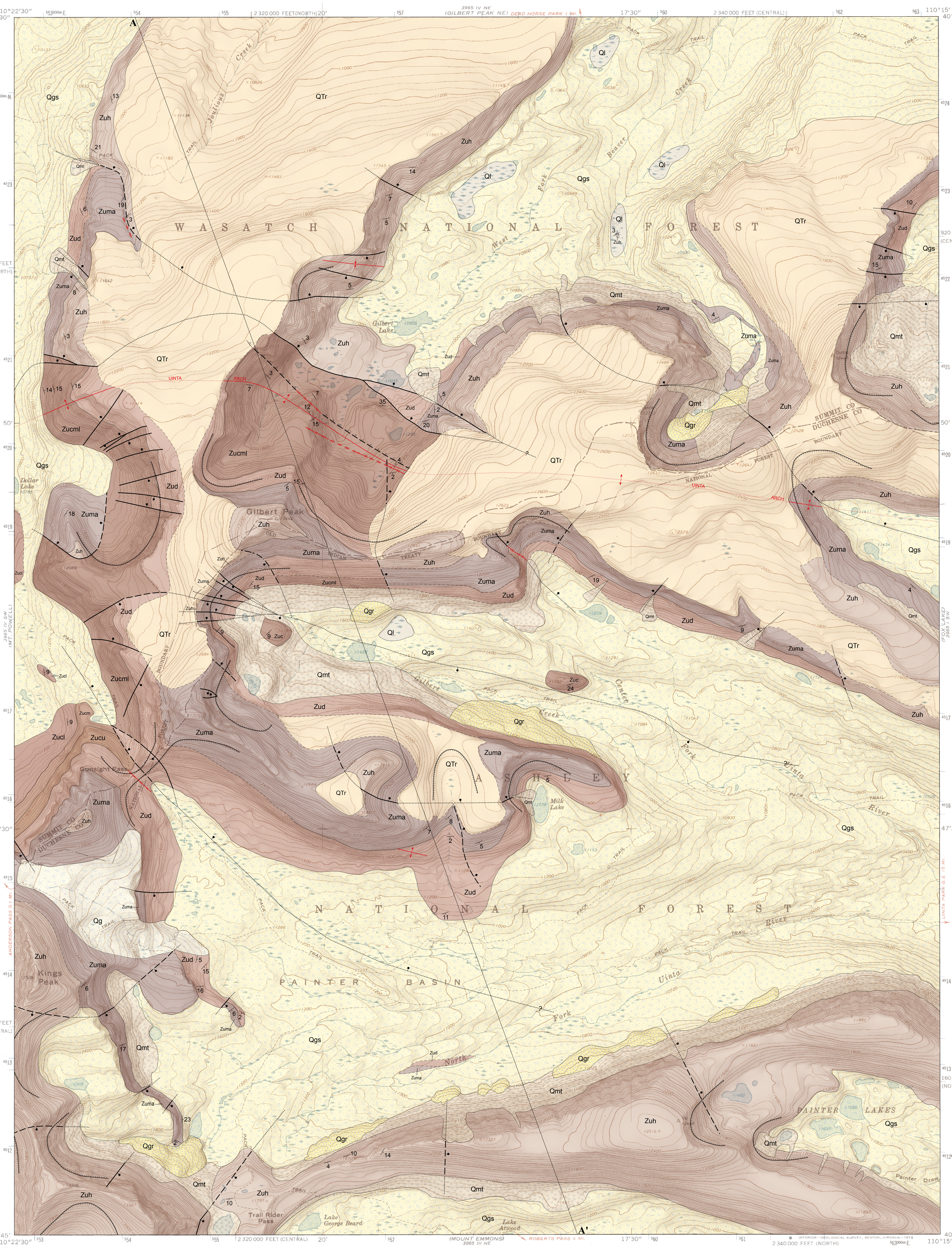
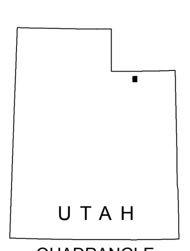
UTAH GEOLOGICAL SURVEY
a division of
Utah Department of Natural Resources



This geologic map was funded by the Utah Geological Survey, U.S. Geological Survey National Cooperative Geologic Mapping Program EDMAP award number 07HQAG0145, and National Science Foundation grant EAR-0819759.

ISBN 978-1557919076



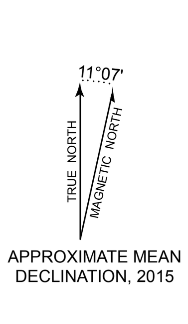
QUADRANGLE LOCATION

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

GEOLOGIC MAP OF THE KINGS PEAK 7.5' QUADRANGLE, DUCHESNE AND SUMMIT COUNTIES, UTAH

by
Esther M. Kingsbury-Stewart[1], Paul K. Link[2], Carol M. Dehler[3], and Shannon L. Osterhout[4]

2015



APPROXIMATE MEAN DECLINATION, 2015

Base from USGS Kings Peak 7.5' Quadrangle (1965)
Projection: UTM Zone 12
Datum: NAD 1927
Spheroid: Clarke 1866

Project Manager: Douglas A. Sprinkel
GIS and Cartography: Zachary W. Anderson and J. Buck Ehler

Utah Geological Survey
1594 West North Temple, Suite 3110
P.O. Box 146100, Salt Lake City, UT 84114-6100
(801) 537-3300
geology.utah.gov

This map was created from Geographic Information System (GIS) data.

1	2	3
4		5
6	7	8

1.Bridger Lake
2.Gilbert Peak NE
3.Hole In The Rock
4.Mount Powell
5.Fox Lake
6.Garfield Basin
7.Mount Emmons
8.Bollie Lake

ADJOINING 7.5' QUADRANGLE NAMES

[1] Wisconsin Geologic and Natural History Survey, 3817 Mineral Point Road, Madison, Wisconsin 53705-5100, esther.stewart@wgnhs.uwex.edu
[2] Idaho State University, Department of Geosciences, Campus Box 8072, Pocatello, ID 83209
[3] Utah State University, Department of Geology, 4505 Old Main Hill, Logan, UT 84322-4505
[4] Pioneer Natural Resources Company, 1401 17th Street, Suite 1200, Denver CO, 80202

UTAH GEOLOGICAL
a division of
Utah Department of Natural Resources

SUMMARY

The Kings Peak quadrangle is located along the crest of the Uinta Mountains anticline in the High Uintas Wilderness Area. The quadrangle's namesake, Kings Peak, is the highest point in Utah, at 4123 meters (13,528 feet) and was named for Clarence King, a pioneering geologist of the Fortieth Parallel Survey, one of the four competing geological surveys of the western United States during the late nineteenth century. The quadrangle is dominated by unconsolidated surficial deposits of mostly glacial origin and the middle part of the Uinta Mountain Group (UMG), a succession of middle Neoproterozoic (ca 770 to 740 Ma) sedimentary rocks several kilometers thick (Dehler and others, 2010). The quadrangle also includes several Ordovician-Cambrian igneous dikes that intrude into the UMG, mostly along pre-existing faults.

Bedrock units are exposed in the high peaks and steep cliffs and include (from stratigraphic lowest to highest) the Red Castle Formation, Dead Horse Pass Formation, Mount Agassiz Formation, and the informal formation of Hades Pass. Facies and stratal architecture of the middle UMG strata exposed in the quadrangle indicate a paleogeography characterized by offshore, shoreface, and nearshore marine, deltaic, and fluvial. The sedimentary bedrock units are interpreted to have been deposited in fluvial and shallow marine environments within an epicontinental sea at least 150 million years before the latest Proterozoic inception of the Laurentian western passive margin. Glacial till of Smiths Fork age covers the basin floors, and related well-defined headwall cirques cut into bedrock at the heads of the basins. The flanks of the basins are somewhat covered by talus or rock glaciers and much of the high tablelands are covered by thin regolith that likely resulted from periglacial processes.

The axis of the Laramide-age Uinta arch strikes through the quadrangle, gently folding the UMG bedrock units with generally shallow north and south dips (3 to 20 degrees). The UMG strata are also cut by minor (several meters of offset) to moderate (several tens of meters of offset) normal and reverse faults.

DESCRIPTION OF MAP UNITS

QUATERNARY-TERTIARY UNITS

Ql — **Lacustrine deposits (Holocene)** – Unconsolidated, laminated fine sand, silt and clay, and fine colluvium with buried organic layers common; deposits infill closed ovoid depressions dammed by end moraines, till ridges, hummocks, and mass-wasting deposits; associated with meadows and small lakes; generally less than 10 meters (33 ft) thick but may locally exceed 10 meters (33 ft).

Qmt — **Talus (Holocene and late Pleistocene [?])** – Unconsolidated, poorly sorted, mostly angular boulders located at the base of cirque headwalls and along glacial valley sides, especially along north-facing cliff walls of the formation of Hades Pass; extremely coarse with most fines having been removed by meltwater; accumulations of fine colluvium are common down slope from many talus deposits, especially where cliffs contain a large component of shale; include small avalanche cones, protalus ramparts, and sheet-like deposits that blanket and skirt cliff faces; rock falls are common, especially following precipitation, and indicate many talus deposits remain active; 1 to 50 meters (3–165 ft) thick.

Qgr — **Rock glacier (Holocene and latest[?] Pleistocene)** – Unconsolidated, poorly sorted, angular boulders and fine-grained materials; fine-grained materials are more common in these features than in talus; lichen-covered boulders typify more stabilized rock glaciers; characterized by steep-sloped lobate bulges that protrude out into basins and on the floor of high-altitude cirque basins; characteristic surface morphology of transverse ridges and furrows results from slow, imperceptible flow by deformation and mobilization of interstitial ice; rock glaciers in the Kings Peak quadrangle are present on north facing slopes, west of Trail Rider Pass (southern margin of Painter Basin), in Gilbert Creek basin, and in a cirque east of Anne triangulation station 12,713; surface meltwater pond emanates from a rock glacier west of Trail Rider Pass; as much as 30 meters (100 ft) thick.

Qg — **Glacial till, undivided (Holocene[?] and late Pleistocene)** – Unconsolidated, poorly sorted diamicton of uncertain age that is similar to Smiths Fork till; mapped northeast and southeast of Kings Peak perched above the western part of Painter Basin; forms steep hummocky topographic relief and exhibits linear patterned ground suggesting the deposit was modified by periglacial processes; till may be younger than Smiths Fork age (Neoglaciation) or possibly older; thickness uncertain but generally forms thin veneer over bedrock.

Qgs — **Smiths Fork till (late Pleistocene)** – Unconsolidated, matrix-supported, poorly sorted diamicton that consists of pebbles, cobbles, and boulders of Uinta Mountain Group lithologies; sandstone and quartzite boulders at the surface are abundant; clasts are commonly angular to subrounded, especially the larger boulders; striated clasts are locally abundant; forms broad deposits on basin floors that are topographically variable, ranging from smooth to hummocky with small ridges or knolls and kettles; deposited during the last glaciation (ca. 32,000 to 14,000 years ago) and considered correlative to the Pinedale Glaciation elsewhere in the Rocky Mountains (Phillips and others, 1997); samples collected for cosmogenic ^{10}Be surface-exposure dating reveal that terminal moraines were abandoned by retreating glaciers before 16,000 years ago (Munroe and others, 2006; Laabs and others, 2007; Refsnider and others, 2007; Munroe and Laabs, 2009); till in the basin centers is generally quite stable due to low surface slopes but lateral moraines and till deposits on steeper bedrock slopes are prone to mass wasting, especially when water-saturated (Munroe and Laabs, 2009); thickness varies from 1 to 10 meters (3–33 ft) in middle of Painter Basin, but may be as much as 50 meters (165 ft) thick in the moraines.

QTr — **Residual deposits (Holocene[?] to Tertiary)** – Unconsolidated, poorly sorted, angular boulders and silt deposited mostly on the 34 million-year-old Gilbert Peak erosion surface (Hansen, 1986; Kowallis and others, 2005); characterized by planar, grass-covered slopes; boulders are commonly concentrated in linear and anastomosing patterns suggesting deposits may be modified by periglacial processes; boulders are typically lichen-covered; may be similar to older piedmont gravel deposits mapped by Sprinkel (2006), which included deposits modified by periglacial processes; unit thinly covers bedrock in some areas and is generally less than 1 meter (3 ft) thick, but may be 1 to 3 meters (3–9 ft) thick in the area of Joulious Creek.

ORDOVICIAN-CAMBRIAN

O€d — **Igneous dikes** – Light- to dark-gray and dark greenish-gray vitreous to porphyritic, melanocratic diabase dikes that trend northwest-southeast and intrude pre-existing faults located at Gunsight Pass, north of Gilbert Peak, and on the north side of Gilbert Creek basin; called biotitic diorite by Ritzma (1983) and gabbroic dike by Rowley and others (1985); isotopic age (K-Ar, uncorrected) from whole rock and ferromagnesian and plagioclase mineral concentrate of three samples range from 453 ± 17 Ma to 552 ± 21 Ma (Ritzma, 1983); a Rb-Sr age of 491 Ma was also obtained (Ritzma, 1983); dikes intrude major northwest-southeast trending faults within the quadrangle (Bryant, 1992); laterally continuous for tens of meters; several meters (tens of ft) thick.

NEOPROTEROZOIC

Zuh — **Formation of Hades Pass (middle Proterozoic)** – Reddish-brown, medium- to very coarse grained quartz to sub-feldspathic arenite with minor meter-scale interbeds of very light gray to purplish-brown, fine- to medium-grained quartz arenite; bed geometry is characterized by laterally aggrading, amalgamated channels and sparse interbedded siltstone greater than 10 cm thick; rare channel-form, white arenite and siltstone (greater than 10 meters [33 ft] thick) occur in high cliff wall exposures at the top of the section exposed in the quadrangle; has soft-sediment deformation (slump folds), planar and trough cross-bedding, and abundant secondary alteration including Liesegang banding; limited paleocurrent measurements (18 measurements) yield an average paleoflow direction of 127°; primarily braided fluvial depositional environment; lower contact with the underlying Mount Agassiz Formation is regionally mappable, sharp, and erosive and represents a stratal discontinuity (composite sequence boundary); upper contact with the overlying Red Pine Shale is not preserved in the quadrangle; informal formation name first used by Wallace (1972); at least 1500 meters (4920 ft) thick, estimated from mapped exposure within the Kings Peak quadrangle.

Zuma — **Mount Agassiz Formation (middle Neoproterozoic)** – Very light gray to light-purple-gray, fine- to coarse-grained quartz arenite and pink sub-feldspathic arenite with centimeters to tens-of-meters thick interbeds of reddish-brown feldspathic siltstone and gray claystone to shale; soft-sediment deformation (slump folds and flame structures), planar cross-beds, bidirectional planar cross-beds (0.5 cm to 1.5 cm thick), mud chips, parting lineations, and interference ripples; paleocurrent measurements (80 measurements) yield a broad span of directions with an average paleoflow direction of 224°; offshore to nearshore marine depositional environment; although not mapped, the formation can be divided into four fine-grained subunits and three coarse-grained subunits, all meters to tens-of-meters thick; coarse-grained subunits on the east-facing wall of Kings Peak have large-scale (several meters tall) prograding foresets; fine- and coarse-grained subunits stack in upward-coarsening cycles interpreted as depositional sequences that consist of retrogradational and aggradational-progradational systems tracts (sensu Neal and Abreu, 2009), which in the traditional terminology of Mitchum and Van Wagoner (1991), are transgressive and highstand systems tracts; lower contact is a stratal discontinuity interpreted as a sequence boundary with the underlying Dead Horse Pass Formation (see Kingsbury-Stewart and others, 2013 for details on internal lithologic descriptions and sequence stratigraphy); the Mount Agassiz Formation is distinguished from the underlying Dead Horse Pass Formation by thicker interbeds of gray shale and light-brown sandstone, which gives the formation a comparatively lighter color; grades laterally to the west into the upper part of the upper member of the Red Castle Formation (see correlation chart and stratigraphic column); informal formation name first used by Wallace (1972) but has been formalized by Kingsbury-Stewart and others (2013); ~140 to 300 meters (460–980 ft) thick.

Zud — **Dead Horse Pass Formation (middle Neoproterozoic)** – Reddish-brown to very light gray quartz arenite and feldspathic arenite with interbedded green-gray to gray claystone and shale and maroon siltstone; planar cross-beds, flaser bedding, ripple marks, and hummocky to swaley cross-stratification; paleocurrent measurements (170 measurements) yield an average paleoflow direction of 238°; offshore to nearshore marine depositional environment; although not mapped, the formation can be divided into three fine-grained subunits (fine-grained sandstone, siltstone, and shale) and two coarse-grained subunits (mostly coarse-grained sandstone), up to a few tens of meters thick; fine- and coarse-grained subunits stack in upward-coarsening cycles that are interpreted as retrogradational and aggradational-progradational systems tracts (sensu Neal and Abreu, 2009), which in the traditional terminology of Mitchum and Van Wagoner (1991) are transgressive and highstand systems tracts; see Kingsbury-Stewart and others (2013) for details on internal lithologic descriptions and sequence stratigraphy; the upper contact with the overlying Mount Agassiz Formation is sharp; the contact with the underlying Red Castle Formation is a sharp or erosive surface interpreted as a composite transgressive surface (Kingsbury-Stewart and others, 2013); in the Kings Peak quadrangle the Dead Horse Pass Formation is distinguished from the underlying middle member of the Red Castle Formation by its greater textural and compositional maturity and bed geometry characterized by stratal terminations (onlap, downlap, and truncation); grades laterally westward to the lower part of the upper member of the Red Castle Formation (see correlation chart and stratigraphic column); informal formation name first used by Wallace (1972) but has been formalized by Kingsbury-Stewart and others (2013); ~150 meters (490 ft) thick.

Zucu — **Upper member of Red Castle Formation (middle Neoproterozoic)** – Reddish-brown silty mudstone to medium-grained quartz arenite, and intervals of coarse-grained to pebbly arkosic arenite; intervals of silty shale are dark reddish gray to green gray (~5 meters [16 ft] thick); sandstone is thin bedded (0.1–0.5 meter [0.3–1.6 ft]) with planar lamination, trough cross-bedding, mud rip-up clasts, lag deposits, scours, hummocky cross-stratification, and herringbone cross-bedding; laterally continuous beds are 0.1–10 meters (0.3–33 ft) thick; sparse coarse-grained to granule quartz arenite is present in intervals less than 1 meter (3 ft) thick with abundant mud rip-up clasts and lag deposits; beds 0.5 to 6 meters (1.5–20 ft) thick; lower contact is gradational (base of green-gray shale of upper member overlying reddish-brown sandstone of middle member); offshore marine and deltaic depositional environment; grades laterally to the Mount Agassiz and Dead Horse Pass Formations in the Gunsight Pass area of this quadrangle; erosional upper contact; less than 30 meters thick (100 ft) in the Kings Peak quadrangle, but ~170 meters (560 ft) thick in the Henrys Fork drainage to ~335 meters (1100 ft) thick in the Smiths Fork drainage (Mount Powell quadrangle).

Zucml — **Red Castle Formation, middle and lower members undivided (middle Neoproterozoic)** – Reddish-brown to reddish-purple, coarse-grained feldspathic arenite, granule conglomerate, and interbedded medium- to dark-gray siltstone and shale; fine-grained interbeds occur at scales from laminations to beds less than tens of meters thick; includes mud drapes, flaser bedding, reactivation surfaces, rip-up clasts, and planar tabular cross-beds; has distinctive tabular, laterally continuous beds and rhythmic alternation of coarse-grained sandstone beds (less than 10 meters [33 ft] thick) and fine-grained beds (less than 10 meters [33 ft] thick); paleocurrent measurements (37 measurements) yield an average paleoflow direction of 8°; nearshore marine and deltaic-tidal flat to fluvial braided plain; base is not exposed and upper contact is sharp to erosive; Red Castle was an informal unit name first used by Wallace (1972) but has been formalized by Kingsbury-Stewart and others (2013); informal members were mapped throughout much of the Red Castle area of the adjoining Mount Powell quadrangle (Osterhout and others, in review) but the middle and lower members could not be subdivided with certainty throughout the Kings Peak quadrangle; ~2600 meters (8530 ft) thick as estimated from map.

Zucm — **Middle member of Red Castle Formation (middle Neoproterozoic)** – Reddish-brown, medium-grained to granular, submature arkosic arenite; laterally continuous cyclic beds of sandstone-siltstone couples that fine upward; abundant trough and planar cross-beds overlain by thin beds of reddish-brown, very fine grained sandstone interbedded with silty mudstone; bedding thickness is tens of centimeters to meter scale; horizontal to gently dipping (less than ~ 30°) tabular, meter-scale beds; contains preserved bed forms on the tops of bed sets (ripples and dunes centimeter to meter scale), mud rip-up clasts (as much as 4 cm [1.5 in]), and rare channel forms; tidal flat to tidal-influenced braided delta depositional environment; lower contact is placed where lenticular bedding of the lower member becomes tabular; member coarsens to the west from the Henrys Fork to the Smiths Fork drainages (Mount Powell quadrangle) and loses much of the interbedded fines; member is exposed in the Gunsight Pass area of the Kings Peak quadrangle but is extensively exposed to the south of the Uinta arch in the Mount Powell quadrangle, around the Red Castle Lakes, the Red Castle, Castle Peak, Smiths Fork Pass above the Smiths Fork drainage, and south in the Henrys Fork drainage; middle member also has limited exposure at the head of the Yellowstone drainage, Garfield Basin, and Oweep drainage; the exposure north of the Uinta arch is limited to the Smiths Fork drainage, mainly on the west side of the basin; middle member crops out in great, striking red cliffs and when the sun is on it, it is clear how the Red Castle got its name; ~300 meters (~980 ft) thick.

Zucl — **Lower member of the Red Castle Formation (middle Neoproterozoic)** – Reddish-brown to reddish-purple, channelized, immature to sub-mature, medium-grained arkosic arenite to pebble conglomerate and sparse discontinuous beds of red silty shale and fine sandstone; channelized sandstone beds have well- and sub-rounded quartz grains up to 1 cm (0.4 in) and subrounded to subangular feldspar grains up to 2 cm (0.8 in); rip-up clasts up to 5 cm (2 in) in diameter are common; bedding consists of sub-meter scale amalgamated channel forms that are laterally continuous on a 1- to 10-meters (3- to 33-ft) scale; within the channel forms are cosets of trough or planar cross-beds and (or) moderately dipping (~20° to 35°) lateral accretion macroforms with internal cross-bedding; contains abundant trough cross-beds which are commonly normally graded (centimeters to tens of centimeters) with pebble- to coarse sand-sized grains at the base and fining up to mixed coarse- to fine-grained sand, the size of the cross-beds generally decreases up section within the unit and sometimes within a single coset; reddish-brown silty to very fine grained sandstone forms beds 2 to 5 cm (0.8-2 in) thick with occasional mud cracks; contains lenticular feldspathic arenite facies; lower member includes interbeds of lenticular to tabular medium (0.3 to 2 m [1-6.5 feet]) structureless beds of the informal Island Lake tongues (Zuci shown in the correlation of map units and stratigraphic column on plate 2); these beds are medium to very coarse grained quartz arenite (quartzite), dark purple to white on fresh surfaces but weathers a gray purple and contains sparse pebbles of polycrystalline quartz, red jasper, and black chert; basal contact of each tongue is sharp and interpreted as a flooding surface; lower member is interpreted as deposited in a braided fluvial depositional environment with interbedded tongues of marine quartzite (Island Lake tongues); Zucl is exposed along the northwest-facing cliff west of Gunsight Pass within the Kings Peak 7.5' quadrangle; in the Mount Powell quadrangle, excellent exposures are on the on the west side of the Red Castle near the head of Smiths Fork drainage (south limb of the Uinta arch) and on both limbs of the Uinta arch in the Henrys Fork drainage, especially near Island Lake on the south limb; beds of the Island Lake tongues are not exposed in this quadrangle but they are mapped in the adjoining Mount Powell quadrangle (Osterhout, 2011; Osterhout and others, in preparation); basal contact of the lower member of the Red Castle Formation is not exposed; >150 meters (>490 ft) thick.

pre-Zucml — **Older Uinta Mountain Group and Red Creek Quartzite (Neoproterozoic and Paleoproterozoic)** – Shown on cross section only.

REFERENCES

Bryant, B., 1992, Geologic and structure maps of the Salt Lake City 1° x 2° quadrangle, Utah and Wyoming: U.S. Geological Survey Miscellaneous Investigations Series Map I-1997, 2 plates, scale 1:125,000.

Dehler, C.M., Fanning, C.M., Link, P.K., Kingsbury, E.M., and Rybczynski, D., 2010, Maximum depositional age and provenance of the Uinta Mountain Group and Big Cottonwood Formation, northern Utah—paleogeography of rifting western Laurentia: Geological Society of America Bulletin, v. 122, no. 9/10, p. 1686–1699.

Gradstein, F.M., Ogg, J.G., Schmitz, M., and Ogg, G., editors, 2012, The geologic time scale, 2012 (first edition): Amsterdam, Elsevier, 2 vol., 1127 p.

Hansen, W.R., 1986, Neogene tectonics and geomorphology of the eastern Uinta Mountains in Utah, Colorado, and Wyoming: U.S. Geological Survey Professional Paper 1356, 78 p.

Kingsbury-Stewart, E.M., Osterhout, S.L., Link, P.K., and Dehler, C.M., 2013, Sequence stratigraphy of the Neoproterozoic middle Uinta Mountains Group, central Uinta Mountains, Utah—a closer look at the western Laurentian seaway at ca. 750 Ma: Precambrian Research, v. 236, p. 65–84.

Kowallis, B.J., Christiansen, E.H., Balls, E., Heizler, M.T., and Sprinkel, D.A., 2005, The Bishop Conglomerate ash beds, south flank of the Uinta Mountains—are they pyroclastic fall beds from the Oligocene ignimbrites of western Utah and eastern Nevada?, *in* Dehler, C.M., Pederson, J.L., Sprinkel, D.A., and Kowallis, B.J., editors, Uinta Mountain geology: Utah Geological Association Publication 33, p. 131–145.

Laabs, B.J.C., Munroe, J.S., Rosenbaum, J.G., Refsnider, K.A., and Mickelson, D.M., 2007, Chronology of the last glacial maximum in the upper Bear River basin, Utah: Arctic, Antarctic, and Alpine Research, v. 39, no. 4, p. 537–548.

Mitchum, R.M., Jr., and Van Wagoner, J.C., 1991, High-frequency sequences and their stacking patterns-sequence-stratigraphic evidence of high-frequency eustatic cycles: Sedimentary Geology, v. 70, no. 2-4, p. 131–160.

Munroe, J.S., and Laabs, B.J.C., 2009, Glacial geologic map of the Uinta Mountains area, Utah and Wyoming: Utah Geological Survey Miscellaneous Publication 09-4DM, 1 plate, scale 1:100,000.

Munroe, J.S., Laabs, B.J.C., Shakun, J.D., Singer, B.S., Mickelson, D.M., Refsnider, K.A., and Caffee, M.W., 2006, Latest Pleistocene advance of alpine glaciers in southwestern Uinta Mountains, Utah, USA—evidence for the influence of local moisture sources: Geology, v. 34, no. 10, p. 841–844.

Neal, J., and Abreu, V., 2009, Sequence stratigraphy hierarchy and the accommodation succession method: Geology, v. 37, no. 9, p. 779–782.

Osterhout, S.L., 2011, Geologic mapping, lithostratigraphic and sequence stratigraphic analysis of the Neoproterozoic Uinta Mountain Group, Mount Powell 7.5' quadrangle, Duchesne and Summit Counties, Utah: Pocatello, Idaho State University, M.S. thesis, 127 p, 1 plate, scale 1:24,000.

Osterhout, S.L., Kingsbury-Stewart, E.M., Link, P.K., and Dehler, C.M., in preparation, Geologic map of the Mount Powell quadrangle, Duchesne and Summit Counties, Utah: Utah Geological Survey Miscellaneous Publication, 7 p., 1 plate, scale 1:24,000.

Phillips, F.M., Zreda, M.G., Gosse, J.C., Klein, J., Evenson, E.B., Hall, R.D., Chadwick, O.A., and Sharma, P., 1997, Cosmogenic ^{36}Cl and ^{10}Be ages of Quaternary glacial and fluvial deposits of the Wind River Range, Wyoming: Geological Society of America Bulletin, v. 109, no. 11, p. 1453–1463.

Refsnider, K.A., Laabs, B.J.C., and Mickelson, D.M., 2007, Glacial geology and equilibrium line altitude reconstruction for the Provo River drainage, Uinta Mountains, Utah, U.S.A.: Arctic, Antarctic, and Alpine Research, v. 39, no. 4, p. 529–536.

Ritzma, H.R., 1983, Igneous dikes of the eastern Uinta Mountains, Utah and Colorado: Utah Geological and Mineral Survey Special Studies 56, 23 p.

Rowley, P.D., Hansen, W.R., Tweto, O., and Carrara, P.E., 1985, Geologic map of the Vernal 1° x 2° quadrangle, Colorado, Utah, and Wyoming: U.S. Geological Survey Miscellaneous Investigations Series Map I-1526, 1 plate, scale 1:250,000.

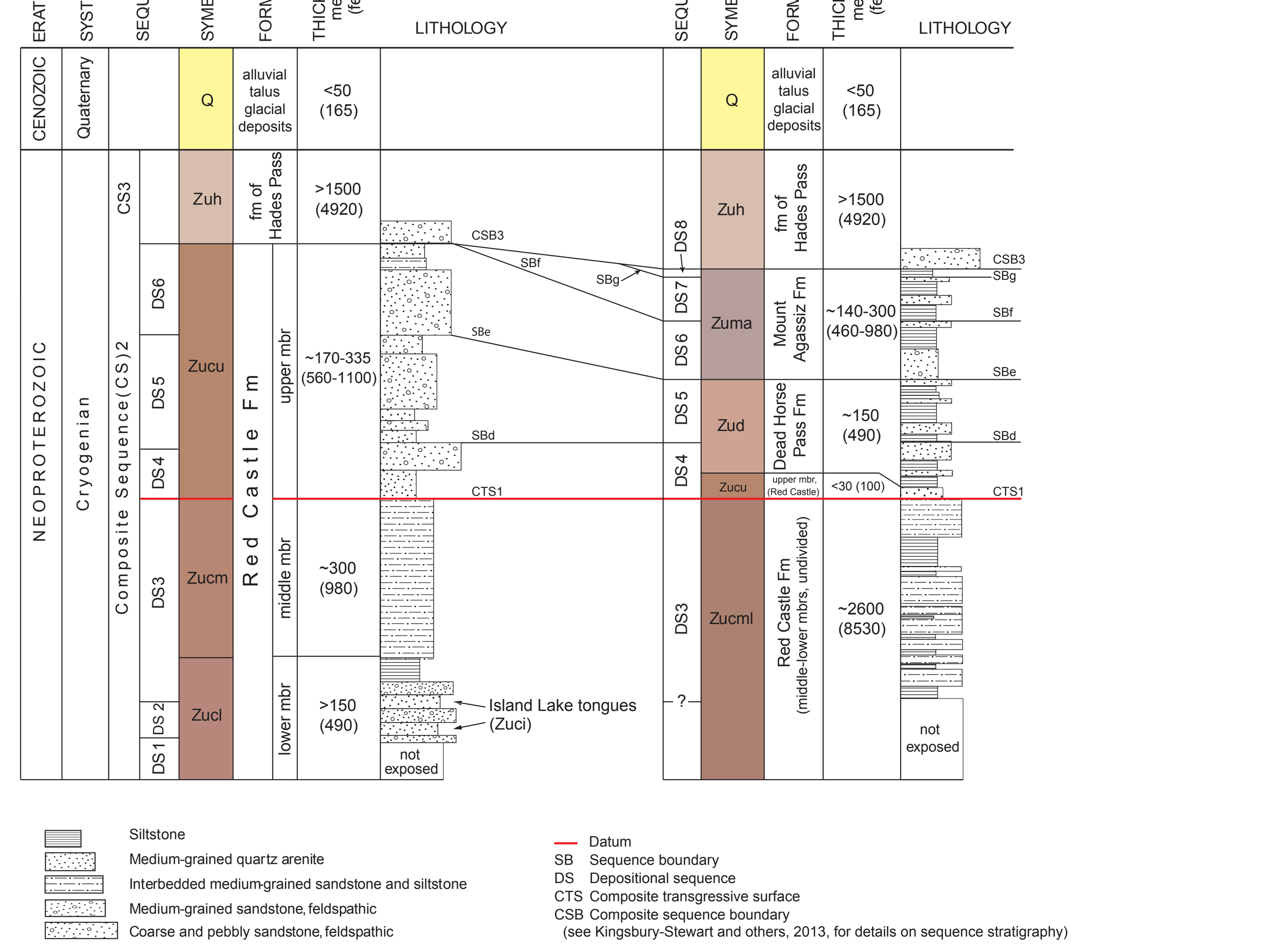
Sprinkel, D.A., 2006, Interim geologic map of the Dutch John 30' x 60' quadrangle, Daggett and Uintah Counties, Utah, Moffat County, Colorado, and Sweetwater County, Wyoming: Utah Geological Survey Open-File Report 491DM, compact disc, GIS data, 3 plates, scale 1:100,000.

Wallace, C.A., 1972, A basin analysis of the upper Precambrian Uinta Mountain Group, Utah: Santa Barbara, University of California-Santa Barbara, Ph.D. dissertation, 412 p.

ACKOWLEDGMENTS

We thank Ashley National Forest for providing field assistance. We also thank Grant Willis and Robert Ressetar (Utah Geological Survey) for their reviews and editing the geologic map, manuscript, and supporting materials. We also thank Buck Ehler (formerly Utah Geological Survey) for his GIS work on earlier versions of the geologic map and Zach Anderson and Lori Steadman (Utah Geological Survey) for their GIS and cartographic work on the final version.

STRATIGRAPHIC SECTIONS



MAP SYMBOLS

Contact – Solid where well located; dashed where approximately located on map; dashed and queried (?) where approximately located on cross section

Normal fault – Solid where well located; dashed where approximately located; dotted where concealed; queried where existence is uncertain; bar and ball on downthrown side where offset is known

Reverse fault – Dashed where approximately located; dotted where concealed

Anticline (upright) – Solid where well located; dotted where concealed

Syncline (upright) – well located

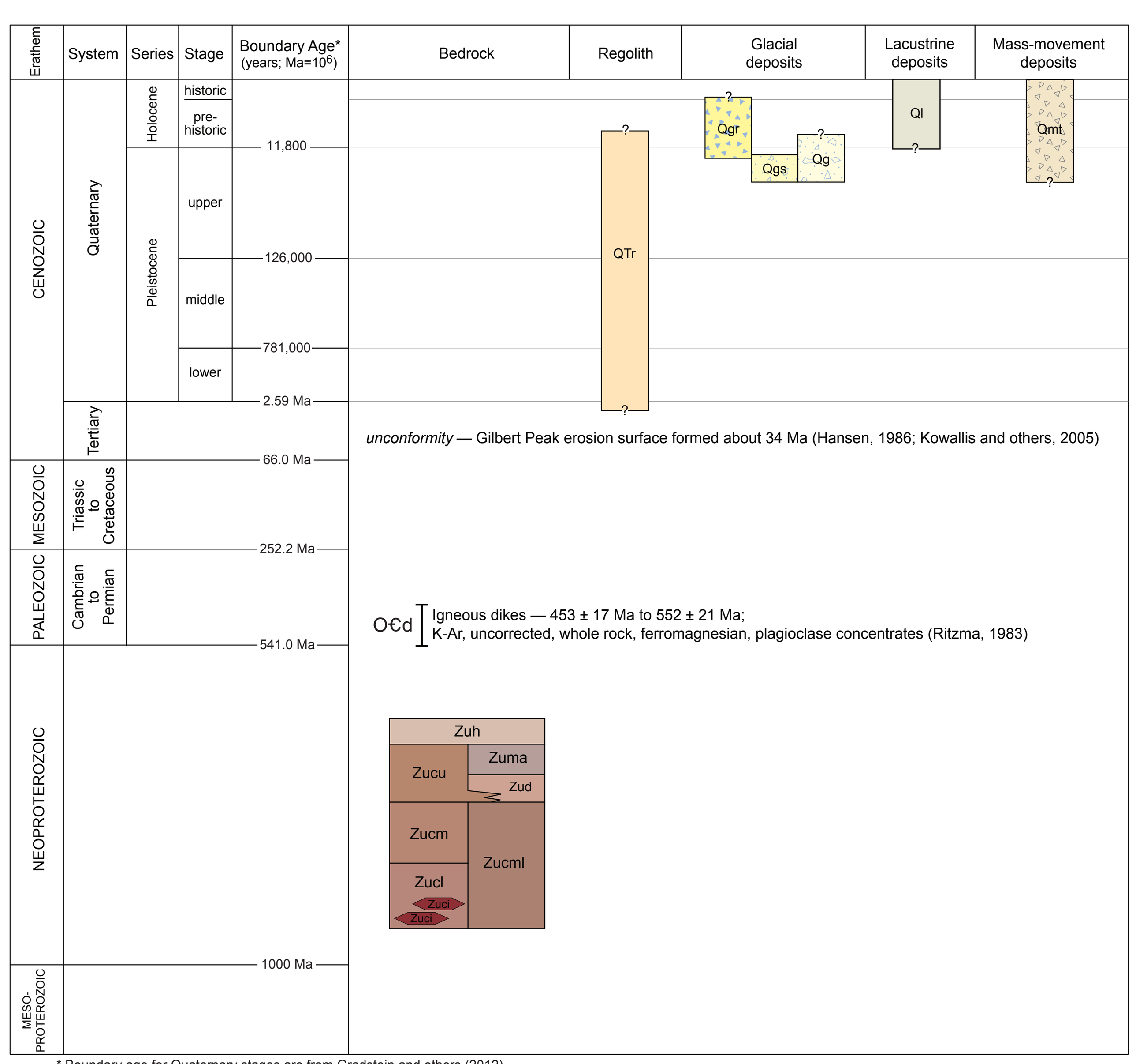
Igneous dike – Solid where well located; dashed where approximately located; shown in red

Cirque headwall – well located

7 Strike and dip of bedding (inclined)

A — A' Cross section, A–A'

MAP CORRELATION



* Boundary age for Quaternary stages are from Gradstein and others (2012)

Correlation of surficial and bedrock map units. A shazam line (an arbitrary line of distinction) is shown between Zucu and Zud because we observed Zucu south of Gunsight Pass in the quadrangle. We expect Zucu to transition laterally southward and eastward into Zuma as well, but it is not explicitly shown here because we did not directly observe the transition.