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UPPER CAMBRIAN STRATIGRAPHY OF WESTERN UTAH

by

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UPPER CAMBRIAN STRATIGRAPHY

OF WESTERN UTAH

A Thesis

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In partial fulfillment

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Master of Arts

by

Craig B. Bentley

June, 1958

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LIST OF ILLUSTRATIONS

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To my wife, Verlyn, I express appreciation for her assistance and encouragement to complete the project.

ABSTRACT

Eight sections exposed in an area extending from central Utah westward to the Deep Creek Range and from the Silver Island Range, Tooele County, southward to the Wah Wah Mountains, Beaver County, were measured and lithic comparisons made. The Dunderberg shale of Nevada, recognized throughout the area as a shale and limestone unit, is found as far east as central Utah. In the Oquirrh Mountains Mississippian rocks unconformably overlie the lower part of the Upper Cambrian, and to the east, in the central Wasatch Mountains, no rocks of Upper Cambrian age are present. In the Tintic district, however, and in the Stansbury Mountains complete sections of the Ajax and Opex formations occur. In the vicinity of the House Range, near the center of the Cordilleran Miogeosyncline, the Upper Cambrian consists of the Weeks, Orr, and Notch Peak formations. In the Deep Creek Range the Hicks, Lamb and Chokecherry formations comprise the Upper Cambrian.

The thickest section occurs in the House Range, where nearly 5000 feet of Upper Cambrian sediments are exposed. The sediments thin both east and west from the House Range. West of Eureka, Nevada, the sediments are of an eugeosynclinal character and begin to thicken noticeably westward. The source area for the miogeosynclinal sediments lay to the east, in eastern Utah and Colorado.

It is proposed that the Dunderberg shale be recognized as a formation in western Utah and that the Chokecherry dolomite be renamed, at least in the Deep Creek Range, to Pogonip formation for the Ordovician part of the Chokecherry and to Notch Peak limestone for the Cambrian part.

INTRODUCTION

Purpose and Scope

Many workers have studied and written about the Lower and early Middle Cambrian formations of the Great Basin, but very few contributions have appeared in print concerning rocks of the Upper Cambrian. It is the purpose of this paper to present descriptions, thicknesses, and correlations of the Upper Cambrian rocks of the part of the Great Basin which lies in western Utah. I have also attempted to relate the sedimentary strata of western Utah with those of adjacent areas.

Locations

I worked primarily with the Upper Cambrian strata at the following locations in western Utah: (see fig. 1)

Tooele County
- Ophir district, approximately 15 miles southeast of Tooele.
- Stansbury Mountains, approximately 12 miles northwest of Grantsville.
- Silver Island Range (Desert Range) approximately 15 miles northeast of Wendover.

Juab County
- Tintic district, approximately two miles south of Eureka.
- Fish Springs Range, west central part of county.
- Deep Creek Range, approximately 12 miles west of Callao.

Millard County
- House Range, west central part of county.

Beaver County
- Wah Wah Mountains, west central part of county.

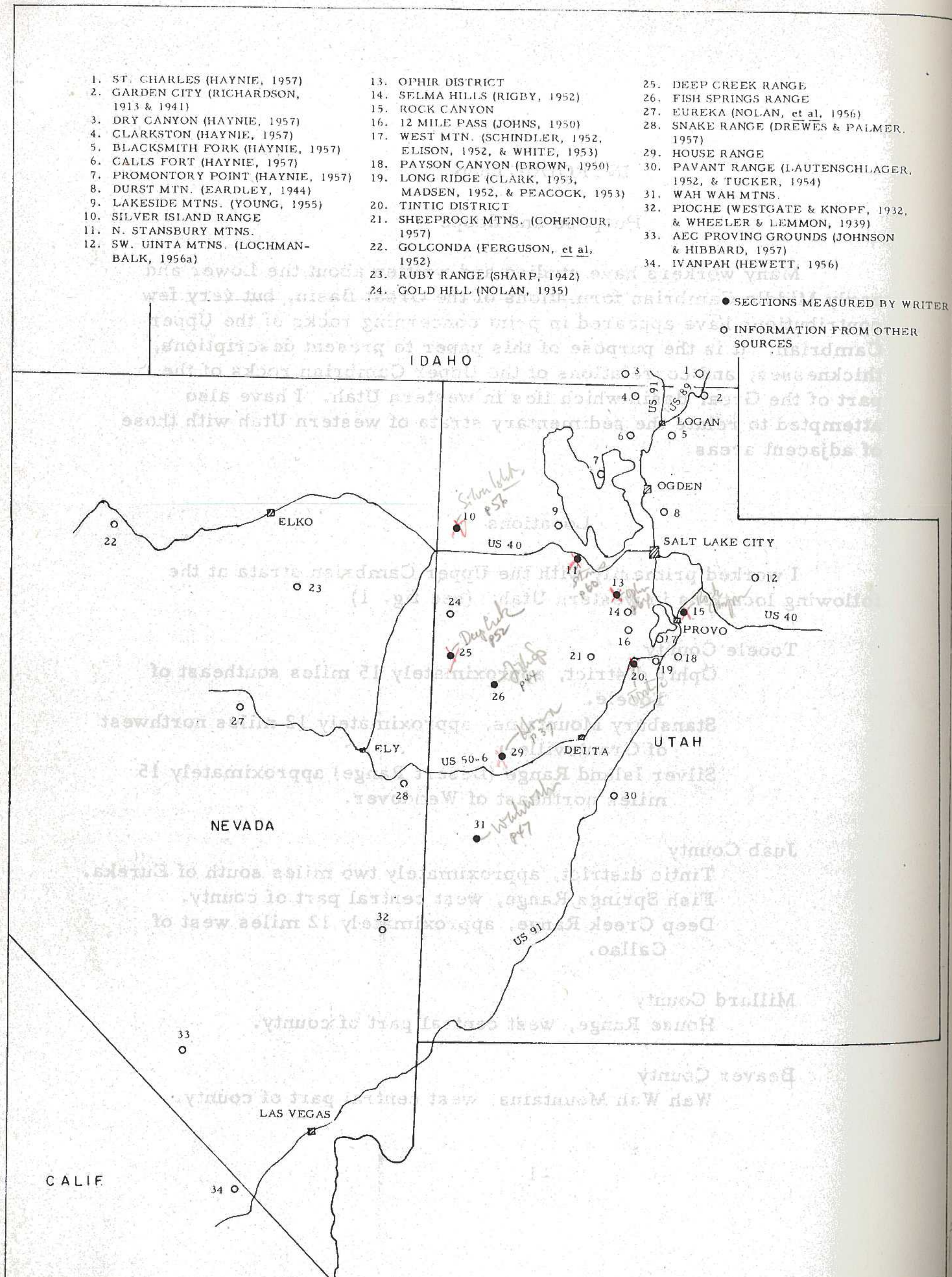

FIGURE I. INDEX MAP OF EASTERN GREAT BASIN

Previous Work

Although many papers have been written concerning some of the individual areas treated herein, only a small amount of regional work has been published, notably Palmer's paper on the Cambrian of the Great Basin (1956) and Wheeler's papers in 1944 and 1948 on the Lower and Middle Cambrian of Nevada and western Utah. Some of the more important papers dealing with local areas where Upper Cambrian rocks are exposed are as follows:

Gilluly (1932) mapped and described the geology of the Ophir district and adjacent areas in the Oquirrh Mountains. Arnold (1956) mapped the northern end of the Stansbury Mountains. Anderson (1957) completed a study of the geology of the northern Silver Island Range, and Schaeffer (in preparation) is presently mapping the southern and central portions of the same range. Lindgren and Loughlin (1919) mapped and described the geology of the Tintic district. More recently, Morris (1957) presented additional information on the stratigraphic sequence in the district. At Gold Hill, approximately 20 miles north of my measured section in the Deep Creek Range, Nolan (1935) mapped and described the geology. Walcott (1908), and later Deiss (1938), studied the Cambrian sequence in the House Range.

Present Work

In June, 1957, Richard A. Robison and I commenced a joint undertaking to measure, described and correlate the Upper Cambrian formations of western Utah. Since that time, Robison has completed a paleontologic study of the Upper Cambrian fauna, and I have studied the lithology.

Robison and I measured all of the sections at the aforementioned locations with a 100-foot metallic tape and Brunton compass. The field work occupied the summer of 1957 and extended into autumn and early winter of the same year. In the laboratory 159 thin-sections were prepared and studied under the petrographic microscope. This phase of the investigation was completed in April, 1958.

STRATIGRAPHY

General Statement

Upper Cambrian strata of western Utah are predominately carbonate with limestone predominating slightly over dolomite. A few thin shale beds, one of which is a prominent stratigraphic key unit, occur at various horizons. The stages of the Upper Cambrian will be referred to throughout the paper and are, from oldest to youngest, Dresbachian, Franconian, and Trempealeauan. A correlation chart (fig. 7) shows the time relations of the main Upper Cambrian formations of the eastern Great Basin.

The thickest section measured is at the House Range, where nearly 5000 feet of Upper Cambrian rocks are present. To my knowledge, this is the thickest Upper Cambrian miogeosynclinal section in the United States. In addition the section has experienced little alteration and no dolomitization. The House Range would be my choice as the type Upper Cambrian section for the Cordilleran miogeosyncline.

Isopach maps have been prepared for the Upper Cambrian (fig 3) and for major subdivisions of the epoch. The thickest sections occur in the House Range and at the AEC Proving Grounds, Nevada, and show a general northeastern trend of the miogeosyncline. Westward from the House Range the sediments thin toward central Nevada and then thicken into the eugeosyncline. Sharp (1942, p. 655-666) reports 3550 feet of limestone and argillite in the Ruby Range. In the Golconda quadrangle, 75 miles west of Elko, Nevada, the Preble formation of Middle and Upper Cambrian age consists to over 12, 000 feet of slate with limestone lenses (Ferguson, Roberts, and Muller, 1952). Eastward from the House Range the sediments thin until, in central Utah they are completely missing, probably through erosion. I measured the Cambrian section at Rock Canyon near Provo and, because of the similarity of the top of the sequence with the Middle Cambrian Cole Canyon limestone elsewhere, concluded that the Upper Cambrian is absent. Baker (1947) also at Rock Canyon came to the same conclusion. In the Cottonwood-American Fork area (Calkins & Butler, 1943, pp. 18-19), Devonian strata unconformably overlie the Middle Cambrian Maxfield limestone. Eardley (1944, pp. 828-830) described 1300 feet of limestone and dolomite above the Ophir shale in the Durst Mountain area of the north central Wasatch Mountains which

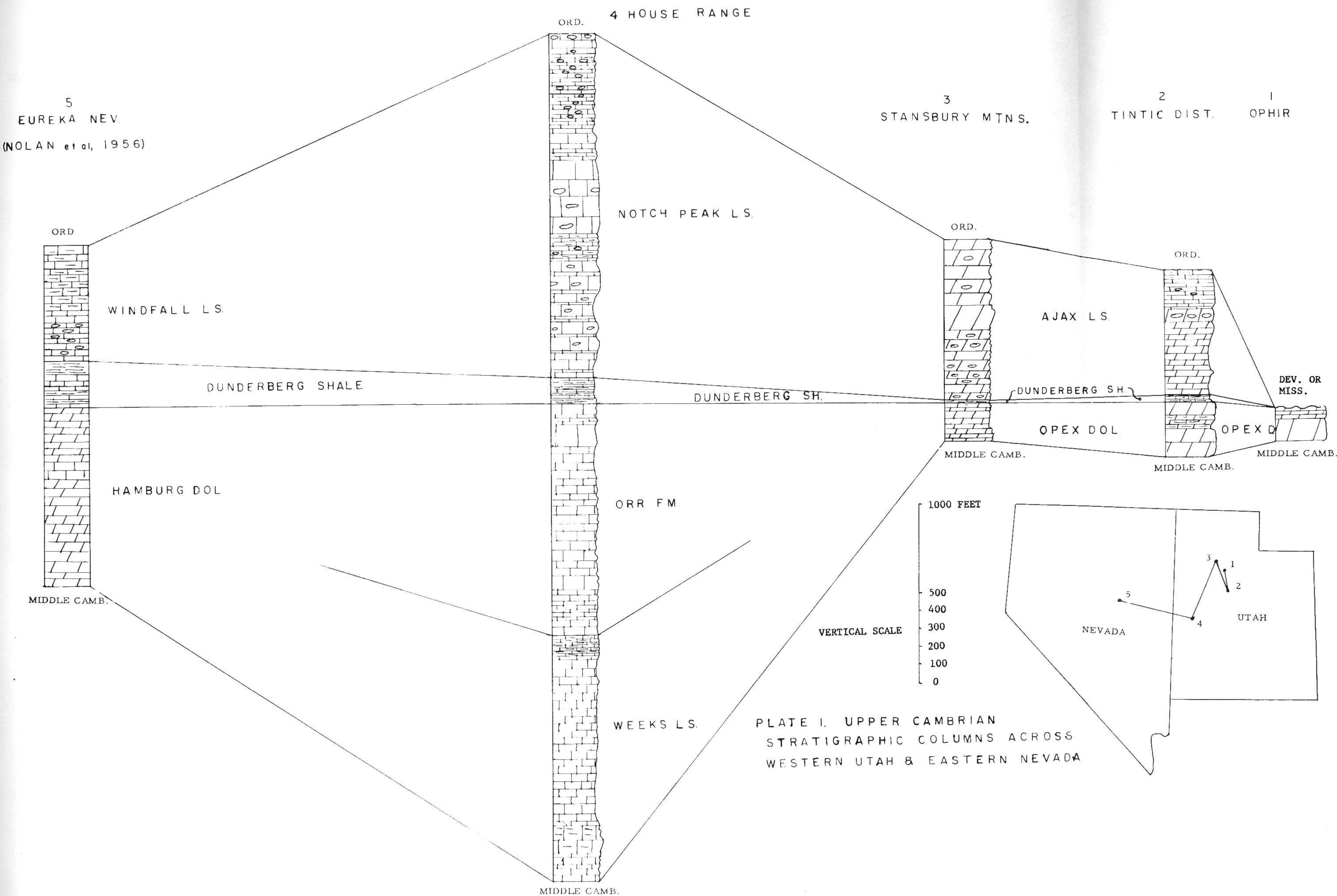

PLATE I. UPPER CAMBRIAN STRATIGRAPHIC COLUMNS ACROSS WESTERN UTAH & EASTERN NEVADA

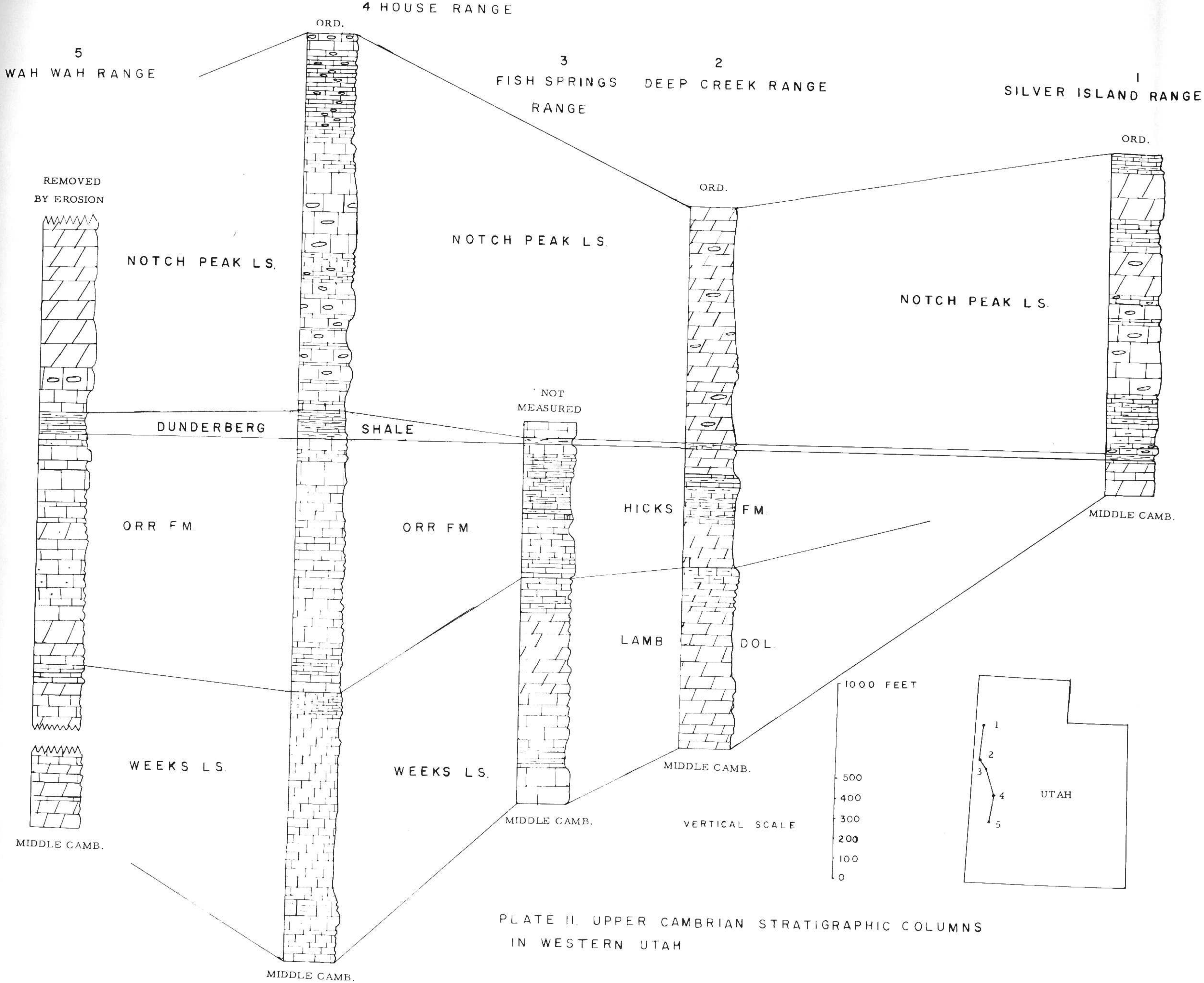

PLATE II. UPPER CAMBRIAN STRATIGRAPHIC COLUMNS IN WESTERN UTAH he believes may include part of the Middle- Upper Cambrian Lynch dolomite, indicating the possibility of Upper Cambrian rocks being present.

The isopach map of the Upper Cambrian shows a marked thinning of sediments in an easterly direction across the miogeosyncline, just south of the present location of Great Salt Lake. I attribute this to activity along the Uinta Positive area to the east. Lochman-Balk (1956, p. 575) believes that during Middle Cambrian times this positive element formed a prominent western peninsula on the coastline of Siouxia ". . . so that the shore and the shallow coastal shelf turned abruptly westward in south-central Wyoming and ran far to the west in Utah. . . ." Most of the peninsula was slightly submerged during the Dresbachian and again in the Trempealeauan thus permitting the deposition of a thin veneer of detrital sediments.

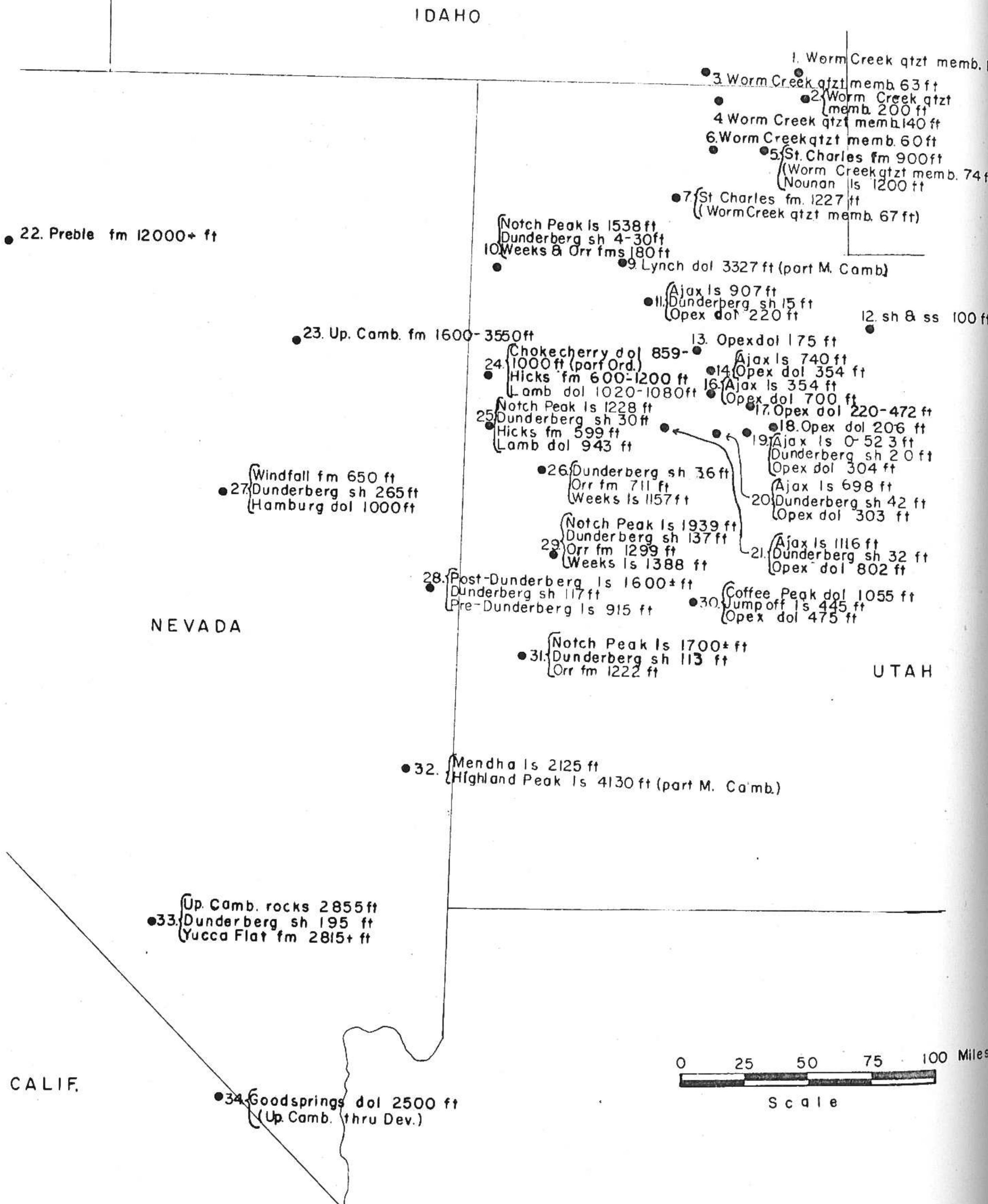

FIGURE 2. Data Sheet for Isopach Maps (figs. 3-6)

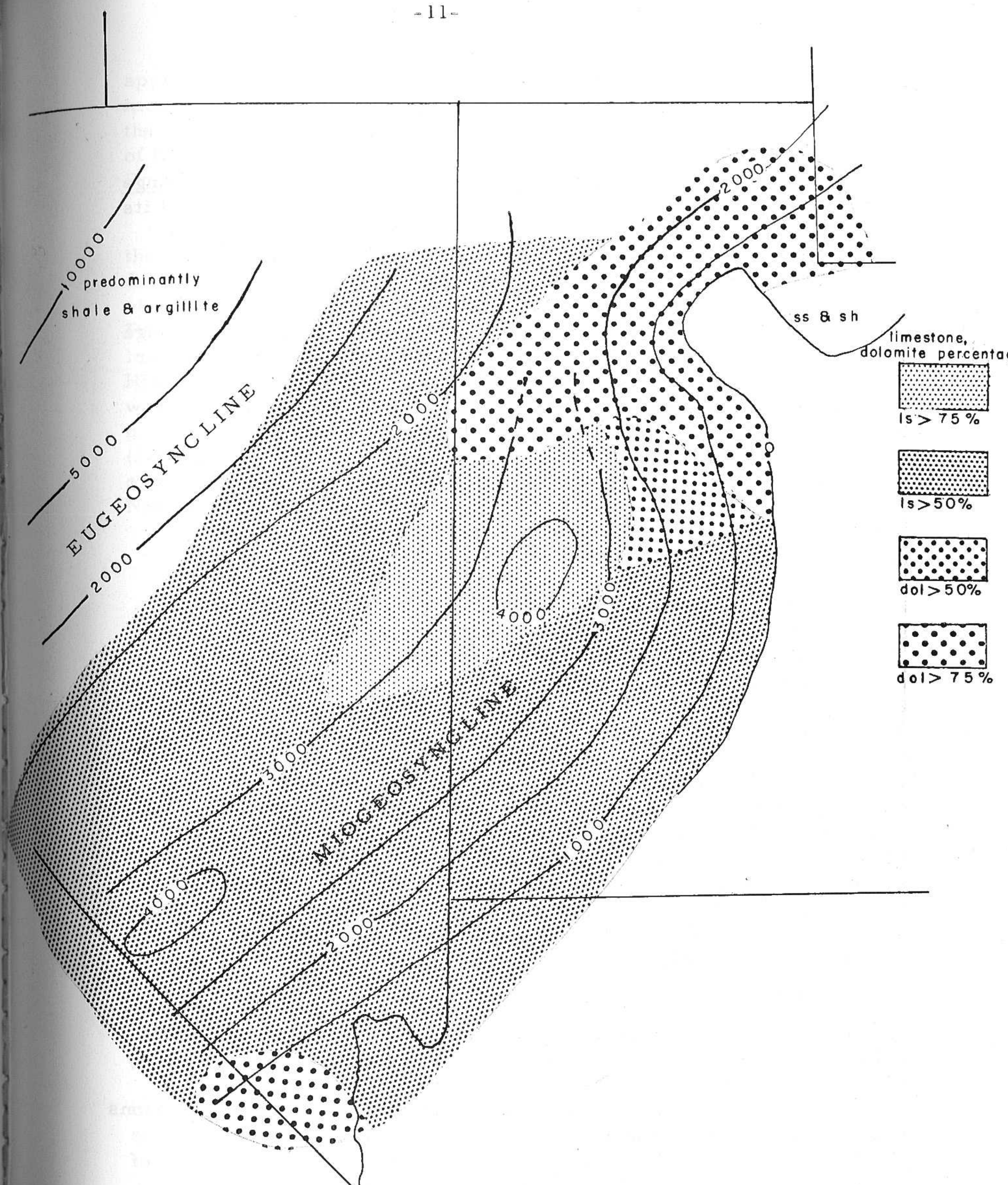

FIGURE 3. Upper Cambrian Isopach Map of the Eastern Great Basin

Weeks Limestone

Walcott (1908a, pp. 9-10) designated the thin-bedded shaly limestones between the Marjum and Orr formations in the House Range as the Weeks limestone. He measured 1390 feet of the formation at its type locality on the north side of Weeks Canyon, north of Orr Ridge.

I measured and described the Weeks limestone near the type locality in the House Range, in the Fish Springs Range, and also the upper part of the formation in the Wah Wah Range. In the House Range 1388 feet of Weeks limestone is exposed. This measurement however is subject to error since most of the formation was measured over a mile-long dip slope, where exposures are poor and infrequent. The thickness of the Weeks limestone in the Wah Wah Range was not determined because of difficulties in defining the Middle and Upper Cambrian boundary through lack of fossils and because the middle part of the formation is not exposed. Extensive primary recrystallization most likely accounts for the lack of fossils. Total thickness is approximately 1000 to 1200 feet.

The Weeks limestone was deposited as a fine-grained, clastic lime mud accompanied by abundant ferruginous clay especially during the latter half of the depositional history. Some fossil fragments, mostly trilobites and brachiopods, were deposited in the lime. Oolites and pisolites are abundant in the Fish Springs Range and occur less frequently in the House Range. When seen under the microscope the oolites and pisolites exhibit a fine granular texture even when enclosed in a coarsely crystalline limestone matrix. Because of their fine granular nature and lack of algal structure I believe the pisolites and oolites to be faecal pellets. Recrystallization and dolomitization in the Fish Springs Range and especially in the Wah Wah Range took place following deposition, probably during early diagenesis. Stratigraphic relationships point to penecontemporaneous alteration and dolomitization in that altered zones and non-altered zones are separated by bedding planes over wide areas.

The Weeks limestone was deposited in fairly shallow water near the center of greatest subsidence of the Cordilleran miogeosyncline. Thin laminae, found in the limestone of the House Range and especially common in the Ibex area 20 miles south, indicate a depositional environment undisturbed by currents. I attribute this to local conditions where deeper waters, possibly as great as several hundred feet, prevailed. Agnostid trilobites, especially abundant in the lower half of the Weeks limestone in the House Range, are indicative of moderately deep, muddy water, conditions which existed throughout much of the deposition of the Weeks limestone.

The Weeks limestone is lowermost Upper Cambrian and occupies approximately the lower half of the Dresbachian stage. Fossils (see the measured sections of the respective locations, Appendix) indicate that the Middle- Upper Cambrian boundary is probably in the lower 100 feet of the formation. However we found no fossils from the transitional Bolaspidella zone.

The Weeks limestone is correlative with the Lamb dolomite of the Deep Creek Range, with approximately the lower half of the Opex dolomite of central Utah, and with the lower half of the Hamburg dolomite of Eureka, Nevada. The formation correlates with part of the Highland Peak formation at Pioche, Nevada. Wheeler (1944b, p. 1788) placed the lower boundary of the Upper Cambrian at the base of Unit J of the Highland Peak formation. Units J possible up through M are correlative with the Weeks limestone. The Weeks limestone is also correlative with part of the Yucca Flat formation at the AEC Proving Grounds, Nevada (Johnson and Hibbard, 1957, pp. 340-342), possibly with units B and C of that formation. In northern Utah approximately the lower half of the Nounan limestone is of the same age (see fig. 7).

Lamb Dolomite

In 1930 Nolan (Wash. Acad. Sci. Jour., 5th, v. 20, no. 17, pp. 421-432, quoted in Wilmarth, 1938, p. 1140 [see also Nolan, 1935]) defined the Lamb dolomite in the Gold Hill district of western Utah as follows:

> Lower third largely thick-bedded oolitic and pisolitic dolomites, some of them cross-bedded. Above this lies thick-bedded medium-gray dol. mottled by patches of dol. containing white rods which closely resemble parts of the Young Peak dol. In upper 100 ft. thinner-bedded dolomites with sandy partings become increasingly abundant, & these grade upward into a ss. that weathers reddish brown, which was chosen to make the top of the fm... Thickness 1,050 ft. No fossils, but believed to be Upper Camb.... Named for exposures in Lamb Gulch, on N. side of Dry Canyon, Gold Hill dist.

The Lamb dolomite is 943 feet thick measured and described in the central part of the Deep Creek Range, approximately 20 miles south of the Gold Hill district (see Appendix). Microscopic evidence shows that the Lamb dolomite had an origin similar to that of the Weeks limestone, and was deposited as a fine-grained lime with considerable iron oxide especially near the latter stages of deposition.

Oolites and pisolites occur at various horizons in the formation. The pisolites are oval to elliptical and are approximately ½ inch in diameter. The oolites vary from 1/5 to 2 millimeters in diameter. Both the oolites and pisolites are fine-grained with small groups of crystals and trilobite fragments scattered through the pisolites, thus confirming a faecal origin. Toward the top the formation becomes increasingly arenaceous in texture and possesses a reddish brown hue. In thin section this feature is noted as being due to red rhombic crystals 1/10 millimeter in length apparently composed of ferruginous dolomite crystals in a gray, fine-grained matrix. Penecontemporaneous recrystallization and dolomitization altered the original sediments throughout the formation. The dolomitization of the Lamb dolomite accounts for the major lithic difference between that formation and the contemporaneous Weeks limestone.

Paleontologic evidence indicates that the Lamb dolomite is almost an exact correlative of the Weeks limestone and is lower Dresbachian.

Orr Formation (restricted)

Walcott (1908a, pp. 9-10) designated 1820 feet of arenaceous limestones and shales, underlying the Notch Peak formation and overlying the Weeks limestone in the House Range, as the Orr formation. As the type locality he designated Orr Ridge, a spur extending east from Notch Peak to the south of Weeks Canyon.

I measured and described complete sections of the Orr formation in the House Range, Fish Springs Range, and in the Wah Wah Range. In the Silver Island Mountains, the Weeks and Orr formations were not differentiated because of intense alteration. The two formations will therefore be discussed together. Robison and I broke the Orr formation into two formations, a lower formation composed predominately of limestone and in some places dolomite, and an upper formation of shale and alternating shale and limestone. The lower formation retains the name of Orr formation. For the upper formation the writer has extended the Dunderberg shale, of the same age, of Nevada into western Utah to occupy this interval. The Dunderberg shale is discussed on page 21 of this paper.

The formation as originally deposited consisted mostly of fine- to medium-grained limestone with extensive deposits of bioclastic material. Trilobite and inarticulate brachiopod fragments in places

CHART OF UPPER CAMBRIAN LITHOLOGY OF WESTERN UTAH

Formations & areas		Units										
		1	2	3	4	5	6	7	8	9	10	11
Ajax ls	Tintic dist	dol, m gy, 99'	dol, lt gy, m-Xl,36'	dol, m gy, calc, 271'	dol, m gy, m Xl, 68'	ls, m gy, v f gr, chty, 224'						
	Stansbury Mtns	dol, m lt gy, 85'	dol, m dk gy, chty, 113'	dol, m dk gy, 62'	dol, m dk gy, f-m Xl, chty, 118'	dol, lt gy, c Xl, 138'	dol, m gy, chty, 314'	dol, m lt gy, f Xl, arg, 57'				
Notch Peak ls	House Rng	ls, m dk gy, cht, sblith, 319'	ls, m dk gy, cht, sblith. 162'	ls, m dk gy, cht, sblith, 197'	ls, m dk gy, v f gr, chty, 137'	ls, lt gy, v f gr, chty, ool, 400'	ls, altng lt & dk, f-m gr, 18'	ls, m dk gy, f-m gr, 21'	ls, m dk gy, f-m gr, chty, 16'	ls, m lt gy, f-m gr, chty, 44'	ls, lt gy, f gr, 49'	ls, m dk gy, f gr, 45'
	Wah Wah Rng	ls m lt gy, cht, sblith, 265'	dol, m gy, m Xl, 243'	dol, v lt gy, 207'	dol, m lt gy, m-c Xl, 163'	dol, m gy, 100+'	? - - -	- - -	- - -	- - -		
	Deep Creek Rng	dol, m gy, chty, 317'	dol, lt gy, 155'	dol, m lt gy, chty, 630'	dol, m lt gy, f-m S, 126'							
	Silver Is Range	ls, m lt gy, chty, arg, 46'	ls, m gy-bl gy, bioclas arg, 79'	ls, gy bl, arg, 185'	ls, lt gy, chty, sblith, 373'	ls, m dk gy, v f gr, 5'	ls, lt gy, chty, sblith, 72'	ls, m dk gy, v f gr, chty, 48'	dol, m bl gy, & ls, chty, 221'	ls, lt bl gy, f gr & bioclas, 172'	dol, m gy, 240'	ls, m bl gy, f-m gr, aren, 240'
Dunderberg sh	House Rng	sh, m gy, fis, 26'	intbd sh & m gy ls, 111'									
	Fish Sprgs Rng	sh, lt olv gy, & dk gy gn, 36'										
	Wah Wah Rng	intbd sh & m lt gy ls, 113'										
	Deep Creek Rng	intbd sh & m gy ls, 30'										
	Silver Is Rng	sh, yel tan-m brn, 4-30'										
	Stansbury Mtns	sltst, lt olv gy, 15'										
	Tintic dist.	ls, dk gy, & sh, olv gy, 42'										
Opex dol	Tintic dist	dol, m gy, Xl & bioclas, 159'	dol, m gy, ool & pis, 28'	dol, m lt gy, m Xl & ool 52'	dol, m dk gy, m-c Xl, ool, 64'							
	Stansbury Mtns	dol, m dk gy, ool 44'	dol, m dk gy, 19'	dol, covered slope 99'	dol, m gy, f-m Xl, 43±5'							
Ophir	Ophir dist	dol, m dk gy, ool 133'	dol, altng lt & dk 42'									
Hicks fm	Deep Creek Rng	dol, m gy, ool & pis, 227'	ls, m gy, bioclas, & sh intbd 252'	dol, m lt gy, 120'								
Orr fm	House Rng	ls, lt tan-dk rd brn, bioclas 79'	ls, m gy, f-m gr 87'	ls, m lt gy, m gr 25'	ls, lt brn gy, f gr & bioclas, 66'	ls, m gy, ool, bioclas, 86'	ls, m dk gy, bioclas 252'	ls, m dk gy, f gr, 145'	ls, dk olv gy, bioclas, 334'	ls, m dk gy, f gr, 118'	ls, dk gy, m gr, 65'	ls, lt gy, f gr, 42'
	Fish Sprgs Rng	ls, m lt gy, m gr & bioclas 202'	ls, m gy, f-m g 99'	ls, m gy, bioclas, 204'	ls, m dk gy, f gr, ool, 129'	ls, lt gy, f gr, 41'						
	Wah Wah Rng	ls, altng lt & dk f gr & bioclas 57'	dol, m lt gy, 60'	dol, lt gy, m Xl, Fe, 118'	ls, m lt gy, m Xl, 72'	ls, m lt gy, f gr & Xl, 35'	ls, m gy, f gr, 192'	ls, altng lt & dk, ool, 129'	dol, m lt gy, 77'	ls, m gy, f gr & bioclas, 171'	ls, m gy, ool, 101'	ls, m gy, bioclas, 51'
Lamb dol	Deep Creek Rng	dol, m gy, ool & pis, 75'	dol, m lt gy, ool & pis, 300'	dol, lt-m lt gy, m Xl, ool, 162'	dol, m dk gy, 173'	dol, m gy, f Xl, arg, 155'	ls, m dk gy, arg, m Xl, 78'					
Weeks ls	House Rng	ls, dk gy, f gr, 171'	ls, dk gy, f gr, arg, 151'	ls, dk gy, f gr, arg, 461'	ls, dk gy, arg, Fe, f gr, 475	ls, m gy-dk yel orng, arg, Fe, 130'						
	Fish Sprgs Rng	ls, m gy, f gr, 177'	ls, m lt gy, & sh intbd, 146'	ls, m lt gy, Fe, pis & ool, 239'	dol, altng lt & dk m-c Xl, 1,373'	dol, m lt gy, fn Xl, 39'	ls, m gy, bioclas, ool, arg, 183'					

PLATE III. Abbreviations after Mitchell, J. G., and Maher, J. C., 1957, "Suggested abbreviations for lithologic descriptions: Am. Assoc. Petroleam Geologists Bull., V. 41, pp. 2103-2107

CHART OF UPPER CAMBRIAN LITHOLOGY OF WESTERN UTAH

	3	4	5	6	7	8	9	10	11	12	13	14
Xl,36'	dol, m gy, calc, 271'	dol, m gy, m Xl, 68'	ls, m gy, v f gr, chty, 224'									
chty,	dol, m dk gy, 62'	dol, m dk gy, f-m Xl, chty, 118'	dol, lt gy, c Xl, 138'	dol, m gy, chty, 314'	dol, m lt gy, f Xl, arg, 57'							
cht,	ls, m dk gy, cht, sblith, 197'	ls, m dk gy, v f gr, chty, 137'	ls, lt gy, v f gr, chty, ool, 400'	ls, altng lt & dk, f-m gr, 18'	ls, m dk gy, f-m gr, 21'	ls, m dk gy, f-m gr, chty, 16'	ls, m lt gy, f-m gr, chty, 44'	ls, lt gy, f gr, 49'	ls, m dk gy, f gr, 45'	ls, m lt gy, chty, bioclas, 239'	ls, m gy, f gr, chty, 168'	ls, lt gy, chty, f gr, 124'
Xl,	dol, v lt gy, 207'	dol, m lt gy, m-c Xl, 163'	dol, m gy, 100+'	? -------	-------	-------	-------					
5'	dol, m lt gy, chty, 630'	dol, m lt gy, f-m S, 126'										
y, 79'	ls, gy bl, arg, 185'	ls, lt gy, chty, sblith, 373'	ls, m dk gy, v f gr, 5'	ls, lt gy, chty, sblith, 72'	ls, m dk gy, v f gr, chty, 48'	dol, m bl gy, & ls, chty, 221'	ls, lt bl gy, f gr & bioclas, 172'	dol, m gy, 240'	ls, m bl gy, f-m gr, aren, 240'	ls, m lt gy-dk gy, & sh, 65'	dol, m lt gy, m Xl, 6'	ls, m gy, f gr, 7'
y ls,												
ol &.	dol, m lt gy, m Xl & ool 52'	dol, m dk gy, m-c Xl, ool, 64'										
. 19'	dol, covered slope 99'	dol, m gy, f-m Xl, 43±5'										
& dk												
oclas, 2'	dol, m lt gy, 120'											
n gr	ls, m lt gy, m gr 25'	ls, lt brn gy, f gr & bioclas, 66'	ls, m gy, ool, bioclas, 86'	ls, m dk gy, bioclas 252'	ls, m dk gy, f gr, 145'	ls, dk olv gy, bioclas, 334'	ls, m dk gy, f gr, 118'	ls, dk gy, m gr, 65'	ls, lt gy, f gr, 42'			
m g	ls, m gy, bioclas, 204'	ls, m dk gy, f gr, ool, 129'	ls, lt gy, f gr, 41'									
60'	dol, lt gy, m Xl, Fe, 118'	ls, m lt gy, m Xl, 72'	ls, m lt gy, f gr & Xl, 35'	ls, m gy, f gr, 192'	ls, altng lt & dk, ool, 129'	dol, m lt gy, 77'	ls, m gy, f gr & bioclas, 171'	ls, m gy, ool, 101'	ls, m gy, bioclas, 51'	ls, m lt gy, f gr & ool, 86'	ls, m lt gy, aren, f-m gr, 73'	
ool	dol, lt-m lt gy, m Xl, ool, 162'	dol, m dk gy, 173'	dol, m gy, f Xl, arg, 155'	ls, m dk gy, arg, m Xl, 78'								
gr,	ls, dk gy, f gr, arg, 461'	ls, dk gy, arg, Fe, f gr, 475	ls, m gy-dk yel orng, arg, Fe, 130'									
& sh	ls, m lt gy, Fe, pis & ool, 239'	dol, altng lt & dk m-c Xl, 1,373'	dol, m lt gy, fn Xl, 39'	ls, m gy, bioclas, ool, arg, 183'								

d Maher, J. C., 1957,
descriptions: Am. Assoc.
2103-2107

comprise 70 to 90 per cent of the rock which can best be described as an organic hash. Some of the fragments show partial recrystallization. These deposits of fragmental shell material are for the most part representative of a thanatocoenose and are therefore of little ecologic use. Nevertheless this rich fossil fauna testifies to an abundance of life throughout Orr deposition. The seas were generally more shallow than during the deposition of the preceding Weeks limestone, and bedding planes, especially in the upper part of the formation in the House Range, exhibit well-preserved oscillation ripple marks. Laminations are not common except in the lower part of the formation in the Wah Wah Range.

In the Wah Wah Range and especially in the Silver Island Mountains, recrystallization and dolomitization altered the sediments. At Silver Island post-diagenetic alteration recrystallized the sediments and changed some of the sediments to marble.

The Orr formation, deposited during the second half of the Dresbachian stage, is correlative with the Hicks formation in the Deep Creek Range, with the upper half of the Opex dolomite in central Utah, with the upper half of the Nounan limestone in northern Utah, and with the upper part of the Highland Peak limestone and lowermost part of the Mendha limestone at Pioche, Nevada. The Orr formation is also equivalent to the upper half of the Hamburg dolomite at Eureka, Nevada, and to the upper part of the Yucca Flat formation at the AEC Proving Grounds, Nevada.

Hicks Formation (restricted)

Nolan (1930, Wash. Acad. Sci. Jour., 5th, v. 20, no. 17, pp. 421-432, quoted in Wilmarth, 1938, p. 951) defined the Hicks formation from the type area at Hicks Gulch, in North Pass Canyon, Gold Hill district, Utah. Nolan measured 1200 feet at Gold Hill, but 3½ miles to the north he found only 600 feet (Nolan, 1935a, p. 14). Nolan attributes this difference in thickness to the presence of a possible unconformity at the top of the Hicks formation. The formation in the Deep Creek Range where I measured it is 600 feet thick. The overlying Dunderberg shale was originally included in the Hicks formation, but in the Deep Creek Range this would only amount to an additional 30 feet.

Oolitic and pisolitic dolomite comprises the basal 227 feet of the formation. This is overlain by an alternating limestone and shale unit. The limestone consists of trilobite and inarticulate brachiopod fragments and occurs in beds one half to three inches thick. The shale is dark greenish gray and is composed of silt-size particles of quartz and calcite.

Microscopically the Hicks formation strongly resembles the Orr formation. Both formations are characterized by abundant bioclastic material. Both formations appear to have been deposited originally as fine-grained lime mud. Pisolite and oolite beds are common to both formations as are also small quartz grains. The Hicks formation apparently was deposited under environmental conditions similar to those of the Orr formation. However much of the formation has partially recrystallized since deposition. The Hicks formation is almost the exact age equivalent of the Orr formation and is upper Dresbachian. Because of their lithic similarities and age relationships, I recommend that the Orr formation and the underlying Weeks limestone be extended to other areas of similar lithology in preference to the Hicks and Lamb formations.

Opex Dolomite (restricted)

Lindgren and Loughlin (1919) defined the Opex dolomite of the Tintic district, Utah, as a poorly exposed gray dolomite and shaly limestone. They designated as the type area the saddle west of Eureka Peak. I measured and described the formation at three localities--at the type area, in the Oquirrh Mountains near the town of Ophir, and in the Stansbury Mountains. At Tintic I designated the uppermost shale and limestone unit of Lindgren and Loughlin as the Dunderberg shale. Devonian or Mississippian dolomite unconformably overlies 175 feet of Opex dolomite at Ophir. The unconformity is in many places difficult to establish. There is no appreciable change of attitude between the Opex dolomite and the overlying beds. The unconformity can be distinguished upon close examination, however, as an irregular erosion surface.

The limestone is oolitic and in many places pisolitic. The pisolites are argillaceous and are composed predominately of silt-size, sub-angular to sub-rounded quartz grains. Intraformational conglomerate beds are common to the formation, especially in the Stansbury Mountains.

The writer agrees with Rigby (1952, p. 140) that the Opex dolomite represents shallow water marine deposition and was originally deposited as fine detrital material. The intraformational conglomerate beds common to the upper Opex dolomite indicate vigorous current and

wave action. Rigby compares the environment of deposition with that of the shelf area of the Bahama Banks which surround the Tongue of the Ocean and Andros Island (Newell, et al, 1951, pp. 13-15). Extensive deposition of lime mud is forming mud flats near or somewhat below sea level. Dessication cracks develop on the mud flats and separate polygons are often transported great distances. In this manner excellent flat pebble intraformational conflomerates are being formed. Locally large dunes of drifting oolites have developed on the banks outside the mud area. A gradual shifting of these lithotopes could produce intertonguing deposits of oolites, intraformational conglomerate beds and fine clastic lime mud, closely resembling the lithology of the Opex dolomite.

A considerable amount of work has been done on the Opex dolomite at other locations in central Utah. Clark (1953, p. 14) measured 303 feet of Opex at Long Ridge. Other writers' (Clark, 1953; Madsen, 1952; Peacock 1953; Peterson, D. O., 1953; and Peterson, H. N., 1953) measurements at Long Ridge vary from 159 feet to 477 feet. Such a wide range in measurements may be due to placing formation boundaries at different horizons by different writers or to the unconformity which in many places overlies the Opex dolomite. At West Mountain measurements have varied from 220 feet to 472 feet. In the Sheeprock Mountains Cohenour (1957, pp. 69-70) measured 938 feet of limestone which he designated the Opex dolomite. However this interval is not an exact age equivalent of the Opex in other localities. The uppermost 104 feet of the formation (Cohenour, 1957, Appendix, p. 38) contains fossils from the Elvinia and Conaspis zones of lower Franconian age. Underlying this unit are shale units of 15 feet and 12 feet separated by a five-foot dolomite unit. This shale zone corresponds in age and stratigraphic position with the Dunderberg shale. This readjustment would leave 902 feet in the Opex dolomite in the Sheeprock Mountains. Johns (1940, p. 41) measured 700 feet of Opex dolomite at Twelve Mile Pass, North Tintic district. White (1953, p. 53) measured 307 feet of the White Lake Hills, between West Mountain and Long Ridge, and Rigby (1952, p. 12) measured 354 feet at the Selma Hills in western Utah County.

The Opex dolomite is of Dresbachian age and closely equivalent to the Weeks and Orr formations and to the Lamb and Hicks formations. It is also correlative with the Nounan limestone of northern Utah and with the Hamburg dolomite of Eureka, Nevada.

Figure 4 is an isopach map of the Dresbachian formations of the eastern Great Basin. The area of greatest subsidence was apparently in western Utah. I believe the thinness of the formation at Silver Island and to a lesser extent in the Stansbury Mountains to be due to activity along the Uinta Positive area.

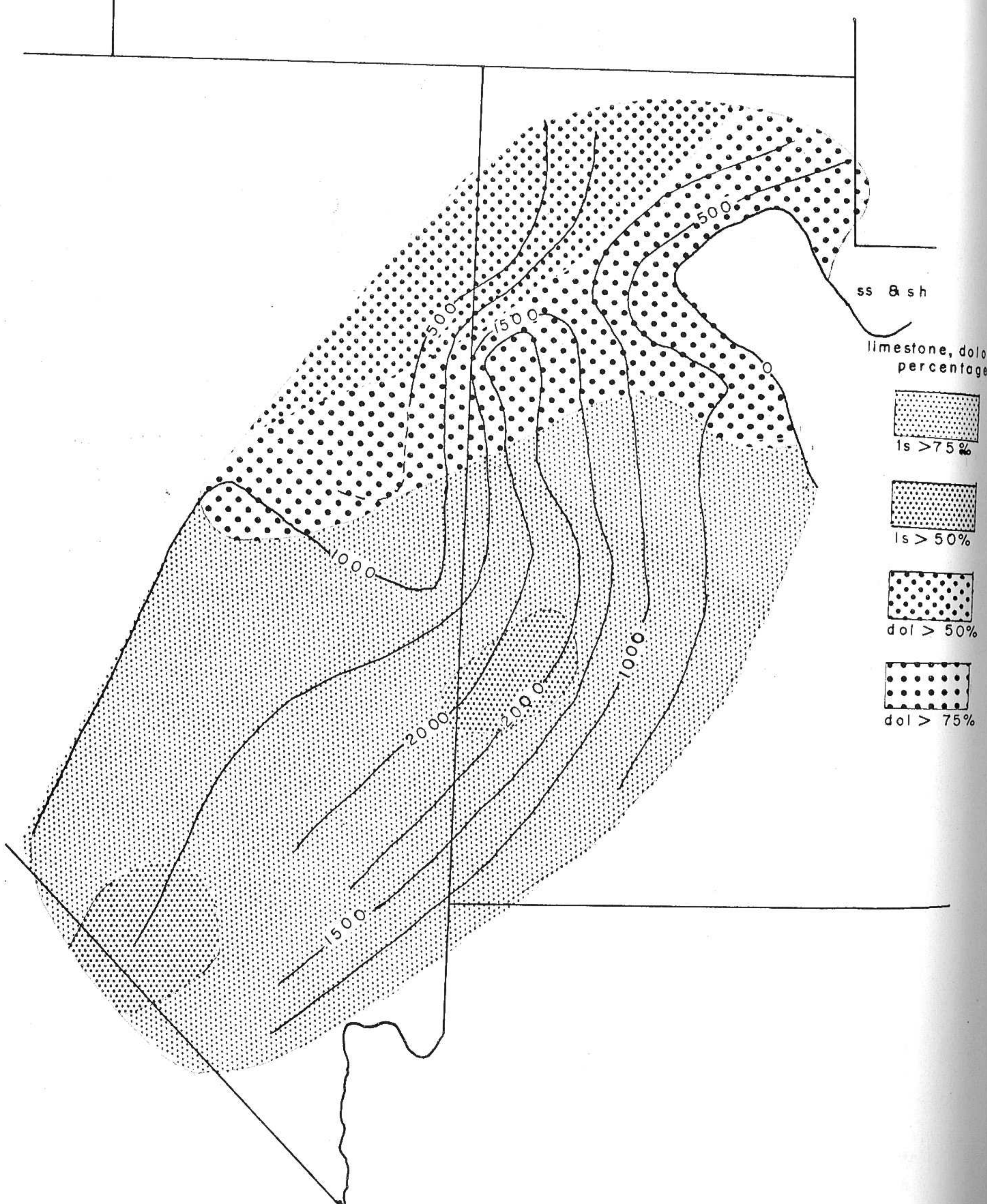

FIGURE 4. Dresbachian Isopach Map of the Eastern Great Basin

Dunderberg Shale

Originally designated by Arnold Hague (1833, pp. 253, 255-256) as the Hamburg shale, the formation was renamed by Walcott (1908b, p. 184) as the Dunderberg shale for exposures opposite the Dunderberg mine, near Eureka, Nevada. A relatively thin but extensive shale unit of similar age extends into western Utah and can be recognized as far east as Long Ridge in central Utah. I propose that this shale unit be recognized as a formation in western Utah and that it be designated as the Dunderberg shale.

Complete sections of the Dunderberg shale were measured and described at the following localities: House Range, Fish Springs Range, Wah Wah Mountains, Deep Creek Range, Silver Island Range, Stansbury Range, and Tintic district.

The formation consists of very fissle, yellow-brown, olive-gray, or greenish gray shale, usually interbedded with bioclastic limestone. In thin-section the shale is seen to consist of clay-size or fine silt-size subangular to subrounded quartz grains. Most of the grains exhibit undulatory extinction and many contain minute inclusions or dust, features generally indicative of igneous quartz.

The Dunderberg shale represents an abrupt lithic and faunal change widespread throughout the Cordilleran region. This change was probably brought about by extensive regional upwarpings of the positive areas accompanied by exposure of broad areas of the shelf (Lochman-Balk, 1956c, pp. 260-650). The Dunderberg shale with its equivalents elsewhere ". . . is the most persistent faunal and lithic unit presently known in the Middle and Upper Cambrian of the Great Basin. Although ordinarily less than 200 feet thick, it is present in the Upper Cambrian part of all known sections of the southern subprovince either as a sandy interval or as a shaly interval usually with fossiliferous limestone interbeds. It is also recognized in most of the sections of the northern subprovince." (Palmer, 1956, p. 669).

The Dunderberg shale is basal Franconian and is equivalent to a sandstone, shale and limestone unit approximately 600 feet above the base of the Mendha limestone at Pioche, Nevada (Westgate and Knopf, 1932, p. 13). The Dunderberg shale is found in the Snake Range, Nevada, where Drewes and Palmer (1957, p. 115) chose to call it the Corset Spring shale. Although they correlated it with the Dunderberg shale of Eureka, Nevada, and found basal Franconian fossils, they designated it as Trempealeauan (Drewes, 1958, p. 227). Underlying the Corset Spring shale is 288 feet of limestone which they designated the Johns Wash limestone (Drewes and Palmer, 1957, p. 115) supposedly of Upper Franconian and basal Trempealeauan age. I can agree with neither their dating, which evidently is in error, nor with the nomenclature employed. It is unfortunate that Drewes and Palmer elected to originate a completely new set of terms for units that can be correlated both lithologically and paleontologically with formations in nearby areas. I feel that their formation names, at least those for the Upper Cambrian, should be suppressed and the section renamed with either Eureka district or House Range terminology.

The Dunderberg shale is also correlative with the Worm Creek quartzite member of the St. Charles formation of northern Utah. The Worm Creek quartzite generally consists of quartzite, sandstone, and limestone variable in thickness from 60 to 200 feet (Haynie, 1957, p. 5). However as the member is followed westward, the quartzite gradually gives way to shale. At Calls Fort, north of Brigham City, the unit is 60 feet thick and capped by two feet of green shale (Haynie, 1957, p. 11), and at Promontory Point 67 feet of the member is present, 15 feet of which is shale (Haynie, 1957, pp. 6, 11, 18-19). Young (1955, p. 94) near the middle of the Lynch dolomite at the Lakeside Mountains encountered 117 feet of interbedded silt, limestone, sandstone, and dolomite.

The easternmost occurrence yet reported of this clastic unit in central Utah is at Long Ridge, where Madson (1952, p. 39-40) found 20 feet of sandstone with dolomite lenses and intraformational conglomerate at the top of the Opex dolomite.

Olson (1956, pp. 47-48) was the first to use the Dunderberg shale in Utah when he designated 378 feet of argillaceous siltstone and limestone in the Promontory Range as Dunderberg. The formation as used by Olson is not equivalent to the Dunderberg shale of Eureka, however, and might not even be Upper Cambrian. Overlying this formation in the Promontory Range is 3800 feet of Upper Cambrian (undifferentiated) dolomites and limestones, 1160 feet below the top of which occurs the Worm Creek quartzite member (Olson, 1956, pp. 48-49). Haynie (1957, pp. 18-19) affirmed Olson's Worm Creek designation. Since the Worm Creek is the same age as the Dunderberg shale of Eureka, it is obvious that Olson's Dunderberg shale is a misnomer and should not be used.

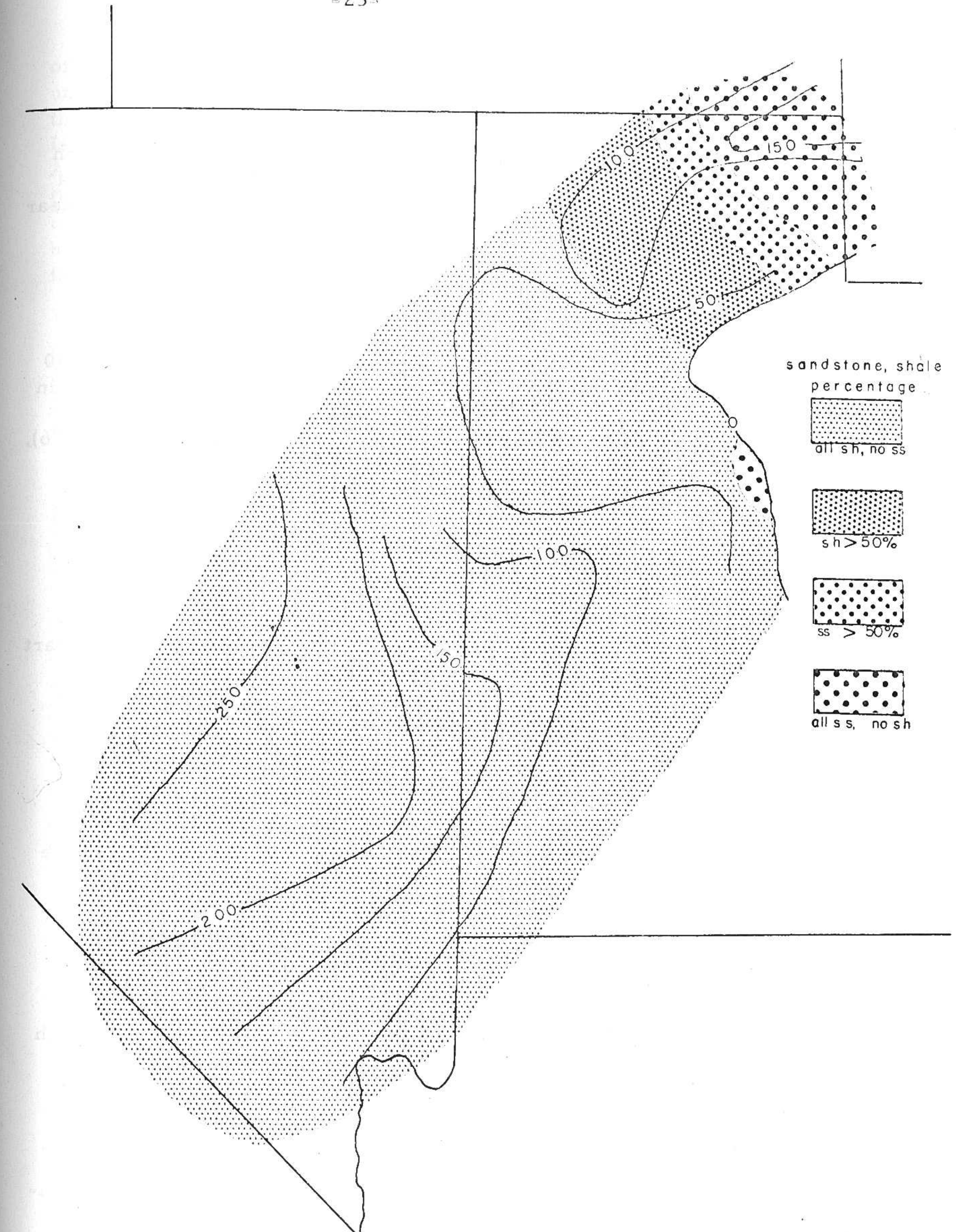

FIGURE 5. Isopach Map of the Dunderberg shale

The isopach map (fig. 5) shows the irregular and variable thickness of the Dunderberg shale wherever it has been measured. The map also includes the Worm Creek quartzite member in northern Utah. The thicknesses together with the lithic relationship indicate a source area to the northeast. The coarser clastics were deposited near shore and the silts and clays farther out into the miogeosyncline.

Notch Peak Limestone

Walcott (1908a, p. 9) named the Notch Peak limestone for 1490 feet of massive gray, arenaceous limestone above the Orr formation in the House Range. Walcott, however, included 375 feet above the Dunderberg shale with the Orr formation (Walcott, 1908b, pp. 175-176), which I have included in the Notch Peak limestone on the basis of lithology. Walcott claimed to have found Ordovician fossils on top of Notch Peak (1908b, p. 173) one of which was Eorthis, now considered to be Upper Cambrian. Robison identified Eurekia from the top of the peak which is definitely diagnostic of the Upper Cambrian.

I measured a complete section of Notch Peak limestone in the House Range and in the Silver Island Range. In the Wah Wah Range part of the formation has been removed by erosion, leaving approximately 1000 feet present along the crest of the range. A complete section of Notch Peak limestone probably exists in the Fish Springs Range, but was not measured because of structural reasons and because of inaccessibility. The Chokecherry dolomite, originally described by Nolan in the Gold Hill district is present in the Deep Creek Range. This formation as mapped by Bick in the quadrangle south of the Gold Hill quadrangle is equivalent to both the Notch Peak limestone and the Pogonip group of lower Ordovician age. The Cambrian part of the formation consists essentially of thick- to massive-bedded dolomite, and the Ordovician part consists of thin-bedded, yellow-brown argillaceous limestone typical of the Pogonip group. Because this formation can easily be broken down into two distinct lithic types separated by major time boundaries, I propose that the Chokecherry dolomite as mapped by Bick on the crest of the Deep Creek Range south of the Gold Hill district be renamed the Pogonip formation for the Ordovician part and Notch Peak for the Cambrian.

The Notch Peak limestone was deposited as a fine clastic lime mud, which upon lithification, produced a limestone ranging from sublithographic to fine- and occasionally medium-grained. Intraformational conglomerate beds found at various horizons in the formation

offer mute testimony to the sometimes vigorous current action and unstable crustal conditions that recurred throughout the deposition of the formation. Dolomitization altered the sediments in the Silver Island Range, Wah Wah Range and especially in the Deep Creek Range. Algal heads, seven to ten inches in diameter are present in at least three horizons in the formation. These, when seen from above resemble large mud cracks, but on the surfaces perpendicular to the bedding they frequently can be seen to have a depth as great as two feet or more.

Probably the most characteristic feature of the Notch Peak limestone is the presence of chert, especially in the lower half of the formation, generally in the form of nodules. Chert is common in other formations of the same age of the Great Basin from central Utah to central Nevada. Nolan (1956, p. 21) reports the occurrence of chert at approximately the same age at Antelope and Eureka, Nevada, and states that the chert zones may be of wide geographic occurrence and of importance stratigraphically. The origin of chert has been the source of considerable speculation for a good many years. In general there are three main theories as to its origin. The first states that chert, especially the nodular type, is a diagenetic segregation. The second claims that cherts are silica reinforcements of special rocks, i. e. silicified diatomite, silicified tuff, or silicified limestone. The third theory states that chert is inorganically precipitated silica (Pettijohn, 1957, pp. 439-444). It is quite possible that two or even all three of these have served as modes of origin of chert. However, because of the wide stratigraphic extent of the chert zones in the Upper Cambrian of this area, I believe the chert was either precipitated directly from sea water at the time of deposition or was a stratigraphically controlled product of replacement during early diagenesis. Most authorities favor the latter explanation for nodular chert (Pettijohn, 1957, p. 439).

The Notch Peak limestone is middle and upper Franconian and Trempealeauan and is a correlative of the Ajax limestone of central Utah, the Windfall formation of Eureka, Nevada, the middle and upper part of the Mendha limestone of Pioche, Nevada. The formation is also equivalent to that part of the St. Charles formation above the Worm Creek quartzite member of northern Utah and with the strata at the AEC Proving Grounds, Nevada, designated as Upper Cambrian rocks, which overlie the Dunderberg shale and underlie the Pogonip formation.

Ajax Limestone

Lindgren and Loughlin (1919, pp. 31-32) named the Ajax limestone of the Tintic district, Utah, for 560 to 570 feet of dolomite and dolomitic limestone exposed near the Ajax mine. They measured a lower member, 90 feet of dolomite; a middle or Emerald member, consisting of 30 to 40 feet of cream-white dolomite; and an upper member, 440± feet thick consisting of dolomitic limestone. I measured 698 feet at Tintic, 130 feet more than obtained by Lindgren and Loughlin. However, Morris (1957, p. 9) claims the thickness ranges from less than 500 feet to 730 feet.

The Ajax limestone was deposited as a fine lime mud near the eastern edge of the miogeosyncline. Nodular chert, though not as abundant as that in western Utah, is common throughout the formation. Dolomitization has altered most of the original composition and texture of the carbonate rocks. Other workers have measured and described the formation throughout central Utah. Cohenour (1957, p. 74) measured 1012 feet of Ajax. However, 104 feet at the top of the Opex should be added to that thickness for correlation purposes (see p.19, this paper). At Twelve Mile Pass, Johns (1950, p. 43) measured a thickness of 738 feet. Rigby (1952, pp. 15, 89-90) measured 461 to 473 feet. Various writers at Long Ridge have reported thickness varying from 310 to 536 feet. At West Mountain the formation is missing by Devonian erosion.

The Ajax limestone is middle and upper Franconian and Trempealeauan, the same age as the Notch Peak limestone. Lindgren and Loughlin (1919, pp. 31-32) originally defined the formation as Ordovician. Morris (1957, pp. 5 & 9) at Tintic found Eorthis at the base of the formation and Eurekia at the top and assigned a late Upper Cambrian age to the formation. The isopach map (fig. 6) of the post-Dunderberg deposition shows the thickness of the Ajax limestone, Notch Peak limestone, and equivalent formations of the eastern Great Basin. The thickest sections are at the AEC Proving Grounds and in the House Range, showing the general trend of the axis of the miogeosyncline and the areas of greatest subsidence. The influence of the Uinta Positive area can be seen in the thinning of the sediments westward from the location of the present Uinta Mountains.

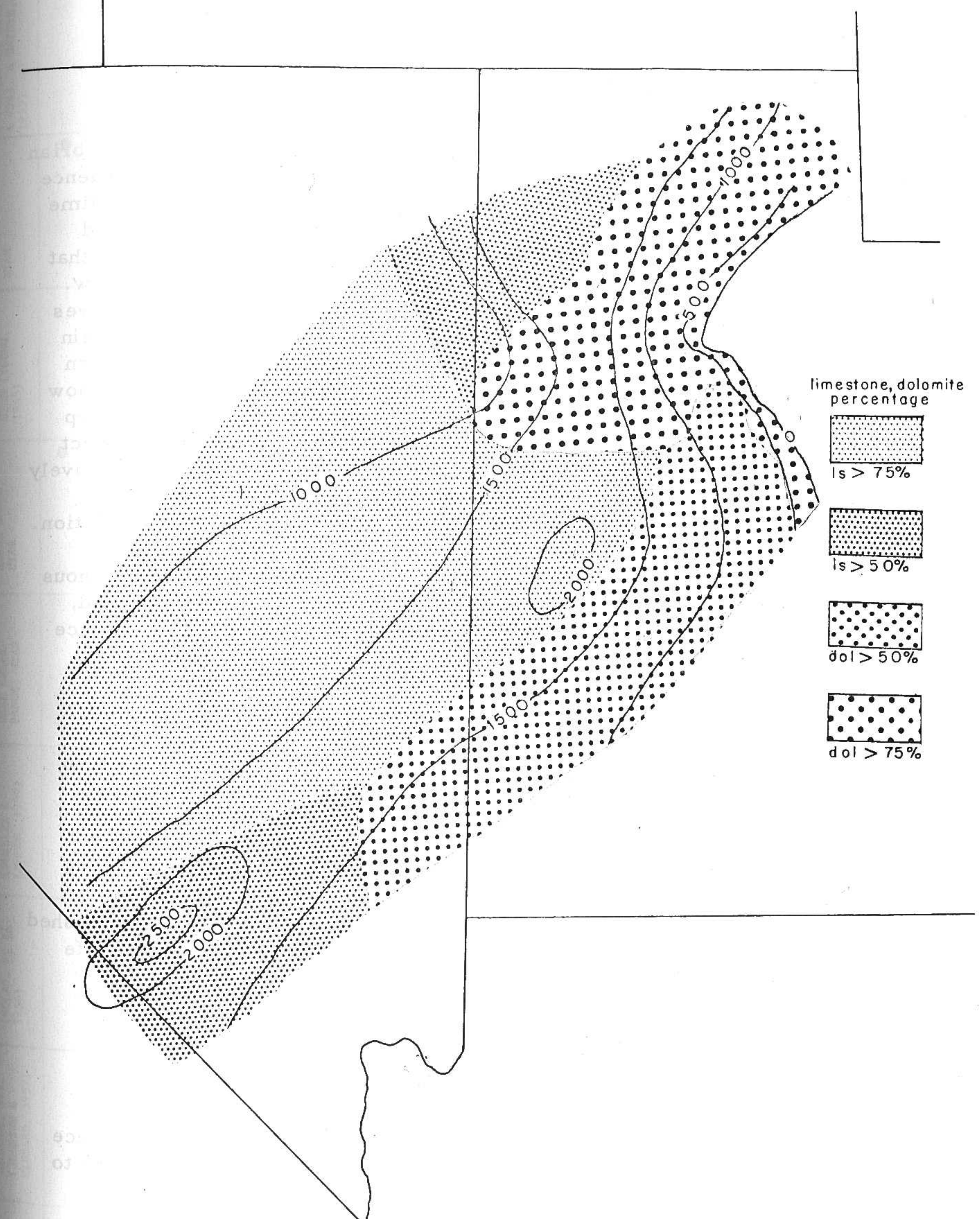

FIGURE 6. Post-Dunderberg Isopach Map of Eastern Great Basin

CONCLUSIONS

The sediments deposited in western Utah during Upper Cambrian times consisted of fine, clastic lime muds. This monotonous sequence was interrupted occasionally by the deposition of coarser grained lime or by clay. Such an accumulation of clastic lime mud is unique and strongly suggests an unstable depositional environment. I believe that the rate of sediment supply and the rate of subsidence were both low. Under such conditions detritus would have been shifted about by waves and currents for long intervals before coming to final rest (Krumbein and Sloss, 1956, p. 353). The source area lay to the east in eastern Utah and western Colorado and was generally an area of relatively low relief. Seas were generally shallow, probably less than 50 feet deep in most instances. Bottom sediments were almost constantly subject to disturbance and redistribution by current activity. Locally relatively deep water areas, possibly of infraneritic depths, prevailed, and sediments were laid down in fine laminae undisturbed by current action.

During early Dresbachian times varying amounts of ferruginous clay deposited with the lime indicates that erosion, though not rapid, was more active, possibly due to minor tectonic activity in the source area. During the latter half of the Dresbachian, however, the seas were generally clear, and limestone containing large amounts of bioclastic material accumulated.

Considerable tectonic activity of the positive areas ushered in the Franconian, elevating extensive stretches of shelf areas above water. This brought about a thin but widespread deposition of sand near shore, and silt and clay farther out into the miogeosyncline. Preceding and during this shale and sand deposition, organisms were exceedingly abundant. With the resumption of carbonate deposition, however, the seas were all but lifeless. Locally a few faunas flourished briefly, but never again in the Cambrian did the seas abound with life as they had in Dresbachian times.

A noticeable characteristic of the post-Dunderberg rock throughout the eastern Great Basin is the presence of chert nodules and less frequently, chert bands. The widespread stratigraphic occurrence of the chert strongly suggests that, whatever its origin, its deposition or emplacement was stratigraphically controlled. Since the weathering of feldspars and other silicates is generally believed to

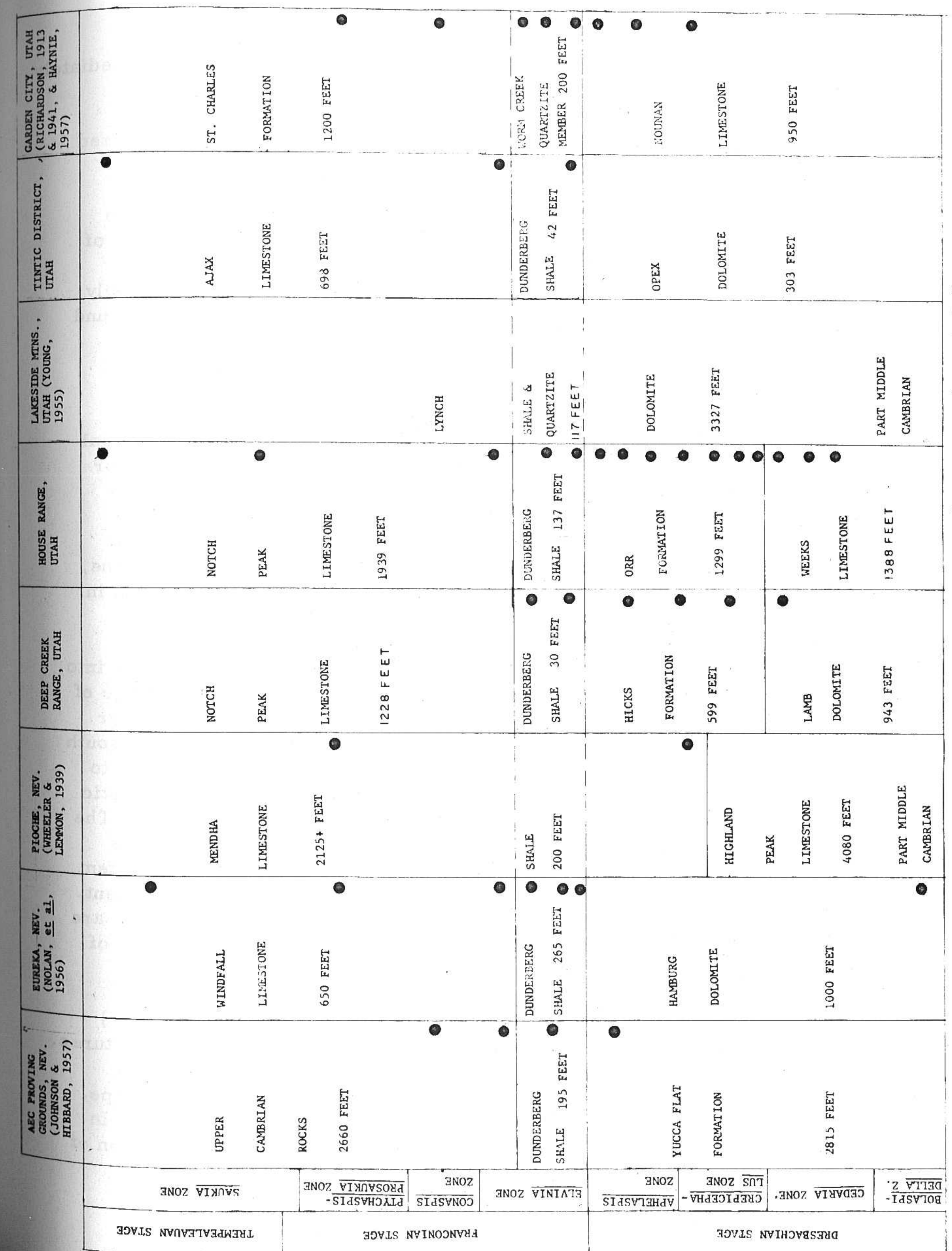

FIGURE 7 CORRELATION CHART OF EASTERN GREAT BASIN UPPER CAMBRIAN FORMATIONS

● VERIFIED BY FOSSILS

be the origin of most chert, the presence of chert in the rocks immediately following the Dunderberg activity is significant though not clearly understood. The acidic rocks could have accompanied the tectonic activity or older rocks were exposed to the elements by the revitalized forces of erosion.

Alteration principally in the form of dolomitization played an important role in transforming the original composition and texture of the sediments. I believe this can mostly be accounted for by early diagenetic (penecontemporaneous) replacement. A few areas, notably in the Silver Island Range, were altered following diagenesis by ground waters or by hydrothermal solutions.

The isopach maps show the general boundaries of the miogeosyncline. The Upper Cambrian isopach map defines quite accurately the western boundary, which separates the miogeosynclinal sediments from those of the eugeosyncline. The eastern boundary or shore line is more difficult to define due to removal of sediments by erosion. The general thinning of the sediments toward central Utah indicates that the Upper Cambrian shore line was in eastern Utah or possibly in western Colorado. The 100 feet of Dresbachian sandstone, silt, and sandy shale reported by Lochman-Balk (1956a, pp. 62-63) in the western Uinta Mountains contributes additional evidence.

Palmer (1956, pp. 669-670) divides the eastern Great Basin into two subprovinces, northern and southern, on the basis of percentage of detrital sediments. The northern subprovince has more than ten per cent detrital sediments in the sections, and the subprovince to the south has less than ten per cent. I am not able to contribute a great deal to this division, as all sections measured with the exception of the Tintic district and the Wah Wah Range, fall in the northern subprovince. The two exceptions are practically on Palmer's boundary separating the northern and the southern subprovinces, and do not differ to any extent from the other sections as to the amount of detrital sediments present. However, my sections which fall in Palmer's northern subprovince are generally at least ten per cent detrital, which agrees with that part of his conclusions.

Microscopic examination of thin-sections (see Plates IV & V) proved valuable in the determination of granular and crystalline textures. In many instances, original textures, fossil fragments, and oolites, obscured by recrystallization, were observable under the microscope, thus revealing original textures and constituents of the sediments. In addition, thin-sections made possible a more accurate determination of the lithic composition of the rock.

PHOTOGRAPHS OF THIN SECTIONS

Explanation of Plate IV

1. Bioclastic limestone from unit 3 of Orr formation, Fish Springs Range; 305 feet above the base of the formation. Magnified 20 times; plain light.

2. Bioclastic and clastic limestone from the Dunderberg shale in the Deep Creek Range; 15 feet above the base of the formation; magnified 20 times; plain light.

3. Bioclastic limestone and algal remains from unit 11 of the Orr formation in the Wah Wah Mountains; 1000 feet above the base of the formation; magnified 20 times; plain light.

4. Oolitic dolomite from the base of the Hicks formation in the Deep Creek Range. Fine-grained oolites are enclosed in a crystalline dolomite matrix. Magnified 20 times; plain light.

5. Interbedded fine-grained limestone (light) and silty shale (dark), from unit 2 of the Hicks formation, Deep Creek Range; 260 feet above the base of the formation. Magnified 20 times; plain light.

6. Crystalline limestone from unit 5 of the Orr formation, Wah Wah Mountains; 310 feet above the base of the formation; magnified 20 times; plain light.

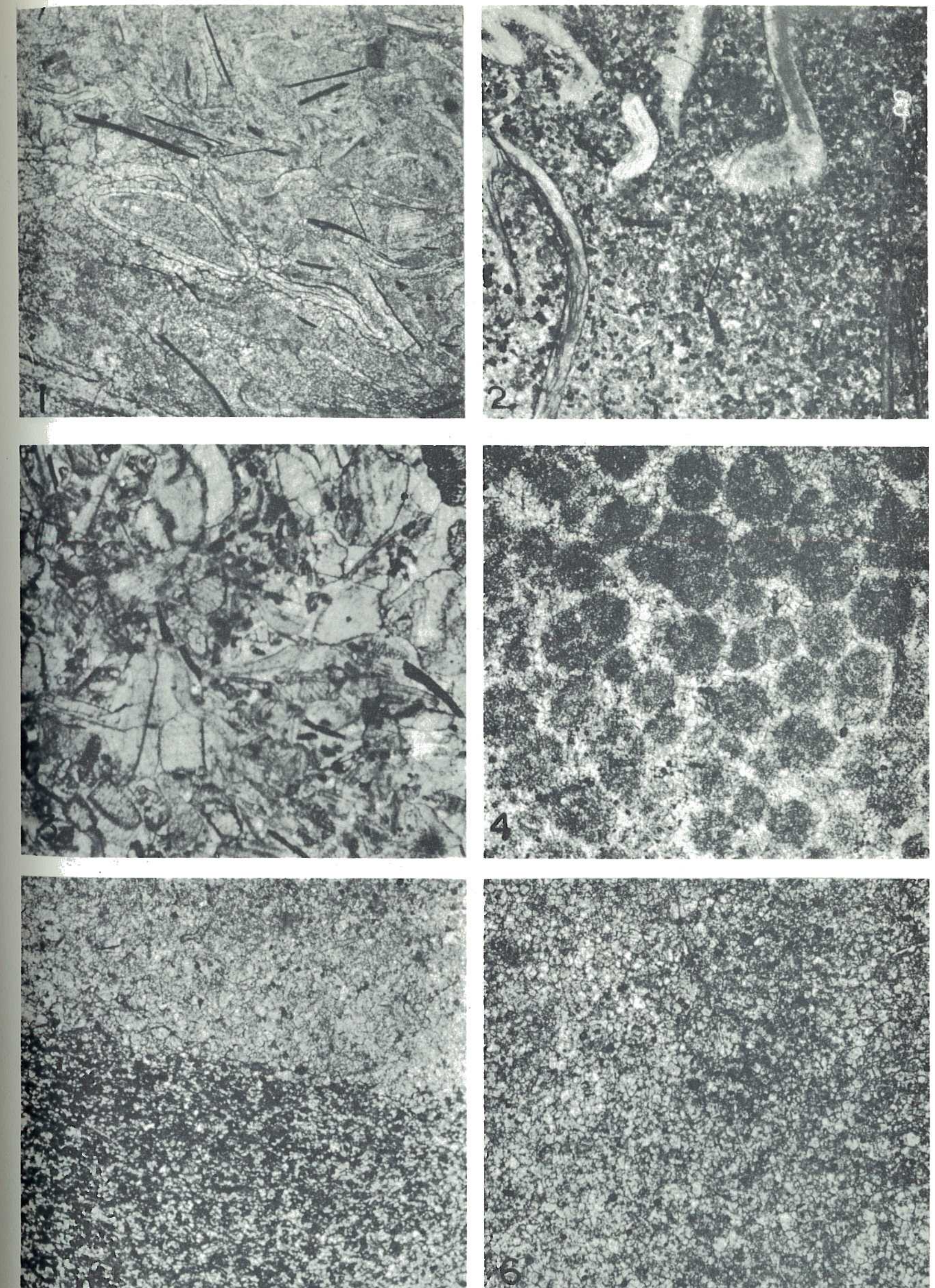

Plate IV.

Explanation of Plate V

1. Pisolitic and oolitic dolomite from unit 2 of the Opex dolomite at Tintic district; 160 feet above the base of the formation; magnified ten times; plain light.

2. Laminated limestone; fine-grained limestone (light) and ferruginous clay (dark) from unit 2 of the Weeks limestone, House Range; 180 feet above the base of the formation; magnified 20 times; plain light.

3. Chert containing small fragments of quartz and free rhombs of dolomite from unit 3 of the Notch Peak limestone, Deep Creek Range; 775 feet above the base of the formation; magnified 50 times; plain light.

4. Partially recrystallized limestone; free rhombs of dolomite in a granular limestone matrix, from the top of the Lamb dolomite in the Deep Creek Range; magnified 50 times; plain light.

5. Fine-grained limestone with subangular to subrounded quartz grains and fossil fragments from the Dunderberg shale in the Wah Wah Mountains; magnified 20 times; plain light.

6. Bioclastic limestone partially recrystallized from unit 9 of the Notch Peak limestone, Silver Island Range; 1030 feet above the base of the formation; magnified 20 times; plain light.

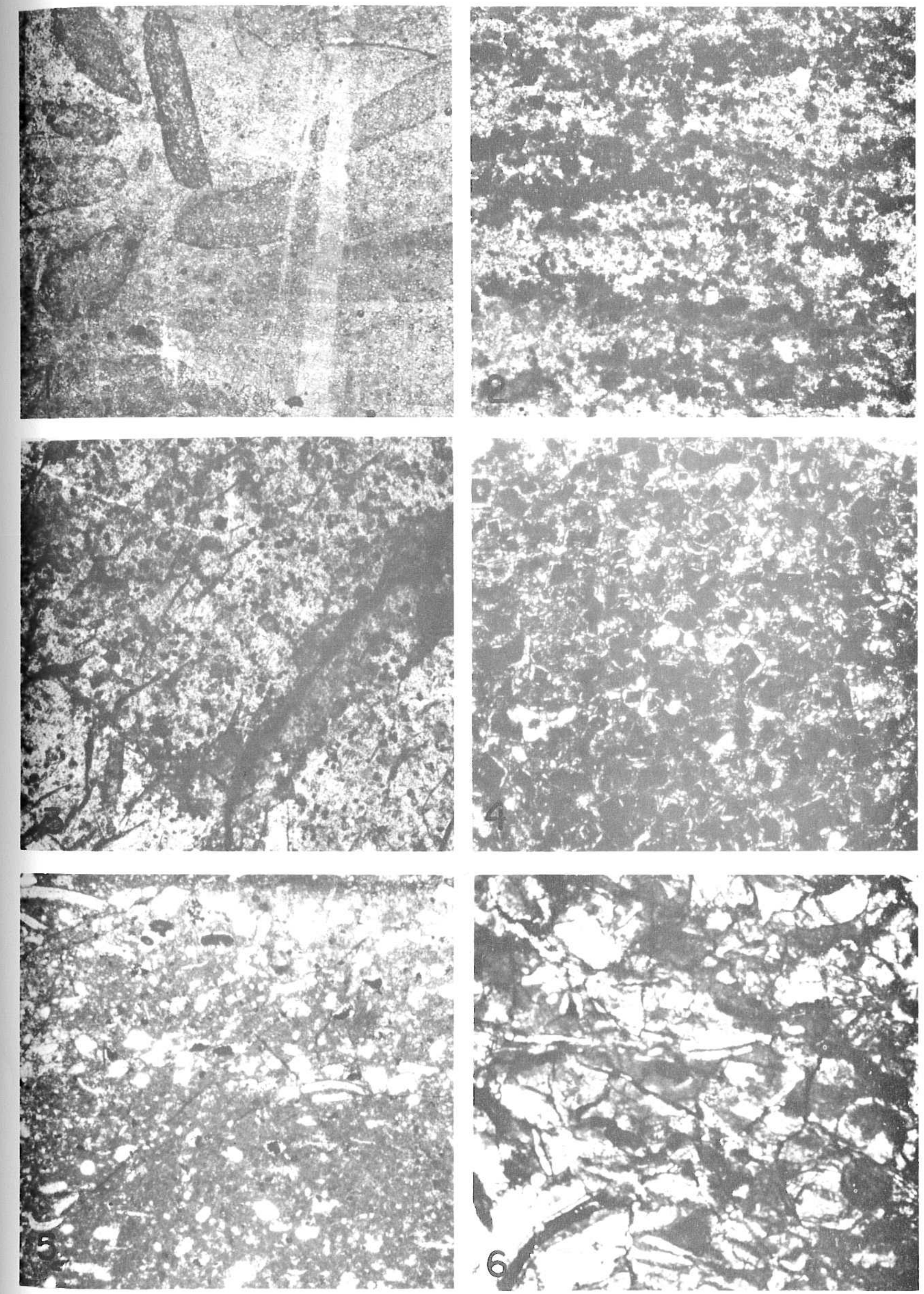

Plate V.

APPENDIX

Measured Sections

House Range--A composite section was measured in four parts--the Weeks limestone was measured at Weeks Canyon in a north-south traverse beginning with the wavy beds 170 feet below the base of the massive cliff two and one-fourth miles south-southwest of Marjum Pass and extending southeast to the massive brown limestone ledges on the south side of Weeks Canyon; the Orr and Dunderberg formations measured in a north-south traverse from the nose of Orr Ridge to the base of the massive gray cliffs; the lower half of the Notch Peak limestone was measured from the head of an unnamed canyon south of Granite Canyon in a southwest direction up Notch Peak, thence offset and continued in a northwest direction to the summit of the peak; the upper half of the Notch Peak limestone was measured in a southwest traverse five miles northeast of Skull Rock Pass in T 20 S, R 13 W, to the base of the House limestone northeast of Skull Rock Pass.

Upper Cambrian

Notch Peak limestone (top)	Thickness in feet
Limestone: light gray, weathers medium light gray, fine-grained, medium-bedded. Chert bands 1 to 2 in. thick, 6 in. apart parallel bedding except for 30 ft. interval 45 ft. from base. Algal heads 8 to 10 in. in diameter occur 20 ft. from top. Unit forms ledges with meringue-weathered surfaces.	124
Limestone: medium gray, weathers medium dark gray, fine-grained, thin bedded but weathers thick. Cherty and arenaceous patches abundant through unit. Unit forms ledges with meringue-weathered surfaces.	168

Limestone: medium light gray with brown tint, weathers tan and medium dark gray with dark brown chert layers 1/8 to ¼ in. thick, ½ in. apart, fine-grained and bioclastic (50% fossil frags.), thin-bedded, cross-bedded in places. Unit forms ledges with sucrose, meringue-weathered surfaces. 239

Limestone: medium dark gray, weathers same, fine-grained, thin- to medium-bedded. Unit forms a slope with good outcrops, surfaces meringue-weathered. 45

Limestone: light gray, weathers medium light gray, fine-grained, thick- to massive-bedded. Meringue weathered cliff-forming unit, lower contact gradational. 49

Limestone: medium light gray, weathers medium gray, fine- to medium-grained, thick- to massive-bedded. Abundant chert nodules 1 to 3 in. x 1 in. and algal heads throughout unit. Meringue-weathered, ledge-forming unit. 44

Limestone: medium dark gray, weathers medium gray with red argillaceous material on bedding planes, fine- to medium-grained, thin bedded, some chert nodules. Unit forms slope and breaks down into platy slabs.
Fauna: Eurekia sp. 16

Limestone: same as dark in underlying unit. Intrafm. cg. bed just below top of unit. 21

Limestone: alternating light and dark; dark: medium dark gray, weathers dark gray, fine-to medium-grained, massive-bedded; light: white, weathers very light gray with red streaks, fine- to medium-crystalline, appears highly altered. Alternating beds 2 to 10 ft. thick. Unit forms a cliff. 18

Limestone: light gray, weathers medium gray, very fine-grained, but fine to medium-grained at base,

massive bedded. Abundant chert nodules in lower half, oolite beds in upper half. Algal heads abundant 40 to 50 ft. from top of unit. Unit forms a cliff 400

Limestone: medium dark gray, weathers dark gray, very fine-grained, thin-bedded (wavy). Tan argil. material on bedding planes. Abundant chert nodules and calcite stringers throughout unit. Unit forms slope and weathers to meringue-weathered slabs. 15 ft. thick unit 15 ft. from base composed of very light gray limestone, weathers mottled light gray and medium gray, very fine grained. Distinctive wavy chert bands 1 to 2 in. thick 1 ft. apart. Forms sucrose, meringue-weathered ledge at base of unit. 137

Limestone: identical to underlying unit, but forms a cliff. Breaks down into blocky fragments. 197

Limestone: same as underlying unit, but thin, wavy-bedded. Alternates with massive-beds. Weathers with smooth undulating surface. Unit forms slope with poor outcrops. 162

Limestone: medium dark gray, weathers medium gray and light tan, sublithographic, thick bedded--beds 5 ft. thick with thin-bedded bands 8 to 24 in. thick in between often showing as white bands. Chert nodules in upper half. Meringue-weathered cliff forming unit with ledges at top and slope at base. 319

Total thickness of Notch Peak limestone 1939

Dunderberg shale (top) Thickness in feet

Limestone and shale interbedded: medium gray limestone, weathers same with tan argil. and pink aren. mottling, fine- to medium-grained, thin-bedded. Weathers with rough sucrose surface partially meringue-weathered. Shale identical to that in underlying unit.

Fauna: Cliffia lataegenae (Wilson)
Irvingella major Ultrich & Resser — 111

Shale: medium gray, weathers light olive brown, fissile inlaminae 1/8 in. thick, composed of fine silt-size grains. Forms covered slope with poor outcrops. Contacts at base and top of unit are obscure.
Fauna: Elvinia roemeri (Shumard)
Housia varro (Walcott) — 26

Total thickness of Dunderberg shale — 137

Orr formation (top) — Thickness in feet

Limestone: light gray, weathers same, fine-grained, massive-bedded. Limestone powders easily to fine flour-like powder, appears casehardened. Unit forms alternating ledges and slopes with smooth to pitted weathered surfaces. — 42

Limestone: dark gray, weathers dark gray with very light gray argil. partings giving zebra-bed effect, medium-grained, thin-bedded. Unit forms a meringue-weathered distinct 30-ft. cliff (marker unit). — 65

Limestone: medium dark gray, weathers tan to brownish gray, fine-grained, massive-bedded. Unit forms a steep slope with a 4-ft. ledge at the base. — 118

Limestone: dark olive gray, weathers medium dark gray, medium-grained, medium-bedded. Unit is highly weathered and porous with partially meringue weathered surface. Limestone is composed of approximately 25% fossil frags. Unit forms a slope with foot-high ledges occurring approximately every 30 ft. (slope distance) in the lower half, with the upper half entirely covered.
Fauna: Pseudagnostus communis (Hall & Whitfield) — 334

Limestone: medium dark gray, weathers tan on surface to dark gray on bedding planes, fine-grained, medium- to thick-bedded, meringue-weathered. Unit forms alternating ledges and slopes with a 31-ft. brown aren. ledge-forming interval at base.
Fauna: Tricrepicephalus coria (Walcott) — 145

Limestone: color and bedding similar to above unit, fine- to medium-grained with 25 to 50% bioclastic. Silt-size particles of quartz make up 1% of rock. Thin oolite beds run through unit.
Fauna: Tricrepicephalus coria (Walcott) — 252

Limestone: medium gray, weathers medium dark gray with brown argil. banding, medium-grained. Oolites and fossil frags. make up 25 to 50% of rock. Unit forms thick-bedded cliff with sucrose meringue-weathered surface along bedding planes.
Fauna: Crepicephalus n. sp.
Kingstonia walcotti Resser — 86

Limestone: light brownish gray, weathers medium gray on surface to light olive-gray through brownish black on bedding planes, fine-grained with 5% limestone frags. 2 mm. in diameter, thin-bedded, but weathers as thick-bedded ledge-forming unit with good outcrops. Argil. on bedding planes. — 66

Limestone: medium light gray with tan mottling, weathers medium gray with tan mottling, medium-grained, massive-bedded. Quartz grains less than ½ mm. make up 1 to 2% of rock. Unit forms alternating ledges and slopes with good outcrops. — 25

Limestone: medium gray, weathers same, fine- to medium-grained, thin bedded, weathers massive, sucrose. Unit forms alternating ridges and slopes with cliff at top.
Fauna: Genevievella campbellina Tasch
Kormagnostus simplex Resser
Maryvillia arion Walcott

Syspacheilus camurus Lochman
Tricrepicephalus coria (Walcott) 87

Limestone: light tan to dark reddish brown, weathers tan to medium gray, bioclastic, partly recrystallized, thick-bedded. Unit weathers with sucrose surface and forms broken cliffs with good outcrops. Base of this unit taken as the base of the Orr formation.

Fauna: Crepicephalus n. sp.
Genevievella campbellina Tasch
Holcacephalus tenerus (Walcott) 79

Total thickness of Orr formation 1299

Weeks limestone (top) Thickness in feet

Argillaceous limestone: medium gray with small red iron specks, weathers tan to dark reddish brown, fine-grained, thin-bedded. Unit forms alternating ridges and slopes covered with ½-in.-thick platy talus. Limestone becomes more argil. toward top and color grades to dark yellowish orange.

Fauna: Cedaria minor (Walcott
Deiracephalus multisegmentus (Walcott)
Holcacephalus tenerus (Walcott)
Tricrepicephalus coria (Walcott)

This interval subject to error 130

Limestone: dark gray, weathers in alternating bands of medium gray and tan, fine-grained, laminated, but weathers medium-bedded. Orange iron blotches found throughout unit. Toward top unit becomes argil. with the tan color predominating over the gray, forming gradational contact with overlying unit, in which gray has completely disappeared. Unit forms a slope with poor outcrops.

Fauna: Cedaria minor (Walcott)
Deiracephalus multisegmentus (Walcott)
Holcacephalus tenerus (Walcott)
Lonchocephalus plena Walcott

Oedorhachis typicalis Resser
Olenoides n. sp.
Tricrepicephalus coria (Walcott)

This interval subject to error 475

Talus covered slope: dark gray limestone talus similar to limestone of underlying unit. Unit forms gentle slope with no apparent outcrops.

Fauna: Cedaria minor (Walcott)
Tricrepicephalus coria (Walcott)
Weeksina n. sp.

This interval subject to error 461

Limestone: dark gray, with alternating argillaceous beds, weathers alternating light olive-gray and medium gray, fine-grained, laminated, but thick-bedded. Unit forms a cliff 50 to 100 ft. high with blocky and platy talus. Cliff is covered with white lichens giving it a white-washed effect. 151

Limestone: dark gray, weathers medium dark gray, fine-grained with thin elongate wollastonite crystals 1/8 to ¼ in. long through rock, thin- to medium-bedded, with some argillaceous bands, wavy-bedded. Calcite stringers and vugs run irregularly through unit. Unit forms ledges and steep slopes with blocky talus 171

Total thickness of Weeks limestone 1388

<u>Fish Springs Range</u>--A section was measured in a single traverse five miles north of Sand Pass on the easternmost salient of the Fish Springs Range, Millard County, Utah, in Secs. 10, 14 and 15, T 13 S, R 14 W (unsurveyed) as shown on the Fish Springs Quadrangle map. The traverse commenced approximately 1800 feet up the east face of the salient from the base of the massive-bedded vertical cliff overlying the Marjum formation to the base of the cliff-forming Notch Peak limestone overlying the thin fissile Dunderberg shale. The Notch Peak limestone was not measured.

Upper Cambrian

Dunderberg shale	Thickness in feet
Shale: light olive gray shale in lower half weathers yellow-brown, of clay-size grains, thinly-fissile. Upper half of unit consists of dark grayish green, weathers grayish green, thinly-fissile shale composed of clay-size grains. Unit forms slope with poor outcrops.	36
Total thickness of Dunderberg shale	36

Orr formation (top)	Thickness in feet
Limestone: light gray, weathers same, fine-grained with large, medium-crystalline calcite crystals in stringers making up five to ten per cent of unit. Unit is medium-bedded and heavily fractured. Fractures filled with calcite. Color grades upward to light tan. Unit forms vertical cliff.	41
Argillaceous limestone: medium dark gray, weathers dark gray and yellow gray on argil. bedding planes, thin-bedded, fine-grained. Unit contains oolite beds near top and calcite stringers throughout. Unit forms cliffs and ledges.	129

Limestone: medium gray, weathers brownish black, 50 to 75 per cent bioclastic in fine-grained matrix, thin-bedded. Unit forms slope with poor outcrops. Fauna: <u>Dunderbergia</u>? <u>granulosa</u> (Hall & Whitfield) <u>Geragnostus tumidosus</u> (Hall & Whitfield) <u>Labiostria conveximarginata</u>? Palmer	204
Limestone: medium gray, weathers medium gray to medium dark gray, fine- to medium-grained, thin- to medium-bedded with dark yellow-orange argil. material on bedding planes. Unit forms slope with poor outcrops.	99
Limestone: medium light gray, weathers medium to medium dark gray, medium-grained with 5% fossil fragments, thin-bedded. Unit forms sucrose, meringue-weathered cliff.	202
Total thickness of Orr formation	711

Weeks limestone (top)	Thickness in feet
Limestone: medium gray, weathers medium dark gray and yellow gray, with light brown argil. material on bedding planes, medium grained, thin- to medium-bedded; contains abundant oolites and bioclastic material. Unit forms meringue-weathered ledges.	183
Dolomite: medium light gray, weathers light gray with brown laminations, finely-crystalline, medium-bedded. Laminae stand out on surface as small ridges. Unit forms ledges.	39
Dolomite: alternating light and dark; light: light gray, weathers light olive gray, coarsely-crystalline, thick bedded; dark: medium gray, weathers same with brownish tint, medium-crystalline. Light and dark beds arranged in disorderly fashion and from distance unit appears brown. Sucrose, ledge-forming unit.	373

Limestone: medium light gray, weathers medium light to medium gray with rust colored stains. Lower 50 to 70 ft. contains abundant fine-grained pisolites and oolites in a medium-crystalline matrix. Rust colored stains are enclosed within many of the pisolites. Unit forms ledges. 239

Interbedded limestone and shale: medium light gray limestone weathers same, fine-grained, partially recrystallized, thick-bedded. Shale: medium dark gray, weathers dusky yellow, fine-grained, calcareous, thin-bedded, semi-fissile. Unit forms slope with good outcrops. 146

Limestone: medium gray, weathers medium dark gray and light olive-gray, fine-grained, massive-bedded. Unit contains abundant calcite stringers and twiggy bodies. Four medium light gray bands 2 ft. thick approximately 10 ft. apart occur near top of unit. Unit forms meringue-weathered cliff. 177

Total thickness of Weeks limestone 1157

Wah Wah Mountains--The base of Upper Cambrian is not exposed. The upper Notch Peak limestone is missing by erosion from the top of the range. An east-northeast traverse was measured up the southwest face of the prominent peak one mile north of Wah Wah Pass, Beaver County, Utah.

Upper Cambrian

Notch Peak Limestone Thickness in feet

Dolomite: medium gray, weathers same, fine-grained, partially recrystallized, massive-bedded, sucrose. Unit forms a sheer cliff at the top of the range. Top of unit missing by erosion. 100+

Dolomite: medium light gray, weathers medium dark gray, medium- to coarsely-crystalline, massive-bedded. Dolomite contains abundant twiggy bodies. Unit forms a sheer cliff. 163

Dolomite: very light gray, weathers same to light gray, fine-grained, partially recrystallized, massive-bedded. Two or 3 dark lenses of dolomite similar to that of underlying unit occur. Unit forms a sheer cliff and because of light color is a distinctive key unit 207

Dolomite: medium gray, weathers same with a slight brownish tint. From distance unit appears darker than underlying unit. Medium crystalline massive with cross bedding in places. Sugary texture. Cliff forming unit. 243

Limestone: medium gray, weathers same, sub-lithographic, medium- to thick-bedded with sucrose bands ½ in. thick ½ in. apart. Upper half of unit contains nodular chert and forms a sheer cliff. Lower 120 feet is a slope with good outcrops. 265

Total exposed thickness of Notch Peak limestone 978+

Dunderberg shale	Thickness in feet
Interbedded shale and limestone: medium light gray limestone, weathers medium dark gray, fine-grained, sucrose. Five per cent of limestone composed of sub-angular to sub-rounded quartz grains 1/10 to 1/5 mm. in diameter. Also contains 3% fossil frags. Shale: medium olive-brown, weathers light olive-gray, fissile. Shale composed of clay-size grains and 5 to 10% brown ferruginous material.	113
Total thickness of Dunderberg shale	113

Orr formation (top)	Thickness in feet
Limestone: medium light gray, weathers medium dark gray with dusky yellow aren. bands ¼ in. thick ½ in. apart composed of quartz grains 1/10 mm. in diameter. Similar quartz grains make up 3 to 5% of the limestone. Limestone is fine- to medium-grained, thin- to medium-bedded. Unit forms sucrose, meringue-weathered ledge which breaks down into platy fragments. Fauna: Aphelaspis? n. sp. Dunderbergia? granulosa (Hall & Whitfield) Labiostria species A.	73
Limestone: medium light gray, weathers medium gray, fine-grained oolites in fine- to medium-grained matrix, massive-bedded with scattered thin beds. Unit forms sucrose, meringue-weathered cliff.	86
Limestone: medium gray, weathers same, bioclastic, medium-bedded. Unit forms a slope with poor outcrops. Fauna: Coosina ariston (Walcott) Crepicephalus n. sp.	

Llanoaspis undulata Lockman Terranovella dorsalis (Hall) Tricrepicephalus coria (Walcott)	51
Limestone: medium gray, weathers dark gray, massive-bedded, with some thin-cross-bedded bands, sucrose, meringue-weathered. Limestone composed of 60% oolites in a fine-grained matrix. Unit forms a sheer cliff. Fauna: Coosina ariston (Walcott)	101
Limestone: medium gray, weathers same and yellow-gray, fine-grained, thick-bedded with occasional thin beds, meringue-weathered. Unit grades lighter upwards and becomes approximately 50% bioclastic with a medium-grained matrix. Fauna: Kingstonia walcotti Resser Maryvillia arion Walcott Unassigned pygidium A	171
Dolomite: medium light gray, weathers same, fine- to medium-grained, partially recrystallized, thick-bedded. Contains brown argil. staining. Surface weathers with sucrose texture. Unit forms ledges.	77
Limestone: alternating light and dark; light: light gray, weathers yellow-gray, fine-grained, partially recrystallized, beds 1 to 1½ ft. thick, laminated (laminae stand out as ridges on surface), sucrose; dark: medium gray, weathers dark gray, medium-grained, oolitic, beds 1 to 2 ft. thick, sucrose, meringue-weathered. Unit forms slope with good outcrops.	129
Limestone: medium gray, weathers same, fine-grained, thick- to massive-bedded, alternating with 2-ft. beds of limestone with arenaceous bands ½ in. thick and ½ in. apart, giving striped effect from distance. Contains abundant calcite stringers. Unit forms meringue-weathered ledges.	192
Limestone: medium light gray, weathers same, fine-grained, partially recrystallized in fine- to	

medium-sized crystals. Limestone lenses in bottom half, very light gray, weathers light gray, fine- to medium-crystalline, sucrose, in beds up to 1 ft. thick. Unit forms ledges.	35
Limestone: medium light gray, weathers medium gray to medium dark gray and grayish brown, medium crystalline, massive-bedded. Basal 5 ft. lighter and aren. Abundant twiggy bodies higher in unit. Unit forms sucrose, meringue-weathered ledges.	72
Dolomite: light gray, weathers yellow-gray, medium crystalline, massive-bedded, sucrose. Contains rust-colored stains. Four bands medium dark gray dolomite, weather same, 2 to 3 ft. thick occur in unit. Unit forms ledges which break down into angular talus.	118
Dolomite: medium light gray, weathers same, fine-grained, partially recrystallized, massive, sucrose. Ledge-forming unit, breaks down into blocky angular debris.	60
Limestone: alternating light and dark; light: medium dark gray, weathers yellow-gray, fine-grained, in laminated beds 2 ft. thick (laminae stand out as ridges); dark: medium gray, weathers same, 60% bioclastic (in thin section) with partially recrystallized matrix, thick-bedded, meringue-weathered, in beds 2 to 5 ft. thick. Unit forms ledges.	57
Total thickness of Orr formation	1222

Weeks limestone	Thickness in feet
Limestone: mottled medium light gray and medium gray, weathers medium dark gray and grayish brown, medium-crystalline, thin bedded (obscure), weathers massive with some banding and cross-bedding. Unit forms sucrose, meringue-weathered ledges.	102

Limestone and dolomite: alternating, white, highly altered, appearing marbleized in places. Base is unexposed.	200+
Total thickness of Weeks limestone	302+

Deep Creek Range-- A section was measured eight miles west-northwest of Callao, Juab County, Utah, on the north side of Goshute Canyon, beginning ½ mile up the canyon from a prominent windfall. Traverse extended northwest from the base of the Lamb dolomite to the top of the Dunderberg shale, then west to the top of the Notch Peak limestone near the crest of the range. The traverse extended through Secs. 27, 28 and 34, T 10 S, R 18 W (unsurveyed) as shown on the Fish Springs Quadrangle map.

Upper Cambrian

Notch Peak limestone (top)	Thickness in feet
Dolomite: medium light gray, weathers light gray, fine- to medium-crystalline, bedding unapparent. Unit forms steep covered slope with poor outcrops.	126
Dolomite: medium light gray, weathers medium gray, fine-grained, partially recrystallized, bedding unapparent. Unit is cherty in places and contains abundant twiggy bodies. Unit forms a covered slope with very poor outcrops.	630
Dolomite: light gray, weathers same, fine-grained, partially recrystallized, thick bedded, interbedded with medium gray dolomite containing twiggy bodies, in beds 3 to 10 feet thick. Upper half of unit composed of very light gray to white dolomite. Ledge-forming unit with good outcrops.	155
Dolomite: medium gray, weathers medium light gray, fine-grained, partially recrystallized, bedding unapparent. Unit forms a covered slope with no outcrops. Chert nodules and calcite stringers observed in talus.	317
Total thickness of Notch Peak limestone	1228

Dunderberg shale	Thickness in feet
Limestone and shale: medium gray limestone, weathers same, fine- to medium-grained, bedding obscure (probably thin). Three per cent of limestone composed of quartz grains 1/10 mm. in diameter. Ten to 20% of limestone composed of fossil frags. Shale: olive-gray, weathers light olive-gray, fissile. Unit forms covered slope with poor exposures. Fauna: Deadwoodia duris (Walcott) Elvinia roemeri (Shumard) Geragnostus tumidosus (Hall & Whitfield) Iddingsia robusta (Walcott) Iddingsia similis (Walcott) Kindbladia affinis (Wallcott) Kormagnostus simplex Resser Labiostria sp. B	30
Total thickness of Dunderberg shale	30

Hicks formation (top)	
Dolomite: medium light gray, weathers light gray, fine-grained, partially recrystallized, bedding unapparent. Unit forms covered slope with no outcrops.	120
Limestone and shale interbedded: medium gray limestone, weathers medium dark gray, fine-grained, in beds ½ to 3 in. thick. Shale: dark greenish gray, weathers grayish brown, of silt-size grains, in beds 1/8 to ¼ in. thick. Unit forms cliff except for slope-forming basal interval composed of 25% fossil frags. in fine- to medium-crystalline limestone. Shale thins upward. Fauna: Aphelaspis? n. sp. Dunderbergia? granulosa (Hall & Whitfield) Dunderbergia nitida (Hall & Whitfield) Dunderbergia? n. sp. Dytremacephalus n. sp. Pseudagnostus? nordicus (Lochman) Pterocephalia sanctisabae Roemer Unassigned pygidium B	252

Dolomite: medium gray, weathers medium light gray, oolites and pisolites in fine- to medium-crystalline matrix, bedding not apparent. Unit forms covered slope with poor outcrops. 227

Total thickness Hicks formation 599

Lamb dolomite (top) Thickness in feet

Argillaceous limestone: medium dark gray, weathers medium gray, medium-crystalline. Argil. beds ½ in. thick, ½ to 3 in. apart occur with an occasional 2 to 4 ft. limestone bed in between. Becomes arenaceous and bioclastic toward top. Unit forms a cliff.
Fauna: Coosella sp.
Geragnostus tumidosus (Hall & Whitfield)
Kormagnostus simples Resser
Maryvillia arion Walcott
Menomonia calymenoides (Whitfield)
Pseudagnostus? nordicus (Lochman)
Syspacheilus camurus Lochman
Tricrepicephalus coria (Walcott) 78

Dolomite: medium gray, weathers medium light gray, finely-crystalline, irregularly thin- to medium-bedded. Tan argil. bands 1/16 to 1/8 in. thick, ½ in. apart occur in places. Ledge forming unit. 155

Dolomite: medium dark gray, weathers same, fine-grained, partially recrystallized, thick-bedded. Forms a steep slope with poor outcrops. 173

Dolomite: light to medium light gray, weathers mottled very light and medium light gray. Medium-crystalline and oolitic, massive-bedded. Two dark dolomite beds 5 to 10 ft. thick similar to above unit with twiggy bodies occur near top. Unit forms steep slope with fair outcrops except at base. 162

Dolomite: medium light gray, weathers medium gray, fine-grained, partially recrystallized and fine-grained oolites and pisolites, partially recrystallized. Argil. material on bedding planes weathers brown. Unit forms ledges and cliffs. 300

Dolomite: medium gray, weathers medium dark gray, fine-grained oolites and pisolites partially recrystallized cross-bedded in irregular beds ½ to 1 ft. thick. Unit forms a steep slope with fair outcrops. Base of Lamb dolomite taken at top of argil. limestone, medium dark gray, thin-bedded, with argil. banding 1/8 in. thick ¼ to ½ in. apart of the Trippe limestone. 75

Total thickness of Lamb dolomite 943

Silver Island Range--A broken section was measured on a northeast traverse along the prominent slope and running south-southwest from East Peninsula Peak, approximately 10 miles northeast of Wendover, Tooele County, Utah, in T 1 N, R 18 W.

Upper Cambrian

Notch Peak limestone (top)	Thickness in feet
Limestone: medium gray, weathers medium to dark gray, fine-grained, some irregular argil. stringers red to brownish yellow, many cavities at base. Contact with overlying Pogonip taken at base of 5-ft. intraformation cg. bed, yellow-brown.	7
Dolomite: medium light gray, weathers dark yellowish orange to dark yellowish brown, arenaceous, medium-crystalline.	6
Limestone and shale: medium light gray to dark gray limestone, weathers medium dark gray, medium-grained. Shale: moderate yellowish brown, red and white liesegang bands, semi-fissile. Slope forming unit. Fauna: Eorthis desmopleura (Meek) Owenella antiquata (Whitfield)	65
Limestone: medium bluish gray, weathers medium gray, fine- to medium-grained, medium-bedded. Varying amounts of sand grains present.	19
Dolomite: medium gray, weathers moderate yellowish brown, fine-grained, partially recrystallized, massive, vuggy cavities lined with mineral dolomite silst. unit 1 ft. thick at base. Unit forms cliff	240
Limestone: light bluish gray, weathers medium bluish gray, bioclastic at base to very fine-grained 70 ft. above base with grayish orange to moderate yellowish brown argil. partings ½ to 6 in. apart. Unit thin-bedded, with thin beds of intrafm. cg. present but not common. Oolite bed at base. Surface weathers knobby and irregular.	172
Dolomite: medium bluish gray, weathers medium light gray, calcareous, fine-grained, partially recrystallized. Unit changes laterally into dark greenish gray limestone weathering medium light gray. Unit is massive with laminations and faint cross-bedding. Oolite bed 2 ft. thick occurs 86 feet from base. Some chert nodules and stringers above oolite bed. Algal bed occurs 154 ft. above base. Upper part of unit becomes arenaceous.	221
Limestone: medium dark gray, thin-bedded, very fine- to fine-grained, irregular bedding planes with argil. partings, and some thin seams of intrafm. cg. Abundant chert nodules and discontinuous lenses occur in unit. Steep slope former.	48
Limestone: light gray, weathers light gray to medium light gray, sub-lithographic, massive-bedded, small amounts of argil. material in partings, chert nodules. Oolite bed 9 in. thick occurs 20 ft. from base.	72
Limestone: medium dark gray, thin-bedded, very fine-grained, moderate brown argil. partings. Fucoids present.	5
Limestone: light gray, weathers same to medium light gray, sub-lithographic, massive-bedded. Small amounts of argil. material 1/32 to 1/16 in. thick on irreg. partings. Chert nodules 1 in. in diameter occur 40 feet from base, also discontinuous chert bands. Some zebra-banding of mineral dolomite occurs in unit. Above 40 ft. from base limestone weathers grayish blue and contains some calcite nodules. At 249 ft. above base chert becomes more abundant to 321 ft. and again at 372 ft. Cliff forming unit.	373
Limestone: grayish blue, weathers light to medium bluish gray, fine-grained, thin-bedded. Unit contains moderate yellowish tan weathering argil.	

material in thin seams and lenses ½ to 1 in. apart and slightly anastomosing. Thirty-seven to 46 feet from base of unit are 3 white calcite bands 1 ft. thick. Thirty-seven in. from top of third band is fourth band and 10 ft. higher is fifth band. Some of the argil. material weathers moderate reddish brown and is platy. 121 ft. from base, unit becomes less argil. and lateral continuity of seams disappears. Cliff forming unit. 185

Limestone: medium gray to medium bluish gray, weathers olive-gray, very fine-grained, thin- to medium-bedded. Tan to reddish brown argil seams and lenses throughout unit and along irregular bedding planes. Base of unit bioclastic. Slope-forming unit. 79

Limestone: medium light gray, weathers light to medium gray, fine-grained. Upper portion of unit limestone, medium gray, weathers medium dark gray with gray mottling, thin-bedded, irregular bedding planes. Limestone alternates with ferruginous argil. limestone every 3 in. to 2 ft. Argil. limestone is red, fissile, 3 to 5 in. thick. Some chert nodules occur in unit. Cliff forming unit. 46

Total thickness of Notch Peak limestone 1538

Dunderberg shale — Thickness in feet

Shale: moderate yellowish tan to moderate brown with prominent red and white liesegang bands, semi-fissile. Unit forms a slope and is variable in thickness throughout range. 4- 30

Total thickness of Dunderberg shale 4- 30

Weeks and Orr formation (top) — Thickness in feet

Limestone: medium blue-gray, weathers light to medium blue-gray, fine-grained, partially recrystallized with many cavities. 17

Dolomite: light gray, weathers light olive gray, medium-crystalline, massive-bedded, vugs containing mineral dolomite. 55

Calcite: altered, white, finely-crystalline, massive-bedded, with seams of brown-weathering argil. material. 41

Dolomite: medium light gray, weathers light olive gray, medium crystalline, becoming coarsely crystalline within 15 ft. of overlying unit. Upper 15 ft. of unit altered to opalescent, massive calcite. Base of formation taken at contact of altered dolomite above thin-bedded argil. limestone of Marjum formation. 67

Total thickness of Weeks and Orr formation 180

Stansbury Mountains--A section was measured in Sec. 18, T. 1 S, R 7 W, 1 3/10 miles southeast of Timpe, Tooele County, Utah, near the northernmost promontory of the Stansbury Mountains. The traverse extended southwest to the crest of the range and then east-west along the crest.

Upper Cambrian

Ajax limestone (top)	Thickness in feet
Dolomite: medium light gray, weathers light to medium light gray, finely-crystalline, medium- to thick-bedded with brown argil. banding. Unit forms a series of small ledges. Base of Opohonga, medium gray limestone, weathers light olive gray.	57
Dolomite: medium gray, weathers medium light gray, fine-grained, partially recrystallized, thick- to massive-bedded. Contains chert nodules and twiggy bodies. Ledge forming unit.	314
Dolomite: light gray, weathers same, coarsely-crystalline, massive-bedded. Unit forms cliffs and ledges.	138
Dolomite: medium dark gray, weathers same, fine- to medium-crystalline, medium- to thick-bedded. Contains 3 light dolomite bands 2 to 3 ft. thick. The dark dolomite is cherty. Unit forms series of small ledges with meringue-weathered surfaces.	118
Dolomite: medium dark gray, weathers dark gray, fine-grained, partially recrystallized, massive-bedded. Abundant calcite stringers run through rock and on fracture planes. Ledge forming unit.	62
Dolomite: medium dark gray, weathers medium light gray, finely-crystalline, medium- to thick-bedded with argil. banding ¼ to ½ in. thick, 6 in. to 2 ft. apart. Contains abundant chert nodules. Unit forms meringue-weathered ledges.	133

Dolomite: medium light gray, weathers yellowish gray, fine-grained, partially recrystallized, medium- to thick-bedded, with sandy surface on bedding planes, calcite and rust stains on fresh surfaces. Contains some chert on bedding planes. Upper 2/3 of unit argil. Cliff and ledge forming unit.	85
Total thickness of Ajax limestone	907

Dunderberg shale	Thickness in feet
Siltstone: light olive gray, weathers pale olive, indistinct clay-size grains, thin-bedded but not fissile. Unit forms slopes with poor outcrops. Fauna: _Housia varro_ (Walcott)	15
Total thickness of Dunderberg shale	15

Opex dolomite (top)	Thickness in feet
Dolomite: medium gray, weathers dusky yellow, fine- to medium-crystalline with fossil fragments and fine sand-size quartz grains, approximately 1%; thin- to medium-bedded with argil. material on bedding planes. Brown sandy unit 16 ft. thick, 12 ft. above base. Ledge forming unit.	43±5
Covered slope with no outcrops	99
Dolomite: medium dark gray, weathers medium light gray, fine-grained, partially recrystallized, massive-bedded with intrafm. cg. bed at base. Contains calcite stringers. Meringue-weathered, ledge forming unit.	19
Dolomite: medium dark gray, weathers light gray with abundant tan and rust argil. material especially on bedding planes, thin-bedded. Contains large amounts of calcite stringers and blebs. Intrafm. cg. bed 1 ft. thick occurs at base of unit and 3 or 4 beds occur higher. Approximately 2% of limestone composed of oolites 1/10 to 1/5 mm. in diameter. Base taken at top of highest light dolomite bed in Cole Canyon limestone.	44
Total thickness of Opex dolomite	220±5

Tintic district--A section was measured along ridge west of Eureka Peak, between Eureka and Mammoth in Juab County, Utah, in Sec. 24, T 10 S, R 3 W.

Upper Cambrian

Ajax limestone (top)	Thickness in feet
Limestone: medium gray, weathers medium light gray very fine-grained, thin-bedded with grayish orange argil. partings. Coarse aren. beds occur in upper half with chert bands.	
Dolomite: medium gray, weathers medium light gray, medium-crystalline, massive-bedded, aren. mottling. Ledge forming unit.	68
Dolomite: medium gray, weathers same, medium-crystalline, thin- to medium-bedded, with argil. banding, calcareous. Slope-forming unit except at top where unit grades into alternating beds of medium dark gray and medium gray dolomite ½ to 1 in. thick.	271
Dolomite: light gray, weathers very light gray, medium- to coarsely-crystalline, thin- to medium-bedded. Contact with overlying unit gradational. Emerald dolomite member.	36
Dolomite: medium gray, weathers medium light gray, fine- to medium-grained, partially recrystallized, thin- to medium-bedded. Contains red argil. streaks and is arenaceous with clastic bands toward top of unit. Base of unit marked by limestone cg. 2 to 5 ft. thick. Slope forming unit.	99
Total thickness of Ajax dolomite	698

Dunderberg shale	Thickness in feet
Limestone and shale: dark gray limestone, weathers medium gray, fine-grained, thin-bedded, interbedded with silt bands, light olive gray, weathers yellow gray, ¼ in. thick ½ in. apart. Three-ft. yellow semi-fissile shale bed occurs at top of unit.	42
Total thickness of Dunderberg shale	42

Opex dolomite (top)	Thickness in feet
Dolomite: medium dark gray, weathers medium light gray, medium- to coarsely-crystalline, thick-bedded, aren. mottling, ledge-forming unit. Oolites ½ mm. in diameter make up approximately 15% of dolomite.	64
Dolomite: medium light gray, weathers light gray, medium-crystalline and oolitic, thin- to medium-bedded with red argil. material on bedding planes and in oolites. Unit grades upward into darker and less argil. dolomite with aren. mottling. Ledge-forming unit.	28
Dolomite: medium gray, weathers same, fine- to medium-crystalline, irregular thin- to medium-bedded. Aren. mottling stands out on meringue-weathered surfaces. Dolomite contains fossil frags. Unit becomes coarser grained toward top with clastic bands 2 to 4 ft. thick and 3 to 6 ft. apart. Ledge-forming unit.	159
Total thickness of Opex dolomite	303

Ophir district--A partial section of Upper Cambrian is present in Ophir Canyon on the west side of the Oquirrh Mountains. The section was measured ½ mile west of Ophir, Tooele County, Utah, up the north side of Kion Hill in Sec. 23, T 5 S, R 4 W.

Upper Cambrian

Opex dolomite	Thickness in feet
Dolomite: alternating light and dark with upper half all light; Light: medium drab gray, weathers light brownish gray, fine-grained, partially recrystallized, thin-bedded, laminated (laminae stand out as ridges on the surface), occurs as bands 2 to 3 ft. thick in lower half of unit; dark: similar to underlying unit, occurs in bands 4 to 5 ft. thick in lower half of unit. Unit forms upper part of sheer cliff.	42
Dolomite: medium dark gray, weathers same, fine-grained, partially recrystallized, thick- to massive-bedded, calcite stringers, twiggy bodies. Five per cent of dolomite composed of oolites, less than 1 mm. in diameter. Unit becomes medium-bedded near top. Forms a sheer cliff. Sharp contact between Opex dolomite and underlying Cole Canyon limestone, the top of which is medium gray, medium-crystalline dolomite, weathers light gray, massive-bedded.	133
Total remaining thickness of Opex dolomite	175

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