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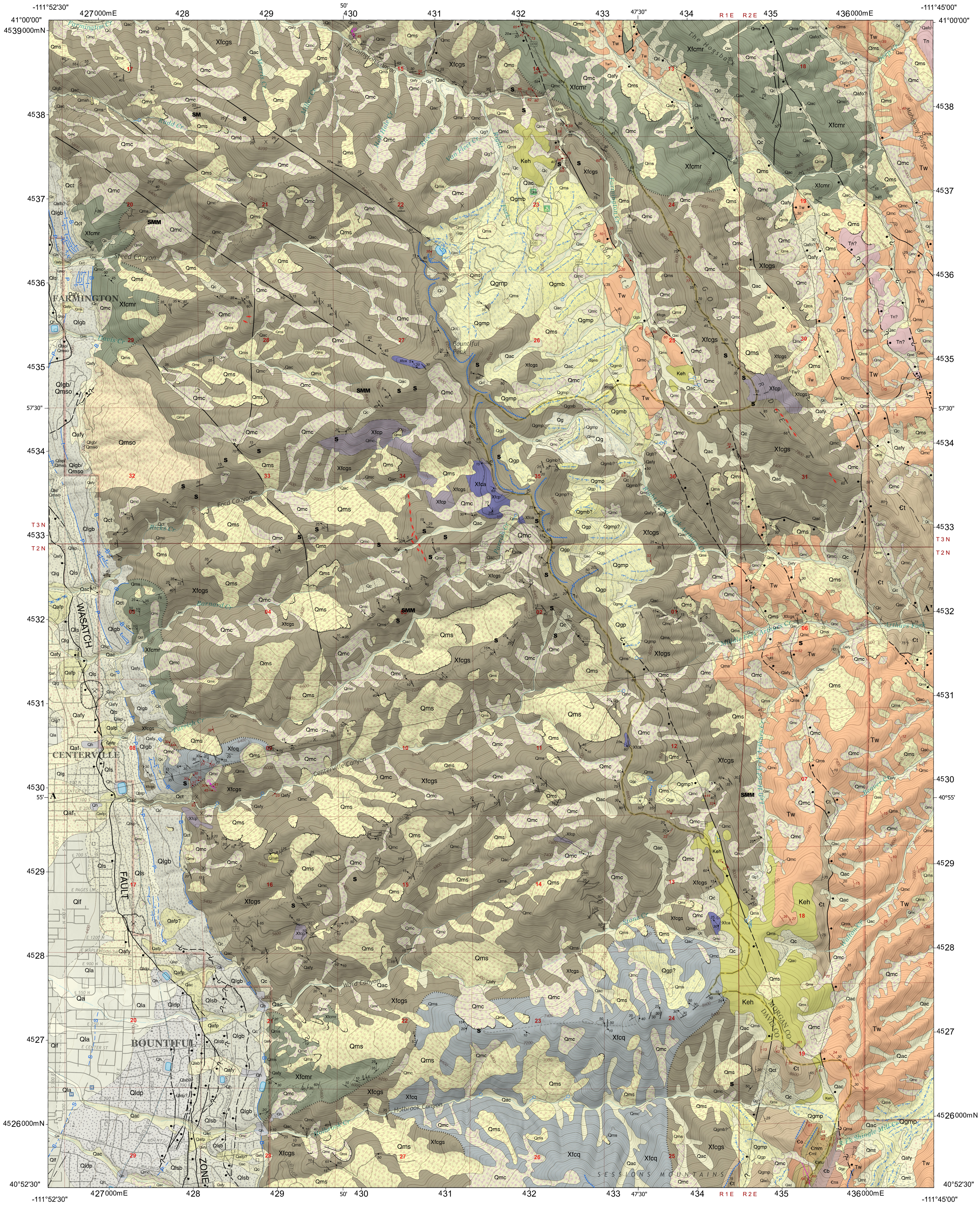

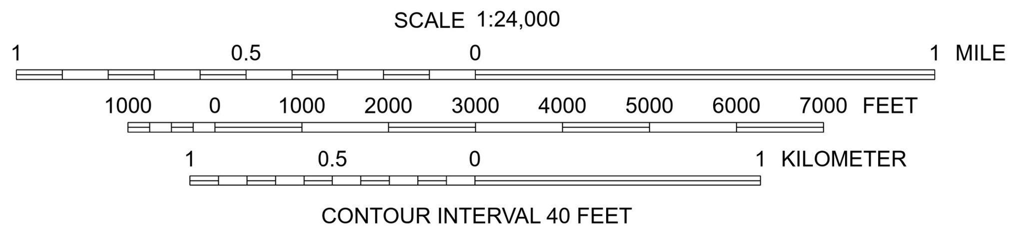

CONTOUR INTERVAL 40 FEET

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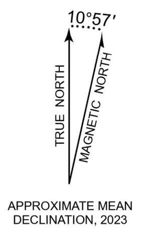


APPROXIMATE MEAN DECLINATION, 2023

GEOLOGIC MAP OF THE BOUNTIFUL PEAK QUADRANGLE, DAVIS AND MORGAN COUNTIES, UTAH

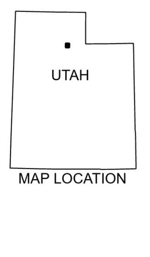
by

Zachary W. Anderson

2023

Base from USGS US Topo Bountiful Peak 7.5′ Quadrangle (2020)
Shaded relief derived from USGS 10-meter NED
Projection: UTM Zone 12
Datum: NAD 1983

Program Manager: Stefan M. Kirby
Project Manager: Jon K. King
GIS and Cartography: Keilee A. Higgs and Jessica S. Pierson
GIS Review: Subigya Shah and Austin J. Jensen



MAP LOCATION

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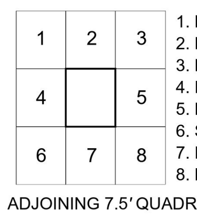

1. Kaysville
2. Peterson
3. Morgan
4. Farmington
5. Porterville
6. Salt Lake City North
7. Fort Douglas
8. Mountain Dell

ADJOINING 7.5′ QUADRANGLE NAMES

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MAP UNITS

see booklet for complete unit descriptions

QUATERNARY DEPOSITS

- Qh — Fill and disturbed land
- Qa — Stream alluvium
- Qaf_1 — Youngest alluvial-fan deposits
- Qafy — Younger alluvial-fan deposits
- Qafp — Alluvial-fan deposits related to regressive phase of Bonneville lake cycle
- Qafb? — Alluvial-fan deposits related to Bonneville shoreline occupation, queried
- Qafo — Older alluvial-fan deposits
- Qlsp — Lacustrine sand and silt related to the Provo shoreline and regressive phase of Lake Bonneville
- Qldp — Deltaic deposits related to the Provo shoreline and regressive phase of Lake Bonneville
- Qlsb — Lacustrine sand and silt related to the Bonneville shoreline and transgressive phase of Lake Bonneville
- Qlgb — Lacustrine gravel and sand related to the Bonneville shoreline and transgressive phase of Lake Bonneville
- Qlf — Lacustrine silt and clay of Lake Bonneville
- Qls — Lacustrine sand and silt of Lake Bonneville
- Qlg — Lacustrine gravel and sand of Lake Bonneville
- Qg — Glacial deposits, undivided
- Qgmp — Glacial moraines, Pinedale age
- Qgp — Glacial deposits, undivided, Pinedale age
- Qgmb — Glacial deposits and moraines, Bull Lake age
- Qgb — Glacial deposits, undivided, Bull Lake age
- Qmsh — Landslide deposits, historical movement
- Qms — Landslide deposits
- Qmso — Landslide deposits, older
- Qmt — Talus deposits
- Qc — Colluvial deposits
- Qct — Colluvial and talus deposits, undivided
- Qac — Alluvial and colluvial deposits, undivided
- Qmc — Mass-movement and colluvial deposits, undivided
- Qla — Lacustrine and alluvial deposits, undivided
- Qlm — Lacustrine and marsh deposits, undivided
- Qlsp/Qmso — Lacustrine sand and silt related to the Provo shoreline and regressive phase of Lake Bonneville over older landslide deposits
- Qlgb/Qmso — Lacustrine gravel and sand related to the Bonneville shoreline and transgressive phase of Lake Bonneville over older landslide deposits
- Qls/Qmso — Lacustrine sand and silt of Lake Bonneville over older landslide deposits

TERTIARY (PALEOGENE) ROCKS

- Tn — Norwood Formation
- Tw — Wasatch Formation

CRETACEOUS ROCKS

- Keh — Hams Fork Member of Evanston Formation, conglomeratic facies

CAMBRIAN ROCKS

- Ꞓns — Nounan and St. Charles Formations, undivided
- Ꞓb — Bloomington Formation
- Ꞓmu — Maxfield Limestone, upper limestone unit
- Ꞓmm — Maxfield Limestone, middle mixed unit
- Ꞓml — Maxfield Limestone, lower limestone unit
- Ꞓo — Ophir Formation
- Ꞓt — Tintic Quartzite

PROTEROZOIC ROCKS

- Xfcgs — Farmington Canyon Complex, gneiss and schist
- Xfcmr — Farmington Canyon Complex, mylonitic gneiss and schist with retrograde metamorphism
- Xfcq — Farmington Canyon Complex, quartzite, gneiss, and schist
- Xfcp — Farmington Canyon Complex, pegmatite, gneiss, and schist
- Xfca — Farmington Canyon Complex, amphibolite

GEOLOGIC SYMBOLS

Contact - Dashed where approximately located; dotted where concealed; hatchured in Farmington Canyon Complex rocks where metamorphic facies contacts are vague, gradational, and approximately located

Approximate location of pegmatite dikes, unit Xfcp

Fault, unknown offset - Dotted where concealed

Normal fault - Dashed where approximately located; dotted where concealed; queried where existence and/or location uncertainty is high; ball and bar on downthrown hanging wall; arrows on cross section show relative movement

Anticline-syncline pair - Dotted where concealed

Lineament

Headwall of glacial cirque

Crest of glacial arete

Crest of asymmetrical glacial moraines; ticks on steep (ice) side

Crest of symmetrical glacial moraines

Crest of glacial moraines with unknown symmetry

Landslide scarp - ticks on down-dropped side

Lacustrine shorelines - Major shorelines of Lake Bonneville; mapped at the top of wave-cut bench; may coincide with geologic contacts

B — Bonneville shoreline (highstand); dashed where approximately located; dotted where concealed

t — Transgressive shoreline (present below the Bonneville shoreline and above the Provo shoreline); dashed where approximately located

P — Provo shoreline; dashed where approximately located; dotted where concealed

r — Regressive shoreline; (present below the Provo shoreline)

S — Stansbury shoreline; dashed because approximately located

Paleochannel margins in Qafp; dashed because approximately located; ticks point toward paleochannel

Extent of abandoned gravel pit

Water boundary

A — A′ Cross section line

Approximate schematic bedding or foliation on cross section

Data from this study

- 12 Approximate strike and dip of inclined bedding
- 12 Strike and dip of inclined bedding
- 12 Strike and dip of inclined bedding, determined by 3-point problem
- 12 Strike and dip of metamorphic cleavage
- 12 Dip and dip direction of fault
- 12 Dip and dip direction of fault determined by 3-point problem
- 12 Minor S-fold showing bearing and plunge of fold hinge
- 12 Minor Z-fold showing bearing and plunge of fold hinge
- 12 Strike and dip of inclined metamorphic foliation
- 12 Bearing and plunge of metamorphic mineral lineation
- Sinkhole
- Spring
- Adit (approximate locations from Gloyn and others, 1995)
- Prospect (approximate locations from Gloyn and others, 1995)
- Abandoned gravel pit

Data from Bryant (1984, 1988)

- 12 Strike and dip of inclined beds
- 12 Strike and dip of overturned beds
- Strike of vertical beds
- 12 Strike and dip of inclined cataclastic foliation and foliation in retrogressively metamorphosed rock
- 12 Strike and dip of inclined metamorphic foliation and compositional layering
- 12 Strike and dip of inclined metamorphic foliation
- Strike of vertical metamorphic foliation
- 12 Bearing and plunge of metamorphic mineral lineation
- Bearing of metamorphic mineral lineation with horizontal plunge
- **S** Microscopic sillimanite
- **S** Megascopic sillimanite
- **SM** Microscopic sillimanite and microcline
- **SMM** Microscopic sillimanite, microcline, and muscovite

LITHOLOGIC COLUMN

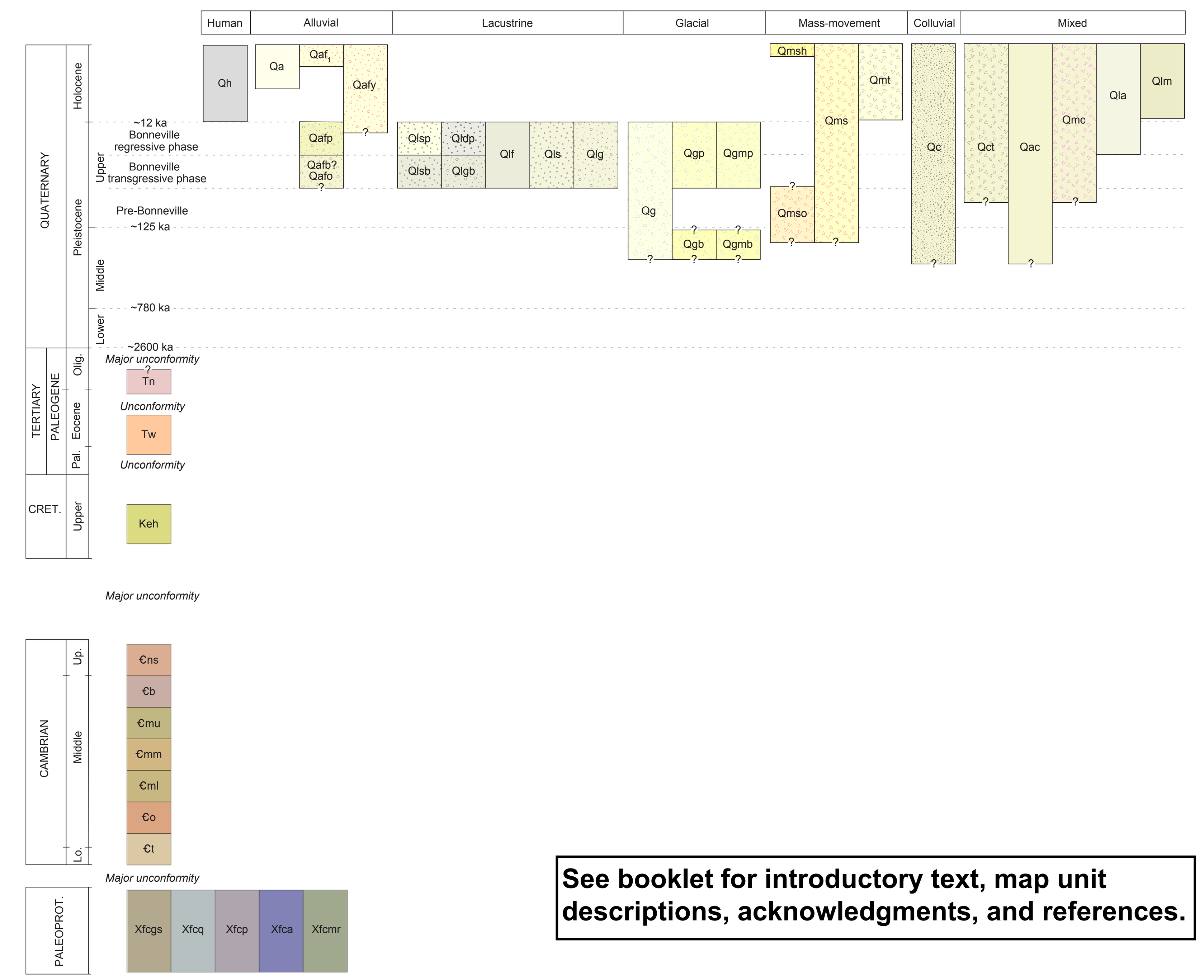
AGE			MAP UNIT SYMBOL	GEOLOGIC UNIT	THICKNESS FEET	THICKNESS METERS	REGIONAL TECTONIC SETTING	OTHER INFORMATION
QUAT.			Q various	Surficial deposits	0–160+	0–50+	Modern basin and range extension	MAJOR UNCONFORMITY
TERTIARY	PALEOGENE	O.	Tn	Norwood Formation	250**	75**	Early extension and collapse of Sevier orogenic belt; calc-alkaline volcanism	Top not exposed in quadrangle; Unconformity
		Paleocene - Eocene	Tw	Wasatch Formation	500–2300**	150–700**		Unconformity
Late CRET.		Ca.-M.	Keh	Hams Fork Member of Evanston Formation	0–400?	0-120?	Sevier orogeny; thrust faults; piggyback basin deposition	MAJOR UNCONFORMITY
CAMBRIAN		Uppper	Ꞓns	Nounan and St. Charles Formations, undivded	510+	150+	Marine deposition on a passive continental margin	Top not exposed in quadrangle
		Middle	Ꞓb	Bloomington Formation	310–350	90–110		
			Ꞓmu	Maxfield Limestone: Upper limestone unit	200*	60*		
			Ꞓmm	Maxfield Limestone: Middle mixed unit	250–340*	80–105*		
			Ꞓml	Maxfield Limestone: Lower limestone unit	160–200	48–60		
			Ꞓo	Ophir Formation	300–380*	90–115*		
		Low.	Ꞓt	Tintic Quartzite	1500–1980?	450–600?		MAJOR UNCONFORMITY
PALEO-PROTEROZOIC			Xfcgs, Xfcq, Xfcp, Xfca, Xfcmr	Farmington Canyon Complex	indeterminant		Terrane collision, amphibolite facies metamorphism, and plutonism	Xfcmr = mylonitic gneiss and schist with retrograde metamorphism; Xfcq = quartzite, gneiss, and schist; Xfcgs = gneiss and schist; Xfca = amphibolite; Xfcp = pegmatite, gneiss, and schist

Diagram is schematic - no fixed thickness scale

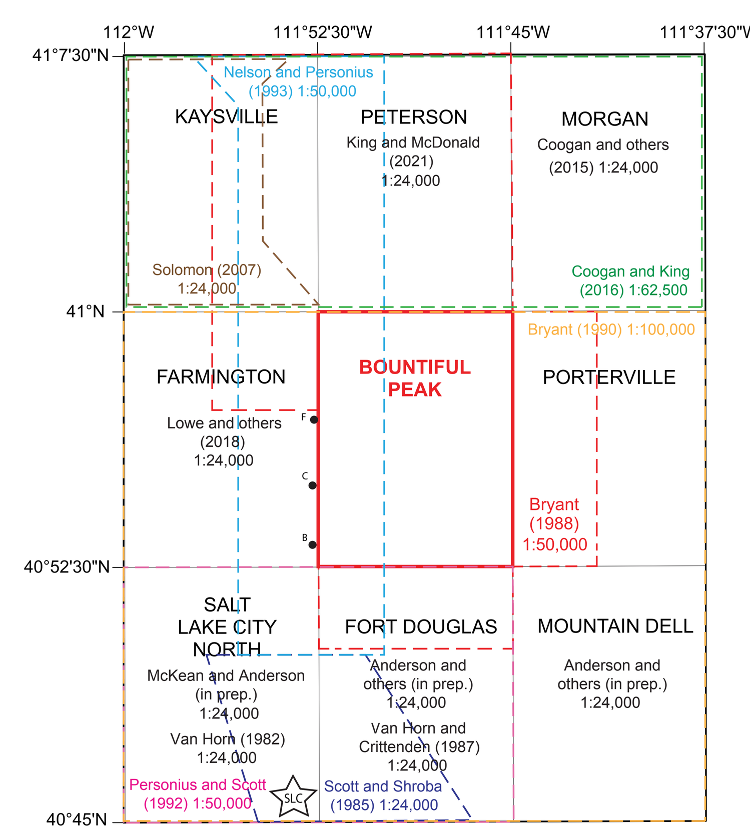
*Apparent thickness, deformed rocks

**Exposed thickness in quadrangle may not be complete. See description of map units for complete thickness in nearby areas.

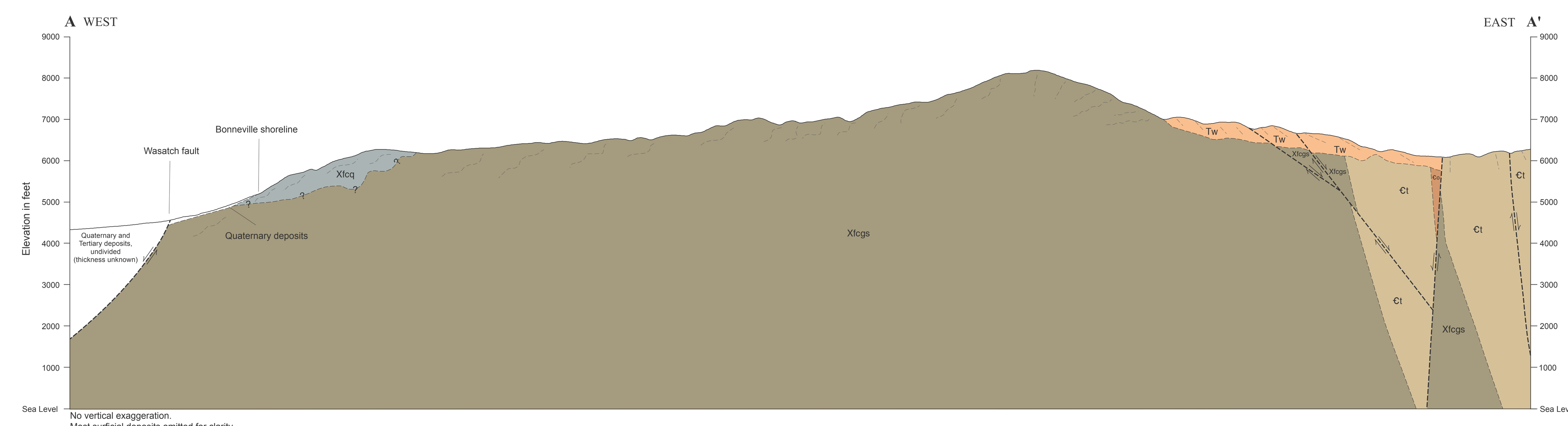
CORRELATION OF MAP UNITS



See booklet for introductory text, map unit descriptions, acknowledgments, and references.

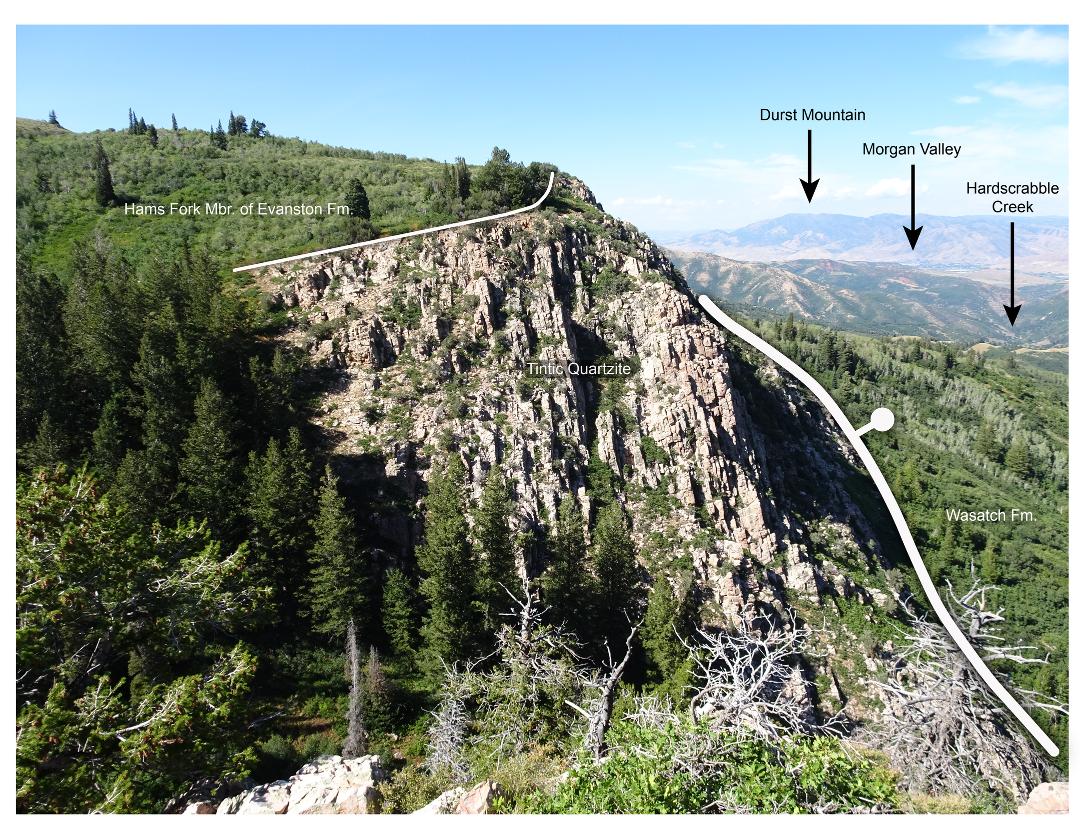


Index map showing selected geologic mapping available for the Bountiful Peak and surrounding 7.5' quadrangles. Downtown Salt Lake City is marked by the black-outlined star. Black dots with B, C, and F show the city centers of Bountiful, Centerville,and Farmington, respectively.



A.

B.



C.

***Photo A.** (unannotated) and **B.** (annotated) taken from approximately 435412 E 4527864 N (UTM NAD 83) looking north. In the middle ground, the bright white Cambrian Tintic Quartzite dips steeply east and is bounded on the east by an east-down normal fault with Paleogene Wasatch Formation on the hanging wall. The Tintic Quartzite is unconformably overlain by the Cretaceous Hams Fork Member of the Evanston Formation. In the background is complex geology of Hardscrabble Creek (see Bryant, 1990), Morgan Valley, and Durst Mountain (see Coogan and King, 2016). **Photo C.** Strongly folded migmatitic gneiss within the gneiss and schist facies (unit Xfcgs) of the Paleoproterozoic Farmington Canyon Complex metamorphic rocks. Brunton compass is 10 cm long.*

***Table 1.** Ages of major shoreline occupations of Lake Bonneville, Gilbert episode, and Great Salt Lake with shoreline elevations in and near the Bountiful Peak quadrangle (after McKean and others, 2019)*

Lake Cycle and Phase	Shoreline (map symbol)	Age: Radiocarbon years (^{14}C yr B.P.)	Age: calibrated years (cal yr B.P.)	Shoreline Elevation feet (meters)
Lake Bonneville				
Transgressive phase	Stansbury shoreline (S)	22,000–20,000[2]	26,000–24,000	4480–4500 (1365–1372)
	Transgressive shorelines (t)	~20,000–15,200[3]	24,000–18,500[3]	4920–5160 (1490–1564)
	Bonneville (B)	~15,200–15,000[4]	~18,500–18,000	5160–5235 (1564–1586)
Overflowing phase	Provo (P)	15,000–12,600[5]	18,000–15,000	4820–4890 (1460–1481)
Regressive phase	Regressive shoreline (r)	12,600–11,500[5]	15,000–13,000	4780–4820 (1448–1460)
Gilbert episode	Gilbert	10,000[6]	11,500	Not present[9]
	early Holocene highstand	9700–9400[7]	11,000–10,500	Not present[9]
	late Holocene highstand	4200–2100[8]	5000–2000	Not present[9]
	Historical highstand		late 1860s to early 1870s and 1986-87[10]	Not present[9]

[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] Oldest and youngest age are from the youngest Stansbury shoreline and the oldest Bonneville shoreline, respectively (see refences [2] and [4], respectively)

[4] Oviatt, 2015; Miller, 2016; and references therein; Bonneville shoreline highstand duration may have been shorter than the rounding error of 500 years

[5] See 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) suggest that regression began shortly after 16.5 cal ka (for example 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] Murchison (1989), Currey and James (1982)

[8] Miller and others (2005)

[9] Shoreline ages are provided for reference only, as they are present only below the lowest elevations in the quadrangle: Gilbert-episode at 4245 to 4250 feet (1294–1295 m), Great Salt Lake early Holocene highstand at 4225 to 4230? feet (1288–1289? m), Great Salt Lake late Holocene highstand at 4217 to 4221 (1285–1287 m) and Great Salt Lake historical highstand at 4212 feet (1284 m)

[10] Arnow and Stephens (1990)

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by Zachary W. Anderson

MAP 298DM
UTAH GEOLOGICAL SURVEY
UTAH DEPARTMENT OF NATURAL RESOURCES
2023

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GEOLOGIC MAP OF THE BOUNTIFUL PEAK QUADRANGLE, DAVIS AND MORGAN COUNTIES, UTAH

by
Zachary W. Anderson

Cover photo: *View looking southeast from Gold Ridge with Paleoproterozoic schist of the Farmington Canyon Complex in the foreground and Paleocene-Eocene Wasatch Formation capping the distant ridges.*

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MAP 298DM
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UTAH DEPARTMENT OF NATURAL RESOURCES
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CONTENTS

GEOLOGIC MAP OF THE BOUNTIFUL PEAK QUADRANGLE, DAVIS AND MORGAN COUNTIES, UTAH

by Zachary W. Anderson

INTRODUCTION

The Bountiful Peak 7.5' quadrangle is in southern Davis and Morgan Counties (plate 1), about 15 miles (9 km) northeast of Salt Lake City, Utah. The western part of the quadrangle includes parts of the cities of Bountiful, Centerville, and Farmington. The central and eastern parts of the quadrangle are dominated by rural, rugged, and steep mountainous terrain of the northern Wasatch Range and Sessions Mountains.

The bedrock geology in the quadrangle includes Paleoproterozoic metamorphic rocks of the Farmington Canyon Complex (see Bryant, 1988), which has a complex history including amphibolite facies metamorphism around 1700 Ma (Barnett and others, 1993; Muller and others, 2011; Nelson and others, 2002, 2009, 2011; Rasmussen and others, 2022). Most of these rocks have a retrograde metamorphic overprint from deformation during the Cretaceous to early Tertiary Sevier orogeny (Bryant, 1988; Yonkee, 1992; Yonkee and others, 1997, 2003; Yonkee and Lowe, 2004; Nelson and others, 2009; Yonkee and Weil, 2011). The Proterozoic rocks are unconformably overlain by Cambrian sedimentary rocks of the footwall of the Willard thrust sheet exposed to the north (Yonkee and Lowe, 2004; King and others, 2008; Coogan and King, 2016). The map area is on the east flank of the Wasatch anticlinorium, a doubly plunging structural arch formed during the Sevier orogeny and cored by the Ogden floor and roof thrusts (Yonkee, 1992; Yonkee and others, 1997; Yonkee and Weil, 2011). The Proterozoic and Cambrian strata of the map area are bounded by the Ogden thrust system (Yonkee, 1992; Yonkee and others, 1997); however, a surface expression of the roof thrust has not been definitively mapped anywhere south of the Durst Mountain area in the Morgan quadrangle to the northeast (Coogan and others, 2015). In the Morgan quadrangle, Coogan and others (2015) showed the roof thrust in their cross section A-A' as queried in the footwall block of the Morgan fault zone, a large, west-down normal fault on the east side of Morgan Valley. Yonkee (1992) showed the Ogden roof thrust inferred above the Bountiful Peak quadrangle. East of the quadrangle, in Hardscrabble Creek, Bryant (1990, cross section C-C') showed Farmington Canyon Complex rocks thrust over Cambrian strata, which may be a southern extension of the Ogden roof thrust (see also Yonkee, 1992, figures 2 and 10; Yonkee and others, 2003, figure 2).

Cambrian strata record a marine transgressive sequence across what was a long-lived slowly subsiding passive margin of the western United States (Rigo, 1968; Hintze and Kowallis, 2021). Proterozoic and Cambrian rocks are overlain by latest Cretaceous and early Paleogene terrestrial, syn- and post-orogenic clastic rocks that record a landscape and tectonic setting that changed from contraction-dominated to extensional orogenic collapse (Constenius, 1996) and basin and range extension (Zoback, 1983). North-northeast-striking normal faults cut the Cretaceous and Paleogene rocks east of the range crest and are likely related to orogenic collapse of the Sevier fold-and-thrust belt (Constenius, 1996) and younger basin and range extension that started about 17 Ma (Parry and Bruhn, 1987). Significant extension and basin formation are indicated by over 6000 feet (1850 m) of Paleocene to Pleistocene sedimentary and volcaniclastic rocks deposited in the adjoining Morgan Valley (Coogan and others, 2015; cross section A-A').

Deposits and shorelines of Lake Bonneville, a large late Pleistocene lake (plate 2), are prominent within the quadrangle at and below about 5200 feet (1575 m) elevation. Lake Bonneville deposits were approximately time-equivalent to most glacial deposits in the higher elevations of the quadrangle. Glacial features and deposits are present in the upper reaches of most north-, northeast-, and east-facing drainages in the quadrangle above 8600 feet (2620 m) in elevation and represent two major pulses of glaciation at about 150 to 130 ka (Bull Lake glaciation) and about 22 to 17.5 ka (Pinedale glaciation). Young alluvial fans and landslides, derived mostly from Farmington Canyon Complex rocks that have been highly weathered and altered to clay minerals, are also prominent features of this map.

Mapping of the Paleoproterozoic Farmington Canyon Complex is primarily based on Bryant (1984, 1988, both 1:50,000 scale) but includes improved locations and identification of additional pegmatite dikes and areas of pegmatite-rich rock (unit Xfcp). Mapped Cambrian units include the Bloomington Formation and the Nounan and St. Charles Formations, undivided. Previous work did not recognize these units and instead mapped these rocks as a thick Maxfield Limestone (Bryant, 1984, 1988, 1990; Van Horn and Crittenden, 1987). This map documents a unique cobble- to boulder-gravel deposit (unit Keh) that is present on the crest of the Wasatch Range and is here interpreted as part of the latest Cretaceous Hams Fork Member of the Evanston Formation. These rocks (unit Keh) represent proximal piggyback basin deposits formed during the latest stages of the Sevier orogeny that progressively buttressed westward onto the east flank of the Wasatch anticlinorium. Previously, these rocks were interpreted as part of the Paleocene to Eocene Wasatch Formation (Bryant, 1984, 1988, 1990).

Geologic hazards are prominent features of this quadrangle. The communities of Bountiful, Centerville, and Farmington have experienced debris floods, debris flows, and landslides since the area was settled in the late 1800s (Woolley, 1946; Wieczorek and others, 1983). Lowe (1989a, 1989b, 1989c, 1990) mapped and described many slope failures and related geologic hazards in the west part of the quadrangle. This map improves the identification and delineation of Quaternary surficial deposits, primarily landslides, within the mountainous areas of the quadrangle by using slope and hill-shade images derived from lidar (light detection and ranging) data. Lowe (1989c) documented about 400 individual slope failures within the Davis County part of the map (approximately western three-fourths of map). This report documents over 800 individual mass-movement deposits within the quadrangle.

One of the main goals of this project was to improve the accuracy and precision of the mapping of the Quaternary deposits and the Wasatch fault zone. The urbanized valley part of the quadrangle that contains the Wasatch fault zone was previously mapped by Nelson and Personius (1993). I used their mapping as a guide but reinterpreted some of the Quaternary deposits and locations of strands of the Wasatch fault zone. The Wasatch fault zone is a major segmented normal fault zone that bounds the east side of the Basin and Range Province, and creates the stark topographic rise of the Wasatch Range in its footwall to the east and the relatively flat valley bottoms in its hanging wall to the west (Gilbert, 1928; Cluff and others, 1970; Machette and others, 1992). The west part of the quadrangle contains the southern part of the active Weber segment of the Wasatch fault zone that presents a significant earthquake hazard to the communities along the Wasatch Front. Based on measured vertical displacements up to 13.8 feet (4.2 m), the Weber segment of the Wasatch fault is considered capable of producing earthquakes as large as about magnitude 7.3 (Swan and others, 1980, 1981; Nelson, 1988; Foreman and others, 1991; McCalpin and others, 1994; DuRoss, 2008; DuRoss and others, 2009; DuRoss and others, 2016, and references therein). Large-magnitude earthquakes produce strong ground shaking, particularly in unconsolidated Lake Bonneville deposits, which can cause lateral spreads (see mapping in the adjacent Farmington quadrangle by Lowe and others [2018]), landslides, liquefaction, and rockfalls, all of which can cause severe damage to infrastructure and loss of property and life.

Mapping of surficial deposits and faults in the valley was primarily done using older black-and-white stereographic photographs from the U.S. Department of Agriculture (USDA) Stabilization and Conservation Service (1958) to limit obscuring human modification. Low-sun-angle, black-and-white oblique aerial photographs from the Woodward-Lundgren & Associates Wasatch fault investigation (Cluff and others, 1970, complied in Bowman and others, 2015) enhance small scarps, and slope-shade images of half-meter lidar data (Utah Automated Geographic Reference Center [UAGRC], 2013–2014) enhance terrain features. Mapping of the Wasatch fault zone from this study is also included in a new map of most segments of the Wasatch fault zone (McDonald and others, 2018).

This map supersedes the open-file release of Anderson (2019), which was the first geologic map of the Bountiful Peak quadrangle published at 1:24,000 scale.

MAP UNIT DESCRIPTIONS

QUATERNARY

Human-Derived Deposits

Qh **Fill and disturbed land** (historical) – Undifferentiated artificial (human) fill and disturbed land related primarily to water storage and debris flood control structures; map outlines of this unit based on 2011 lidar data; only larger areas of disturbed land are mapped; unmapped fill and disturbed lands are present in most developed areas of Centerville and Bountiful and contain continually changing mix of cuts and fills; thickness unknown.

Alluvial Deposits

Qa **Stream alluvium** (Holocene) – Pebble and cobble gravel, locally includes boulders, with matrix of sand, silt, and clay; locally stratified, thin to medium bedded with planar and cross-bedding; poorly to moderately sorted; clasts subangular to subrounded; typically clast supported; includes modern stream channel, active floodplain deposits, and minor stream terraces up to 6.5 feet (2 m) above active drainages; locally includes minor colluvial, debris-flow, and alluvial-fan deposits; mapped in valley bottom below the westernmost strand of the Wasatch fault zone where stream gradients decrease and main channels become less confined; estimated thickness less than 15 feet (5 m).

Qaf_1 **Youngest alluvial-fan deposits** (upper Holocene) – Poorly to moderately sorted, pebbles to large boulders in matrix of sand, silt, and clay; clasts subangular to well rounded; typically matrix supported; unconsolidated; typically fan-shaped lobes of sediment deposited by debris flows and floods during heavy rain and runoff events; mapped at mouths of Centerville Canyon and Parrish Creek; on USDA (1958) aerial photographs they have a distinct rough texture, local levees and channels, and large boulders indicative of debris-flow deposits; equivalent to younger parts of Qafy, some of which are mapped by Nelson and Personius (1993) as debris-flow deposits (their cd1 and cd2); locally cut by the Wasatch fault, but is primarily seemingly younger than the most recent fault scarps; estimated thickness is typically less than 30 feet (10 m).

Out of the 11 major canyons that drain the west side of the Wasatch Range in the quadrangle (from south to north: Mill Creek, Holbrook Canyon, Ward Canyon/Stone Creek, Centerville Canyon, Parrish Creek, Barnard Creek, Ford Canyon/Ricks Creek, Davis Creek, Steed Creek, Rudd Creek, and Farmington Canyon), all but Mill Creek, Centerville Canyon, and Barnard Creek have historical evidence of debris flows and floods that passed the mouths of the canyons and contributed sediment to active alluvial fans (Woolley, 1946; Wieczorek and others, 1983). It is uncertain if Holbrook and Ward Canyons had historical floods as Woolley (1946) reported a flood that left the highway (presumably U.S. Hwy 89) under 2 feet (60 cm) of water and sediment near historic Perry Station in Bountiful but did not specify which drainage the flood originated from. Although Mill Creek, Centerville Canyon, and Barnard Creek do not have historical evidence of debris floods, the USDA (1958) aerial photographs show evidence of likely pre-historical floods at the mouths of these canyons, and Miller (1980) mapped "Young fan alluvial deposits" (his map unit f) at the mouths of each of these canyons.

Qafy **Younger alluvial-fan deposits** (Holocene to upper? Pleistocene) – Poorly to moderately sorted pebbles to large boulders in matrix of sand, silt, and clay; clasts subangular to well rounded; typically matrix supported; deposited by debris flows, debris floods, and streams at mouths of smaller drainages, where larger drainages enter the valley floor, and on benches of Bonneville and Provo shorelines; mostly postdate regression of Lake Bonneville from Provo and lower shorelines; includes both ages of younger alluvial-fan deposits (Qaf1 and Qaf2) and mapped where relative ages cannot be determined or separated at map scale; Qaf2 not mapped in this quadrangle due to lack of distinguishable deposits of this age but mapped in neighboring quadrangles of Farmington (Lowe and others, 2018), Fort Douglas (Anderson and others, in preparation), Salt Lake City North (McKean and Anderson, in preparation), and Kaysville (Solomon, 2007); all or parts of the fans are active and may impinge on or deflect active drainages; estimated thickness between 10 and 40 feet (3–12 m) thick.

Qafp, Qafp?

Alluvial-fan deposits related to regressive phase of Bonneville lake cycle (upper Pleistocene) – Poorly to moderately sorted, pebble to cobble gravel, locally contains boulders, in matrix of sand, silt, and minor clay; typically matrix supported; clasts typically angular but well rounded where derived from Lake Bonneville deposits; poorly bedded, medium to very thick bedded; deposited by debris flows, debris floods, and streams at mouths of minor and major drainages below Bonneville shoreline; downslope portions may be gradational into regressive Lake Bonneville deltaic deposits, particularly at mouths of Mill Creek, Holbrook, and Ward Canyons; inactive and deeply incised by modern streams at mouths of major drainages; typically more incised with less of an apparent fan morphology than Qafy where mapped at mouths of small drainages between Bonneville and Provo shorelines; queried south of Holbrook Canyon because age is uncertain (could be Qafy); exposed thickness less than 80 feet (25 m).

Qafb? **Alluvial-fan deposits related to Bonneville shoreline occupation?** (upper Pleistocene) – Poorly to moderately sorted, pebble to cobble gravel in matrix of sand, silt, and minor clay; clasts mostly subangular; typically matrix supported; deposited by debris flows and debris floods in small drainages on the mountain front above the Bonneville shoreline; toe or depositional surface of fan is graded to the Bonneville shoreline; deeply incised by modern drainages and have a smooth and rounded surface; queried because unit designation is alluvial and its relation to Bonneville shoreline is uncertain; exposed thickness less than 30 feet (10 m).

Qafo, Qafo?

Older alluvial-fan deposits (upper? Pleistocene) – Poorly to moderately sorted, pebbles to large boulders in matrix of sand, silt, and clay; clasts subangular to well rounded; typically matrix supported; deposited by debris flows, debris floods, and streams; mapped only in and near Deep Creek in the northeast corner of the quadrangle; forms incised and inactive surfaces up to 100 feet (30 m) above modern drainages; likely similar age to unit Qafb? and may be related to the highstand of Lake Bonneville in Morgan Valley (see King and McDonald, 2021); queried where unit identification and age uncertain; estimated up to 60 feet (20 m) thick.

Lacustrine Deposits

Deposits related to the Provo shoreline and regressive phase of Lake Bonneville – Mapped only below the Provo shoreline at elevations of about 4820 to 4890 feet (1460–1481 m) in the Bountiful Peak quadrangle (plate 2). Elevations of the shoreline vary, in part due to offset across the Wasatch fault zone and isostatic rebound following the regression of Lake Bonneville.

Qlsp **Lacustrine sand and silt** (upper Pleistocene) – Moderately to well-sorted, subrounded to rounded, fine to coarse sand and silt with minor pebbly gravel; commonly ripple laminated to very thick bedded with some planar bedding; mostly wavy to sub-horizontal bed sets with minor channel features; commonly interbedded with or laterally gradational into lacustrine gravel and sand (Qlg); exposed thickness less than 60 feet (20 m).

Qldp, Qldp?

Deltaic deposits (upper Pleistocene) – Moderately to well-sorted pebble and cobble gravel in matrix of sand and silt; locally includes thin beds of silt and sandy silt; clasts subrounded to rounded; deposited as thin to thick planar and foreset beds; locally includes topset beds that may be alluvial; mapped at mouths of Mill Creek, Holbrook, and Ward Canyons as a deltaic complex related to lake regression from Provo shoreline; gradational and likely equivalent to alluvial-fan deposits related to regressive phase of Lake Bonneville (Qafp) mapped immediately upslope and approximately above Provo shoreline elevation of about 4850 feet (1470 m); mapped from aerial photographs (USDA, 1958; Cluff and others, 1970, compiled in Bowman and other, 2015) and lidar; queried where mapped near the Provo shoreline elevation and uncertain if unit is mostly subaqueous (Qldp) or mostly subaerial (Qafp); estimated thickness less than 120 feet (35 m).

Deposits related to the Bonneville shoreline and transgressive phase of Lake Bonneville – Mapped below the Bonneville shoreline and above the Provo shoreline. The Bonneville shoreline is at elevations from about 5160 to 5235 feet (1564–1586 m) in the Bountiful Peak quadrangle (plate 2). Elevations of the shoreline vary, in part due to offset across the Wasatch fault zone.

Qlsb, Qlsb?

Lacustrine sand and silt (upper Pleistocene) – Moderately to well-sorted, subrounded to rounded, fine to coarse sand and silt with minor pebbly gravel; thin to very thick bedded with mostly wavy to subhorizontal bed sets; commonly ripple laminated with some planar bedding and minor channel features; commonly interbedded with or laterally gradational into lacustrine gravel and sand (Qlgb); queried in Bountiful between Holbrook and Ward Canyons where unit designation is uncertain (could be Qldp); exposed thickness less than 75 feet (20 m).

Qlgb **Lacustrine gravel and sand** (upper Pleistocene) – Moderately to well-sorted, clast- to matrix-supported, pebble to cobble gravel with boulders in places in matrix of sand and pebbly sand; locally planar and cross-bedded; locally interbedded with thin beds and lenses containing sand, silt, and clay; clasts commonly subrounded to rounded, but some deposits consist of poorly sorted, angular gravel derived from nearby bedrock outcrops; typically overlies bedrock near the foot of Wasatch Range, some small exposures of bedrock within this unit have been omitted because they are too small to show at map scale; estimated thickness less than 120 feet (36 m).

Locally, large (up to 15 feet [5 m] diameter), subrounded boulders of Farmington Canyon Complex are conspicuous in outcrop and in aerial photography, particularly along the lakeward edges of shorelines. These boulders were likely derived from rockfall and slope failure upslope prior to and during the Lake Bonneville transgression and were subsequently rounded by wave action.

Lacustrine deposits, undivided – Mapped below the Provo shoreline where these deposits may be related to the transgressive, regressive, or both phases of Lake Bonneville.

Qlf **Lacustrine silt and clay** (upper Pleistocene) – Interbedded deposits of moderately to well-sorted silt and clay; locally may contain sand; typically thin bedded; downslope of and likely laterally equivalent to parts of regressive alluvial (Qafp) and deltaic deposits (Qldp); mapped in southwest corner of quadrangle; estimated thickness 20 feet (6 m).

Qls **Lacustrine sand and silt** (upper Pleistocene) – Moderately to well-sorted, subrounded to rounded, fine to coarse sand and silt with minor pebbly gravel; thin to thick bedded; commonly ripple laminated with some planar bedding and minor channel features; may grade laterally and vertically into Qlg; mapping and unit designation after Nelson and Personius' (1993) "Lacustrine sand, undivided" (lbps); estimated thickness less than 60 feet (20 m).

Qlg, Qlg?

Lacustrine gravel and sand (upper Pleistocene) – Moderately to well-sorted, clast- to matrix-supported, pebble to cobble gravel in a matrix of sand and pebbly sand; locally interbedded with thin beds and lenses containing sand, silt, and clay; clasts commonly subrounded to rounded; may grade laterally and vertically into Qls; mapping and unit designation after Nelson and Personius' (1993) "Lacustrine sand and gravel, undivided" (lbpg); queried where uncertain of unit designation; estimated thickness less than 60 feet (20 m).

Glacial Deposits

Upper to middle(?) Pleistocene glacial features and deposits are present in the upper reaches of most north-, northeast-, and east-facing drainages in the quadrangle above 8600 feet (2620 m) in elevation. Cirque headwalls and arêtes are carved into bedrock units. Glacial deposits include till of ground, end, recessional, and lateral moraines and may include a minor component of alluvial outwash. End, recessional, and lateral moraines form distinct curvilinear ridges. Non-symmetrical moraines have a steeper side that faces toward the former glacier. All glacial deposits are prone to slope failure due to their high clay content and locally include mass-movement deposits (Qms and Qmc) that are too small to show separately at map scale.

Two distinct glacial cycles are represented in the quadrangle that correlate to the wetter and/or colder Marine Oxygen Isotope Stages (MIS) 2 and 6. The youngest is the Pinedale glaciation, which is roughly correlative in age to MIS 2 (14 to 29 ka; Lisiecki and Raymo, 2005). In the Wasatch Range, maximum ice extent during the Pinedale glaciation occurred about 17.5–22 ka (Labbs and Munroe, 2016; Quirk and others, 2018, 2020). Deglaciation and minor moraine-building pauses occurred through about 13 ka (Labbs and others, 2011; Labbs and Munroe, 2016; Quirk and others, 2018, 2020). These ages coincide with ages of the Pinedale glaciation in the Wind River and Teton Ranges (about 13 to 30 ka; Gosse and others, 1995; Phillips and others, 1997; Pierce and others, 2018 and references therein).

Correlation of glacial advances and Lake Bonneville levels is complicated. Laabs and Munroe (2016) described the problems of relative timing of glacial advances and retreats and the rise and fall of Lake Bonneville. Based on ^{10}Be cosmogenic exposure ages and stratigraphic relationships between lake and glacial deposits, they reported that Pinedale terminal moraines at the mouths of Little Cottonwood and Bells Canyons were occupied near the time of or possibly before the Bonneville highstand around 18 ka and subsequently abandoned while the lake continued to overflow at the Provo level, consistent with stratigraphic studies of Godsey and others (2005). Quirk and others (2018) used coupled glacier energy–mass balance and ice-flow models to reconstruct glacier extents in Big and Little Cottonwood Canyons and American Fork Canyon and also showed that Pinedale glaciers reached and abandoned their maximum extent prior to the Bonneville highstand. Although undated, the proximity of the map area Pinedale-age glacial deposits to those of the central Wasatch Range suggests that they too reached their maximum extent about 18 ka.

The Bull Lake glaciation is roughly correlative in age to MIS 6 (130 to 191 ka; Lisiecki and Raymo, 2005). Bull Lake glacial deposits are typically higher on ridges and farther away from cirques, suggesting larger ice volumes during this glacial cycle than during the Pinedale. However, many of the Bull Lake glacial features were obliterated by the younger Pinedale glaciation. Minimal chronology data exist for the Bull Lake glaciation in the Wasatch Range. Quirk and others (2018) reported a ^{10}Be exposure age of 132.2 ± 5.9 ka from a striated bedrock surface in Big Cottonwood Canyon (about 20 mi [6 km] to the south of the quadrangle) and interpreted this as a minimum age for the onset of Bull Lake glacial retreat. Sharp and others (2003) and Pierce and others (2018, and references there in) suggest a Bull Lake glacial maxima of about 140 to 160 ka for the Wind River and Teton Ranges.

Qg, Qg?

Glacial deposits, undivided (upper to middle? Pleistocene) – Non-stratified, poorly sorted clay- to boulder-size sediment; mostly glacial till with some component of alluvial outwash; alluvial component is better sorted and bedded than till and is similar to map unit Qal but is derived mainly from glacial till; mapped as undivided glacial because deposits lack distinct geomorphic shapes of end, recessional, and lateral moraines; mapped as undivided age because of lack of significant cross-cutting or geomorphic relationship to Pinedale (Qgmp) or Bull Lake (Qgmb) moraines (see discussion of ages of glaciation above [in booklet]); queried where uncertain if deposits are of glacial origin; estimated thickness up to 120 feet (35 m).

Qgmp, Qgmp?

Glacial moraines, Pinedale age (upper Pleistocene) – Till of ground, end, recessional, and lateral moraines; till is non-stratified, poorly sorted clay- to boulder-size sediment; mapped moraines have poorly to moderately developed soil and moderate to sharp moraine morphology; inset lateral and recessional moraines mapped within Qgmp suggest episodes of minor glacial advance or pauses during the Pinedale deglaciation, as described by Quirk and others (2018); multiple Pinedale-age moraines are present in upper Holbrook Canyon, Right Hand Fork of Shingle Mill Creek, Right Hand Fork of Authors Creek, and the Right Fork of Farmington Creek; queried where interpretation as end, recessional, or lateral moraine is uncertain; see discussion of ages of Pinedale glaciation above (in booklet); estimated thickness up to 120 feet (36 m).

Just east of Bountiful Peak and at Farmington Lakes are multiple recessional moraines that are mapped here as Qgmp and are interpreted to be recessional moraines of the Pinedale glaciation.

These moraines have a distinctly sharper morphology than the larger Qgmp moraines down drainage and laterally upslope and therefore could be related to a younger (Holocene) glacial cycle. However, the soil and vegetation development on these moraines is more similar to other Pinedale moraines downslope and it is likely that these cirques lacked the appropriate elevation and northly aspect to form glaciers during the Holocene.

Qgp, Qgp?

Glacial deposits, undivided, Pinedale age (upper Pleistocene) – Mostly glacial till with some component of alluvial outwash; till is non-stratified, poorly sorted clay- to boulder-size sediment; alluvial component is better sorted and bedded than till and is similar to map unit Qal but is derived mainly from glacial till; mapped as undivided glacial because deposits lack distinct geomorphic shapes of end, recessional, and lateral moraines; see discussion of ages of Pinedale glaciation above (in booklet); estimated thickness less than 60 feet (20 m).

Qgmb, Qgmb?

Glacial deposits and moraines, Bull Lake age (middle? Pleistocene) – Till of ground, end, recessional, and lateral moraines; till is non-stratified, poorly sorted clay- to boulder-size sediment; commonly heavily vegetated with well-developed soil; moraine morphology more subdued and dissected than Pinedale moraines (Qgmp); lateral moraines commonly directly downslope of mapped bedrock aretes and ridges between higher parts of cirques; mapped down drainage or laterally upslope from Pinedale moraines (Qgmp) and mapped laterally downslope from older glacial deposits (Qgo); mapped in Farmington Flats and upper part of Holbrook Canyon; queried where age designation is uncertain; see discussion of ages of Bull Lake glaciation above (in booklet); estimated thickness up to 120 feet (36 m).

Qgb, Qgb?

Glacial deposits, undivided, Bull Lake age (middle? Pleistocene) – Mostly glacial till with some component of alluvial deposits; till is non-stratified, poorly sorted clay- to boulder-size sediment; alluvial component is better sorted and bedded than till and is similar to map unit Qal but is derived mainly from glacial till; mapped as undivided glacial because deposits lack distinct geomorphic shapes of end, recessional, and lateral moraines; see discussion of ages of Bull Lake glaciation above (in booklet); queried where age designation is uncertain; estimated thickness less than 60 feet (20 m).

Mass-Movement Deposits

Qmsh, Qms

Landslide deposits (historical to upper? middle? Pleistocene) – Poorly sorted clay- to boulder-size material with some large (hundreds of cubic feet) bedrock blocks; includes slides, slumps, and debris-flow and flood deposits; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced blocks; composition depends on local sources but in this quadrangle is primarily Farmington Canyon Complex metamorphic rocks and the Wasatch Formation; Farmington Canyon Complex rocks are prone to sliding due to clay alteration of mica and amphibole crystals; morphology typically becomes more subdued with age but can also be a function of water content during emplacement; estimated thickness up to 120 feet (40 m).

Only two landslides are mapped as Qmsh (h for historical movement). One is in section 16, T. 2 N., R. 1 E. (Salt Lake Base Line and Meridian) along the Ward Canyon/Skyline Drive road. This landslide initiated in 2006 as a small slide that was reactivated in 2011 as a larger landslide (Rich Giraud, UGS, verbal communication, August 2018). The map shows the extent of the 2011 landslide and its prominent main scarp that is within the road switchback. The other landslide mapped as Qmsh is in lower Rudd Creek on the south side of the drainage (section 17, T. 2 N., R. 1 E). The landslide moved in 1983 (Brabb and others, 1989) and again in 2011 (Rich Giraud, UGS verbal communication, March 2019); the scar is still clearly visible on recent aerial imagery.

Several other landslides in the quadrangle mapped as Qms have similar fresh morphology and may have moved during the late Holocene, potentially during historical times, but there is no documentation of historical movement. However, Brabb and others (1989) documented over 120 small debris flows and debris avalanches that occurred in 1983 within the quadrangle. There were also debris flows and floods in 1986 and 1987 within the quadrangle as shown and described by Lowe (1990). All small slope failures, except the landslide in Rudd Creek mentioned above, are too small to show at map scale. Lowe (1989a, 1989b, 1989c, 1990) mapped and described slope-failure hazards for Davis County and labeled several slope failures in the Bountiful Peak quadrangle as "active" based on the classification of McCalpin (1984). Most "active" slope failures of Lowe (1989c) are debris slides and debris flows that are incorporated into units Qms, Qmc, or Qac on this map.

Landslides mapped as Qms (likely Holocene to upper Pleistocene) commonly have distinct morphological features such as main scarps, flanks, and toes that are conspicuous on slope-shade images of 0.5-meter lidar data (UAGRC, 2020, https://gis.utah.gov/data/elevation-and-terrain/). Landslides mapped as Qms may be in contact with other Qms landslides where distinct/different slides abut or are inset into larger landslide complexes. In most places these deposits deflect modern streams. In other places, like along the western range front, these deposits are both younger and older than the Bonneville shoreline occupation, indicating a gradational and overlapping age range with older landslide deposits (Qmso).

Landslides of all ages may continue to exhibit slow creep or are capable of renewed movement if stability thresholds are exceeded (Ashland, 2003). Vegetation and widespread colluvium may conceal unmapped landslides, and more detailed imaging techniques such as lidar may reveal evidence of creep or shallow landslides. Understanding the location, age, and stability of landslides and slopes requires detailed geotechnical investigations.

Qmso **Landslide deposits, older** (upper? to middle? Pleistocene) – Poorly sorted clay- to boulder-size material with some large (hundreds of cubic feet) bedrock blocks; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced blocks; predates the Bonneville shoreline occupation; estimated thickness up to 160 feet (50 m).

Mapped only between Ford Canyon (Ricks Creek) and Steed Creek (section 32, T. 3 N., R. 1 E.) where a distinct concave area of the mountain front above the Bonneville shoreline adjoins a prominent convex area below the Bonneville shoreline. Here, the toe of this landslide complex is covered by Lake Bonneville deposits (see stacked units) and is mostly in the Farmington 7.5' quadrangle (Lowe and others, 2018) in sections 30 and 31, T. 3 N., R. 1 E. The Bonneville and Provo shorelines do not change elevation as they cross the landslide mass but are deflected from their normal northwesterly trend in an arcuate pattern, suggesting the shorelines developed on the toe of the landslide mass and that the landslide predates Lake Bonneville, hence its designation as Qmso rather than simply Qms. Mapping by Nelson and Personius (1993) showed the Wasatch fault zone splays into many strands as it passes through landslides, as is the case in the toe of this particular landslide (see mapping in Farmington 7.5' quadrangle [Lowe and others, 2018]).

Qmt **Talus deposits** (Holocene) – Unsorted, angular to rounded cobbles to boulders with minor sand and silt; unconsolidated; clast supported; deposited on and at the base of steep, unvegetated slopes at the head of Right Fork of Shingle Mill Creek; primarily consists of clasts derived from Wasatch Formation (Tw); estimated thickness up to 30 feet (10 m).

Colluvial Deposits

Qc **Colluvial deposits** (Holocene to middle Pleistocene?) – Pebble, cobble, and boulder gravel, commonly clast supported, in a matrix of sand, silt, and clay; clasts commonly angular to subangular, but includes some subrounded to rounded recycled lacustrine gravel below the Bonneville shoreline; unlithified; very poorly sorted, poorly stratified, locally derived; consists of residuum, slopewash, and soil creep deposits; may include landslides, rockfalls, and debris flows that are too small to map separately; mapped as small cones and debris aprons near the bottom of very small drainages and on hillsides; similar to Qac but mapped where drainage is poorly developed; similar to Qct but typically mapped on less steep slopes and where soil and vegetation are well developed; most bedrock is covered by at least a thin veneer of colluvium, but only the larger, thicker (> 3 feet [1 m]) deposits are mapped; estimated thickness up to 30 feet (10 m).

Mixed-Environment Deposits

Qct **Colluvial and talus deposits, undivided** (Holocene to upper Pleistocene?) – Unsorted, unstratified, angular to subangular pebbles, cobbles, and boulders with variable component of sand, silt, and clay; unlithified; locally derived; deposited on steep, partially vegetated slopes by slopewash, rockfall, and minor soil creep; commonly deposited on Bonneville shoreline bench and conceals the shoreline; also mapped in steeper parts of glacial cirques near Bountiful Peak, in upper parts of Holbrook Creek (derived from Tintic Quartzite [Ꞓt]), and in Deep Creek near Mahogany Ridge; estimated thickness up to 30 feet (10 m).

Qac **Alluvial and colluvial deposits, undivided** (Holocene to middle Pleistocene?) – Poorly to moderately sorted, angular to rounded, poorly to well stratified, clay- to boulder-size sediment; aggraded deposits in bottoms of drainages and on adjacent slopes; deposited by slopewash, soil creep, floods, and perennial streams; includes debris flows, talus, stream deposits, alluvial-terrace deposits, earthflow deposits, small fans, and minor landslides that are too small to map separately; incised 0 to 12 feet (0–4 m) by modern drainages; estimated thickness up to 60 feet (20 m).

Qmc **Mass-movement and colluvial deposits, undivided** (Holocene to upper Pleistocene?) – Poorly sorted to unsorted clay- to boulder-size material; mixed landslide, slump, slopewash, and soil creep that are gradational into one another; typically have a hummocky appearance on lidar slope-shade images; lacks clear landslide scarps and flanks; thickness 0 to 30 feet (0–10 m).

Qla **Lacustrine and alluvial deposits, undivided** (Holocene to upper Pleistocene) – Sand, silt, and clay with minor pebble and cobble gravel in areas of mixed alluvial and lacustrine deposits that cannot be shown separately at map scale because deposits are gradational into each other or thin patches of one unit overlie the other (most commonly alluvial deposits overlying lacustrine deposits); mapped below Provo shoreline in the flat parts of the valley near section 20, T. 2 N., R. 1 E.; estimated thickness up to 40 feet (12 m).

Qlm **Lacustrine and marsh deposits, undivided** (Holocene) – Organic-rich silt and clay with minor sand and pebbles; likely some boulders derived from rockfall and colluvium upslope; deposited in lakes, ponds, marshes, and other wetlands in and around Farmington Lakes; commonly wet, but seasonally dry; estimated thickness less than 30 feet (10 m).

Stacked-Unit Deposits

Stacked units are mapped where Lake Bonneville deposits have been deposited on older landslide deposits (Qmso) concealed beneath a thin sedimentary cover of lacustrine units.

Qlsp/Qmso

Lacustrine sand and silt of regressive phase of Bonneville lake cycle over older landslide deposits (upper Pleistocene/upper to middle? Pleistocene) – Qlsp: Moderately to well-sorted, subrounded to rounded, fine to coarse sand and silt with minor pebbly gravel; commonly ripple laminated to very thick bedded with some planar bedding; mostly wavy to subhorizontal bed sets with minor channel features; commonly interbedded with or laterally gradational into lacustrine gravel and sand (Qlg); exposed thickness less than 60 feet (20 m). Qmso: Poorly sorted clay- to boulder-size material with some large (hundreds of cubic feet) bedrock blocks; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced blocks; predates the Bonneville shoreline occupation; estimated thickness up to 160 feet (50 m).

Qlgb/Qmso

Lacustrine gravel and sand of transgressive phase of Bonneville lake cycle over older landslide deposits (upper Pleistocene/upper to middle? Pleistocene) – Qlgb: Moderately to well-sorted, clast- to matrix-supported, pebble to cobble gravel with boulders in places in matrix of sand and pebbly sand; locally planar and cross-bedded; locally interbedded with thin beds and lenses containing sand, silt, and clay; clasts commonly subrounded to rounded, but some deposits consist of poorly sorted, angular gravel derived from nearby bedrock outcrops; typically overlies bedrock near the foot of Wasatch Range, some small exposures of bedrock within this unit have been omitted because they are too small to show at map scale; estimated thickness less than 120 feet (36 m). Qmso: Poorly sorted clay- to boulder-size material with some large (hundreds of cubic feet) bedrock blocks; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced blocks; predates the Bonneville shoreline occupation; estimated thickness up to 160 feet (50 m).

Qls/Qmso

Lacustrine sand and silt of Lake Bonneville over older landslide deposits (upper Pleistocene/upper to middle? Pleistocene) – Qls: Moderately to well-sorted, subrounded to rounded, fine to coarse sand and silt with minor pebbly gravel; thin to thick bedded; commonly ripple laminated with some planar bedding and minor channel features; may grade laterally and vertically into Qlg; mapping and unit designation after Nelson and Personius' (1993) "Lacustrine sand, undivided" (lbps); estimated thickness less than 60 feet (20 m). Qmso: Poorly sorted clay- to boulder-size material with some large (100s of cubic feet) bedrock blocks; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced blocks; predates the Bonneville shoreline occupation; estimated thickness up to 160 feet (50 m).

Major unconformity

PALEOGENE

Tn, Tn? **Norwood Formation** (lower Oligocene? to Eocene) – Typically light-gray to light-brown, altered tuff, claystone, siltstone, sandstone, conglomerate, and minor limestone; only present in the northeast corner of the quadrangle. The exposures are on private land that the author could not access, hence this description is modified from previous mapping and observations in the surrounding areas (Bryant, 1990; Coogan and others, 2015; Coogan and King, 2016; King and McDonald, 2021): may have beds of unaltered tuff and volcanic-clast conglomerate similar to adjacent Porterville quadrangle; variable calcareous cement; zeolitization and alteration is less common to south; unaltered tuff is present in the adjoining Porterville and East Canyon Reservoir quadrangles; typically weathers into low-relief hills; unconformable lower contact with Wasatch Formation (Tw); queried where identification uncertain and may be Tw; corrected K-Ar isotopic ages are 38.4 Ma (sanidine) from a sample taken along Utah Highway 66 near the Norwood type area (Evernden and others, 1964) to the east in the north part of the Porterville quadrangle, and 39.3 Ma (biotite) from farther south in a different depositional basin, the East Canyon graben, East Canyon Reservoir quadrangle (Mann, 1974); Bryant (1990) reported a thickness of approximately 3300 feet (1000 m) in the south end of Morgan Valley near Porterville, which is likely representative of the thickness only in the east limb of the Morgan Valley syncline (Coogan and others, 2015); approximate exposed thickness in the quadrangle is 250 feet (75 m).

Unconformity

Tw, Tw?

Wasatch Formation (Eocene to upper Paleocene) – Light-red, light-gray, grayish red-purple, moderate reddish-orange to pale-brown, moderately to well-indurated conglomerate, sandstone, calcareous sandstone, and minor siltstone; conglomerate beds with some interbedded sandstone commonly dominate the lower part of the unit, grading into mixed lithologies typical of the upper parts of the unit; conglomerate beds are up to 9 feet (3 m) thick, clast- to matrix-supported, with subangular to rounded pebbles to cobbles and occasional large (6 feet [2 m]) boulders; conglomerate clasts are dominantly quartzite, well-indurated gray sandstone, limestone, minor chert, and locally metamorphic and intrusive rocks of the Farmington Canyon Complex; clast assemblages are a mix of sandstone, limestone, and quartzite sourced from the footwall and stratigraphically lower parts of the hanging wall of the Willard thrust sheet; conglomerate matrix is reddish brown, moderately sorted, medium sand with some silt and clay; conglomerate beds commonly have channel-shaped geometries, and fine upward into pebble conglomerate and sandstone; sandstone beds are thin to very thick bedded with planar laminations to structureless, poorly to well sorted, fine to coarse grained, and moderately to well indurated; sandstone composed of rounded quartz and black chert grains, angular grains of gray limestone, and variably colored lithic fragments; forms heavily vegetated rubbly slopes with coarser beds typically forming ribs and ledges; unconformable lower contact that may buttress north and west onto the residual paleotopography of the Wasatch anticlinorium; locally includes landslides, slumps, and colluvium that are too small to show separately; queried where not visited in the field and interpretation as Tw from stereo photographs is uncertain.

Palynomorph data from Wasatch strata to the northeast in the Ogden 30' x 60' quadrangle (Coogan and King, 2016), and to the east in the Salt Lake City 30' x 60' quadrangle (Nichols and Bryant, 1990), yielded late Paleocene to Eocene ages. McKean and others (2016) reported a detrital zircon age of 48.47 ± 0.76 Ma (middle Eocene) from the upper part of a package of conglomeratic rocks exposed on the Salt Lake salient that are tentatively correlated to the Wasatch Formation (Anderson and McKean, 2018).

Thickness of the Wasatch Formation in the quadrangle is difficult to determine because it was deposited across hilly topography that developed prior to deposition, and because the base is commonly faulted in the map area. Thickness is estimated to vary from 500 to 2300 feet (150–700 m) in the quadrangle. King and McDonald (2021) reported map-based thicknesses ranging from 1250 to 2700 feet (380–830 m) in the neighboring Peterson quadrangle. Bryant (1988) reported 1320 feet (400 m) north of the map area, and 3960 feet (1200 m) to the south (including his Twc).

Unconformity

CRETACEOUS

Keh **Hams Fork Member of Evanston Formation** (Upper Cretaceous, Maastrichtian to Campanian) – Unconsolidated, poorly to moderately sorted cobbles to boulders with minor component of pinkish sand, silt, and clay; cobbles and boulders are subangular to rounded, range in size from small cobbles to boulders up to 9 feet (3 m) (along their long axis); dominantly quartzite clasts with minor amounts of Farmington Canyon Complex metamorphic rocks, black chert, moderately indurated sandstone, and rare basalt; forms conspicuous, large, stepped surfaces on crest of Wasatch Range in sections 18 and 19, T. 2 N., R. 2 E. that dip gently north-northeast; escarpments between the stepped surfaces are 30 to 45 feet (10–15 m) high and separate minor variations in clast composition, possibly suggesting each step is a different depositional pulse; aside from stepped surfaces there is no evidence of any planar fabric; unconformable lower and upper contacts; mapped by

Bryant (1990) as "Wasatch Formation, conglomerate dominant" (his Twc) in both faulted and depositional juxtaposition with older rocks; includes small landslides and colluvial deposits too small to show at map scale; estimated approximately 160 feet (50 m) thick, but possibly up to 400 feet (120 m).

Clast lithology and size are indicative of the origin and age of these deposits. Some quartzite clasts are white, yellowish gray, or tan with minor reddish streaks, and can be conglomeratic with clasts of white or red chert pebbles. These quartzite clasts appear similar to exposed Tintic Quartzite in the quadrangle. Other quartzite clasts are variegated white, pink, red, brown, purple, or greenish black likely sourced from the Geertsen Canyon Quartzite, Mutual Formation, Caddy Canyon Quartzite, and other Neoproterozoic quartzites of the Willard thrust sheet (see Coogan and King, 2016, for descriptions of these units). The rare basalt clasts are interpreted to be sourced from the Neoproterozoic Browns Hole Formation, also found only in the hanging wall of the Willard thrust sheet (Coogan and King, 2016). Some Neoproterozoic quartzite boulders are up to 9 feet (3 m) long, suggesting a proximal source or reworking of a proximally sourced deposit. The nearest exposure of the Willard thrust sheet is currently ~20 miles (32 km) to the north. The most reasonable timing to erode and transport large clasts from the Willard thrust sheet is pre-Paleocene when the Wasatch anticlinorium was at its peak structural height and now-eroded rocks of the Willard thrust sheet were likely much closer to the location of the deposit (see Yonkee and Weil, 2011, and Coogan and King, 2016, for further discussion of Wasatch anticlinorium and rocks of the Willard thrust sheet). Clast composition of this unit matches that of what has recently been identified as conglomerate facies of Hams Fork Member of Evanston Formation in the neighboring Mountain Dell and Fort Douglas quadrangles just south of the quadrangle border (Anderson and others, in preparation). These rocks are part of a package of synorogenic deposits that progressively onlap the Wasatch anticlinorium in a northwestward buttressing relationship.

Major unconformity

MISSISSIPPIAN AND DEVONIAN – Mississippian Gardison and Deseret Limestones and Devonian Stansbury and Fitchville Formations are not exposed in the quadrangle but are likely present beneath the Wasatch Formation (Tw) in the southeast part of the quadrangle. These units are exposed immediately to the south in the Fort Douglas 7.5' quadrangle (Van Horn and Crittenden, 1987; Anderson and others, in preparation). Ordovician and Silurian strata are missing at a major regional unconformity below Devonian rocks (Hintze, 1959; Rigby, 1959).

Major unconformity

CAMBRIAN

Ꞓns **Nounan and St. Charles Formation, undivided** (Upper Cambrian) – Gray- to light-gray dolomite and minor sandy dolomite that weathers light gray to white; medium to thick bedded with some wavy laminations and mottled shale partings; lower contact is abrupt and placed above a boundstone bed of the Bloomington Formation where rocks rapidly transition from limestone to dolomite; thick-bedded, vuggy, gray dolomite overlain by a light gray to white horizon of sandy dolomite that may be equivalent to parts of the Worm Creek Quartzite (not mapped in this area) and the approximate contact between the Nounan and St. Charles Formations; forms steep blocky slopes and cliffs; not mapped by Byrant (1988) as a separate unit and was likely included in his Maxfield Formation; likely included in the upper part of Van Horn and Crittenden's (1987) "dolomitic unit" of the Maxfield Limestone; Lochman-Balk's (1976) figure 2 shows a dolomitic unit at the top of a Parleys Canyon stratigraphic column as Upper Cambrian, which may be equivalent to the newly mapped Nounan and St. Charles Formations of this report; Oviatt (1986) reported the upper Nounan in the Wellsville Mountains (allochthonous strata in the Willard thrust sheet) is Dresbachian (Upper Cambrian) based on *Dunderbergia*(?) and *Crepicephalus* zone trilobite fauna; Taylor and others (1981) reported an earliest Ordovician and Late Cambrian age for the St. Charles Formation in the Bear River Range (upper plate of Willard thrust) based on trilobite and conodont fossils, but here the upper part may be eroded due to the Ordovician Tooele Arch and/or the Devonian Stansbury uplift (see Hintze, 1959; Rigby, 1959); upper part and contact with the Devonian Stansbury Formation are not exposed in the quadrangle but are exposed about 0.75 mi (1.2 km) to the south in the neighboring Fort Douglas 7.5' quadrangle (Van Horn and Crittenden, 1987; Anderson and others, in preparation) where map patterns suggest a total thickness of 1000 feet (300 m); at least 510 feet (150 m) exposed in this quadrangle.

Ꞓb **Bloomington Formation** (Middle Cambrian) – Light-gray to light-brown, moderate yellowish-brown, light olive-brown to light-olive calcareous shale, shaley limestone with interbeds of limestone; limestone is mottled with shale partings; thin to medium bedded, commonly micritic, with some oolites, oncolites, "twiggy" structures, thrombolites, and "flat pebble conglomerates" (as described in Lochman-Balk [1976]); shales form slopes and swales, limestones form ledges and ridges; upper-most beds marked by resistant boundstone unit with abundant fossil hash; lower contact with the Maxfield Formation is gradational and mapped at the lowest shale over six feet (2 m) thick; in the Wellsville Mountains (allochthonous strata in the Willard thrust sheet), the Bloomington Formation is Middle Cambrian (*Bolaspidella* zone; Oviatt, 1986; Jensen and King, 1996); in Ogden Canyon (autochthonous strata in the footwall of the Willard thrust), Rigo (1968) reported *Eldoradia* sp. trilobite fossils from the Bloomington Formation, suggesting the Bloomington Formation of the Wellsville Mountains may be equivalent to parts of what is mapped as Maxfield Limestone in Ogden Canyon and this quadrangle; Yonkee and Lowe (2004) reported a thickness of 100 to 200 feet (30–60 m) in the Ogden 7.5' quadrangle to the north; in this quadrangle, map pattern suggests a thickness of about 310 to 350 feet (90–110 m).

This unit has previously not been mapped in this part of the Wasatch Range (see Bryant, 1988, 1990, and discussion below in Ꞓmu description). The Bloomington Formation in the map area is equivalent to the upper part of what Van Horn and Crittenden (1987) mapped as a "lower limestone unit" of the Maxfield Limestone (their Ꞓml). The sequence of interbedded shales and limestones described here, and the stratigraphic location of the unit are similar to the Bloomington Formation described and mapped in Ogden Canyon (Yonkee and Lowe, 2004; King and others, 2008), but differ slightly in thickness and total shale content.

Maxfield Limestone

Bryant (1988, 1990) mapped all Cambrian limestones and shales above the Ophir Formation (Ꞓn, Ꞓb, Ꞓmu, Ꞓmm, Ꞓml of this report) as Maxfield Limestone (his Ꞓm); Van Horn and Crittenden (1987) mapped a "lower limestone and shale" unit of the Maxfield Limestone (their Ꞓml) that is likely equivalent to this report's Bloomington Formation (Ꞓb) and all units of the Maxfield Formation (Ꞓmu, Ꞓmm, Ꞓml). In this report the Maxfield Limestone is separated into three informal units after Yonkee and Lowe (2004).

Ꞓmu **Maxfield Limestone, upper limestone unit** (Middle Cambrian) – Dark-gray to gray mottled limestone with minor moderate orange-pink, light-red, grayish yellow-green shale partings; well bedded, thick bedded to wavy laminated; abundant "twiggy" structures (as described in Lochman-Balk [1976]) that are more apparent on weathered surfaces; limestone mostly micritic with some oolitic beds, oncolites, fossil hash, and rare "flat pebble conglomerate" (as described in Lochman-Balk [1976] and Yonkee and Lowe [2004]); generally forms a ridge between Ꞓmm and Ꞓb; lower contact is gradational through a transitional interval of about 6 feet (2 m); Robison (1976, figure 2) showed a Middle Cambrian age for limestone strata overlying the Ophir Formation in the Wasatch Range, but this may be based on correlation rather than paleontological samples; Yonkee and Lowe (2004) reported a thickness of 330 to 500 feet (100–150 m) in the Ogden 7.5' quadrangle; map pattern suggests a thickness of about 200 feet (60 m).

Ꞓmm **Maxfield Limestone, middle mixed unit** (Middle Cambrian) – Mostly gray to black argillaceous shale, limey shale, and shaley limestone that weather light-gray to pale yellowish-orange; well bedded; thick bedded and structureless to ripple laminated; limestone content increases up section; nodular limestone mottled with shale is present near the top of the unit; forms a dark recessive swale; lower contact is gradational through a transitional interval of about 3 feet (1 m); Robison (1976, figure 2) showed a Middle Cambrian age for limestone strata overlying the Ophir Formation in the Wasatch Range, but this may be based on correlation rather than paleontological samples; Yonkee and Lowe (2004) reported a thickness of 130 to 260 feet (40–80 m) in the Ogden 7.5' quadrangle to the north; in this quadrangle map pattern suggests a structurally attenuated thickness of about 250 to 340 feet (80–105 m).

Ꞓml **Maxfield Limestone, lower limestone unit** (Middle Cambrian) – Medium light-gray, dark-gray, to very pale blue, mostly microcrystalline limestone with oolitic beds and boundstone; well-bedded, very thin to medium-bedded sets that are commonly wavy; limestone is commonly mottled with pale to dark yellowish-orange siltstone and shale partings; forms distinctive resistant blue-gray ridge; lower contact is gradational over about 3 feet (1 m) and is placed above the last shale of the Ophir Formation; in strata of Ogden Canyon, Rigo (1968) reported *Bathyuriscus* sp., *Elrathia* sp., *Peronopsis* sp., and *Ptychagonstus* sp. trilobite fossils in the basal limestone of the Maxfield Formation as mapped by Yonkee and Lowe (2004); Yonkee and Lowe (2004) reported a thickness of 130 to 260 feet (40–80 m) in the Ogden 7.5' quadrangle; in this quadrangle, map pattern suggests a thickness of about 160 to 200 feet (48–60 m).

Ꞓo **Ophir Formation** (Middle Cambrian) – Grayish-green to grayish yellow-green, grayish orange, light- to dark-gray, sometimes with a metallic (phyllitic-micaceous) sheen, thinly laminated to medium-bedded shale and argillite with a medial mottled shaley limestone and minor sandy limestone; where exposed, micaceous shale is commonly fissile with thin, wavy laminations; limestone beds are mottled with pale yellowish-orange shale partings; commonly poorly exposed and forms heavily vegetated swales; lower contact is gradational and is mapped just above the last sandstone of the Tintic Quartzite; Rigo (1968) reported an early Middle Cambrian age for the lower part of the Ophir in Ogden Canyon based on *Ehmaniella* sp., *Alokistocare* sp., and *Zachanthoides* sp. trilobites; Bryant (1988) reported a thickness of 495 to 660 feet (150–200 m); in this quadrangle, map pattern suggests a thickness of 300 to 380 feet (90–115 m).

The Ophir Formation commonly exhibits a tri-part stratigraphy: an upper shale unit, a medial micritic and mottled shaley limestone unit, and a lower argillaceous shale unit. These units are not distinguishable in the Bountiful Peak quadrangle but are discernable and mappable to the south in the adjacent Fort Douglas quadrangle (Anderson and others, in preparation) as well as in the Ogden 7.5' quadrangle to the north (Yonkee and Lowe, 2004).

Ꞓt **Tintic Quartzite** (Middle and Lower? Cambrian) – Dominantly white, with less common yellowish- to pinkish-gray, grayish orange-pink, grayish-pink, and moderate red to red-purple, well-indurated, orthoquartzitic sandstone and conglomerate with minor argillaceous siltstone and shale; well bedded with thin laminations in shale and siltstone and very thin to thick bedding in sandstone and conglomerate; conglomerate beds vary from matrix to clast supported with quartz sandstone matrix and clasts of well-rounded pebbles and cobbles of white, grayish red-purple, and very dark red chert and quartzite; sandstone is fine to very coarse grained, quartz arenite with planar beds and trough and planar-tabular cross-beds; pale-purple to dark-gray argillaceous siltstone and shale beds, common in base and top of unit, are typically thinly bedded, ripple-laminated, and contain minor muscovite; forms light-colored, blocky, resistant ridges and prominent outcrops; basal contact with Farmington Canyon Complex rocks is sharp, unconformable, and locally has up to 20 feet (6 m) of relief; trace fossils in the upper part of the formation in the Ogden Canyon area include *Skolithus* tubes and *Plagiogmus* traces that indicate Middle Cambrian age (Peterson and Clark, 1974); Robison (1976) reported an Early and/or Middle Cambrian age for the Tintic Quartzite in the Wasatch Range; however, as noted in Lochman-Balk (1976), Robison (1976) did not present any fossils to support these ages; Bryant (1988) reported a thickness of 1980 feet (600 m) at the south end of the map area; map pattern suggests a complete thickness of about 1500 feet (450 m) near the south end of the quadrangle.

Major unconformity

PROTEROZOIC

The Farmington Canyon Complex is a suite of metamorphic rocks that include schist, paragneiss, orthogneiss, quartzite, with some phyllite, mylonite, and discontinuous bodies of amphibolite and pegmatite (Bryant, 1988). Peak metamorphism occurred about 1.7 Ga, reaching upper amphibolite facies, with retrograde metamorphism taking place during the Cretaceous Sevier orogeny when these rocks were largely exhumed in the core of the Wasatch anticlinorium (Barnett and others, 1993; Nelson and others, 2009; Yonkee and others, 2014). Metamorphic grade generally increases to the north in the map area, as described and mapped by Bryant (1988), Yonkee and Lowe (2004), and Coogan and King (2016). Age of protoliths for metasedimentary rocks ranges from Archean (<3.5 Ga) to Paleoproterozoic (>1.6 Ga), representing a diverse and complex source area (Hedge and others, 1983; Andreasen, 2007; Nelson and others, 2011; Muller and others, 2011; Rasmussen and others, 2022). Metaigneous rocks are consistently Paleoproterozoic (~2.4 – 1.7 Ga) (Hedge and others, 1983; Barnett and others, 1993; Nelson and others, 2002, 2011; Muller and others, 2011; Rasmussen and others, 2022).

I map five informal units after Bryant (1988). The units are listed in order of abundance in the map area. Contacts between some units are gradational, hard to distinguish in the field, and mostly follow the mapping of Bryant (1988), with contributions from Andreasen (2007). Gloyn and others (1995) reported minor precious metal mineralization in quartz veins, minor faults, and shear zones. The thickness of the Farmington Canyon Complex and most sub-units is unknown due to lack of structurally deeper exposures anywhere in the Wasatch Range or in drill hole data, and because of the shape and nature of the contacts between the sub-units. The thickness of the pegmatite unit (Xfcp) can be estimated from map patterns because it is primarily composed of layered dikes (see unit description below). All units are commonly covered by thin to thick veneers of colluvium and soil, and likely contain landslides and debris flows that are too small to map at the target scale.

Xfcgs **Farmington Canyon Complex, gneiss and schist** (Paleoproterozoic) – Grayish yellow to moderate-brown, dusky- to pale-green, light olive-gray to greenish gray, and dark-gray biotite-feldspar-quartz gneiss, muscovite- and biotite-schist, sillimanite-garnet-biotite schist, pegmatite, and minor quartzite and amphibolite; mylonite and migmatite with garnet and sillimanite are more common in the north part of the quadrangle, consistent with the pattern of metamorphic grade increasing to the north, as described by Bryant (1988); forms both cliffs and slopes; internal contacts are sharp to diffuse and are commonly concordant with foliation and cleavage; mylonitic zones are present but contacts are diffuse and difficult to map.

Xfcmr **Farmington Canyon Complex, mylonitic gneiss and schist with retrograde metamorphism** (Paleoproterozoic) – Grayish yellow to moderate-brown, dusky- to pale-green, light olive-gray to greenish gray mylonitic gneiss and phyllite with some areas of other Farmington Canyon Complex lithologies; chlorite, epidote, and albite common; most rocks show some degree of retrograde chloritic alteration and some have pervasive phyllonitization; however, not all areas in the map unit are strained and highly altered; mapped separately as KXc by King and others (2008) and King and McDonald (2021), and as "areas of sheared and retrogressively metamorphosed rock" by Bryant (1988); alteration is likely a result of strain during retrograde metamorphism in the Cretaceous when these rocks were deformed (Bryant, 1988; Yonkee, 1992; Yonkee and others, 1997, 2003; Yonkee and Lowe, 2004; Yonkee and Weil, 2011).

Xfcq **Farmington Canyon Complex, quartzite, gneiss, and schist** (Paleoproterozoic) – Light-brown, very pale orange, medium-gray to grayish yellow, fine- to medium-grained quartzite with interlayered paragneiss and schist; similar to Xfcgs but with more abundant quartzite and less sillimanite and garnet-bearing schist and gneiss; forms cliffs and slopes; contacts with Xfcgs are gradational.

Xfcp **Farmington Canyon Complex, pegmatite, gneiss, and schist** (Paleoproterozoic) – Generally white, yellowish gray, pale yellowish orange, and light-pink, coarse-grained mica-feldspar-quartz pegmatite with minor schist, gneiss, and quartzite; feldspars are plagioclase and microcline with individual crystals up to 5 inches (13 cm); veins and books of biotite and muscovite; contacts with surrounding metamorphic rocks are mostly sharp where dikes cut across foliation but can be diffuse where pegmatite layers are concordant with foliation; only larger pegmatite dikes, veins, and pegmatite-rich bodies are mapped; smaller pegmatite veins, dikes, and layers are lumped into other Farmington Canyon Complex units; outcrops tend to be slightly lighter in color and more resistant than surrounding units; commonly forms cliffs and ridges; thickness of veins and dikes up to 60 feet (20 m); thickness of pegmatite-rich bodies of rock estimated up to 800 feet (240 m) in NW1/4, section 34, T. 3 N., R. 1 E.

Xfca **Farmington Canyon Complex, amphibolite** (Paleoproterozoic) – Black, greenish-black, to dark-gray lenses and pods of hornblende-plagioclase amphibolite; metamorphic fabrics are typically poorly developed; only the largest pods are mapped and based on Bryant (1988); small lenses and pods occur in other Farmington Canyon Complex units; forms slopes and ledges; contacts with other Farmington Canyon Complex units are indistinct and gradational; as described by Yonkee and Lowe (2004), the amphibolite pods may represent metamorphosed gabbro that was intruded into Xfcgs during later stages of metamorphism, or xenoliths of older amphibolite dikes.

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