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The Upper Ordovician Through Middle Silurian of the Eastern Great Basin. — Part 1. Introduction: Historical Perspective and Stratigraphic Synthesis.

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Abstract: This introductory paper is the first in a sequence of reports in the Milwaukee Public Museum Contributions series describing and revising the stratigraphy of Late Ordovician through Middle Silurian dolostones in the eastern Great Basin. These strata were deposited as part of an extensive belt of similar aged rocks along the western margin of the North American Plate. Early in this century these strata in the eastern Great Basin were assigned to three formations, the Ordovician Fish Haven and Ely Springs Dolostones and the Silurian Laketown Dolostone. The area of study lies approximately between parallels 36° and 42° N, and meridians 111° and 117° W, an area of over 110,000 square miles. The Fish Haven Dolostone is confined to the north-eastern part of this area, and the Ely Springs Dolostone occupies the remaining part. The Fish Haven Dolostone is divisible into three members (informally named by Keller, 1963) which are, from bottom to top, the Paris Peak Member, the Deep Lakes Member, and the Bloomington Lake Member. The Ely Springs Dolostone is divisible into four members, which are, from bottom to top, the Ibex Member (new), the Barn Hills Member (new), the Lost Canyon Member (new), and the Floride Member (Osterwald, 1953). The Laketown Dolostone is present throughout most of the study area and disconformably rests on the Ordovician formations. It is divisible into six members, some of which intertongue laterally. The lowest is the Tony Grove Lake Member (new) which is successively overlain by the High Lake Member (new), the Gettel Member (new), the Portage Canyon Member (new), the Jack Valley Member (Rush, 1956), and the Decathon Member (Rush, 1956).

INTRODUCTION

This museum report is the first of a series describing the Upper Ordovician through Middle Silurian stratigraphy of the eastern Great Basin. It includes a historical sketch covering prior research on these deposits, a brief discussion of the methodology employed in our study, and definition of the major stratigraphic subdivisions we recognized.

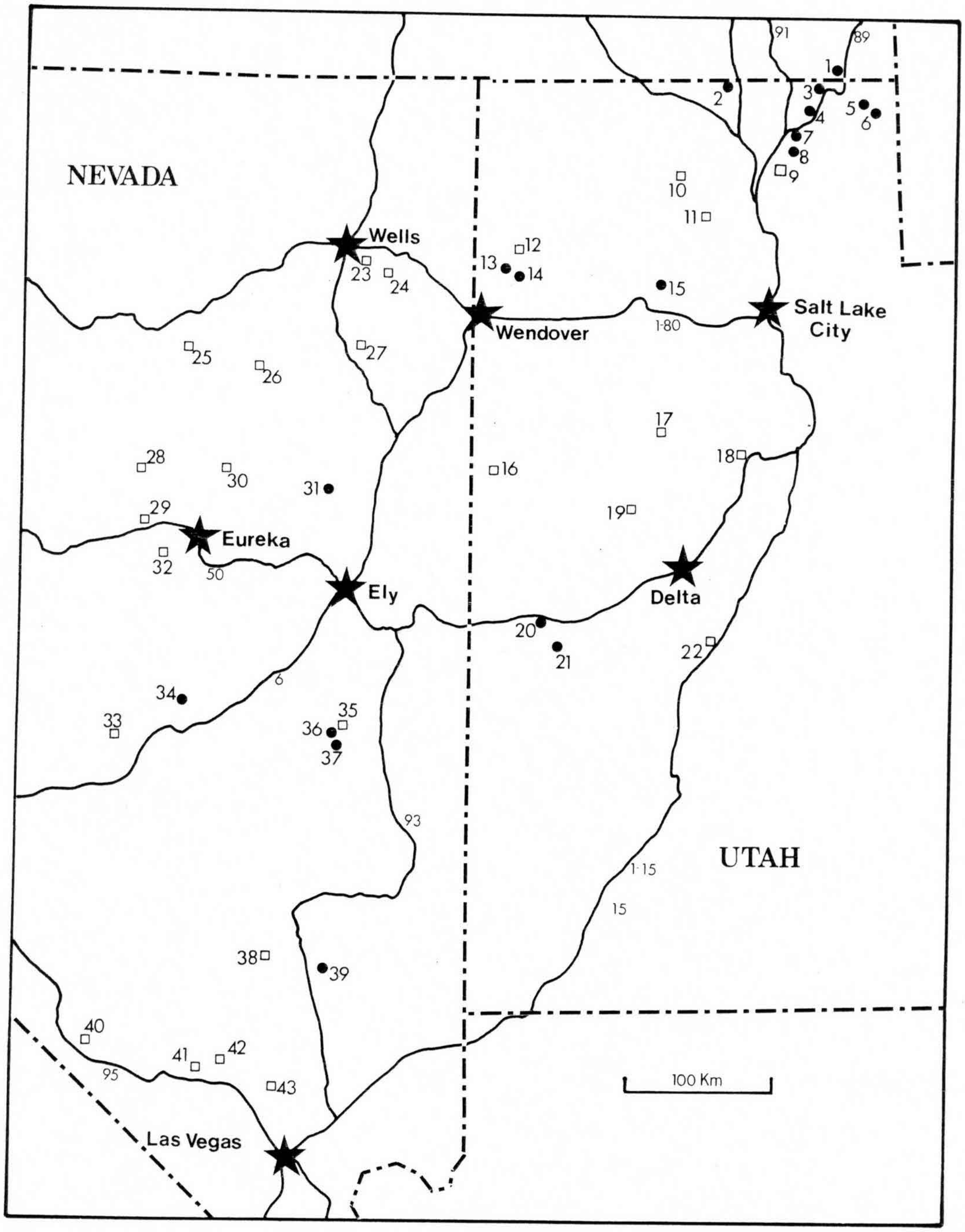
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Figure 1. The map indicates the location of sections that have been measured (solid circles) or examined (open boxes). Highways are shown as solid lines.

Key:
1. Fish Haven Canyon
2. Portage
3. Tony Grove Lake
4. Logan Canyon
5. Laketown Canyon
6. East Fork, Laketown Canyon
7. Blacksmith Fork
8. Hyrum Canyon
9. Four-mile Canyon
10. West side, Promontory Mountains
11. East side, Promontory Mountains
12. Crater Island
13. West side Silver Island Mountains
14. East side Silver Island Mountains
15. Lakeside Mountains
16. Deep Creek Mountains
17. Sheeprock Mountains
18. East Tintic Mountains
19. Thomas Range
20. Confusion Range
21. Barn Hills
22. Pavant Range
23. Wood Hills
24. Pequop Mountains
25. Pinyon Range
26. Ruby Mountains
27. Spruce Mountain
28. Roberts Creek Mountains
29. Lone Mountain
30. Bald Mountain
31. Cherry Creek Mountains
32. Mahogany Hills
33. Hot Creek Range
34. Pancake Range
35. South Egan Range
36. South Egan Range
37. South Egan Range
38. Pahranagat Range
39. Delamar Mountains
40. Bare Mountain
41. Spotted Range
42. Ranger Mountains
43. Sheep Range

Subsequent reports in this series will present lithologic descriptions of sections, a detailed lithostratigraphic synthesis, interpretation of the temporal relationships of the rocks involved and a synthesis of the depositional history of the formations. The rocks are essentially dolostones deposited in shelf seas along the western (present direction) margin of the North American Plate. The study focuses on the Ordovician Fish Haven and Ely Springs Dolostones and the Silurian Laketown Dolostone which were named in the early part of this century.

Forty-three stratigraphic sections (Fig. 1) containing Ordovician and/or Silurian strata were examined in Utah, Nevada and Idaho. Nineteen of the sections were selected for measurement on the basis of completeness, degree of exposure, and accessibility. The initial effort began with six measured sections described by Budge (1966 a and b). The thirteen remaining sections will be described in Parts I and II of this series.

During the project large numbers of silicified fossils were acid-etched from about 17,000 pounds of carbonate rock. Sheehan studied the brachiopods and Budge the corals. Because of the large number of fossils obtained only about one-half have been studied in detail to date. Gathering stratigraphic data was a joint concern.

Field work was undertaken in the summers of 1963-1965 by the senior author, and by both during the summers of 1967-1970. Initially the project included only Silurian strata, but at the completion of the 1967 field season it was decided to include the Ordovician carbonate strata lying above the Eureka and Swan Peak Quartzites. This made it possible to establish a regional boundary between the Ordovician and Silurian since fossils from both systems were collected in their stratigraphic context.

Location of Area Studied

The region examined (Fig. 1) lies approximately between parallels 36° and 42° N., and meridians 111° and 117° W., and has an area of almost 110,000 square miles. Physiographically, the region is in the westernmost part of the Middle Rocky Mountain Province and the eastern half of the Basin and Range Province (Fenneman, 1931). The elevation ranges from about 2200 feet in southern Nevada to about 10,000 feet in north-central Utah. The climate is mostly semiarid or high desert, exceptions being the low deserts of southern Nevada and the high mountains of north-central Utah. Precipitation through these extremes of altitude ranges from a few inches to forty inches annually. The flora consists of sage, juniper, and grasses in the high desert and joshua and cactus in the low desert areas; at higher elevations scrub oak, quaking aspen and pine predominate. The land is used for recreation, farming and grazing.

Geological Setting of the Region

Outcrops of Ordovician and Silurian strata in the Great Basin are excellent for detailed stratigraphic studies because of low rainfall and the consequent sparse flora. Complex facies and tectonic problems, which are briefly outlined below, have made stratigraphic relationships much more intricate than first appearances indicate.

Strata in the eastern Great Basin are arranged in two parallel, northeast south-west trending bands. The eastern band consists predominantly of shelf deposits and the western band of slope and basinal deposits. Over the years several hypothesis and concepts have been presented concerning these strata. Schuchert (1923) referred to this region as the Cordillerian Geosyncline. Kay (1951) named the slope and basinal deposits the Fraser Belt and the shelf deposits the Millard Belt. Later, Roberts *et al.* (1958) termed the belts the Western and Eastern Assemblages. Some investigators have recognized a transitional zone between the two. Traditionally, previous authors working in the Late Ordovician and Silurian considered the Western Assemblage as eugeosynclinal and the Eastern Assemblage as miogeosynclinal in origin.

More recently, plate-tectonic interpretations have been applied to explain the stratigraphic patterns and geologic development of this region. For example, Stewart (1972) suggested that the western margin of Paleozoic North America formed by late Precambrian rifting, which established a north-south trending continental margin through Nevada. Stewart's interpretation has gained general acceptance and most recent discussions of Ordovician and Silurian paleogeography show a north-south trending continental margin through central Nevada (see Stewart and Poole, 1974; Ross, 1977; Poole *et al.*, 1977 for details). If Stewart's hypothesis is followed the platform carbonates with which this study is concerned were deposited east of the continental margin, while the slope deposits were deposited to the west, at or just beyond the margin. Discussions of the slope and basinal deposits are in Johnson (1971), Johnson and Potter (1975), Burchfiel and Davis (1972, 1975), Churkin (1974), Poole, *et al.* (1977), Matti and McKee (1977). It has also been hypothesized that basinal deposits west of the continental margin may have been laid down in an inner arc basin (Burchfiel and Davis, 1972; Poole, 1974). Ketner (1977) provided an alternative to these interpretations and suggested that granitic continental terrains with a sedimentary cover extended far west of the carbonate shelf margin and were the source for many of the Western Assemblage rocks. These interesting ideas aside, the stratigraphic sequence of the study area, the Middle Rocky Mountain and Great Basin Provinces is represented by formations ranging in age from Precambrian through Cenozoic. The Paleozoic sequence is composed of approximately 25,000 feet of shelf sediments (Williams, 1958, p. 17). Shelf deposits are predominantly marine carbonates, with quartz sandstones, quartzites, and minor amounts of shale. Slope and basinal deposits contain more shale and fewer coarse clastics than shelf deposits. Mesozoic strata in the Middle Rocky Mountain Province consist of over 6,000 feet of marine and terrestrial deposits. To the west, in the Great Basin, Mesozoic sequences are much thinner. All Cenozoic rocks are of terrestrial origin, occurring as isolated patches, having stratigraphic thicknesses estimated at over 15,000 feet in the Middle Rocky Mountain Province (Williams, 1958, p. 17) with similar thicknesses possible to the west.

Summarizing the work of numerous investigators in the Great Basin, the Phanerozoic structural history of the Middle Rocky Mountain and Great Basin Provinces involves the development of structural features of two major types. The first is composed of folds and thrust faults formed during four major orogenic events. The second involves truncation of the first type of structural features during Basin and Range block faulting. The Antler Orogeny in central Nevada is the first orogenic event. Here, rocks of the slope and basin were thrust eastward over shelf deposits during the Late Devonian-Mississippian. During the Late Permian and Early Triassic the Sonoma Orogeny again disturbed the strata of central Nevada with the movement of another plate eastward from the western flank of the old Antler Orogenic Belt. The Late Jurassic-Early Cretaceous Sevier Orogeny is the third event. It was centered on the eastern flanks of the old Antler Orogenic Belt. The deformation apparently consisted primarily of uplift followed by erosion. The Laramide Orogeny of Late Cretaceous and Early Tertiary age was the last of the folding and thrusting events. It was located east of the Sevier Orogenic Belt, and was more complex than the earlier ones. It was a series of uplifts over a broad region and not restricted to narrow orogenic belts as were the preceding deformations. It has been suggested that down-slope movements caused by gravity moved large masses of shelf deposits from these uplifted areas, eastward, over other shelf strata. Finally, Cenozoic block faulting cut the previous orogenic belts and formed the present Basin and Range topography, which consists of north-south trending mountains separated by alluvium filled valleys.

History of Prior Studies

Ordovcian and Silurian strata, in the present sense, have been known in the western United States since 1859 when Drexler discovered "*Halysites catinulata (Catenipora escharoides)*" (*in* Simpson, 1876, p. 272). Although at that time the Ordovician System had not been named, the fossil was considered diagnostic of the upper Lower Silurian (=Upper Ordovician), or the Upper Silurian (=Silurian) interval.

This observation, that two different geologic horizons were involved is important because the fact was rediscovered by Walcott in the 1890's (see discussion below). Drexler's specimen was found at Rocky Ridge, in the vicinity of South Pass City, Wyoming, in rocks probably belonging to the Bighorn Dolostone of Late Ordovician age.

A second discovery of rocks of Drexler's time interval was made in north-central Utah. Hayden (1872, pp. 15-20) noted that in 1871 *"Halysites catinularia"*, had been found in the last bed of limestone in Box Elder Canyon, twenty-five miles north of Ogden, Utah. This area is probably just south of what is known today as Dry Lake, through which U.S. Highways 89 and 91 pass. Both Late Ordovician and Silurian strata are now known in the area. Bradley (1873, pp. 194-199), who discovered the *"Halysites catinulata"* mentioned above (King, 1878, p. 178), considered it to be representative of the Niagara Group of the eastern United States.

Comstock (1874, pp. 110-112), in reporting the third occurrence of strata of this age, found *"Halysites catenulatus"* at several areas in west-central Wyoming, and he thought a Niagara [sic] or Upper Silurian age was indicated.

The fourth report of Ordovician and Silurian strata was from Nevada. Hague (1883, pp. 262-263), in an investigation of the geology in the Eureka District, Nevada, recognized and named the Lone Mountain Limestone. Trenton fossils were noted as being found near the base of the formation, and in the upper part, so were a few poorly preserved specimens of *"Halysites"*, which he considered characteristic of the Niagara of the East. Walcott (1884, pp. 4, 273, 284), in studying the fossils of the Eureka District, Nevada, stated that Hague's limestone above the (Eureka) quartzite contained a Trenton-like fauna in the lower part, and that in the upper part a higher Silurian horizon was indicated by the presence of *"Halysites"*. Walcott's Paleozoic section (p. 284) showing *"Halysites"* in the lower part of the formation may be in error since it was taken from one of Hague's earlier publications.

Hague (1892, pp. 12-13, 57-59), in a detailed discussion of the geology of the Eureka District, Nevada, restated his earlier observations and inferences that the Lone Mountain Limestone could be divided on paleontological evidence into two horizons, Trenton and Niagara. The Trenton assignment was based on fossils from the Mahogany Hills, which are presently assigned an "early Trenton" age. The upper part of the limestone was assigned to the Silurian because *"Halysites catenulatus"* was collected 1500 feet above the base. Hague (p. 61) noted that at Lone Mountain the Trenton fauna appeared to be absent above the Eureka Quartzite, since rocks fifty feet above the base of the Lone Mountain Limestone contained the Niagara coral *"Halysites catenula-*

tus", which he thought usually occurred several hundred feet above the base. Hague's Paleozoic section (p. 13) shows the Lone Mountain Limestone with its Trenton and Niagaran horizons in the uppermost division of the Silurian.

In North America, Walcott (1887) became the first person to use the term Ordovician for the upper part of the lower division of the Silurian. After his visit to Europe in 1888 he apparently recognized the usefulness of subdividing the Silurian, and, being able to correlate with North America, he began forcefully advocating the utility of Lapworth's Ordovician fauna for delimiting strata in North America.

In 1892 an event occurred which altered the supposed temporal significance of "*Halysites*" which brought it more into line with Drexler's discovery made years earlier (see discussion above). During his investigation of the vertebrate fauna from the Harding Sandstone of Colorado, Walcott (1892) discovered that the range of "*Halysites catenulatus*" extended down into the Ordovician. Thus, the so-called guide fossil, which had been thought to be limited to the Niagaran, and often had been the only means of recognizing the Silurian, could not be used confidently in age determinations.

Beecher (1896, pp. 32-33), following Walcott's lead, noted that rocks he had identified in the Black Hills as Niagara [sic] on the presence of "*Halysites*" were probably Ordovician. Also, he noted that the discoveries cited above of "*Halysites*" in northern Utah, central Wyoming, and central Nevada did not necessarily imply the presence of Niagara [sic] strata at these localities. Beecher's statement, plus the earlier one by Walcott (1892), raised considerable doubt as to whether any Silurian strata actually existed in the West. Kindle (1908a, pp. 125, 127-129) removed all such doubt when he stated:

> "Decisive evidence of the occurrence of Silurian faunas has been obtained in three widely separated regions. They have been found in northeastern Alaska, in southeastern Alaska, and in northern Utah."

The decisive evidence was the brachiopod *Pentamerus oblongus* Sowerby.

Initial studies dealing directly with the regional Upper Ordovician and Silurian stratigraphic succession of Nevada, Utah, and Idaho are found in two publications. Richardson (1913) made the first lithostratigraphic subdivision of the western upper Ordovician and Silurian sequences. Working in north-central Utah and southeast Idaho he subdivided the "Wahsatch [sic] limestone" of King (1876, pp. 478-480), who had suggested that the lowermost part of the formation might contain Silurian fossils. Richardson named the upper Ordovician and Sulurian sequences the Fish Haven and Laketown Dolomites.

(throughout our report we have replaced the mineral term "dolomite" with the rock term "dolostone"). Later at Lone Mountain, Nevada, Merriam (1940) subdivided and restricted Hague's Lone Mountain sequence into the Hanson Creek, Roberts Mountains, and Lone Mountain Formations.

Earlier Westgate and Knopf (1932) had named Ordovician strata in east-central Nevada the Ely Springs Dolomite.

About a half dozen other geologic investigations during the period 1910 to 1948 centered around mining districts and quadrangle mapping projects which were of a more general nature, with the exception of Nolan (1935). Based on his detailed observations in the Gold Hill District, Utah, Nolan subdivided this stratigraphic interval into distinctive lithologic units.

After the basic stratigraphic sequences were established little was done until the period from about 1955 to 1965 when a flurry of about 25 more regional geologic investigations began. They produced many new facts and ideas on the nature of Late Ordovician and Silurian rocks in the Great Basin. Out of these studies a better stratigraphic framework emerged and more refined correlations became possible.

Of these studies, McFarlane (1955) is of interest because he was the first to attempt an evaluation of the Laketown Dolostone's regional stratigraphic relationships in the Great Basin. There is no similar investigation involving Upper Ordovician strata.

Beginning in 1970 and continuing to the present, Late Ordovician and Silurian rocks of the West entered a study phase placing them in the context of plate tectonics and continental and intercontinental correlations. Examples are Berry and Boucot (1970), Poole *et al.* (1977), Johnson (1974), Stewart and Poole (1974), Ross (1976, 1977) and Hintze (1973) which have considered these as platform carbonates in a regional context.

Only a few Late Ordovician and Silurian fossils have been described and illustrated from the platform carbonates of the Great Basin; these studies include those done by Waite (1956), Buehler (1956), Duncan (1956), Johnson and Reso (1964), Howe and Reso (1967), Merriam (1973a, b), and Sheehan (1976).

Progress reports on this particular project include Budge (1966a, b, 1969, 1972, 1977), Budge and Sheehan (1968), Sheehan (1969, 1970, 1971, 1976) and Sheehan and Budge (1968).

Methods

Nineteen stratigraphic sections were measured with a one-hundred foot steel tape and a Brunton compass. The bedding thickness terminology employed is that of Ingram (1954, pp. 937-938). Thick beds were

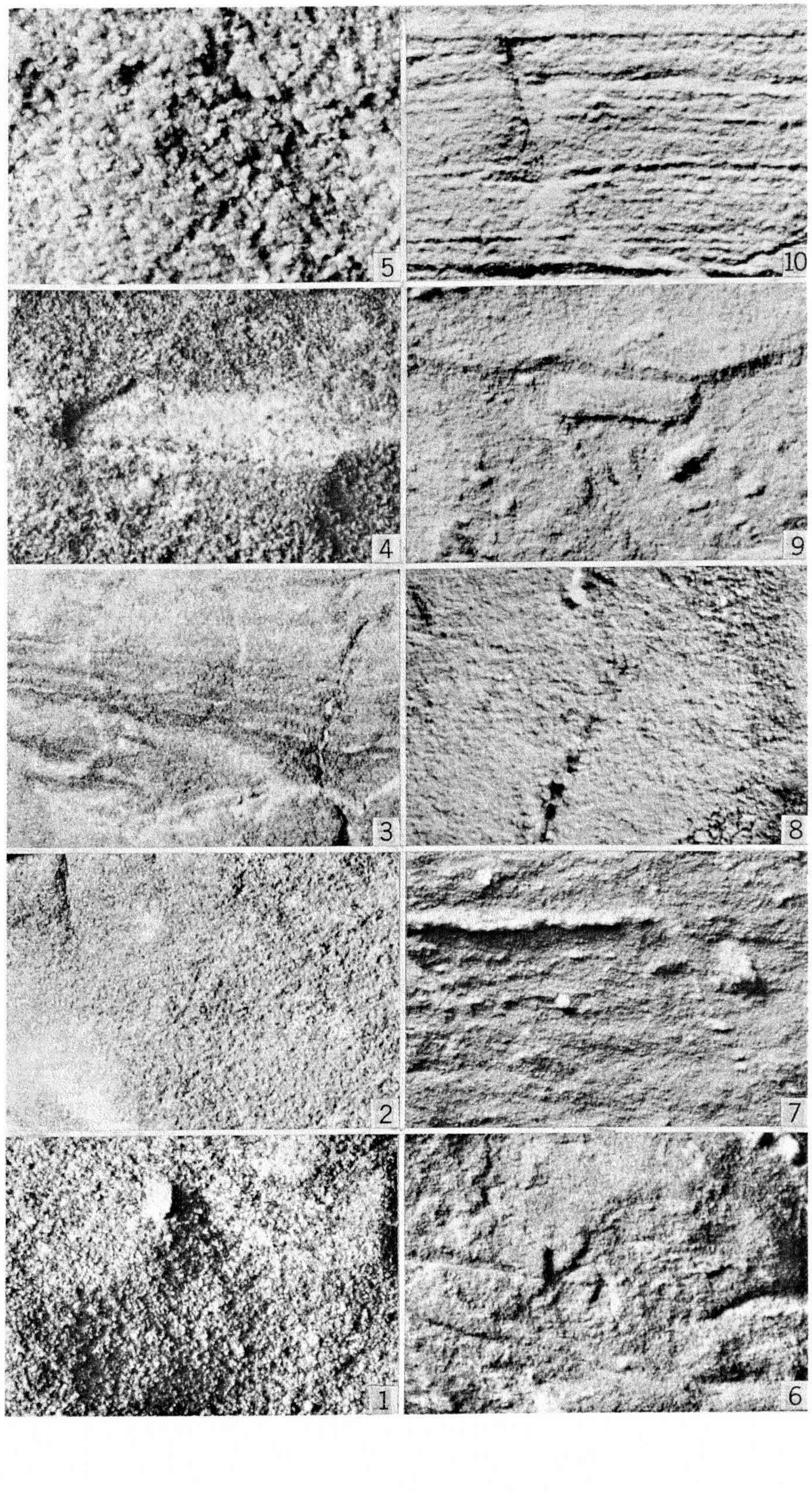
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Figure 2. Textures of dolostones. An example of texture is presented for each of the members of the Fish Haven and Laketown Dolostones in the Tony Grove Lake Section. Samples are in superpositional order. Magnification is X 3.6.

1. Fish Haven Dolostone, Paris Peak Member, dark-gray (N3) weathers dark gray (N3) to medium dark gray (N4), former predominates, very finely crystalline.

2. Fish Haven Dolostone, Deep Lakes Member, brownish-gray (5 YR 4/1) to medium dark-gray (N4), weathers light brownish gray (5 YR 6/1) to medium light brownish gray (5 YR 5/1), microcrystalline to very finely crystalline.

3. Fish Haven Dolostone, Bloomington Lake Member, laminae dark-gray (N3) and medium dark-gray (N4), weathers light gray (N7) and medium dark gray (N4), microcrystalline.

4. Laketown Dolostone, Tony Grove Lake Member, dark-gray (N3) to grayish-black (N2), weathers medium dark gray (N4) to dark gray (N3), finely crystalline to very finely crystalline.

5. Laketown Dolostone, High Lake Member, light olive-gray (5 Y 6/1) to yellowish olive-gray (5 Y 7/1), weathers yellowish olive-gray (5 Y 7/1), medium-crystalline.

6. Laketown Dolostone, Portage Canyon Member, dark brownish-gray (5 YR 3/1) to dark-gray (N3), weathers medium light brownish gray (5 YR 5/1) to brownish gray (5 YR 4/1), very finely crystalline to microcrystalline.

7. Laketown Dolostone, Jack Valley Member, brownish-black (5 YR 2/1), weathers brownish gray (5 YR 4/1), microcrystalline.

8. Laketown Dolostone, Decathon Member, medium light olive-gray (5 YR 5/1), weathers light gray (N7), very finely crystalline.

9. Water Canyon Formation, lower breccia unit, medium light brownish-gray (5 YR 5/1), weathers light brownish pinkish gray (5 YR 7/1), former predominates, clasts light-gray (N7), very finely crystalline.

10. Water Canyon Formation, light olive-gray (5 YR 6/1), weathers yellowish gray (5 Y 8/1), microcrystalline to very finely crystalline.

measured to the nearest one-fourth foot and thinner ones as accurately as possible. In addition, where bedding surfaces were readily apparent, exact measurements were recorded. The graphical method of Mertie (1922, pp. 44-46) was used in the calculation of stratigraphic thicknesses. Rock specimens were collected for comparison each time there was a change in the degree of crystallinity or color. Early in the investigation it was learned that it is important to discriminate between minor color differences since Ordovician and Silurian dolostones are a monotonous gray color. To help standardize color observations, fresh and weathered rock colors were determined in the laboratory with the aid of the color chart prepared in 1951 by the Rock Color Chart Committee headed by E.N. Goddard and distributed by the Geological Society of America. After etching with dilute hydrochloric acid, fresh surfaces were examined under a binocular microscope for original grain surfaces. The examination revealed that the original sedimentary particles had been completely recrystallized in all dolomitized formations; and, therefore, descriptive terminology was more desirable than terminology with genetic connotations. Degree of crystallinity was determined by a comparison with the sedimentary particle size chart based on the Wentworth Grade Scale manufactured by the Geological Specialty Company of Houston, Texas. After the degree of crystallinity was established, descriptive terminology developed by Payne (1942, p. 1706) was applied. Illustrations of textures are presented in Fig. 2.

About 17,000 pounds of fossiliferous limestone and dolomite were collected. The majority of the fossils were silicified. They were removed from their enclosing matrix by using dilute hydrochloric acid to dissolve the rock. Some fossils, preserved as dolomitized replacements, which would have been destroyed in the acid, were examined in thin and polished section. The remaining fossils were preserved as molds and were prepared with a rock splitter.

The fragile, etched, silicified fossils were handled with delicately tipped tweezers manufactured by the Turtox Company, Germany. The silicified fossils were stored in cotton filled boxes to insure safe preservation.

Each fossil collection was assigned a U.S. National Museum (USNM) locality number, and an accurate record was made of its position in the stratigraphic succession. Coral collections studied by the senior author are now in the collections of the National Museum of Natural History, Washington, D.C. Brachiopods studied by the junior author are still being examined. These numbered collections came from either a thin bed or a specified position within a thicker bedded unit. Collections were separated from one another by vertical distances ranging from about an inch to several feet. As an aid to future use of these collections by other workers, locality numbers followed by a (T) indicate that the fossil collection came from talus and not bedrock.

LITHOSTRATIGRAPHY

Overlying the extensive middle Ordovician Swan Peak and Eureka Quartzites of the Great Basin and Middle Rocky Mountain Provinces are the Late Ordovician Fish Haven Dolostone in the north-eastern part of the region and to the south and west the Ely Springs Dolostone. These Late Ordovician Dolostones are overlain disconformably by the Silurian Laketown Dolostone. These three dolostones are the principle stratigraphic units examined during this project. The Laketown Dolostone is disconformably overlain by extensive, essentially similar, rock units termed the Sevy Dolomite in the west and the Water Canyon Formation in the east.

There is confusion in the literature concerning the lithology, boundaries, sequence, genesis, and correlations of the Ordovician and Silurian formations. This confusion is present because many of the early investigators who established formational names lacked a clear understanding of the regional aspects of strata belonging to the two systems. Inconsistent application of paleontologic and lithologic criteria and concepts when subdividing the formations has caused further confusion. For example, lithostratigraphic units have been named and delimited on fossil content rather than rock characteristics. Under these circumstances the authors have tried to pay homage to the past and at the same time develop a useable system of stratigraphic nomenclature. We have subdivided the three formations on the basis of color, degree of crystallinity, bedding, and fossil content into thirteen members (see Table 1).

Ely Springs Dolostone

The Ely Springs Dolostone is divisible into four members (Figs. 3-5, 7) that are recognizable through most of the areal distribution of the formation studied to date. The Ibex Member (new name), the lowest unit, consists of grayish-black to medium-gray or brownish-black, microcrystalline to very finely crystalline dolostone, which is thin- to thick-bedded. The member weathers from dark gray to brownish gray. Frosted quartz sand grains are common to abundant throughout the unit. Its average thickness over the eastern Great Basin is about 28 feet. The type section of the Ibex Member is in the Barn Hills of the Confusion Range, Utah, in the SE 1/4 NW 1/4 sec. 26, T. 21 S., R. 14 W. (Fig. 3).

The Barn Hills Member (new name) overlies the Ibex Member and is composed of dark brownish-gray to medium brownish-gray, microcrystalline to very finely crystalline dolostone which is thin- to thick-bedded. It weathers from dark gray to medium light gray and is laminated in part. Its thickness over the eastern Great Basin is not well known, but it averages about 180 feet. The type section is

Table 1

Formation	Member (author)	Location of type section
Laketown Dolostone	Decathon (Rush, 1956)	Snake Range, Nevada
	Jack Valley (Rush, 1956)	Confusion Range, Utah
	Portage Canyon (Budge & Sheehan, 1979)	Bear River Range, Utah
	Gettel (Budge & Sheehan, 1979)	Barn Hills, Utah
	High Lake (Budge & Sheehan, 1979)	Bear River Range, Utah
	Tony Grove Lake (Budge & Sheehan, 1979)	Bear River Range, Utah
Ely Springs Dolostone	Floride (Osterwald, 1953)	Thomas Range, Utah
	Lost Canyon (Budge & Sheehan, 1979)	Silver Island Mountains, Utah
	Barn Hills (Budge & Sheehan, 1979)	Barn Hills, Utah
	Ibex (Budge & Sheehan, 1979)	Barn Hills, Utah
Fish Haven Dolostone	Bloomington Lake (Keller, 1963, informal)	Bear River Range, Idaho
	Deep Lakes (Keller, 1963, informal)	Bear River Range, Idaho
	Paris Peak (Keller, 1963 informal)	Bear River Range, Idaho

Table 1—List of members and location of type sections.

in the Barn Hills of the Confusion Range, Utah, in the SE 1/4 NW 1/4 sec. 26, T. 21 S., R. 14 W. (Fig. 3).

Overlying the Barn Hills Member is the Lost Canyon Member (new name), which is composed of interbedded light-gray and dark-gray dolostones. The dark-gray dolostones range from brownish black to dark gray, and the light-gray dolostones from brownish gray to olive gray. They range from microcrystalline to finely crystalline, and are thin- to very thick-bedded and laminated in part. The average thickness, which is also poorly known, is about 220 feet. The type section is in the Silver Island Mountains, Utah, in the NE 1/4 of unsurveyed sec. 30, T. 3 N., R. 17 W.

The Floride Member, the uppermost member, was named by Osterwald (1953). It consists of dark-brown to medium-gray, microcrystalline to very finely crystalline dolostone which is mostly laminated and thin- to very thick-bedded. Agrillaceous material and shaly partings are common throughout. The member weathers from light brown to light olive gray with an average thickness of about 120 feet. The type section is in the Thomas Range, Utah.

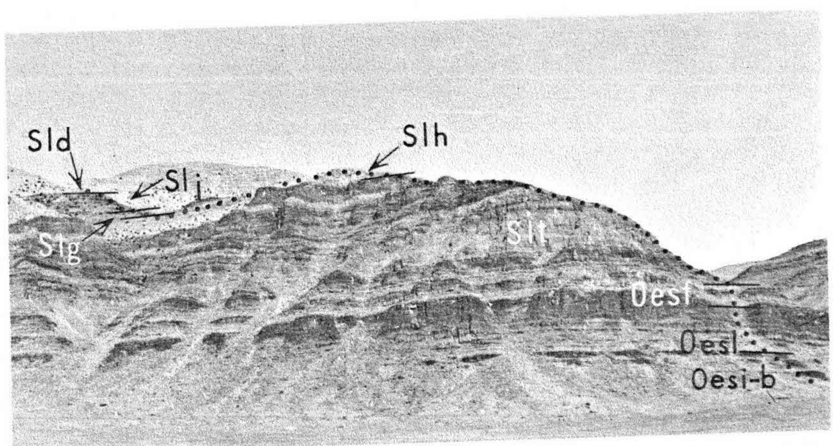

Figure 3. Section in the Barn Hills, west of Gettel Playa, Confusion Range, Utah. Members of the Laketown and Ely Springs Dolostones are indicated by letters. View is toward the west. Ely Springs Dolostone: Oesi-b—Ibex and Barn Hills Members (type sections of members); Oesl—lost Canyon Member; Osef—Floride Member. Laketown Dolostone: Slt—Tony Grove Lake Member; Slh—High Lake Member; Slg— Gettel Member (type section of the member); Slf—Jack Valley member (type section of the member); Sld—Decathon Member.

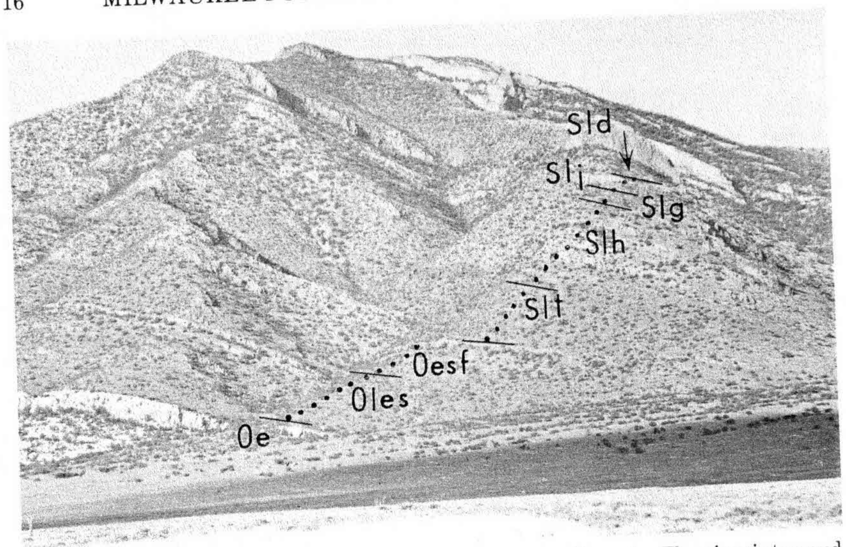

Figure 4. Section at Sunnyside, southern Egan Range, Nevada. The view is toward the northeast. Members of the Laketown and Ely Springs Dolostones are indicated by letters. The Eureka Quartzite (Oe) crops out in the lower left hand part of the mountain. Ely Springs Dolostone: Oles—lower part of the formation (undivided); Oesf—Floride Member. Laketown Dolostone: Slt—Tony Grove Lake Member; Slh—High Lake Member; Slg—Gettel Member; Slj—Jack Valley Member; Sld—Decathon Member.

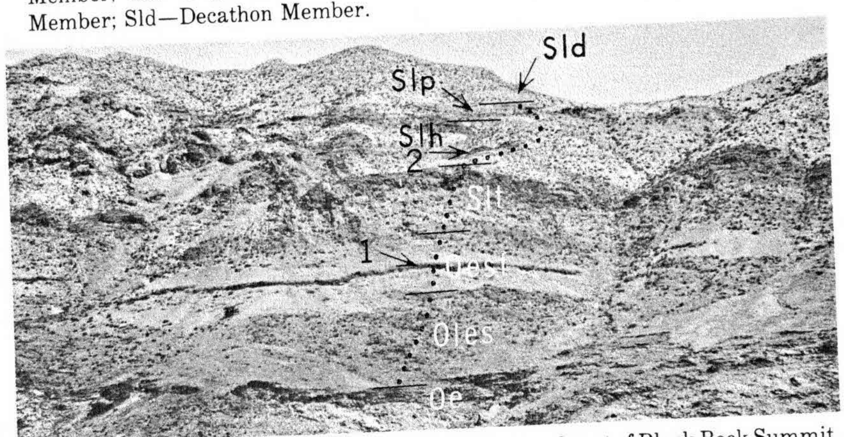

Figure 5. Section in the Pancake Range, 8.5 miles northeast of Black Rock Summit, Nevada. The view is to the east. Members of the Ely Springs and Laketown Dolostones are indicated by letters. The Eureka Quartzite (Oe) is at the base of the mountain. Ely Springs Dolostone: Oles—lower part of the formation (undivided); Oesf—Floride Member. Laketown Dolostone: Slt—Tony Grove Lake Member; Slh—High Lake Member; Slp—Portage Canyon Member; Sld—Decathon Member. (1) indicates a tongue of lower Ely Springs lithology within the Floride Member. (2) indicates a quartzite breccia resting on the High Lake Member.

Fossil corals found in the formation and in the collections of the National Museum of Natural History indicate that the Ibex and Barn Hills Members probably are of "late Trenton", early Late Ordovician age. The Lost Canyon and Floride Members are of late Late Ordovician age.

Fish Haven Dolostone

The Fish Haven Dolostone is divisible into three members (Fig. 6) that were informally named by Keller (1963, unpublished Ph.D. thesis). The Paris Peak Member, the lowest, is a grayish-black to dark-gray, very finely to medium-crystalline dolostone that is medium- to thick-bedded, with an average thickness of about 130 feet. It weathers from dark gray to medium dark gray. The type section is in a saddle north of Paris Peak, Idaho.

Overlying the Paris Peak Member is the Deep Lakes Member, which is composed of interbedded light- and dark-gray dolostone. The dark beds are medium dark gray and the light beds are medium light gray. Both range from very finely to finely crystalline. The member is medium- to very thick-bedded. Regionally its thickness is not well

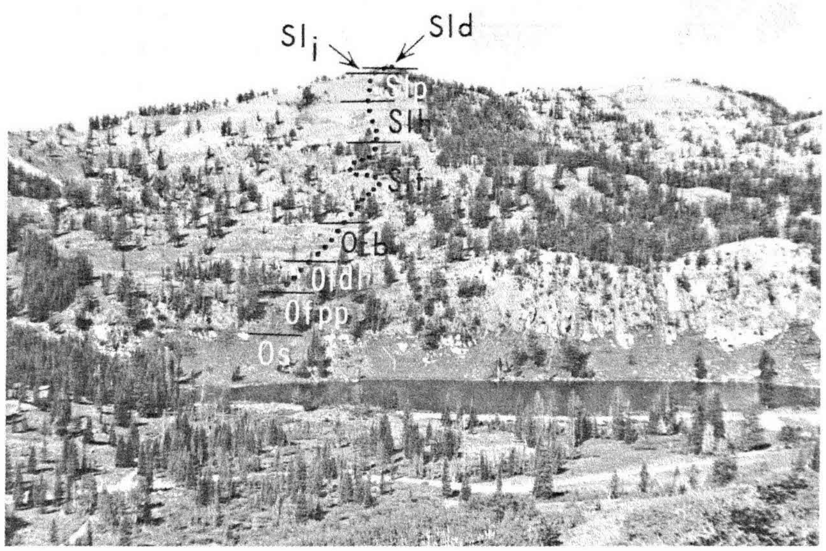

Figure 6. Section at Tony Grove Lake, Bear River Range, Utah. The view is to the west. Members of the Fish Haven and Laketown Dolostones are indicated by letters. The Swan Peak Quartzite (Os) is found at lake level. Fish Haven Dolostone: Ofpp—Paris Peak Member; Ofdl—Deep Lakes Member; Ofb—Bloomington Lake Member. Lakestone Dolostone: Slt—Tony Grove Lake Member (type section of member); Slh—High Lake Member (type section of member); Slp—Portage Canyon Member; Slj—Jack Valley Member; Sld—Decathon Member.

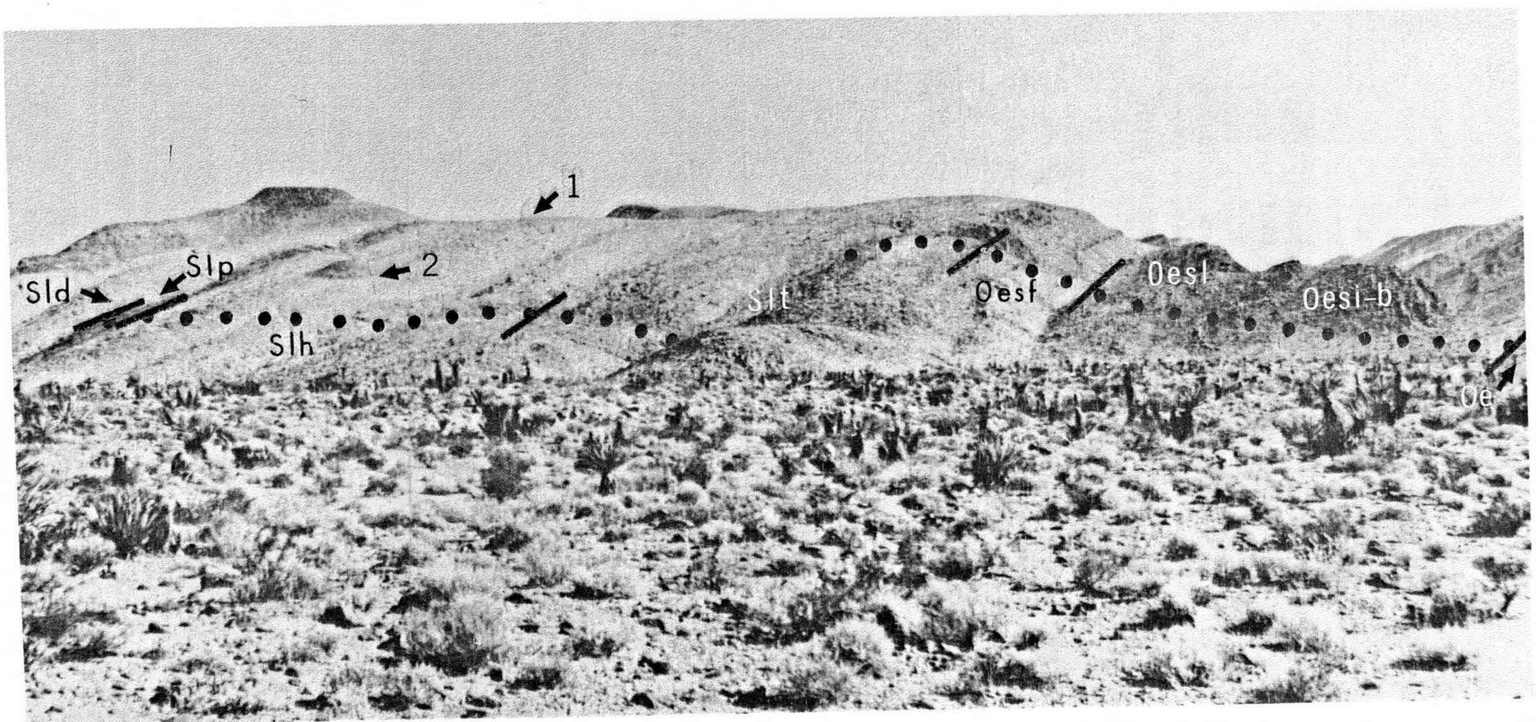

Figure 7. Section at the southern end of the Delamar Mountains, Nevada. The view is a composite photograph. Members of the Ely Springs and Laketown Dolostones as indicated by letters. The Eureka Quartzite (Oe) is at the right margin of the photograph. Ely Springs Dolostone: Oesi-b Ibex and Barn Hills Members; Oesl—Lost Canyon Member; Oesf—Floride Member. Laketown Dolostone: Slt—Tony Grove Lake Member; Slh—High Lake Member; Slp—Portage Canyon Member; Sld—Decathon Member. (1) indicates a tongue of the Portage Canyon Member lithology in the High Lake Member. (2) indicates volcanics resting on the High Lake Member.

known but it averages about 100 feet. The type section is on the high ridge west of Bloomington Lake, Idaho.

Overlying the Deep Lakes Member is the Bloomington Lake Member. It is composed of dark-gray to medium-gray dolostone which weathers medium gray to light gray. Darker interbeds are common in places. Some parts are laminated and have a crystallinity ranging from microcrystalline to very finely crystalline. The member is medium- to very thick-bedded. Regionally its thickness is poorly known but it averages about 270 feet. The type section is at Bloomington Lake, Idaho.

Fossil corals collected from the formation show that the age of the three members in north-central Utah is probably late Late Ordovician, approximately the same age as the Lost Canyon and Floride Members of the Ely Springs Dolostone. At present, studies to determine the depositional environment of the members have not been completed.

Laketown Dolostone

The Laketown Dolostone is divisible into six members, some of which are facies equivalents of one another. These units range in age from middle Early Silurian through Middle Silurian, and locally the uppermost unit extends into the Late Silurian. Representative sections are illustrated in Figs. 3-7. The Tony Grove Lake Member (new name), the lowest, is present throughout the areal extent of the formation examined to date. It is composed of light-gray to grayish-black, microcrystalline to finely crystalline dolostone, which ranges from thin- to very thick-bedded. It weathers from dark brownish gray to light gray. Some parts are laminated and banded, and others contain intraformational conglomerate. The member averages about 350 feet in thickness. The member was deposited in intertidal and shallow subtidal, relatively high-energy environments. The type section is at Tony Grove Lake, Utah (Fig. 6).

Overlying the Tony Grove Lake Member is the High Lake Member (new name) which is also present throughout the areal extent of the formation studied to date. It is a light-gray to medium-gray, very finely to coarsely crystalline dolostone that is medium- to very thick-bedded, partly lenticular and laminated. It weathers from light gray to medium gray and averages about 370 feet thick. A subtidal, lower energy environment than the preceding unit characterizes the member. The type section is at Tony Grove Lake, Utah, in the SW 1/4 SW 1/4 of unsurveyed sec. 5, T. 13 N., R. 3 E (Fig. 6).

The Gettel Member (new name) is restricted to the southern part of the study area. It is found in the Barn Hills, the southern part of the Egan Range and may extend as far south as Bare Mountain, but it does not extend as far east as the Delamar Mountains, nor as far northwest as the Pancake Range. It overlies the High Lake Member and is light olive-gray to brownish-gray, weathering light brownish-gray, microcrystalline to finely crystalline dolostone. It is medium- to thick-bedded and has an average thickness of about 130 feet. Deposition was subtidal in a lower energy environment than the underlying members. The type section is west of Gettle Playa in the Barn Hills, in the NE 1/4 SW 1/4 sec. 26, T. 21 S., R. 14 W. (Fig. 3).

The Portage Canyon Member (new name), which overlies the Gettel or the High Lake Members depending on geographic position, has a wide areal distribution. It is not found in the more eastern outcrops of the Laketown. It is composed of brownish-black to medium dark-gray dolostone. It weathers medium dark gray to medium light gray. The degree of crystallinity ranges from microcrystalline to finely crystalline. Some parts are very finely laminated. Thickness averages about 160 feet. Deposition was in a subtidal, low energy environment similar to that of the member above it. The type section is in the West Hills near the mouth of Portage Canyon, Utah, T. 14 N., R. 4 W.

Overlying the Gettel, High Lake, or Portage Canyon Members, again depending on geographic position, is the Jack Valley Member, named by Rush (1956). The member is best developed in south-western Utah and east-central Nevada (Barn Hills, Cherry Creek Range, southern part of the Egan Range). It is absent in southern Nevada and in the region of the Tooele Arch. In northern Utah a few feet of strata at Tony Grove Lake and possibly in Logan Canyon are assigned to this member. It is a brownish-black to medium brownish-gray,weathering brownish gray to light brownish gray, microcrystalline to very finely crystalline dolostone that is thin- to very thick-bedded and partly laminated. It averages about 110 feet thick. It, of all the members, appears to have been deposited in the lowest energy, subtidal environment. The type section is west of Gettel Playa, Barn Hills, Utah.

The Decathon Member, named by Rush (1956) is the uppermost unit tentatively assigned to the Laketown Dolostone. It is composed of medium brownish-gray to light olive-gray, microcrystalline to medium-crystalline dolostone, which ranges from thick- to very thick-bedded. In places it appears to disconformably overlie the Portage Canyon and Jack Valley Members. The member weathers from medium brownish gray to very light gray. It averages 220 feet in thickness in more western sections; to the east it is much thinner. It is absent in central Utah and thin in northern Utah. The Decathon was deposited in a subtidal environment similar to that of the High Lake Member. The type section is in the Snake Range, Nevada, but because the upper and lower contacts are more readily distinguished at Tony Grove Lake, we use the latter as a reference section.

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