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GEOLOGIC MAP OF THE SHIVWITS AND WEST MOUNTAIN PEAK QUADRANGLES WASHINGTON COUNTY, UTAH

By

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DESCRIPTION OF MAP UNITS

Qya YOUNGER ALLUVIUM (Holocene and Pleistocene)--Sand, gravel and boulders along present stream channels

Ql LANDSLIDE DEPOSITS (Holocene and Pleistocene)--Incoherent slumped masses of Petrified Forest Member of the Chinle Formation that form hummocky hillslopes near Shivwits

Qd DUNE SAND DEPOSITS (Holocene and Pleistocene)--Loose sand deposits derived mostly from the Navajo and Kayenta formations and found mostly in the immediate vicinity of their outcrops. Only the largest dune areas are shown on the map. Dune sand forms a cover more than 10 m thick in places

Qt TALUS DEPOSITS (Holocene and Pleistocene)--Mostly large blocks of basalt that cover hillslopes on the east side of the Santa Clara River valley between Shivwits and Gunlock

Qc COLLUVIUM (Holocene and Pleistocene)--Talus and slope-wash consisting of angular debris of all sizes; forms a cover more than 20 m thick in places

Qoa OLDER ALLUVIUM (Holocene? and Pleistocene)--Sand, gravel, and bouldery deposits that form benches and terraces above present stream channels; 20 m thick in places

Qb BASALT (Quaternary)--Brownish-black olivene-bearing basalt that fills an inverted valley just east of the Santa Clara River. Embree (1970) called it the Gunlock flow and described its characteristics in detail. Myron G. Best (personal communication) obtained a K-Ar date of 1.6 my from a sample from section 8 in the northeast corner of the Shivwits quadrangle. The Gunlock flow is about 10 m thick

QTa ALLUVIUM (Pleistocene and Pliocene?)--Exhumed alluvial pediment deposits that form extensive surfaces that slope towards Beaver Dam Wash. Deposits consist of silt, sand, gravel, and boulders derived mostly from Precambrian metamorphic and Paleozoic sedimentary rocks of the Beaver Dam Mountains but also include a variety of clasts of volcanic rocks derived from the Bull Valley Mountains to the north. Deposits are more than 100 m thick along Beaver Dam Wash. On the Shivwits quadrangle QTa formed pediment-capping deposits that are presently being eroded away by the Santa Clara River and its tributaries. Because QTa is more resistant than most of the folded Mesozoic rocks on which it was originally depsoited, it now caps inter-stream hilltops and ranges up to 30 m in thickness

QTl LANDSLIDE BLOCKS AND RUBBLE (Pleistocene and Pliocene?)--Detached masses of Paleozoic rocks that have moved downslope retaining various degrees of coherence. Identity of source Paleozoic formations is shown on map in parentheses where blocks are mostly coherent. Landslide blocks along the western base of the range are part of detached masses described by Cook (1960a, 1960b) as "breccia blocks". Origin of these brecciated masses is reviewed briefly by Hintze (1984). The landslide area in the south-central part of the Shivwits quadrangle where U.S. Highway 91 passes by upturned beds of the Kaibab Formation is developed mainly on the Harrisburg Member of that formation. It is likely that the accumulation of landslide debris is related to solution and flowage of gypsum beds in the Harrisburg Member

CARMEL FORMATION (Middle Jurassic)--Nomenclature follows that of Pipiringos and O'Sullivan (1978) as modified by Blakey and others (1983)

Jcj JUDD HOLLOW MEMBER (Bajocian)--Represented by one small exposure near the northeast corner of the Shivwits quadrangle. The complete Carmel sequence is exposed 2 km to the northwest on the west side of the Gunlock Reservoir where it was described by Wright, Snyder, and Dickey (1979, p. 43-52). Their Kanarraville unit has been reassigned to the Judd Hollow Member by later workers noted above. Their Gunlock unit is now assigned to the Temple Cap Formation which is not exposed in these quadrangles. The Judd Hollow Member consists of thin-bedded grayish-yellow shaly fossiliferous limestone that forms ledges, interbedded with slope-forming claystone that makes up more than half of the member. The upper 30 m of the member includes three yellowish-brown-weathering ledge-forming fine-grained sandstone beds. Wright, Snyder, and Dickey (1979, p. 45) reported a thickness of 170 m for the Judd Hollow Member

JTRn NAVAJO SANDSTONE (Jurassic and Triassic?)--Grayish-orange to pale-reddish-brown cross-bedded eolian sandstone; commonly shows joint patterns on aerial photographs more conspicuously than any other formation. Variably cemented; commonly covered with Quaternary dune sand of local origin. Thickness estimated to be about 700 m

TRk KAYENTA FORMATION (Upper Triassic?)--Pale-red sandstone with thin interbeds of reddish-brown mudstone and siltstone. Mostly stream-deposited with planar bedding and minor small-scale cross-bedding. Forms ledges. Thickness about 250 m

TRmo MOENAVE FORMATION (Upper Triassic?)--Interbedded sandstone, siltstone and shale of various shades of reddish- and orangish-brown, but overall aspect of this formation is dark reddish-brown. It shows on aerial photographs in the darkest tones of any sedimentary formation. It is only moderately resistant and forms low ledges and low rounded hills. It is about 400 m thick. Wilson and Stewart (1967) extended this formation name into southwestern Utah

CHINLE FORMATION (Upper Triassic)--Members as mapped follow subdivisions used by Stewart and others (1972a). Thicknesses reported below mostly come from the Shivwits quadrangle area, because strata in the northeast corner of the West Mountain Peak quadrangle have been attenuated as they approach the west side of the range.

Ꞧcp PETRIFIED FOREST MEMBER--Varicolored mudstone, siltstone, and some sandstone ranging from white to purplish-red and orangish-red. Fossil wood common. Member is broadly exposed on both flanks of the Shivwits syncline where it forms low topography. Bentonitic layers make this member prone to slump. Wilson and Stewart (1967) extended usage of this member's name into this area. Member is about 350 m thick

Ꞧcs SHINARUMP CONGLOMERATE MEMBER--Ranges from cobble conglomerate to coarse sandstone and has an overall orangish-brown color. Fossil wood common. Caps a prominent hogback on both flanks of the Shivwits syncline. Ranges in thickness from 30 to 120 m

MOENKOPI FORMATION (Lower Triassic)--Members as mapped follow subdivisions discussed by Stewart and others (1972b)

Ꞧmu UPPER RED MEMBER--Grayish-red to moderate brown siltstone, mostly evenly and thinly bedded and with about 30 percent of the layers showing laminated ripple marks. Light brown to yellowish- or orangish-brown sandstone that forms ledges makes up about 10 percent of the member and thin gypsum beds and stringers make up less than one percent. Member is well exposed along both flanks of the Shivwits syncline where it ranges from 150 to 200 m in thickness

Ꞧms SHNABKAIB MEMBER--Banded white and pale red gypsiferous mudstone and siltstone with lesser dolomite and limestone. The conspicuous broad white bands, largely containing the gypsum, set this member apart from the red members bounding it. Primary gypsum is laminated to thin-bedded, very light gray to bluish gray; secondary gypsum stringers occur throughout the member. Fossils are absent except in one thin bed of limestone that bears gastropods and echinoderm fragments. Shnabkaib Member forms ledge-slope topography and is more resistant than the red members bounding it. Jenson (1984) reported that the member ranges in thickness from 240 to 260 m within the Shivwits quadrangle

Ꞧmm MIDDLE RED MEMBER--Pale reddish-brown laminated or thinly bedded siltstone and mudstone with very thin interbeds and stringers of white or greenish-gray gypsum. Upper contact with Shnabkaib Member is gradational in some places; the lowest gypsum bed thicker than 1 m was taken as basal Shnabkaib. Jenson (1984) reported that the member is 90-120 m thick in this area

Ꞧmv VIRGIN LIMESTONE MEMBER--Limestone comprises only 20 percent of this member, but it forms three distinctive sharp ledges or low cliffs near the base, middle, and top that make the member easily identifiable in the field and on aerial photographs. The basal limestone is 2-5 m thick and contains abundant five-sided echinoderm fragments. The upper limestone caprock is 3-7 m thick and is underlain by a conspicuous light colored siltstone and mudstone that makes it readily identifiable on aerial photographs. The middle limestone is variable in thickness and position within the member. The limestones are yellowish-brown to medium gray and composed of pelloids, ooids, intraclasts, and shell fragments usually in a micritic matrix. Lenticular chert occurs here and there in the limestone but is not consistent in distribution. Fossils include echinoid debris, pelecypods, gastropods, brachiopods, and ostracodes. Eighty percent of the member is made up of yellowish-brown weathering mudstone and siltstone that form slopes. Its drab color readily sets the Virgin apart from adjacent members of the Moenkopi Formation, but where the lower red member is missing and the Virgin Limestone Member rests directly on the Harrisburg Member of the Kaibab Formation the color change is sometimes less evident. Virgin Limestone Member appears to be absent along the west flank of the Shivwits syncline west of Pahcoon Spring. Permian strata are overturned here, and it is possible that the Virgin Member could have been eliminated by attenuation along bedding-plane faults. Or it might have never been deposited over the top of Permian highgrounds. Jenson (1984) reported that the Virgin Limestone Member ranges from 65 to 85 m in thickness in the central and southern part of the Shivwits quadrangle. In the northeast corner of the West Mountain Peak quadrangle it is 50 to 60 m thick

₮ml LOWER RED MEMBER--Reddish-brown siltstone and mudstone with thin interbeds of gypsum and dolomite. Gypsum makes up much of the middle third of the member in places. Small-scale crossbeds and ripple marks are common. This member pinches out abruptly on the flanks of hills on the paleotopography developed on the Harrisburg Member of the Kaibab Formation. Thickness ranges from zero to 50 m in the Shivwits quadrangle

KAIBAB FORMATION (Lower Permian)--Members as mapped follow subdivisions proposed by Reeside and Bassler (1922), modified by Sorauf (1962), and adopted by Cheevers and Rawson (1979) and Nielson (1981)

Pkh HARRISBURG MEMBER--Where better exposed 10 km southeast of this area the lower half of this member is laminated gypsum with thin beds and lenses of dolomite limestone and siltstone; the middle 40 m is thin-bedded cherty limestone and dolomite interbedded with gypsum; the upper 40 m is silty gypsum with thin interbeds of dolomite and limestone including one 10 cm bed of very fossiliferous limestone bearing crinoid fragments and brachiopods. Gypsum in the Harrisburg is light gray and weathers to a powdery or clinkery surface. The thin bedded limestone and dolomite beds are seldom seen in place but commonly form a residual surface covered with reddish-orange cherty chips. Large solution collapse folds and breccias are common and the member usually forms rounded hummocky topography. Detailed measured sections of the Harrisburg Member in the Shivwits quadrangle may be found in Nielson (1981) and Jenson (1984). Welsh and others (1979, p. 147) correlate this member with the Plympton Formation of western Utah. Considerable relief developed on the Harrisburg Member prior to deposition of the overlying Moenkopi Formation, consequently the Harrisburg in the map area ranges in thickness from 25 to 150 m

Pkf FOSSIL MOUNTAIN MEMBER--This member stands out by forming prominent ledges and cliffs bounded by the slope-forming gypsiferous units above and below. The member is composed entirely of yellowish-brown cherty limestone that commonly is fossiliferous; brachiopods, often silicified, are the most common fossils, followed by bryozoans, corals and mollusca. Disarticulated rounded crinoid debris make up much of the rock. This member has been measured and described in detail by Nielson (1981). His thickness for the member in these quadrangles ranges from 75 to 120 m

TOROWEAP FORMATION (Lower Permian)--Map unit nomenclature follows that defined by Sorauf (1962) and Rawson and Turner-Peterson (1979, 1980) and used by Nielson (1981) in his detailed studies within the present quadrangles.

Ptw WOODS RANCH MEMBER--Grayish-orange gypsiferous siltstone with thin interbeds of white gypsum and pale orange limestone and dolomite. Member is topographically weak and generally covered or very poorly exposed. Nielson (1981) measured eight sections of this member within these quadrangles. He reported that thickness of the member ranges from 30-115 m and averages about 70 m. Gypsum claims have been established in this member in section 11, T. 41 S., R. 18 W.

Ptb BRADY CANYON AND SELIGMAN MEMBERS, UNDIVIDED--The Brady Canyon Member is a cliff-forming fossiliferous limestone that resembles the Fossil Mountain Member of the Kaibab Formation and is underlain by the recessive gypsiferous siltstone that makes up the Seligman Member. The Brady Canyon Member ranges from 50 to 140 m in thickness, as reported by Nielson (1980) for nine sections measured within these quadrangles, whereas the Seligman Member ranges between 25-65 m in thickness. Because of the thinness and recessive character of the Seligman Member it was not feasible to map it separately

Pq QUEANTOWEAP SANDSTONE (Lower Permian)--Very-pale-orange to grayish-orange-pink, thin- to thick-bedded, fine-to medium-grained, variably cemented sandstone. McNair (1951, p. 525-526) named the formation for exposures in Queantoweap (Whitmore) Canyon near the Grand Canyon and noted that in tracing it into southwestern Utah it should replace the term "Supai" previously used (Reeside and Bassler, 1922) because it has neither the color nor the lithology of typical Supai. The change in color and lithology occurs along the southern margin of the present quadrangle so that it is appropriate that Steed (1980) in mapping a nearby quadrangle used different names for this interval. Within these quadrangles the Queantoweap Sandstone ranges in thickness from 500 to 600 m

Pp PAKOON DOLOMITE (Lower Permian)--Light gray fine-grained dolomite that weathers to light-brownish-gray ledges and low cliffs. Formation is often cherty but rarely fossiliferous, most fossils occurring in thin limestone beds in its upper third. The uppermost 20 m is sometimes gypsiferous with minor limestone and sandstone. Thickness here ranges between 250 and 300 m

IPc CALLVILLE LIMESTONE (Pennsylvanian)--Medium-gray limestone, medium- to thick-bedded, commonly cherty and fossiliferous, with cyclic inter-beds of orange-weathering sandstone and light gray dolomite increasing in the upper third. <u>Lithostrotionella</u> (hair coral) common in upper part, other corals, brachiopods and bryozoans common in limestone beds throughout. Poorly preserved fusulinids occur in some limestone beds. Forms step-ledge topography with few ledges greater than 2 m high. The Callville Limestone ranges in thickness in these quadrangles from 500 to 600 m

Mr REDWALL LIMESTONE (Mississippian)--Cliff-forming, massive, medium- to dark-gray limestone, divided by McKee and Gutschick (1969) into four members which were traced into the Virgin Gorge area by Steed (1980) but which are not differentiated on the present maps, although one member, the very cherty Thunder Springs Member forms a conspicuous marker interval from 20 to 45 m above the base of the formation. Steed (1980, p. 112) presented a detailed measured section of the formation that applies to the sequence in this map area as well. Basal Redwall is coarse-grained and dolomitic and about 20 m thick. The Thunder Springs Member is cherty bioclastic limestone that weathers to a conspicuous dark brownish band about 25 m thick. The upper part of the Redwall is bioclastic and fossiliferous containing horn corals, colonial corals, and brachiopods and is about 140 m thick. The entire formation is about 185 m thick

Dm MUDDY PEAK DOLOMITE (Devonian)--Two informal members described below were mapped where structure and exposure permitted. Muddy Peak beds are distinguished from adjacent formations principally by their color and topographic expression. A few layers contain distinctive pelletoidal structures and partly silicified stromatoporoidal fossils are some-times present. More rarely gastropods and brachiopods occur within local crinoidal mounds. Steed (1980, p. 99) reported that conodonts, corals, and stromatoporoids from this formation in the Virgin Gorge area indicate a Late Devonian age. Steed (1980) assigned 109 m of beds to the formation; in the present map area the formation is 210 m thick

Dmp PINNACLE MEMBER--The name of this informal member describes one of its characteristics: it weathers to form light-gray hoodoos or pinnacles just below the massive dark-gray Redwall cliffs. It is composed of medium-gray medium-crystalline massive dolomite that contains scattered chert nodules and sandy laminae. The base was taken at the top of the ledge-forming sandstone beds in the upper part of the slope member. The pinnacle member is about 50 m thick

Dms SLOPE MEMBER--Silty fine-grained light olive-gray to pale yellowish gray thin- to medium-bedded dolomite. A variety of features occur locally within this member: reddish-brown weathering sandy dolomite beds form a few ledges 1-2 m thick; a few thin beds near the top include pelletoidal structures; small stromatoporoidal hemispherical structures, usually grossly silicified, occur in several layers; sparse biohermal mounds include crinoid debris and scattered coral, gastropod and brachiopod fragments; some units appear to be bioturbated. This member forms a ledgy slope between more resistant adjacent units; it is about 160 m thick

€n NOPAH DOLOMITE (Upper Cambrian)--Medium- to fine-grained, thick-bedded, light-brownish-gray dolomite that generally forms cliffs and steep slopes. A few beds contain algal stromatolites 20 cm in diameter and up to 50 cm tall; more commonly, dolomitized twiggy bodies or small tubular structures suggest bioturbation. Steed (1980, p. 98) reported a fossiliferous shaly horizon near the base of this formation but this horizon was not found in the present map area. Measurement along the spur on the north side of Horse Trail Canyon in the West Mountain Peak quadrangle gave a thickness of 420 m

€bk BONANZA KING FORMATION (Upper and Middle Cambrian)--Mostly medium- to light-brownish-gray fine- to medium-grained, medium- to thick-bedded dolomite. Many beds are mottled light- to medium-gray and other beds contain abundant light gray to white "twiggy bodies" or short thin irregular tubular structures. The lowest 100 m includes some bluish-gray silty limestone beds, and an olive-gray slope-forming shaly limestone, about 7 m thick, occurs 15 m above the base and may correspond to part of the Chisholm Shale of the Pioche area, Nevada. The upper half of the formation includes numerous thin beds of light-gray laminated boundstone typical of upper Middle Cambrian rocks in western Utah and eastern Nevada. No fossils have been obtained from any part of the formation in this area, but Steed (1980, p. 113) reported a Late Cambrian trilobite, *Crepicephalus* sp. from the top of this formation in the Virgin Gorge just to the south of this area. Measurement along the north side of Horse Canyon in the West Mountain Peak quadrangle gave a thickness of 800 m

€ba BRIGHT ANGEL SHALE (Middle Cambrian)--Recessive thin bedded micaceous siltstone, shale, and quartzite; includes a pale-brown-weathering ledge-forming dolomite 3 m thick about 40 m above the base; above this dolomite the strata are mostly yellowish-gray micaceous sandstone and siltstone with a 15 cm limestone bed 15 m below the top.

Unfossiliferous. Bright Angel Shale is best exposed along its strike-valley just north of U.S. Highway 91 on the Castle Cliff quadrangle where it is 80 m thick. In locations in the West Mountain Peak quadrangle it is tectonically thinned or absent due to younger-on-older attenuation faulting

€t TAPEATS QUARTZITE (Middle? and/or Lower? Cambrian)--Reddish-orange to orange quartzite with a few thin layers of pebble conglomerate and sandstone; thin-bedded to very-thick-bedded; generally forms ledges and dip-slopes; upper contact is gradational. Formation is about 400 m thick except where thinned by attenuation faulting

p€ PRECAMBRIAN GNEISS, SCHIST AND PEGMATITE (Middle Proterozoic?)--Dark-gray gneissic diorite consisting mostly of amphibole with about 10 percent each of feldspar, quartz, and pyroxene. Gneissic diorite is the most resistant and most extensively exposed Precambrian rock type and is intimately interrelated with schist, amphibolite, pegmatite, and other lithologies so that no separation of rock types was mappable on the 1:24,000 scale. Schists range in composition with mica or amphibole as the principal mineral with lesser feldspar, quartz, garnet, and sillimanite. Pink granitic pegmatite dikes invade both gneissic diorite and schist and probably also intrude the white pegmatite dikes but this relationship is rarely seen. Pink pegmatites are composed mostly of K-feldspar with lesser orthoclase, quartz, and mica. White pegmatite, the least common rock type, is 60 percent orthoclase, 25 percent quartz, with lesser mica, plagioclase and garnet; graphic granite textures are common in this rock type. Detailed coverage of Precambrian rocks exposed in the West Mountain Peak quadrangle did not reveal any discrete mappable intrusive body such as shown on recent state map compilations (Hintze, 1980). Age of Precambrian rocks in the Beaver Dam Mountains has not been determined specifically but the rocks are comparable to the Vishnu and Brahma schists of the Grand Canyon area which are assigned a Middle Proterozoic age as discussed by King (1976, p. 63). Olmore (1971, p. 57) reported a 1.7 billion-year K-Ar date (mineral not specified) on a pegmatite in similar Precambrian rocks in the East Mormon Mountains, Nevada, some 30 km southwest of the Beaver Dam outcrops

EXPLANATION

Map units	Age	Period / Era
Qya, Ql, Qd, Qt, Qc, Qoa	Pleistocene and Holocene	QUATERNARY
Qb	Pleistocene	QUATERNARY
QTa, QTl	Pliocene and Pleistocene	TERTIARY
Jcj	Jurassic	MESOZOIC
JTRn	Jurassic-Triassic	MESOZOIC
TRk, TRmo, TRcp, TRcs, TRmu, TRms, TRmm, TRmv, TRml	Triassic	MESOZOIC
Pkh, Pkf, Ptw, Ptb, Pq, Pp	Permian	PALEOZOIC
IPc	Pennsylvanian	PALEOZOIC
Mr	Mississippian	PALEOZOIC

Map unit		Age
Dm	Dmp	Devonian
	Dms	
€n		Cambrian
€bk		
€ba		
€t		
p€		PRECAMBRIAN

EXPLANATION OF MAP SYMBOLS

CONTACT--Dashed where approximately located or inferred

HIGH-ANGLE NORMAL FAULT--Dashed where approximately located or inferred; dotted where concealed. Bar and ball on relatively downdropped side

LOW-ANGLE ATTENUATION FAULT--Dashed where approximately located; dotted where covered. Barbs on upper plate which places younger rocks on older

THRUST FAULT--Dashed where approximately located; dotted where covered. Barbs on upper plate which places older rocks on younger

GRAVITY SLIDE BLOCK--Tertiary or Quaternary age

ORIENTATION OF BEDDING

- Inclined
- Overturned
- Vertical
- Horizontal

TRACE OF AXIAL SURFACE OF FOLD

SURFACE TRACE OF STRONG CHANGE IN GRAVITY METER READINGS--The dots are centered over a zone about 1 km wide in which readings drop westward at the rate of about 8 mgal/km as compared to a drop of 2-4 mgal/km east of this zone and 1-2 mgal/km west of this zone

STRUCTURE

Structures in the Shivwits and West Mountain Peak quadrangles are continuous with those described in adjacent quadrangles as shown in Figure 2. Steed (1980) and Moore (1972) mapped and described the geology of areas to the south. Hintze (1983) briefly summarized structure of the Beaver Dam Mountains. Reber (1951, 1952) described structure of parts of the area. Cook (1960b) summarized regional structures of southwestern Utah. Rocks in the two quadrangles have been subjected to two principal deformations: a late Mesozoic compressional phase and a late Cenozoic extensional phase. The compressional phase produced the southeastward-trending Beaver Dam Mountains anticline, the Shivwits syncline and associated smaller folds and faults. Moore (1972) mapped a southwestward-trending anticline of magnitude similar to Beaver Dam Mountains anticline about 20 km to the south in the Virgin Mountains. Variation in the anticlinal trends and sinuosity of the Shivwits syncline as shown in Figure 2 suggests that compression from the west may have been deflected locally by preexisting buttresses.

AUTOCHTHONOUS ROCKS

Except for the detached Paleozoic rocks along the west flank of the range discussed below, all rocks in this part of the Beaver Dam Mountains are autochthonous. That is, these strata can be traced directly eastward onto the Colorado Plateau stable platform.

EXTENSIONAL FAULTS

Cenozoic extensional deformation is reflected most clearly in the Gunlock fault segment of the Grand Wash fault. Along the northeast edge of the Shivwits quadrangle the Gunlock fault juxtaposes northwesterly-dipping strata on the east limb of the Shivwits syncline with gently northeasterly-dipping strata of the Red Mountains block. The Red Mountains are on the west limb of the broad north-plunging Pine Valley Mountains syncline, the axis of which passes through St. George, 15 km to the east. Although most of the displacement on the Gunlock fault had occurred prior to deposition of the Quaternary Gunlock Basalt, dated at 1.6 my, recurrent movement has created a few meters of offset seen on the surface of the flow 3 km northwest of Shivwits as noted by Embree (1970, plate 1).

The Gunlock fault is similar to the Hurricane fault 50 km to the east in that both are downdropped on the west side, both cut conspicuous folds developed on the downdropped block, and both have upthrown blocks that are less folded than the adjacent downdropped blocks. R. E. Andersen (personal communication, January 27, 1984) suggested that the fault may have a substantial component of strike-slip which has resulted in juxtapositioning of dismembered structures. An alternative explanation is that the Cenozoic faulting follows an older sharp monoclinal flexure and represents reactivation of the zone of weakness. Although strike-slip faulting has not been much recognized in Utah, several faults with left-lateral displacement have been mapped in Nevada north of Lake

Mead as shown on tectonic maps by Longwell and others (1965, figure 5), Anderson (1973, figure 8), and Wernicke and others (1982, figure 1). Bohannon (1979, figure 1) inferred that the Lake Mead left-lateral fault system extends along the west flank of the Virgin Mountains and heads northward under cover of valley fill towards the west side of the Beaver Dam Mountains. Bohannon dates the strike-slip faulting as principally Miocene.

The Jackson Wash-Pahcoon Flat fault is best exposed where it juxtaposes Kaibab Formation against Callville Limestone at the south end of Pahcoon Flat where it separates rocks of strongly contrasting attitudes. There it dips westward at 35 degrees. It steepens along its course to the south edge of the map. Its trace is covered across Pahcoon Flat but it must surely pass along the south edge of the hogback of overturned Callville Limestone at the boundary of the Shivwits and West Mountain Peak quadrangles. Its identity northwestward from the west end of that hogback is less certain. Its main branch trends northward towards Jackson Reservoir on the Motoqua quadrangle and from this main fault numerous northwesterly-trending splays branch off; their net effect is to step the strata down to the southwest. The splay having the largest displacement is located about one km north of where Jackson Wash passes westward out of bedrock exposures on the Motoqua quadrangle (Hintze and Anderson, 1985).

The southeasterly-trending fault on the east side of West Mountain Peak is antithetic to the Jackson Wash-Pahcoon Flat fault and together they bound the Hell Hole graben in the southwest corner of the Shivwits quadrangle. A basin-and-range normal fault of great displacement presumably bounds the western flank of the Beaver Dam Mountains, but it is nowhere exposed, nor do any of the late Cenozoic surficial deposits show any fault offset, although surface faulting has been reported by Moore (1972) along the base of the Virgin Mountains nearby to the southwest. Gravity profiles made in 1981 and 1982 by Brigham Young University students working under the direction of Dr. James L. Baer showed a substantial drop along the trend indicated on the West Mountain Peak quadrangle south of Jackson Wash. The trend shown by the drop in density diverges from the nearly north-south trend of the range front.

FAULT-DRAG STRUCTURES

One of the unique aspects of the northwestern end of the Beaver Dam Mountains is the "fish-hook" curve that describes the structure of rocks a few kms north and south from Jackson Wash. The curvature seems to have been produced by drag along a north-trending range-bounding fault, here called the Red Hollow fault for its exposures along Red Hollow on the Motoqua quadrangle (Hintze and Anderson, 1985). No other Great Basin range in Utah shows such large-scale drag features. These features are most prominent in the Moenkopi Formation, likely because of the ease of mobility of its shaly members. The downthrown block of the Red Hollow fault is not exposed on these quadrangles but is well exposed on the adjoining Motoqua quadrangle where it consists of Permian strata that can be traced along the Red Hollow fault into the upper plate of the Square Top Mountain overthrust. It appears that the thrust fault plane has been reactivated and that the allochthonous Permian beds were down-tilted westward by Tertiary movement on the Red Hollow fault. The fish-hook drag structures in the autochthonous Triassic and earlier beds may have been produced by late

Mesozoic movement on the Square Top Mountain thrust, and later modified by reactivation of that fault plane along the along the Red Hollow fault.

DETACHED PALEOZOIC ROCKS

Most of the detached blocks are found to the south in the Castle Cliff quadrangle (Hintze, 1984), but a few are present along the west flank of the range in the south half of the West Mountain Peak quadrangle. Here the detached masses consist of thoroughly brecciated Cambrian quartzite and dolomite as well as the larger masses of Redwall Limestone near the south edge of the map. The emplacement mechanism of the sheets and blocks of Paleozoic rocks along the southwestern flank of the Beaver Dam Mountains has been discussed by several previous observers (Dobbin, 1939; Reber, 1952; Cook, 1960; Jones, 1963). Dobbin and Reber believed that the blocks are remnants of a post-Miocene eastward-moving thrust sheet. Cook suggested that most of the breccia blocks of Mississippian limestone moved westward as slide blocks, and he was supported by Jones (1963) in this interpretation.

ATTENUATION FAULTING

Slippage along and at low angles to bedding surfaces during folding has caused the Bright Angel Shale to be structurally thinned or eliminated from most of its expected stratigraphic position near the base of the Cambrian rock column in the West Mountain Peak quadrangle. Variation in thickness of the Tapeats Quartzite may have a similar origin.

In the north central portion of the West Mountain Peak quadrangle almost all of the Paleozoic and Mesozoic map units have been attenuated and bent as they approach the almost completely concealed Red Hollow fault. Strata are commonly thinned to 60 percent of their original thickness: The nearest thing to an exposure of the Red Hollow fault on the map is in the east central part of section 11, T. 41 S., R. 19 W. where members of the Triassic Moenkopi Formation are extremely attenuated where they strike northwards against southwesterly striking less attenuated Permian strata.

Olmore (1971) mapped near-bedding plane detachment faults that attenuate Paleozoic strata in the East Mormon Mountains which lie about 30 km west of the Beaver Dam Mountains. Although stratal extension may result from movement of upper beds over lower strata, regardless of whether that movement is produced by thrusting or by gravity induced gliding, I believe that the attenuation faulting in the Beaver Dam Mountains is mostly the result of slippage along bedding surfaces during thrusting because of its close relationship to the folding of the beds.

Figure 1. Summary stratigraphic erosional column for the Shivwits and West Mountain Peak quadrangles showing relative resistance and other characteristics of rock units.

15A

Map Symbol	Age	Formations and Members		Thickness meters	
Qya,Ql Qd,Qt,Qc	QUATERNARY	Qya-younger alluvium, Ql-landslide, Qd-dune sand, Qt-talus, Qc-colluvium		0-30	surficial deposits
Qoa		older alluvium		0-20	just above present floodplains
Qb		basalt flow		10	1.6 m.y.
QTa,QTl	QUATERNARY -TERTIARY	QTa- alluvium, QTl- landslide		0-100	QTa- exhumed pediment deposits
Jcj	JURASSIC	Carmel Formation	Judd Hollow Member	170	*Pentacrinus* in yellow and gray thin-bedded limestone and shale
Jt		Temple Cap Formation		(150)	concealed in this map area
JTRn	JURASSIC -TRIASSIC	Navajo Sandstone		700+	eolian cross-bedding highly jointed
TRk	TRIASSIC	Kayenta Formation		250	stream-deposited sandstone and siltstone
TRmo		Moenave Formation		400	dark red; shows dark shades on aerial photos
TRcp		Chinle Formation	Petrified Forest Member	350	variegated colors; mostly light shades on aerial photographs
TRcs			Shinarump Cg Member	30-120	petrified wood common
TRmu		Moenkopi Formation	Upper red member	150-200	
TRms			Shnabkaib Member	240-260	gypsum; many thin beds of limestone and limy dolomite
TRmm			Middle red member	90-120	ripple marks, gypsum
TRmv			Virgin Limestone Mbr	50-60	2-3 m limestone beds at base, middle and top
TRml			Lower red member	0-50	
Pkh	PERMIAN	Kaibab Formation	Harrisburg Member	25-150	gypsum; red rubbly chert; red beds
Pkf			Fossil Mountain Member	75-120	cherty, fossiliferous
Ptw		Toroweap Formation	Woods Ranch Member	30-115	gypsum
Ptb			Brady Canyon and Seligman Members, undivided	110-150	cherty, unfossiliferous
Pq		Queantoweap Sandstone		500-600	small-scale cross bedding
Pp		Pakoon Dolomite		250-300	cyclic deposition
IPc	PENNSYLVANIAN	Callville Limestone		500-600	*Lithostrotionella* in upper beds; cyclic deposition; cherty
Mr	MISSISSIPPIAN	Redwall Limestone		185	Thunder Springs Cherty Member
Dm: Dmp	DEVONIAN	Muddy Peak Dolomite	Pinnacle member	50	stromatoporoids
Dm: Dms			Slope member	160	
€n	CAMBRIAN	Nopah Dolomite		420	stromatolites forms cliffs
€bk		Bonanza King Formation		800	laminated white boundstone in upper part
€ba		Bright Angel Shale		80	green micaceous shale, siltstone
€t		Tapeats Quartzite		400	often attenuated
p€	PRECAMBRIAN	gneiss, schist, pegmatite			probably Vishnu Schist

Lithology

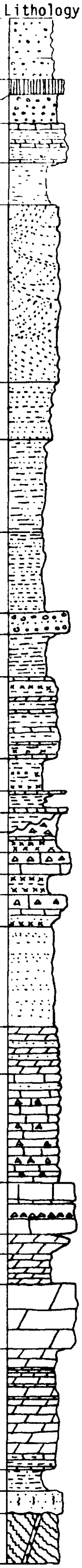

Figure 2. Summary structural map of the Beaver Dam Mountains area showing area covered by adjacent geologic maps.

A. Motoqua and Gunlock quadrangles (Hintze and Anderson, 1985)
B. West Mountain Peak and Shivwits quadrangles (this map)
C. Castle Cliff and Jarvis Peak quadrangles (Hintze, 1984)

Bold letters on map: G-Gunlock, M-Motoqua, S-Shivwits

Map units:

Qs	Surficial deposits undivided
Qb	Basalt
Tm	Muddy Creek Formation
Tv	Volcanic rocks (mostly Quichapa Group)
Tn	Needles Range Formation
Tc	Claron Formation
Ki	Iron Springs Formation
Jc	Carmel and Temple Cap formations
JTRn	Navajo Sandstone
TRk	Kayenta and Moenave formations
TRc	Chinle Formation
TRm	Moenkopi Formation
Pk	Kaibab and Toroweap formations
Pq	Queantoweap Sandstone
PIP	Pakoon Dolomite and Callville Limestone
MD	Redwall Limestone and Muddy Peak Dolomite
Ꞓn	Nopah Dolomite and Bonanza King Formation
Ꞓt	Tapeats Quartzite and Bright Angel Shale
pꞒ	gneiss, schist, pegmatite

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Figure 2

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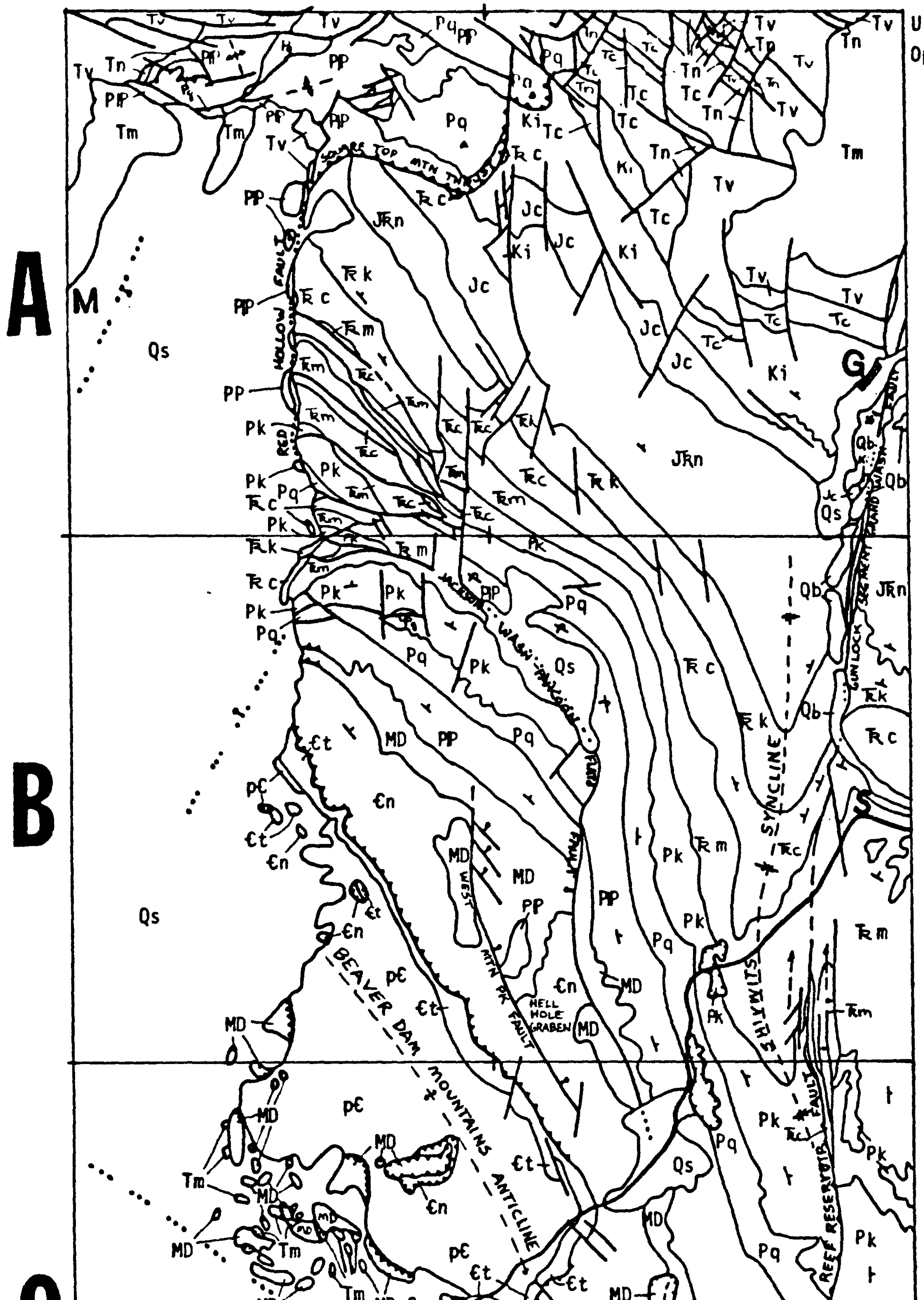

REFERENCES CITED

Anderson, R. E., 1973, Large-magnitude Late Tertiary strike-slip faulting north of Lake Mead, Nevada: U. S. Geological Survey Professional Paper 794, 18 p.

Best, M. G., McKee, E. H. and Damon, P. E., 1980, Space-time-composition patterns of late Cenozoic mafic volcanism, southwestern Utah and adjoining areas: American Journal of Science, v. 280, p. 1035-1050.

Blakey, R. C., Peterson, Fred, Caputo, M. V., Geesaman, R. C., and Voorhees, B. J., 1983, Paleogeography of Middle Jurassic continental shoreline, and shallow marine sedimentation, southern Utah: Paleogeography of the West-Central United States, Rocky Mountains Paleogeography Symposium 2, Rocky Mountain Section, Society of Economic Paleontologists and Mineralogists, p. 77-100.

Bohannon, R. G., 1979, Strike-slip faults of the Lake Mead Region of southern Nevada: Cenozoic Paleogeography of the Western United States - Pacific Coast Paleogeography Symposium 3, Pacific Section of Society of Economic Paleontologists and Mineralogists, p. 129-139.

Cheevers, C. W., and Rawson, R. R., 1979, Facies analysis of the Kaibab Formation in northern Arizona, southern Utah and southern Nevada: Four Corners Geological Society Guidebook 9, Permianland, p. 105-113.

Cook, E. F., 1960a, Breccia blocks (Mississippian) of the Welcome Spring area, southwest Utah: Geological Society of America Bulletin, v. 71, p. 1709-12.

Cook, E. F., 1960b, Geologic Atlas of Utah: Washington County: Utah Geological and Mineral Survey Bulletin 70, 119 p.

Embree, G. F., 1970, Lateral and vertical variations in a Quaternary basalt flow: petrography and chemistry of the Gunlock flow, southwestern Utah: Brigham Young University Geology Studies, v. 17, part 1, p. 67-115.

Fisher, W. L., and Sorauf, J. E., 1962, Correlation chart of Permian formations of North America: Discussion of the Grand Canyon section: Geological Society of America Bulletin, v. 73, p. 649-652.

Hintze, L. F., 1980, Geologic map of Utah: Utah Geological and Mineral Survey, scale 1:500,000, Salt Lake City, UT 84108

Hintze, L. F., 1983, Structures in the Beaver Dam Mountains, southwestern Utah: Geological Society of America Abstracts with Programs v. 15, no. 5, p. 379.

Hintze, L. F., 198~~4~~5, Geologic map of the Castle Cliff and Jarvis Peak quadrangles, Washington County, Utah: U. S. Geological Survey Open-File Report ~~84- (in preparation~~ 85-120).

Hintze, L. F., and Anderson, R. E., 1985, Geologic map of the Motoqua and Gunlock quadrangles, Washington County, Utah: U. S. Geological Survey Open-File Report 85- (in preparation).

Jenson, John, 1984, Stratigraphy and facies analysis of the upper Kaibab and lower Moenkopi formations in southwest Washington County, Utah: Brigham Young University Geology Studies (in press).

Jones, R. W., 1963, Gravity structures in the Beaver Dam Mountains, southwestern Utah: Intermountain Association of Petroleum Geologists Guidebook 12, p. 90-95.

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.

Longwell, C. R., Pampeyan, E. H., Bowyer, Ben, and Roberts, R. J., 1965, Geology and mineral deposits of Clark County, Nevada: Nevada Bureau of Mines Bulletin 62, 218 p.

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

McNair, A. H., 1951, Paleozoic stratigraphy of part of northwestern Arizona: America Assocation of Petroleum Geologists Bulletin v. 35, p. 503-541.

Moore, R. T., 1972, Geology of the Virgin and Beaver Dam Mountains, Arizona: Arizona Bureau of Mines Bulletin 186, 65 p.

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

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

Pipiringos, G. N., and O'Sullivan, R. B., 1978, Principal unconformities in Triassic and Jurassic rocks, western interior United States - a preliminary survey: U.S. Geology Survey Professional Paper 1035-A, 29 p.

Rawson, R. R., and Turner-Peterson, C. E., 1980, Paleogeography of northern Arizona during deposition of the Permian Toroweap Formation: Paleozoic Paleogeography of the West-Central United States, Rocky Mountain Paleogeography Symposium 1, Rocky Mountain Section, Society of Economic Paleontologists and Mineralogists, Denver, Colorado, p. 341-352.

Rawson, R. R., and Turner-Peterson, C. E., 1979, Marine-carbonate, sabka, and eolian facies transitions within the Permian Toroweap Formation, northern Arizona: Four Corners Geological Society Guidebook 9, Permianland, p. 87-99.

Reber, S. J., 1951, Stratigraphy and structure of the south-central and northern Beaver Dam Mountains, Washington County, Utah: unpublished master's thesis, Brigham Young University, Provo, Utah, 68 p.

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.

Reeside, J. B., Jr., and Bassler, Harvey, 1922, Stratigraphic sections in southwestern Utah and northwestern Arizona: U. S. Geological Survey Professional Paper 129-D, p. 53-77.

Sorauf, J. E., 1962, Structural geology and stratigraphy of Whitmore area, Mohave County, Arizona: unpublished Ph.D. dissertation, University of Kansas, Lawrence, 361 p.

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

Stewart, J. H., Poole, F. G., and Wilson, R. F., 1972a, Stratigraphy and origin of the Chinle Formation and related Upper Triassic strata in the Colorado Plateau region: U.S. Geology Survey Professional Paper 690, 336 p.

Stewart, J. H., Poole, F. G., and Wilson, R. F., 1972b, Stratigraphy and origin of the Triassic Moenkopi Formation and related strata in the Colorado Plateau region: U. S. Geological Survey Professional Paper 691, 195 p.

Welsh, J. E., Stokes, W. L., and Wardlaw, B. R., 1979, Regional stratigraphic relationships of the Permian "Kaibab" or Black Box Dolomite of the Emery High, central Utah: Four Corners Geological Society Guidebook 9, Permianland, p. 143-148.

Wernicke, B. P., 1982, Geology of the central Mormon Mountains, Lincoln County, Nevada: in Processes of extensional tectonics: unpublished Ph.D. dissertation, Massachusetts Institute of Technology, p. 74-134.

Wernicke, Brian, Spencer, J. E., Burchfiel, B. C., and Guth, P. L., 1982, Magnitude of crustal extension in the southern Great Basin: Geology, v. 10, p. 499-502.

Wilson, R. F., and Stewart, J. H., 1967, Correlation of Upper Triassic and Triassic (?) formations between southwestern Utah and southern Nevada: U. S. Geological Survey Bulletin 1244-D, 20 p.

Wright, J. C., Snyder, R. P., and Dickey, D. D., 1979, Stratigraphic sections of Jurassic San Rafael Group and adjacent rocks in Iron and Washington Counties, Utah: U. S. Geological Survey Open-File Report 79-1318, 53 p.