GEOLOGIC MAP OF THE SAINT JOHN QUADRANGLE, TOOELE COUNTY, UTAH

by Stefan M. Kirby

SCALE: 1:24,000

Cover photo: View to the southwest across the Saint John quadrangle. The quadrangle covers most of the valley floor in the foreground and the snowcapped Onaqui Mountains in the distance.

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INTRODUCTION

Location and Geographic Setting

The Saint John quadrangle covers part of Rush Valley in southeastern Tooele County, Utah (plate 1). State Highway 36 runs roughly north to south across the eastern part of the quadrangle. State Highway 199 runs east to west through the communities of Clover and Rush Valley near the center of the quadrangle. The community of Saint John is along the Mormon Trail Road in the northwest part of the quadrangle. Clover Creek flows to the east parallel to State Highway 199. The grounds of the Tooele Army Depot South Area cover part of the quadrangle along its eastern boundary.

Scope of Work

The Saint John quadrangle was mapped in conjunction with adjoining Faust quadrangle to the south as part of the 2010 US Geological Survey STATEMAP award number G10AC00386 made to the Utah Geological Survey (UGS). This geologic map continues geologic mapping in the adjacent Vernon NE, Lofgreen, Vernon, Faust, and Ophir quadrangles (see Kirby, 2010a, b, c, and d; Kirby, 2012), and was completed in conjunction with a larger mapping project for the Rush Valley 30’ x 60’ quadrangle (Clark and others, 2012) and a hydrogeologic framework study of the Rush Valley area (Gardner and Kirby, 2011). I mapped geologic contacts directly on available digital orthophotography and 1:24,000-scale Saint John topographic map base using ArcGIS. I also examined available 1:20,000-scale black and white air photos, and 5-meter digital elevation data to delineate unit contacts. I completed several weeks of mapping and field checking of units in the Saint John quadrangle during the spring of 2010.

Previous Investigations and Mapping Background

Several investigators mapped the geology of the Saint John quadrangle at various scales smaller (less detailed) than 1:24,000, including Bucknam (1977), Moore and Sorensen (1979), and Everitt and Kaliser (1980). Several adjoining quadrangles to the south and east have been mapped at 1:24,000 scale (Kirby, 2010a, b, c, and d; Kirby 2012) and areas to the north have been mapped recently at 1:62,500 scale (Clark and others, 2012). Perkins and others (1998) provided age control for the Salt Lake Formation using ash correlation methodology for several sites in the adjacent Faust and Vernon NE quadrangles. Adjoining mapping relevant to both bedrock and unconsolidated deposits includes Gilluly (1932), Dishbrow (1957), Cohenour (1959), Groff (1959), Armin and Moore (1981), Tooker and Roberts (1998), and Clark and others (2012). Work by Hood and others (1969) and Gardner and Kirby (2011) examined the hydrogeology of the Rush Valley area including the Saint John quadrangle.

Geologic Summary

Sedimentary rocks exposed in the quadrangle include Pennsylvanian bedrock of the Oquirrh Group and consolidated Tertiary basin fill of the Salt Lake Formation. Pennsylvanian-age Oquirrh Group bedrock of the Butterfield Peaks Formation (?) crops out at a single location in the southwest corner of the quadrangle where these rocks dip to the northwest. Oquirrh Group bedrock in adjoining quadrangles is structurally complicated by folds and faults. Basin fill of the Salt Lake Formation (?) crops out just north of Saint John and at small exposures in the west central part of the quadrangle and along the eastern edge of the quadrangle. Based on gravity data and well logs (Everitt and Kaliser, 1980; Pan-American Center for Earth and Environmental Studies, 2010; Utah Division of Water Rights, 2010), the Salt Lake Formation underlies unconsolidated surficial deposits across at least the eastern two-thirds of the quadrangle.

Unconsolidated surficial deposits of Holocene to early (?) Pleistocene age, and possibly late Pliocene age, cover nearly the entire the quadrangle. These deposits include various alluvial fan and channel sediments, and lacustrine units deposited during both the transgression and regression of Lake Bonneville. Below the elevation of ~5220 feet (1590 m) Rush Valley was isolated from the main body of lake Bonneville by Stockton Bar. Following regression of Lake Bonneville below this level, Rush Valley hosted at least two unique lake elevation shorelines (Burr and Currey, 1988, 1992). The western quarter of the quadrangle is above the highstand of Lake Bonneville and consists of east-sloping alluvial-fan and fluvial channel deposits. The remainder of the quadrangle is characterized by
a mix of alluvial, fluvial, and lacustrine deposits. Unconsolidated lacustrine deposits related to the transgression and regression of Lake Bonneville are mapped below the elevation (5230 feet [1594 m] above sea level) of a prominent erosional shoreline located south of Clover. Elsewhere shoreline features related to the Lake Bonneville highstand are mapped at elevations between 5240 feet (1597 m) in the north and 5220 feet (1591 m) in the south part of the quadrangle. Shoreline features are absent across much of the central part of the quadrangle. A prominent regressive lake level (Shambip level [Burr and Currey, 1988, 1992]), unique to Rush Valley and below the Lake Bonneville highstand, is located near the 5050 foot (1539 m) elevation. Deposits relating to this lake level include erosional benches, constructional barriers and spits, and correlative lagoon fill deposits in the central and eastern parts of the quadrangle.

Normal faults cut unconsolidated deposits in the western half and northeast corner of the quadrangle. Faults of the “Saint John Station fault zone” (U.S. Geological Survey and Utah Geological Survey, 2006) offset late Pleistocene mixed alluvial and lacustrine and alluvial-fan deposits. Conjugate normal faults form a prominent horst and series of west-facing scarps in late Pleistocene mixed alluvial and lacustrine deposits. Scarp heights are between 3 and 30 feet (1–10 m), and the largest scarp forms the western margin of this significant horst block. Upper Pleistocene shoreline deposits related to the 5050 foot (1539 m) Lake Shambip level overlap scarps that form the prominent horst block, and none of these scarps appear to offset deposits younger than late Pleistocene. Numerous scarps in the western part of the study area near the communities of Clover and Saint John generally occur in a north-south-trending belt. The northern series of scarps near Saint John is part of the “South Mountain marginal fault” discussed by Everitt and Kaliser (1980), and the southern scarps are the northern part of the “Clover Fault Zone” (U.S. Geological Survey and Utah Geological Survey, 2006). The “South Mountain marginal fault” near Clover and Saint John is a zone of three to four subparallel, down-to-the-east fault scarps, each with heights ranging between 3 and 9 feet (1–3 m). These faults cut both transgressive lacustrine deposits of the Lake Bonneville highstand (unit Qlao) and alluvial fans (units Qafo, Qafy, Qafz, and Qafq) that may be as young as early Holocene. Faults of the “Clover fault zone” cut late Pleistocene and older alluvial fan deposits (units QTaf, Qafo, and Qafq) in the western part of the quadrangle. Most of these scarps face to the east and scarps heights range between 3 and 20 feet (1–7 m). Trenching studies of both the “Clover fault zone” and the “South Mountain marginal fault” have not been performed, and numerical age control is lacking for surface faulting along both of these fault zones.

Rush Valley area gravity data suggest that several thousand feet of basin fill, consisting primarily of Salt Lake Formation, overlies bedrock near the center of the quadrangle east of Clover (Everitt and Kaliser, 1980; Pan-American Center for Earth and Environmental Studies, 2010). The total thickness of basin fill is unconstrained by well data in the quadrangle, but correlation of gravity anomalies in the quadrangle with those in areas of known basin depth in the adjoining Vernon NE quadrangle indicates a total thickness of up to 4200 feet (1280 m) (plate 2). The thickness of unconsolidated sediment fill is greatest near the center of the quadrangle. Water well drill holes near the center of the quadrangle encounter at least 1100 feet (336 m) of unconsolidated sediment without the presence of the Salt Lake Formation (Utah Division of Water Rights, 2010). Unconsolidated deposits and basin fill likely thin westward across the quadrangle and may rest directly on Oquirrh Group bedrock near the western quadrangle boundary.

The early tectonic history of the quadrangle is recorded by exposed Pennsylvanian-age strata that were deposited within the rapidly subsiding Oquirrh basin (Geslin, 1998). These rocks were then folded and faulted by dominantly east-directed thrust faulting and compression during the Late Jurassic to Eocene Sevier orogeny (Armstrong, 1968; DeCelles and Coogan, 2006, and references therein). Exposures of folded and faulted rocks directly related to the Sevier orogenic event occur in the adjoining Vernon, Lofgreen, and Onaqui Mountain South quadrangles (Gropp, 1959; Armin and Moore, 1981; Kirby, 2010b and c). During the Eocene, crustal shortening was replaced by roughly east-west extension and significant regional volcanism (Constenius, 1996; Constenius and others, 2003). Pennsylvanian-age bedrock is overlain by a thick section of basin fill deposited during Miocene to Holocene Basin-and-Range extension. Extension remains the dominant tectonic style in the area, but it has varied in magnitude, style, and extent through Eocene to Holocene time (Stewart, 1998). Major pulses of extension, during the Miocene and possibly the Pliocene, correlate with deposition and deformation (faulting and folding) of the Salt Lake Formation (Perkins and others, 1998). Subsequent extension has controlled deposition of unconsolidated sediments and surface faulting during the Quaternary (Everitt and Kaliser, 1980).

**MAP UNIT DESCRIPTIONS**

**QUATERNARY**

**Human Disturbance**

**Qh Fill and disturbed areas** (Historical) – Excavations and fill, soil disturbance, and associated fill at part of the Tooele Army Depot South Area along the east margin of the quadrangle, fill along major roads, railroads, and several earthen dams; mapped where surficial grading, road building, excavations, and associated fill obscure the underlying unconsolidated deposits; material includes sand, gravel, angular cobble-size clasts, silt, and clay; variable thickness 0 to 50 feet (0–15 m).
Geologic map of the Saint John quadrangle, Tooele County, Utah

**Alluvial Deposits**

Qaly **Younger alluvial deposits** (Holocene to upper Pleistocene) – Moderately to well-sorted sand, pebble and cobble gravel, silt, and minor clay; deposited along the major drainage on the valley floor; locally includes small alluvial-fan and colluvial deposits; mapped along incised drainages where alluvial deposits cannot be differentiated because of map scale or in areas where the specific age of Holocene deposits cannot be determined; postdates regression of Lake Bonneville; thickness variable, probably less than 15 feet (5 m).

Qat **Stream-terrace deposits** (middle Holocene to upper Pleistocene) – Moderately to well-sorted sand, pebble and cobble gravel, silt, and minor clay; deposited as a gently sloping terrace along the south side of Clover Creek; includes inactive stream and flood-plain deposits; all terrace deposits lie 10 to 20 feet (3–6 m) above active stream and flood-plain levels; thickness varies from 5 to 20 feet (1.5–6 m).

Qaf1 **Level-1 alluvial-fan deposits** (upper Holocene) – Poorly to moderately sorted, crudely stratified or massive pebble to cobble gravel with boulders near bedrock exposures, sand, silt, and minor clay; clasts are angular to subrounded and commonly matrix supported; deposited principally by debris flows and sheet floods at the mouths of small, intermittent stream channels, and near the mouths of other channels in older alluvial-fan or lacustrine deposits and other unconsolidated deposits; locally incised in and/or overlying older alluvial-fan deposits; deposits equivalent to, and grade into the younger part of young alluvial-fan deposits (Qafy); differentiated from other alluvial-fan deposits due to a relatively smooth undissected fan surface radiating away from a defined fan apex and deposition overlying or incised into other alluvial and lacustrine units; no fault scarp cuts Qaf1 deposits in the quadrangle; exposed thickness less than 10 feet (3 m).

Qaf2 **Level-2 alluvial-fan deposits** (lower Holocene) – Poorly to moderately sorted, crudely stratified or massive pebble to cobble gravel with boulders near bedrock exposures, sand, silt, and minor clay; clasts are angular to subrounded and commonly matrix supported; deposited principally by debris flows and sheet floods; locally incised in and/or overlying older alluvial-fan deposits and lacustrine deposits; deposits equivalent to, and grade to the older part of Qafy, locally above younger Qafy deposits; fan surface is abandoned and commonly dissected and irregular; south of Clover Creek Qaf2 obscures Shambip shoreline; deposits grade above alluvial-fan level (Qaf1); several fault scarps offset Qaf2 fan surface southeast of Clover below the Bonneville highstand elevation; exposed thickness less than 15 feet (5 m).

Qaf3 **Alluvial-fan deposits, Bonneville lake cycle, undivided** (upper Pleistocene) – Poorly to moderately sorted, crudely stratified or massive sand, pebble gravel, silt, and minor clay; clasts subangular to subrounded and commonly matrix supported; deposited principally by debris flows and sheet floods; locally incised in older alluvial fan deposits; locally above younger Qafy deposits; fan surface grades near and just below the Lake Bonneville highstand shoreline and exposures of Lake Bonneville sediments; deposition was contemporaneous with transgression, regression, and highstand of Lake Bonneville in Rush Valley; surface is incised by active drainages; forms extensive surface in western part of the quadrangle south of Clover Creek; fault scarps 6 to 9 feet (2–3 m) high cut Qaf3 in the western half of the quadrangle south of Clover Creek; exposed thickness less than 15 feet (5 m).

Qafy **Younger alluvial-fan deposits** (Holocene to upper Pleistocene) – Poorly to moderately sorted, crudely stratified or massive pebble to cobble gravel with boulders near bedrock exposures, sand, silt, and minor clay; clasts are angular to subrounded and commonly matrix supported; deposited principally by debris flows and sheet floods at the mouths of intermittent stream channels draining bedrock, near the mouths of other channels in older alluvial-fan and other unconsolidated deposits, or across large alluvial slopes where individual fan surfaces cannot be differentiated; mapped along much of the Clover Creek drainage; includes level-1 and -2 alluvial-fan deposits (Qaf1 and Qaf2) that postdate Lake Bonneville and the youngest part of alluvial fans deposited during Lake Bonneville regression (Qaf3); also mapped in areas where the specific age of deposits that postdate the Lake Bonneville highstand cannot be determined; thickness variable, probably less than 40 feet (12 m).

Qaf0 **Older alluvial-fan deposits, pre-Bonneville lake cycle** (upper to lower? Pleistocene) – Poorly sorted pebble to cobble gravel, locally bouldery, in a matrix of sand, silt, and clay; Qaf0 fans are etched by or overlain by shoreline deposits of the Lake Bonneville highstand; Qaf0 mapped in the northeast corner of the quadrangle is below the Lake Bonneville shoreline but lacks obvious lacustrine deposits; fan surface is generally more incised than younger fan deposits; Qaf0 alternately overlaps and is cut into oldest (QTa) alluvial fans in the southwest and northwest parts of the quadrangle; unit is incised by and alternately overlain by syn- and post-Bonneville
alluvial fan deposits (Qafy, Qaf₁, Qaf₂, and Qaf₃); thickness probably less than 60 feet (18 m).

**Lacustrine Deposits**

**QLGSH**  
**Lacustrine gravel and sand deposits, Shambip lake level** (upper Pleistocene) – Moderately to well sorted, sub-rounded to rounded pebble gravel, sand, and minor silt; deposited as gravel bars and sheets at and below the Lake Shambip shoreline elevation (~5045 to 5060 feet [1538–1542 m]) in northern Rush Valley (Burr and Currey, 1992; Nelson, 2012); locally contains small gastropod shells; locally overlies and is inset in older lacustrine and or mixed units including Qlf and Qlao; unit is cut by and overlain by alluvial fans that postdate the Lake Bonneville highstand (Qafy); Qlgsh deposits lack overlying lacustrine fine-grained lacustrine deposits; age of Lake Shambip deposits ranges from 13,300 to 14,300 \(^{14}\)C years BP (Nelson, 2012) for correlative deposits to the north in the South Mountain quadrangle; thickness is less than 25 feet (8 m).

**QLISH**  
**Lacustrine lagoon deposits, Shambip lake level** (upper Pleistocene) – Light-colored, well-sorted silt, clay, sand, and marl; deposited leeward of barrier bars and spits of Qlgsh near the Shambip lake level (~5045 to 5060 feet [1538–1542 m]); unit overlies older mixed lacustrine and alluvial deposits (Qlao) and appears to interfinger with or be overlain by younger lacustrine deposits of unit Qlgsh; age of Lake Shambip deposits ranges from 13,300 to 14,300 \(^{14}\)C years BP (Nelson, 2012) for correlative deposits to the north in the South Mountain quadrangle; sediment in this unit may also include alluvial material transported into areas bounded by barrier bars (Qlgsh); thickness is less than 20 feet (6 m).

**QLGB**  
**Lacustrine gravel and sand deposits, transgressive phase of the Bonneville lake cycle** (upper Pleistocene) – Moderately to well-sorted, sub-rounded to rounded pebble gravel, sand, and minor silt; deposited as gravel bars and sheets at and below the Lake Bonneville highstand; deposited during the transgressive phase of Lake Bonneville; mapped along a broad gently sloping shoreline platform south of Clover Creek and above the Lake Shambip shoreline; deposited during the transgressive and highstand phase of Lake Bonneville; thickness is less than 30 feet (10 m).

**QLMB**  
**Lacustrine silt, clay, and marl, transgressive phase of the Bonneville lake cycle** (upper Pleistocene) – Light-colored, well-sorted silt, clay, marl, and very fine grained sand deposited in sheets and pods below the Lake Bonneville highstand; deposited during the transgressive phase of Lake Bonneville, mapped near the center of the quadrangle; thickness is less than 10 feet (3 m).

**QLF**  
**Lacustrine fine-grained deposits, Bonneville lake cycle** (upper Pleistocene) – Light colored, poorly to moderately sorted silt, clay, marl, and very fine grained sand deposited below the Lake Bonneville highstand; unit is mapped along areas of the valley floor where surface is dominated by a variety of fine-grained lacustrine deposits either too thin or stratigraphically complex to map separately; includes fine-grained sediment probably deposited during both the transgressive and regressive phases of Lake Bonneville in Rush Valley; thickness is less than 30 feet (10 m).

**Spring Deposits**

**QSM**  
**Spring and marsh deposits** (Holocene) – Moderately to well-sorted silt, sand, clay, and dark organic-rich material in areas of high water tables, perennial spring flow, and seasonal standing water in the quadrangle; mapped in several broad low-gradient areas and confined channels along the central valley floor with seasonal or perennial standing water and/or shallow groundwater; total thickness up to 30 feet (10 m).

**Mixed-Environment Deposits**

**QSL**  
**Lacustrine deposits and younger alluvial-fan deposits, undivided** (Holocene to upper Pleistocene) – Poorly to well-sorted sand, silt, clay, gravel and marl; deposited below the Lake Bonneville highstand as smooth, sloping sheets of sediment; differentiated from Qlao by a lack of shoreline features and a relatively smooth and undissected surface topography similar to Qafy; includes a variety of lacustrine and alluvial facies either too complex or too poorly exposed to map; thickness less than 40 feet (12 m).
**QUATERNARY-TERTIARY**

**QTaf**  **Oldest alluvial-fan deposits** (lower Pleistocene? to Pliocene?) – Poorly sorted boulder, cobble, and pebble gravel, sand, silt, and clay; unit composed of unconsolidated boulders, cobbles, and gravels; clasts include sandstone, limestone, and various Paleozoic carbonate rocks apparently sourced from bedrock exposed to the west in the Oquirrh Mountains; **QTaf** is the highest standing alluvial-fan unit and is deeply incised by all younger alluvial fan units including **Qaf** and **Qaf**; in the southwest corner of the quadrangle **QTaf** mantles Oquirrh Group bedrock; fault scarps between 15 between 20 feet (5–7 m) abut **QTaf**; absolute age is unknown; thickness up to 300 feet (90 m).

**TERTIARY**

**Tsl**?  **Salt Lake Formation?** (Miocene?) – White to pale-gray, consolidated, interbedded marl and siltstone; **Tsl**? is mapped at a poorly exposed outcrop near Saint John and at a single small outcrop along the eastern boundary of the quadrangle; unit is queried because of the limited exposures in the quadrangle and their unknown correlation with mapped **Tsl** in the adjoining Faust and Vernon NE quadrangles; the base of the Salt Lake Formation is not exposed, but it likely rests on underlying Paleozoic age rocks in angular unconformity; there are no direct ages for the Salt Lake Formation in the quadrangle; south of the study area in the adjoining Vernon NE and Faust quadrangles (Kirby, 2010a, d) the age of the Salt Lake Formation is between 6.6 ± 0.03 and 9.8 ± 0.23 Ma, based on tephra interpolations and correlations from Perkins and others (1998); thickness estimate is complicated by poor exposure and lack of direct measurement of the strike and dip, but exposed thickness could be up to 100 to 200 feet (30–60 m); total thickness in the subsurface is 3600 to 4200 feet (1100–1280 m) based on several drill holes along the Pony Express Road in the adjacent Vernon NE quadrangle (Kirby, 2010a).

**PENNSylvanian**

**Pobp? Butterfield Peaks Formation of the Oquirrh Group?** (Middle to Lower Pennsylvanian [Desmoinesian-Morrowan]) – Interbedded, brown- to gray-weathering, fine- to medium-grained calcareous and quartzitic sandstone, and medium-gray, fine- to medium-grained limestone, sandy limestone, and minor siltstone; unit characterized by repeated intervals of quartzitic or calcareous sandstone overlain by intervals of gray limestone or sandy limestone; sandstone is typically light brownish gray and planar bedded, and locally displays low-angle cross-stratification and small-scale cross-bedding; both calcareous and quartzitic sandstone exist in nearly equal proportions; limestone intervals are typically medium gray, medium to thick bedded, commonly sandy with very fine to fine-grained sand; fossils include rugose corals, crinoids, brachiopods, fossil hash, and fusulinids in localized beds; locally contains black chert nodules and thin chert beds; limestone and sandy limestone commonly grade upward to finer grained, platy-weathering limestone and argillaceous limestone and siltstone; generally poorly exposed; forms slopes and ridge at a single isolated outcrop mantled by **QTaf** in the southwest corner of the quadrangle; age of Butterfield Peaks exposures in the Vernon Hills to the south is Atokan (Middle Pennsylvanian) (Kirby, 2010b and c); unit is queried in the quadrangle because of limited exposure and a lack of age control; incomplete exposed thickness in the quadrangle is roughly 300 feet (~100 m); Tooker and Roberts (1970) reported the formation is about 9000 feet (2740 m) thick in the Oquirrh Mountains.

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**LITHOLOGIC COLUMN**

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<td>Pleistocene</td>
<td>Butteville Peaks Formation?</td>
<td>Pdp?</td>
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<td>Salt Lake Formation?</td>
<td>Td1?</td>
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<td>Unconformity</td>
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**GEOLOGIC MAP SYMBOLS**

- Contact - Dashed where approximately located
- Normal fault - Dotted where concealed, bar and ball on down-thrown block

- Lineament
- Highest shoreline of the Bonneville (transgressive) phase, dashed where approximate
- Other transgressive shorelines of the Bonneville phase
- Highest shoreline of the Shambip Lake dashed where approximate
- Beach ridge crest
- Strike and dip of inclined bedding
- Sand and gravel pit
- Wall
- Line of cross section

**Table 1. Ages and elevations of major shorelines of Lake Bonneville in Rush Valley.**

<table>
<thead>
<tr>
<th>Lake Cycle and Phase</th>
<th>Shoreline (map symbol)</th>
<th>Age radiocarbon years (14C yr) B.P</th>
<th>Elevation feet (meters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Bonneville</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transgressive Phase</td>
<td>Bonneville (B) fixed</td>
<td>14,800¹</td>
<td>5220-5240 (1590-1597)</td>
</tr>
<tr>
<td>Regressive Phase</td>
<td>Shambip (SB) 14,300-15,500³</td>
<td>17,400-18,200³</td>
<td>5040-5060 (1518-1542)</td>
</tr>
<tr>
<td></td>
<td>Horsethief Knolls¹²</td>
<td>age not constrained¹⁵</td>
<td>not present</td>
</tr>
</tbody>
</table>

¹ Miller and others (2012).
² All calendar calibration made using OxCal 14C calibration and analysis software (Bronen and others, 2009).
³ Bee and Curley (1988, 1982) reported that regressive-phase shorelines in Rush Valley fluctuated independently from the main body of Lake Bonneville subsequent to construction of the Stockton Flat and lowering of the lake level below this threshold following the Lake Bonneville flood. Both the Shambip and Horsethief Knolls lake levels (~5100 [1556m] and ~5100 [1557m] respectively) form erosional shorelines in transgressive Bonneville deposits near Stockton and must therefore have occurred at sometime following the initial regression of Lake Bonneville.
⁴ Nelson (2012).

![Image of Lithologic Column](image-url)

![Image of Geologic Map](image-url)


**CORRELATION OF UNITS**

- Sand and gravel pits
- Unconformity
- Gravel

Note: This map is an important reference for understanding the geologic information related to the mapped area. Gray color indicates quadrangles mapped for this project. Numbers correspond to references in the text.