UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources

INTRODUCTION

The area covered by the Kaysville quadrangle is subject to a variety of geologic hazards. These result from a unique combination of geologic, topographic, and climatic conditions.

Geologic Setting

Sediments deposited by Pleistocene Lake Bonneville dominate the surficial geology of the Kaysville quadrangle. Lake Bonneville was a large ice-age lake that covered much of northwestern Utah between about 32,500 and 11,600 years ago. Several regional shorelines of Lake Bonneville are found in the Kaysville quadrangle (table 1). The earliest of these shorelines is the Stansbury shoreline, resulting from a climatically induced lake oscillation from about 24,400 to 23,200 years ago. A small part of the Stansbury shoreline is mapped on the east edge of Kaysville City, but this shoreline cannot be extensively traced because of subsequent erosion and deposition. The lake continued to rise until it reached its highest level about 18,000 years ago that was controlled by an external overflow threshold (the Zenda threshold) in southern Idaho, creating the Bonneville shoreline. The Bonneville shoreline forms a bench near the base of the Wasatch Range. About 16,800 years ago, catastrophic incision of the Zenda threshold lowered the threshold and lake level 340 feet (105 m) in less than one year (Jarrett and Malde, 1987; O'Connor, 1993). Lake Bonneville stabilized at a lower level controlled by the Red Rock Pass threshold and formed the Provo shoreline, measured at an altitude of 4,810 feet (1,466 m) by Currey (1982) where it crosses Hillfield Road in the northern part of the quadrangle. The lake oscillated at or near the Provo level until about 13,500 years ago (Godsey and others, 2005), when climatic factors induced further lowering of the lake level, which eventually fell below the elevation of the present Great Salt Lake. Lake Bonneville subsequently rose and formed the Gilbert shoreline, mapped in the southwest part of the Kaysville quadrangle, from about 12,800 to 11,600 years ago. Lake Bonneville finally regressed about 10,000 years ago, leaving Great Salt Lake as one of its remnants. A lake rise about 3400 years ago resulted in the highest static lake level reached during the Holocene. Small parts of a shoreline formed at this level, commonly referred to as the Holocene highstand, are found near the current shore of Great Salt Lake.

Geologic Hazards

The Weber segment of the Wasatch fault zone separates the Wasatch Range from the adjacent valley in the Kaysville quadrangle. Although this segment has not generated any large (greater than magnitude 6.5) historical earthquakes, such events are expected from this segment and other nearby faults, which may result in heavy damage and loss of life (Black and others, 2003). In 1978, a research trench was excavated across the Weber segment in the Kaysville quadrangle about 0.6 miles (1.0 km) south of the mouth of Bair Canyon (Swan and others, 1980, 1981). The trench was reexcavated in 1988 to reevaluate the timing of Holocene faulting (McCalpin and others, 1994). Data from these and other studies along the Weber segment outside of the quadrangle indicate that the most recent large earthquake generated by the Weber segment may have occurred about 500 years ago, with such events recurring on average about every 1,400 years (Lund, 2005). Recurrence intervals on the adjacent Brigham City and Salt Lake City segments of the Wasatch fault zone are similar to that of the Weber segment, but the timing of large earthquakes on each of the three segments is not identical. Because the Kaysville quadrangle will be subject to strong ground shaking from earthquakes on adjacent segments as well as the Weber segment (see, for example, Solomon and others, 2004), the earthquake risk in the quadrangle from large earthquakes along the Wasatch fault zone is greater than the risk posed by the Weber segment alone.

The prehistoric Farmington Siding landslide complex (first mapped by Van Horn, 1975), in the southeastern part of the Kaysville quadrangle and northern part of the adjacent Farmington quadrangle, is evidence of one of the hazards posed by large earthquakes. This landslide complex, covering an area of about 7.5 mi^2 (19.5 km^2), comprises some of the largest landslides triggered by earthquakes in the United States. Mass movement within the landslide complex was probably a combination of liquefaction-induced lateral spreading and flow, and may have occurred four times between about 14,500 and 2370 years ago (Hylland and Lowe, 1998; Harty and Lowe, 2003).

Several recent landslides have occurred in the Kaysville quadrangle under static (non-earthquake) conditions, damaging a number of homes. Recent landslides include the 1998 Sunset Drive landslide along the North Fork Kays Creek (SE1/4SE1/4 section 10, T. 5 N., R. 1 W.) (Giraud, 1999a), an unnamed landslide on the South Fork Kays Creek (SW1/4NW1/4 section 15, T. 4 N., R. 1 W.) (Giraud, 1999b), and the 2001 Heather Drive landslide on the South Fork Kays Creek (SE1/4NW1/4 section 15, T. 4 N., R. 1 W.) (Giraud, 2002). These landslides were the result of partial reactivation of prehistoric landslides, which are common in the northeastern part of the Kaysville quadrangle and may be targets for future development. Reactivation is likely due to higher ground-water levels caused by increased precipitation and landscape irrigation (Ashland, 2003). Lowe (1989) compiled mapping of other historical landslide deposits.

Debris flows and debris floods have also occurred in the Kaysville quadrangle during historical time, causing considerable damage to engineered structures and property. Many debris flows occurred in 1983 following a period of unusually heavy precipitation and rapid spring snowmelt (Kaliser and Slosson, 1988), and one in 1984 damaged a house in the northeast corner of the Kaysville quadrangle (Lowe and others, 1992). Another debris flow in 2004 damaged a house in the southeast corner of the quadrangle (Solomon and others, 2005). Debris flows, consisting of a muddy slurry, may originate on slopes and in stream channels in the Wasatch Range but can deposit debris over large areas on alluvial fans at and beyond canyon mouths. Debris floods, consisting of mixtures of soil, organic material, and rock debris transported by fast-moving flood waters, may travel farther than debris flows to more distal parts of alluvial fans.

Expansive soils may be found locally in the Kaysville quadrangle. Such soils contain large amounts of clay that have a high potential for shrinking and swelling due to hydration and drying. Over time, these volumetric changes can cause significant damage to buildings and infrastructure. Erickson and Wilson (1968) mapped expansive soils in the central and west parts of the quadrangle, developed on fine-grained silt and clay deposited by Lake Bonneville. These soils also contribute to the landslide hazard because of their lack of cohesion when wet.

The potential for elevated levels of indoor radon in the Kaysville quadrangle is generally highest in benches along the Wasatch Range front, and decreases to the west (Black and Solomon, 1996). The decreasing hazard potential is related to: (1) lower permeability in fine-grained deposits which impedes the flow of soil gas, (2) shallower ground water which traps soluble radon gas and prevents the dissolved gas from entering foundation openings, and (3) decreasing concentrations of uranium and thorium (the parent elements of radon) away from the range front. The hazard potential is commonly high in benches underlain by well-drained and highly permeable Lake Bonneville shoreline deposits of sand and gravel, moderate to high in areas underlain by similar deltaic deposits in the north part of the quadrangle, moderate west of the benches in areas underlain by shoreline deposits and shallower ground water, and low in low-lying areas to the west underlain by impermeable fine-grained silt and clay saturated by shallow ground water (Black, 1993).

MAP UNIT DESCRIPTIONS

QUATERNARY

Alluvial deposits

Qal_1 — **Modern (level 1) stream deposits (upper Holocene)** – Moderately to well-sorted sand, silt, clay, and pebble to cobble gravel in active stream channels and flood plains; clast-supported coarse-grained deposits common near the range front; locally includes small alluvial-fan and colluvial deposits, and small terrace deposits up to 10 feet (3 m) above current stream level; equivalent to the younger part of Qal, but differentiated where deposits can be mapped separately; mapped principally along the larger streams; commonly less than 20 feet (6 m) thick.

Qal_2 — **Level 2 stream deposits (middle Holocene to upper Pleistocene)** Moderately sorted, clast-supported pebble and cobble gravel, sand, and gravelly sand in inactive stream channels and flood plains; equivalent to the older part of Qal, but differentiated where deposits can be mapped separately; mapped in abandoned benches at least 30 feet (10 m) above active stream channels along modern drainages from Kays Creek southward, in small abandoned channels northwest of Kays Creek, and in abandoned channels formed prior to diversion of streams to their current drainage pattern between Kays Creek and Haight Creek; commonly less than 20 feet (6 m) thick.

Qat_1, Qat_2, Qat_3 — **Stream-terrace deposits (middle Holocene to upper Pleistocene)** – Moderately sorted, clast-supported pebble and cobble gravel and gravelly sand that form level to gently sloping terraces; deposited by the Weber River in stream channels and flood plains southwest of the mouth of Weber Canyon; subscript denotes height above the modern flood plain; level 1 deposits are 50 to 65 feet (15-20 m) above the modern flood plain, level 2 deposits are 65 to 75 feet (20-25 m) above the modern flood plain, and level 3 deposits are 75 to 90 feet (25-30 m) above the modern flood plain; commonly less than 20 feet (6 m) thick.

Qal — **Stream deposits, undivided (Holocene to upper Pleistocene)** – Moderately sorted sand, silt, clay, and pebble to cobble gravel deposited in stream channels and flood plains after regression of Lake Bonneville from the Provo level; includes older stream deposits (Qal_2) incised by active stream channels and modern stream deposits (Qal_1) that are too small to map separately from older stream deposits; locally includes small alluvial-fan and colluvial deposits; mapped along streams near the range front; commonly less than 20 feet (6 m) thick.

Qaf_1 — **Modern (level 1) alluvial-fan deposits (upper Holocene)** – Poorly to moderately sorted, weakly to non-stratified, silt- to boulder-size sediment deposited principally by debris flows and debris floods at the mouths of mountain-front canyons; upper parts characterized by abundant boulders and debris-flow levees that radiate away from the fan apex; small, finer grained alluvial-fan deposits are found on gentle slopes in the northern part of the quadrangle, deposited by shallow, dispersive flows; equivalent to the younger part of Qafy but differentiated where deposits can be mapped separately; commonly overlies lacustrine and older alluvial-fan deposits; debris-flow and debris-flood hazards are highest on modern alluvial fans, their undivided equivalents within younger alluvial fans (Qafy), and debris-flow deposits (Qmf); less than 30 feet (9 m) thick.

Qaf_2 — **Level 2 alluvial-fan deposits (middle Holocene to upper Pleistocene)** – Commonly poorly sorted sand, silt, clay, and minor pebbles deposited in the southwest part of the quadrangle, where stream flow from major drainages lost confinement and dispersed on a gently sloping plain near the Great Salt Lake shore; also found as poorly to moderately sorted, silt- to boulder-size sediment at the mouths of minor drainages along the mountain front, mostly south of Bair Canyon; deposited by debris flows and debris floods graded to or slightly above modern stream level; equivalent to the older part of Qafy, but differentiated where deposits can be mapped separately; commonly overlies or incised into lacustrine deposits; probably less than 30 feet (9 m) thick.

Nelson and Personius (1993) mapped level 2 alluvial-fan deposits at the surface of the graben at the site of the 1978 research trench excavated across the Weber segment of the Wasatch fault zone. When the trench was reexcavated in 1988, McCalpin and others (1994) interpreted surficial sediment filling the graben above sediment equivalent to level 2 alluvial-fan deposits in the trench as a combination of hillslope colluvium, stream alluvium, and pond deposits. The surficial graben sediment is here mapped as mixed alluvial and colluvial deposits (Qac). McCalpin and others (1994) reported a calendar-calibrated radiocarbon age of 6,297 –326/-348 cal yr B.P. on a buried paleosol developed on hillslope colluvium above sediment equivalent to level 2 alluvial-fan deposits, and calendar-calibrated radiocarbon ages of 737 +243/-187 and 600 +180/-272 cal yr B.P. on an overlying paleosol beneath younger colluvial and pond deposits.

Qafy — **Younger alluvial-fan deposits, undivided (Holocene to upper Pleistocene)** – Poorly to moderately sorted, weakly to non-stratified, silt- to boulder-size sediment deposited principally by debris flows, debris floods, and streams; equivalent to modern and level 2 alluvial-fan deposits (Qaf_1 and Qaf_2) that are undifferentiated because units are complexly overlapping or too small to show separately; also mapped where the age of Holocene alluvial-fan deposits is uncertain; upper parts of fans are locally deeply incised; occurs near canyon mouths along the mountain front; probably less than 40 feet (12 m) thick.

Qafp — **Alluvial-fan deposits related to the Provo (regressive) phase of the Bonneville lake cycle (upper Pleistocene)** – Poorly to moderately sorted, silt- to cobble-size sediment, with local boulders, deposited principally by debris flows whose surfaces are graded to the Provo shoreline at the mouth of Bair Canyon; incised by active streams; probably less than about 40 feet (12 m) thick.

Qafb — **Alluvial-fan deposits related to the Bonneville (transgressive) phase of the Bonneville lake cycle (upper Pleistocene)** – Poorly to moderately sorted, silt- to cobble-size sediment, with local boulders, deposited principally by debris flows whose surfaces are graded to the Bonneville shoreline; locally weakly cemented by calcium carbonate; surfaces are incised by active streams; mapped at the mouths of several drainages from South Fork Kays Creek northward; probably less than about 40 feet (12 m) thick.

Qafo — **Older alluvial-fan deposits (upper to middle Pleistocene)** Poorly to moderately sorted, weakly to non-stratified, silt- to boulder-size sediment deposited principally by debris flows; mapped near canyon mouths of Middle Fork Kays Creek and a small drainage south of Hobbs Canyon; truncated by, and thus predates, the Bonneville shoreline; exposed thickness as much as 150 feet (45 m).

Artificial deposits

Qf — **Artificial fill (historical)** Engineered fill used as debris-basin dams across several large streams draining the Wasatch Range, and a small area of fill on a slope underlying an irrigation pond near South Weber (the site of the Cedar Bench landslide; Solomon, 1999); unmapped fill may be present in any developed area.

Colluvial deposits

Qc — **Colluvial deposits (Holocene to upper Pleistocene)** – Poorly to moderately sorted, angular, clay- to boulder-size, locally derived sediment deposited by rock fall, slopewash, and soil creep on moderate to steep mountain-front spurs above the Bonneville shoreline; most bedrock is covered by at least a thin veneer of colluvium, and only the larger, thicker deposits are mapped; maximum thickness about 20 feet (6 m).

Eolian deposits

Qed — **Eolian dunes (Holocene to upper Pleistocene)** – Very fine sand and silty sand; moderately to well sorted, forms low parabolic dunes in the north-central part of the quadrangle, derived from reworked Lake Bonneville deltaic deposits; the dunes are visible on 1958 aerial photographs, but most have since been removed by grading during development; minimum thickness 3 feet (1 m).

Lacustrine deposits

Qli — **Lacustrine mud (Holocene)** Poorly sorted clay, silt, and minor sand deposited in mud flats or playas exposed by fluctuations of Great Salt Lake; local accumulations of gypsum, halite, and other salts form a thin crust on the ground surface; generally less than 10 feet (3 m) thick.

Qlf — **Lacustrine silt and clay deposits (Holocene to upper Pleistocene)** Poorly sorted silt, clay, and minor sand deposited in deep and (or) quiet water of Lake Bonneville and, below the Gilbert shoreline, of Great Salt Lake; commonly calcareous; typically laminated or thin bedded; ostracodes locally common; grades upslope into lacustrine sand, silt, and deltaic deposits; mapped on gentle slopes below the Provo shoreline where deposits cannot be correlated with a specific phase of the Bonneville lake cycle; etched by the Gilbert shoreline, minor shorelines above the Gilbert shoreline from the regressive phase of Lake Bonneville, and faint shorelines below the Gilbert shoreline from the post-Gilbert recession of Great Salt Lake; a small part of the earlier Stansbury shoreline from the transgressive phase of Lake Bonneville is mapped in Qlf on the east edge of Kaysville, extending to the southeast into lacustrine sand and silt (Qlsbp); generally less than 15 feet (5 m) thick.

Qlsp — **Lacustrine sand and silt related to the Provo (regressive) phase of the Bonneville lake cycle (upper Pleistocene)** – Fine- to coarse-grained lacustrine sand and silt with minor gravel deposited at and below the Provo shoreline; locally overlain by a thin veneer of eolian sand; grades downslope into fine-grained Lake Bonneville deposits and laterally northward to sandy deltaic deposits (Qldp); typically thick bedded and well sorted; gastropods locally common; deposited in relatively shallow water in beaches and, at the mouths of larger canyons, in deltas that no longer retain distinctive morphology; as much as 50 feet (15 m) thick.

Qldp — **Deltaic deposits related to the Provo (regressive) phase of the Bonneville lake cycle (upper Pleistocene)** – Thin to thick beds of moderately to well-sorted, moderately to well-rounded sand, silty sand, and gravelly sand; locally overlain by a thin veneer of eolian sand and partly cemented with calcium carbonate; mapped along the relatively steep delta front at the distal part of the Weber River delta; maximum thickness may be as much as 100 feet (30 m).

The Weber River delta includes deltaic deposits related to both the transgressive (Qldb) and regressive phases of the Bonneville lake cycle. However, Bonneville deposits may have buried deltaic sediments from previous lake cycles. The Little Valley lake cycle, for example, preceded the Bonneville lake cycle and reached an elevation of about 4890 feet (1490 m) between about 90,000 and 150,000 years ago (Scott and others, 1983). I found no evidence of Weber River deltaic deposits from previous lake cycles in the Kaysville quadrangle, and Lemons and others (1996) found no evidence of previous lake cycles in 27 outcrops examined throughout the Weber River delta. Lemons and others (1996) also found that the sediment volume of the delta is consistent with the area of the drainage basin from which the sediment was derived given time constraints imposed by Lake Bonneville deposition. This implies that the Weber River delta is the result of deposition only during the Bonneville lake cycle and not during previous cycles.

Qlsbp — **Lacustrine sand and silt of the Bonneville lake cycle, undivided (upper Pleistocene)** – Fine- to coarse-grained lacustrine sand and silt with minor gravel; mapped south of Webb Canyon downslope from Provo shoreline deposits, where transgressive- and regressive-phase deposits cannot be differentiated and deposits cannot be directly correlated with regressive-phase shorelines; may include unmapped deltaic deposits at the mouths of Bair and Shepard Canyons; also mapped in a small area in the northeast part of the quadrangle south of the mouth of Weber Canyon, where the location of the Provo shoreline is uncertain; may be as much as 75 feet (25 m) thick.

Qlsb — **Lacustrine sand and silt related to the Bonneville (transgressive) phase of the Bonneville lake cycle (upper Pleistocene)** Fine- to coarse-grained lacustrine sand interbedded with gravelly sand and silty sand deposited between the Bonneville and Provo shorelines; grades laterally northward to sandy deltaic Lake Bonneville deposits (Qldb); typically thick bedded and well sorted; gastropods locally common; deposited in relatively shallow water as beaches and, at the mouths of larger canyons, deltas that no longer retain distinctive morphology; mapped near the base of the Wasatch Range north of Bair Canyon; as much as 50 feet (15 m) thick.

Qlgb — **Lacustrine gravel and sand related to the Bonneville (transgressive) phase of the Bonneville lake cycle (upper Pleistocene)** – Moderately to well-sorted, moderately to well-rounded, clast-supported, pebble to cobble gravel interbedded with lesser amounts of pebbly sand and clean sand, deposited between the Bonneville and Provo shorelines; thin to thick bedded; gastropods locally common in sandy lenses; locally partly cemented with calcium carbonate; typically forms a bench along the Bonneville shoreline near the base of the Wasatch Range; locally as much as 200 feet (60 m) thick.

Qldb — **Deltaic deposits related to the Bonneville (transgressive) phase of the Bonneville lake cycle (upper Pleistocene)** – Moderately to well-sorted, moderately to well-rounded, sand, silty sand, gravelly sand, silt and clay; silt and clay content increases downward and westward; thin to thick bedded; partly cemented with calcium carbonate and locally overlain by a thin veneer of eolian sand. Mapped at two locations on the Weber River delta: (1) between the Provo and Bonneville shorelines in the north-central part of the quadrangle, east of Hill Air Force Base, incised by linear channels; the channels (Qafp/Qldb) probably record scour into the delta during the rapid drawdown of the lake as it fell from the Bonneville shoreline to the Provo shoreline when the lake's threshold in Idaho failed (O'Connor, 1993); and (2) below the Provo shoreline in the northwest part of the quadrangle, between Layton and Clearfield, the eastward extension of deltaic deposits on the south flank of a ridge on the border between the adjacent Clearfield and Roy quadrangles interpreted by Sack (2005a, 2005b) as a landscape component created during the transgressive phase of Lake Bonneville. Maximum thickness about 70 feet (20 m).

Mass-movement deposits

Qmf — **Debris-flow deposits (upper Holocene)** – Very poorly sorted, subangular, cobble- to boulder-size gravel in a matrix of silt, sand, and minor clay; unsorted and unstratified; deposits characterized by rubbly surface, debris-flow levees, and alluvial channels; mapped near the mouth of Corbett Canyon in the northeast part of the quadrangle. Many debris flows occurred in 1983 following a period of unusually heavy precipitation and rapid spring snowmelt, but their deposits cannot be differentiated at map scale from landslide deposits at canyon mouths and most are mapped here as younger landslide deposits (Qmsy); other debris flows are too small to map and are included in units Qaf_1, Qafy, Qal_1, and Qal. Maximum thickness about 20 feet (6 m).

Qml — **Lateral-spread deposits (Holocene to upper Pleistocene)** Clayey to sandy silt, well-sorted fine sand, silty sand, and minor clay and gravel of the Bonneville lake cycle, redeposited by lateral spreading and flow as a result of liquefaction; forms longitudinal ridges and undrained depressions within the landslide complex, named the Farmington Siding landslide by Van Horn (1975) for a location on the landslide where it extends southward into the adjacent Farmington quadrangle; a main scarp on the northern and northeastern margin of the landslide lies mostly in the Kaysville quadrangle. Miller (1980) identified what he believed to be another lateral-spread deposit west of Kaysville; Harty and Lowe (2003) named it the West Kaysville landslide and concurred with Miller's (1980) interpretation. The geomorphic features and deposits of the area are reinterpreted here to be the result of erosion of fine-grained lake sediments (Qlf) by middle Holocene to Upper Pleistocene alluvial fans (Qaf_2), and spring sapping (Qsm) of lake deposits along older lacustrine shorelines, leaving low knobs and mounds superficially resembling landslide hummocks and closed depressions. Thickness of the deposits is highly variable.

Qms_1 — **Landslide deposits, unit 1 (historical to middle Holocene)** – Very poorly sorted clay, silt, sand, and minor gravel; grain size and texture varies with the nature of the deposits in the source area; unit 1 landslides occur in bluffs bordering the Weber River flood plain and north of Kaysville along steep bluffs incised by drainages following regression of Lake Bonneville; characterized by moderately fresh scarps and hummocky topography, with freshest scarps in areas of historical movement. Most unit 1 landslides along the Weber River originate in sandy Lake Bonneville deltaic deposits, form gently sloping alluvial-fan shaped deposits overlying unit 2 landslide deposits on river terraces that fringe the bluffs, and apparently result from flow failure, perhaps liquefaction induced, of the bluff face; one landslide along the Weber River, the Cedar Bench landslide, is an earth slide resulting from fill failure on the slope bordering an irrigation pond (Solomon, 1999). Landslides along other drainages are found at and slightly below the gradational contact between overlying Lake Bonneville sand and silt and underlying silt and clay and are the result of a combination of rotational and translational earth slides; parts of several of these landslides have been historically reactivated, resulting in damage to roads and houses. Thickness of the deposits is highly variable.

Qms_2 — **Landslide deposits, unit 2 (middle Holocene to upper Pleistocene)** – Very poorly sorted clay, silt, sand, and minor gravel; grain size and texture varies with the nature of the Lake Bonneville deltaic deposits in the source area; unit 2 landslides are found in steep bluffs bordering the Weber River flood plain and extend on to the adjacent stream terrace; the landslide deposits are rounded, heavily vegetated, and incised by alcoves formed from unit 1 landslides, suggesting that unit 2 deposits predate unit 1 deposits; unit 1 and unit 2 landslide deposits along the bluffs in the Kaysville quadrangle are the southeastern extension of the South Weber landslide complex mapped by Pashley and Wiggins (1972); thickness of the deposits is highly variable.

Qmsy — **Younger landslide deposits, undivided (historical to upper Pleistocene)** – Very poorly sorted, clay to boulder-size gravel in a matrix of silt, sand, clay, and pebbles; grain size and texture varies with the nature of the deposits in the source area. Younger landslide deposits are found near Adams, Hobbs, and Holmes Reservoirs and along the Wasatch Range front; deposits along steep bluffs near the reservoirs are derived from Lake Bonneville deposits incised by drainages following regression of Lake Bonneville and resemble unit 1 landslide deposits but lack relatively fresh scarps; younger landslide deposits along the range front are derived from the Farmington Canyon Complex (Xfc) and either result from incision of drainages after Lake Bonneville regression, obscure the Bonneville shoreline, or overlie Lake Bonneville deposits; younger landslide deposits may include unit 1 and unit 2 landslide deposits that are undifferentiated because units complexly overlap; thickness of the deposits is highly variable.

Qmso — **Older landslide deposits (upper to middle Pleistocene)** – Very poorly sorted, clay to boulder-size gravel in a matrix of silt, sand, clay, and pebbles; older landslides are mapped along the Wasatch Range front, one south of Hobbs Canyon, another north of Adams Canyon, and two small deposits south of Bair Canyon; older landslide deposits are derived from the Farmington Canyon Complex and are cut by the Bonneville shoreline and thus predate Lake Bonneville regression; thickness of the deposits is highly variable.

Spring deposits

Qsm — **Marsh deposits (Holocene)** – Wet, fine-grained, organic-rich sediment associated with springs, ponds, seeps, and wetlands along the shore of Great Salt Lake; thickness commonly less than 5 feet (1.5 m).

Mixed-environment deposits

Qac — **Alluvial and colluvial deposits, undifferentiated (Holocene to upper Pleistocene)** Poorly to moderately sorted, generally poorly stratified, clay- to boulder-size, locally derived sediment deposited in drainages along the Wasatch Range front by fluvial, rock-fall, slopewash, and creep processes; generally less than 30 feet (9 m) thick.

Qla — **Lacustrine and alluvial deposits, undifferentiated (Holocene to upper Pleistocene)** – Silt, clay, and minor sand in fluvially reworked lake deposits and lake and alluvial-fan deposits undifferentiated because units complexly overlap; less than 10 feet (3 m) thick.

Stacked-unit deposits

Qaf₁/Qli — **Modern alluvial-fan deposits over lacustrine mud (Holocene)** – Lacustrine mud along the shore of Great Salt Lake concealed by a thin veneer of level 1 alluvial-fan deposits at the mouths of small streams; surficial deposits are generally less than 5 feet (2 m) thick.

Qafp/Qldb — **Alluvial-fan deposits related to the Provo (regressive) phase of the Bonneville lake cycle over deltaic deposits related to the Bonneville (transgressive) phase of the Bonneville lake cycle (upper Pleistocene)** – A thin layer of reworked deltaic silt and sand deposited in linear alluvial-fan channels and the adjacent distal fan on the Weber River delta by scouring during the rapid drawdown of the lake as it fell from the Bonneville shoreline to the Provo shoreline when the lake's threshold in Idaho failed (O'Connor, 1993); surface of the alluvial-fan deposits are graded to the Provo-level delta; thickness of surficial deposits is unknown but probably less than 3 feet (1 m) thick.

Qlsp/Qldb — **Lacustrine sand and silt related to the Provo (regressive) phase of the Bonneville lake cycle over deltaic deposits related to the Bonneville (transgressive) phase of the Bonneville lake cycle (upper Pleistocene)** – A thin veneer of regressive lacustrine silt and sand reworked from underlying transgressive deltaic sediment on a large slope extending westward into the adjacent Clearfield quadrangle; Sack (2005a) referred to this slope as the Clearfield slope, which lies between surficial transgressive deltaic sediment and the Gilbert shoreline and is etched by regressive shorelines; surficial deposits are generally less than 10 feet (3 m) thick.

unconformity

PRECAMBRIAN

Xfc — **Farmington Canyon Complex (Early Proterozoic)** – Metamorphic and igneous rocks, not mapped in detail for this study; Bryant (1984) concluded that these rocks in the Kaysville quadrangle record a Late Archean metamorphic event, but Barnett and others (1993) and Nelson and others (2002) found evidence that metamorphism was Early Proterozoic, affecting rocks either initially deposited as Archean sediment or Early Proterozoic sediment incorporating material eroded from nearby Archean crust; Yonkee and Lowe (2004) supported this interpretation and provided further interpretations based on detailed mapping of the Farmington Canyon Complex in the adjacent Ogden 7.5-minute quadrangle.

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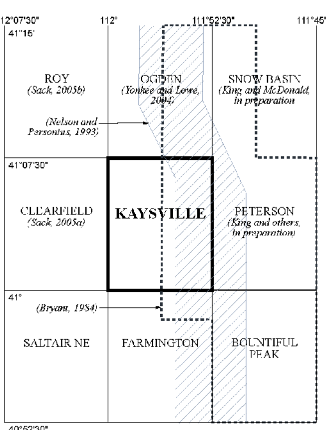

Index map showing selected geologic maps available for the Kaysville and surrounding 7.5' quadrangles.

Table 1. Ages and elevations of major shorelines of Lake Bonneville and Great Salt Lake in the Kaysville quadrangle.

Lake Cycle and Phase	Shoreline (map symbol)	Age* calendar years B.P.	Elevation feet (meters)
Lake Bonneville			
Transgressive Phase	Stansbury (S)	24,400-23,200	4,510-4,520 (1,375-1,378)
	Bonneville (B)	18,000-16,800	5,200-5,230 (1,585-1,595)
	flood		
Regressive Phase	Provo (P)	16,800-13,500	4,790-4,820 (1,460-1,470)
	Gilbert (G)	12,800-11,600	4,240-4,245 (1,292-1,294)
Great Salt Lake			
	Holocene highstand (H)	3,400	4,217-4,221 (1,285-1,287)

*All calendar-calibrated ages are from D.R. Currey, University of Utah (written communication to Utah Geological Survey, 1996) except for the age of end of the Provo shoreline. Godsey and others (2005) revised the timing of the occupation of the Provo shoreline and subsequent regression. Calendar-calibrated ages are derived from radiocarbon ages. Oviatt and Thompson (2002) summarized many recent changes in the interpretation of the Lake Bonneville radiocarbon chronology. The most recent radiocarbon chronology in the summary is from Oviatt (1997), which modified data published by Oviatt and others (1992).

MAP SYMBOLS

- Contact
- Normal fault, dashed where approximately located, dotted where concealed and approximately located; bar and ball on down-dropped side
- Lake Bonneville shorelines - shorelines of the Bonneville lake cycle. Mapped at the top of the wave-cut platform
  - S — Stansbury shoreline of the Bonneville (transgressive) phase; elevation from about 4,510 to 4,520 feet (1,375-1,378 m)
  - B — Highest shoreline of the Bonneville (transgressive) phase; elevation from about 5,200 to 5,230 feet (1,585-1,595 m)
  - Y — Other shorelines of the Bonneville phase
  - P — Highest shoreline of the Provo (regressive) phase; elevation from about 4,790 to 4,820 feet (1,460-1,470 m)
  - X — Other shorelines of the Provo phase
  - G — Highest shoreline of the Gilbert phase; elevation from about 4,240 to 4,245 feet (1,292-1,294 m)
  - H — A late Holocene high shoreline of Great Salt Lake; elevation about 4,217 to 4,221 feet (1,285-1,287 m)
- Landslide scarp, hachures on down-dropped side, may coincide with geologic contacts
- Sand and gravel pit
- Trench for paleoseismic investigations (Swan and others, 1980, 1981; McCalpin and others, 1994)

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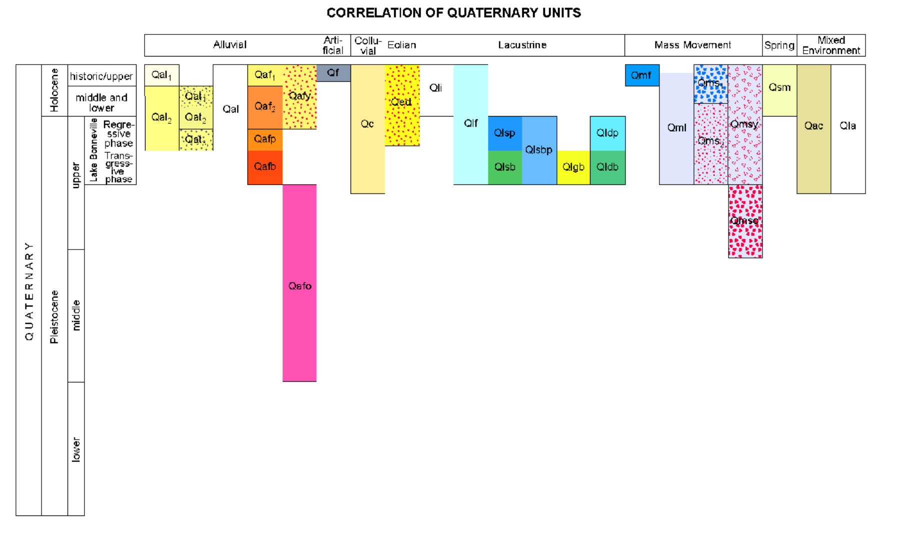
CORRELATION OF QUATERNARY UNITS



All Locations are Approximate.
SURFICIAL GEOLOGIC MAP OF PART OF THE
KAYSVILLE QUADRANGLE , DAVIS COUNTY, UTAH by
Barry J. Solomon (2007)

GeoStrata

City of Fruit Heights
Geologic Hazard Overlay Zones
Fruit Heights, Utah
Project Number: 1058-001

Map 10A

Surfical Geologic Map Descriptions