograph by L.F. Hintze.*

less, scarp morphology studies indicate that some fault scarps along the House Range piedmont may be as young as 12,000 years old (Wallace, 1977; Piekarski, 1980; Sack, 1990). Bucknam and others (1980) estimated that House Range piedmont fault scarps resulted from earthquakes in the Richter magnitude range of 7.0 to 7.5. Specific hazards within the map area associated with potential earthquakes along the House Range fault include surface rupture, ground shaking, ground cracking, rockfall, slides, and slumps. These hazards would affect range-front localities. Ground shaking could trigger liquefaction on the valley floor.

Blowing dust has been observed in the quadrangle during periods of moderate winds (figure 13). Under high wind velocities sand is also saltated by the wind. The main hazards associated with these phenomena are reduced visibility and damage to automobiles and other machinery.

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*Figure 13. Dust blowing across the extensive area of eolian-reworked lacustrine fines (Qel/Qlm). The view is to the east and shows fine-grained lacustrine deposits in the foreground and House Range in the background.*

# REFERENCES


Allmendinger, R.W., Sharp, J.W., Von Tish, Douglas, Serpa, Laura, Brown, Larry, Kaufman, Sidney, Oliver, Jack, and Smith, R.B., 1983, Cenozoic and Mesozoic structure of the eastern Basin and Range Province, Utah, from COCORP seismic-reflection data: Geology, v. 11, p. 532-536.

Bankey, Viki, and Cook, K.L., 1989, Complete Bouguer gravity map and related geophysical maps of the Delta 1° x 2° quadrangle, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-2081-A, scales 1:250,000 and 1:150,000.

Beaty, C.B., 1968, Sequential study of desert flooding in the White Mountains of California and Nevada: U.S. Army Natick Laboratories, Earth Sciences Laboratory Technical Report 68-31-E5, 96 p.

Bucknam, R.C., Algermissen, S.T., and Anderson, R.E., 1980, Patterns of late Quaternary faulting in western Utah and an application in earthquake hazard evaluation: U.S. Geological Survey Open-File Report 80-801, p. 299-314.

Bucknam, R.C., and Anderson, R.E., 1979, Map of fault scarps in unconsolidated sediments, Delta 1° x 2° quadrangle, Utah: U.S. Geological Survey Open-File Report 79-366, 22 p, scale 1:250,000.

Burr, T.N., and Currey, D.R., 1988, The Stockton Bar, *in* Machette, M.N., editor, In the footsteps of G.K. Gilbert--Lake Bonneville and neotectonics of the eastern Basin and Range Province: Utah Geological and Mineral Survey Miscellaneous Publication 88-1, p. 66-73.

Crosson, R.S., 1964, Regional gravity survey of parts of western Millard and Juab Counties, Utah: Salt Lake City, University of Utah, M.S. thesis, 34 p.

Currey, D.R., 1990, Quaternary palaeolakes in the evolution of semidesert basins, with special emphasis on Lake Bonneville and the Great Basin, U.S.A.: Palaeogeography, Palaeoclimatology, Palaeoecology, v. 76, p. 189-214.

Currey, D.R., Atwood, Genevieve, and Mabey, D.R., 1984, Major levels of Great Salt Lake and Lake Bonneville: Utah Geological and Mineral Survey Map 73, scale 1:750,000.

Currey, D.R., and Oviatt, C.G., 1985, Durations, average rates, and probable causes of Lake Bonneville expansions, stillstands, and contractions during the last deep-lake cycle, 32,000 to 10,000 years ago, *in* Kay, P.A., and Diaz, H.F., editors, Problems of and prospects for predicting Great Salt Lake levels: Salt Lake City, University of Utah Center for Public Affairs and Administration, p. 9-24.

Gilbert, G.K., 1890, Lake Bonneville: U.S. Geological Survey Monograph 1, 438 p.

Gile, L.H., Peterson, F.F., and Grossman, R.B., 1966, Morphological and genetic sequences of carbonate accumulation in desert soils: Soil Science, v. 101, p. 347-360.

Hintze, L.F., 1981, Preliminary geologic map of the Swasey Peak and Swasey Peak NW quadrangles, Millard County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1333, scale 1:24,000.

Hintze, L.F., Taylor, M.E., and Miller, J.F., 1988, Upper Cambrian-Lower Ordovician Notch Peak Formation in western Utah: U.S. Geologic Survey Professional Paper 1393, 30 p.

Hose, R.K., 1963, Geologic map and section of the Cowboy Pass NE quadrangle, Confusion Range, Millard County, Utah: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-377, scale 1:24,000.

— 1977, Structural geology of the Confusion Range, west-central Utah: U.S. Geological Survey Professional Paper 971, 9 p.

Hunt, C.B., editor, 1982, Pleistocene Lake Bonneville, ancestral Great Salt Lake, as described in the notebooks of G.K. Gilbert, 1875-1880: Brigham Young University Geology Studies, v. 29, pt. 1,231 p.

Hunt, C.B., 1987, Physiography of western Utah: Utah Geological Association Publication 16, p. 1-29.

Hunt, C.B., Varnes, H.D., and Thomas, H.E., 1953, Lake Bonneville: Geology of northern Utah Valley: U.S. Geological Survey Professional Paper 257-A, p. 1-99.

Jarrett, R.D., and Malde, H.E., 1987, Paleodischarge of the late Pleistocene Bonneville flood, Snake River, Idaho, computed from new evidence: Geological Society of America Bulletin, v. 99, p. 127-134.

Machette, M.N., 1985, Calcic soils of the southwestern United States: Geological Society of America Special Paper 203, p. 1-21.

Malde, H.E., 1968, The catastrophic late Pleistocene Bonneville flood in the Snake River Plain, Idaho: U.S. Geological Survey Professional Paper 595, 52 p.

McCoy, W.D., 1987, Quaternary aminostratigraphy of the Bonneville basin, western United States: Geological Society of America Bulletin, v. 98, p. 99-112.

Morris, H.T., 1978, Preliminary geologic map of Delta 2° quadrangle, west-central Utah: U.S. Geological Survey Open-File Report 78-705, scale 1:250,000.

Nolan, T.B., 1943, The Basin and Range Province in Utah, Nevada, and California: U.S. Geological Survey Professional Paper 197-D, p. 141-196.

Oviatt, C.G., 1989, Quaternary geology of part of the Sevier Desert, Millard County, Utah: Utah Geological and Mineral Survey Special Studies 70, 41 p.

Oviatt, C.G., and Currey, D.R., 1987, Pre-Bonneville Quaternary lakes in the Bonneville Basin, Utah: Utah Geological Association Publication 16, p. 257-263.

Oviatt, C.G., McCoy, W.D., and Reider, R.B., 1987, Evidence for a shallow early or middle Wisconsin-age lake in the Bonneville basin, Utah: Quaternary Research, v. 27, p. 248-262.

Piekarski, Lee, 1980, Relative age determination of Quaternary fault scarps along the southern Wasatch, Fish Springs, and House Ranges: Brigham Young University Geology Studies, v. 27, pt. 2, p. 123-139.

Powell, D.K., 1958, The geology of southern House Range, Millard County, Utah: Brigham Young University Geology Studies, v. 6, 49 p.

Reeves, C.C., Jr., 1978, Economic significance of playa lake deposits: Special Publications of the International Association of Sedimentologists, No. 2, p. 279-290.

Robison, R.M., and McCalpin, J.P., 1987, Surficial geology of Hansel Valley, Box Elder County, Utah: Utah Geological Association Publication 16, p. 335-349.

Sack, Dorothy, 1988, Lacustrine history of the Tule Valley, Utah, subbasin of Lake Bonneville during the last lake cycle [abs.]: Geological Society of America Abstracts with Programs, v. 20, p. 466-467.

— 1990, Quaternary geology of Tule Valley, west-central Utah: Utah Geological and Mineral Survey Map 124, 26 p., map scale 1:100,000.

— 1992, Obliteration of surficial paleolake evidence in the Tule Valley subbasin of Lake Bonneville, *in* Wehmiller, J.F., and Fletcher, C.

H., editors., Quaternary coasts of the United States: Marine and lacustrine systems: Society for Sedimentary Geology (SEPM) Special Publication no. 48, p. 427-433.

— 1994, Geologic map of the Coyote Knolls quadrangle, Millard County, Utah: Utah Geological Survey Map 162, 18 p., 2 pl., scale 1:24,000.

Scott, W.E., McCoy, W.D., Shroba, R.R., and Rubin, Meyer, 1983, Reinterpretation of the exposed record of the last two cycles of Lake Bonneville, western United States: Quaternary Research, v. 20, p. 261-285.

Stephens, J.C., 1977, Hydrologic reconnaissance of the Tule Valley drainage basin, Juab and Millard Counties, Utah: Utah Department of Natural Resources Technical Publication 56, 37 p.

Stevens, D.J., and Brough, R.C., 1987, Western Utah climatography: Utah Geological Association Publication 16, p. 31-57.

Tinl, T.L., and Pierce, R.W., 1984, Diatom paleoecology of the Bonneville Formation, Tule Valley, Millard County, Utah [abs.]: Geological Society of America Abstracts with Programs, v. 16, p. 258.

Varnes, D.J., and Van Horn, Richard, 1951, Surficial geology of the Oak City area, Millard County, Utah: U.S. Geological Survey Open-File Report 51-12.

Wallace, R.E., 1977, Profiles and ages of young fault scarps, north-central Nevada: Geological Society of America Bulletin, v. 88, p. 1,267-1,281.

Wilberg, D.E., and Stolp, B.J., 1985, Physical characteristics and chemical quality of selected springs in parts of Juab, Millard, Tooele, and Utah Counties, Utah: U.S. Geological Survey Water-Resource Investigations Report 85-4324, 39 p.

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