

TULE 30X60-MINUTE QUADRANGLE  
and Fitzhugh D. Davis

GEOLOGY OF THE TULE VALLEY, UTAH 30 X 60-MINUTE QUADRANGLE

by  
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GEOLOGY OF THE TULE VALLEY 30x60-MINUTE QUADRANGLE

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DESCRIPTION OF MAP UNITS

- Qal<sub>1</sub> ALLUVIUM--Youngest alluvium in the floodplain and channel of Baker Creek and tributaries in Snake Valley; mostly light-gray or light tan clay, silt, and sand. Late Holocene in age.
- Qaf<sub>1</sub> ALLUVIAL-FAN DEPOSITS--Coarse to fine-grained alluvium deposited mostly on piedmont slopes after regression of Lake Bonneville from the Bonneville shoreline. Late Pleistocene to late Holocene in age.
- Qpm PLAYA MUD--Poorly sorted clay, silt, sand, and marl locally with gypsum, halite, and other salts. Holocene in age.
- Qed EOLIAN DUNES--Mostly well sorted sand composed largely of quartz in well developed dunes, but local sand sheets; also includes sand-size aggregates of clay and silt mixed with sand that have accumulated in irregular dunes ("clay" dunes or lunettes). Holocene in age.
- Qes EOLIAN SILICEOUS SAND--Chiefly silica sand deposited as sand sheets rather than in well developed dunes. Occurs in

the northeast and southeast parts of Tule Valley. Holocene in age.

Qeg EOLIAN GYPSUM DEPOSITS--Primarily sand-sized gypsum deposited in sand sheets rather than in well developed dunes. Occurs in the central part of Tule Valley. Holocene in age.

Qsm MARSH DEPOSITS ASSOCIATED WITH SPRINGS--Clay, silt, and fine sand, often salty and/or organic; associated with present-day springs and related high groundwater areas. Holocene in age.

Qdm DELTAIC MUD--Deltaic mud of the Holocene delta of the Sevier River at the northeastern end of Sevier Lake.

Qla LACUSTRINE AND ALLUVIAL DEPOSITS UNDIFFERENTIATED--Deposits in piedmont areas where pre-Lake Bonneville alluvial sediments were reworked by waves and currents in Lake Bonneville, but where the lacustrine sediment component is thin; includes pre-Bonneville alluvial fans etched by wave action in Lake Bonneville as well as thin lacustrine gravel capping QT1f.

Qaf<sub>2</sub> ALLUVIAL FAN DEPOSITS--Pre-Lake Bonneville alluvial fans in piedmont areas above the Bonneville shoreline; also

alluvial sediments in mountainous valleys and canyons above the Bonneville shoreline; includes some minor and mostly thin post-Bonneville fan deposits above the Bonneville shoreline.

Qlf FINE-GRAINED LACUSTRINE DEPOSITS--Varying percentages of clay, silt, sand, and marl; locally includes the white marl (Qlm), but also includes local, thin, surficial influxes of alluvium. Late Pleistocene to Holocene in age.

Qms MASS MOVEMENT DEPOSITS--Talus, colluvium, and debris-flow deposits. Late Pleistocene to Holocene in age.

Qlt LACUSTRINE TUFA--Calcium carbonate deposits precipitated in Tule Valley during the Provo shoreline time of Lake Bonneville and the subsequent regressive phase of Lake Bonneville and Lake Tule Valley; usually white to light gray and porous. Late Pleistocene to Holocene in age.

Qls LACUSTRINE SAND--Quartz sand, marly sand, or pebbly sand in beaches, bars, <sup>spits,</sup> and embankments deposited in Lake Bonneville. In Tule Valley, the Qls was deposited 10-60 ft. below the Provo shoreline. In the Sevier Desert and Snake Valley, the Qls was deposited at lake stages higher than the Provo shoreline.

- Q1m LACUSTRINE MARL--Fine-grained, finely bedded to indistinctly laminated, white to gray marl deposited in Lake Bonneville. Includes Gilbert's "white marl" as well as reworked sandy and silty marl; also mapped in extensive valley flats of Tule Valley. The marl contains abundant ostracodes and locally has gastropods near the base and top of the unit; the thickness ranges from 2 to 10m depending on depositional setting. Commonly there is clastic-rich marl at the base and top of the unit.
- Q1l LACUSTRINE LAGOON DEPOSITS--White, tan, or light-gray clay, silt, and sand filling lagoons behind gravel (Q1g) barrier beaches and bars. Includes local, thin, surficial influxes of later alluvium. Late Pleistocene to Holocene in age.
- Q1g LACUSTRINE GRAVEL--Sandy gravel deposited as beaches, bars, embankments, and spits (including tombolos) in Lake Bonneville, Lake Gunnison, Lake Tule Valley, and Sevier Lake. These deposits are excellent sources of construction aggregate. Late Pleistocene to late Holocene in age.
- QT1f FINE-GRAINED LACUSTRINE DEPOSITS--Light-red, light-green, brownish-green, and light yellowish-gray to light orangish-gray clayey marl and calcareous silty clay and sand; slightly bentonitic; forms badlands. Oviatt (1987) reported that these lacustrine beds contain the Bishop ash (0.74 m.y.

B.P.) and the Huckleberry Ridge ash (2.02 m.y. B.P.)

Tc TUFFACEOUS CONGLOMERATE AND LIMESTONE--In the Confusion Range this unit includes deposits that may range considerably in age. On the east flank of the range a late Tertiary conglomerate overlies Needles Range Group and probably represents basin-range valley-filling sediments. This conglomerate is variably cemented, has subangular sedimentary and volcanic clast up to 1-foot in diameter, and lenses of tuff and tuffaceous sandstone. Elsewhere within the Confusion Range an older tuffaceous conglomerate is interbedded with fresh-water limestone beds of Oligocene age. This limestone is very-pale-orange, dense, and includes concentric algal structures up to 3 inches in diameter. The limestone underlies Needles Range Group volcanic rocks and may be equivalent to the Tertiary limestone, T1, mapped in the House Range. Quadrangle maps of the Confusion Range by Hose and his collaborators, as listed in the references, state that stratigraphic relations of Tertiary units is not clear because of poor exposures, but was inferred on the basis of scattered outcrops.

Tn NEEDLES RANGE GROUP--Includes both the Cottonwood Wash and Wah Wah Springs Tuffs in this area. These are crystal-rich ash-flow tuffs that range in field appearance from white, friable, poorly-welded, poorly exposed tuffs, to black

vitrophyre; the most typical expression, however, is a moderate-orange-pink dacite tuff, mostly welded, and including abundant pumice fragments, usually flattened. Biotite is conspicuous, and small quartz and hornblende phenocrysts are abundant. See Best and Grant (1987) for summary of lithology and distribution of the Needles Range Group. Its age is about 29 m.y. Anderson (1983) remapped some areas in the Confusion Range where the earlier quadrangle maps had shown Tertiary welded tuffs. The senior author (Hintze) field checked the identity of all rocks shown as Needles Range Group on this map. The easiest exposures to see are at the head of Kings Canyon on U.S. Highway 50-6; the thickest preserved sequence is on Toms Knoll on the Conger Range NE quadrangle (Hose, 1965) where the Needles Range Group is nearly 400 feet thick.

Tsr SKULL ROCK PASS CONGLOMERATE--Unstratified, poorly sorted, uncemented clast-supported conglomerate with clasts ranging up to 20 feet in diameter, in a silty and clayey matrix made up largely of comminuted volcanic rock. Clasts are 95 percent derived from lower Paleozoic carbonate rocks and range from well-rounded to angular, with subrounded being most common. Boulders of Eureka Quartzite (of which Skull Rock, itself, is a conspicuous example) make up most of the non-carbonate clasts. Boulders, cobbles, or pebbles of igneous rock are almost entirely absent except in the Red

Knolls 7.5-minute quadrangle (Hintze and Davis, 1988b) where boulders of basaltic andesite are fairly common. Occasional boulders of Notch Peak granite can be found on Long Ridge. The type area for the Skull Rock Pass Conglomerate is on Long Ridge (Hintze and Davis, 1988a) where the formation is about 300 feet thick.

T1 Limestone AND Limestone Breccia--Limestone is white to pinkish or orangish gray, coarsely crystalline, fresh-water limestone that forms low ledges and rounded hills in the central House Range (Hintze, 1981a) where its lower third contains abundant recrystallized plant stem or root structures. Some layers contain poorly preserved fossil leaves of willow, poplar, and rush-like aspect. Terrestrial and fresh -water snails, Helix and Lymnaea are scarce. The limestone has a maximum thickness of about 100 feet. A limestone breccia underlies the limestone in places. The breccia is comprised chiefly of Cambrian limestone and dolomite fragments ranging from gravel size to tens of feet; it is well cemented and resistant and may be about 100 feet thick.

Tt TUNNEL SPRING TUFF--Rhyolitic crystal-vitric tuff, white to pinkish gray, that contains abundant small doubly-terminated quartz crystals, glass shards, and lithic fragments. Named and described by Bushman (1973). Its age is about 33 m.y.

It ranges from 0 to 50 feet thick in the map area, and is found in small outcrops in both the House and Confusion Ranges.

Trk RED KNOLLS TUFF--Light-gray to grayish orange-pink moderately resistant tuff which contains 10 to 30 percent lithic fragments, mostly of volcanic rocks of similar composition. Phenocrysts make up about half of the rock and are, in decreasing order of abundance, plagioclase, biotite, quartz, hornblende, and a trace of bright green augite. The type area for this tuff is the Red Knolls quadrangle (Hintze and Davis, 1988b) where the formation is 210 feet thick. Isotopic age of the tuff is uncertain; Hintze (1981c) reported an age of 36 m.y. based on K-Ar analysis of slightly altered biotite. Lindsay (1988, personal communication) said that fission-track studies on zircons from presumably the same tuff in the Little Drum Mountains yielded an age of 30 m.y. Additional dating studies are underway.

Tld LITTLE DRUM VOLCANICS--This includes several units mapped by Leedom (1974) and Pierce (1974) in the Little Drum Mountains. The composition of most of these rocks is hornblende-pyroxene latite, pyroxene andesite, and pyroxene shoshonite, and the deposits are laharic breccias, conglomerates, and some flows. Limited isotopic dating of

these rocks suggest they are 38-40 m.y. old. They appear to be as much as 2500 feet thick, and represent an accumulation around a volcanic center near or within the Little Drum Mountains area.

Tldt OLDER TUFFS OF THE LITTLE DRUM MOUNTAINS--Pink to gray, poorly welded andesite and latite tuffs that contain abundant biotite and some amphibolite, and pumice and lithic fragments, as reported by Leedom (1974) and Pierce (1974). In the southern Little Drum Mountains, a conglomerate similar to those in the Little Drum Volcanics, is interbedded with these tuffs. The tuffs range in thickness from about 400 to 800 feet.

Jg GRANITE STOCK IN THE HOUSE RANGE--Porphyritic granite, medium to coarsely crystalline, with euhedral to subhedral pink orthoclase phenocrysts. Large sills and small dikes extend into adjacent sedimentary rocks as described by Gehman (1958), Gillett et al. (1982), and Hover Granath et al. (1983). The contact aureole has produced small tungsten deposits and attracted some gold prospecting. Geophysical studies suggest that the intrusion may be rootless. Its age is probably greater than the 143 m.y. reported in older reports (Hintze 1974b).

TRt THAYNES FORMATION--Predominantly yellowish-gray claystone

and platy siltstone. Fine-grained sandstone beds from 900 to 1,200 feet above base. Limestone beds from half a foot to 16 feet thick are present throughout; those of lower 500 feet weather dark brown. Reddish-colored claystone and siltstone from 550 to 850 feet above base. Upper part of Thaynes removed by erosion so that it is overlapped by Tertiary and Quaternary rock. Maximum preserved thickness in Confusion Range is about 1900 feet.

Pg GERSTER LIMESTONE--Resistant ledge-forming organic detrital limestone interbedded with thicker zones of slope-forming rusty brown argillaceous detrital limestone. Brownish-black irregularly shaped siliceous limestone nodules characterize the resistant beds. Punctospirifer pulcher (Meek) fauna ranges throughout. Thickness ranges from 800 to 1100 feet.

Pp PLYMPTON FORMATION--Mainly yellowish-gray to olive-gray, medium- to fine- grained dolomite; chert abundant as beds, nodules, and concretions; local siltstone and sandstone units in upper half of formation weather grayish yellow to pale red; gypsum or its brecciated residuum occurs in upper 200 feet; a zone of collophane and brownish-black collophane-bearing dolomite present 150 to 200 feet above base locally. Ranges from 550 to 680 feet in thickness.

- Pk KAIBAB LIMESTONE--Principally massive light-gray to yellowish-gray coarse-grained organic detrital limestone with resistant coarse-grained grayish-yellow limy dolomite in upper 70 feet and earthy grayish-yellow dolomite in middle 30 feet; siliceous limestone concretions and chert nodules common. Fossils typical of the Kaibab Limestone of the Colorado Plateau area occur just above the middle. Formation is 500-600 feet thick.
- Pa ARCTURUS FORMATION--Predominantly fine-grained, poorly indurated grayish yellow sandstone, throughout which limestone and limy dolomite beds 4 to 10 feet thick are spaced more or less evenly; brick-red colors common in upper few hundred feet; gypsum present at several horizons. Because of gypsum the Arcturus deforms readily and its true original thickness cannot be determined, but it appears to be about 3,000 feet thick. See Hose and Repenning (1959).
- PPMe ELY LIMESTONE--Medium- to light-gray limestone, mostly bioclastic, in alternating ledge- and slope- forming beds as much as 50 feet thick but mostly between 1 and 20 feet thick. Gray to reddish-brown chert occurs as thin beds and nodules amounting to as much as 10 percent of some beds in the lower third of the formation. Reddish-brown siliceous concretionary bodies, up to 4 feet long, and with concentric laminations, occur in the middle third of the formation.

Organic detritus consists of fragments of brachiopods, bryozoans, corals, crinoid stems, algae, and foraminifera. Fossils in the basal 60 feet are regarded as Mississippian (Hose and Repenning, 1959, p. 2173), while those in the upper 350 feet are assigned to the Wolfcampian (Permian). A regional unconformity within the formation places the Permian strata on rocks of early Desmoinesian age; Missourian and Virgilian-age rocks are absent. Some stratigraphers have called the Permian portion of the Ely Limestone the Reipe Spring Limestone, but the present compilation follows Hose and Repenning (1959) and includes the Permian rocks as part of the Ely Limestone which is about 2,000 feet thick in the Confusion Range.

Mc CHAINMAN SHALE--Mostly dark-gray shale and platy light-gray siltstone, conspicuously less resistant than the overlying and underlying formations. Lowest 200 feet is olive-gray siltstone, which is overlain by 975 feet of shale at the base of which is a limestone marker bed 5 to 15 feet thick; another thin limestone marker bed occurs about 200 feet above the basal one; above the thick shale unit is a 360 foot sequence of shale, shaly limestone, and dark-gray dense limestone that forms resistant ledges; the uppermost 180 feet of the Chainman Shale is light-brown-weathering shale and siltstone with lesser fine-grained sandstone and limestone; this highest part of the Chainman is very

fossiliferous, yielding mostly corals and brachiopods of the Rhipidomella nevadensis zone of late Chesterian age. Gordon (1984) reviewed the biostratigraphy of the Chainman Shale. Goniatite cephalopods that are found 200 to 400 feet above the base of the Chainman in the Confusion Range are classified as Visean (late Meramecian and early Chesterian. Sandberg et al. (1980) summarized Chainman conodont zonation. The Chainman Shale is 1,600-1,800 feet thick in the Confusion Range.

Mj JOANA LIMESTONE--Medium- to dark-gray massive limestone that weathers to a light-brownish-gray cliff or hogback between less resistant shaly formations. Fossils are not characteristically abundant or well preserved, but include gastropod impressions, corals, crinoid columnals, and Kinderhookian brachiopods. Joana Limestone thins to about 10 feet at the north end of the Confusion Range. In the southern part of the map area it is as much as 300 feet thick.

MDp PILOT SHALE--Platy calcareous siltstone and shale that weather yellowish-gray and form covered slopes and strike valleys. Lower third is olive gray and dolomitic; 4 feet of algal nodular limestone forms a ledge underlain by 10 feet of shale about 170 feet below the top of the formation. Sandberg et al. (1980) presented a detailed measured

section of Pilot Shale 1090 feet thick from the Confusion Range. They identified 12 conodont zones within the formation. The lower Pilot is Frasnian; the bulk of the formation is Famennian; the upper 190 feet is Kinderhookian.

Dg GUILMETTE FORMATION--The upper 500 feet of the Guilmette is medium-gray to dark-gray limestone that includes stromatoporoidal biostromes, brachiopod beds, and some brown-weathering quartzose sandstone beds up to 4 feet thick. From 500 to 1,300 feet below the top the Guilmette is mostly finely crystalline dark-gray dolomite that includes many stromatoporoidal biostromes and a few corals and brachiopods. Dense dark-gray limestone 1,300 to 2,000 feet below the top is thin to medium-bedded and forms low ledges. The basal 650 feet of Guilmette is a dark-gray, finely crystalline, generally massive limestone that forms rounded cliffs and knolls. In a few places the bedding becomes less massive along strike. In many places this basal unit consists of a breccia of angular limestone blocks, up to 3 feet in diameter, cemented in a dense matrix of the same kind of limestone, suggesting that the breccia was formed by solution cavity collapse shortly after its original deposition. The Guilmette Formation in the Confusion Range was described by Hose (1966). It is 2,650 feet thick.

Ds SIMONSON DOLOMITE--Alternating light- and dark-brownish-gray dolomite forming low ledges beneath massive beds of the Guilmette Formation. Basal 150 feet of Simonson Dolomite is pale yellowish-brown coarsely crystalline dolomite. Above this is 40 feet of dark-gray finely crystalline dolomite with abundant gastropods and stromatoporoids. Highest 200 feet alternates from fine to coarsely crystalline dolomite with some limestone. Hose (1966, p. 39) reported Stringocephalus sp. from the upper 20 feet. The Simonson Dolomite is about 650 feet thick.

Dsy SEVY DOLOMITE--Remarkably homogeneous light-gray-weathering dolomite; fresh surface is medium gray, finely crystalline, dense; beds range from 6 inches to a few feet in thickness but are mostly about 2 feet thick and quite uniform. Usually forms low, rounded slopes and hills with no conspicuous cliffs. Upper 100 feet contains several 4- to 12-inch bands of well-rounded frosted coarse quartz sand grains that float in a dolomite matrix. Sand grains are light yellowish-brown and etch into relief on weathered surfaces. Lower two-thirds of the formation contains occasional laminated cherty beds up to 3 feet thick. Unfossiliferous in this area. The Sevy Dolomite is about 1,300 feet thick.

S1 LAKETOWN DOLOMITE--Mostly dark-gray, massive, cliff-forming

dolomite but contains two light-colored marker beds of pinkish-gray, coarsely crystalline dolomite in upper half. Upper thicker pinkish-gray bed occurs from 235 to 360 feet below the top; thinner pinkish-gray bed is 450 to 480 feet below the top. The upper 80 feet of the Laketown Dolomite contains a beautifully silicified brachiopod-coral fauna. Poorly preserved corals and dasycladacean algae are common in the middle part of the formation. Pentamerid brachiopod impressions are common in a bed about 400 feet above the base. Bedded brachiopod impressions are common in a bed about 400 feet above the base. Bedded light-gray chert nodules make up about 5 percent of the upper 500 feet of the formation. Budge and Sheehan (1980 a, b) have described the Silurian stratigraphy of western Utah. The Laketown Dolomite is 1,000-1,200 feet thick.

Oes ELY SPRINGS DOLOMITE--Lower 460 feet is dark gray, sparsely cherty, medium to finely crystalline dolomite which weathers dark brownish gray and forms ledges capped by a cliff-forming unit 360 to 460 feet above the base. Uppermost 170 feet is alternating light and dark brownish-gray ledge-and-slope forming unit. Budge and Sheehan (1980a, b) have described the Ely Springs Dolomite in the Confusion Range.

Sole UNDIVIDED LAKETOWN AND ELY SPRINGS DOLOMITE--In areas of structural complexity the dark dolomites of the Ely Springs

and Laketown Dolomites cannot be differentiated and are shown on the map by the symbol "SOle".

Oew EUREKA QUARTZITE, CRYSTAL PEAK DOLOMITE, AND WATSON RANCH QUARTZITE UNDIVIDED--These three formations were grouped as a single map unit because of map scale considerations. The Eureka Quartzite consists of orthoquartzite and quartz sandstone, vitreous in part, white to light-gray, medium- to fine-grained; weathers reddish-brown; spherical pockholes, about one-half inch in diameter, are numerous and characteristic of Eureka Quartzite here. Formation forms light orange cliffs contrasting conspicuously with dark dolomites above. Upper and lower few feet are gradational dolomite sandstone. Eureka Quartzite shatters and attenuates in folded and thrust areas. It is 450-500 feet thick. The Crystal Peak Dolomite is a medium to finely crystalline thin-bedded dolomite that weathers light olive gray and contains a coral and brachiopod fauna (Hintze 1973 c, 1979). The Crystal Peak Dolomite is 90 feet thick. The Watson Ranch Quartzite is orthoquartzite and quartz sandstone, similar to Eureka Quartzite but weathers darker reddish brown, is less massively bedded, and forms lower ledges and cliffs; contains some silty partings and fucoidal markings and few pockholes. It is 200-250 feet thick.

Opu UPPER POGONIP GROUP--This map unit includes the Lehman,

Kanosh, Juab, and Wah Wah Formations. See Hintze (1973c, 1979, 1987) for detailed measurements and summary of fossils. The Lehman Formation is a bluish-gray-weathering thin-bedded silty limestone with some interbeds of crosslaminated quartzite. Ostracodes and brachiopods common. The Lehman is 210 feet thick. The Kanosh Shale is a light-olive-gray fissile shale with interbeds of thin-bedded fossiliferous calcarenite and, in the upper half, yellowish-brown siltstone beds a few feet thick. Kanosh Shale erodes to form slopes and covered intervals. Orthid brachiopods and large and small ostracodes form thin-bedded coquinas throughout the formation. Trilobites, gastropods, bryozoans, and orthocone cephalopods are common. Kanosh Shale is 550 feet thick. The Juab Limestone is a medium-gray fine-sandy calcisiltite in beds up to 4 feet thick that erode to low ledges. Orthid brachiopods are common. The Juab is 160 feet thick. The Wah Wah Limestone consists of ledge and slope-forming silty limestones bearing abundant fossils of the Pseudocybele nasuta (J) zone. Where exposed, Wah Wah Limestone forms conspicuous ledges above the slopes of the Fillmore Formation. It is 250 feet thick.

Of FILLMORE LIMESTONE--The Fillmore Limestone is mostly intraformational conglomerate, medium-gray, thin-bedded; contains flat pebbles of silty to fine quartz-sandy limestone in a muddy limestone matrix. Intraformational

conglomerate forms a platy talus that commonly conceals the interbeds of yellowish-gray shale that make up much of the formation which is about 1,800 feet thick. Only the lowest 1000 feet of the Fillmore Formation is exposed in the Tule Valley quadrangle. The cuesta in SW1/4 sec. 13, T. 20S., R. 14W. exposes the lowest 500 feet. The east end of the road cut at Skull Rock Pass exposes small sponge-algal patch reefs about 360 feet above the base of the Fillmore Formation. Silicified trilobites of the Tesselacauda (E) zone occur in these reefs. A small fault zone disrupts the Fillmore in the Skull Rock Pass roadcuts but does not produce much stratigraphic displacement. Successively younger beds of Fillmore Formation are well exposed in roadcuts from Skull Rock Pass westward for 2 miles. Shales in the road-cuts yield Adelograptus and other graptolites. The youngest beds exposed are about 950 feet above the base of the Fillmore Formation and contain trilobites belonging to the Protopliomerops contract (G-2) zone.

Oh HOUSE LIMESTONE--This formation is a medium-gray, quartz-silty, sparsely cherty, finely crystalline nonalgal limestone in beds mostly 2 to 4 feet thick; erodes to ledges less massive than underlying Notch Peak Formation but more resistant than overlying Fillmore Formation. Trilobites of the Symphysurina (B) zone occur from the base to within 20 feet of the top. Upper 15 feet is a massive limestone ledge

with a Syntrophina-Paraplethopeltis (C) zone coquina at its base. The type locality for the House Limestone is located in this quadrangle (Hintze 1951, 1952, 1973c, 1979). The House Limestone is 500 feet thick.

OCn NOTCH PEAK FORMATION--This quadrangle includes the type section for this formation as described by Hintze et al. (1988). The upper member consists of 380 feet of medium- to dark-gray limestone; upper 160 feet largely algal stromatolites in massive beds that form rounded cliffs. Lower 220 feet is less massive, alternating medium and coarsely crystalline limestone and intraformational conglomerate. Partly silicified Euptychaspis trilobite horizon about 115 feet above base of member. The middle member is a reddish-brown-weathering slope-forming calcarenite. The lower member is 1,200 feet thick and is medium- to dark-gray limestone, thick bedded to massive, eroding to cliffs and ledges which hold up the highest parts of the House Range. The limestone is mostly medium to coarsely crystalline but some finely crystalline beds are present. Light-reddish and yellowish silty zones etch to irregular wavy forms on weathered surfaces; thin chert zones make up about 1 percent of the member. Two-thirds of the upper 430 feet consists of algal stromatolitic limestone. Individual algal growths are 6 inches to 2 feet across and up to 3 feet high and form massive intergrowths.

Cou UPPER ORR FORMATION--This quadrangle includes the type section of the Orr Formation as redefined by Hintze and Palmer (1976). The upper Orr map unit consists of the Sneakover, Corset Spring, Johns Wash, and Candland Members of the Orr Formation. The Sneakover Pass Limestone Member consists of 110-150 feet of medium-bedded blocky, medium-gray limestone that has purplish-red silty bedding-plane partings in its upper 50 feet and contains sparse trilobites and brachiopods. The Corset Spring Shale Member is a recessive unit about 100 feet thick that consists of light-olive-gray shale interbedded with nodular silty limestone. The Johns Wash Limestone Member is 140-200 feet thick and is medium-light-gray silty limestone in its upper half and contains light- and dark-gray banded oolitic limestone 25 to 75 feet above its base. The Candland Shale Member is a recessive unit, 210-270 feet thick, and consists of slope-forming dark-gray silty thin-bedded limestone in basal 60 feet; middle 130 feet is interbedded dark-gray shale and nodular fossiliferous limestone; upper 80 feet mostly nodular silty limestone. Trilobite fragments are abundant and characteristic of this member; four trilobite zones are represented in ascending order: Aphelaspis, Dicanthopyge, Prehousia, and Dunderbergia.

Cob BIG HORSE MEMBER, ORR FORMATION--Bioclastic limestone

composed of trilobites and inarticulate brachiopods is the most distinctive lithology of this member. Girvanellid algal beds are common, particularly in the upper part, and Collenia-type reefs also occur near the top. The member is thin to thick bedded, forms stairlike ledges, is mostly medium to dark gray, and contains oscillation ripple marks on bedding surfaces. Silt-size quartz detritus in some beds weathers to brown and gray streaked and mottled patterns. Crepicephalus Zone trilobites are common. The Big Horse Member is 720 feet thick.

Clw

LAMB, TRIPPE, AND WEEKS FORMATIONS--The Weeks Limestone is restricted in occurrence to its type locality in North Canyon in the central House Range. Elsewhere its temporal equivalents are the Lamb Dolomite and the upper part of the Trippe Limestone as indicated by Hintze and Robison (1975). The Weeks Formation is laminated dark-gray fine-grained limestone alternating with 1/8- to 1/4-inch beds of medium-gray silty limestone. Lowest 100 feet is more resistant than the remainder of the formation, which weathers to platy talus-covered slopes. Weathered color is yellowish to reddish gray. The lowest 160 feet contains the agnostid Lejopyge, a trilobite indicative of Middle Cambrian age. Upper Cambrian Cedaria Zone trilobites including Tricrepicephalus and Cedaria occur from 290 feet above the base to the top of the formation. The Weeks is about 1,200

feet thick. The Lamb Dolomite is the dolomitic equivalent of the upper Weeks Limestone that occurs on the east flank of Swasey Mountain in the central House Range. There it was divided by Hintze (1981c) into two members, an upper member, 180 feet thick, of light-gray, medium-bedded, sugery dolomite, and a lower member, 250 feet thick, of medium-dark-gray, fine- to medium-crystalline, medium-bedded to massive cliff-forming dolomite. The Trippe Limestone is exposed on the east flank of Swasey Mountain where it consists of two members Hintze (1981c). The upper member, about 300 feet thick, is characterized by thin white laminated boundstone, a lithology that is virtually restricted to this formation. The upper Trippe member forms slopes between the cliff-forming units above and below; laminated boundstone makes up about a quarter of the upper Trippe member; the remainder is mostly light- to medium-gray, medium- to thick-bedded limestone and dolomite; some of the beds are mottled, bioturbated dolomitic limestone. The lower member of the Trippe is unfossiliferous limestone and dolomite that forms ledges and cliffs about 200 feet thick above the less resistant shaly Marjum Formation; the upper 300 feet of lower Trippe is medium-brownish-gray, coarsely crystalline, slightly vuggy dolomite that forms cliffs. The entire Trippe Limestone in the House Range is about 850 feet thick.

Cmp      MARJUM AND PIERSON COVE FORMATIONS--The Pierson Cove Formation is equivalent to the lower part of the Marjum Formation as indicated by Hintze and Robison (1975). The Marjum Formation is predominantly medium- to dark-gray thin-bedded, fine-grained, silty limestone, interbedded with shale and mudstone. Occasional beds of intraformational flat-pebble conglomerate and thin algal biostromes constitute less than 2 percent of the formation. The formation weathers to slopes and ledges, and is fossiliferous, bearing upper Middle Cambrian trilobites. It is about 1,400 feet thick. The Pierson Cove Formation is dark-gray, mottled, unfossiliferous, massive dolomitic limestone with interbeds of medium-gray limestone. It forms cliffs and ledges and is about 1,200 feet thick on the east flank of Swasey Mountain.

Cww      WHEELER, SWASEY, AND WHIRLWIND FORMATIONS--These formations are grouped into a single map unit to accommodate the scale of the map. The Wheeler Shale is nonresistant calcareous shale and thin-bedded platy shaly limestone that weathers light olive gray. The Wheeler Shale of the central House Range is world-famous for its trilobites (Hintze and Robison, 1987). Elrathia kingii (Meek), Asaphiscus wheeleri (Meek), and Peronopsis interstricta (White) are the most common representatives of the Bathyriscus fimbriatus Subzone which extends through the Wheeler Shale into the

Lower Marjum Formation. The Wheeler Shale is 420-490 feet thick in the House Range. The Swasey Limestone is a medium-dark-gray fine-grained limestone with yellowish- and reddish-brown silt partings and mottled zones. It forms a prominent cliff between the weaker Wheeler and Whirlwind Formations. It is 250 feet thick. The Whirlwind Formation is a calcareous shale and thin-bedded shaly limestone. Thirty feet of dark-gray silty limestone forms ledges in the middle. Thin limestone coquinas of heads of the trilobite Ehmaniella occur in the upper third of the formation which is 140 feet thick.

Cdh DOME, CHISHOLM, AND HOWELL FORMATIONS--These formations are grouped to accommodate the 1:100,000 map scale. The Dome Limestone is a dark-gray fine- to coarse-grained limestone that weathers to medium- to light-gray cliffs; silty material shows on weathered cliff faces. Minor crossbedding is found in some oolitic beds in the upper half. The Dome Limestone is 320 feet thick. The Chisholm Shale is nonresistant dark-gray thin-bedded fine- to coarse-grained limestone; some layers are oolitic to pisolitic. Glossopleura most abundant from 40 to 100 feet below top. Upper 40 feet is mostly olive-brown shale. The Chisholm is 220 feet thick. The Howell Limestone includes a light-gray upper member, 380 feet thick, and a dark-gray lower member 310 feet thick. The upper member is light gray fine-to

medium-grained limestone; weathers to light-gray cliffs which contain many reddish-stained solution caverns. Howell Limestone averages 96 percent carbonate; impurities are mostly fine quartz and clay particles. The lower Howell, called the Millard Member, is medium-dark-gray medium-grained limestone; forms the lower dark portion of the Howell Limestone cliff. Girvanellid algal spheres 1/4- to 3/8-inch in diameter characterize the member.

Cp PIOCHE FORMATION--The Pioche Formation consists of two members, the Tatow Member, 180 feet thick, and an unnamed lower member 720 feet thick (Hintze and Robison, 1975). The Tatow Member is moderate- and light-brown calcareous quartzite with interbeds of limestone constituting 20 percent of formation in beds as much as 67 feet thick, some bearing Albertella? Zone trilobites. The lower member of the Pioche is predominantly phyllitic quartzite, light-greenish-gray and grayish-brown, with some interbeds of grayish-green phyllite. Vertical "worm tubes" and Olenellus (Robison & Hintze, 1972) impressions occur 260 feet beneath the top in dark-brown ledge-forming quartzites.

Cpm PROSPECT MOUNTAIN QUARTZITE--The base of this formation is not exposed in this quadrangle but its thickness nearby is about 4,000 feet. It consists of pinkish-gray vitreous quartzite that weathers pale reddish-brown, is mostly fine-

to medium-grained with small-scale crossbeds, and thin quartz-pebble conglomerate in some horizons. Prospect Mountain Quartzite is exposed along the west foot of the House Range from Dome Canyon northward.

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