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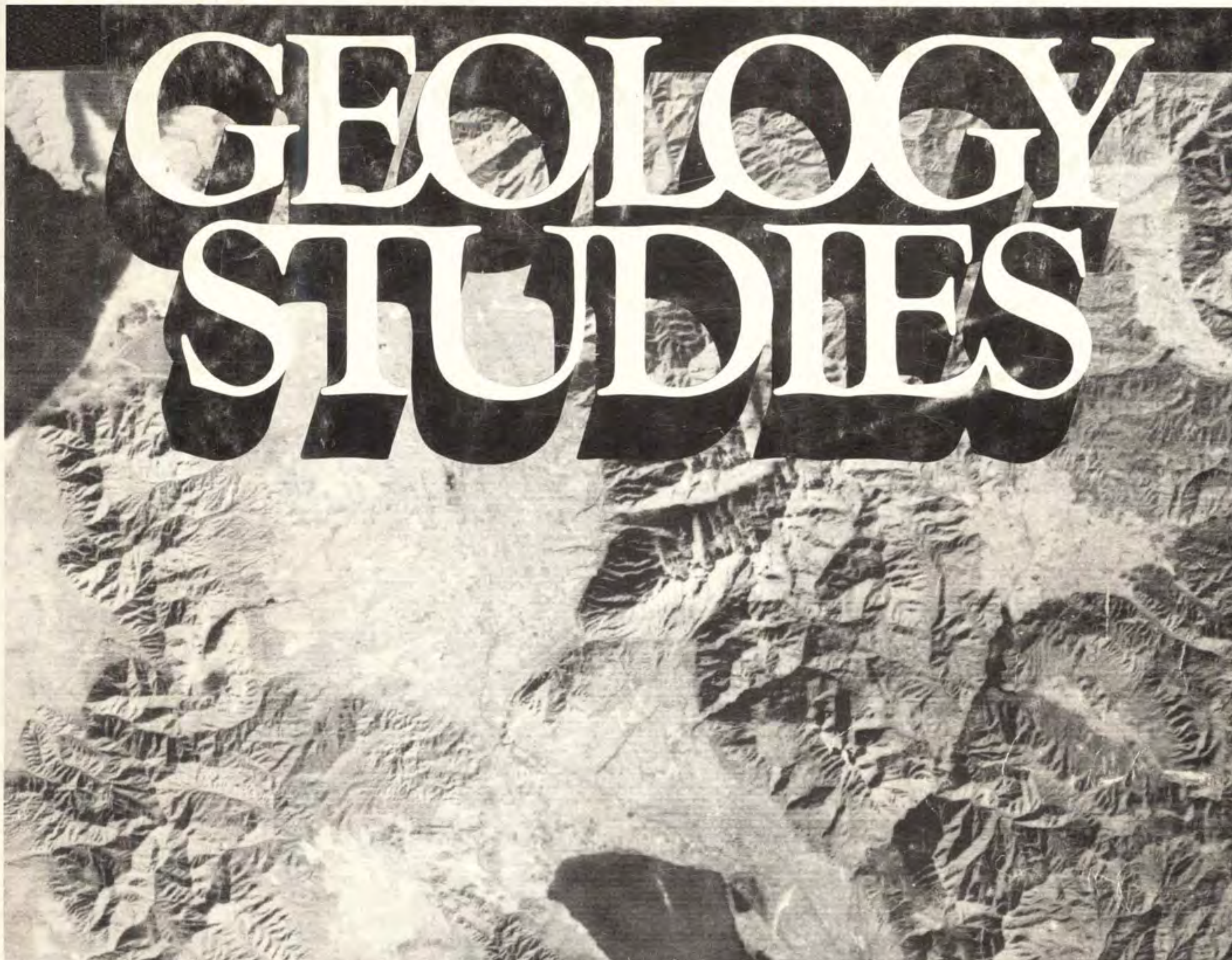

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The Geology of the Drum Mountains: Millard and Juab Counties, Utah

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ABSTRACT.–Rock units of the Drum Mountains have been assigned regional formational names, replacing informal names used previously.

Precambrian units consist of 1,220 m of clastic rocks. Paleozoic carbonates and shales are 4,130 m thick. Tertiary volcanic units are about 580 m thick. The following sequence is recognized:

Precambrian Y (?)–Caddy Canyon Quartzite; Precambrian Z–Inkom Shale and Mutual Formation; Lower Cambrian–Prospect Mountain Quartzite and lower Pioche Formation; Middle Cambrian–upper Pioche Formation, Howell Limestone, Chisholm Formation, Dome Limestone, Whirlwind Formation, Swasey Limestone, Wheeler Shale, Pierson Cove Formation, and Trippe Limestone, including the Fish Springs Member; Upper Cambrian–Lamb Dolomite, Orr Formation, including Big Horse Limestone Member, light colored member, Corset Spring Shale Member, and Sneakover Limestone Member, Notch Peak Formation; Lower Ordovician–House Limestone, Fillmore Formation, and Wah Wah-Juab Formations undivided; Middle Ordovician–Kanosh Shale and Eureka Quartzite; Tertiary–andesites undivided, Wah Wah Springs Tuff Member of Needles Formation, tuff of Laird Spring, tuff of Mount Laird, intrusions, lapilli tuff, landslide, and rhyolite flows.

Paleozoic rocks have been faulted by three sets of high-angle faults of probable Sevier age. These faults trend east, northeast, and northwest. The Oligocene (?) tuff of Mount Laird was extruded in connection with caldera collapse along the arcuate Joy Fault, interpreted as a caldera ring fault. Basin and range movement in Miocene time tilted the Drum Mountains block to the west, reactivated the Joy Fault, produced several minor faults, and produced the eastern boundary fault of the Drum Mountains. Subsequently, rhyolite flows and related mineralized bodies were emplaced.

INTRODUCTION

The Drum Mountains of west central Utah have long been the subject of geologic interest. Mining of gold, copper, and manganese in the late 1800s and early 1900s was followed by renewed interest in beryllium, gold, manganese, and uranium in the past twenty years. Until this report, however, the geology of the Drum Mountains has never been delineated with regional formational names. The primary effort of this work is stratigraphic, bringing generally accepted regional formational names into usage in the Drum Mountains. Mapping has also brought structure and geologic history into focus.

The Drum Mountains are located about 56 km northwest of Delta, Utah. The location of the range and adjacent areas is shown on the index map (fig. 1). Most of the Drum Mountains are included on the southern two-thirds of the Topaz Mountain 15-minute quadrangle. The western half of the Drum Mountains Well 7½-minute quadrangle includes most of the rest of the range.

Economic mineral investigations in the Drum Mountains have been done by Bailey (1975), Crittenden and others (1961), and Newell (1971). Shawe (1972) and Lindsey (1978) also considered items pertinent to economic geology of the Drum Mountains.

Robison (1964), Oldroyd (1973), White (1973), and Randolph (1973) have done paleontological work on Cambrian faunas in the Drum Mountains.

Davis and Prince (1959) did reconnaissance mapping in the Drum Mountains for the state map (Stokes 1962). Morris (1978) compiled the Delta 2° map, which includes the Drum Mountains.

Pertinent work on volcanic rocks in adjacent areas has been done by Hogg (1972), Leedom (1974), Lindsey (1978), Lindsey and others (1975), Shawe (1972), Staatz and Carr (1964), and Staub (1975).

Present work was done during May, June, and July of 1979. Field mapping was done on aerial photographs at a scale of 1:24,000 and then transferred to a topographic base map of the same scale. Sections were measured with a Jacob's staff.

Acknowledgments

Lehi F. Hintze served as committee chairman and Myron G. Best as committee member for this writer's thesis. Thanks are due them both for answering innumerable questions and for field orientation. Assistance by Brigham Young University Field Camp students D. Okerlund, D. Jenkins, M. Urie, D. Weick, and W. Whitlock was greatly appreciated. Allison R. Palmer identified trilobites from the Corset Spring Shale. I give special thanks to R. D. Benton, who provided a field vehicle, and to my wife, Lisa, who typed the manuscript.

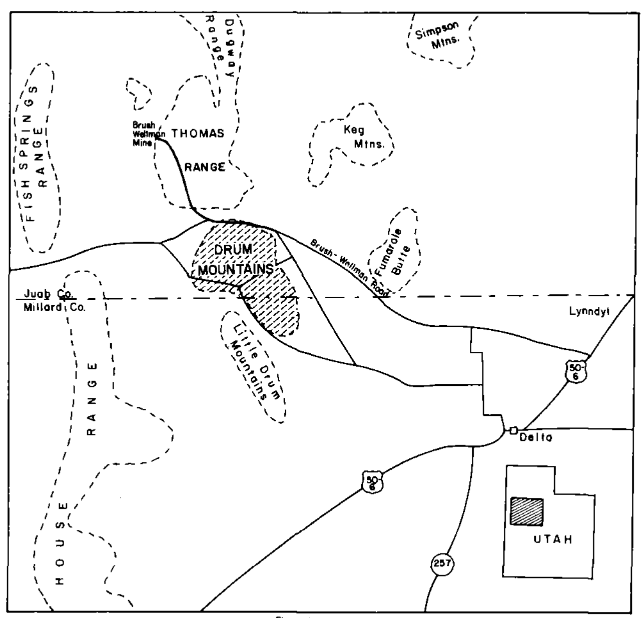


FIGURE 1.–Index map.

*A thesis presented to the Department of Geology, Brigham Young University, in partial fulfillment of the requirements for the degree Master of Science, August 1979. Thesis chairman: L. F. Hintze.

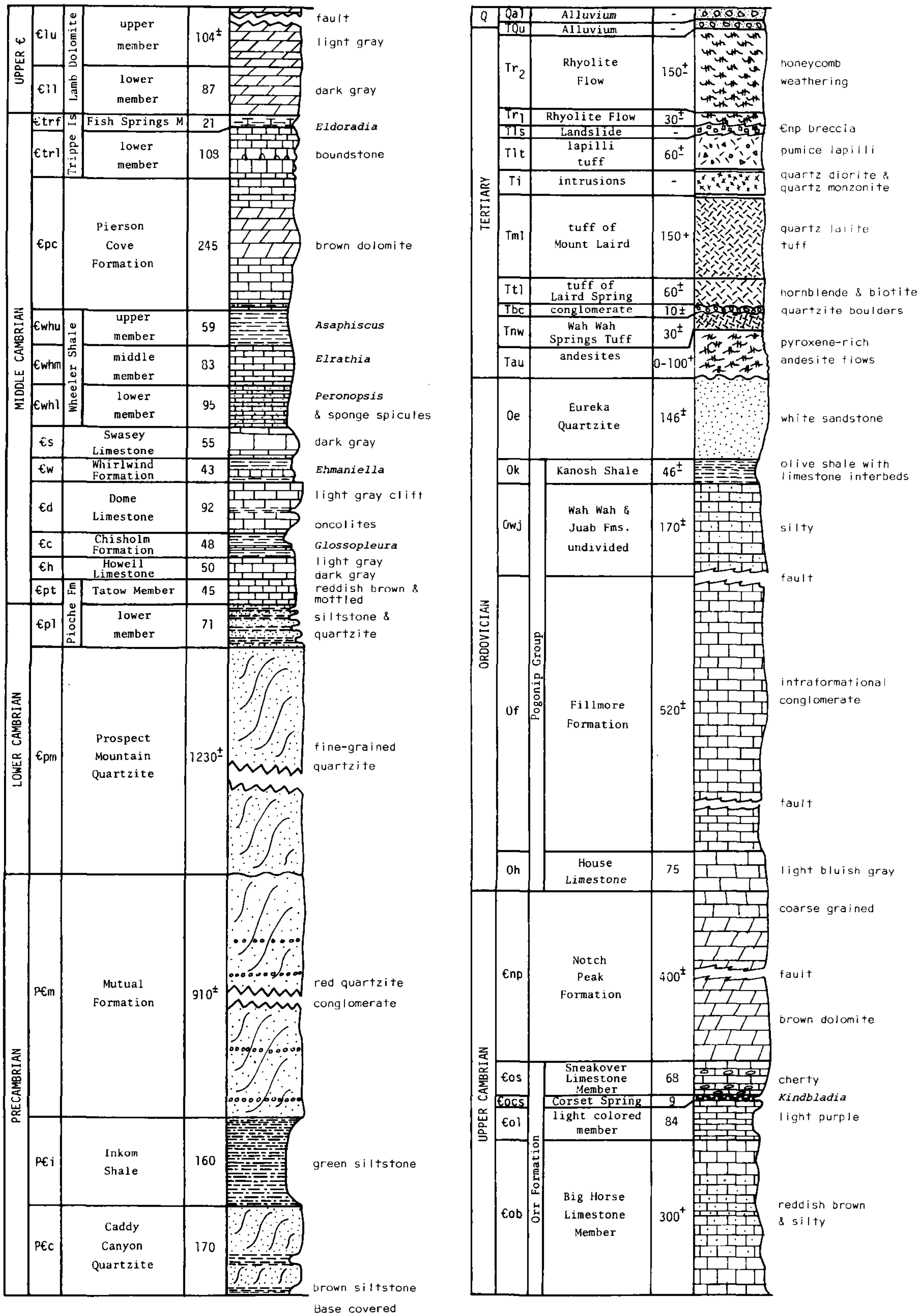


FIGURE 2.–Stratigraphy of the Drum Mountains (thickness in meters).

STRATIGRAPHY

Strata of the Drum Mountains constitute a nearly complete late Precambrian through Middle Ordovician stratigraphic section. Cambrian and Ordovician rocks are underlain slightly angularly by Precambrian metasedimens, and overlain unconformably by Tertiary volcanic rocks. Other unconformities are unknown. Precambrian formations are approximately 1,220 m thick. Paleozoic units total 4,130 m. Tertiary volcanics are about 580 m thick. Figure 2 summarizes the stratigraphy of the Drum Mountains.

The Paleozoic stratigraphy of the Drum Mountains has, until this report, never been assigned regional formational names of currently accepted usage. Hintze and Robison (1975) delineated units of a Lower and Middle Cambrian nomenclature which has been utilized throughout much of west central Utah. Hintze and Palmer (1976) and Hintze and others (1980) have defined mappable units of an Upper Cambrian nomenclature. I was able to readily map and measure these units in the Drum Mountains. Ordovician nomenclature is after Hintze (1951, 1973) and Webb (1956). Precambrian units are those of Crittenden and others (1971), as extended by Morris (1978 and personal communication). Tertiary volcanic units are not easily correlated without radiometric dating, so informal names are applied, using the works of Shawe (1972), Newell (1971), Lindsey and others (1975), and Lindsey (1978) as guidelines.

A summary of correlation of Drum Mountains Paleozoic stratigraphy with nearby ranges is best shown in diagrammatic form (fig. 3). Rocks of the Cambrian-Ordovician interval are correlated by fossils, rather than lithology, because of lithologic variability from range to range. Designations of Crittenden and others (1961) in the Drum Mountains are included in figure 3 to facilitate transition to the nomenclature of this report. Ages of Paleozoic units, where not given in the following descriptions, may be had from figure 3.

Precambrian Rocks

Precambrian units present in the Drum Mountains are the Mutual Formation, Inkom Shale, and Caddy Canyon Quartzite (Morris 1978 and personal communication). Exposed Precambrian rocks total 1,244+ m in the Drum Mountains.

Caddy Canyon Quartzite

Crittenden and others (1971) described the Caddy Canyon Quartzite in the Pocatello, Idaho, area. Morris (1978) extended its usage to the Drum Mountains.

In the Drum Mountains the Caddy Canyon Quartzite consists of 97.5 m of pinkish to tan quartzite grit and pebble conglomerate underlain by 73.2 m of alternating siltstone and quartzite. Total measured thickness is 170.7 m (section 6, appendix).

The base of the Caddy Canyon Quartzite is covered. The Caddy Canyon Quartzite is overlain by the grayish green siltstones of the Inkom Shale. The top is easily located at the base of the Inkom Shale slope.

Crittenden and others (1971) dated the Caddy Canyon Quartzite as late Precambrian. Morris (1978), after Cohenour (1959), indicated that the Caddy Canyon Quartzite is Precambrian Y (?) in age.

Inkom Shale

The Inkom Shale is nearly all grayish green silty shale and siltstone in the Drum Mountains. At the top, the siltstone is a very dark red, and one quartzite ledge occurs between the extensive grayish green siltstone and the red siltstone. Total measured thickness is 159.4 m (section 6, appendix).

The Inkom Shale slope is easily located on aerial photos between the more resistant quartzite ledges of the Mutual Formation and the Caddy Canyon Quartzite. The upper contact is placed above the uppermost red siltstone. Quartzite is nearly continuous in the Mutual Formation above. Crittenden and others (1971) dated the Inkom Shale as late Precambrian. The Inkom Shale was shown by Morris (1978) as Precambrian Z in age.

Mutual Formation

Granger and Sharp (1952) defined the Mutual Formation in northeastern Utah. It has since been extended to western Utah (Crittenden and others 1971, Morris 1978).

The Mutual Formation is a fairly uniform reddish grit and pebble quartzite conglomerate estimated to be 914 m thick in the Drum Mountains (partial section in appendix, section 6). Grit-size particles are angular, and pebbles are rounded. Sorting is poor. Pebbles and grit occur in lenses which pinch out within a few tens of meters laterally. Locally, lenses may be dark gray to dark purple. Pebbles may be up to 5 cm in diameter. The Mutual Formation is medium to thick bedded and forms steep rugged slopes and high peaks.

The contact of the Mutual Formtion with the overlying Prospect Mountain Quartzite is subtle, but is placed above the uppermost grit conglomerate below the fine-grained quartzites of the Prospect Mountain Quartzite. The uppermost grit conglomerate is a light pinkish color, which contrasts with the overlying darker fine-grained quartzites of the Prospect Mountain Quartzite. The upper contact of the Mutual Formation is thought to be slightly angular on a regional basis (Cohenour 1959, Woodward 1972). Crittenden and others (1971) dated the Mutual Formation as late Precambrian. Morris (1978) indicated the Mutual Formation is Precambrian Z in age.

Lower Cambrian Rocks

Prospect Mountain Quartzite

Hague (1883) named the Prospect Mountain Quartzite in the Eureka district in central Nevada. The name has since been used widely in Utah and Nevada for Early Cambrian and older quartzites. Misch and Hazzard (1962) limited the usage to the currently accepted definition of pink, tan, and brown quartzites of probable Early Cambrian age (Hintze and Robison 1975).

The Prospect Mountain Quartzite in the Drum Mountains is light red, pink to tan, fine grained, well sorted, and clean. It is medium to thick bedded and locally cross-bedded, and it forms blocky ledges and talus-strewn slopes that, from a distance, look much like the Mutual Formation.

The Prospect Mountain Quartzite is overlain by the Pioche Formation, the contact of which is placed at the base of the lowest dark brown quartzite ledge of the Pioche Formation. The lower Pioche Formation is darker and less resistant than the Prospect Mountain Quartzite. The contact of the Prospect Mountain Quartzite with the lower Cambrian Pioche Formation is conformable, and that conformity is the basis for assigning a lower Cambrian age to the Prospect Mountain Quartzite.

The thickness of the Prospect Mountain Quartzite is estimated at 1,228 + m by map calculation.

Pioche Formation

Walcott's (1908a, p. 11–12) original work on the Pioche Shale has been evaluated (Merriam 1964) and revised (Hintze and Robison 1975) to include, in Utah, a lower member of alternating phyllitic quartzite and light green siltstone and an upper reddish brown carbonate member named the Tatow Member of Pioche Formation (Hintze and Robison 1975). Deiss (1938) and Hanks (1962) described these units in the House Range. In the Drum Mountains, rocks of the Pioche Formation are nearly identical in lithology to those of the House Range, but are not as thick.

Crittenden and others (1961) mapped Cabin Shale and Busby (?) Quartzite in the Drum Mountains. The Cabin Shale and Busby (?) Quartzite are nearly equivalent to the lower member of the Pioche Formation as mapped by me. The lowest brown weathering quartzite ledge of the lower member was included by Crittenden and others in the Prospect Mountain Quartzite.

Lower Member of the Pioche Formation. The lower member of the Pioche Formation in the Drum Mountains consists of four dark brown phyllitic quartzite units interbedded with four light green micaceous shale and siltstone units.

The quartzite forms 3–15-m-thick ledges. On a fresh surface, the dark brown quartzite is medium gray with brown speckles of iron oxide. Some units of quartzite have abundant *Scolithus* tubes. No other fossils were found, but Hintze and Robison (1975, p. 883) noted that M. B. McCollum found a fragmentary olenellid cephalon in the lower-member interval. This finding indicates a lower Cambrian age, which age was documented in the House Range and elsewhere (A. R. Palmer, in Merriam 1964, p. 25–27; and Robison and Hintze 1975).

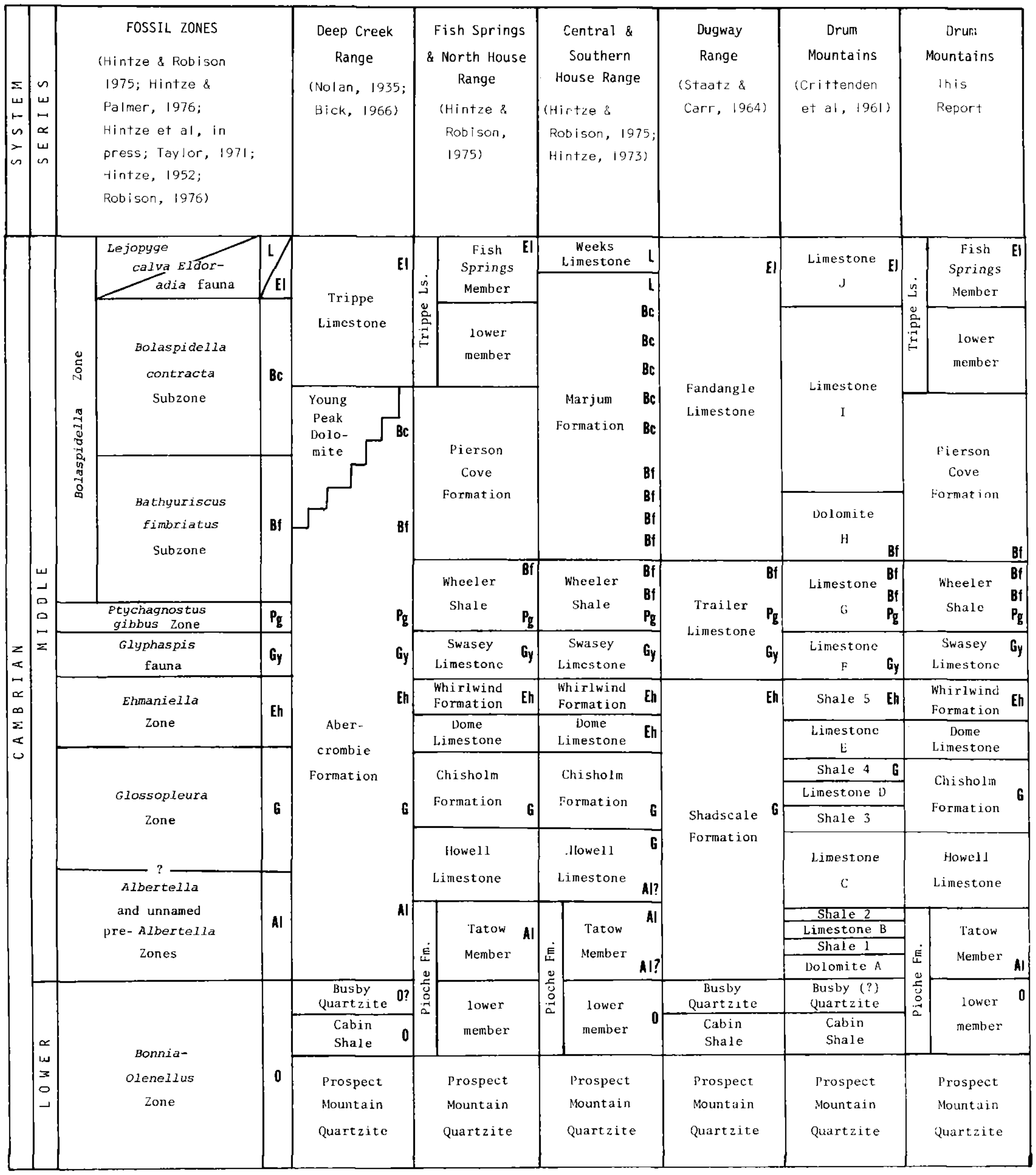
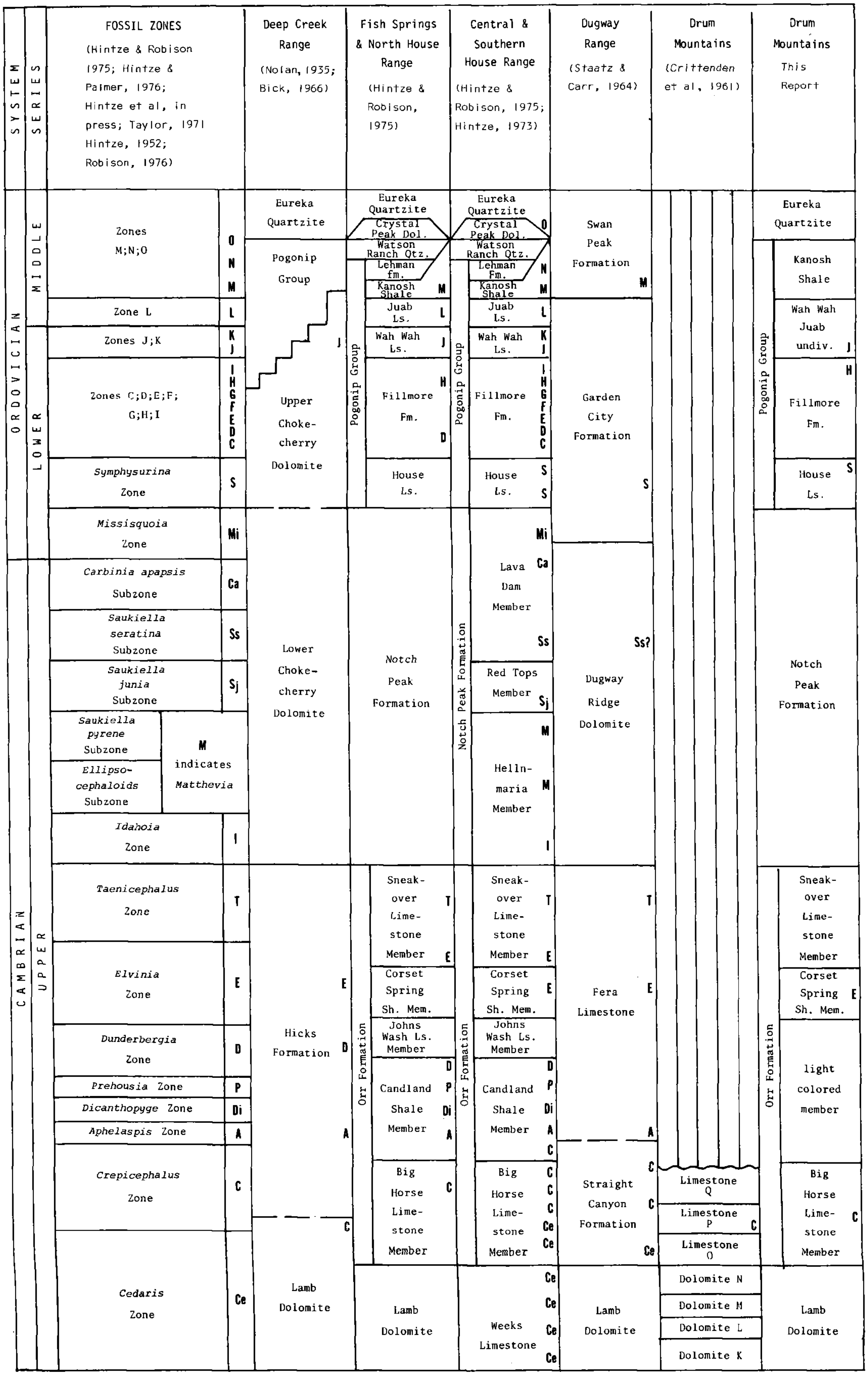


FIGURE 3.–Correlation of Cambrian and Ordovician formations in western Utah (after Hintze and Robison 1975; thickness of rock units is not to scale).


SYSTEM
SERIES
FOSSIL ZONES (Hintze & Robison 1975; Hintze & Palmer, 1976; Hintze et al, in press; Taylor, 1971 Hintze, 1952; Robison, 1976)
Deep Creek Range (Nolan, 1935; Bick, 1966)
Fish Springs & North House Range (Hintze & Robison, 1975)
Central & Southern House Range (Hintze & Robison, 1975; Hintze, 1973)
Dugway Range (Staatz & Carr, 1964)
Drum Mountains (Crittenden et al, 1961)
Drum Mountains This Report
ORDOVICIAN
MIDDLE
LOWER
CAMBRIAN
UPPER
Zones M;N;O
Zone L
Zones J;K
Zones C;D;E;F; G;H;I
Symphysurina Zone
Missisquoia Zone
Carbinia apapsis Subzone
Saukiella seratina Subzone
Saukiella junia Subzone
Saukiella pyrene Subzone
Ellipsocephaloids Subzone
M indicates Matthevia
Idahoia Zone
Taenicephalus Zone
Elvinia Zone
Dunderbergia Zone
Prehousia Zone
Dicanthopyge Zone
Aphelaspis Zone
Crepicephalus Zone
Cedaris Zone
O N M L K J I H G F E D C S Mi Ca Ss Sj I T E D P Di A C Ce
Eureka Quartzite
Pogonip Group
Upper Choke-cherry Dolomite
Lower Choke-cherry Dolomite
Hicks Formation
Lamb Dolomite
Crystal Peak Dol.
Watson Ranch Qtz.
Lehman fm.
Kanosh Shale
Juab Ls.
Wah Wah Ls.
Fillmore Fm.
House Ls.
Notch Peak Formation
Orr Formation
Sneak-over Lime-stone Member
Corset Spring Sh. Mem.
Johns Wash Ls. Member
Candland Shale Member
Big Horse Lime-stone Member
Lava Dam Member
Red Tops Member
Hellnmaria Member
Weeks Limestone
Swan Peak Formation
Garden City Formation
Dugway Ridge Dolomite
Ss?
Fera Limestone
Straight Canyon Formation
Limestone Q
Limestone P
Limestone O
Dolomite N
Dolomite M
Dolomite L
Dolomite K
Kanosh Shale
Wah Wah Juab undiv.
Fillmore Fm.
House Ls.
Notch Peak Formation
light colored member

The lower member of the Pioche Formation has a measured thickness of 71 m in the Drum Mountains (section 1, appendix). It is overlain by the reddish brown carbonates of the Tatow Member. The contact is placed at the lowest occurrence of carbonate rock in the section.

Middle Cambrian Rocks

Tatow Member of Pioche Formation

The Tatow Member in the Drum Mountains is essentially all reddish brown weathering limestone. The Tatow Member is mostly medium to thin bedded and forms a slope with a few ledges. The reddish brown color is due to oxidation of iron in dolomitic laminations and mottles. The measured thickness of the Tatow Member is 44.5 m (section 1, appendix). It is overlain by the massive dark limestone of the Howell Limestone. The contact is placed above the uppermost reddish brown weathering slope and ledge-forming carbonate.

Howell Limestone

Walcott (1908a, p. 11) originally designated the Howell Limestone. It has since been emended, redescribed, and restricted by several workers (Deiss 1938, p. 1146; Wheeler 1948; Wheeler and Steele 1951; Robison 1960). Robison (1960, p. 49–51) defined a dark gray lower (Millard) member and a light gray upper member in the House Range. Although much thinner in the Drum Mountains, these same two units can be recognized. They are not, because of the thinness of the Howell Limestone, mappable as units at the scale used in this work.

The Howell Limestone is 50 m thick in the Drum Mountains (section 1, appendix), including 36 m of dark gray cliff- and ledge-forming limestone (Millard Member) and 14 m of light gray to light pink limestone at the top (upper member). Oncolites (*Girvanella?*) are abundant in the Howell limestones. The Howell Limestone is overlain by the slope-forming, thin-bedded limestones and siltstones of the Chisholm Formation and underlain by the reddish brown carbonates of the Tatow Member of the Pioche Formation. The upper contact of the Howell Limestone is placed above its uppermost light gray limestone.

Chisholm Formation

The Chisholm Formation was named by Walcott (1916, p. 409) at Pioche, Nevada. Merriam (1964, p. 32), Robison (1960, p. 49), Deiss (1938, p. 1135–36), and Hanks (1962, p. 123) made contributions to our understanding of the Chisholm Formation at Pioche, Nevada, and in the House Range.

The Chisholm Formation in western Utah is typified by its appearance in the House Range, where it consists of a lower 18-m, slope-forming limestone and siltstone unit, a middle 41-m pisolite and *Glossopleura*-bearing limestone, and an upper 14-m slope-forming shale (Hintze and Robison 1975, p. 885).

Its appearance in the Drum Mountains is similar to that in the House Range, except that it is somewhat thinner. It forms an easily mappable unit above the Howell Limestone ledges and below the Dome Limestone cliffs. The lower 16.2 m consist of slope-forming medium- to thin-bedded limestone and siltstone. A middle thin-bedded oolitic limestone unit, 18 m thick, forms low ledges and contains abundant *Glossopleura* in its upper 9 m. The upper unit forms a 13.7-m-thick light olive weathering slope with about 0.5 m of reddish shale at the top. The total measured thickness of the Chisholm Formation is 47.9 m (section 1, appendix).

Oldroyd (1973) documented and described the faunas of the Chisholm Formation in the Drum Mountains and the House Range. Oldroyd states that the faunas differ considerably between ranges, but *Glossopleura, Alokistocare, Kootenia,* and *Zacanthoides* are found in both ranges. Oldroyd (1973, p. 29–35) grouped the faunas of the Chisholm Formation in the Drum Mountains into three faunules in the *Glossopleura* zone.

The upper contact of the Chisholm Formation is placed above the thin red shale horizon at the base of the dark gray, oncolitic, ledge-forming limestones of the Dome Limestone.

Dome Limestone

Walcott's (1908a) original definition of the Dome Limestone has been changed little by subsequent work. The Dome Limestone is defined as a light gray fossil-barren cliff between the shale slopes of the Chisholm and the Whirlwind Formations.

The Dome Limestone's aspect in the Drum Mountains is somewhat unique. A dark gray oncolitic-to-pisolitic, massive, ledge-forming unit 32.6 m thick occurs at the base. Greenish tan-weathering fissile shale 15.5 m thick separates the lower limestone unit from a thick upper cliff-forming dark limestone capped with light gray limestone. This shale interval causes the Dome to weather in two segments on the dip slope in the southwest corner of the map and elsewhere. The lower ledges cap the cliff in section 16, T. 15 S, R. 10 W, and the upper cliffs are located 0.8 km southwest, near the bottom of the dip slope.

The total measured thickness of the Dome Limestone is 92.3 m (section 1, appendix). The lower contact is placed below the oncolitic dark gray ledges and above the green shale of the Chisholm Formation. Care must be taken not to confuse the shale interval of the Dome Limestone with the shale of the Chisholm Formation. The upper contact of the Dome Limestone is placed above its highest light gray limestone.

Whirlwind Formation

Walcott (1908a) included what is now the Whirlwind Formation as a slope-forming unit of the Swasey Limestone. Robison (1960) proposed that the slope-forming units below the dark Swasey Limestone cliffs be called Whirlwind Formation.

The Whirlwind Formation in the House Range is nearly identical to the Whirlwind Formation in the Drum Mountains. In the Drum Mountains it forms a characteristic lower shale slope, reddish middle limestone ledge, and upper shale slope, making it easily identifiable and mappable. The shales are grayish yellow to light olive gray and weather light olive. The middle limestone is mottled with yellowish brown dolomite.

The upper shale contains limy thin-bedded layers of diagnostic trilobite "hash" of the *Ehmaniella* Zone of Robison (1976). The lower shale is 15.9 m, the middle limestone 6.1 m, and the upper shale 21.3 m thick. Total thickness is 43.3 m (section 1, appendix). The upper contact of the Whirlwind Formation is at the base of the dark Swasey Limestone cliff.

Swasey Limestone

The original Swasey Limestone of Walcott (1908a) included both a lower slope-forming unit and an upper cliff-forming unit. As noted above, Robison (1960, p. 51) restricted the Swasey Limestone to the upper dark gray cliff-forming unit.

The Swasey Limestone in the Drum Mountains appears much as it does elsewhere in western Utah. The lower 24.1 m form a dark gray, mostly fossil-barren cliff. The upper 31.4 m are also fossil poor, thin bedded, and somewhat argillaceous

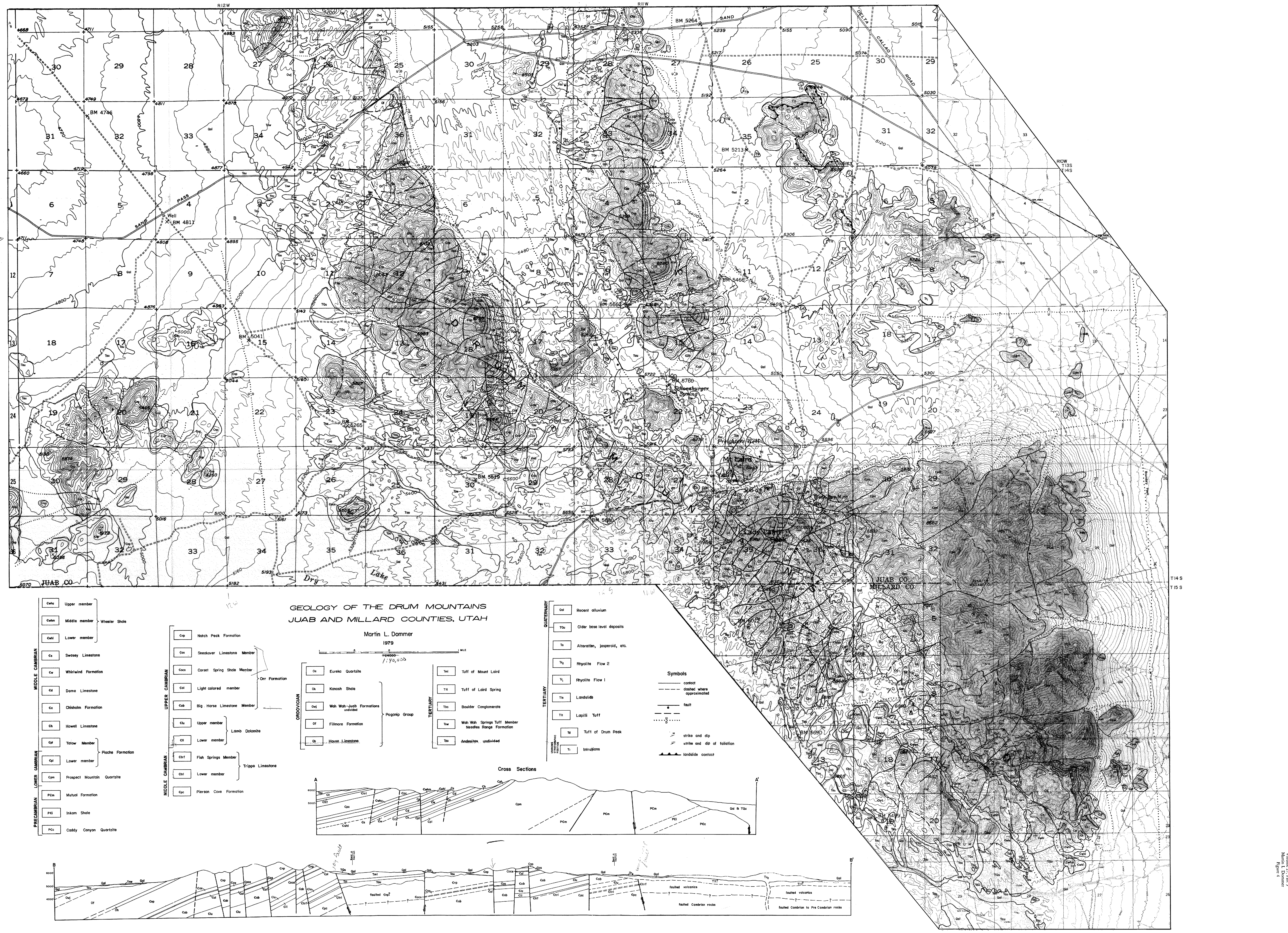


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Figure 4

and form a flaggy backslope above the cliff. Total measured thickness is 55.5 m (section 1, appendix).

Randolph (1973) described the informally named *Glyphaspis* fauna from the upper part of the Swasey Limestone. White (1973) placed the upper contact of the Swasey Limestone above an "oolitic facies" (White 1973, p. 16; fig. 4). According to White, the lithofacies change is abrupt and may even truncate fossil fragments at the boundary of dark gray thin-bedded limestone (section 1, appendix) and the overlying argillaceous light gray "silver shale" limestone of the Wheeler Shale. Abundant *Peronopsis* and siliceous sponge spicules are found in beds above the contact.

Wheeler Shale

Walcott (1908a) named the Wheeler Shale. Hintze has mapped it following Walcott's original definition in the House and Fish Springs Ranges (Hintze and Robison 1975). Robison (1960, 1964) has done considerable work on the Wheeler Shale, showing that in most ranges the Swasey Limestone is overlain by slope-forming argillaceous limestones containing extensive agnostid trilobite faunas. White (1973) studied the paleontology and depositional environments of the Wheeler Shale in the Drum Mountains, detailing the faunas of the Wheeler Shale and placing the base of the Middle Cambrian *Bolaspidella* Zone 61 m above the base of the Wheeler. Below that zone the Middle Cambrian *Ptychagnostus gibbus* Zone is represented (Randolph 1973, in White 1973, p. 8; Robison 1976).

In the Drum Mountains, I mapped three informal members in the Wheeler Shale, which together totaled 239.5 m in thickness. Robison (personal communication) confirmed that the Wheeler Shale is anomalously thick here as compared to nearby ranges.

Lower Member of Wheeler Shale. The lower member consists of 94.5 m of thin- to very-thin-bedded argillaceous limestone, with abundant agnostid trilobites and siliceous hexactinellid sponge spicules. The lower member forms a silver colored flaggy slope (section 1, appendix). The upper contact of the lower member is placed at the base of the dark gray, cliff-forming limestones of the middle member, 94.5 m above the base of the Wheeler Shale.

Middle Member of Wheeler Shale. The middle member consists of 82.6 m of medium- to dark-gray thin-bedded limestone, the upper portion of which forms prominent ledges in the midst of the Wheeler slopes (section 1, appendix). The upper contact of the middle member is placed at the top of the ledge-forming limestone, below the ledge and slope units of the lower upper member.

Upper Member of Wheeler Shale. The upper member consists of 58.8 m of buff-weathering siltstone with limestone interbeds at the base. The limestone interbeds at the base of the upper member are extremely fossiliferous, containing abundant *Elrathia, Asaphiscus,* and trace fossils. The siltstones above the base also contain common *Elrathia* (section 1, appendix).

The upper contact of the upper member of the Wheeler Shale is placed at he top of the buff-weathering siltstone slopes, where limestone is interbedded with the siltstone. These interbedded rocks constitute the lowest portion of the overlying Pierson Cove Formation.

Pierson Cove Formation

Robison (1964, p. 1001) observed that the Marjum Formation interval in the House Range becomes more limy north, east, and south of Marjum Pass. This observation holds true in the Drum Mountains, which are northeast of Marjum Pass. The Marjum interval, overlying the Wheeler Shale, is all limestone and dolomite in the Drum Mountains.

Hintze and Robison (1975) called the limestone and dolomite equivalent of the Marjum Formation the Pierson Cove Formation. The Pierson Cove has been mapped by Hintze in the Wah Wah Mountains, in the southern House Range, northern House Range, and Fish Springs Range (Hintze and Robison 1975). Hintze and Robison (1975, p. 888) listed the two most predominant lithologies of the Pierson Cove Formation as dark gray lime mudstone mottled with dolomitic mudstone, and fine-crystalline, medium gray limestone, sometimes containing veins of white calcite.

The Pierson Cove Formation in the Drum Mountains is composed of 28.3 m of slope-forming, fossiliferous limestones at the base; 73.2 m of nearly featureless dark gray limestone; 70.4 m of light gray dolomite; 31.7 m of limestone with calcite stringers; 24.3 m of ledge-forming medium gray limestone; and 16.8 m of limestone with dolomitic mottling at the top. Its total measured thickness is 244.7 m (section 1, appendix). The lowest 28.3 m of fossiliferous limestone varies along strike, becoming more shaly and more fossiliferous southeast from the measured section. The Pierson Cove Formation is locally secondarily dolomitized to light brown dolomite, but the measurements given above represent a mostly undolomitized section. The lowest 28.3 m of slope-forming limestones contain various well-preserved undescribed trilobites.

The contact of the Pierson Cove Formation with the underlying upper member of the Wheeler Shale is somewhat gradational and is usually covered. The base of the lowest limestone and dolomite cliff of the Pierson Cove was used as the contact since it is much more easily mapped The contact of the Pierson Cove with the overlying Trippe Limestone is placed at the base of the lowermost thin, very light gray, planar boundstone unit of the Trippe Limestone.

Trippe Limestone

Nolan (1935) defined the Trippe Limestone in the Deep Creek Range, Utah. Kepper (1972) extended it to the Fish Springs and Schell Creek Ranges. Hintze and Robison (1975) divided the Trippe Limestone into two members, a lower member composed of alternating lime mudstone and laminated dolomitic boundstone, and the Fish Springs Member, a thin *Eldoradia*-bearing intraformational conglomerate unit. Boundstone in the lower unit and intraformational conglomerate that contains *Eldoradia* in the overlying slope-forming Fish Springs Member facilitate identification and mapping of the Trippe Limestone over a widespread area in western Utah (Hintze 1974). The Drum Mountains section of Trippe Limestone is very similar to Trippe Limestone beds in the Fish Springs Range.

Lower Member of Trippe Limestone. The lower member of the Trippe Limestone in the Drum Mountains is composed of six units of boundstone, constituting 30 percent of the total thickness of the lower member, alternating with six units of dark gray, mottled limestone. The second boundstone unit from the base contains domal and undulose varieties of boundstone; the other five boundstone units contain only planar boundstone. The boundstone is thinly laminated and usually weathers light yellow to very light gray. Total measured thickness of the lower member is 107.9 m (section 1, appendix). The upper contact of the lower member with the Fish Springs Member is mapped above.

the highest boundstone bed and just below the reddish stained slope of the Fish Springs Member.

Fish Springs Member of Trippe Limestone. The Fish Springs Member of the Trippe Limestone in the Drum Mountains is usually covered, but it has been verified (section 1, appendix, and Hintze and Robison 1975) that it contains thin-bedded, silty, intraformational conglomerate with a few *Eldoradia* fragments. The Fish Springs Member slope is easily mapped from aerial photos between the banded lower member and the lower Lamb Dolomite cliffs. The Fish Springs Member measures 21 m thick (section 1, appendix).

The Fish Springs Member of the Trippe Limestone is overlain by the oncolitic, cliff-forming dolomites of the Lamb Dolomite. The contact is placed at the top of the Fish Springs Member slope.

Upper Cambrian Rocks

Lamb Dolomite

The Lamb Dolomite was first described by Nolan (1935, p. 13) in the Deep Creek Range as mostly light to medium gray dolomite, commonly pisolitic. Staatz and Carr 91964) extended the name *Lamb Dolomite* to the Dugway Range and noted that *Girvanella* oncolites occur at the base of the formation.

The Drum Mountains section of Lamb Dolomite consists of two mappable members with a total thickness of 190.5 ± m, a lower dark gray pisolitic to oncolitic dolomite, and an upper light gray to nearly white dolomite. The Lamb Dolomite, like the Pierson Cove Formation, may be secondarily dolomitized.

Lower Member of Lamb Dolomite. The lower member exposes 2.1 m of medium-bedded limestone at the base, overlain by 22.9 m of cliff-forming oncolitic and pisolitic brown dolomite. This brown dolomite is overlain by 61.9 m of medium gray, coarsely crystalline dolomite. The total measured thickness of the lower member is 86.9 m (section 2, appendix). The upper contact of the lower member of the Lamb Dolomite is placed where the dark gray dolomite grades to light gray.

Upper Member of Lamb Dolomite. The upper member of Lamb Dolomite is coarsely crystalline, light gray and light brown to nearly white recrystallized dolomite. The upper 61 ± m of the upper member is faulted. The upper member of the Lamb Dolomite is overlain by the Big Horse Limestone Member of the Orr Formation. The contact is placed at the top of the nearly white dolomite, where it is overlain by dark gray limestone (small exposure, NE¼ section 2, T. 14 S, R. 11 W). Total thickness of the upper member is 103.6 m.

Orr Formation

Walcott (1908b) originally defined the Orr Formation. Recently Hintze and Palmer (1976) defined the members of the Orr Formation. All the members they defined can be mapped in the Drum Mountains except the Candland Shale and the Johns Wash Limestone Members. A light purple unfossiliferous, slope-forming limestone occurs in the interval which corresponds to the Candland Shale Member. Above it are very light gray limestone cliffs, which probably correspond to the Johns Wash Limestone Member. To facilitate mapping and to avoid implications not documented by fossils, these two units are informally lumped together as a "light colored member." Total measured thickness of the Orr Formation in the Drum Mountains is 450 ± m.

Big Horse Limestone Member of Orr Formation. Rocks assigned to the Big Horse Limestone Member are 300 + m thick in the Drum Mountains (section 3, appendix). The lower 80 m consist of uniform dark gray, ledge-forming limestone, the base of which is either covered or faulted out in most exposures in the Drum Mountains. The basal gray limestone is best exposed in the locale of measured section 3.

The upper 219.5 m of Big Horse Limestone forms cliffs and ledges of medium gray limestone with as much as 20 percent reddish brown silty laminated interbeds. These reddish brown and gray limestones form unique, stairlike cliffs at the south ends of both the major north-trending ridges in the northern half of the map area. Crittenden and others (1961) documented *Tricrepicephalus* in Limestone P, which corresponds to a portion of the reddish brown silty beds of the Big Horse Limestone Member and establishes an Upper Cambrian age for it. The upper contact of the Big Horse Limestone Member with the overlying light colored member is placed below a light tan ledge which occurs at the base of the light colored member slope.

Light Colored Member of Orr Formation. The light colored member of the Orr Formation consists of light pink- to light purple-weathering, soft, covered slope-forming, fossil-poor limestones bounded at the base by nearly white limestone ledges and at the top by a light gray limestone cliff. The basal ledges are 19.8 m thick, the middle slope is 46.6 m thick, and the upper cliff is 17.6 m thick. Total measured thickness of the light colored member is 84.1 m (section 4, appendix). The contact of the light colored member and the overlying Corset Spring Shale Member is placed at the top of the upper light colored member cliff, below the narrow Corset Spring Shale slope.

Corset Spring Shale Member of Orr Formation. The Corset Spring Shale Member slope is narrow but easily identified in the Drum Mountains. It occurs as a break between the cliffs of the upper light colored member and the ledgy cliffs of the Sneakover Limestone Member. The Corset Spring Shale consists of 8.6 m of medium green fissile shale with a few thin grayish brown coquinoid limestone interbeds (section 4, appendix). The limestones contain a trilobite identified by A. R. Palmer (letter dated 31 May 1979) as *Kindbladia,* of the *Elvinia* Zone. The upper contact of the Corset Spring Shale is placed below the blocky banded ledges of the lower Sneakover Limestone Member.

Sneakover Limestone Member of Orr Formation. The Sneakover Limestone forms a prominent dark gray band below the brown and tan dolomites of the Notch Peak Formation in the Drum Mountains. The Sneakover Limestone consists mostly of thin-bedded, flaggy, dark gray limestone ledges, although the basal 7.6 m is a light and dark gray banded blocky cliff. Small wads of silicified fossils containing *Eoorthis* occur at various horizons in Sneakover Limestone beds. Nodular chert and trace fossils are also common.

Total measured thickness of the Sneakover Limestone Member is 67.6 m (section 4, appendix). It is overlain by the brown dolomite cliffs of the Notch Peak Formation, the base of which marks the upper contact of the Sneakover Limestone Member.

Notch Peak Formation

Walcott (1908a, b) defined the Notch Peak Formation at Notch Peak in the House Range, where it has no top. It has been redefined, divided into members, and zoned paleontologically by Hintze and others (1980).

In the Drum Mountains the Notch Peak Formation has not been divided into members. It is faulted to such an extent that there is doubt that true measurements can be obtained. However, a partial section is given in the appendix (section 7).

The Notch Peak Formation is about 396 m thick. The lower 329± m consist of cliff-forming alternating tan, brown, and medium gray, coarsely crystalline dolomites. The upper 67± m consist of medium gray limestone. Stromatolitic algal heads occur approximately 46 m from the top. Dolomite of the Notch Peak Formation is extensively recrystallized, locally resulting in coloration not coincident with bedding planes.

Hintze and others (1980) reported that in other ranges a small portion of uppermost Notch Peak Formation may be Lower Ordovician, but the bulk of the formation is Upper Cambrian. They also note that the upper contact of the Notch Peak Formation and House Limestone is conformable. Lithologic contrasts at the upper contact of the Notch Peak Formation in the Drum Mountains are subtle, but the contact is placed at the top of the coarsely crystalline, medium gray limestones, below the finely crystalline, bluish gray limestones of the House Limestone.

Lower and Middle Ordovician Rocks

Pogonip Group

Hintze (1951, 1973) divided the Pogonip Group in west central Utah into six lithologic units. Four were mapped in the Drum Mountains–the House Limestone, the Fillmore Formation, the Wah Wah and Juab Formations undivided, and the Kanosh Shale.

The House, Fillmore, and Wah Wah Formations are reported by Hintze (1973) to be Canadian in age. The Juab and Kanosh Formations are Chazyan (Hintze 1973). Pogonip rocks are exposed only in the northernmost Drum Mountains.

House Limestone

The House Limestone is exposed in the Drum Mountains as light bluish gray, finely crystalline limestone that forms ledgy slopes. It is quite uniform in appearance, except for local nodular chert. The measured thickness of the formation is 74.7 m (section 5, appendix).

The House Limestone is overlain by the Fillmore Formation. The contact is placed below the first medium to dark gray intraformational conglomerate of the Fillmore Formation. A marked contrast in both color and erosional style facilitates placement of this contact. The House Limestone forms low light blue ridges whereas the Fillmore Formation forms dark gray, partially covered rolling slopes.

Fillmore Formation

The Fillmore Formation consists mostly of dark gray, fossil-barren, intraformational conglomerate that forms weathered, partially covered, nearly flat to rolling slopes. The Fillmore Formation exposure is uniformly obscured and probably faulted, making measurement difficult. Estimated thickness of the Fillmore Formation is 518 m.

The contact of the Fillmore Formation with the overlying Wah Wah-Juab Formations undivided is placed at the lithologic and erosional change from weathered intraformational conglomerate slopes of the Fillmore Formation to the cuesta-forming, orange-weathering, silty limestones of the Wah Wah-Juab Formations undivided.

Wah Wah-Juab Formations Undivided

The Wah Wah and Juab Formations are not readily differentiated in the Drum Mountains Together they consist of silty, siliceous, orange-weathering, medium gray limestone. Ironstone horizons are common. "Chicken wire" weathering is characteristic Intraformational conglomerate and rip-up clasts are common. The Wah Wah-Juab Formations undivided is faulted at its base and also higher in the section. It is estimated to be 168 m thick.

The Wah Wah-Juab Formations undivided is distinct from the underlying Fillmore Formation in siltiness, erosional character, and fossil occurrence. It has more silt, forms ledges and slopes, and contains silicified trilobites assigned to zone J (L F Hintze personal communication 1979). The contact is placed below the lowest small cuesta of the Wah Wah-Juab Formations undivided. The Wah Wah-Juab Formations undivided is overlain by the Kanosh Shale. There are few good exposures of the Kanosh Shale, making placement of the contact difficult. Generally, the contact is placed above the uppermost medium gray carbonate at the base of the Kanosh Shale olive shale slope.

Kanosh Shale

The Kanosh Shale is poorly exposed in the Drum Mountains Where it is exposed, it consists of olive brown fissile shale with thin, brownish, orthid brachiopod coquina interbeds The Kanosh Shale is probably about 46 m thick in the Drum Mountains. The upper contact of the Kanosh Shale with the overlying Eureka Quartzite is placed at the base of the Eureka Quartzite cliff.

Eureka Quartzite

According to Webb (1956), the quartzites of the Thomas Range may include both Swan Peak and Eureka beds. Staatz and Carr (1964) designated Middle Ordovician quartzites as Swan Peak in the same area. But the Swan Peak Formation as used by Staatz and Carr includes a lower member of Kanosh Shale equivalent beds. In addition, Webb (1956, p 43) indicated that correlation of Thomas Range quartzites is in doubt. To retain the Pogonip terminology in general usage south of the Ordovician Tooele Arch, the name Eureka Quartzite is used in the Drum Mountains.

The Eureka Quartzite in the Drum Mountains consists of about 146 m of tan to reddish brown-weathering, medium to very thick-bedded sandstone cliffs. Ironstone horizons locally cause iron staining. The upper contact of the Eureka Quartzite is covered.

Tertiary Rocks

Previous workers (Shawe 1972, Lindsey and others 1975) have recognized and dated three periods of volcanic activity in the Thomas Range and Keg Mountains: late Eocene (38–41 m.y. ago), early Oligocene (30–32 m.y. ago), and Miocene (6–21 m.y. ago).

Note· After this manuscript went to press radiometric ages of the volcanic units in the Drum Mountains became available in U.S Geological Survey Open-file Report 79-1076 by David A. Lindsey (Preliminary report on Tertiary volcanism and uranium mineralization in the Thomas Range and Northern Drum Mountains, Juab County, Utah). These ages indicate that units which I informally named lapilli tuff, tuff of Mount Laird, and tuff of Laird Spring are all about 38 m.y. old instead of 32 m.y. This information places the unit that I identified as the Wah Wah Springs Tuff Member of the Needles Range Formation stratigraphically above the landslide unit, even though the apparent stratigraphic placement is as I have reported.

Lindsey has also formally named the unit that I called "tuff of Mount Laird" the Joy Tuff, and the unit I called "tuff of Laird Spring" the Mount Laird Tuff.

Andesites (Undivided)

Andesites (undivided) include a flow-layered pyroxene hornblende andesite, a body of pyroxene andesite and breccia, and other dark pyroxene-rich andesites. These andesites are dark gray to brownish black and contain 1-2 mm pyroxene phenocrysts, and, locally, 3-7 mm plagioclase phenocrysts in a dark colored groundmass. Thickness varies from 0-30 m. Leedom (1974) indicated that these andesites thicken from the Drum Mountains toward the Little Drum Mountains, where they may be several hundred meters thick Leedom (1974) dated the andesites of the Little Drum Mountains with a K-Ar age of 37.3 ± 0.4 m.y., indicating late Eocene age.

Andesites (undivided) are underlain unconformably by various Paleozoic rocks from Middle Cambrian to Ordovician. They are overlain, at least in part, by the gray to pink tuffs of the Wah Wah Springs Tuff Member of the Needles Formation (M.G. Best personal communication) They are overlain locally by a quartzite boulder conglomerate.

Boulder Conglomerate

The boulder conglomerate consists of tan to white quartzite boulders and cobbles of probable Ordovician Eureka Quartzite origin. The boulder conglomerate occurs only in isolated patches overlying Fillmore Formation, andesites (undivided), and in one case Notch Peak Formation

It is speculated that these boulder deposits represent landslides, talus, or stream deposits from an Oligocene landscape. Hintze (personal communication) has noted the occurrence of similar deposits in other ranges in western Utah.

Wah Wah Springs Tuff Member of Needles Range Formation

West of the western north-south-trending ridge of the northern Drum Mountains, a light pinkish tan crystal-rich tuff is exposed It overlies andesites (undivided) in this area.

This tuff is tentatively identified as the Wah Wah Springs Tuff Member of Needles Range Formation (M. G. Best personal communication). This unit has also been identified in the Little Drum Mountains by Leedom (1974, p. 84-85). The Wah Wah Springs Tuff Member contains abundant biotite, hornblende, and plagioclase, with some quartz and augite The Wah Wah Springs Tuff Member is probably overlain in the Drum Mountains by the tuff of Laird Spring (Shawe 1972, p B70). The Wah Wah Springs Tuff Member is a maximum of 30 m thick. Armstrong (1970) has dated the Needles Range Formation at about 30 m.y. or from early Oligocene time.

Radiometric dating and possibly paleomagnetic study are needed to clearly establish the identity of this unit. Field identifications indicate, however, that this tuff is not correlative with the overlying tuff of Laird Spring and tuff of Mount Laird or with a rhyolitic tuff in the Thomas Range dated by Lindsey and others (1975) at 38-39 m.y.

Tuff of Laird Spring

Laird Spring issues from rocks which have been informally named the tuff of Laird Spring.

Shawe (1972, p. B70) described this unit as a "fairly uniform dacite to quartz latite tuff .. exposed extensively at the north end of the Drum Mountains." Large plagioclase phenocrysts give this tuff a striking appearance. It also contains hornblende, biotite, and other crystals in a brown glass shard groundmass.

The thickness of the tuff of Laird Spring is estimated to be 60 m. Its age is early Oligocene (?). The tuff of Laird Spring is overlain by the tuff of Mount Laird.

Tuff of Mount Laird

The tuff which caps Mount Laird has been informally named the tuff of Mount Laird. It is a pinkish tan, welded, ash-flow tuff with abundant phenocrysts of quartz and sanidine. Dark minerals are rare. Shawe (1972, p. B71) described it as a rhyolitic to quartz-latitic welded tuff. The basal portion has abundant flattened black pumice lapilli which lend a dark gray color to exposures of the base. It is a resistant volcanic unit in the Drum Mountains, forming peaks with a relief of 90-120 m. The thickness of the tuff of Mount Laird is estimated at 150-180 m in the Drum Mountains.

The tuff of Mount Laird is underlain by the biotite and hornblende-rich tuff of Laird Spring. The relationship of the upper contact of the tuff of Mount Laird with younger rocks is not known. Lindsey and others (1975) dated tuffs similar to the tuff of Mount Laird at 30-32 m y in the Thomas Range, indicating early Oligocene (?) age for the tuff of Mount Laird.

Tuff of Drum Peak

Just east of Drum Peak about 2.5 km south of the Millard County line is an extensive exposure of isolated dark gray plagioclase-bearing ash-flow tuff, that is here designated the tuff of Drum Peak. It contains abundant 1-3 mm plagioclase phenocrysts and some biotite in a dark gray groundmass. Lithic fragments 1-5 cm in size are abundant. These lithic fragments are composed of a variety of Paleozoic rocks and possibly some volcanic rocks. Flattened pumice lapilli are common.

The thickness of the tuff of Drum Peak is estimated at 50 m. It is underlain angularly by Prospect Mountain Quartzite and various Lower and Middle Cambrian units. Stratigraphic position of the tuff of Drum Peak is unknown, but its age is probably Oligocene (?).

Intrusions—Quartz Diorite and Quartz Monzonite

Small intrusions located in a valley of weathered and altered Middle Cambrian rocks on the Millard-Juab County line in the central Drum Mountains have been identified by Crittenden and others (1961) as fine-grained quartz diorite.

Small dikes of quartz monzonite intrude about a mile west of Lady Laird Peak. Crittenden and others (1961) indicated these dikes contain phenocrysts of plagioclase and brown biotite with some green hornblende and quartz

Shawe (1972) included these intrusions in his "middle assemblage of rocks" and indicated a possible early Oligocene (?) age.

Lapilli Tuff

The lapilli tuff consists of a black vitrophyre, a middle welded portion, and an upper loosely welded portion. The middle and upper portions are light brown to very light tan with abundant pumice lapilli and a few lithic fragments. Phenocrysts are quartz, sanidine, plagioclase, and a few biotite crystals. Thickness of the lapilli tuff is estimated at about 60 m. It is probably late Miocene (?) in age (Shawe 1972) Its base is covered, and it is overlain by brecciated Notch Peak dolomite and also by late Miocene rhyolite flows.

Newell (1971, p. 29-32) divided the lapilli tuff into three tuff units corresponding to the black basal vitrophyre, middle welded portion, and upper loosely-welded portion of an ash-flow tuff. Shawe (1972, p. B73) identified the unit as an ash-fall tuff with a water-laid upper unit.

Landslide Deposits

Broken and brecciated dolomite of the Notch Peak Formation overlies a portion of the lapilli tuff in the northeast Drum Mountains. The contact is a nearly horizontal fault (Shawe 1964). Shawe (1972) later modified this identification:

> It appears more likely that they moved into a place on a gravity slide that broke away from an oversteepened caldera wall composed of Paleozoic rocks and moved out across the water-saturated, clay-rich, water-laid tuff on the floor of the caldera.

Rhyolite Flows

Two rhyolite flows overlie the lapilli tuff in the northeast Drum Mountains.

Flow 1 is a medium gray rhyolite and overlies various Paleozoic rocks and also the lapilli tuff. It is aphanitic, locally spherulitic, and may contain small quartz phenocrysts.

Flow 2 is exposed extensively in the northeast Drum Mountains. It is light gray, contains topaz crystals, is commonly flow banded and iron stained, and exhibits what Staatz and Carr (p. 97) called "honeycomb" weathering. Flow 2 overlies the lapilli tuff and Flow 1. Staub (1975) called this unit the Drum Mountains Rhyolite. Rhyolite flows are about 150 m thick in the Drum Mountains. Flows of identical lithology in the Thomas Range and Keg Mountains have been dated as late Miocene (6–7 m.y.) (Lindsey and others 1975).

Alteration

Jasperoids (Bailey 1975), hydrothermally altered rocks, rocks altered by intrusions, dolomitized and bleached rocks, pebble dikes, intrusive breccias, and mineralized bodies are all included in this unit called "alteration." Much of this alteration occurs along faults. It is present in varying degrees in most rocks in the Drum Mountains except the rhyolite flows in the northeastern part of the range.

Tertiary and Quaternary Unconsolidated Deposits

Consisting mostly of unconsolidated, poorly sorted sand, gravel, and cobbles related to some erosional base level other than the present one, Tertiary and Quaternary deposits occur in the southern and western Drum Mountains as dissected sheets of alluvium overlying Tertiary andesites (undivided). This alluvium is probably not more than 30 m thick in most areas. Wave-cut benches of Lake Bonneville origin occur locally in this unit.

Quaternary Deposits

Alluvium

Alluvium includes all recent unconsolidated sands, gravels, cobbles, and boulders associated with present-day erosional base level. It includes talus, slopewash, colluvium, and alluvium.

STRUCTURE

Strata in the Drum Mountains form a faulted homocline tilted variously from southwesterly to northwesterly and cut by an arcuate fault named the Joy fault by Crittenden and others (1961).

Structures in the Drum Mountains have been classified into three periods of deformation: prevolcanic faulting, caldera-related faulting, and basin and range tilting and faulting.

Most faults in the Drum Mountains are high angle. Neither folds nor thrusts were observed. Recent faults have been reported by Bucknam and Anderson (1979) in unconsolidated sediments just outside the eastern margin of the map area, but none have been reported in the map area.

Prevolcanic Faulting

Crittenden and others (1961) aptly described faults in Paleozoic rocks in the central Drum Mountains as forming a "complex branching and interlocking pattern." This pattern recurs in most of the Paleozoic rocks in the Drum Mountains. Prevolcanic faults strike in three general directions: northeast, northwest, and east, and usually dip at angles greater than 70°. Most of these faults place stratigraphic units relatively down to the south. Tertiary volcanic rocks are not displaced by these faults, indicating this faulting occurred in Sevier or earlier time. Mineralization and hydrothermal alteration, as well as some intrusive activity, has occurred along many of these faults.

East-trending faults present in the central and southern Drum Mountains have the largest displacements, longest length, and the fewest numbers. Stratigraphic displacements may be as much as 300 m. The Drum Peak fault is an example of the east-trending group.

Northwest-trending faults have the next fewest numbers and the least displacement. Most have displacements of 3–30 m. Northeast-trending faults are about twice as common as northwest faults, and have greater stratigraphic displacement.

Northeast-trending faults may offset northwest-trending faults although it is likely that both sets were formed at the same time. The net effect of these three prevolcanic fault sets sets in northwestward-dipping rocks is a repetition of stratigraphic section. No slickensides were observed to indicate slip direction, but these faults may represent Sevier tear faulting. Leedom (1974 p. 78) cited attitudes of volcanic rocks as evidence that a slope of 5°–10° may have been present in the prevolcanic surface, indicating that tear faulting could have produced the stratigraphic displacements I observed. Prevolcanic faults have been mapped without indication of downthrown side to avoid the implication that slip direction is known.

Caldera-Related Faulting

Newell (1971) suggested that the Joy fault might be a ring fault of a Valles-type caldera (Williams and McBirney, 1968). Newell also noted that the Joy fault was probably reactivated by Miocene basin and range faulting and pointed out several features in the Drum Mountains which correlate with those of a Valles-type caldera, notably the existence of a moat between the central and west north-south-trending ridges.

Shawe (1964) reported an anomalous block of brecciated Cambrian carbonates underlain by late Tertiary volcanic rocks in the northeast Drum Mountains. Shawe (1972) has since interpreted this as a landslide from the oversteepened wall of the caldera. Landslides may be found as much as 6.5 km out from the inner ring fracture in Valles-type calderas (Smith and Bailey 1968).

Shawe (1972) proposed the Thomas caldera, the ring fault of which is partly exposed as the arcuate Joy fault in the Drum Mountains. Lindsey and others (1975) dated the volcanics responsible for the collapse of the Thomas caldera at 30–32 m.y. Lindsey (1978) cited the age of the Thomas caldera and displacement of a 21 m.y. old rhyolite along the ring fault of the Thomas caldera in the Thomas Range as evidence that the ring fault of which the Joy fault is part must either be wholly a basin and range feature, or have been reactivated by basin and range fault activity.

Since the Joy fault does not fit the normal north-south pattern for basin and range type faulting, and also because it is so well expressed after 30 million years, I interpret the Joy fault as a ring fault reactivated by basin and range faulting. I conclude (after Shawe 1972) that extrusion of the tuff of Mount Laird was responsible for caldera collapse along the Joy fault, inside of which the tuff of Mount Laird puddled to more than 150 m deep. Cross section B-B′ indicates 1,130 m of vertical displacement along the Joy fault. Furthermore, the boundary fault on the east side of the north central north-south-trending horst is interpreted as a possible inner ring fault. It is speculated that this possible inner ring fault continues to parallel the Joy fault until it is truncated by the eastern basin and range boundary fault of the Drum Mountains. It is possible that the horst and moat well expressed in the north central portion of the map area may also continue to parallel the Joy fault under alluvium until truncated by the eastern boundary fault. This possibility is made plausible by the occurrence of remnants of northwest-dipping Prospect Mountain Quartzite north of the Joy fault in the east portion of the map area. These remnants are situated about where they should be after displacement by the Joy fault

Basin and Range Tilting and Faulting

Both Paleozoic and Tertiary rocks in the Drum Mountains are tilted variously from southwesterly to northwesterly at about 20° except rhyolite flow 2. Rhyolite flow 2 is thought to be 6–7 m.y. old, while tilted underlying volcanic rocks are thought to be 30–32 m.y old, indicating that tilting in the Drum Mountains occurred during the basin-and-range episode.

Volcanic rocks believed extruded during caldera collapse are faulted in and around Mount Laird and Schoenburger Spring. This area has been broken by faults of small displacement and length, which were probably adjustments caused by reactivation of the Joy fault by basin-and-range activity Other basin-and-range-related faults displace rocks as young as the late Miocene (?) lapilli tuff. They also fault the landslide in the northeast portion of the map area. Rhyolite flow 2 is comparatively unfaulted.

The north-south-trending horst in the north central portion of the map has been faulted by two nearly north-trending faults on its north end which are thought to be basin-and-range faults

The Joy fault and other caldera faults formed lines of weakness which were reactivated by basin-and-range faulting.

A major north-south basin-and-range boundary fault truncates the structure of the Drum Mountains at the east margin of the map area. It is completely covered by unconsolidated sediments.

The buried fault between the west north-south-trending ridge and the far western hills is probably a basin-and-range fault.

SHORT SUMMARY OF GEOLOGIC HISTORY

As Inferred by This Report

Thick, shallow-water clastic deposition took place from Precambrian Y (?) time to Lower Cambrian time. Shallow-water carbonates were deposited, interspersed with a few thin shales, beginning in lowest Middle Cambrian time and continuing until Middle Ordovician time. In Middle Ordovician time shale and then sandstone were deposited. Nearby ranges attest that carbonates in the Middle and Late Paleozoic, and then clastics in the Mesozoic, were deposited on Middle Ordovician rocks.

Uplift of the Sevier geanticline in Cretaceous time resulted in myriad faults in the Drum Mountains. Erosion in Cretaceous and Paleocene time removed a thick sequence of rocks down to the Middle Ordovician Eureka Quartzite.

Large quantities of andesitic material were extruded from local volcanoes at the end of Eocene time. In early Oligocene time the tuff of Mount Laird was emplaced in connection with collapse of the Thomas caldera of Shawe (1972) along the Joy fault. Resurgence may have generated the intrusions south of the east-trending portion of the Joy fault. Landslide activity from a steep caldera wall also occurred at about this time.

Basin-and-range activity commenced in probable Miocene time, producing westward tilt of the Drum Mountains block, reactivation of the Joy fault, and truncation of the eastern margin of the Drum Mountains by a boundary fault. Basin-and-range fault activity occurred mostly before deposition of late Miocene rhyolites, but continues to the present.

In late Miocene time a final volcanic episode extruded rhyolite and was probably responsible for emplacement of mineralized bodies in the Drum Mountains (Shawe 1972, Lindsey 1978).

Alluvial deposits of older base levels were left stranded in several areas. Some may be related to pre-Bonneville and Lake Bonneville base levels.

A thin layer of recent alluvium, slopewash, and talus has been deposited in Recent times.

ECONOMIC GEOLOGY

The economic future of the Drum Mountains area is bright. Recent interest in gold-bearing jasperoid has been spurred by the rising price of gold. The search for beryllium and uranium is by no means excluded from the Drum Mountains. Manganese deposits may someday become economic. I believe there is great potential for ore-bearing deposits related to structure buried by alluvium in the Drum Mountains.

Bailey's (1975) dissertation on the occurrence, origin, and economic significance of gold-bearing jasperoids is an important work for those interested in the economic possibilities of jasperoids in the Drum Mountains. Newell (1971) performed geochemical analyses in the northern Drum Mountains in an attempt to reveal anomalies of gold, silver, copper, and other minerals. Crittenen and others (1961) delineated the manganese deposits of the Drum Mountains Shawe (1972) and Lindsey (1978) speculated on the genesis of ore minerals in the Drum Mountains area

CONCLUSIONS

1. Rocks of the Drum Mountains have been assigned mappable regional formational names Nomenclature is after Hintze and Robison (1975), Hintze and Palmer (1976), Hintze and others (1980), Hintze (1951), Webb (1956), and Morris (1978). The following usage is proposed:

> Precambrian Y (?)–Caddy Canyon Quartzite, Precambrian Z–Inkom Shale, and Mutual Formation; Lower Cambrian–Prospect Mountain Quartzite and lower member of the Pioche Formation, Howell Limestone, Chisholm Formation, Dome Limestone, Whirlwind Formation, Swasey Limestone, lower member of Wheeler Shale, middle member of Wheeler Shale, upper member of Wheeler Shale, Pierson Cove Formation, lower member of Trippe Limestone

and Fish Springs Member of Trippe Limestone; Upper Cambrian–lower member of Lamb Dolomite, upper member of Lamb Dolomite, Big Horse Limestone Member of Orr Formation, light colored member of Orr Formation, Corset Spring Shale Member of Orr Formation, Notch Peak Formation, and Wah Wah-Juab Formations undivided; Middle Ordovician–Kanosh Shale and Eureka Quartzite. Tertiary–andesites undivided, Wah Wah Springs Tuff Member of Needles Formation, tuff of Laird Spring, tuff of Mount Laird, intrusions, lapilli tuff, landslide, rhyolite flows.

2. Stratigraphy of the Drum Mountains can be correlated by fossils with adjacent ranges, specifically the House, Fish Springs, Deep Creek, and Dugway Ranges in this report (fig. 3).

3. Precambrian rocks are all terrigenous clastics, ranging from siltstones to pebble conglomerates. They have been slightly metamorphosed and are about 1,220 m thick. Paleozoic rocks consist of 4,130 m of carbonates with about 10 percent shale. Tertiary volcanic rocks are intermediate to silicic flows and tuffs, 580 m thick.

4. Notable anomalies in Paleozoic stratigraphy are the following:
   a. A 15.5-m shale occurs midway in the otherwise cliff-forming limestone of the Middle Cambrian Dome Limestone.
   b. The Middle Cambrian Wheeler Shale is anomalously thick here as compared to nearby ranges. This finding has been confirmed by R. A. Robison (personal communication).
   c. Secondary dolomitization occurs in the Pierson Cove, Lamb Dolomite, Orr, and Notch Peak Formations.
   d. The interval of the Orr Formation which is probably equivalent to the Candland Shale Member consists of a light purple fossil-poor limestone, informally called the light colored member in the Drum Mountains.

5. Tertiary volcanic rocks were extruded during three periods of volcanic activity:
   a. Late Eocene andesitic flows.
   b. Early Oligocene (?) silicic ash-flow tuffs and accompanying caldera collapse.
   c. Late Miocene (?) rhyolitic volcanism and mineralization.

6. The Joy Fault is a caldera ring fault, reactivated by basin-and-range fault activity.

7. Extrusion of Tuff of Mount Laird resulted in the collapse of the Thomas caldera along the Joy fault (see Shawe 1972).

8. Ore deposits in the Drum Mountains are genetically related to late Miocene rhyolitic volcanism.

9. Structures in the Drum Mountains have been classified into three periods of deformation:
   a. Prevolcanic faulting, thought to be related to the Sevier orogeny.
   b. Caldera-related faulting, including the Joy fault and a possible inner ring fault, thought to have occurred in early Oligocene time.
   c. Basin-and-range tilting and faulting of probable Miocene age.

10. Basin-and-range movement tilted the Drum Mountains block to the west.

11. Brecciated Notch Peak Formation material in the northeast Drum Mountains was emplaced by a landslide.

APPENDIX

Measured Section I

Measured by Martin Dommer 4 and 5 June 1979 with Jacob's staff
Location NE¼ SE¼, section 8, T 15 S, R 10 W
Direction measured N 125°–135° W to SW¼ SW¼ SW¼ section 18, T 15 S, R 10 W
Prospect Mountain Quartzite through Wheeler Shale measured along large wash, Pierson Cove through Lamb measured down a prominent dip slope Directions, strike, and dips noted
Strike N68°W to N35°W Dip 16°–22°SW

	Unit Thickness Meters	Meters Above Base
Lamb Dolomite		
1 Dolomite, light brown, weathers tan, very thick bedded, massive, forms cliff, contains abundant pisolites and oncolites identified by Staatz and Carr (1964) in the Dugway Range as *Girvanella*.	6+	1,020
Strike N68°W Dip 16°SW		
Trippe Limestone–Fish Springs Member, 21 metres		
1 Limestone, silty intraformational conglomerate, weathers reddish brown and gray, laminated to very thin bedded, flaggy, forms a prominent slope, contains *Eldoradia*	21	1,014
Trippe Limestone–Lower Member, 107.9 meters		
12 Limestone, dark gray, medium to thin bedded, slabby weathering, ledges and slopes.	11.5	993
11 Limestone, planar stomatolites or boundstone, light gray, weathers light gray, laminated to thinly laminated, some very thin layers of rip-up clasts, slope former	6.1	981.5
10 Limestone, dark gray, weathers medium gray, medium to light gray dolomitic mottles, thin bedded, ledgy	4	975.4
9 Limestone, planar boundstone, light gray to light tan, thinly laminated, forms slope	1.2	971.4
8 Limestone, dark gray with medium gray dolomitic mottles, thin to medium bedded, slabby, forms ledges	4.6	970.2
7 Limestone, planar boundstone, very light tan, laminated, forms slope	3.3	965.6
6 Limestone, dark to medium gray, weathers dark to medium gray, medium bedded, slabby weathering, forms ledges, common dolomitic mottling	32.1	962.3
5 Limestone, planar boundstone, light brown, weathers tan, laminated bedding, slope former	85	930.2
4 Limestone, dark gray, weathers medium gray, medium to thin bedded, ledges and slopes	20.7	921.7
3 Limestone, planar, undulose and domal boundstone with a few very thin beds of intraformational conglomerate, light gray to tan weathering, forms slight ledges	10.7	901
2 Limestone, dolomitic mottling, limestone dark gray, mottles light gray, thin bedded, ledge former	3	890.3
1 Limestone, planar boundstone, medium to light gray weathering, laminated bedding, slope	2.2	887.3
Strike N40°W Dip 21°SW		
Pierson Cove Formation–244.7 meters		
6 Limestone, dolomitic mottling, medium gray, weathers medium gray, thick bedded, blocky ledge former, trace fossils	16.7	885.1

5	Limestone, medium gray, weathers a little darker, medium bedded, slabby, slope near bottom, ledges near top.	24.4	868.4
4	Limestone, medium gray, weathers medium dark gray, very thick bedded, blocky, massive, with secondary calcite stringers, ledge former.	31.7	844
3	Dolomite, light gray, weathers grayish orange, thick bedded, massive, ledge and cliff former, becomes limier near top with some mottling.	70.4	812.3
2	Limestone, dark gray, weathers dark gray, medium to very thick bedded, massive, cliff former, dolomite near top.	77.4	741.9
1	Limestone with interbedded siltstone (about 20%); limestone medium gray, weathers medium gray to reddish brown, bioturbated, trace fossils and trilobites abundant; rip-up clasts, very thin bedded, flaggy, siltstone light gray, weathers buff, unit forms slope, often covered in other areas.	24.1	664.5
	Offset along strike 4,300 feet in direction N60°W; Strike: N35°W Dip: 19°SW measuring in direction N135°W		
	Wheeler Shale–Upper Member, 58.8 meters		
7	Siltstone, calcareous, light gray, weathers buff, laminated bedding, shaly slope, *Asaphiscus, Elrathia* common.	36	640.4
6	Limestone and calcareous shale, limestone medium gray, weathers dark gray, thin bedded, flaggy; shale or siltstone, medium gray, laminated, forms stairstep ledgy slope consisting of five ledges and four slopes. Third ledge from base is oolitic, trace fossils, *Asaphiscus* and *Elrathia* are abundant.	22.8	604.4
	Middle Member–82.6 meters		
5	Limestone, medium gray, weathers medium gray, thin to medium bedded, slabby, cliff former.	18.3	581.6
4	Limestone, very dark gray, weathers dark gray, medium bedded, slabby, forms ledges.	64.3	563.3
	Lower Member–94.5 meters		
3	Limestone, argillaceous, medium gray, weathers medium gray, thin bedded, flaggy, slope former, agnostid *Peronopsis* trilobites abundant.	10.7	499
2	Limestone, shaly, "silver shale" light to medium gray, weathers light brown to tan, thin to thinly laminated bedding, slope former; *Peronopsis* and silicified sponge spicules abundant.	12.8	488.3
1	Limestone, shaly, light gray to medium gray, weathers light gray to tan, slope former; *Peronopsis* and silicified sponge spicules abundant.	16.8	360.3
	Offset 213 m southeast Strike: N40°W Dip: 18°SW		
	Swasey Limestone–55.5 meters		
3	Limestone, dark gray, weathers medium gray, thin to thinly laminated bedding, flaggy slope.	31.4	404.5
2	Limestone, dark gray, featureless, very thick bedded, massive, cliff former.	13.5	373.1
1	Limestone, medium gray, weathers medium gray, some light gray dolomitic mottling, medium bedded, slabby, ledge former.	10.6	359.6
	Whirlwind Formation–43.3 meters		
3	Shale, calcareous, light brown to light olive gray, weathers same, 5 percent limy interbeds, shale laminated bedding, slope former; *Ehmaniella* hash in very thin limestone interbeds.	21.3	349
	Strike: N45°W Dip: 16°SW		
2	Limestone, very mottled with yellowish brown dolomite, limestone medium gray, weathers medium gray, thin to medium bedded, flaggy, unit weathers to a characteristic ledgy reddish slope.	6.1	327.7
1	Shale, grayish yellow, weathers greenish tan, laminated bedding, shaly, partially covered slope.	15.9	321.6
	Dome Limestone–92.3 meters		
4	Limestone, light gray to very light gray, weathers light gray, thick bedded, massive, cliff forming	19.8	305.7
3	Limestone, dark gray, weathers medium gray, very thick bedded, massive, somewhat dolomitic near top, cliff forming, thin pisolite horizons interspersed.	24.4	285.9
2	Shale, olive green, weathers tan, fissile laminated bedding, often covered.	15.6	261.5
1	Limestone, dark gray, weathers dark gray, thick bedded, blocky to massive, forms sharp ledges. Oncolites and pisolites abundant, decreasing up in unit. Pisolite horizon 8.5 m from unit base.	32.5	245.9
	Strike: N45°W Dip: 20°SW		
	Chisholm Formation–47.9 meters		
4	Shale, medium reddish brown to olive green, weathers tan to light olive, laminated to thinly laminated bedding, fissile, shaly slope former, a few thin limestone ledges at base.	13.8	213.4
3	Limestone, dolomitic mottling, medium gray, weathers medium gray, thin bedded, oolitic, oolites grade upward in increasing size and occurrence, forms slabby ledge: *Glossopleura* common in top 9 m.	17.9	199.6
2	Siltstone, light brown, weathers medium greenish brown, laminated to thin bedded, forms shaly to flaggy slope.	5.8	181.7
1	Limestone, medium gray, weathers medium gray, light gray dolomitic mottles, medium bedded, forms ledgy slope.	10.4	175.9
	Offset up strike-gully 366 m (N27°W)		
	Howell Limestone–50 meters		
5	Limestone, medium to light gray, weathers light gray, thin bedded, slabby slope former, abundant oncolites and pisolites.	8.2	165.5
4	Limestone, light gray, weathers very light pink, thick bedded, massive, ledge former.	6.1	157.3
3	Dolomite, coarse grained, medium gray, weathers medium light gray, thick bedded, massive, oncolitic, cliff former.	12.8	151.2
2	Limestone, medium gray, weathers light gray, thin bedded, some dolomitic mottling and dolomitic interbeds, slope former.	4.6	138.4
1	Limestone, medium gray, weathers medium gray, thick bedded, massive, slight dolomitic mottling, oncolitic to pisolitic, cliff former.	18.3	133.8
	Pioche Formation–Tatow Member, 44.5 meters		
5	Limestone, medium gray with reddish brown dolomitic mottles, weathers light orange brown, thin bedded, flaggy, slope former.	9.1	115.5
4	Limestone, medium gray, weathers light gray, medium bedded, slabby, ledge former.	9.2	106.4
3	Limestone, reddish brown, dolomitic mottling, medium gray, weathers light orange brown, thick bedded, massive, forms ledges.	9.2	97.2
2	Limestone, medium gray, weathers medium and light gray "chicken wire" weathering, medium bedded, forms mostly ledges.	5.4	88
1	Limestone, reddish brown, medium gray, weathers light orange brown, medium bedded, forms a slabby slope to ledgy slope.	11.6	82.6

Offset northwest about 46 m (50 yds) across gully

	Unit Thickness Meters	Meters Above Base
Lower Member—71 meters		
10 Siltstone, micaceous, medium green, weathers tannish green, thin bedded to laminated, shaly slope former	6.7	71
9 Quartzite, phyllitic, hematitic, medium gray, weathers dark brown, medium bedded, slabby ledge former.	3.6	64.3
8 Siltstone, micaceous, light green to green, weathers greenish tan, laminated bedding, shaly slope former	3.1	60.7
7 Quartzite, phyllitic, hematitic, medium gray, weathers dark brown, medium bedded, slabby ledge former.	14.7	57.6
6 Covered	9.1	42.9
5 Siltstone, light green, weathers greenish tan, bedding not evident, slope former.	4.5	33.8
4 Quartzite, light brown to tan, weathers light brown, medium bedded, slabby ledge former.	7	29.3
3 Siltstone, micaceous, light green, weathers greenish tan, laminated bedding, forms a ledgy slope.	10.7	22.3
2 Shale, silty, micaceous, olive green, weathers same, laminated bedding, slope former	2.5	11.6
1 Quartzite, with shale partings, phyllitic, reddish gray to grayish green, medium bedded, slabby to shaly ledge and slope former.	9.1	9.1

Strike: N68°W Dip: 22°SW measuring in direction N125°W

Prospect Mountain Quartzite

1 Quartzite, light red, weathers light brown and yellowish gray, medium to thick bedded, blocky ledge former.

Measured Section II

Measured by Martin Dommer 1979 June 5 with Jacob's staff

Location: Starting point SE¼ SE¼ NE¼, section 2, T. 15 S, R. 11 W, in a little Fish Springs Member strike valley.

Direction measured· N70°W to NW¼ SW¼ NE¼ section 2, T 15 S, R 11 W

Strike. N15°W Dip· 15°W Dip 15°W

	Unit Thickness Meters	Meters Above Base
Lamb Dolomite—Upper Member, 103.6 meters		
6 Dolomite, coarse grained, very light brown, weathers very light tan, very thick bedded, massive, cliff former, faulted; top not exposed here; estimated in thickness at SW¼, section 35, T 14 S, R. 11 W.	61±	190.5±
5 Dolomite, coarse grained, medium gray, weathers light gray, medium to thin bedded, light gray mottles near top, forms a ledgy slope.	22.8	129.5
4 Dolomite, light gray to light tan, weathers light tan, medium bedded, forms slabby ledges and slopes	19.8	106.7
Lower Member—285 feet; 86.9 meters		
3 Dolomite, coarse grained, medium gray, weathers gray brown, very thick bedded, massive, cliff former	61.9	86.9
2 Dolomite, light brown, weathers tan, thin to medium bedded, forms slabby ledges and includes several horizons of pisolites and/or oncolites—*Girvanella?*	22.9	25
1 Limestone, medium gray, medium bedded, slabby ledge	2.1	2.1
0 Fish Springs Member of Trippe Slope	0	0

Measured Section III

Measured by Martin Dommer 19 July 1979 with Jacob's staff

Location Easternmost reddish brown ridge north of the road in section 10, T. 14 S, R. 11 W

Direction measured Up section in direction N70°W from SE¼ NE¼ SE¼, section 10 to the center of section 10

Strike N30°E, Dip· 25°NW in lower half of section, N70°E dip 20°NW in upper half

	Unit Thickness Meters	Meters Above Base
Orr Formation—Light Colored Member		
11 Limestone, light gray, weathers very light gray, medium bedded, forms slabby ledge	6.1±	305.1
Big Horse Member—300+ meters		
10 Limestone, coarse grained, medium gray, weathers light medium gray, forms medium-to thick bedded slabby ledges	35	299
Fault, about 9 m displacement down to the southeast		
9 Limestone, medium gray with reddish brown silt laminae, weathers reddish brown and light gray, thin bedded, flaggy, contains several thin horizons of intraformational conglomerate, fossil hashes and trace fossils	27.5	264
8 Limestone, medium gray with light gray mottling and laminae, weathers light gray, medium bedded, slabby ledges	18.3	236.5
7 Limestone, medium gray, weathers light gray, medium bedded, slabby, a few coarse-grained horizons, forms ledges and slopes	59.4	218.2
6 Limestone, with 10 percent reddish brown silty laminae, limestone medium gray, weathers light gray, medium bedded with a few very thin intraformational conglomerate horizons, ledges	28.3	158.8
5 Limestone, with 20 percent reddish brown silty interbeds, limestone dark gray, weathers medium gray, thin bedded, flaggy ledges, trace fossils on bedding planes, intraformational conglomerate at base	27.5	130.5
4 Limestone, medium gray, weathers light gray, medium bedded, slabby slopes, a few reddish brown laminae of silt	13.1	103
3 Limestone, with reddish brown silty laminae, medium gray, weathers light gray, medium bedded, flaggy slope former.	6.1	89.9
2 Limestone, medium light gray, weathers same, laminated bedding, trace of reddish brown laminae, trace chert, forms ledgy slope	4.6	83.8
1 Limestone, dark gray, weathers dark gray, with a little lighter dolomitic mottling, medium to thick bedded, slabby ledge former Base covered.	79.2±	79.2

Measured Section IV

Measured by Martin Dommer 5 June 1979 with Jacob's staff

Location· Banded slope north of road; beginning point, bottom of slope, NW¼ SE¼ SW¼, section 10, T. 14 S, R 11 W

Direction measured· N10°W to base of cliff NW¼ NE¼ SW¼, T 14 S, R 11 W

Strike: N75°E Dip 15°W

	Unit Thickness Meters	Meters Above Base
Notch Peak Formation		
9 Dolomite, banded, medium gray and brown, coarse grained, thick bedded, massive, cliff	30.5	190.8
Orr Formation—Sneakover Limestone Member—67.6 meters		

8	Limestone, dark to medium gray, very thin bedded to thin bedded, flaggy, ledge former, mottled near base; contains fossils in little silicified wads near base, including *Eoorthis* 3 m from base, fucoidal markings and trace fossils on bedding planes, numerous nodular chert horizons.	56.4	160.3
7	Covered	12	103.9
6	Limestone, laminated coloring, medium to light gray, weathers light gray, medium to thick bedded, forms blocky cliff; unidentified fossils.	7.6	100.3
	Corset Spring Shale Member–8.6 meters		
5	Shale, moderate green, with a few grayish brown very thin limestone beds, shale hackly weathering, laminated bedding; limestone is coquinoid and contains *Kindbladia* (identified by A. R. Palmer, letter 29 May 1979); unit forms a slope.	86.	92.7
	Light Colored Member–84.1 meters		
4	Limestone, light gray, weathers very light pink, medium to very thick bedded, massive, cliff former.	10.6	84.1
3	Limestone, light gray, weathers light purple to pinkish orange, very thick bedded, massive, ledge former.	7.1	73.5
2	Covered. In section 18, T. 14 S, R. 11 W, this unit has exposures of limestone, light purple, soft, weathers light purple, medium bedded, slabby slopes.	46.6	66.4
1	Limestone, light gray, weathers very light gray, thick bedded, blocky ledge former (This unit is the same as unit 11, section III.).	19.8	19.8

Measured Section V

Measured by Martin Dommer 20 June 1979 with Jacob's staff.

Location: A little ridge south of the large sandy wash, SW¼, NW¼, section 25, T. 13 S, R. 12 W.

Strike: N40°E Dip: 35°NW

		Unit Thickness Meters	Meters Above Base
	Fillmore Formation		
3	Limestone, mostly intraformational conglomerate, dark gray, weathers dark gray, very thin bedded, forms low uniform rolling hills.	91.5+	181.4
	House Limestone–74.7 meters		
1	Limestone, light bluish gray, weathers light bluish gray, thick to medium bedded, blocky ledges and slopes, occasional chert nodules.	74.7	89.9
	Notch Peak Formation		
1	Limestone, coarse grained, medium gray, weathers medium gray, medium bedded, forms slabby ledges, contains interbedded coarse-grained horizons.	15.2+	15.2

Measured Section VI

Measured by Lehi F. Hintze with Jacob's staff. Described by Martin Dommer 7 August 1979.

Location: Beginning at the base of a spur on SE¼ SW¼, section 27, T. 14 S, R. 10 W

Direction: Measured west to SW¼ SE¼, section 28, T 14 S, R 10 W

Strike: N40°W Dip: 22°SW

		Unit Thickness Meters	Meters Above Base
	Mutual Formation		
4	Quartzite, grit and pebble conglomerate, reddish gray, thick bedded, blocky ledge former. Grit: angular, poorly sorted, lensing; pebbles, rounded, poorly sorted, lenses; some dark gray conglomerate lenses–one at 396 m; a few jasper pebbles in pebble lenses.	342.9	596.2
	Dip change from 22° to 31° at about 488 m.		
3	Quartzite, grit conglomerate, pinkish white, medium to thick bedded, blocky ledge former, grit angular and lenses.	3	342.9
2	Siltstone, yellowish tan, laminated bedding, shaly slope former.	2.2	339.9
1	Quartzite, pinkish white, medium to thick bedded, blocky ledge former, quartzite medium to coarse grained.	7.6	337.7
	Inkom Shale–159.4 meters		
8	Siltstone with laminated interbeds, light gray sandstone, siltstone very dark red, laminated bedding, current cross-bedded, sandstone coarse grained, unit contains about 50 percent each of sandstone and siltstone, unit forms slope.	8.5	330.1
7	Siltstone, very dark red, laminated bedding, shaly slope former.	16.2	321.6
	Dip change to 19°		
6	Siltstone, grayish green, laminated bedding, shaly slope former.	17.3	305.4
5	Siltstone, very dark red, laminated bedding, shaly slope former.	3.4	288.1
4	Quartzite, grit conglomerate, pinkish red, thick bedded, blocky ledge former; grit angular, poorly sorted.	8.5	284.7
3	Shale, silty, grayish green, hackly weathering, laminated bedding, shaly slope former. Unit becomes siltier near top, contains ironstone nodules and iron alteration occurring in bands across and in bedding planes. Lower 30 m light brown to tan, color change is gradational.	100.9	276.1
2	Shale, silty, chippy, almost papery, weathering yellow brown, thinly laminated, shaly slope former.	3.1	175.3
1	Shale, silty, olive green laminated bedding, shaly slope former.	1.5	172.2
	Caddy Canyon Quartzite–170.7 meters		
10	Quartzite, grit conglomerate, reddish pink, medium to thick bedded, blocky ledge former; grit angular, poorly sorted, lenses; unit coarsens upward.	10.7	170.7
9	Quartzite, pebble conglomerate, red matrix, very light gray pebbles, some red jasper pebbles, thick bedded, blocky ledge former, pebbles up to 5 cm, poorly sorted, rounded pebbles occur in lenses.	12.8	160
8	Quartzite, fine at bottom, coarsens to grit conglomerate, reddish pink, desert varnished, thick bedded, blocky ledge former, grit angular, poorly sorted, lenses.	11.6	147.2
7	Quartzite, conglomerate, grit to pebble lenses, reddish pink, very thick bedded, blocky prominent ledge former, grit angular, pebbles rounded, poorly sorted, lensing.	30.4	135.6
	Fault–offset 12 m downslope		
6	Quartzite, light tan with pink mottling, thick bedded, blocky ledge former, coarsens from medium grained at bottom to grit at top, base well sorted, grit angular, poorly sorted.	10.7	105.2
5	Quartzite, coarse grain to grit and pebble conglomerate, tan, weathers brownish red near top, medium bedded, blocky ledge former, grain size coarsens up; coarse grain and grit, angular, pebbles rounded, poorly sorted, all occur in lenses.	21.3	94.5
4	Siltstone, yellowish brown to reddish brown laminated bedding, shaly slope former.	15.3	73.2

3 Quartzite, reddish pink, desert varnish, very thick bedded, massive, ledge former, coarse grained to grit lenses; grit angular, poorly sorted.	16.7	57.9
2 Siltstone, olive green to olive brown, laminated bedding, shaly slope former.	38.1	41.2
1 Quartzite, tan, with reddish brown stains, thick bedded, blocky ledge former; base covered.	3.1	3.1

Measured Section VII

Measured by Martin Dommer with Jacob's staff.
Described by Martin Dommer 7 August 1979.
Location: Beginning at base of hill at NE corner of NE¼ SE¼, section 9, T. 14 S, R. 11 W
Direction measured: In a northeast direction to a ridge SE¼ NE¼, section 9, T. 14 S, R. 11 W
Strike: N55°E Dip: 21°NW

	Unit Thickness Meters	Meters Above Base
Notch Peak Formation		
An estimated 62 m of dolomite and 67 m of limestone overlie unit 6.		
Fault		
7 Dolomite, coarse grained, light tan, very thick bedded, recrystallized, 6.2 m of medium gray about 12.4 m from base, forms massive cliffs.	30.5+	268.2
6 Dolomite, coarse grained, medium gray with a few interbeds of tan dolomite, very thick bedded, probably recrystallized, massive cliff former.	76.2	237.7
5 Dolomite, coarse grained, light gray to tan, very thick bedded, massive cliff former; often caps ridges, recrystallized.	31	161.5
4 Dolomite, same as unit 5, vuggy 15.2 m from base of unit.	36	130.5
3 Dolomite, coarse grained, medium gray, very thick bedded, massive, cliff former, oncolites at 80.5 m.	44.2	94.5
2 Dolomite, coarse grained, tan, very thick bedded, massive, cliff former.	16.8	50.3
1 Dolomite, coarse grained, medium gray, very thick bedded, massive, cliff former, base covered.	33.5	33.5

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