Interim Geologic Map of the Gooseberry Creek Quadrangle, Sevier County, Utah

by

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OVERVIEW

Exposed bedrock in the Gooseberry Creek 7.5' quadrangle ranges from late Cretaceous (Campanian) to Oligocene in age (representing deposition from 77 to 25 million years ago) and includes the Blackhawk, Castlegate, Price River, North Horn, Flagstaff, Colton, Green River, and Crazy Hollow Formations, and two volcanic units, the latite of Johnson Valley Reservoir and the tuff of Albinus Canyon. Quaternary surficial deposits of Holocene and Pleistocene age include alluvium, mass-movement, and mixed-environment deposits. Rocks in the western part of the quadrangle dip westward on the steep flank of the westward-facing Wasatch monocline; the Water Hollow normal fault zone is in the eastern part of the quadrangle.

The Gooseberry Creek 7.5' quadrangle is located in central Utah, its northwest corner being about 9 miles (15 km) southeast of the town of Salina in the northwest corner of the Fish Lake Plateau. The terrain is mountainous with elevations between 6200 and 10,550 feet (1900–3215 m) above sea level. Private ranches are present in the northwest corner of the quadrangle, otherwise the remainder is part of Fish Lake National Forest. Principal access is via paved Forest Service Road 640 that extends southeasterly from Interstate Highway 70, which traverses the area about 3 to 4 miles (5–6 km) north of the north quadrangle boundary.

Spieker (1946, 1949) first described the Salina area geology in detail and was responsible for naming most of the formations of the region and defining its structural nature. Later, some of his students at Ohio State University worked in the quadrangle area and prepared theses as a part of their degree requirements: McGookey (1958, 1960) geologically mapped the quadrangle area, Bachmann (1959) discussed the Water Hollow fault zone, and Alexander (1965) also mapped the quadrangle area. Williams and Hackman (1971) included the area in their 1:250,000-scale map of the Salina 1° x 2° quadrangle area.

DESCRIPTION OF MAP UNITS

QUATERNARY

Q **Undifferentiated surficial deposits (Quaternary)** – Shown on cross section only.

Human Disturbance

Qhd **Disturbed ground (late Holocene)** – Areas that have been altered by humans, including dikes, small dams, and roads; variable thickness up to 40 feet (12 m); most Qhd is mapped where materials have obscured structural elements, formational contacts, and other geologic features; we did not map smaller features such as most road fill, small mine tailings, small quarries, and small water catchments.

Alluvial Deposits

Qal **Alluvial stream deposits (Holocene)** – Moderately sorted sand, silt, clay, gravel, cobbles, and boulders along small, wide, flat-bottomed stream channels; generally less colluvial or alluvial fan input than units Qac or Qacf; commonly contain volcanic debris; mapped in larger side drainages to Salina Canyon; up to 10 feet (3 m) thick.

Qaf, Qafo

Alluvial fans and local alluvium (Holocene to Pleistocene) – Unconsolidated, poorly sorted sand, silt, clay granules, cobbles, and sparse boulders; angular to subrounded; deposited as debris flows at the bases of steep slopes, cliffs, and at decreases in gradient along drainages at the mouths of some streams and washes; older dissected deposits in southwest and northeast corners mapped as Qafo and form poorly to well-defined fans and pediment-like surfaces; up to 30 feet (10 m) thick.

Qago **Older high-level alluvial gravel deposits (Pleistocene)** – Poorly to moderately sorted gravel containing rounded cobbles and pebbles; clasts are mostly quartzite, siliceous limestone, and well-cemented sandstone reworked from unknown Tertiary or Late Cretaceous conglomerate; cap a beveled bedrock surface (pediment) at the head of Dead Horse Canyon; may be remnant of older widespread deposit that covered most bedrock in the eastern half of the quadrangle; where Qmcs deposits are thin, similar gravels are locally present at the base of some deposits; 10 to 40 feet (3–12 m) thick.

Mixed Deposits

Qatc **Alluvial and colluvial terrace deposits (Holocene to late? Pleistocene) –** Terraces flanking Gooseberry Creek composed mostly of volcanic stream and fan alluvium, and colluvium; clasts subrounded to angular; poorly sorted; locally similar in composition to Qcv; colluvium more prevalent on flanks and upper parts of deposits; 5 to 20 feet (2–6 m) thick.

Qac **Mixed alluvium and colluvium (Holocene)** – Moderately to poorly sorted sand, silt, clay, gravel, cobbles, and boulders in small ephemeral canyons and washes with abundant colluvial contribution from side slopes; commonly contains volcanic debris; small drainages are dry most of the year but are active during rainstorms and spring run-off; similar to Qacf deposits but generally have smaller alluvial fan component; up to 10 feet (3 m) thick.

Qacf **Mixed alluvium, colluvium, and alluvial fan deposits (Holocene to late Pleistocene)** – Moderately to poorly sorted sand, silt, clay, gravel, cobbles, and boulders in small ephemeral canyons and washes with abundant colluvial contribution from side slopes and small alluvial fans from side washes and gullies; small drainages are dry most of the year but are active during rainstorms and spring run-off; similar to Qac deposits but generally have larger alluvial fan component; up to 10 feet (3 m) thick.

Qacl **Mixed alluvium, colluvium, and lacustrine deposits (Holocene to Pleistocene)** – Poorly sorted clay, silt, sand, and pebbles with some cobbles; common in hollows on gentle slopes and in undrained depressions mostly on mass-movement deposits; similar to Qac and Qacf deposits but generally include thin lake or marsh deposits in shallow closed depressions (mostly on landslides) and human-made reservoirs; up to 10 feet (3 m) thick.

Mass-Movement and Colluvial Deposits

Qcv **Volcanic colluvium (Holocene to middle Pleistocene)** – Mostly volcanic debris; clasts subrounded to angular; poorly sorted; overall, unit is light- to dark-gray; similar to Qmcs, but includes fewer landslide deposits; some deposits cap separate geomorphic surfaces including small benches and pediments, others mantle broad slopes and hills; these surfaces are commonly at higher levels than most alluvial fan and terrace deposits; primarily composed of volcanic boulders, but have smaller amounts of sand, cobbles, and silt; volcanic boulders can exceed 10 feet (3 m) in diameter; where deposits are thin, bedrock material is worked into the deposit; calcic soil (caliche) coats bottom of some boulders; 5 to 20 feet (2–6 m) thick.

Qmcs **Colluvium and landslide deposits (Holocene to early Pleistocene)** – Poorly sorted, mostly angular debris that covers bedrock; generally more eroded than Qmr; mostly sedimentary clasts; commonly form veneers on old bedrock surfaces; hummocky; include slope-creep, slopewash, debris flow, mud flow, and landslide deposits; mostly covers Flagstaff Formation; 5 to 20 feet (2–6 m) thick.

Qmt **Talus (Holocene)** – Unconsolidated angular volcanic rock debris on steep slopes; forms steep fan-shaped deposits derived from weathering of the adjacent cliff or ridge; at the base of volcanic cliffs in southern part of quadrangle; locally grade into other deposits; 10 to 20 feet (3–6 m) thick.

Qmsh **Historical landslides (late Holocene)** – Unconsolidated masses of poorly sorted mud, sand, and angular broken rock that have moved down steep slopes; surfaces of deposits have open fractures and are deformed; younger and smaller than Qms deposits; some are reactivated parts of Qms; deposits commonly form long narrow strips in and adjacent to gullies; perennial vegetation disturbed; commonly contain undrained depressions and springs; formed during consecutive years of higher-than-average precipitation; most in Water Hollow fault zone down-dip of a retreating resistant ledge; thickness varies.

Qms **Landslides and related debris flows (Holocene to Pleistocene)** – Unconsolidated masses of poorly sorted mud, sand, and angular broken rock that have moved down slope; display typical landslide morphology; most occur on weak slopes in the North Horn Formation and some show evidence of historical movement; locally include remobilized alluvial material in lower parts of deposit; hummocky upper surface with many small internal basins; landslides develop where weak, soft, clayey deposits underlie a hard layer (sandstone or limestone) that slumps or rotates down the dip slope and ends as lobate masses of disarticulated debris; shallow slides also develop where talus and debris accumulating from an overlying soft layer have broken away and slumped down the face of the more resistant ledges and cliffs; stands of quaking aspens commonly grow on these deposits; thickness varies.

Qmr **Rock glacier deposits (Holocene to Pleistocene)** – Large angular and blocky boulders in lobate heaps that crept downhill; derived from nearby volcanic cliffs; probably inactive rock glaciers, but may be landslides; rock glacier deposits have lobate features similar to landslides but contained an ice core when active; present at higher elevations in southern end of quadrangle; 10 to 30 feet (3–10 m) thick.

Tertiary

Tac **Tuff of Albinus Canyon (Oligocene)** – Welded trachyte tuff that caps the high plateau; 64% SiO_2 and 10% Na_2O+K_2O based on whole-rock chemical analysis; vesicular and finely crystalline; bluish-gray to gray; phenocryst-poor (3%–12%) dominated by plagioclase with some sanidine and pyroxene in a tuffaceous groundmass; forms resistant cliff; $^{40}Ar/^{39}Ar$ geochronologic analysis on whole rock from sample GC110309-2 yielded an age of 25.77± 0.14 Ma (Utah Geological Survey and Nevada Isotope Geochronology Laboratory, 2012a), which is slightly older than the $^{40}Ar/^{39}Ar$ single-crystal sanidine age of 25.13 ± 0.02 Ma from the Fish Lake area to the south (Utah Geological Survey and Nevada Isotope Geochronology Laboratory, 2012b); unit was called the trachyte of Lake Creek in the Fish Lake area to the south (Bailey and others, 2007), but regionally it correlates well with the previously named 25.5 Ma tuff of Albinus Canyon in the Richfield area to the west (Willis, 1986; Rowley and others, 1994; Cunningham and others, 2007); 150 to 1200 feet (50–450 m) thick.

Tjv **Latite of Johnson Valley Reservoir (Oligocene)** – Welded tuff or flow that partially caps the high plateau (58% SiO_2 and 7.5% Na_2O+K_2O); gray to black; phenocryst-rich (36%–46%); south of the quadrangle it has an $^{40}Ar/^{39}Ar$ age on plagioclase of 26.01±0.04 Ma (Utah Geological Survey and Nevada Isotope Geochronology Laboratory, 2012b); affinity to previously named unit not yet established but probably equivalent to part of 23 to 26 Ma Bullion Canyon Volcanics (Rowley and others, 1994; Bailey and others, 2007; Cunningham and others 2007); 300 to 1350 feet (100–450 m) thick.

unconformity

Tch **Crazy Hollow Formation (Eocene)** – Medium- to very coarse grained sandstone, pebble sandstone, mudstone, siltstone, and a lenticular basal pebble conglomerate (McGookey, 1958; Willis, 1986); grains and clasts are mostly mixed light (pale-yellow-gray to white) and dark (dark-brown-gray to black) chert and quartzite; overall unit is mostly brown-red to orange-red that contrasts with the light-gray-green Green River Formation below; top is not exposed but formation is estimated to be 600 to 800 feet (180–240 m) thick (Willis, 1986).

The Crazy Hollow Formation is a fluvial deposit with mudstones representing overbank deposits. McGookey (1960) reported that the formation gradually thins southward and is only about 300 feet (90 m) thick west of Lost Creek south of the Gooseberry Creek quadrangle. He indicated that the Crazy Hollow strata disconformably overlie those of the Green River Formation. The Crazy Hollow Formation is Eocene in age (Weiss and Warner, 2001; Judge, 2007).

Tgu **Upper Green River Formation (Eocene)** – Yellow-gray to light-gray limestone and calcareous shale; mostly thin to medium bedded; weathers slabby to blocky; some limestone is oolitic and cherty; forms massive cliffs above shallower light-green-gray slopes of lower member; typically forms two strong ledges or cliffs with an intervening shale slope; "cauliflower" texture limestone is present near the base of the unit, probably formed by algae; upper contact placed below the basal conglomerate of the Crazy Hollow; 700 feet (240 m) thick.

Tgl **Lower Green River Formation (Eocene)** – Interbedded light-green-gray limestone, calcareous sandstone, and laminated shale; forms poorly exposed steep slopes with scattered ledges; limestone is finely crystalline and commonly oolitic; less resistant than cliff-forming upper unit; 400 feet (120 m) thick.

The Green River Formation is a mainly lacustrine deposit that overlies the Colton Formation with a lower contact that is marked by the change to red-brown silty mudstone. The contact between Tgu and Tgl is placed below the cliffy yellow-gray to tan limestone deposits of the upper Green River unit. The unit is middle Eocene in age (Bryant and others, 1989; Remy, 1992; Judge, 2007; Smith and others, 2008).

Tc **Colton Formation (early Eocene)** – Interbedded mudstone, shale, limestone, and minor sandstone; mudstone and shale beds are generally mottled red-brown, purple-red, olive green, and gray; limestone is gray, yellow-gray and pink-gray; forms slope at the base of Green River Formation and above limestone ledges of Flagstaff Formation; 500 to 550 feet (150–170 m) thick.

The Colton Formation is commonly covered by surficial deposits in the Gooseberry Creek quadrangle, and forms valleys where ranching or agriculture has been established. The locally variegated siltstone and mudstone, along with the thin limestone deposits, indicate the Colton Formation is an interbedded fluvial-lacustrine deposit. McGookey (1960) reported the presence of various fossil genera of ostracods including *Heterocypris, Cyprois*, and *Cypris*. The Colton Formation is early Eocene in age (Franczyk and others, 1992; Judge, 2007; Dickinson and others, 2012), and is interbedded with the upper Flagstaff Formation.

Tf **Flagstaff Formation (early Eocene to Paleocene)** – Limestone, calcareous sandstone, conglomeratic sandstone, and sandy limestone; red-brown, gray, and very light gray; limestone is micritic to crystalline; contains three limestone ledges with sandy slopes in between; pelecypods, gastropods, and mollusks are found in the limestone beds; 800 to 1500 feet (240-460 m) thick.

The Flagstaff Formation is exposed along the west side of the Gooseberry Creek quadrangle, and in fault blocks on the east side in the Water Hollow fault zone. In the west the Flagstaff contains a dominant resistant ledge of sandstone near the top of the unit. However, slope-forming, red-brown, argillaceous limestone and calcareous siltstone interrupted by ledges of yellow-gray fine-grained sandstone underlie this capping unit. These lower units resemble the outcrop pattern of the North Horn Formation below, but are mostly thin and evenly bedded in contrast to the variegated indistinctly bedded mudstones of the North Horn. Eastward, the Flagstaff ledges grade into limestone or calcarenite and the red-brown calcareous siltstone reverts to thin-bedded light-gray marl. A few of the reddish calcareous siltstone beds are also recognizable in the Water Hollow fault zone area. The Flagstaff strata in the Gooseberry quadrangle were nearshore lake deposits receiving their sediments from a source of red rocks exposed along the Sanpete-Sevier Valley anticline (SSVA) (Willis, 1986). These deposits lap onto the North Horn and older deposits to the west as exposed above the angular unconformity exposed in Salina Canyon. The Flagstaff Formation eventually pinches out westward in lower Salina Canyon above the unconformity. About a mile north of the Gooseberry Creek quadrangle, the North Horn-Flagstaff contact appears concordant. Not recognizing the unconformity or hiatus in the western part of the quadrangle, McGookey (1960) assigned much of the Flagstaff Formation to the North Horn Formation. The Flagstaff Formation is early Eocene to Paleocene in age (La Rocque, 1960; Stanley and Collinson, 1979; Franczyk and others, 1992).

Tertiary-Cretaceous

TKn **North Horn Formation (Paleocene to Late Cretaceous)** – Variegated gray, green, yellow-orange, purple, and pink argillaceous mudstone; light-gray, yellow-brown, and pink sandstone; light- to dark-gray limestone and calcarenite; subordinate red-brown to yellow-gray pebble conglomerate; forms slopes and is prone to landslides; 1100 feet (335 m) thick.

The North Horn Formation overlies the Price River Formation concordantly in the Gooseberry Creek quadrangle. It was deposited under fluvial conditions with the lenticular sandstone representing channel deposits and the mudstone representing overbank deposits. The argillaceous mudstone, which commonly weathers into badland topography, makes the North Horn Formation landslide prone. McGookey (1960) measured the North Horn Formation in the northwest part of the Gooseberry Creek quadrangle and the southwest corner of the Steves Mountain quadrangle at 1200 feet (370 m) thick. We measured only 587 feet (179 m) on the Steves Mountain quadrangle in unsurveyed SW1/4 section 28, T. 21 S., R. 2 E. McGookey's measurement probably includes much of our Flagstaff Formation as he recognized less than 100 feet (30 m) of Flagstaff Formation (see discussion under Flagstaff Formation). The North Horn Formation is Late Cretaceous (Maastrichtian) to Paleocene in age (Franczyk and others, 1992; Difley, 2007). No direct evidence of the Cretaceous-Tertiary boundary is recognized in the quadrangle.

Cretaceous

Kpr **Price River Formation (Late Cretaceous)** – Sandstone, gritstone, conglomeratic sandstone, and conglomerate; light-gray to yellow-gray; moderately to poorly sorted; forms massive cliff with thick-bedded ledges at top; about 300 to 350 feet (90–110 m) thick.

The Price River Formation conformably overlies the Kc3 unit of the Castlegate Sandstone. It is not as resistant as the two Castlegate Sandstone ledges, but is locally difficult to distinguish from them. However, it contrasts sharply with the more gentle slopes and ledges of the North Horn Formation above it. The top is generally a bench upon which thin scabs of the North Horn remain. We measured 335 feet (102 m) of Price River Formation about one mile (1.6 km) north of the quadrangle on the west side of Maple Spring Canyon. Previous investigators considered the Castlegate to consist of only the lower cliff (Kc1) (McGooky, 1960), but our Kc2 and Kc3 units are more consistent with the Castlegate to the east. If we add our 335 feet (102 m) of Price River to the 770 feet (235 m) of Castlegate our total of the interval is 1105 feet (337 m) and compares well to the 1118 feet (341 m) indicated by McGookey (1960). The Price River was laid down as fluvial deposits. Fouche and others (1983) showed the Price River Formation to have been deposited between 72 and 75 Ma making it latest Campanian (Late Cretaceous) in age. Later studies have confirmed this age (Tidwell and others, 2007, fig. 3).

Castlegate Sandstone

Kc3 **Upper cliff unit (Late Cretaceous, Campanian)** – Sandstone, light-gray, fine-grained, quartzose, calcareous, contains 15% dark grains and lithic fragments; coarsens upward, has pebble and gritty streaks at top; beds are thick to massive with low-angle cross-beds; 360 feet (110 m) thick.

Kc2 **Medial slope unit (Late Cretaceous, Campanian)** – Interbedded sandstone and silty gray shale; sandstone is light to medium yellow-gray, fine grained, and dominates in the upper half of the unit; shale is mostly silty and gray and dominates in the lower half; bedding indistinct; forms a narrow bench above the lower cliff that changes to a steep slope under the upper cliff; about 125 feet (38 m) thick.

Kc1 **Lower cliff unit (Late Cretaceous, Campanian)** – Sandstone interbedded with 15 percent slope-forming gray shale, silty shale, and carbonaceous shale; mostly yellow-gray; contains fine- to coarse-grained beds, but generally coarsens upward; mostly quartzose, but some beds contain abundant lithic grains and dark minerals; grains are subrounded to subangular; calcareous; bedding ranges from thin to massive, but is dominantly thick bedded; locally bioturbated and contains impressions of branches and twigs; about 285 feet (87 m) thick.

The Castlegate Sandstone overlies the Blackhawk Formation in the northeast corner of the Gooseberry Creek quadrangle on the east side of the east-bounding fault of the Water Hollow fault zone. The total thickness of the Castlegate is 770 feet (235 m). It is Campanian in age, deposited about 74 Ma (Fouch and others, 1983; Tidwell and others, 2007, fig. 3).

Kb **Blackhawk Formation (Late Cretaceous)** – Interbedded fine-grained sandstone, shale, and coal beds; coal beds are about 1 to 5 feet (0.3–2 m) thick; forms slopes below Castlegate cliffs with minor sandstone ledges about 2 to 10 feet (0.6–3 m) thick; 750 feet (230 m) thick but lower part not exposed in quadrangle.

The upper part of the Blackhawk Formation is the oldest unit exposed in the study area and is exposed in the northeastern corner of the Gooseberry Creek quadrangle, immediately east of the Water Hollow fault zone on the east side of Browns Hole along Catamount Canyon. The upper 175 feet (53 m) is exposed in Catamount Canyon. Bachman (1959) measured an incomplete section 2 miles (3 km) northeast of Catamount Canyon on the north wall of Salina Canyon of about 550 feet (170 m). Doelling (1972) reported a total of 800 to 900 feet (240–270 m) of Blackhawk Formation in upper Salina Canyon. It is largely a lagoonal deposit to the east of the quadrangle, becoming more terrestrial westward. The Blackhawk Formation is Campanian in age, deposited about 77 Ma (Fouch and others, 1983).

GEOLOGIC HISTORY AND STRUCTURAL GEOLOGY

Cretaceous formations exposed in the Gooseberry Creek quadrangle were deposited on an alluvial to coastal plain east of an active Sevier orogenic belt. Mountains to the west supplied sediment that fined eastward, and the presence of coal in the Blackhawk Formation, the oldest unit exposed in the quadrangle, alludes to lagoonal deposition marginal to the Cretaceous interior seaway. The shoreline retreated eastward and deposition gradually shifted from marine-influenced deposition to fluvial deposition. Fluvial processes dominated by North Horn time, with lacustrine and overbank deposits dominating over channel deposition. Muddy paleosols dominate the North Horn Formation in the Gooseberry Creek quadrangle.

The angular unconformity exposed in the lower part of Salina Canyon, west of the Gooseberry Creek quadrangle (Willis, 1986), is evidence of tectonic activity that developed to the west in the Late Cretaceous in which the Middle Jurassic Arapien Shale was folded upward, pushing overlying rocks into steeply dipping attitudes. This anticlinal fold developed near the front of the Sevier thrust belt. Through a probable combination of buoyancy and flowage of weak Arapien mudstone and micrite, isostatic rebound, Tertiary tectonics, and gravitational unroofing the SSVA continued as a positive structure throughout the Tertiary and Quaternary (Willis, 1986; Cline and Bartley, 2007; Schelling and others, 2007).

The Salina Canyon unconformity developed along the east flank of the SSVA, where Upper Jurassic and Cretaceous formations in vertical or angular attitudes are overlain by a thin Flagstaff Formation. The position of the unconformity in the Gooseberry Creek quadrangle is less clear since Cretaceous and Tertiary strata are parallel and a major erosional surface is not apparent. The Flagstaff Formation was mostly deposited under lacustrine conditions (La Rocque, 1960), but in the western Gooseberry Creek quadrangle area it is partially fluvial and was receiving sediment from islands or highlands to the west. Close to the anticline, Flagstaff sediments consist mostly of gravel and sandstone, but fine eastward to reddish mudstones and shales and calcareous sandstones, and then into light-gray and nearly white limestone and gray calcareous shale farther to the east. In some places the Flagstaff Formation

tion pinches out over the paleohighs, and thickens eastward across the Salina 7.5' and Gooseberry Creek quadrangles (Willis, 1986). The Flagstaff was deposited as an onlap on top of the North Horn Formation.

Willis (1986, p. 5) reported that the Colton thins over the anticlinal high to the west, but was the first formation to cover it. The Colton thickens eastward from the paleohigh and is over 500 feet (150 m) thick at its exposures on the west side of Gooseberry Creek. The Green River Formation covered the fold with only minor influence; however, the structure has had renewed movement that may continue to the present.

All sedimentary units exposed in the Gooseberry Creek quadrangle were folded to form the Wasatch monocline. Sedimentary units exposed in the western two-thirds of the quadrangle dip westward from 5 to 30 degrees, the steeper dips prevalent along its west edge (see cross section A–A'). Witkind (1994) indicated that the monocline trends north-northeastward along the east side of Sevier and Sanpete Valleys from south of the Gooseberry Creek quadrangle (where it is buried beneath or involves volcanic deposits) to about 50 miles (80 km) north; more than 70 miles (110 mi) in length. The monocline formed between about 40 and 30 million years ago, but the mechanism is still unclear (Willis, 1986, p. 10; Schelling and others, 2007); however, Judge (2007) stated that it is an extensional roll-over fold produced during slip on the listric, fault-bounding half-graben in Sanpete Valley. All sedimentary formations through the late Eocene participate in the structure, but the volcanic tuffs in the south-central part of the quadrangle may not.

The Water Hollow fault zone consists of a zone of north-south trending faults that has a width of about 2 miles (3 km). All large-displacement faults but one are down to the east; the east-bounding fault is down to the west. The fault zone appears to die out southward, but extends northward on the east side of the Wasatch monocline about 50 miles (80 km). The displacement on the east-bounding fault is at least 1000 feet (300 m) in the northeast corner of the quadrangle. The cumulative displacement of the western faults is at least 1400 feet (430 m). Some of the fault blocks are also folded, and unmapped faults and shattered zones of small displacement may also be present in some areas. Displacements diminish in the southern part of the quadrangle, but are difficult to determine because of ubiquitous landslide cover. East of the Water Hollow fault zone strata exhibit only gentle dips and mark the west edge of the Wasatch Plateau.

The timing of faulting is unclear, but most may have occurred in connection with the formation of the Wasatch monocline or later. Tuffs in the south-central part of the Gooseberry Creek quadrangle are some of the northernmost outcrops of the Marysvale volcanic complex of Oligocene age. Down-to-the-west faulting occurred after the tuff emplacement, but the displacements are not great, perhaps 30 to 40 feet (10–12 m), and die out north of those units. Bailey and others (2007), working to the south, dated the Fremont graben, which probably is related to the Water Hollow fault zone, at 1 to 5 Ma.

A period of erosion took place in the Neogene while regional uplift was in progress. Uplift from the SSVA and in the Wasatch Plateau continues through the present. The relief of the region is the product of Neogene and Quaternary erosion and uplift.

SELECTED ECONOMIC RESOURCES

One drillhole and a couple of quarries were developed in the Gooseberry Creek quadrangle. Phillips Petroleum drilled one gas exploration well, Maple Springs U1, in the Gooseberry Creek quadrangle, in section 3, T. 23 S., R. 2 E. The Squaw Hollow sand and gravel pit in section 15, T. 23 S., R. 2 E. on Fish Lake National Forest lands (see geologic map) is located in a Qaf deposit. The sand and gravel was used for road base in the area. Another pit was opened to exploit dense welded tuff deposits in section 3, T. 24 S., R. 2 E. on Fish Lake National Forest lands (see geologic map). During the time we mapped the quadrangle, the Gooseberry Creek road leading from I-70 to the north to a point just south of the quadrangle was under construction. Rock quarried from the welded tuff was crushed for road metal and broken up to provide rip-rap for the project.

The Blackhawk Formation contains coal beds actively mined to the east of the area in the Wasatch Plateau. No coal mines have been opened in the Gooseberry Creek quadrangle; however, some small mines were opened up in the 1920s along Salina Creek Canyon a few miles northeast of the quadrangle. The coal beds were thin and under present (2015) economic conditions would not be considered an exploitable resource. In that area, Doelling (1972) noted three coal zones, none of which contained beds over 4 feet (1.3 m) in thickness, and that these coal zones thinned westward. Spieker and Baker (1928) noted that the coal beds along Salina Creek are resinous, especially the upper beds. Buranek and Crawford (1943) reported that selected samples contained up to 15 percent resin by volume and that the average coal contained 8 percent. Such beds may be present under colluvial cover in the northeastern part of the quadrangle.

SELECTED GEOLOGIC HAZARDS

Geologic hazards are common in Utah and a comprehensive review of all hazards in this quadrangle is not possible in this report. For a more comprehensive review of hazards in the area please refer to the Utah Geological Survey website at http://geology.utah.gov/hazards/. Some hazards of note in the Gooseberry Creek quadrangle are landslides and slumps. The North Horn, Flagstaff, Colton Formations, volcanic units, and surficial cover are commonly affected during "wet years", cloudburst storms, or rapid spring snowmelt. The high amount of precipitation in 1983 to 1985 caused many landslides on steep slopes in these formations. In 1983 a low-angle debris flow developed in alluvium near Gooseberry Creek (Metcalfe and Larrabee, 1985; Christenson and Ashland, 2006) (figure 1). This flow was caused from failure due to high pore pressures from saturation from the floods that year. Since the area is sparsely populated, roads are most susceptible to damage from these type of events.

Figure 1. *1983 Debris flow along Gooseberry Creek in alluvium (from Christenson and Ashland, 2006).*

Historical earthquakes in the area are uncommon. However, the Sevier fault about 10 miles (16 km) to the southwest could generate a 6.0 to 7.0 magnitude earthquake. Expected impacts, should a large earthquake occur, are widespread ground shaking and local liquefaction in areas underlain by saturated sand and silt.

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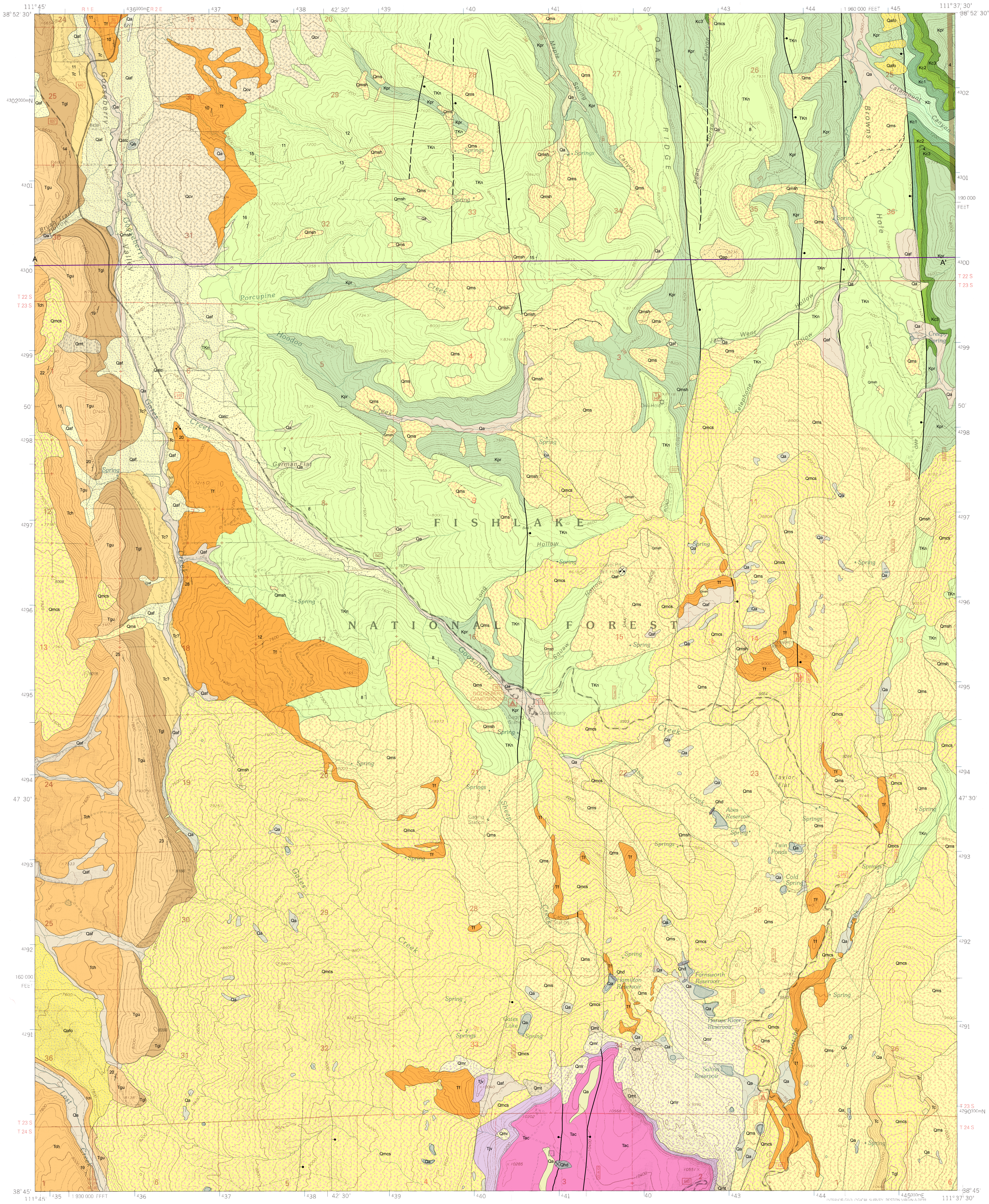

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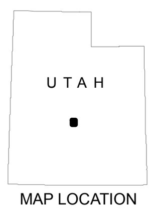
SCALE 1:24,000

1 0.5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0.5 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET

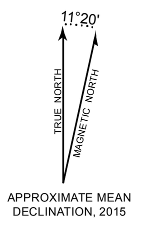


MAP LOCATION

INTERIM GEOLOGIC MAP OF THE GOOSEBERRY CREEK QUADRANGLE, SEVIER COUNTY, UTAH

by
Paul A. Kuehne and Hellmut H. Doelling

2016



APPROXIMATE MEAN DECLINATION, 2015

Base from USGS Gooseberry Creek 7.5' Quadrangle (2001)
Projection: UTM Zone 12
Datum: NAD 1927
Spheroid: Clarke 1866

Project Manager: Grant Willis
GIS and Cartography: Jay Hill and Paul Kuehne

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(801) 537-3300
geology.utah.gov

1	2	3
4		5
6	7	8

1. Salina
2. Steves Mtn.
3. Water Hollow Ridge
4. Rex Reservoir
5. Yogo Creek
6. Boobe Hole Reservoir
7. Mt. Terrill
8. Hilgard Mountain

ADJOINING 7.5' QUADRANGLE NAMES

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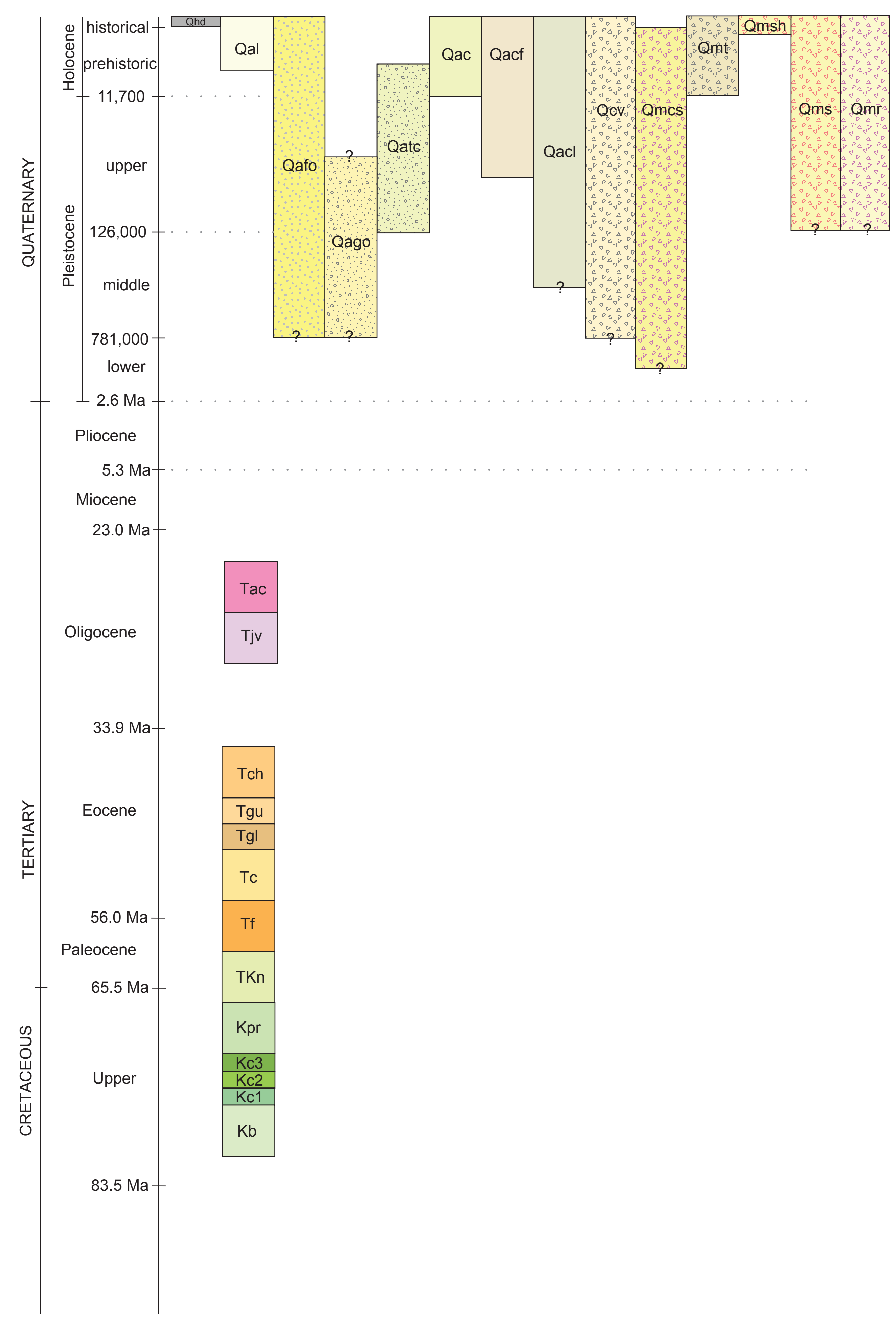
Plate 2
Utah Geological Survey OFR-641
Interim Geologic Map of the Gooseberry Creek Quadrangle

LITHOLOGIC COLUMN

AGE			FORMATION		MAP SYMBOL THICKNESS FEET (METERS)	LITHOLOGY
TERTIARY (Paleogene)	Oligocene		Tuff of Albinus Canyon		Tac 150-1200 (50-450)	
TERTIARY (Paleogene)	Oligocene		latite of Johnson Valley Res.		Tjv 300-1350 (100-450)	
TERTIARY (Paleogene)	Eocene	middle	Crazy Hollow Formation		Tch 600-800 (180-240)	
TERTIARY (Paleogene)	Eocene	middle	Green River Fm.	upper	Tgu 700 (240)	
TERTIARY (Paleogene)	Eocene	middle	Green River Fm.	lower	Tgl 400 (120)	
TERTIARY (Paleogene)	Eocene	lower	Colton Formation		Tc 500-550 (150-170)	
TERTIARY (Paleogene)	Eocene / Paleocene	lower	Flagstaff Formation		Tf 800-1500 (240-460)	
TERTIARY (Paleogene) / CRETACEOUS	Paleocene / Maastrichtian		North Horn Formation		TKn 1100 (335)	
CRETACEOUS	Maastrichtian / Campanian		Price River Formation		Kpr 300-350 (90-110)	
CRETACEOUS	Campanian		Castlegate Sandstone	upper cliff unit	Kc3 360 (110)	
CRETACEOUS	Campanian		Castlegate Sandstone	medial slope unit	Kc2 125 (38)	
CRETACEOUS	Campanian		Castlegate Sandstone	lower cliff unit	Kc1 285 (87)	
CRETACEOUS	Campanian		Blackhawk Formation		Kb 750 (230)	

CORRELATION OF MAP UNITS



GEOLOGIC SYMBOLS

- contact, dashed where approximately located
- normal fault, dashed where inferred, dotted where concealed, ball and bar on down-thrown side
- mass-movement scarp, dashed where approximately located
- 50 strike and dip of bedding
- rock quarry (crushed)
- road fill or gravel quarry
- drill hole, plugged and abandoned
- sample location, sample number