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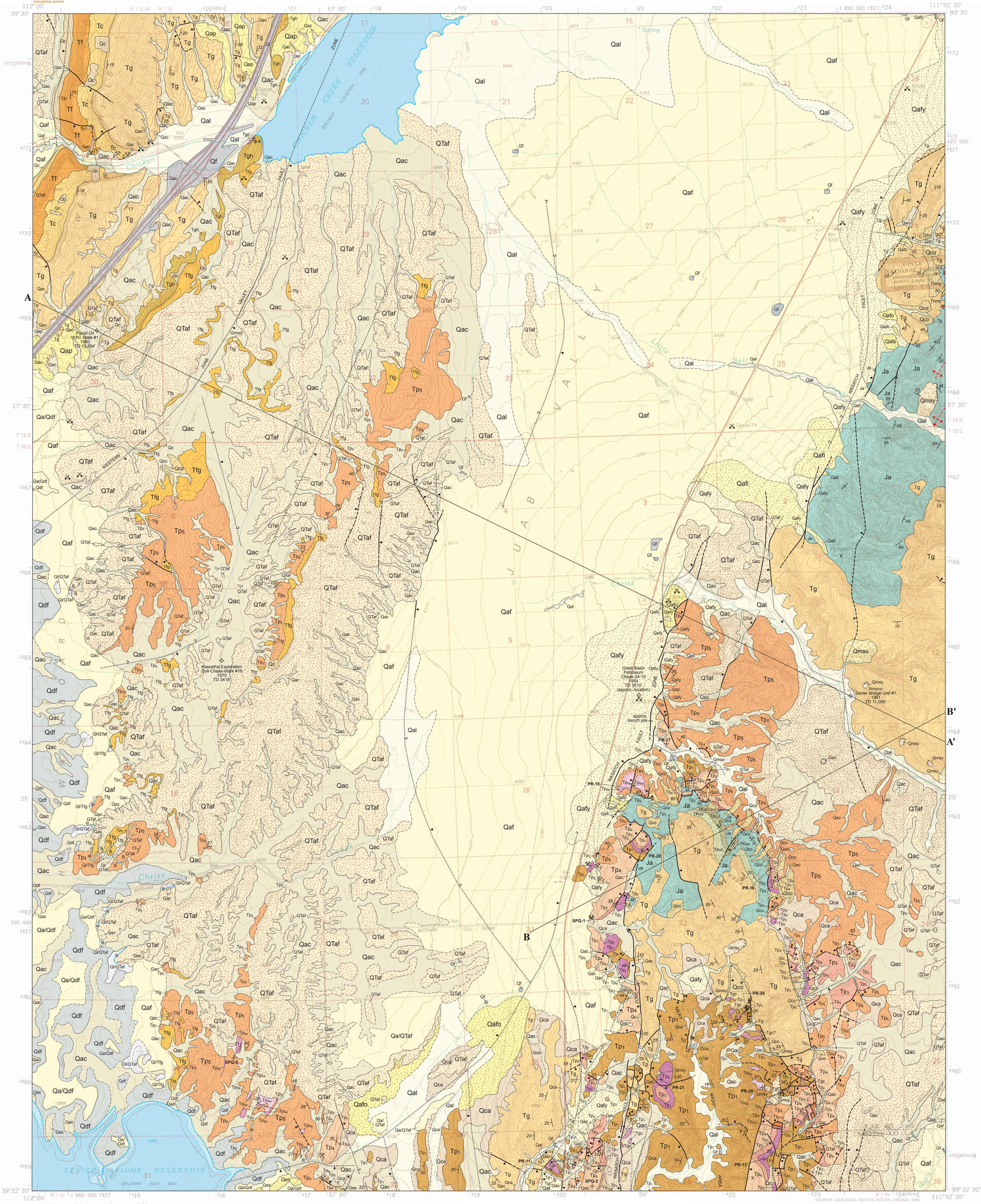
Plate 1
Utah Geological Survey Map 223
Geologic Map of the Skinner Peaks Quadrangle



Base from U.S. Geological Survey, Skinner Peaks 7.5' quadrangle, 2001
Geologic data and base map in NAD 1927

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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 20 FEET
SUPPLEMENTARY CONTOUR INTERVAL 10-FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

12°25'
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 2007

GEOLOGIC MAP OF THE SKINNER PEAKS QUADRANGLE, JUAB AND SANPETE COUNTIES, UTAH

by

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UTAH
QUADRANGLE LOCATION

1	2	3	1. Sage Valley
4		5	2. Juab 3. Levan 4. Mills 5. Chriss Canyon 6. Scipio North 7. Hells Kitchen Canyon SW 8. Hells Kitchen Canyon SE
6	7	8	

ADJOINING 7.5' QUADRANGLE NAMES

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Field mapping by authors 1988-89, 2003-05
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MAP UNIT DESCRIPTIONS

QUATERNARY

Alluvial deposits

Qal — **Stream alluvium** (Holocene) – Gravel, sand, and silt with minor clay and scattered cobbles and boulders; clasts well rounded to subangular; generally stratified; deposited in modern stream channels and flood plains, and adjacent to Chicken Creek Reservoir; locally forms terraces less than 30 feet (10 m) above stream level that grade downslope into upper Holocene alluvial-fan deposits (unit Qafy); also grades to map units Qaf and Qac; may include small alluvial fans and minor colluvium along steep stream embankments; exposed thickness less than 30 feet (<10 m).

Qafy — **Younger fan alluvium** (upper Holocene) – Pebble and cobble gravel, locally bouldery, in a matrix of sand, silt, and minor clay; clasts angular to subrounded; deposited by intermittent streams, debris flows, and debris floods graded to modern stream level; deposits form discrete fans, typically with bar and swale topography; local weak stage I carbonate morphology (Birkeland and others, 1991); exposed thickness less than 15 feet (<5 m).

Qafi — **Intermediate-age fan alluvium** (lower Holocene) – Pebble and cobble gravel, locally bouldery, in a matrix of sand, silt, and minor clay; clasts angular to well rounded; preserved as intermediate-level remnants incised by modern streams and locally buried by younger fan alluvium (Qafy); incised by, and grades downslope into, undifferentiated fan alluvium (Qaf); stage I+ carbonate morphology (Birkeland and others, 1991); exposed thickness less than 15 feet (<5 m).

Qafo — **Older fan alluvium** (upper to middle Pleistocene) – Pebble and cobble gravel, locally bouldery, in a matrix of sand, silt, and minor clay; clasts subangular to well rounded; preserved as relatively high, isolated remnants that lack fan morphology; stage II to III+ carbonate morphology (Birkeland and others, 1991); exposed thickness less than 50 feet (<15 m).

Qaf — **Undifferentiated fan alluvium** (upper Holocene to middle? Pleistocene) – Proximal facies: pebble and cobble gravel, locally bouldery, in a matrix of sand, silt, and minor clay; clasts subangular to well rounded; distal facies: silt and fine sand with minor clay; deposited by perennial and intermittent streams, debris flows, and debris floods graded to or slightly above modern stream level; includes a significant component of eolian silt; deposits form large, low-gradient fans that cover most of the floor of Juab Valley and a small area of Flat Canyon in the southeast corner of the quadrangle; includes local areas of active fan deposition (unit Qafy) and deposits of unit Qal too small to map separately; locally includes small unmapped debris-flow deposits; maximum thickness greater than 600 feet (>180 m); Qaf represents only the uppermost portion of the Juab Valley basin-fill deposits, which thicken northward.

Qap — **Pediment alluvium** (lower Holocene to upper Pleistocene) – Gently sloping mantle of clay- to boulder-size material overlying a truncated bedrock surface on the east flank of the West Hills in the northwest part of the quadrangle; exposed thickness from 0 to over 40 feet (0-12+ m); total thickness unknown.

Lacustrine deltaic deposits

Deltaic and lacustrine sediment was deposited in the Sevier River estuary in the southwestern part of the quadrangle during the transgressive phase of Lake Bonneville and during its highstand (Bonneville level). The shoreline elevation in the quadrangle is approximately 5100 feet (1555 m) (also see Crittenden, 1963; Currey, 1982, Oviatt, 1992).

Qdf — **Deltaic (estuarine) fines** (upper Pleistocene) – Light-brown, unconsolidated, coarse- to fine-grained sand, silt, and mud deposited by Lake Bonneville; deposits are finely laminated and cross-laminated; soft-sediment deformation structures and ripple cross-lamination are common near the base of the exposed section; exposed thickness up to about 20 feet (0-6 m), but total thickness uncertain.

Colluvial deposits

Qc — **Colluvium** (upper Holocene) – Slope-wash deposits of clay- to boulder-size, locally derived sediments deposited on upland slopes adjacent to drainages; generally less than 20 feet (<6 m) thick.

Qco — **Older colluvium** (lower Holocene to upper Pleistocene) – Locally derived clast- and matrix-supported pebble and cobble gravel, locally bouldery; clasts angular; matrix consists of sand, silt, and clay; grain size generally decreases downslope; forms a dissected surface on various bedrock units around the base of Skinner Peaks; thickness from 0 to over 40 feet (0-12+ m).

Eolian deposits

Qes — **Eolian sand** (Holocene) – Moderate-brown sand forming hummocky surfaces along the southern map border; derived from lacustrine or beach deposits or bedrock near Sevier Bridge Reservoir; exposed thickness from 0 to 20 feet (0-6 m); total thickness unknown.

Mixed-environment deposits

Qca — **Colluvium and alluvium, undivided** (Holocene to upper Pleistocene) – Undifferentiated hillslope colluvium, stream and fan alluvium, and small landslide deposits; thickness up to approximately 50 feet (0-15 m).

Qac — **Alluvium and colluvium, undivided** (Holocene) – Undifferentiated stream and fan alluvium and hillslope colluvium; may also locally include eolian silt and sand; deposited in shallow drainages associated with intermittent streams, and in small, shallow basins; thickness up to approximately 50 feet (0-15 m).

Mass-movement deposits

Qmsy — **Younger landslide deposits** (historical to upper Pleistocene?) – Angular, poorly sorted debris and blocks of rock, similar to Qmso; derived from volcanic rock units, Arapien Shale, and Green River Formation; includes one slide along State Route 28 having probable historical movement; thickness highly variable.

Qmso — **Older landslide deposits** (upper? to middle Pleistocene) – Angular, poorly sorted debris and blocks of rock; derived from the Green River Formation, volcanic rock units, and surficial deposits; dissected and subdued morphology distinguishes these deposits from unit Qmsy; thickness highly variable.

Human-made deposits

Qf — **Fill** (historical) – Fill material along Interstate Highway 15 (I-15); fill and local earth materials that have been graded or reworked in the vicinity of the Mills interchange on I-15; local earth materials used to construct dams for stock ponds and berms to divert drainages; thickness 0 to 20 feet (0-6 m).

Stacked-unit deposits

Qa/Qdf — **Undifferentiated alluvium over deltaic fines** (Holocene/upper Pleistocene) – Fine-grained alluvial deposits forming a veneer over Lake Bonneville deltaic fines; forms flat-topped and irregular surfaces covering underlying materials; thickness 0 to 10 feet (0-3 m).

Qa/QTaf — **Undifferentiated alluvium over oldest alluvial-fan deposits** (Holocene/Pleistocene to Pliocene?) – Fine-grained alluvial deposits forming a veneer over oldest alluvial-fan deposits; forms gently sloping to irregular surfaces covering underlying materials; thickness 0 to 10 feet (0-3 m).

Ql/QTaf — **Undifferentiated lacustrine deposits over oldest alluvial-fan deposits** (upper Pleistocene/Pleistocene to Pliocene?) – Clay- to pebble-size lacustrine sediment forming a veneer over oldest alluvial-fan deposits located immediately below the Bonneville shoreline; thickness less than 20 feet (<6 m).

Ql/Tfg — **Undifferentiated lacustrine deposits over Tertiary fines and gravels** (upper Pleistocene/Pliocene? to Miocene?) – Clay- to pebble-size lacustrine sediments forming a veneer over Tertiary fines and gravels located immediately below the Bonneville shoreline; thickness less than 20 feet (<6 m).

QUATERNARY-TERTIARY

QTaf — **Oldest alluvial-fan deposits** (Pleistocene to Pliocene?) – Yellowish-gray to light-brownish-orange, coarse- to fine-grained, poorly sorted, deeply dissected alluvial, debris flow, and colluvial sediment shed from San Pitch Mountains to the east (much of it derived from the Green River Formation); typically unconsolidated, but locally consolidated; covers a large portion of the South Hills and Flat Canyon areas; clasts include brown sandstone, quartzite, carbonates, and volcanic rocks; higher in elevation and more deeply incised than younger alluvial fans; locally unconformably overlies Tertiary fines and gravels (Tfg) and various bedrock units; query indicates uncertain designation; exposed thickness up to about 200 feet (0-60+ m); total thickness uncertain.

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TERTIARY

Tfg — **Tertiary fines and gravels** (Pliocene? to Miocene?) – Moderate-reddish-orange, fine-grained to pebbly alluvial debris; typically unconsolidated with no obvious stratification, but locally consolidated; the unit primarily consists of silt and clay with few clasts, while pebbly and cobbly areas contain clasts of rounded quartzite, light-red sandstone, and minor volcanics; locally exposed beneath older alluvial-fan deposits (QTaf) throughout the South Hills, where it unconformably overlies paleotopography developed on volcanic bedrock units (map units Tgh and Tp5); exposed thickness up to about 100 feet (0-30+ m); total thickness unknown.

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TERTIARY INTRUSIVE ROCKS

The Utah Geological Survey (UGS) submitted rock samples to the New Mexico Geochronology Research Laboratory (NMGRL) for geochronologic analyses; NMGRL and UGS (2005) and UGS and NMGRL (2006) provide selected $^{40}Ar/^{39}Ar$ radiometric age data. Clark (2006) includes major- and trace-element whole-rock geochemical data. Rock names are derived from a total alkali-silica diagram (after LeBas and others, 1986) (figure 1), excluding hornblende monzonite porphyry (sample PR-15).

Thmp — **Hornblende monzonite porphyry** (upper Oligocene) – Pinkish-gray to light-gray hornblende monzonite porphyry that weathers to a yellow and brown grusy talus with a cinder-like appearance; exposed in two small outcrops north of Little Salt Creek as dikes or sills within the Jurassic Arapien Shale near the contact with the Green River Formation; similar rock types form stocks, plugs, dikes, and sills in adjacent quadrangles to the east and north (John, 1964, 1972; Auby, 1991; Weiss and others, 2003); the rock has an aphanitic groundmass of K-feldspar and andesine and phenocrysts of feldspar, hornblende, and biotite (also see John, 1964, 1972). K-Ar ages of related intrusions are 23.3 to 23.8 million years (Witkind and Marvin, 1989; Auby, 1991); we obtained a new $^{40}Ar/^{39}Ar$ isochron age on hornblende of 23.97 ± 0.14 Ma from a hornblende monzonite porphyry (sample PR-15) that crops out one mile (1.6 km) northeast of the Skinner Peaks quadrangle exposures (in the Chriss Canyon quadrangle) (NMGRL and UGS, 2005; Clark, 2006); exposed width less than 30 feet (<9 m).

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TERTIARY SEDIMENTARY AND VOLCANIC ROCKS

Tv — **Undifferentiated Oligocene-Eocene volcanic rocks** – Subsurface only.

Formation of Painted Rocks *(new informal name)* (lower Oligocene to middle Eocene) We recommend use of this informal unit terminology rather than applying the name Goldens Ranch Formation for selected map units, pending a regional study of the volcanic rocks. Refer to Correlation of Map Units. Further clarification of volcanic stratigraphy in this region is warranted.

Tp_{4-5} — **Members 4 and 5, undivided** – Locally mapped as combined unit in small exposures.

Tp_{3-5} — **Members 3, 4 and 5, undivided** – Locally mapped as combined unit in small exposures.

Tp_5 — **Member 5** – Gray to brown volcanic conglomerate, "salt and pepper" quartz sandstone, and tuffaceous sandstone; poorly consolidated, rubbly to sandy exposures; volcanic conglomerate with pebbles to boulders of dark-gray to dark-pink subangular to subrounded volcanic clasts and lesser quartzite and carbonate clasts; conglomerate exposures typically contain welded Fernow Quartz Latite clasts, and South Hills exposures also locally contain clasts of tuff derived from member 4 and tuff of Little Sage Valley (Clark, 2003); sandstone forms a few ledges but typically weathers to moderate- to dark-brown sandy expanses; total thickness unknown due to poor exposures and structural complications, but possibly 1000 to 2000 feet (300-600 m) thick; locally includes small areas of other members too small to map separately; interbedded with these lahar and alluvial deposits are welded tuff and ash-flow tuff units described below.

Tp_{5w} — **Member 5, welded-tuff unit** – Grayish-pink densely welded rhyolite with phenocrysts of quartz and biotite (Clark, 2006); unit is typically fractured with no obvious layering or foliation; forms small cliffs; sample PR-28 yielded an $^{40}Ar/^{39}Ar$ age of 29.81 ± 0.14 Ma (on biotite); as mapped may also include small exposures of Tp_{5a}; stratigraphic position within Tp_5 not well constrained; thickness up to approximately 50 feet (0-15 m).

Tp_{5a} — **Member 5, ash-flow-tuff unit** – Very light gray, poorly to moderately welded dacite with phenocrysts of quartz, feldspar, and bronze biotite flakes (see Clark, 2006); forms slopes to small cliffs; locally present beneath welded tuff unit; as mapped may include small exposures of Tp_{5w}; stratigraphic position within Tp_5 not well constrained; thickness up to approximately 50 feet (0-15 m).

Tp_{1-4} — **Members 1, 2, 3 and 4, undivided** – Combined unit; cross section A-A' only.

Tp_{2-4} — **Members 2, 3 and 4, undivided** – Combined unit; cross section B-B' only.

Tp_4 — **Member 4** – Very pale orange to grayish-orange-pink, poorly to moderately welded rhyolitic ash-flow tuff with conspicuous pumice and rock fragments and some quartz and biotite phenocrysts (Clark, 2006); exposures vary from poor to good; weathers to honeycomb pattern and small caves; vertical fracturing and lack of layering typical; distinctive rock unit capping Painted Rocks cuesta at Yuba State Park (section 32, T. 16 S., R. 1 W. and section 5, T. 17 S., R. 1 W., Hells Kitchen Canyon SW quadrangle); sample PR-9 yielded an $^{40}Ar/^{39}Ar$ single crystal fusion sanidine age of 34.00 ± 0.13 Ma, which supercedes prior K-Ar ages from Witkind and Marvin (1989); locally includes small outcrops of other members too small to map separately; locally quarried for use as poultry grit and soil mineralizer (Pratt and Callaghan, 1970); approximately 70 to 150 feet (20-45 m) thick.

Tp_{2-3} — **Members 2 and 3, undivided** – Locally mapped as combined unit in small exposures.

Tp_3 — **Member 3** – Pinkish-gray to locally moderate-reddish-orange (near Skinner Peaks) quartz-rich sandstone; unique unit containing about 60-80% coarse to very coarse sand-size, euhedral to subangular quartz grains; also locally includes rounded pebbles and cobbles of volcanic rocks and quartzite, including welded Fernow Quartz Latite clasts (34.83 ± 0.15 Ma; Clark, 2003), thus suggesting a northward source area; ledge-forming unit that is medium to thickly bedded with very low-angle cross-stratification; locally includes small outcrops of other members too small to map separately; unit thickness from about 50 to 90 feet (15-25 m).

Tp_2 — **Member 2** – Grayish-pink, poorly to moderately welded rhyolitic ash-flow tuff, with phenocrysts of quartz, sanidine(?), and minor biotite, as well as pumice(?) and dark rock fragments; sample PR-16 yielded an $^{40}Ar/^{39}Ar$ age of 35.19 ± 0.14 Ma on sanidine; available data suggest that member 2 correlates with the Fernow Quartz Latite exposed in the southern East Tintic Mountains and Sage Valley; typically forms poorly exposed slopes; locally includes small outcrops of other members too small to map separately; from 40 to 100 feet (12-30 m) thick.

Tp_1 — **Member 1** – Upper part of unit (about 200 feet [60 m]) exposed at Painted Rocks consists of gray and light-bluish-gray volcanic conglomerate and tuffaceous sandstone; pebble- to boulder-size, dark-gray to dark-pink, subangular to subrounded volcanic clasts with minor quartzite and carbonate clasts; most extensive exposures of member 1 in "Milky Wash" area of Vogel (1957) (not named on topographic base map; section 27 and 34, T. 16 S., R. 1 W.); also includes gray, brown, green, and blue tuffaceous sandstone and mudstone with minor volcanic conglomerate and tuff; includes the Chicken Creek Tuff (38.61 ± 0.13 Ma; Clark, 2003) within the lower part of the unit; the Placid Oil Barton #1 well (table 1) contains an incomplete section of member 1 totaling about 1325 feet (405 m), which includes about 470 feet (143 m) of member 1 below the Chicken Creek Tuff; locally includes small outcrops of other members too small to map separately; total member 1 thickness unknown but estimated at 1700 feet (520 m).

Goldens Ranch Formation (upper? to middle Eocene) – Originally defined by Muessig (1951a, 1951b). Revised by Meibos (1983) to include only the lower part of Muessig's formation and divided into three members, named the upper Sage Valley Limestone, middle Hall Canyon Conglomerate, and lower Chicken Creek Tuff. We do not follow the suggested revision of the Goldens Ranch Formation by Witkind and Marvin (1989), and believe that a regional study of the volcanic rocks is needed to clarify outstanding stratigraphic issues. Refer to Correlation of Map Units. After Meibos (1983) and excluding the Sage Valley Limestone Member, which is not present in this quadrangle:

Tgh — **Hall Canyon Conglomerate Member** – Gray, poorly consolidated conglomerate and volcanic conglomerate; clast composition varies from quartzite-carbonate to volcanic; clasts are angular to subrounded pebbles to boulders in an ashy to sandy matrix; typically forms rubbly slopes; mapped in the northwest part of the quadrangle near Chicken Creek Reservoir where it directly overlies the Green River Formation; apparently laterally equivalent to lower portion of member 1 – formation of Painted Rocks; exposed thickness about 100 to 300 feet (30-90 m).

Tgc — **Chicken Creek Tuff Member** – Grayish-pink to light-gray, poorly welded, vitric, dacitic ash-flow tuff with pumice lapilli, volcanic and quartzite rock fragments, and minor biotite; generally not well exposed; named for small exposure southwest of Chicken Creek Reservoir in section 19, T. 15 S., R. 1 W.; other exposures are in and near "Milky Wash"; query indicates uncertain designation; $^{40}Ar/^{39}Ar$ age of 38.61 ± 0.13 Ma from Sage Valley (Clark, 2003) supercedes K-Ar ages from Everenden and James (1964) and Witkind and Marvin (1989); source unknown; near the reservoir, located within the Hall Canyon Conglomerate Member from roughly 200 feet (60 m) or less above the top of the Green River Formation; near Painted Rocks and "Milky Wash" located stratigraphically within the lower part of member 1 (about 470 feet [145 m] above base); exposed thickness less than 100 feet (30 m), but total dip-corrected thickness in Placid Barton well is 170 feet (50 m).

Tg — **Green River Formation** (middle Eocene) – West Hills exposures (see Clark, 1987, 1990; Felger, 1991): upper part is interbedded moderate-greenish-yellow and moderate-greenish-gray mudstone, and yellowish-gray, fossiliferous, platy, micritic limestone; mudstones become ashy near contact with overlying Hall Canyon Conglomerate; middle part is orange, brown, and gray conglomerate, mudstone, sandstone, and siltstone; lower part is green mudstone capped by yellowish-gray to light-olive-gray stromatolitic limestone; the formation is nearly 900 feet (275 m) thick (Clark, 1990).

Skinner Peaks area exposures: clastic lithofacies previously referred to as the "Tawny facies" (Zeller, 1949; Hardy and Zeller, 1953; Vogel, 1957; Millen, 1982; Felger, 1991; Weiss and others, 2003) composed of green, red, and variegated mudstone, and yellowish-tan coarse-grained sandstone, conglomerate, conglomeratic sandstone, and limestone; this lithofacies grades laterally eastward into the upper limestone member of the Green River Formation in the adjacent Chriss Canyon quadrangle (Millen, 1982; Weiss and others, 2003); sandstone near top of section contains reptilian(?) vertebrate fossils (Vogel, 1957; Felger, 1991); on the north side of Chriss Creek, unit has a heavy colluvial cover or locally a veneer of QTaf that has not been mapped separately; contact with overlying volcanic rocks not exposed, but present in Barton #1 well and is possibly conformable; directly overlies the Jurassic Arapien Shale at and north of Skinner Peaks; total thickness in subsurface from 1100 to 1300 feet (335-395 m).

Tc — **Colton Formation** (lower Eocene) – Moderate-reddish-orange, moderate-reddish-brown, and pale-red mudstone, and lesser sandstone, conglomerate, and mottled carbonates (mottled pale red, reddish orange, and white with reduction spots); existence in West Hills follows Witkind and Weiss (1991), but is apparently absent in the Skinner Peaks area; conformable with overlying Green River Formation and underlying Flagstaff Formation; thickness from 0 to 300 feet (0-90 m); 414 feet (126 m) logged in the State #1 drill hole.

Tf — **Flagstaff Formation** (lower Eocene to upper Paleocene) – As mapped in West Hills, grayish-yellow to pale-reddish-orange calcareous mudstone, sandstone, sandy limestone, limestone, and conglomerate (also see Lambert, 1976; Vorce, 1979); base not exposed; exposed thickness 525 feet (160 m), but total thickness in West Hills is about 650 feet (200 m) (Clark, 1987, 1990); 295 feet (90 m) logged in the State #1 drill hole; locally absent near Skinner Peaks or included within map unit TKuu and/or TKul.

TKnh — **North Horn Formation** (Paleocene? to Upper Cretaceous [Maastrichtian]) – Subsurface only (refer to cross section A-A'); may be included within map unit TKuu and/or TKul.

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TERTIARY-CRETACEOUS

TKu — **Tertiary-Cretaceous strata, undifferentiated** – Corresponds to Colton, Flagstaff, and North Horn Formations; subsurface only (see Correlation of Map Units).

TKuu — **Upper unit of undifferentiated Tertiary-Cretaceous strata** (middle to lower Eocene? to Upper Cretaceous [Maastrichtian]?) – Outcrops on the northeast side of Skinner Peaks between the Green River Formation (Tawny facies) above and TKul (conglomeratic unit) or Arapien Shale below; consists of sandstone, sandy limestone, mudstone, pebble conglomerate, and oncolitic limestone; possible equivalent to Green River, Colton, Flagstaff, and/or North Horn Formations; Felger (1991) measured 216 feet (65 m); thickness from 0 to 300 feet (0-90 m).

TKul — **Lower unit of undifferentiated Tertiary-Cretaceous strata** (lower Eocene? to Upper Cretaceous?) – One conglomeratic outcrop belt on the northeast side of Skinner Peaks consisting of gray carbonate-clast conglomerate overlying red quartzite-clast conglomerate; the carbonate clast conglomerate contains predominantly pebbles and cobbles of gray carbonate and forms a cliff; the quartzite-clast conglomerate contains cobbles and boulders of Proterozoic Mutual Formation and Dutch Peak Formation (distinctive frosted lime-green quartzite) and Cambrian Prospect Mountain Quartzite, and forms ledges and small cliffs; the quartzite-clast conglomerate appears somewhat similar to the Red Narrows Conglomerate and North Horn Formation mapped in the West Hills (see Meibos, 1983; Clark, 1990); possible equivalent to Flagstaff Formation, North Horn Formation, or Indianola Group strata; Felger (1991) measured approximately 300 feet (90 m); thickness from 0 to 300 feet (0-90 m).

unconformity

CRETACEOUS

Refer to table 1 for data on subsurface units of Cretaceous and older age from exploratory drill holes (see Sprinkel, 1994; Sprinkel and others, 1999).

Ku (Kiu, Kisp) — **Cretaceous strata, undifferentiated** (Upper and Lower Cretaceous) – Corresponds to the Indianola Group undifferentiated (Kiu), San Pitch Formation (Kisp), and Cedar Mountain Formation; subsurface only (see Correlation of Map Units and cross section A-A').

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JURASSIC

Jtg — **Twist Gulch Formation** (Middle Jurassic) – Subsurface only in Barton well (table 1).

Ja — **Arapien Shale** (Middle Jurassic [Callovian to Bathonian]) – Mostly thin-bedded calcareous mudstone and muddy micritic limestone, which is light yellowish or olive gray, weathering to very light gray or white; includes a few beds of calcareous, fine-grained sandstone or sandy siltstone; gypsum occurs in thin discontinuous beds and also forms beds or large pods locally tens of feet thick; the pods on the north side of Skinner Peaks have been mined; more extensive gypsum beds are present along the eastern map border; many mudstone beds near the larger pods of gypsum are red or light gray streaked with red; the depositional thickness of the Arapien Shale is not known, and the Arapien is so folded and faulted that a reasonable thickness cannot be measured (see Witkind, 1983, 1994; Lawton, 1985; Villien and Kligfield, 1986; Lawton and others, 1997; Willis, 2006); a maximum thickness of 3500 feet (1065 m) is reported from exploratory drill holes in the quadrangle. Also refer to the discussion of Arapien Shale Relations.

Jtc — **Twin Creek Limestone, undivided** (Middle Jurassic) – Subsurface only.

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Jn — **Navajo Sandstone** (Lower Jurassic) – Subsurface only; unit may include Kayenta Formation (Lower Jurassic) and Wingate Sandstone (Lower Jurassic-Upper Triassic) strata based on unpublished well log interpretation; the Navajo, Kayenta, and Wingate are collectively referred to as the Glen Canyon Group.

unconformity

TRIASSIC

TRc — **Chinle Formation, undivided** (Upper Triassic) – Subsurface only.

unconformity

TRm — **Moenkopi Formation, undivided** (Middle to Lower Triassic) – Subsurface only.

unconformity

PERMIAN – CAMBRIAN?

Pz — **Paleozoic strata, undivided** (Permian to Cambrian?) – Differing interpretations of Paleozoic units in well logs; subsurface only; Pz unit of cross section A-A' includes Permian Black Box Dolomite and Toroweap Formation, and Mississippian Humbug Formation and Deseret Limestone.

Arapien Shale Relations

In the Skinner Peaks quadrangle, the Jurassic Arapien Shale is present near Little Salt Creek and at Skinner Peaks, the southernmost exposures of the Levan culmination (John, 1972; Ritzma, 1972; Standlee, 1982; Auby, 1991; Weiss and others, 2003; Willis, 2006). The Levan culmination is a large north-trending, doubly plunging anticlinal structure cored by Arapien along the west side of the San Pitch Mountains (Gunnison Plateau), extending about 20 miles (32 km) from near Salt Creek Canyon (Nephi quadrangle) southward to Little Salt Creek (Standlee, 1982; Auby, 1991; Biek, 1991; Weiss and others, 2003). The specific relationship of the Arapien to other rock units and structures in the quadrangle is complex and presently not well understood; accordingly, we provide this brief background discussion on this interesting aspect of the quadrangle.

In general, the Arapien played a major role in the structural development of central Utah, but the nature of that role has been debated for decades. Two primary schools of thought have emerged regarding the dominant structural mechanisms: (1) Sevier-age (Late Cretaceous to Eocene) thrust faulting and folding (compression) followed by later extension (Standlee, 1982; Lawton, 1985; Villien and Kligfield, 1986; DeCelles and others, 1995; Lawton and others, 1997; Bartley and Walker, 1999; Willis, 1999; Cline and Bartley, 2002), and (2) diapirism of Arapien shale and evaporite (Stokes, 1952, 1982; Baer, 1976; Witkind, 1982, 1983, 1987, 1992, 1994; Witkind and Page, 1984). A useful synthesis of the concepts presented in the aforementioned references is given in Willis (2006). The Arapien is known to have been a weak zone that accommodated Sevier-age thrust faulting and structural shortening, but the extent of shale-evaporite diapirism is unclear. Most geologists currently favor the thrusting and extension structural mechanism with possible localized shale-evaporite diapirism (D.A. Sprinkel, UGS, verbal communication, 2005; Willis, 2006).

Interesting geologic relations in the Skinner Peaks quadrangle associated with the Arapien Shale include complex structures, thinning and thickening of units, and unusual unconformities and contacts. These relations are explained by Sevier-age compression forming the Levan culmination, possible localized shale-evaporite diapirism, post-Sevier relaxation and rebound, and Basin and Range extension.

In the vicinity of Little Salt Creek, the Green River Formation directly overlies an antiformal mass of highly deformed Arapien; the Green River strata there comprise part of the West Gunnison monocline (refer to cross section A-A'). The West Gunnison monocline is a west-dipping panel of Green River and adjacent rocks extending from near Hartleys Canyon (Levan quadrangle) southward to Fayette Wash (Gunnison quadrangle) (Mattox, 1987, 1992; Auby, 1991; Felger, 1991; Weiss and others, 2003). The unconformable relationship of Green River on Arapien may be depositional or structural. It is not clear whether intervening beds between the Arapien and Green River were not deposited over the Levan culmination, or were eroded from it as stated by Weiss and others (2003). Later extension appears to have further modified these exposures, particularly considering their proximity to the Wasatch fault zone.

Exposures in the Skinner Peaks area indicate that the Levan culmination formed as thrust faulting stacked up thickened, incompetent Arapien strata (see cross section B-B'). This thickened mass then stood as a paleotopographic high from the Late Cretaceous to early Tertiary. Possible localized shale-evaporite diapirism or rebound may have helped maintain this topographic high for roughly 40 million years. The Arapien in this area is so highly deformed that bedding is generally unrecognizable, whereas bedding in overlying units can often be readily determined. The Tertiary-Cretaceous strata (TKu) are relatively thin and pinch out, and locally there are some unusual contacts between the Arapien and Green River. The presence of volcanic strata adjacent to the Arapien suggests post-Sevier relaxation and Basin and Range extension along steep- to low-angle faults, or possibly some intermittent localized shale-evaporite diapirism. The degree of structural influence (faulting or diapirism) versus paleotopography (causing depositional thinning and unconformities) is generally difficult to determine in the Skinner Peaks area.

DESCRIPTION OF GEOLOGIC SYMBOLS

Contact – Dashed where approximately located; includes probable depositional? and structurally deformed contact between Arapien Shale and overlying units (see Arapien Shale Relations discussion)

Tp_{5w} G — Marker bed – G indicates major bed of gypsum in Arapien Shale

Normal fault – Dashed where approximately located, dotted where concealed and approximately located; query indicates uncertain presence; bar and ball on down-dropped side; arrows on cross section show relative displacement

Thrust fault (cross section A-A') – Dashed where approximately located; arrows show relative displacement; double barbed arrows indicate two senses of fault displacement

Axial trace of anticline – Dashed where approximately located; arrow shows direction of plunge

B — Lake Bonneville shoreline (Bonneville level) – Dashed where poorly developed

Landslide scarp – Hachures on down-dropped side

Closed depression

Strike and dip of bedding

20 — Inclined

Vertical

Approximate strike and dip direction

Hydrocarbon exploration drill hole (dry hole, abandoned) – From Utah Division of Oil, Gas and Mining files

Sand and gravel pit

Quarry – G = gypsum, T = tuff, D = decorative stone, S = stone or aggregate (locations from field mapping)

Adit

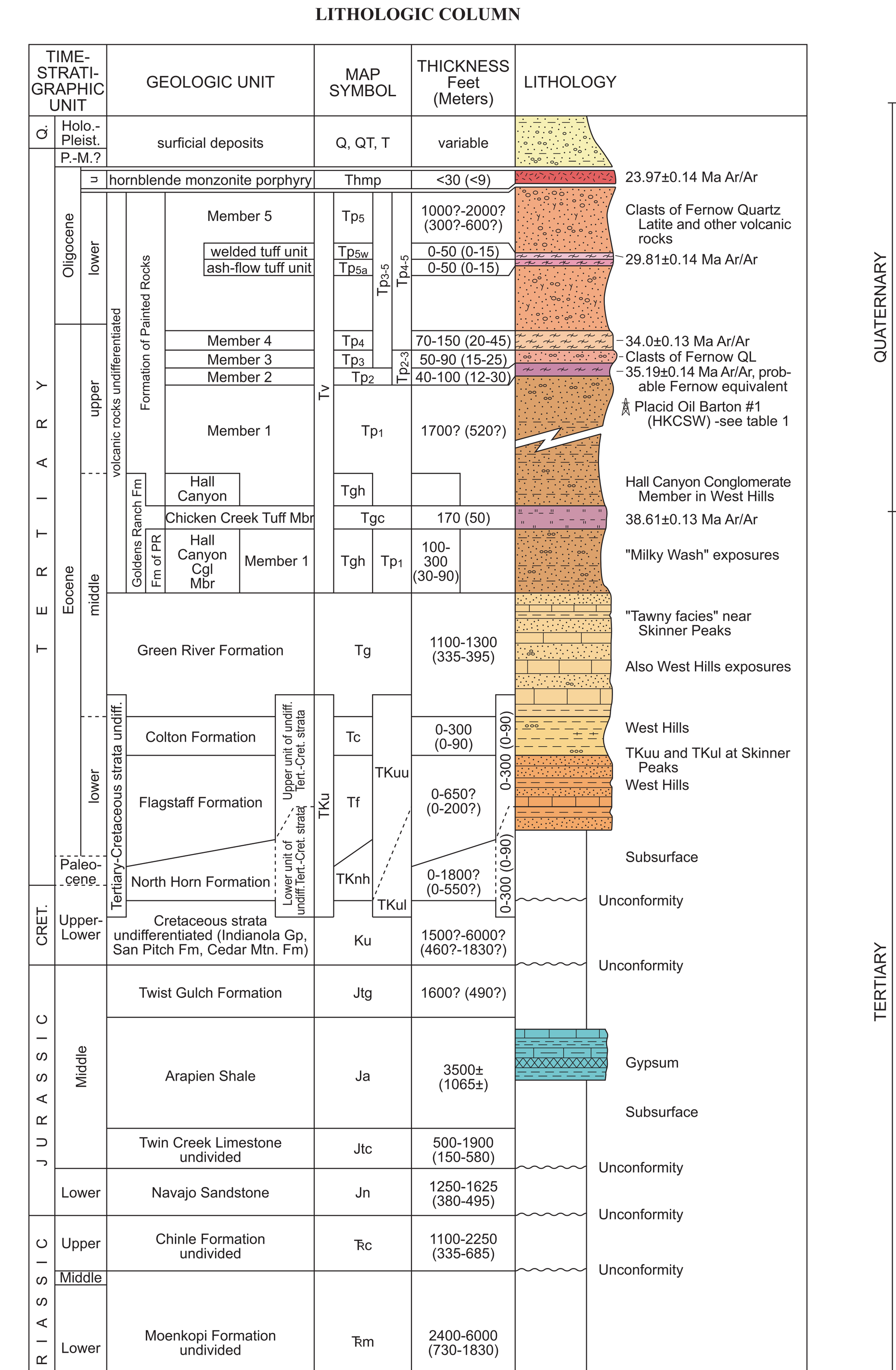
x — Prospect pit

Paleoseismic trench location on Wasatch fault scarp (see Jackson, 1991)

PR-21 — Rock sample location and number (see NMGRL and UGS, 2005; UGS and NMGRL, 2006; Clark, 2006 for analytical data)

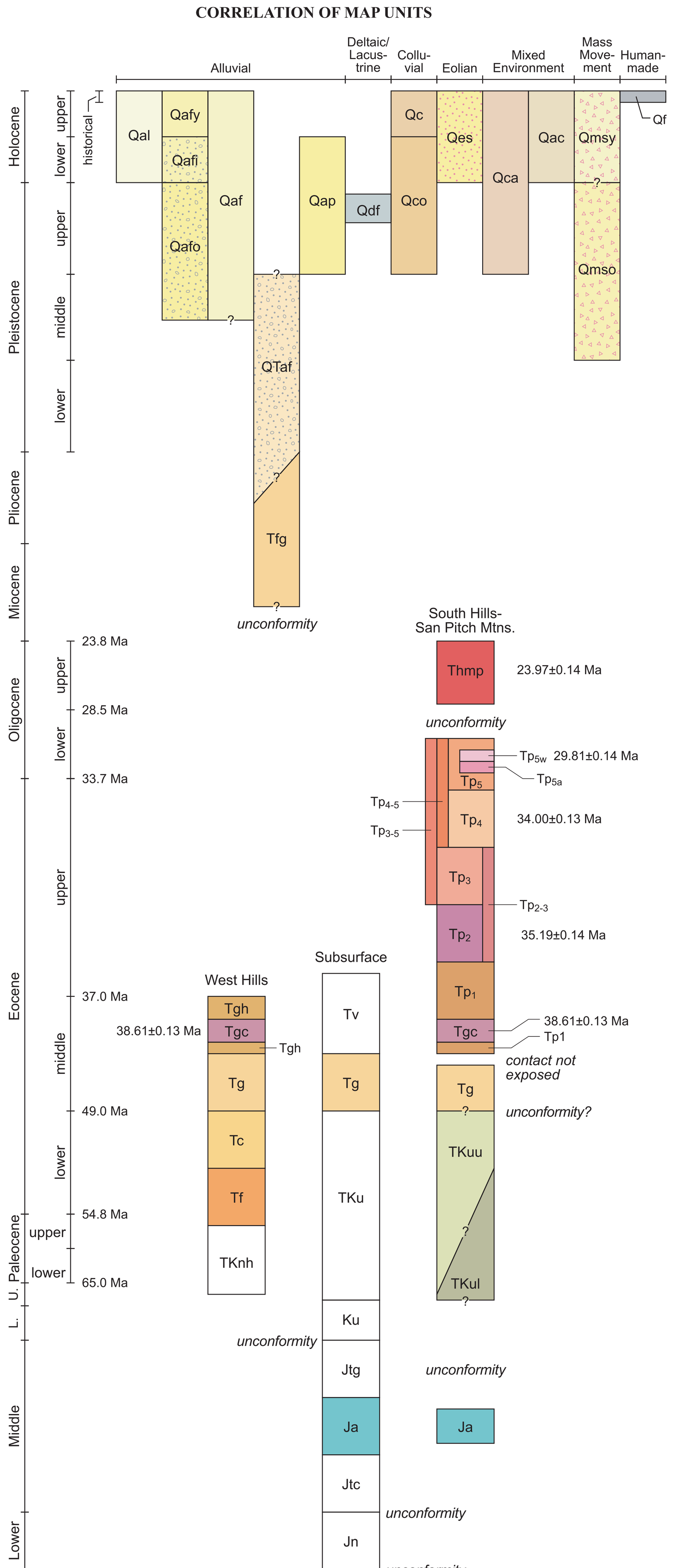
A — A' Line of cross section

LITHOLOGIC COLUMN



Vertical scale reduced for subsurface units. Time scale after Palmer and Geissman (1999).

CORRELATION OF MAP UNITS



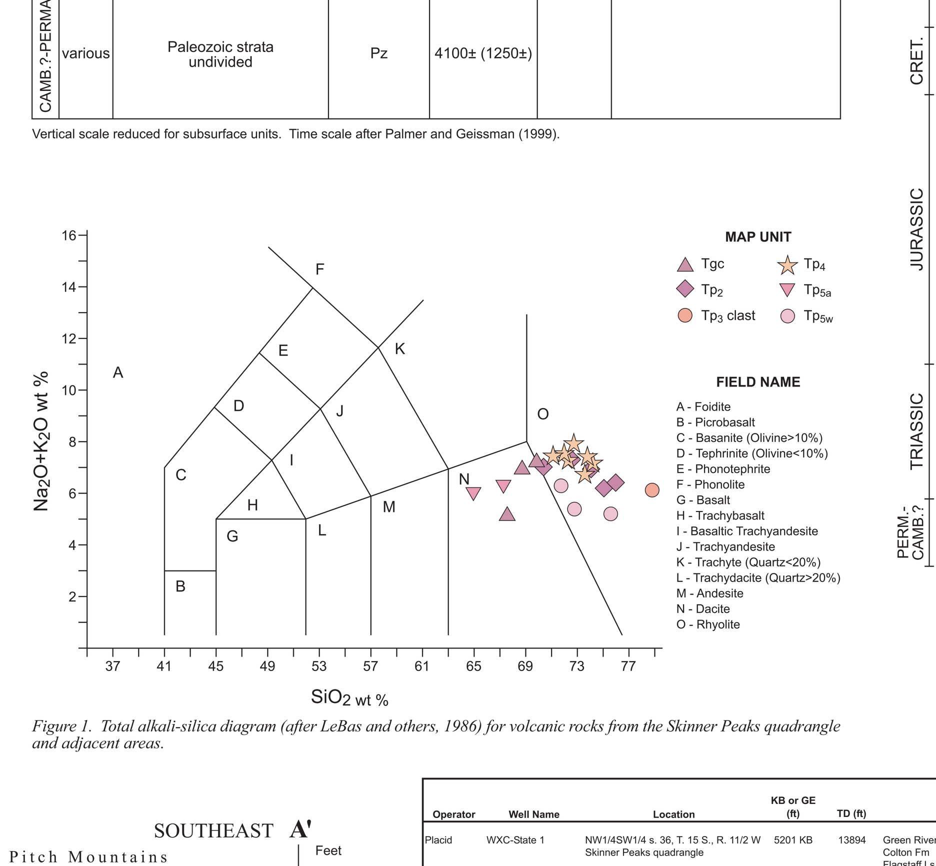
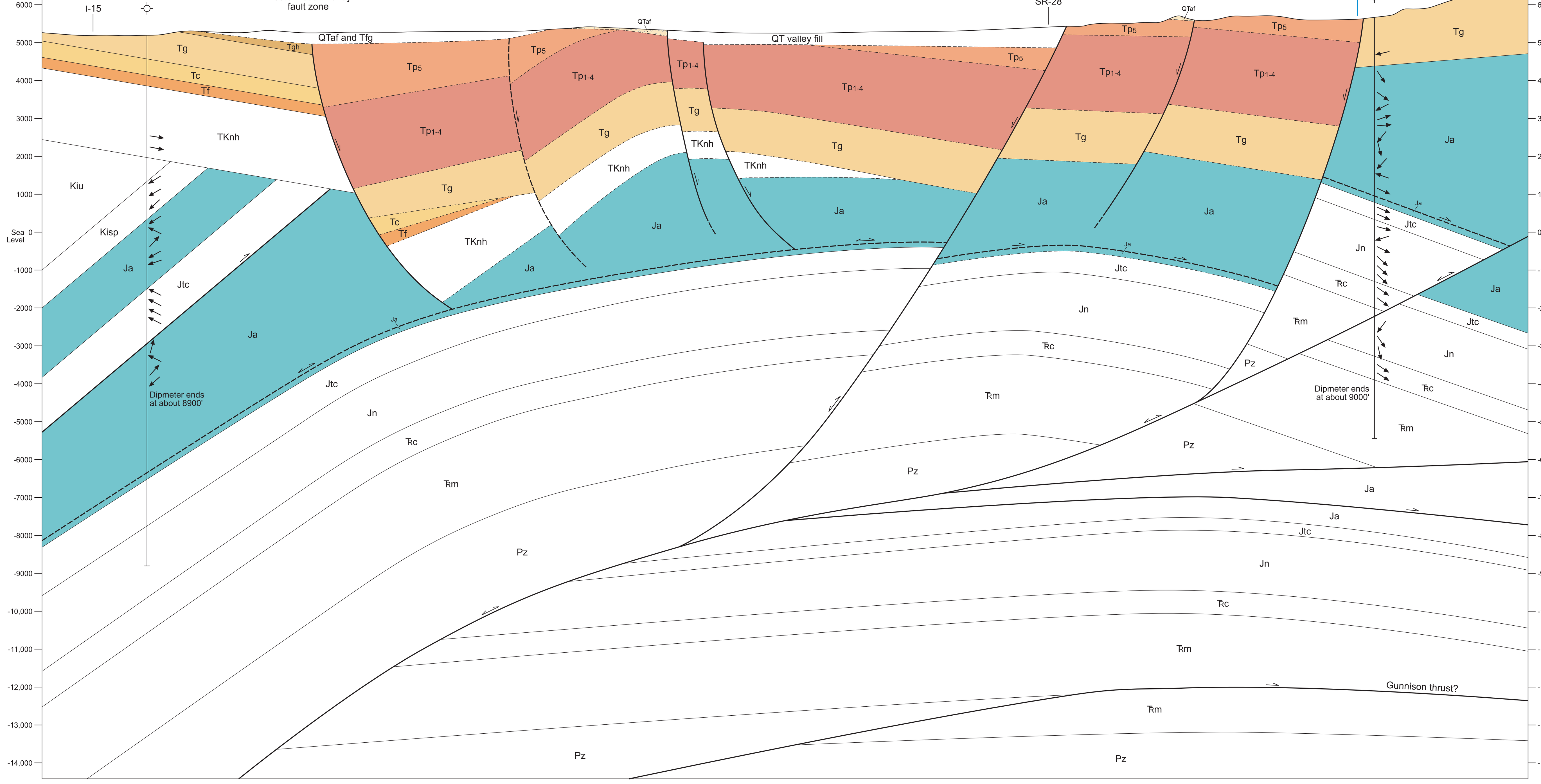


Figure 1. Total alkali-silica diagram (after LeBas and others, 1986) for volcanic rocks from the Skinner Peaks quadrangle and adjacent areas.

Operator	Well Name	Location	KB or GE (ft)	TD (ft)	Formation	Top (ft)	Thickness (ft)	Subsea (ft)
Placid	WXC-State 1	NW1/4SW1/4 s. 36, T. 15 S., R. 11/2 W Skinner Peaks quadrangle	5201 KB	13894	Green River Fm	0	796	5201
					Colton Fm	796	414	4405
					Flagstaff Ls	1210	295	3991
					North Horn Fm	1505	1840	3696
					Indianola Gp	3345	581	1856
					Unnamed conglomerate	3926	922	1275
					Arapien Shale	4848	1904	353
					Twin Creek Ls	6752	999	-1551
					Gypsum Spring Mbr of Twin Ck Ls	7751	344	-2550
					thrust fault	8095	0	-2894
					Arapien Shale	8095	3561	-2894
					Twin Creek Ls	11656	919	-6455
					Gypsum Spring Mbr of Twin Ck Ls	12575	344	-7374
					Navajo Ss	12919	975	-7718
					TD	13894		-8693
Amoco	Sevier Bridge Unit 1	SW1/4SE1/4 s. 11, T. 16 S., R. 1 W. Skinner Peaks quadrangle	5655 KB	11000	Green River Fm	0	1280	5655
					Arapien Shale	1280	3489	4375
					Twin Creek Ls	4769	421	886
					Gypsum Spring Mbr of Twin Ck Ls	5190	45	465
					Navajo Ss	5235	1624	420
					Petrified Forest Mbr of Chinle Fm	6859	611	-1204
					Moss Back Mbr of Chinle Fm	7470	130	-1815
					Moenkopi Fm	7600	390	-1945
					thrust fault	7990	0	-2335
					Navajo Ss	7990	857	-2335
					Petrified Forest Mbr of Chinle Fm	8847	465	-3192
					Moss Back Mbr of Chinle Fm	9312	95	-3657
					Upper Red Mbr of Moenkopi Fm	9407	1054	-3752
					Shnabkaib Mbr of Moenkopi Fm	10461	217	-4806
					Middle Red Mbr of Moenkopi Fm	10678	310	-5203
					Sinbad Ls Mbr of Moenkopi Fm	10988	12	-5333
					TD	11000		-5345
Placid Oil	WXC-Barton #1	NW1/4SE1/4 s. 32, T. 16 S., R. 1 W. Hells Kitchen Canyon SW quadrangle	5116 KB	21845	Goldens Ranch Fm	0	1641	5116
					Green River Fm	1641	1076	3475
					Indianola Gp	2717	1733	2399
					Unnamed conglomerate	4450	767	666
					Cedar Mountain Fm	5217	205	-101
					Twist Gulch Fm	5422	308	-306
					Arapien Shale	5730	1820	-614
					Twin Creek Ls	7550	560	-2434
					Gypsum Spring Mbr of Twin Ck Ls	8110	162	-2994
					Navajo Ss	8272	1246	-3156
					Petrified Forest Mbr of Chinle Fm	9518	367	-4402
					Moss Back Mbr of Chinle Fm	9885	162	-4769
					Moenkopi Fm	10047	1638	-4931
					thrust fault	11685	0	-6569
					Paleozoic	11685	1403	-6569
					thrust fault	13088	0	-7972
					Black Box Dolomite (inverted)	13088	235	-7972
					Black Dragon Mbr of Moenkopi Fm (inverted)	13323	287	-8207
					Sinbad Ls Mbr of Moenkopi Fm (inverted)	13610	572	-8494
					Middle Red Mbr of Moenkopi Fm (inverted)	14182	408	-9066
					Shnabkaib Mbr of Moenkopi Fm (inverted)	14590	241	-9474
					Upper Red Mbr of Moenkopi Fm (inverted)	14831	299	-9715
					thrust fault	15130	0	-10014
					Sinbad Ls Mbr of Moenkopi Fm	15130	584	-10014
					thrust fault	15714	0	-10598
					Upper Red Mbr of Moenkopi Fm	15714	346	-10598
					Shnabkaib Mbr of Moenkopi Fm	16060	260	-10944
					Middle Red Mbr of Moenkopi Fm	16320	310	-11204
					Sinbad Ls Mbr of Moenkopi Fm	16630	565	-11514
					Black Dragon Mbr of Moenkopi Fm	17195	460	-12079
					Black Box Dolomite	17655	235	-12539
					Toroweap Fm	17890	1083	-12774
					Humbug Fm	18973	87	-13857
					Deseret Ls	19060	920	-13944
					Gardison Ls	19980	584	-14864
					Fitchville Fm	20564	246	-15448
					Pinyon Peak Ls	20810	187	-15694
					Cambrian(?)	20997	848	-15881
					TD	21845		-16729
Hiawatha Exploration	Doll-Chase-Mark #18	SE1/4, s. 7, T. 16 S., R. 1 W. Skinner Peaks quadrangle	5215 GE	3418	*no data at surface*	–	–	–
					Green River Fm	1000	–	–
Great Basin Petroleum	Chase 24-10	SE1/SW1/4, s. 10, T. 16 S., R. 1 W. Skinner Peaks quadrangle	5357 GE	3510	*no data at surface*			
					Flagstaff Fm	2070	680	–
					North Horn Fm	2750	–	–

Table 1. Simplified logs of exploratory drill holes in and adjacent to the Skinner Peaks quadrangle. Data for Placid and Amoco drill holes from Sprinkel (1994) and data for other two drill holes from PI/Dwights Plus database; also refer to Welsh's interpretation in Hintze and Davis (2003). KB denotes kelly bushing and GE is ground elevation; TD is total depth.

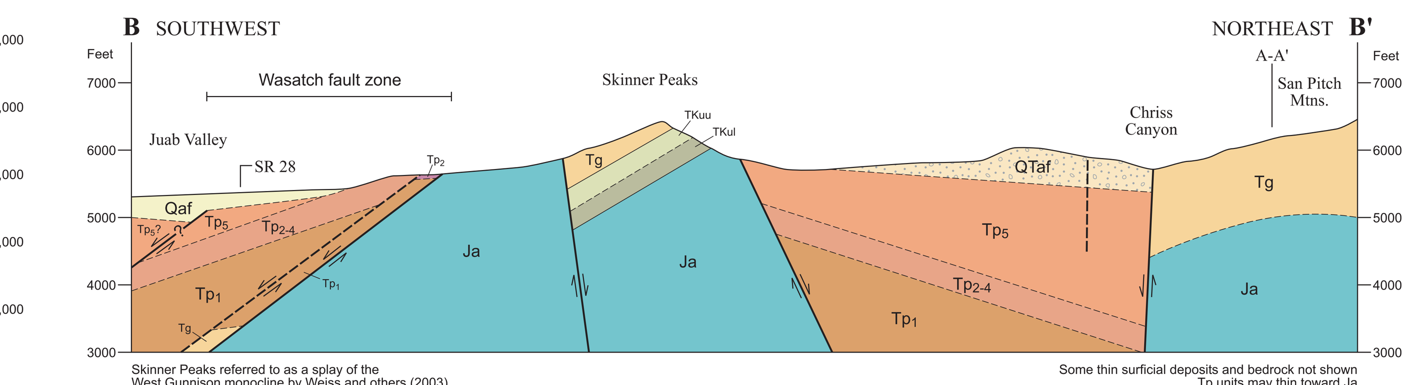


Some thin surficial deposits not shown.
Symbols indicate direction of dip (from dipmeter logs); amount of dip indicated by bedding attitudes depicted on cross section.

Cross section developed with assistance from D. A. Sprinkel (UGS) using drill hole and proprietary seismic-reflection data, and part of regional cross sections of Coogan and others (1995) and DeCelles and Coogan (2006).

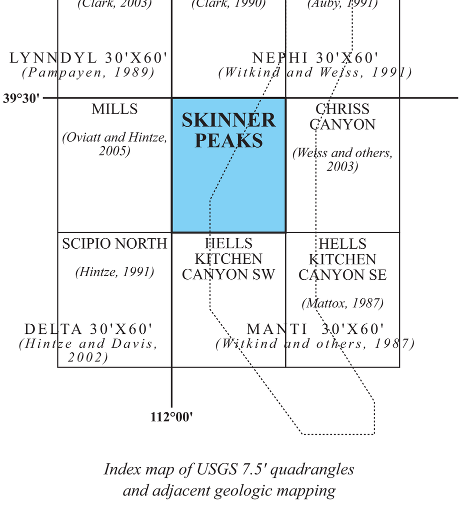
Refer to table 1 for subsurface data (formation tops) of drill holes within and immediately adjacent to the Skinner Peaks quadrangle.

For prior structural interpretations of this general area refer to Standlee (1982), Lawton (1985), Villien and Kligfield (1986), Coogan and others (1995), DeCelles and others (1995), Lawton and others (1997), and DeCelles and Coogan (2006). Geophysical data and interpretations by Zoback (1983, 1992) and Smith and Bruhn (1984).



Skinner Peaks referred to as a splay of the West Gunnison monocline by Weiss and others (2003).

Some thin surficial deposits and bedrock not shown
Tp units may thin toward Ja
TKu units may thin to SW



Index map of USGS 7.5' quadrangles and adjacent geologic mapping

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