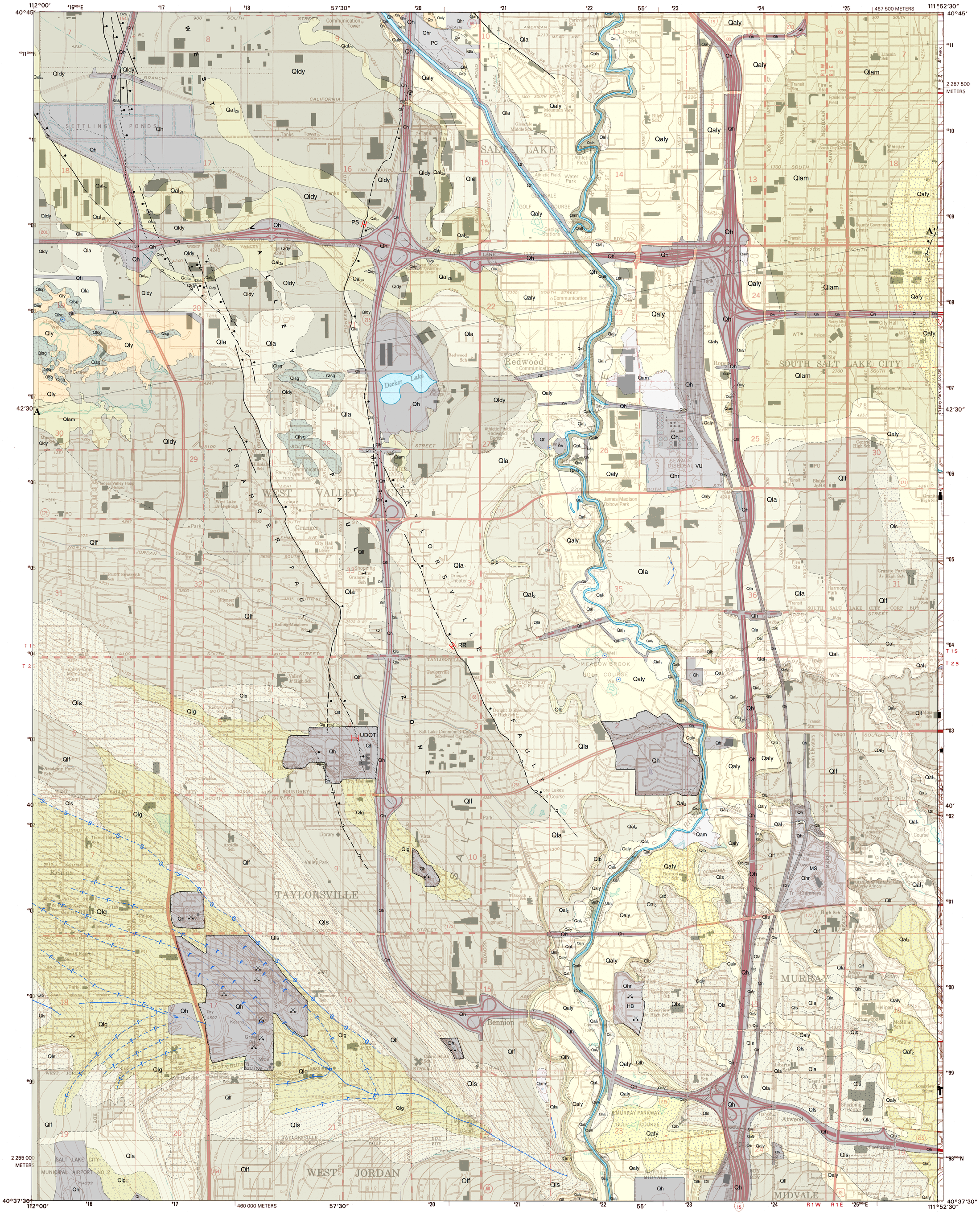
UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources



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11°29′
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2017

SCALE 1:24,000
1 0.5 0 1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0.5 0 1 KILOMETER
CONTOUR INTERVAL 5 FEET

UTAH
QUADRANGLE LOCATION

INTERIM GEOLOGIC MAP OF THE SALT LAKE CITY SOUTH QUADRANGLE, SALT LAKE COUNTY, UTAH

by
Adam P. McKean
2017

1	2	3
4	·	5
6	7	8

1. Baileys Lake
2. Salt Lake City North
3. Fort Douglas
4. Magna
5. Sugar House
6. Copperton
7. Midvale
8. Draper

ADJOINING 7.5′ QUADRANGLE NAMES

Base from USGS Salt Lake City South 7.5′ Quadrangle (1999)
Projection: UTM Zone 12
Datum: NAD 1983
Spheroid: Clarke 1866

The topographic base map appears shifted because the newer base map, published in 1997 using the North American Datum of 1983 (NAD 83), was used to show recently developed areas. The geology is mapped to the NAD 27 quadrangle boundary to conform to adjoining geologic maps. The geology is accurately shown relative to cultural and topographic features on the base map.

Project Manager: Jon K. King
Aerial photo and field mapping of geology:
Adam P. McKean, 2016-2017
GIS and Cartography: Adam P. McKean

Utah Geological Survey
1594 West North Temple, Suite 3110
Salt Lake City, UT 84116
(801) 537-3300
geology.utah.gov

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OPEN-FILE REPORT 676
UTAH GEOLOGICAL SURVEY
a division of
UTAH DEPARTMENT OF NATURAL RESOURCES
2017

STATE OF UTAH
Gary R. Herbert, Governor

DEPARTMENT OF NATURAL RESOURCES
Michael Styler, Executive Director

UTAH GEOLOGICAL SURVEY
Richard G. Allis, Director

PUBLICATIONS
contact
Natural Resources Map & Bookstore
1594 W. North Temple
Salt Lake City, UT 84116
telephone: 801-537-3320
toll-free: 1-888-UTAH MAP
website: mapstore.utah.gov
email: geostore@utah.gov

UTAH GEOLOGICAL SURVEY
contact
1594 W. North Temple, Suite 3110
Salt Lake City, UT 84116
telephone: 801-537-3300
website: geology.utah.gov

INTRODUCTION

Location and Geographic Setting

The Salt Lake City South 7.5′ quadrangle is located in central Salt Lake County. The quadrangle contains parts of Salt Lake City, City of South Salt Lake, West Valley City, City of Taylorsville, Murray City, Kearns Township, City of West Jordan, Midvale City, City of Millcreek, and the northern part of South Valley Regional Airport. In addition to the metropolitan areas, the Jordan River, Mill Creek, and Big and Little Cottonwood Creeks flow through the quadrangle. The study area contains the southern parts of the Granger and Taylorsville faults of the West Valley fault zone. The surficial geology is composed of alluvial, deltaic, lacustrine, marsh, and mass-movement deposits. No bedrock is exposed in the quadrangle. The Salt Lake City South quadrangle was mapped to provide the basis for identifying and delimiting potential geologic hazards in future derivative Utah Geological Survey (UGS) geologic hazard mapping of urban and rapidly developing areas by the UGS Geologic Hazards Mapping Initiative.

GEOLOGY

Surficial Geology

Surficial unconsolidated geologic deposits within the quadrangle consist of alluvial, lacustrine, deltaic, marsh, and mass-movement deposits of Quaternary age. Lacustrine and deltaic sediments were deposited in late Pleistocene Lake Bonneville (30 to 13 ka), the Gilbert-episode lake (~11.5 ka), and Holocene Great Salt Lake (since ~11 ka) (see table 1, all ages in this report are in calibrated years). Following Oviatt (2014) the Gilbert-episode lake is regarded as a separate lake, rather than a phase of the Bonneville or Great Salt Lake cycles. Table 1 is based on features produced by Lake Bonneville, the Gilbert-episode lake, and Great Salt Lake and provides time constraints and elevations for many geologic units.

Lake Bonneville transgressive, overflow, and regressive deposits (Qlf, Qls, Qlg, Qlb) are likely the oldest exposed Quaternary deposits in the quadrangle. Following regression of Lake Bonneville, alluvial streams flowed north into the Gilbert-episode lake and Holocene Great Salt Lake, forming alluvial, lacustrine, and deltaic deposits (Qlsg, Qla, Qldy, Qal_{2a}). During and soon after the regression of Lake Bonneville, the Jordan River, and Big and Little Cottonwood Creeks incised through the older alluvial and lacustrine deposits forming Holocene floodplains, alluvial fans, and marsh deposits (Qal_1, Qal_2, Qaly, Qafy, Qam, Qlam). Shallow Holocene (including historical) lakes (Qly) occupied topographically low areas.

A number of mapped and unmapped geologic hazards are present in the quadrangle, including a landslide deposit (Qms) and surface fault ruptures (scarps). The quadrangle contains the Granger and Taylorsville normal faults, which have Holocene scarps and form the north-south-trending West Valley fault zone. The West Valley fault zone is partially antithetic to the Salt Lake City segment of the Wasatch fault zone. On the eastern boundary of the quadrangle a queried fault, located west of the East Bench fault of the Wasatch fault zone, enters the quadrangle. The East Bench fault dips westward beneath the quadrangle. These faults and other geologic hazards are described and discussed in more detail in the "Surface Fault Rupture" subsection of the "Selected Geologic Hazards" section of this report.

Human disturbances are widespread throughout the quadrangle; areas of large disturbance are mapped as Qh and environmentally remediated land is mapped as Qhr, which is an important distinction in this quadrangle due to remediated smelting and other industrial operations. The Jordan River has been modified significantly by human channelization and levee construction compared to its pre-development floodplain, as seen by the difference of Qal_1 (pre-1937 floodplain) and Qalh (historical modified channel and levees). See map unit descriptions for more information regarding the characteristics of each geologic unit.

PREVIOUS MAPPING

Previous detailed surficial geologic maps of the study area include Van Horn's (1979) Salt Lake City South quadrangle (a 1:24,000-scale map) and a regional surficial geologic map of the Wasatch Front by Miller (1980) at a scale of 1:100,000. However, neither map shows the Granger and Taylorsville faults of the West Valley fault zone. Personius and Scott (1992) compiled a surficial geologic map of the Salt Lake City segment of the Wasatch fault zone at 1:50,000 scale, using the 1:24,000-scale map of Scott and Shroba (1985) as the primary source. Scott and Shroba's (1985) mapping does not extend far enough west to include the West Valley fault zone.

My mapping consulted these previous surficial geologic maps (Van Horn, 1979; Miller, 1980; Personius and Scott, 1992) and soil maps (U.S. Natural Resources Conservation Service [USNRCS], 2015). When compared with previous maps, the largest changes are the addition of the West Valley fault zone and the revision of Quaternary stratigraphy, particularly of Lake Bonneville deposits. Contacts and units were mapped and field checked in 2016–17.

METHODS

My approach for mapping surficial deposits is the same as that used by the UGS Geologic Mapping Program which is based on age and depositional environment or origin. The letters of the map units in order indicate (1) age (geologic period, e.g., Q for Quaternary); (2) primary depositional environment or origin, usually determined from geologic setting, landform or morphology; (3) grain size(s), bedding, or other distinctive characteristics of the deposits; and (4) additional significant information, such as tighter age constraints (Doelling and Willis, 1995) as related to the phases of Lake Bonneville or numbered with 1 being the youngest. For example, unit Qal_1 is a Quaternary surficial deposit of alluvial stream origin (al), and the number one indicates it is young and potentially historically active.

Mapping for the project was accomplished using stereographic pairs of aerial photographs that included black-and-white photographs at a scale of approximately 1:20,000 from the U.S. Department of Agriculture (USDA) Agricultural Adjustment Administration (1937) and photographs of approximately 1:10,000 scale from the USDA Agricultural Stabilization and Conservation Service (1958). Some unit contacts were mapped with the aid of USNRCS (2015) soil map data. Gravel pit outlines and some contacts were revised using 2016 orthophotographs (Utah Automated Geographic Reference Center [UAGRC], 2016) and 0.5-meter lidar elevation data (UAGRC, 2013–2014). The geologic map was made by transferring the geology from the aerial photographs to a geographic information system (GIS) database in ArcGIS for a target scale of 1:24,000, using the lidar data, orthophotographs of Salt Lake County (UAGRC, 1977), and 2016 orthophotographs (UAGRC, 2016).

Cross-section A–A′ was created by combining available subsurface and gravity data. Well logs from Meiiji Resource Consultants (1983), Case (1985), and others compiled online (UGS, undated) were used to estimate the subsurface contact between Quaternary unconsolidated deposits and Tertiary semi-consolidated to consolidated strata. Depth of unconsolidated to semi-consolidated material was also inferred from water well logs in the area (online well data from Utah Division of Water Rights, 2009). The top of semi-consolidated material described in well logs (Meiiji Resource Consultants, 1983; Case, 1985; UGS, undated) was marked mostly by a transition from unconsolidated clay, silt, sand, and gravel to more semi-consolidated deposits, typically described as hard pan, various types of cemented or hard material, conglomerate, or lava (Arnow and others, 1970), but also may include shale or limestone. While none of the reviewed well logs in the quadrangle specifically identified strata of the Pliocene to Miocene Salt Lake Formation or older Oligocene to Eocene volcanic and volcaniclastic rocks that are common along the Salt Lake Valley margins (see for example Van Horn, 1982; Van Horn and Crittenden, 1987; Biek, 2005a; Biek, 2005b; Biek and others, 2007; McKean, in preparation a), these units are likely part of the Tertiary strata in subsurface. Depth to Mesozoic and Paleozoic bedrock was estimated from gravity models by Meiiji Resource Consultants (1983) and Hill and others (1990). Basin depth and structure were estimated from gravity data from Cook and Berg (1961), Zoback (1983), and the Pan-American Center for Earth and Environmental Studies (PACES) (2012) gravity database. The actual depth to Mesozoic and Paleozoic bedrock is uncertain as no wells in the quadrangle penetrated the entire thickness of Tertiary strata.

SELECTED GEOLOGIC HAZARDS

Geologic hazards in the map area include surface fault rupture (normal faulting), landsliding (Qms), and flooding (Qalh, Qal_1, Qal_2, Qaly, Qafy, Qam, and Qlam). Other potential geologic hazards that are not addressed in this report include debris flow (Qafy), earthquake ground shaking, liquefaction, tectonic subsidence/tilting, expansive soils, collapsible soils, shallow groundwater, corrosive soils, and other problem soils. For example, spring and marsh deposits (Qam and Qlam) can indicate areas of shallow groundwater, while clay-rich lacustrine deposits (Qly, Qlf, Qldy, and Qlam) can indicate soil problems like expansive or impermeable soils. See the map unit descriptions and geologic map (plate 1) for more information and the location of potential hazards. Below is a brief discussion of the surface fault rupture and flooding hazards in the quadrangle. While only one landslide (Qms) is mapped in quadrangle (see plate 1 and unit description), there are numerous steep unconsolidated slopes along the Jordan River incision and other steep slopes in the quadrangle that have potential for mass movement. Additional geologic hazards may exist, but are not listed in this section. All po-

tential geologic hazards require comprehensive site-specific geotechnical and geologic hazard investigation. See the UGS website (geology.utah.gov) for additional information on these and other geologic hazards.

Surface Fault Rupture

The north-south-trending West Valley fault zone is partially antithetic to the Salt Lake City segment of the Wasatch fault zone. These fault zones bound an intrabasin graben in northern Salt Lake Valley. The West Valley fault zone includes the Granger (western) and Taylorsville (eastern) faults. The southern parts of the Granger and Taylorsville faults are in the Salt Lake City South quadrangle. Surface traces of the West Valley fault zone were first shown as faults by Marsell and Threet (1960) on their Salt Lake County geologic map. Cook and Berg (1961) correlated the Granger-area faults to their steep gravity gradient in what they called the Jordan Valley graben. Marine and Price (1964) named the faults the Granger and Taylorsville faults of the Jordan Valley fault zone, and provided drill hole data for displacement minimums across the faults. Van Horn's (1979 and 1982) 1:24,000-scale surficial geologic maps of the area did not show the fault zone; instead he attributed the scarps to differential erosion of distinct stratigraphic units (Van Horn, 1986, personal communication in Keaton and others, 1987). Miller's (1980) 1:100,000-scale surficial geologic mapping included the northern part of the Granger fault as scarps with uncertain origin. Keaton and others (1987) and Keaton and Currey (1989) conducted the first detailed investigations of the fault zone and confirmed, through geomorphic mapping, trenches, and borings, the existence of the Granger and Taylorsville faults. They proposed the West Valley fault zone name for the structure and retained the existing Granger and Taylorsville fault names. Only a few paleoseismic research investigations (Keaton and others, 1987; Keaton and Currey, 1989; Hylland and others, 2014; 2017) have been done on the fault zone, partly because development has obscured the scarps and prevented the excavation of trenches needed in investigations. These studies are discussed in the sections below.

Another fault is mapped in the quadrangle on the eastern boundary with the Sugar House quadrangle. It is a queried fault that just enters the quadrangle. This fault is part of a larger fault zone that is mapped in the Sugar House quadrangle west of the East Bench fault of the Salt Lake City segment of the Wasatch fault zone (for discussion of this fault see McKean, in preparation b).

Granger Fault

The Granger fault, the western fault of the West Valley fault zone, is a down-to-the-east normal fault approximately 11.5 miles (~18.5 km) long end-to-end, and is discontinuously exposed in this quadrangle and the Baileys Lake and Salt Lake City North quadrangles (McKean and Hylland, 2013; McKean, in preparation a).

Paleoseismic investigations by Keaton and others (1987) and Keaton and Currey (1989) studied the Granger fault at three localities within the quadrangle. At two localities, they used borings to determine offset in the subsurface across the Granger fault. One set of borings was at a 1300 South locality (Keaton and Currey, 1989) and the other locality was in a lot at 3166 South 3200 West (Keaton and others, 1987). They excavated two trenches and drilled six borings at the Utah Department of Transportation facility near 4501 Constitution Blvd (see UDOT on plate 1 for approximate trench location; Keaton and others, 1987). They conducted geomorphic mapping of cross-cutting relationships between the Granger fault and several post-Bonneville alluvial channels (see figure 6a in Keaton and others, 1987; unit Qaf_{2a} on plate 1). They also characterized surface faulting along the Granger fault as a typically discrete normal fault plane (Keaton and others, 1987). These studies provided definitive evidence for surface-fault ruptures on the Granger fault and long-term (140 kyr) cumulative displacements and slip rates for the West Valley fault zone. However, they were unable to provide individual earthquake timing and displacement data.

A recent paleoseismic investigation to the northwest in the adjacent Baileys Lake quadrangle (Hylland and others, 2014) revealed that prehistoric earthquakes on the Granger fault have created 1- to 3-foot-high (0.4–1 m) fault scarps. The investigation documented four large (surface-faulting) earthquakes since the highstand of Lake Bonneville (~18 ka), the most recent having occurred about 5.5 ka. Although their earthquake timing does not provide an unequivocal coseismic link between the Granger fault and Salt Lake City segment of the Wasatch fault zone, it does suggest that large earthquakes on the West Valley fault zone are likely coseismic with or triggered by faulting on the Salt Lake City segment (Hylland and others, 2014; DuRoss and Hylland, 2015).

Taylorsville Fault

The Taylorsville fault is the eastern fault of the West Valley fault zone and is down-to-the-east in the southern part. However, the northern part that extends into the Salt Lake City North quadrangle has both down-to-the-east and -west faults between the Granger fault and Warm Springs fault of the Wasatch fault zone (McKean, in preparation a). The Taylorsville fault is approximately 9.7 miles (~15.6 km) long end-to-end and is discontinuously exposed.

Paleoseismic investigations by Keaton and others (1987) and Keaton and Currey (1989) of the Taylorsville fault of the West Valley fault zone included previous consultant reports of surface-fault-rupture-investigation trenching: one at the Pioneer Square locality (between Pioneer Road, 1700 South, Interstate Highway 215, and State Route 201; see PS on plate 1) and the other located northwest of 4100 South Street and Redwood Road (see RR on plate 1; Keaton and others, 1987; Keaton and Currey, 1989). At the Pioneer Square locality, trenching revealed monoclinal warping of the deposits with minor down-to-the-east step faulting (Keaton and others, 1987; Keaton and Currey, 1989). At the 4100 South Street locality trenching revealed monoclinal warping of the deposits and only minor offset of a clay marker bed (Keaton and others, 1987). Keaton and others, (1987) also conducted geomorphic mapping of the cross-cutting relationships between the Taylorsville fault and several post-Bonneville alluvial channels north of Decker Lake (see figure 6a in Keaton and others, 1987; unit Qaf_{2a} on plate 1). These paleoseismic studies provided definitive evidence for surface-fault ruptures on the Taylorsville fault and long-term cumulative displacements and slip rates for the West Valley fault zone. However, like with the Granger fault, they were unable to provide individual earthquake timing and displacement data.

To the north, several consultant's geotechnical investigations within the Salt Lake City North quadrangle reported locating the Taylorsville fault (see McKean, in preparation a). An AGRA (1997) fault investigation documented surface faulting in trenches on the northernmost Taylorsville fault (east of about 1300 North on 2200 West Street in Salt Lake City; or about 3.3 miles [~5.3 km] north of the quadrangle). Two organic-rich bulk-soil samples from these trenches (one of the samples was interpreted as scarp-derived colluvium) yielded an average calendar-calibrated age of 2200 years (Solomon, 1998). The 2200-year age was interpreted as approximating the time of a surface-faulting earthquake.

A recent UGS paleoseismic investigation trench near the AGRA (1997) site on the Taylorsville fault (Hylland and others, 2017) revealed evidence for three late Holocene surface-faulting earthquakes on the fault. Trenching depth was limited due to shallow groundwater, and exposed deposits were only as old as mid-Holocene. The youngest event occurred at 0.4 ± 0.2 ka, the mean late Holocene (post-2 ka) recurrence interval is 800 years, and geologic (open-interval) slip rates range from 0.1–0.2 mm/yr over the past ~5000 years to 0.2–0.4 mm/yr over the past ~2500 years (Hylland and others, 2017). Combined with other West Valley fault zone paleoseismic data, four mid- to late Holocene earthquakes have mean modeled times similar to earthquakes on the Salt Lake City segment and Weber segment of the Wasatch fault zone (Hylland and others, 2017). This provides additional support to the theory that the West Valley fault zone moves coseismically with or has faulting triggered by faulting on the Salt Lake City or Weber segment of the Wasatch fault zone.

Flooding

Flood and debris-flow hazard areas are primarily in, but are not limited to, alluvial channels (Qalh, Qal_1, Qal_2, and Qaly) and areas mapped as alluvial fan deposits (Qafy). Flood hazard exists along the Jordan River, Mill Creek, and Big and Little Cottonwood Creeks. Locations of these potential flood hazard units are on the geologic map (plate 1) and additional information is included in the unit descriptions. Flooding could also occur in areas of shallow groundwater. Delineation of exact flood and debris-flow hazards requires detailed geotechnical investigations.

MAP UNIT DESCRIPTIONS

QUATERNARY

Alluvial deposits

Qalh **Historical alluvial deposits and human-made levees, undivided** (historical) – Moderately sorted sand, silt, and minor clay alluvial deposits and artificial earthen levees, undifferentiated along channelized Jordan River; very fine to medium-grained sand; rounded to angular sand grains; thin to medium bedded; mapped in active channels, modified channel margins and minor terraces less than 10 feet (3 m) above active channels; includes human-made channels and levees; locally includes minor colluvial deposits along steep embankments; most streams have been modified from their natural course and are channelized; estimated thickness less than 15 feet (5 m).

Qal_1 **Active floodplain and stream deposits** (upper Holocene) – Moderately to well-sorted, medium- to light-brown sand, silt, and minor clay; locally may contain gravel; very fine to medium-grained rounded to angular sand grains; contains thin discontinuous sand lenses; thin to medium bedded; sand grains are quartz, lithic fragments, and mica flakes; mapped in channels and active floodplains of Jordan River, Big and Little Cottonwood Creeks

and on terraces less than 5 feet (1.5 m) above creek and river channels; includes oxbow lakes and marshy areas too small to map separately; equivalent to the younger part of Qaly; differentiated from Qaly where active channels incise older Qal_2 or Qaly along the Jordan River; this unit is the historical alluvial floodplain and channel from 1937 aerial photographs (USDA, 1937) before human modification of much of its natural course; locally includes minor colluvial deposits along steep embankments and natural levees; some deposits are channelized in Big and Little Cottonwood Creeks and include channel embankments; may locally include small unmapped mixed alluvial and marsh deposits and channelization (Qalh) that cannot be shown individually at map scale; thickness variable, probably less than 30 feet (10 m).

Qal_2 **Level-2 floodplain and stream deposits** (middle Holocene to upper Pleistocene) – Moderately to well-sorted, medium- to light-brown sand, silt, and minor clay; locally may contain gravel; very fine to medium-grained rounded to angular sand grains; contains thin discontinuous sand lenses; thin to medium bedded; sand grains are quartz, lithic fragments, and mica flakes; forms terraces 5 to 15 feet (1.5–5 m) above and adjacent to channels and floodplains of Jordan River and Big Cottonwood Creek; may be in the floodplain; includes oxbow lakes and marshy areas too small to map separately; inset into Lake Bonneville deposits and incised by Qal_1; equivalent to the older part of Qaly; thickness variable, probably less than 30 feet (10 m).

Qaly **Young floodplain and stream deposits, undivided** (Holocene to upper Pleistocene) – Moderately to well-sorted sand, silt, and minor clay; locally may include gravel; mapped in channels and active floodplains of Jordan River, Mill Creek and smaller creeks; includes oxbow lakes and marshy areas too small to map separately; locally includes small areas of alluvial-fan and colluvial deposits; inset into Lake Bonneville deposits; includes level-2 floodplain and stream deposits (Qal_2) incised by active floodplain and stream (Qal_1); Qaly mapped where Qal_1 and Qal_2 deposits cannot be mapped separately due to lack of bars and swales and because patches of deposits are too small to show separately at map scale; postdates regression of Lake Bonneville from the Provo shoreline and lower shorelines; thickness variable, probably less than 30 feet (10 m).

Qal_{2a} **Stream deposits related to Gilbert-episode lake and/or Great Salt Lake** (middle Holocene? to upper Pleistocene?) – Moderately sorted, light olive-gray sand, silt, and minor clay; very fine to medium-grained subangular to angular sand grains; contains thin discontinuous sand lenses; thin to medium bedded; sand grains are quartz, lithic fragments, and mica flakes; located west of the Jordan River and north of 3100 South Street and mapped in abandoned channels and floodplains of streams that once flowed into and through a regressive Gilbert-episode delta (Murchison, 1989; Qalo, Qdo of McKean and Hylland, 2013); deposited 5 to 15 feet (1.5–5 m) above adjacent floodplains of Jordan River (Qal_1 and Qaly); delta and stream deposits mentioned above are located below the Gilbert-episode lake highstand elevation, so could also be related to early Holocene highstand of Great Salt Lake based on elevation (see table 1); unit correlative with regressive Gilbert-episode deltaic deposits in the undivided young deltaic deposits (Qldy) in the quadrangle; older then Qaly and Qal_2, the 2a designation is to signify that the unit is post-Bonneville rather than Lake Bonneville age (Qal_3 on many other maps in the area); estimated thickness less than 15 feet (5 m).

Qaf_2 **Level-2 alluvial-fan deposits** (middle Holocene and upper Pleistocene) – Poorly sorted pebble and cobble gravel, in a matrix of sand, silt, and minor clay; clasts subangular to well-rounded; thin to thick planar bedding and low-angle cross-bedding; deposited by debris flows, debris floods, and streams; mapped in the southeast part of the quadrangle; the alluvial fan is present downslope from regressive-phase Lake Bonneville deltaic deposits mapped in the Sugar House and Draper quadrangles (unit Qldp of McKean, in preparation b; McKean and Solomon, in preparation) and incised by streams along Little Cottonwood Creek (Qal_1) and Qaly near 5900 South; equivalent to the older part of Qafy, but mapped separately based on incision by active streams; exposed thickness less than 30 feet (10 m).

Qafy **Younger alluvial-fan deposits, undivided** (Holocene to upper Pleistocene) – Poorly to moderately sorted sand, silt, and clay on gentle slopes of distal alluvial-fan deposits; thin to thick planar bedding and low-angle cross-bedding; deposited by debris flows, debris floods, and streams; mapped in the northeast part of the quadrangle at the distal margins of Emigration, Parleys, and Mill Creeks alluvial fans; also mapped in the southeast corner of the quadrangle where alluvial channels (Qaly) empty into the Jordan River incision; these fans are cut by the Jordan River (Qal_1 and Qaly) but not mapped as Qaf_2 because in 1937 aerial photographs (USDA, 1937) they appear to have small potentially active stream channels (Qal_1 or Qaly) that cannot be subdivided from the alluvial-fan deposit; includes both ages of younger alluvial-fan deposits (Qaf_1 and Qaf_2); postdates the regression

of Lake Bonneville from the Provo shoreline and lower shorelines; a more specific age cannot be determined because incision by active streams (Qal_1 or Qaly) is uncertain; Lake Bonneville shorelines are not present on these alluvial fans; estimated thickness less than 30 feet (10 m).

Human-derived deposits and disturbances

Qh **Fill and disturbed land** (historical) – Undifferentiated artificial (human) fill and disturbed land related to construction of road, rail, and bridge embankments, water storage, canals, flood control structures, water treatment plants, settlement ponds, landfills, borrow pits, and sand and gravel operations (commonly in Lake Bonneville gravel and sand deposits [Qlg]); the map outlines of fill and disturbed land are based on 1958 aerial photographs; updated using 2016 orthophotography (UAGRC, 2016) and 0.5 m lidar (UAGRC, 2013–2014); only the larger areas of disturbed land are mapped; unmapped fill and disturbed land are present in most developed areas, note city street system on base map; land within developed areas contains a changed and still changing mix of cuts and fills; thickness unknown.

Keaton and others (1987) suggested that the large berm north of Decker Lake, seen in the pre-1958 aerial imagery and topographic maps, is an eolian lunette dune developed on the margin of a playa in a depression adjacent to the Taylorsville fault. However, the lack of other eolian features in the quadrangle and the large scale of the berm suggest that it is a pre-1937 manmade or modified feature used to create a dam for Decker Lake and thus is mapped as Qh along with the mostly now filled in lake.

Qhr **Remediated land** (historical) – This unit delineates the approximate boundaries of selected environmentally remediated sites in the quadrangle including: Vitro uranium mill and tailings, Murray lead smelter, Portland Cement kiln dust #2 and #3, and Highland Boy copper smelter site; these sites are described below; other remediated lands may exist in the quadrangle; the extent of surficial (soil) or groundwater contamination may exceed the mapped unit; areas near these remediated sites may contain latent contaminated material or groundwater and a comprehensive site-specific environmental investigation is recommended; thickness of remediation is variable.

The Vitro Corporation of America uranium and vanadium mill was in operation from 1951 to 1968; as of July 1970 the uranium mill tailings at the mill site occupied about 107 acres north of 3300 South Street (west of 900 West Street and east of the railroad line), (see VU on plate 1) (Duncan and Eadie, 1974; U.S. Department of Energy [USDOE], 2016). Clean up of the site was conducted by the State of Utah under the direction of the USDOE between 1984 and 1989; tailings and contaminated soil and debris were removed to the Clive Disposal Facility (USDOE, 2016). Some radiation concentration levels indicate small pockets of contamination exceeding the radium-226 and thorium-230 cleanup standards were left in place along two utility lines (USDOE, 2016). Groundwater monitoring ended in 2007 (USDOE, 2016). Radon gas hazard may also be a concern in the area. The site is now occupied by the Central Valley Golf Course, a water treatment plant, a concrete plant, and a waste transfer station.

The Murray lead smelter site, located near 5300 South Main Street in Murray (see MS on plate 1), was operated from 1872 to 1902 by Germania Smelter and Refinery Works, and then from 1902 to 1949 by American Smelting and Refining Company (ASARCO) (Robbins, 2005; U.S. Environmental Protection Agency [USEPA], undated a). The 142-acre site remediation occurred between 1995 and 2001 and included excavation of 580 tons of high concentration arsenic waste and off-site disposal at a hazardous waste landfill; 84,000 cubic yards of lower concentration arsenic-contaminated soils and debris were placed in secure repositories on site (Robbins, 2005; USEPA, undated a). Long-term groundwater monitoring is ongoing (USEPA, undated a). The site is now occupied by the Intermountain Medical Center, Costco warehouse store, and commuter train and light rail station.

Portland Cement kiln dust #2 and #3 site is an approximately 71-acre triangular area west of Redwood Road (~1000 South) between Indiana Ave and the Jordan River Surplus Canal (see PC on plate 1) (USEPA, 1992). Between 1965 and 1983 waste cement kiln dust and chromium-bearing refractory kiln bricks were disposed of at the site (USEPA, 1992); the dust and bricks were from a cement plant located at the southwest corner of 600 West Street and 800 South Street that was operated by several companies. The site remediation took place between 1995 and 1998 when the cement kiln dust and chromium-bearing bricks were removed, treated, and disposed of off-site (USEPA, undated b). Groundwater monitoring is ongoing (USEPA, undated b). The site is now being developed and partially occupied by several large warehouses.

The Highland Boy copper smelter site was located at about 5800 South 900 West in Murray (see HB on plate 1). The smelter operated from 1899 through 1908 when it closed as a result of a court injunction requiring that smelters in the area reduce sulfur emissions (Lamborn and Peterson, 1985). The lawsuit was brought by organized farmers whose crops, orchards, and animals had been damaged due to sulfur dioxide (mixed with water/moisture to form sulfuric acid) from the stacks of five smelters, all but one closed as a result (Lamborn and Peterson, 1985). Apparently, prior to mitigation slag was removed from the site and used to construct Interstate Highway 15 (Hansen, 1986). During remediation, remaining debris was removed and buried in a clay lined pit within the adjacent Utah Light and Power utility transmission line right-of-way (Resource Recovery and Conservation Company, 1986). The site is now occupied by residential, church, and commercial properties.

Lacustrine deposits

Qly **Young lacustrine deposits** (Holocene to upper Pleistocene?) – Moderately sorted, dark yellowish-brown silt, olive-gray quartz sand, light olive-gray clay, and yellowish-gray marl; subangular to angular, fine to coarse quartz sand; mapped where standing water or mud flat playas are visible on the 1937 aerial photographs (USDA, 1937); includes historical lakes shown on Van Horn's (1979) surficial geologic map including Hunter Lake, Moon Lake, and Silver Lake (also shown on the 1951 U.S. Geological Survey topographic map of the quadrangle) and one Van Horn called White Lake, that he cited from a 1906 map (source of map reference has not been found); all these lakes have been drained and built over; distinguished from young lacustrine and deltaic deposits (Qldy) by the lack of natural levee deposits and deltaic distributary channels; distinguished from Qlf by the presence of standing water and dry lake bed (playa) surfaces visible on aerial 1937 and 1958 photographs (USDA, 1937, 1958); might include deposits related to the Gilbert-episode lake as the unit surrounds Gilbert sands (Qlsg) but a constructed water control feature may be causing the water to pond and form lakes; similar deposits mapped as Qlay in the Magna quadrangle (Solomon and others, 2007); estimated thickness 15 feet (5 m).

Deposits of the Gilbert-episode lake – Only mapped below the Gilbert shoreline (not preserved in the quadrangle but is at elevations of about 4245 to 4250 feet [1294–1295 m] in the surrounding area).

Qlsg **Lacustrine sand and silt related to Gilbert-episode lake** (middle Holocene to upper Pleistocene) – Moderately to well-sorted, subrounded to rounded, fine to coarse sand and silt with minor pebbly gravel; thick to very thick bedded; commonly planar bedded, with some ripple marks and scour features; described as barrier beaches along the Gilbert shoreline (Solomon and others, 2007); mapped as Qlsp in the Magna quadrangle (Solomon and others, 2007); estimated thickness 15 feet (5 m).

Undivided deposits of the transgressive and regressive phases of Lake Bonneville – Throughout the region transgressive-, overflow-, and regressive-phase deposits of late Pleistocene Lake Bonneville are mapped separately where possible based on shoreline (example Qlgb, Qlgp). In the Salt Lake City South quadrangle most deposits of these phases are difficult to distinguish and are combined because all elevations are below the Provo shoreline (Qlf, Qls, and Qlg). Some mappable transgressive-phase deposits (Qlb) are exposed in cutbanks along the Jordan River.

Qlf **Lacustrine silt and clay related to the transgressive and regressive phase of Lake Bonneville** (upper Pleistocene) – Moderately to well-sorted, silt, clay, fine sand and minor pebbly gravel; typically laminated or thin bedded; variably calcareous; may locally contain ostracods; deposited in shallow to moderately deep parts of Lake Bonneville; commonly gradational upslope into lacustrine sand and silt (Qls); locally concealed by loess veneer; regressive Lake Bonneville shorelines typically poorly developed in contrast to shorelines on unit Qlg; distinguished from Qls and Qlg by the presence of silty sand, silt, and clay as indicated in soil maps (USNRCS, 2015); mapped as Qlmbp in the Magna quadrangle (Solomon and others, 2007); exposed thickness more than 25 feet (7 m).

Qls **Lacustrine sand and silt related to the transgressive and regressive phase of Lake Bonneville** (upper Pleistocene) – Moderately to well-sorted, fine to coarse sand, silt, clay, and minor pebbly gravel; thin- to thick-bedded; commonly has ripple marks and scour features; deposited in relatively shallow water nearshore, downslope from gravel and sand (Qlg); distinguished from Qlf and Qlg by the presence of silty sand and sand as indicated in soil maps (USNRCS, 2015); mapped as Qlsbp in the Magna quadrangle (Solomon and others, 2007); exposed thickness more than 30 feet (10 m).

Qlg **Lacustrine gravel and sand related to the transgressive and regressive phase of Lake Bonneville** (upper Pleistocene) – Moderately to poorly-sorted, subrounded to rounded, pebble to cobble gravel in a matrix of pebbly sand, sand, and silt; locally interbedded with and containing lenses of silt and sand; thin to thick planar and cross beds; mapped near Kearns and Bennion on an east-west-oriented spit that developed during both Bonneville Lake transgression (see "S" = Stansbury shoreline on plate 1) and regression (see "r" = regressive shorelines on plate 1); shorelines typically well developed in contrast to the lack of shorelines on units Qlf and Qls; distinguished from Qlf and Qls by the presence of gravel and sand as indicated in soil maps (USNRCS, 2015); commonly interbedded with or laterally gradational with lacustrine sand and silt (Qls); mapped as Qlgbp in the Magna quadrangle (Solomon and others, 2007); exposed thickness more than 60 feet (20 m).

Deposits of the transgressive phase of Lake Bonneville – Mapped below the Bonneville and Provo shorelines in bluffs along the incised Jordan River where transgressive phase deposits likely underlie the undivided deposits of the transgressive, overflow, and regressive phases of Lake Bonneville.

Qlb **Transgressive phase deposits, undivided** (upper Pleistocene) – Moderately to well-sorted, subrounded to rounded, fine to coarse sand, silt, and clay with pebbly gravel; locally includes beds of gravel and sand; limited to exposures in bluffs along Jordan River and stream terraces where slope colluvium conceals the relative amounts of gravel, sand, silt, and clay in these transgressive deposits; may include pre-Bonneville deposits that have not been differentiated; exposed thickness less than 100 feet (30 m).

Mass-movement deposits

Qms **Landslide deposits** (historical to upper Pleistocene) – Poorly sorted, clay- to pebble-sized material in one small mapped landslide; composition depends on Qlf, Qls, and Qlb source material; landslide characterized by hummocky topography and main scarp; landslide is mapped on the western bluff above the Jordan River just southeast of Winchester Street (~6500 South) and 1300 West; apparent age is post-incision of Jordan River, likely after Lake Bonneville began to regress from the Provo shoreline (see table 1 for shoreline age); even landslides with subdued morphology (suggesting that they are older, weathered, and have not moved recently) may continue to exhibit slow creep or are capable of renewed movement if stability thresholds are exceeded (Ashland, 2003); stability determinations require detailed geotechnical investigations; other unmapped landslides or unstable slopes may be present along the Jordan River bluff or other steep slopes; thickness unknown.

Mixed-environment deposits

Qam **Alluvial and marsh deposits, undivided** (Holocene to upper Pleistocene) – Moderately to well-sorted sand, silt, clay, and organic-rich sediment associated with springs, ponds, seeps, and wetlands; commonly wet, but may be seasonally dry; may locally contain peat deposits; mapped at: (1) about 900 West and 2760 South and partially concealed by the water treatment plant and old Vitro uranium mill, (2) near 2100 South and Interstate Highway 15, (3) along the Jordan River floodplain just south of the confluence with Little Cottonwood Creek where low-lying meandering alluvial channels, oxbow lakes, and marsh lands are intermixed where the water table is high; growth of tall reeds aids mapping on aerial photographs; another deposit is mapped above the Jordan River incision (near the southwest corner of Bennion Boulevard, at approximately 6235 South and 1300 West) where a small depression is wet and supported a marsh in 1937 aerial photographs; deposit may be the result of a perched water table and/or an abandoned Jordan River channel, note terrace scarp just to south and in line with the depression; areas of mixed alluvial and marsh deposits too small to be mapped separately may be included in units Qal_1, Qal_2, and Qaly; estimated thickness 15 feet (5 m).

Qla **Lacustrine and alluvial deposits, undivided** (Holocene to upper Pleistocene) – Well to moderately sorted sand, silt, and clay in areas of mixed alluvial and lacustrine deposits that cannot be shown separately at map scale, or because the deposits are gradational with each other, or thin patches of one unit overlie the other; locally may include closed depressions that may have been marsh areas and areas near the Gilbert-episode lake shoreline that may have been small deltas; mapped above the Jordan River incision where post-regression streams flowed north toward the Gilbert-episode lake and Great Salt Lake before incision of the Jordan River to its current drainage; also mapped in areas around the quadrangle where lacustrine units are likely overlain by thin alluvial deposits; exposed thickness more than 20 feet (6 m).

Qlam **Lacustrine and alluvial and marsh deposits, undivided** (Holocene to upper Pleistocene) – Silt, clay, and minor sand and pebbles, with organic-rich sediment associated with springs, ponds, seeps, and other wetlands; commonly wet, but seasonally dry; mapped in northeast corner of the quadrangle, south of Decker Lake, and west of Bangerter Highway and north of 3100 South Street where marsh, alluvial, and lacustrine deposits may be patchy and intermixed, and cannot be shown separately at map scale; estimated thickness 15 feet (5 m).

Qldy **Young lacustrine and deltaic deposits** (Holocene to upper Pleistocene) – Well to moderately sorted, light olive-gray to moderate yellowish-brown, silty sand and clay; commonly more clay rich with very little silt and sand; sand is fine to medium grained; contains thin discontinuous sand, clay, and silt lenses; subangular to rounded sand grains; thin to medium bedded; sand grains are composed of quartz, lithic fragments, and mica flakes; distinguished from lacustrine and alluvial deposits (Qla) by its broad uniformly flat geomorphic surface along the northwest-flowing pre-Jordan River alluvial channels (Qal_{2a}), and from young lacustrine deposits (Qly and Qlf) by the presence of alluvial channels (Qal_{2a}); to the northwest in the Baileys Lake quadrangle the unit includes a loess veneer and buried soil, and it is underlain by the Gilbert-episode lake tufa breccia and clays; and Lake Bonneville olive-gray and red-brown clays and olive-gray quartz sands (McKean and Hylland, 2013; Hylland and others, 2014); estimated thickness 15 feet (5 m).

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Table 1. *Ages of major shoreline occupations of Lake Bonneville, Gilbert-episode lake, and Great Salt Lake and shoreline elevations in the Salt Lake City South quadrangle.*

Lake Cycle and Phase	Shoreline (map symbol)	Age: radiocarbon years (^{14}C yr B.P.)	Age: calibrated years (cal yr B.P.)[1]	Elevation feet (meters)
Lake Bonneville				
Transgressive phase	Stansbury (S) shorelines	22,000–20,000[2]	26,000–24,000	4480–4500 (1365–1372)
	Bonneville (B) —flood—	~15,200–15,000[3]	~18,500–18,000	Not present[4]
Overflowing phase	Provo (P)	15,000–12,600[5]	18,000–15,000	Not present[4]
Regressive phase	Regressive shorelines (r)	12,600–11,500[5]	15,000–13,000	~4500–4600+ (~1371–1402+)
Gilbert-episode lake	Gilbert	10,000[6]	11,500	Not recognized[7]
Great Salt Lake				
	early Holocene highstand	9700–9400[8]	11,000–10,500	Not recognized[7]
	late Holocene highstand	4200–2100[9]	5000–2000	Not present[4]
	Historical highstand		late 1860s to early 1870s and 1986–87[10]	Not present[4]

[1] All calibrations made using OxCal ^{14}C calibration and analysis software (version 4.3.2; Bronk Ramsey, 2009; using the IntCal13 calibration curve of Reimer and others, 2013), rounded to the nearest 500 years. B.P. = before present, meaning the number of years before A.D. 1950

[2] Oviatt and others (1990)

[3] Oviatt (2015), Miller (2016), and references therein

[4] Shoreline ages are provided for reference only, as they are present only above and below the highest and lowest elevations, respectively, in the quadrangle, Lake Bonneville highstand at 5180 to 5200 feet (1579–1585 m), Provo shoreline at 4820 to 4860 feet (1469–1482 m), and Great Salt Lake late Holocene highstand at 4217 to 4221 (1285–1287 m) and historical highstand at 4212 feet (1284 m).

[5] Godsey and others (2005, 2011), Oviatt (2015), Miller (2016) for the timing of the occupation of the Provo shoreline and subsequent regression of Lake Bonneville to near Great Salt Lake level. Alternatively, data in Godsey and others (2005) may suggest that regression began earlier, shortly after 16.5 cal ka (see sample Beta-153158, with an age of 13,660 ± 50 ^{14}C yr B.P. [16.5 cal ka] from 1.5 m below the Provo shoreline). Also, lacustrine carbonate deposits in caves reported by McGee and others (2012) seem to support an earlier Lake Bonneville regression beginning around 16.4 cal ka.

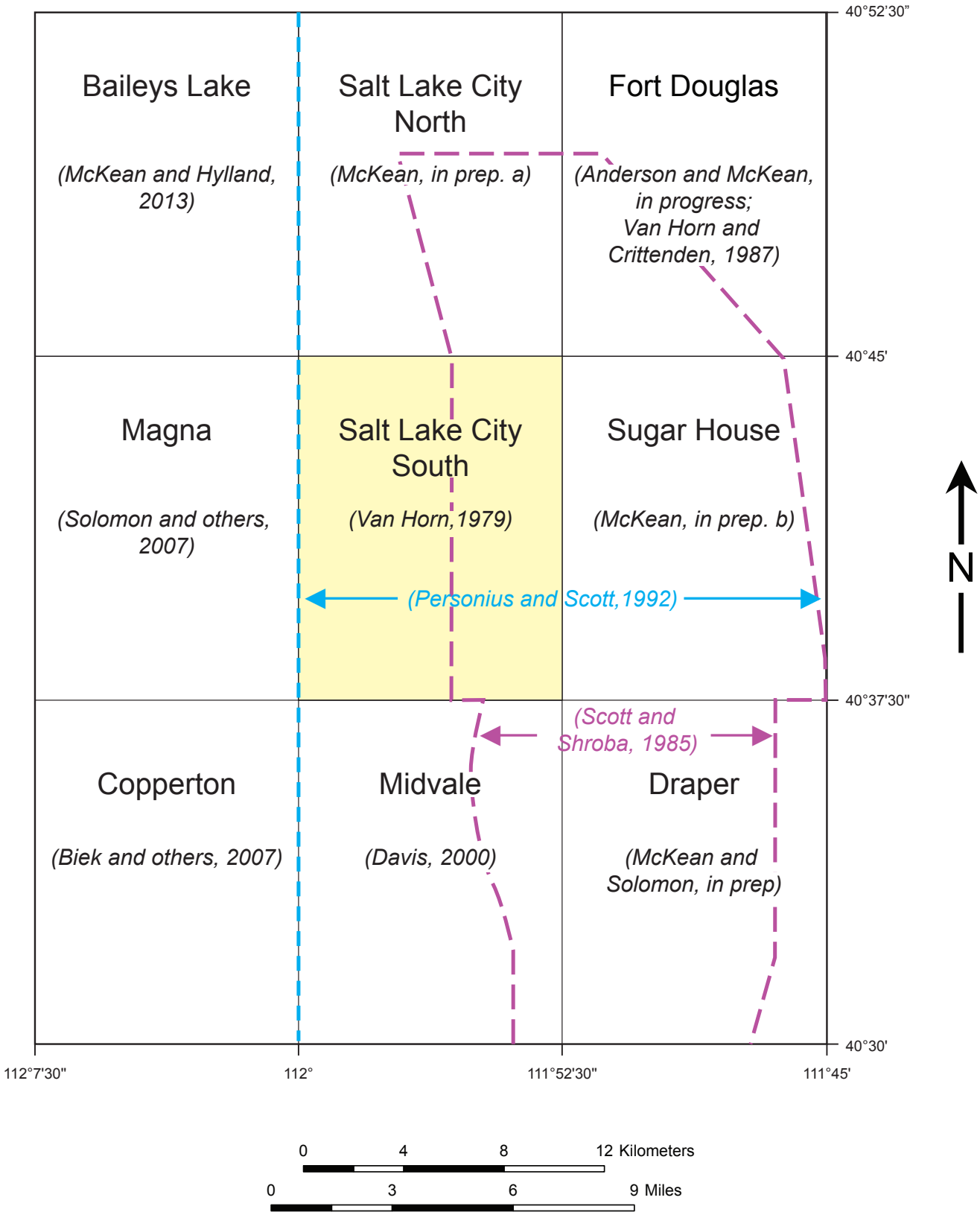
[6] Gilbert-episode highstand may have been very short lived; age represents lake culmination (Oviatt and others, 2005; Oviatt, 2014).

[7] Gilbert-episode and early Holocene Great Salt Lake highstand shoreline formed at 4245 to 4250 feet (1294–1295 m) and 4225 to 4230? feet (1288–1289? m), respectively; although these elevations occur within the quadrangle, the shorelines were either weakly developed or poorly preserved and have not been identified.

[8] Murchison (1989), Currey and James (1982)

[9] Miller and others (2005)

[10] Arnow and Stephens (1990)



Index map showing selected geologic maps available for the Salt Lake City South and surrounding 7.5′ quadrangles.

GEOLOGIC SYMBOLS

Contact – Dashed where approximately located; dotted where concealed; queried on cross section where uncertain

Normal fault – Dashed where approximately located, dotted where concealed; bar and ball on downthrown side; queried where existence uncertain; arrows on cross section indicate direction of relative movement

Lacustrine shorelines – Stansbury and regressive shorelines of the Bonneville lake cycle, mapped at the top of constructional bars and barrier beaches; may coincide with geologic contacts

S

Stansbury shoreline – Dashed where approximately located

r

Regressive shorelines (present below the Provo shoreline) – Dashed where approximately located, dotted where destroyed but present on older photographs

Crest of lacustrine barrier bar or spit – Dotted where destroyed but present on older photographs

Alluvial terrace scarp – Dashed where approximately located (only mapped in two locations where prominent)

A A'

Line of cross section

Outline of sand and gravel pit operations, contact based on 2016 orthophotography (Utah Automated Geographic Reference Center, 2016), some pits reclaimed and now used for other purposes

Water well (selected)

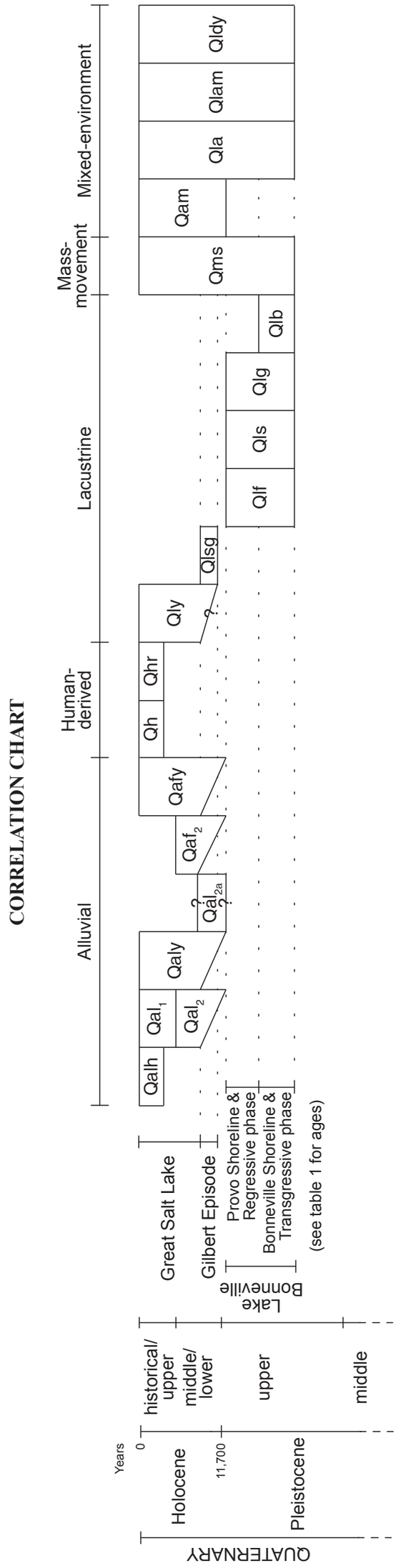
Sand and gravel pit

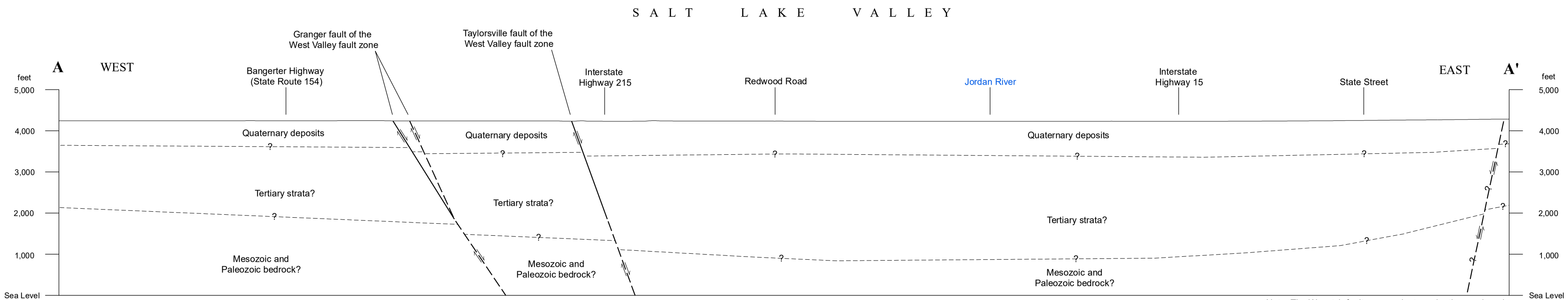
UDOT

Trench sites for paleoseismic investigations: UDOT - Utah Department of Transportation (Keaton and others, 1987); PS - Pioneer Square (Keaton and others, 1987; Keaton and Currey, 1989); RR - 4100 South Street and Redwood Road (Keaton and others, 1987)

VU

Selected environmentally remediated sites (Qhr): VU - Vitro Corporation of America uranium and vanadium mill; MS - Murray lead smelter site; PC - Portland Cement kiln dust #2 and #3 site; HB - Highland Boy copper smelter site


CORRELATION CHART
Alluvial
Human-derived
Lacustrine
Mass-movement
Mixed-environment
Qalh
Qal1
Qal2
Qaly
Qal2a
Qaf2
Qafy
Qh
Qhr
Qly
Qlsg
Qlf
Qls
Qlg
Qlb
Qms
Qam
Qla
Qlam
Qldy
Great Salt Lake
Gilbert Episode
Provo Shoreline & Regressive phase
Bonneville Shoreline & Transgressive phase
(see table 1 for ages)
Lake Bonneville
Years
0
11,700
historical/ upper middle/ lower
upper
middle
Holocene
Pleistocene
QUATERNARY



Created using data from Cook and Berg (1961), Arnow and others (1970), Meiji Resource Consultants (1983), Zoback (1983), Case (1985), Hill and others (1990), and data from the PACES (2012) gravity database and UGS, undated.

Note: The Wasatch fault zone projects under the quadrangle