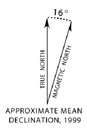
SCALE 1:24,000

Contour Interval 40 feet

1 0.5 0 1 2 Miles



Geologic data in NAD 1927; base map in NAD 1927.
Field mapping by authors, 2005.
Cartographic assistance by Paul Kuehne and Darryl Greer.

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Interim Geologic Map of the West Mountain Peak Quadrangle, Washington County, Utah

by
Janice M. Hayden, Lehi F. Hintze, and J. Buck Ehler

2005

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Description of Map Units

QUATERNARY

Alluvial deposits

Qal_1 **Alluvial-stream deposits** (Holocene) – Moderately to well-sorted clay to boulder deposits in large active drainages; includes terraces up to 5 feet (1.5 m) above modern channels; mapped along Beaver Dam Wash and the lower reaches of Jackson Wash in the northwest corner of the quadrangle; 0 to 30 feet (0-9 m) thick.

Qat_2-Qat_5

Alluvial-terrace deposits (Holocene to Pleistocene) – Moderately to well-sorted sand, silt, and pebble to boulder gravel that forms level to gently sloping surfaces above modern drainages; subscript denotes height above drainages; level-2 deposits are about 5 to 30 feet (1.5-9 m), level-3 deposits are 30 to 60 feet (9-18 m), level-4 deposits are 60 to 120 feet (18-37 m), and level-5 deposits are 120 to 180 feet (37-55 m) above modern drainages; deposited primarily in stream-channel and flood-plain environments; mapped along Beaver Dam Wash and Jackson Wash in the northwest corner of the quadrangle; map unit includes underlying Quaternary-Tertiary alluvial-pediment and basin-fill deposits (QTapb) that cannot be differentiated along the steep margins of Beaver Dam Wash due to lithologic similarities; 0 to 30 feet (0-9 m) thick.

Colluvial deposits

Qc **Colluvial deposits** (Holocene to Pleistocene) – Poorly to moderately sorted, angular to subrounded, clay- to boulder-size, locally derived sediment deposited principally by slope wash and soil creep on moderate to steep slopes; locally includes talus and alluvial deposits too small to map separately; commonly included in mixed alluvial and colluvial deposits (Qac) along the edges of drainages and at the head of canyons; 0 to 20 feet (0-6 m) thick.

Mass-movement deposits

Qms **Landslide deposit** (Pleistocene) – Very poorly sorted, clay- to boulder-size, subangular to subrounded debris in chaotic, hummocky mounds; involves Triassic rocks from the Shinarump Conglomerate Member of the Chinle Formation along with the upper red and Shnabkaib Members of the Moenkopi Formation; sits on the Permian Pakoon Dolomite in the northeast corner of the quadrangle; 0 to 100 feet (0-30 m) thick.

Mixed-environment deposits

Qac, Qaco

Mixed alluvial and colluvial deposits (Holocene to Pleistocene) – Poorly to moderately sorted, clay- to boulder-size, locally derived sediment; gradational with alluvial and colluvial deposits; younger material (Qac) is deposited in swales and minor active drainages whereas older deposits (Qaco) are younger

than and commonly derived from alluvial-pediment and basin-fill deposits (QTapb); older deposits form incised, inactive, gently sloping surfaces along minor active drainages that are similar to terraces along a major drainage; 0 to 30 feet (0-9 m) thick.

Qeac **Mixed eolian and alluvial deposits with pedogenic carbonate soil** (Holocene to Pleistocene) – Windblown sand, silt, and clay with minor alluvial deposits; bluish-white, stage V (Birkeland and others, 1991), laminated pedogenic carbonate (caliche) deposits with crinkle bedding and well-developed pisoliths; eolian deposition is ongoing; map unit locally includes 0 to 5 feet (0-1.5 m) of yellowish-gray to light-olive-gray conglomerate of the underlying unit, that is generally better-cemented; forms isolated deposit on top of Quaternary-Tertiary alluvial-pediment and basin-fill (QTapb) deposits along the north edge of the quadrangle but becomes more extensive to the northwest and in the Terry Benches quadrangle to the southeast; 5 to 15 feet (1.5-4.5 m) thick.

QUATERNARY - TERTIARY

Alluvial deposits

QTapb **Alluvial-pediment and basin-fill deposits** (Pleistocene to Pliocene) – Silt, sand, gravel, and boulder conglomeratic deposits derived mostly from Precambrian metamorphic and Paleozoic sedimentary rocks of the Beaver Dam Mountains, but also includes a variety of volcanic rocks derived from the Bull Valley Mountains to the north; forms extensive surfaces, which slope toward Beaver Dam Wash, that are deeply incised, in some areas up to 300 feet (90 m); conglomerate is matrix or clast supported with poorly cemented, light-brownish-gray matrix of poorly sorted silt to angular, coarse sand; clast size ranges from pebbles to large boulders and clasts are subangular to rounded; usually forms a slope, which is steeper and more resistant where clast supported; commonly includes pedogenic carbonate surfaces, not mapped separately, that are not part of the broad, elevated surface mapped as mixed eolian and alluvial deposits (Qeac); maximum exposed thickness is 300 feet (90 m).

Mass-movement deposits

QTms (Mr)
QTms (Dm)
QTms (Cbk)
QTms (Ct)

Landslide deposits (Pleistocene to Pliocene) – Detached gravity slide blocks of highly brecciated lower Paleozoic rocks that have moved down slope and have come to rest at the foot of the mountain (Cook, 1960); identity of source formation is indicated on the map in parentheses, but queried where brecciation makes identification questionable; where the base is exposed, a landslide detachment fault symbol is used to show the contact between these slide blocks

and their underlying unit; a simple contact line is used locally where the basal parts of the slide blocks are buried by alluvial-pediment and basin-fill deposits or mixed alluvial and colluvial deposits; timing of emplacement is poorly constrained, but seems to coincide with deposition of QTapb; slide masses are 10 to 40 feet (3-12 m) thick.

unconformity

TERTIARY

Tmc **Muddy Creek Formation** (Pliocene to Miocene) – Shown on cross section only.

unconformity

JURASSIC

Jk **Kayenta Formation** (Lower Jurassic) – Dark-brownish-red, friable siltstone interbedded with medium-brownish-red, fine-grained, thinly bedded, cross-bedded sandstone with ripple marks and very dark brown desert varnish; discordant gypsum stringers fill fractures; forms step-slope topography; partially exposed in the north-central part of the quadrangle; exposed thickness about 630 feet (190 m).

unconformity

JURASSIC-TRIASSIC

JTRm **Moenave Formation** (Lower Jurassic to Upper Triassic) – Although too thin to map as members, both the Whitmore Point and the underlying Dinosaur Canyon Members are present in the north-central part of the quadrangle. Whitmore Point Member consists of interbedded, pale-reddish-brown, greenish-gray, and grayish-red mudstone and claystone, with thin-bedded, moderate-reddish-brown, very fine to fine-grained sandstone and siltstone; siltstone is commonly thin bedded to laminated in lenticular or wedge-shaped beds; claystone is generally flat bedded; contains several 3- to 12-inch-thick (7-32 cm), bioturbated, cherty, very light gray to yellowish-gray dolomitic limestone beds with algal structures, some altered to jasper, and fossil fish scales of *Semionotus kanabensis*; forms poorly exposed slope; upper unconformable contact is placed at the base of the dark-brownish-red sandstone ledge of the Kayenta Formation; deposited in low-energy lacustrine and fluvial environments (DeCourten, 1998); about 20 feet (6 m) thick. Dinosaur Canyon Member is uniformly colored, interbedded, generally thin-bedded, moderate-reddish-brown to moderate-reddish-orange, very fine to fine-grained sandstone, very fine grained silty sandstone, and lesser siltstone and mudstone; ripple marks and mud cracks common; forms ledgy slope; the contact between the Dinosaur Canyon and Whitmore Point Members

is gradational; deposited on broad, low flood plain that was locally shallowly flooded by water (fluvial mud flat and lacustrine) (DeCourten, 1998); 110 to 140 feet (34-43 m) thick. Combined thickness of Whimore Point and Dinosaur Canyon Members is 130 to 160 feet (40-50 m).

unconformity (J-0)

TRIASSIC

Chinle Group

[Note, in a departure from traditional nomenclature used in southern Utah, the Chinle is herein considered a group following Lucas (1993). This change is currently under consideration, and may or may not be adopted over the next few years.]

TRcp **Petrified Forest Formation** (Upper Triassic) – Not well exposed within this quadrangle except for a few small outcrops of a purplish-gray, medium-grained sandstone with subrounded grains, which contains locally abundant, brightly colored fossilized wood, especially near the contact with the underlying Shinarump Conglomerate; mudstone weathers to a "popcorn" surface of somewhat punky, purplish-gray to light-gray soils with desiccation cracks up to 2 inches (5 cm) wide; weathers to badland topography and is mostly slope forming; upper unconformable contact corresponds to a color change between the purplish mudstone below and the moderate-reddish-brown, fine-grained sandstone of the Moenave Formation above; to the east of St. George, the Petrified Forest Formation is highly variegated, light-brownish-gray, pale-greenish-gray, to grayish-purple bentonitic shale, mudstone, siltstone, and claystone, with lesser thick-bedded, resistant sandstone and pebble to small cobble-size chert and quartzite conglomerate near base (Hayden, 2004); deposited in lacustrine, flood-plain, and braided-stream environments (Dubiel, 1994); 575 feet (175 m) thick.

unconformity

TRcs **Shinarump Conglomerate** (Upper Triassic) – Varies from grayish-orange to moderate-yellowish-brown, medium- to coarse-grained sandstone with locally well-developed limonite bands ("picture stone" or "landscape rock") to moderate-brown pebble conglomerate with subrounded clasts of quartz, quartzite, and chert; mostly thick- to very thick bedded with both planar and low-angle cross-stratification; contains locally abundant, poorly preserved petrified wood; steep dip creates fractured, prominent ridges of resistant sandstone; slickenside surfaces common; weathered surface forms a dark-grayish-brown desert varnish; upper contact is placed between the yellowish-brown sandstone and pebbly sandstone of the Shinarump Conglomerate below and the base of the varicolored bentonitic mudstone beds of the Petrified Forest

Formation above; variable in composition and thickness because it represents stream-channel deposition over Late Triassic paleotopography (Dubiel, 1994); generally 100 to 225 feet (30-70 m) thick.

unconformity (TR-3)

Moenkopi Formation

TRmu **Upper red member** (Middle? and Lower Triassic) – Moderate-reddish-brown, thin-bedded siltstone and very fine grained sandstone with some thin gypsum beds and abundant discordant gypsum stringers; ripple marks, both asymmetrical and parallel symmetrical, are common in the siltstone; forms a steep slope with a few sandstone ledges; vertical fractures along two axes can make the top of a well-exposed sandstone bed resemble a stretched checkerboard; upper contact is based on distinct lithologic changes between the ledges of moderate-reddish-brown siltstone and sandstone of the upper red member below and the cliff of moderate-yellowish-brown sandstone of the Shinarump Conglomerate above; deposited in coastal-plain and tidal-flat environments (Dubiel, 1994); ranges from 200 to 375 feet (60-115 m) thick.

TRms **Shnabkaib Member** (Lower Triassic) – Differs greatly from its type section at Shinob Kibe Butte to the east near Washington City (Hayden, 2004); the Shnabkaib Member in the West Mountain Peak quadrangle contains more limestone, far fewer red beds, and is more resistant, forming step-slope topography and rounded hills. Divisible into five informal units, in ascending order:

(1) basal unit of light-gray to pale-red, friable, gypsiferous siltstone with bedded gypsum, having the characteristic "bacon-striped" pattern;
(2) light-brownish-red to light-yellowish-gray ledge-forming limestone with crinoid stems;
(3) interbedded, slope-forming, yellowish-gray siltstone and ledge-forming, medium-yellowish-gray micritic limestone, including at least five distinct ledge formers, some over 8 feet (2.5 m) thick; topographic expression and rock characteristics of this limestone unit are very similar to the Virgin Limestone Member; forms bulk of Shnabkaib Member;
(4) unit with characteristic "bacon-striped" pattern of interbedded, slope-forming, friable, reddish-brown gypsiferous siltstone and slope-forming, friable, grayish-white gypsiferous siltstone and limestone, with the grayish-white beds about twice as thick as the reddish-brown beds; and
(5) very gypsiferous upper unit that weathers to a powdery soil commonly covered by microbiotic crust.

Upper gradational contact, marked by a prominent color change and lesser slope change, is placed at the top of the highest light-colored, thick gypsum bed, above which are steeper slopes of laminated to thin-bedded, moderate-reddish-brown siltstone and sandstone of the upper red member; deposited on a broad, shallow coastal shelf of very low relief where minor fluctuations in sea level

produced interbedding of evaporites, limestone, and red beds (Dubiel, 1994); generally 500 to 775 feet (150-235 m) thick.

TRmm **Middle red member** (Lower Triassic) – Interbedded moderate-red to moderate-reddish-brown siltstone, mudstone, and thin-bedded, very fine grained sandstone with thin interbeds and veinlets of greenish-gray to white gypsum; poorly exposed and very weak, forming a U-shaped strike valley between the steeply dipping limestone ledges of the Virgin Limestone below and the Shnabkaib Member; upper contact is placed at the base of the first thick gypsum bed where the moderate-reddish-brown siltstone below gives way to banded, greenish-gray gypsum and pale-red siltstone above; deposited in tidal-flat environment (Dubiel, 1994); commonly attenuated; 100 to 300 feet (30-90 m) thick.

TRmv **Virgin Limestone Member** (Lower Triassic) – Three distinct medium-gray to yellowish-brown limestone ledges interbedded with nonresistant, moderate-yellowish-brown, muddy siltstone, pale-reddish-brown sandstone, and light-gray to grayish-orange-pink gypsum; limestone beds are typically 5 to 10 feet (1.5-3 m) thick and contain five-sided crinoid columnals and *Composita* brachiopods; upper contact is drawn at the top of the highest limestone bed; deposited in shallow-marine environment (Dubiel, 1994); commonly attenuated; generally 250 to 500 feet (75-150) thick.

TRml **Lower red member** (Lower Triassic) – Moderate-reddish-brown siltstone, mudstone, and fine-grained, slope-forming sandstone; generally calcareous with interbeds and stringers of gypsum; ripple marks and small-scale cross-beds are common in the siltstone; only present in two locations above the unconformity with the Harrisburg Member of the Kaibab Formation; upper contact drawn at the color change from moderate-reddish-brown siltstone of the lower red member to moderate-yellowish-brown, muddy siltstone, usually about one foot (30 cm) thick, which underlies the base of the first limestone ledge of the Virgin Limestone Member; deposited in tidal-flat environment (Dubiel, 1994); 0 to about 40 feet (0-12 m) thick.

unconformity (TR-1)

PERMIAN

Kaibab Formation

Pkh **Harrisburg Member** (Lower Permian) – Interbedded thin- to very thick bedded gypsum, gypsiferous mudstone, and limestone, some of which contains chert; laterally variable; mostly slope-forming, but includes a resistant, cliff- and ledge-forming medial white chert and limestone interval; Late Permian to Early Triassic subaerial erosion created significant topography on the Harrisburg Member in Washington County, although in this map area, the member remained topographically high as evidenced by the lack of deposition of the Rock Canyon Conglomerate or Timpoweap Members of the Moenkopi

Formation and the thinness of the lower red member; upper contact is unconformable with the lower red member of the Moenkopi Formation, or, where that member is not present, the Virgin Limestone Member of the Moenkopi Formation; deposited in a complex sequence of sabkha and shallow-marine environments (Nielson, 1981); 400 to 500 feet (120-150 m) thick.

Pkf **Fossil Mountain Member** (Lower Permian) – Light-gray, thick- to very thick bedded, planar-bedded, laterally consistent, cherty limestone and fossiliferous limestone; whole silicified brachiopods abundant near top; calcite stringers fill fractures; "black-banded" due to abundant reddish-brown, brown, and black chert; forms prominent cliff with "meringue-like" weathering; upper conformable contact drawn at the break in slope between the limestone cliff of the Fossil Mountain Member and the gypsiferous mudstone and gypsum slope of the Harrisburg Member; deposited in shallow-marine environment (Nielson, 1986); 500 to 750 feet (150-230 m) thick.

Toroweap Formation

Ptw **Woods Ranch Member** (Lower Permian) – Grayish- to yellowish-orange gypsiferous siltstone with thin interbeds of white gypsum and light-gray to pale-orange limestone and dolomite; recessive slope former below the massive cliff of Fossil Mountain Member of the Kaibab Formation; in this area and near Red Hollow to the north, some of the gypsum has been dissolved and calcite and aragonite have been deposited in the lower portion (Nielson, 1986) in a process of calcitized anhydrite formation (Lucia, 1972); generally unfossiliferous except for fusulinids (Hammond, 1991) and poorly preserved brachiopods or algal stromatolites (Hintze, 1986) in the upper dolomite beds; upper contact placed at the change in slope at the base of the massive cliff of the overlying Fossil Mountain Member of the Kaibab Formation; deposited during shallow-marine regression (Nielson, 1986); thickness varies from 65 to 250 feet (20-75 m) because of dissolution and/or attenuation faulting.

Ptb **Brady Canyon Member** (Lower Permian) – Light-gray to pale-yellowish brown, fine- to medium-grained, thick- to very thick bedded limestone with common reddish-orange chert nodules and ribbon chert; base of member is dolomitic; brachiopods are common in the lower part with gastropod, coral, crinoid, bryozoan, and sponge fragments present throughout (Hintze, 1986); forms massive cliff to stair-step topography; upper contact is placed at the top of the massive cliff at the change in slope created by the recessive Woods Ranch Member; deposited by transgressive shallow sea (Nielson, 1986); thickness varies from 200 to 500 feet (60-150 m) probably because of attenuation faulting.

Pts **Seligman Member** (Lower Permian) – Grayish-orange gypsiferous siltstone interbedded with lesser white gypsum and light-olive-gray, fine-grained sandstone; as with the Woods Ranch Member, much of the gypsum has been altered and replaced by aragonite and calcite (Nielson, 1986); slope-former; upper contact drawn at the slope change at the base of the massive cliff of the

Brady Canyon Member; deposited during shallow-marine regression (Nielson, 1986); thickness varies from 80 to 150 feet (25-45 m) because of dissolution and/or attenuation faulting.

Pq **Queantoweap Sandstone** (Lower Permian) – Very pale orange to grayish-orange-pink, fine- to medium-grained, thin- to thick-bedded, calcareous sandstone with festoon cross-bedding and cross-laminations; locally bioturbated (Nielson, 1986); upper contact is drawn at the top of the grayish-orange, cross-bedded sandstone that weathers to a ledgy slope and at the base of the overlying yellowish-orange, gypsiferous, sandy siltstone that forms a slope; 1050 to 1750 feet (320-530 m) thick.

Pp **Pakoon Dolomite** (Lower Permian) – Light-gray, medium- to thick-bedded, fine-grained dolomite with chert nodules, which weathers to light-brownish-gray ledges and low cliffs; mostly unfossiliferous, but bryozoans and fusilinids occur in thin limestone beds interbedded with rare, ledge-forming sandstone in the upper part (Hintze, 1986); top 50 feet (15 m) is mostly gypsum with minor limestone and sandstone intervals; upper contact, which in this quadrangle coincides with an attenuation fault, is at the base of the massive sandstone of the Queantoweap Sandstone, above the gypsum/limestone intervals of the Pakoon Dolomite; regional depositional thickness is 700 to 900 feet (213-275 m) (Hintze, 1986); structurally attenuated to 350 to 650 feet (105-200 m) thick.

PENNSYLVANIAN

IPc **Callville Limestone** (Upper to Lower Pennsylvanian) – Medium-gray, fine- to medium-grained, medium- to thick-bedded limestone with cyclic interbeds of moderate-orange-pink sandstone and light-gray dolomite increasing in the upper third; commonly cherty and fossiliferous; *Lithostrotionella* coral is common in upper part whereas brachiopods and bryozoans are common in limestone beds throughout (Hintze, 1985a); forms ledge-slope topography similar to the overlying Pakoon Dolomite; upper contact is placed at the base of the lighter-colored dolomite beds; regional depositional thickness 1500 to possibly 2000 feet (450-600 m) (Hintze, 1986); structurally attenuated to 350 to 1200 feet (105-365 m) thick.

unconformity

MISSISSIPPIAN

Mr **Redwall Limestone** (Lower Mississippian) – Medium- to dark-gray, very thick bedded, cherty, fossiliferous, cliff-forming limestone; in the Beaver Dam Mountains, the basal 60 feet (18 m) is coarse grained and dolomitic, above which is an 80-foot-thick (25 m) cherty, bioclastic limestone that weathers to a dark yellowish brown and probably correlates to the Thunder Springs Member of McGee and Gutschick (1969) as mapped by Steed (1980) in the Virgin River

Gorge south of the map area; upper 460 feet (140 m) is bioclastic, containing horn corals, colonial corals, and brachiopods (Hintze, 1985a); forms a massive cliff that includes the top of West Mountain Peak; in the map area, the Redwall Limestone is partially attenuated beneath the Callville Limestone; of the many slide blocks of Redwall Limestone in the area (Hayden and others, 2005), only one is present in the West Mountain Peak quadrangle along the south edge, where it is partially buried by Quaternary-Tertiary alluvial-pediment and basin-fill deposits (QTapb) and mapped as a Quaternary-Tertiary mass-movement slide mass [QTms(Mr)]; structurally attenuated to 450 to 850 feet (135-260 m) thick.

DEVONIAN

Muddy Peak Dolomite

Divided into two informal units after Hintze (1985b).

Dm **Muddy Peak Dolomite, undivided** (Upper Devonian) – Used on map only to identify slide block at bottom center of map where one side of the block is still in contact with Precambrian rocks. Where blocks are partially buried by Quaternary-Tertiary alluvial-pediment and basin-fill deposits (QTapb), label is connected to Quaternary-Tertiary landslide label and queried where brecciation makes identification of probable source formation difficult [QTms (Dm?)].

Dmp **Pinnacle unit** (Upper Devonian) – Light- to medium-gray, medium- to coarse-grained, crystalline, very thick bedded dolomite with scattered chert nodules and sandy laminae that weathers to form light-gray hoodoos or pinnacles below the massive Redwall Limestone cliffs; 140 to 190 feet (45-55 m) thick.

Dms **Slope unit** (Upper Devonian) – Light-olive-gray to pale-yellowish-gray, fine-grained, thin- to medium-bedded, silty dolomite that forms a ledgy slope; includes small, silicified, stromatoporoidal structures as well as rare biohermal mounds that include crinoid debris and scattered coral, gastropod, and brachiopod fragments (Hintze, 1985b); upper contact drawn at the base of the very thick bedded, medium-gray dolomite that weathers to form pinnacles; 300 to 450 feet (90-135 m) thick.

unconformity

CAMBRIAN

Cn **Nopah Dolomite** (Upper Cambrian) – Light-gray to brownish-gray, fine- to medium-grained, thick-bedded dolomite; contains algal stromatolites, small tubular trace fossils (twiggy bodies), and mottled zones that suggest bioturbation during deposition in a warm, shallow-marine environment (Hammond, 1991); forms steep slopes to cliffs; upper unconformable contact is drawn at the change to the more gentle slope of the slope unit of the overlying Muddy Peak Dolomite; 1200 to 1400 feet (365-425 m) thick.

Cbk **Bonanza King Formation** (Upper to Middle Cambrian) – Medium- to light-brownish-gray, fine- to medium-grained, medium- to thick-bedded dolomite with some bluish-gray silty limestone beds in the lowest 300 feet (90 m) (Hintze, 1986); upper half consists of numerous thin beds of light-gray, very fine grained boundstone (Hammond, 1991); upper contact is drawn at the change in slope at the base of the steeper slope of the overlying Nopah Dolomite; several slide blocks [QTms(Cbk)] are mapped from the center to the south edge of the map; Hintze (1985b) measured 2623 feet (800 m) along the north side of Horse Canyon; 2200 to 2600 feet (670-790 m) thick.

Cba **Bright Angel Shale** (Middle to Lower Cambrian) – Olive-green, slope-forming, micaceous shale, siltstone, and fine-grained sandstone or quartzite with a ledge-forming, pale-brown-weathering, 10-foot-thick (3 m) dolomite about 125 feet (38 m) above the base and a 6-inch-thick (15 cm) limestone bed about 50 feet (15 m) below the top; no fossils have been reported in the Beaver Dam Mountains (Hintze, 1986); best exposures are in the southeast corner of the quadrangle; upper contact is gradational and drawn at the top of the predominantly shale and siltstone sequence above which are the limestone ledges of the Bonanza King Formation; locally thinned or absent due to attenuation faulting; 0 to complete thickness of 350 feet (0-105 m).

Ct **Tapeats Quartzite** (Lower Cambrian) – Dark-reddish-orange to pale-reddish-brown quartzite with a few thin layers of quartz pebble conglomerate to metaconglomerate and sandstone; thin to very thick bedded; generally forms ledges and dip slopes; upper contact is gradational and drawn where the quartzite gives way to the shale and siltstone sequence of the overlying Bright Angel Shale; commonly attenuated by faulting; several slide blocks [QTms(Ct)] are mapped near the center of the quadrangle; Hammond (1991) reported a complete thickness of 1300 feet (400 m) near the north edge of the Jarvis Peak quadrangle to the southeast; attenuated thickness 730 to 800 feet (225-245 m).

unconformity

PRECAMBRIAN

pC **Precambrian gneiss, schist, and pegmatite, undivided** (Middle to Early Proterozoic) – Dark-gray dioritic gneiss consisting mostly of amphibole with about 10 percent each of feldspar, quartz, and pyroxene, interrelated with schist and pegmatite (Hintze, 1985a); dioritic gneiss is the most resistant and most extensively exposed rock type; schist contains principally either mica or amphibole with some plagioclase feldspar, quartz, garnet, and sillimanite (Reber, 1952); granitic pegmatites are common and intrude both gneiss and schist; less common, white pegmatites are composed of 60 percent orthoclase and 25 percent quartz with some mica, plagioclase, and garnet (Hintze, 1986); numerous mining prospects are mapped near the south edge of the quadrangle;

exposed in a continuous belt about 8 miles (13 km) long and 4 miles (6 km) wide with at least 2500 feet (750 m) of relief. Although the age of Precambrian rocks in the Beaver Dam Mountains has not been determined, King (1976) compared them to the Vishnu and Brahma schists of the Grand Canyon area, which are Middle Proterozoic age. Olmore (1971) reported a 1.7-billion-year K-Ar age (mineral not specified) on a pegmatite in similar Precambrian rocks in the East Mormon Mountains, Nevada, 15 miles (24 km) to the southwest, which would make those rocks Early Proterozoic. A nonconformity of approximately 1.2 billion years, referred to in the Grand Canyon as the "Great Unconformity," separates the Precambrian rocks from the overlying Cambrian strata.

Structure

The complex structure of the area is discussed in detail by Reber (1952), Hintze (1986), Anderson and Barnhard (1993), Carpenter and Carpenter (1994), and O'Sullivan and others (1994). Only a short summary is given here. The study area includes the east flank and northward-plunging nose, as well as the truncated west flank, of the Precambrian-cored Virgin-Beaver Dam Mountains anticline, interpreted by Reber (1952) to be a Late Cretaceous Laramide-type compressional structure. However, the Beaver Dam Mountains anticline formed prior to being overridden by the Muddy Mountain-Tule-Square Top Mountain thrust, exposed to the north and west of the study area, during Late Cretaceous time between 97 to 70 million years ago (Carpenter and Carpenter, 1994). This suggests two separate phases of southeast-directed compression (Hintze, 1986).

Crustal extension in the area began in late Oligocene to early Miocene time (Carpenter and Carpenter 1994). In some cases, normal faults reactivated old zones of structural weakness inherited from both Precambrian rifting and Cretaceous compression, whereas other normal faults initiated as new zones of brittle failure (Anderson and Barnhard, 1993). Movement along these normal faults created the modern basin-range physiography and resulted in significant extension of the crust. In addition, the Virgin-Beaver Dam Mountains-Red Hollow normal fault system, which is listric in nature, has attained greater than 26,000 feet (8000 m) of vertical separation just south of the study area at the latitude of the Virgin Valley depocenter, which contains that thickness of Oligocene to Quaternary syntectonic clastic deposits shed from adjacent tilted horsts (Carpenter and Carpenter, 1994). Also associated with this vertical component of extension are rootless gravity slide blocks ranging from 10 to 40 feet (3-12 m) thick exposed along the western margin of the Beaver Dam Mountains and along the eastern Virgin Valley basin margin.

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References

Anderson, R.E., and Barnhard, T.P., 1993, Heterogeneous Neogene strain and its bearing on horizontal extension and horizontal and vertical contraction at the margin of the extensional orogen, Mormon Mountains area, Nevada and Utah: U.S. Geological Survey Bulletin 2011, 43 p.

Birkeland, P.W., Machette, M.N., and Haller, K.M., 1991, Soils as a tool for applied Quaternary geology: Utah Geological and Mineral Survey Miscellaneous Publication 91-3, 63 p.

Carpenter, J.A., and Carpenter, D.G., 1994, Analysis of Basin-Range and Fold-Thrust structure, and reinterpretation of the Mormon Peak detachment and similar features as gravity slide systems, southern Nevada, southwest Utah and northwest Arizona, *in* Dobbs, S.W., and Taylor, W.J., editors, Structural and stratigraphic investigations and petroleum potential of Nevada, with special emphasis south of the Railroad Valley producing trend: Nevada Petroleum Society Conference Volume II, p. 15-52.

Cook, E.F., 1960, Breccia blocks (Mississippian) of the Welcome Spring area, southwestern Utah: Geological Society of America Bulletin, v. 71, p. 1709-1712.

DeCourten, Frank, 1998, Dinosaurs of Utah: Salt Lake City, University of Utah Press, 300 p.

Dubiel, R.F., 1994, Triassic deposystems, paleogeography, and paleoclimate of the Western Interior, *in* Caputo, M.V., Peterson, J.A., and Franczyk, K.J., editors, Mesozoic systems of the Rocky Mountain region, USA: Rocky Mountain Section of Society of Economic Paleontologists and Mineralogists, p. 133-168.

Hammond, B.J., 1991, Interim geologic map of the Jarvis Peak quadrangle, Washington County, Utah: Utah Geological Survey Open-File Report 212, 63 p., scale 1:24,000.

Hayden, J.M., 2004, Geologic map of the Washington Dome quadrangle, Washington County, Utah: Utah Geological Survey Map 209, 29 p., 2 plates, scale 1:24,000.

Hayden, J.M., Hintze, L.F., Ehler, J.B., in press, Interim geologic maps of the Castle Cliff and the east half of Terry Benches quadrangles, Washington County, Utah and Mohave County, Arizona: Utah Geological Survey Open-File Report, 12 p., scale 1:24,000.

Hintze, L.F., 1985a, Geologic map of the Castle Cliffs and Jarvis Peak quadrangles, Washington County, Utah: U.S. Geological Survey Open-File Report 85-120, 19 p., scale 1:24,000.

—1985b, Geologic map of the Shivwits and West Mountain Peak quadrangles, Washington County, Utah: U.S. Geological Survey Open-File Report 85-119, 19 p., scale 1:24,000.

—1986, Stratigraphy and structure of the Beaver Dam Mountains, southwestern Utah, *in* Griffin, D.T. and Phillips, W.R., editors, Thrusting and extensional structures and mineralization in the Beaver Dam Mountains, southwestern Utah: Utah Geological Association Publication 15, p. 1-36.

King, P.B., 1976, Precambrian geology of the United States–an explanatory text to accompany the Geologic Map of the United States: U.S. Geological Survey Professional Paper 902, 85 p.

Lucas, S. G. 1993. The Chinle Group: Revised Stratigraphy and Biochronology of Upper Triassic Nonmarine Strata in the Western United States. In: *Aspects of Mesozoic Geology and Paleontology of the Colorado Plateau.* Morales, M., editor. *Museum of Northern Arizona Bulletin* 59, pp 27–50.

Lucia, F.J., 1972, Recognition of evaporite carbonate shoreline sediments: Society of Economic Paleontologists and Mineralogists, Special Publication 16, p. 160-191.

McGee, E.D., and Gutschick, R.C., 1969, History of the Redwall Limestone of northern Arizona: Geological Society of America Memoir 114, 726 p.

Nielson, R.L., 1981, Depositional environment of the Toroweap and Kaibab Formations of southwestern Utah: Salt Lake City, University of Utah, Ph.D. dissertation, 495 p.

—1986, The Toroweap and Kaibab Formations, southwestern Utah, *in* Griffen, D.T., and Phillips, W.R., editors, Thrusting and extensional structures and mineralization in the Beaver Dam Mountains, southwestern Utah: Utah Geological Association Publication 15, p. 37-53.

Olmore, S.D., 1971, Style and evolution of thrusts in the region of the Mormon Mountains, Nevada: Salt Lake City, University of Utah, Ph.D. dissertation, 110 p.

O'Sullivan, P., Carpenter, D.G., and Carpenter, J.A., 1994, Cooling history of the Beaver Dam Mountains, Utah, determined by apatite fission track analysis, *in* Dobbs, S.W., and Taylor, W.J., editors, Structural and stratigraphic investigations and petroleum potential of Nevada, with special emphasis south of the Railroad

Valley producing trend: Nevada Petroleum Society Conference Volume II, p. 53-63.

Reber, S.J., 1952, Stratigraphy and structure of the south-central and northern Beaver Dam Mountains, Utah: Intermountain Association of Petroleum Geologists Guidebook 7, p. 101-108.

Steed, D.A., 1980, Geology of the Virgin River Gorge: Brigham Young University Geology Studies, v. 27, part 3, p. 96-115.

Map Symbols

Contact – dashed where approximated

Normal fault – dashed where approximated, dotted where concealed, bar and ball on down-thrown side

High-angle fault (probably normal) – identified using geophysical data

Attenuation fault – dashed where approximated, dotted where concealed, triangles on hanging-wall block

Landslide detachment fault bounding slide block - hachures on displaced block

35 Strike and dip of bedding

20 Strike and dip of overturned bedding

40 Strike and dip of foliation

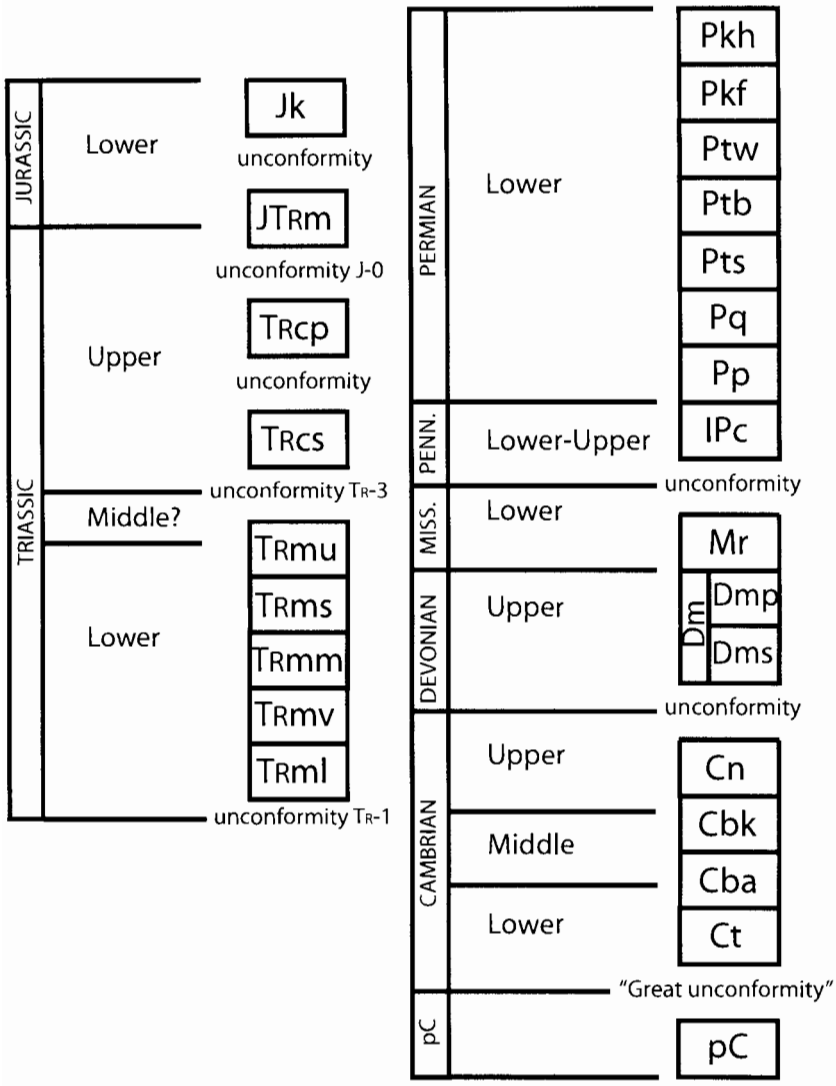
Spring

Prospect

SYSTEM	SERIES	FORMATION	MEMBER	SYMBOL	THICKNESS Feet (Meters)	LITHOLOGY
QUATERNARY		Surficial Deposits		Q	0-100 (0-30)	parent bedrock identified on gravity slide blocks
QUAT.-TERTIARY		Surficial Deposits		QT	0-300 (0-90)	
JUR.	Lower	Kayenta Formation		Jk	630+ (190+)	
		Moenave Formation		JTRm	130-160 (40-50)	
TRIASSIC	Upper	Chinle Gp.	Petrified Forest Formation	TRcp	575 (175)	variegated colors
			Shinarump Conglomerate	TRcs	100-225 (30-70)	petrified wood common
	Middle?	Moenkopi Formation	upper red member	TRmu	200-375 (60-115)	
	Lower		Shnabkaib Member	TRms	500-775 (150-235)	gypsum
			middle red member	TRmm	100-300 (30-90)	ripple marks; gypsum locally attenuated
			Virgin Limestone Member	TRmv	250-500 (75-150)	locally attenuated
			lower red member	TRml	0-40 (0-12)	
PERMIAN	Lower	Kaibab Formation	Harrisburg Member	Pkh	400-500 (120-150)	gypsum; red rubbly chert; red beds
			Fossil Mountain Member	Pkf	500-750 (150-230)	cherty limestone ledges; fossiliferous
		Toroweap Formation	Woods Ranch Member	Ptw	65-250 (20-75)	gypsum
			Brady Canyon Member	Ptb	200-500 (60-150)	structurally attenuated
			Seligman Member	Pts	80-150 (25-45)	cherty
		Queantoweap Sandstone		Pq	1050-1750 (320-530)	medium to small-scale cross-bedding inclined in many directions in lower part
		Pakoon Dolomite		Pp	350-650 (105-200)	structurally attenuated
PENNSYLVANIAN	Lower-Upper	Callville Limestone		IPc	350-1200 (105-365)	cyclic *Lithostrotionella* (hair coral) beds in upper part structurally attenuated cherty
MISSISSIPPIAN	Lower	Redwall Limestone		Mr	450-850 (135-260)	structurally attenuated Thunder Springs Member
DEVONIAN	Upper	Muddy Peak Dolomite	pinnacle unit	Dmp	140-190 (45-55)	stromatoporoids
			slope unit	Dms	300-450 (90-135)	includes pebbly dolomite beds stromatolites
CAMBRIAN	Upper	Nopah Dolomite		Cn	1200-1400 (365-425)	forms cliffs
	Middle	Bonanza King Formation		Cbk	2200-2600 (670-790)	laminated white boundstone in upper part thin-bedded shaly limestone at base
		Bright Angel Shale		Cba	0-350 (0-105)	green micaceous shale, siltstone, quartz locally attenuated
	Lower	Tapeats Quartzite		Ct	730-800 (225-245)	locally attenuated
PreCambrian		Gneiss, Schist, Pegmatite		pC		"Great Unconformity" ~ 1.2 billion years probably Vishnu Schist

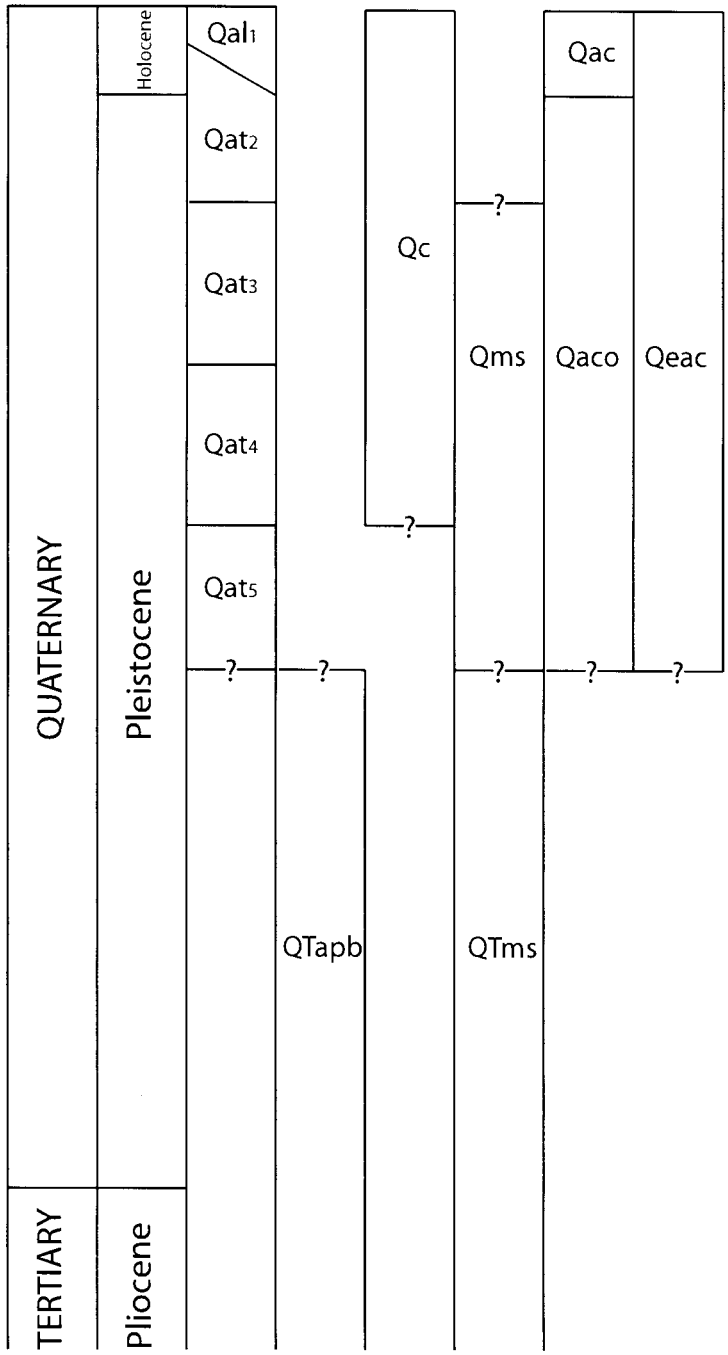
WMP 11/21/05 J. Buck Ehler

CORRELATION OF BEDROCK UNITS

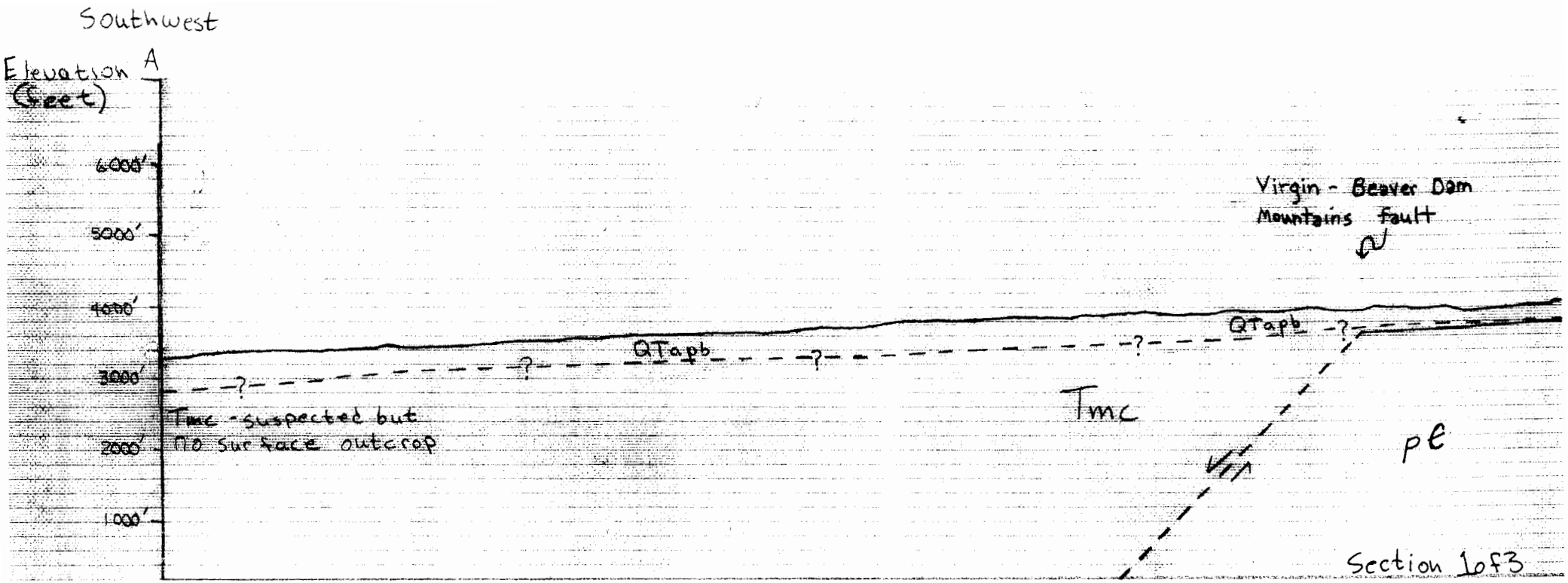


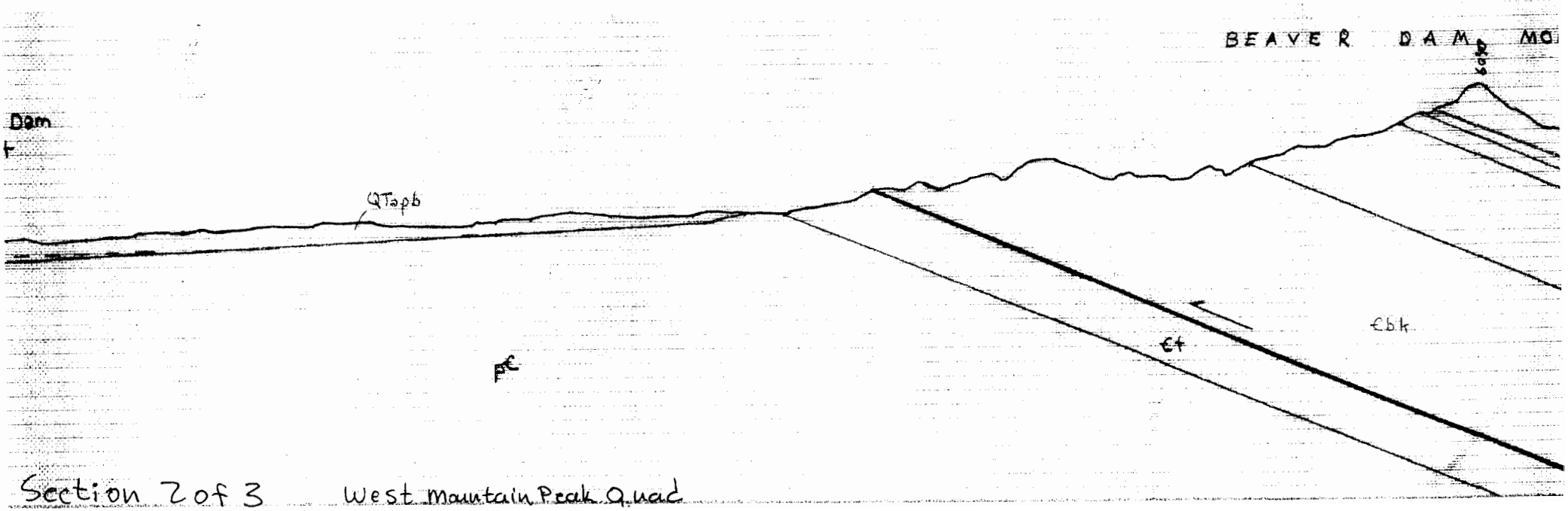
West Mountain Peak quadrangle
J.M. Hayden, J.B. Ehler, November 2005

CORRELATION OF SURFICIAL DEPOSITS

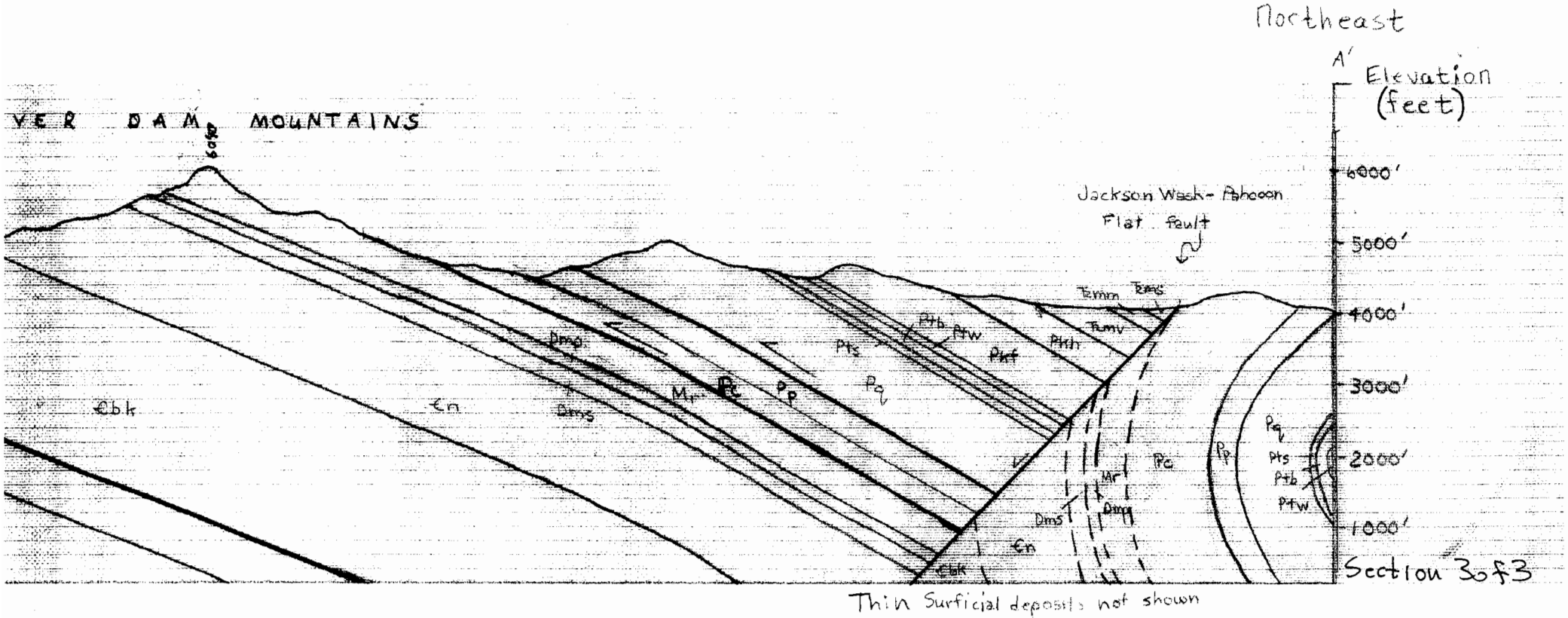


West Mountain Peak quadrangle
J.M. Hayden, J.B. Ehler, November 2005





Section 2 of 3 West Mountain Peak Quad



West Mountain Peak quad
November 2005

J. M. Hayden
J. B. Ehler