ABSTRACT

A study of regional Devonian relationships throughout central and western Utah and adjacent areas of Idaho, Wyoming and Nevada leads to unification and simplification of the existing diverse rock unit nomenclature and the determination of the valid limits of applicability of established formation names. Regional relationships of the Devonian stratigraphy are examined by means of isopach and lithofacies maps.

For purposes of this study the Devonian Sequence is arbitrarily divided into three operational lithic intervals which are established on the basis of criteria recognizable throughout the region. Each interval is examined in terms of sediment distribution and depositional environment. Tectonic environment is inferred from thickness and gross lithologic aspect. The three lithic intervals are, in ascending order, the Sevy, the Jefferson and the Three Forks. The Sevy represents predominantly restricted basinal conditions with the ensuing deposition of primary dolomites. The Jefferson sediments are principally normal marine carbonates and indicate sedimentation in basins and on unstable shelves under essentially open ocean conditions. The Three Forks is composed of calcareous shales and, on the stable shelf, of normal marine limestones. The increased clastic content of the Three Forks interval is interpreted as indicative of increased positive tectonism in the source areas. Finally, the three intervals are integrated in an isopach-lithofacies map of the total Devonian Sequence. This map, with its supporting data, indicates that the deposition of the Devonian

Sequence in the area of study was controlled by two tectonic environments--the stable shelf to the east and south and, peripheral to this, on the west and north, the miogeosyncline. Several subsidiary basins and swells are recognized within the miogeosyncline. The record demonstrates the existence of a complete Devonian section in at least one of these basins and evidence is ample to indicate the transgression of Devonian seas eastward and northward from this basin into the remainder of the miogeosynclinal area and, ultimately, onto the stable shelf.

REGIONAL DEVONIAN STRATIGRAPHY

IN CENTRAL AND WESTERN UTAH

by

JAMES ELWOOD BROOKS

A thesis submitted in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

UNIVERSITY OF WASHINGTON

1954

Approved by ____________________
Department ____________________
Date ____________________

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ILLUSTRATIONS

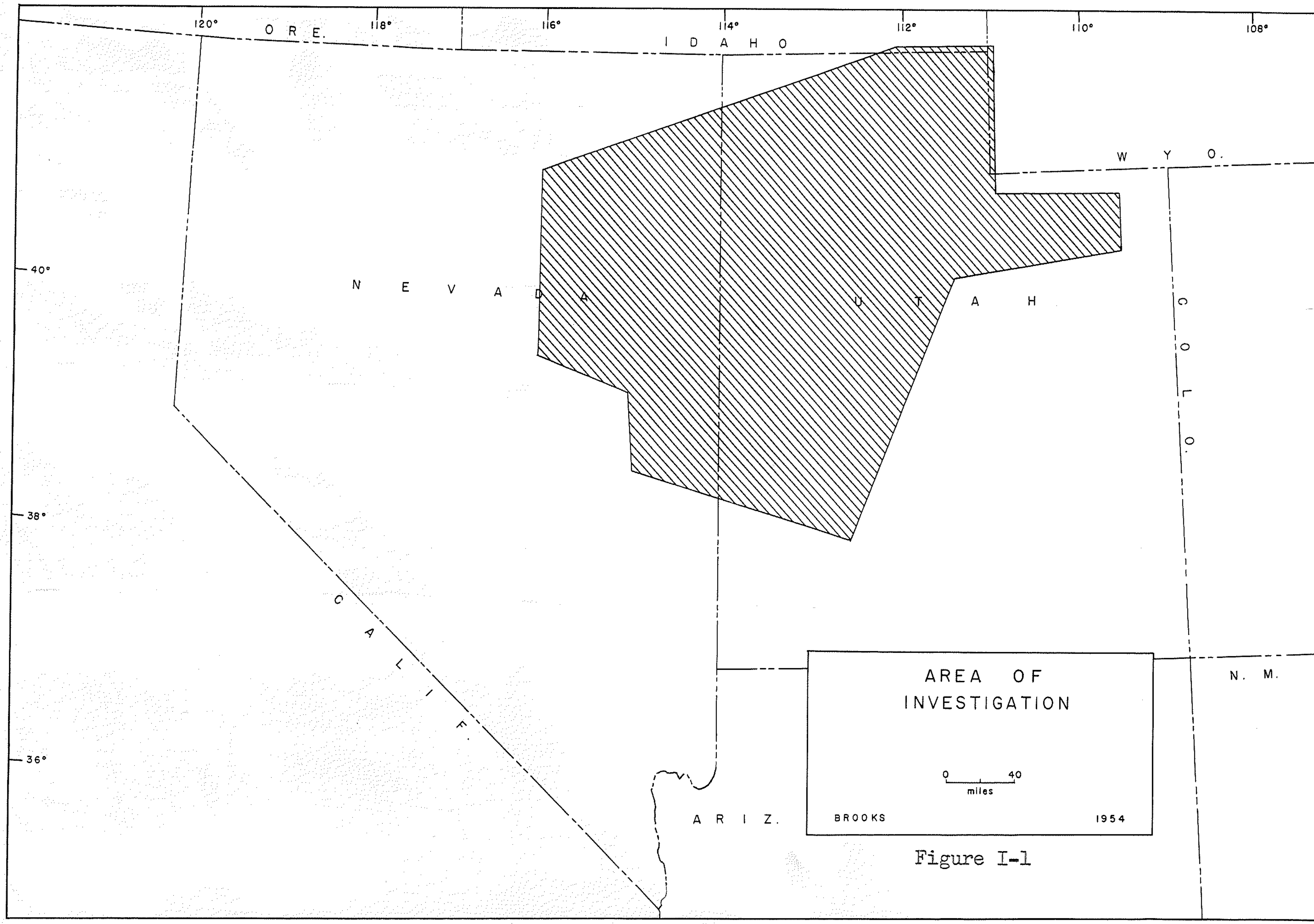
CHAPTER I

INTRODUCTION

STATEMENT OF PROBLEM

Strata of Devonian age occur throughout central and western Utah and in adjacent portions of Nevada, Idaho and Wyoming. The regional relations and significance of these rocks has not been clearly understood in the past. It is the purpose of this study to examine the regional distribution of these Devonian strata, to suggest correlations of known stratigraphic units, and to report and correlate previously undescribed sections. Attempt is made to clarify and simplify the diverse nomenclature which has been applied to the Devonian in the region and adjacent areas. The existing stratigraphy is interpreted in terms of sedimentary environments, regional tectonic environments and paleogeography.

The area of study is bounded on the east and southeast by the zero Devonian isopach which runs generally southwest from the vicinity of Whiterocks, Utah, to the vicinity of the southwest corner of the state. In northeastern Utah arbitrary limits are determined by the extent of Andrichuk's (1951) study of the Devonian in Wyoming and Idaho, and the limits thus established coincide approximately with the common boundaries of Utah with southeastern Idaho and southwestern Wyoming. To the west and southwest the limits of the problem are established by the location of sections which the writer has been able to examine in eastern Nevada. These are confined to the southern portion of Elko County, the eastern portion of Eureka County, White Pine County and the northern most part of Lincoln County.


120°
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114°
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IDAHO
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NEVADA
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AREA OF INVESTIGATION
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Figure I-1

Briefly, the stratigraphic limits of the problem are: at the base, the Silurian-Devonian systemic boundary or the disconformity that occurs in much of the region between the rocks of those two systems; and at the top, the contact between the Madison limestone, together with its lithic equivalents, and the underlying sediments. It is recognized that in some areas the sediments which lie directly beneath the Madison may be of earliest Mississippian age, but because they are lithologically correlatable with units of demonstrable Devonian age in other areas, they are included within the study. Because of the uncertainty of the upper limit, the term Devonian Sequence is used in preference to Devonian System which denotes acceptance of only time-stratigraphic boundaries as the limiting criteria of vertical interval.

METHODS OF STUDY

Because little subsurface data is available in the region most of the basic stratigraphic investigation was carried on in the field. Previously described stratigraphic sections of Devonian rocks were visited, remeasured, sampled and described. In addition, regional reconnaissance revealed seven previously undescribed sections. These were also examined in detail, where conditions permitted, and are recorded in the Appendix of the thesis. In some instances it was impossible to examine new sections in detail and this fact is noted at the beginning of these sections. Subsurface data were available from three wells and generalized descriptions of these data are included. Pertinent literature in and peripheral to the area of investigation was also employed. A total of thirty two stratigraphic sections were examined and the results applied to the study. Twenty six of these are measured surface sections, three are surface sections covered in reconnaissance only, and three are from the subsurface. In addition, data from three published surface sections not visited by the writer were used.

Lithologic samples were collected at appropriate intervals, described in the field and restudied in the laboratory. Where obtainable, faunal material was collected and subsequently identified. The fossil material is on file as Lot No. 2, University of Washington, Department of Geology, Paleontology Thesis Collections.

The data made available by the above investigation is expressed in the form of stratigraphic cross sections, isopach and lithofacies maps, paleogeologic maps, comparative nomenclature tables and interpretive cross sections designed to aid in expressing the erosional and transgressional relationships of the Devonian interval.

The lithologic data are analysed by application of the principles set forth by Sloss, Krumbein and Dapples (1949). Additional references on which interpretations are based are cited in the appropriate places in the text. The conventional statistical lithologic triangle has been modified in various ways in order to most effectively portray the distribution of significant petrographic end members, and to thus indicate distribution of sedimentary and tectonic environments. The modification applied to the triangle used on a particular map is discussed in the introductory material accompanying the interpretation of that map.

Correlation of formations is based almost entirely upon lithologic criteria. Faunal formation boundaries established by other workers are so indicated, and suggestions are made for appropriate revision. By recognizing only valid lithic units it is believed that formations constituting useful cartographic units have been regionally determined.

ACKNOWLEDGMENTS

Expression of gratitude is due many persons and organizations who have contributed in various ways to the study. They are: The Gypsy Exploration Division of the Gulf Oil Corporation which made possible the field investigations through a generous research grant; D. R. Collier and E. J. Baltrusaitis of the Gulf Oil Corporation for their cooperation and assistance in expediting the field investigations; W. L. Stokes, University of Utah, J. Stewart Williams, Utah State Agricultural College, Harold J. Bissell, Brigham Young University, Ralph Kraetsch and John C. Young, Standard Oil Company of California, C. W. Merriam, T. B. Nolan, M. D. Crittenden, Jr., T. S. Lovering, Helen Duncan and Jean Berdan, all of the United States Geological Survey and Walter Sadlick, University of Iowa, all of whom have contributed information, suggestions and criticisms which bore on the problem; Charles Ryniker, Gulf Oil Corporation, John M. Andrichuk, formerly of Gulf Oil Corporation, and Curtis J. Little, Gulf Oil Corporation, for stimulating and helpful discussions in the field and laboratory which aided materially in the synthesis and interpretation of the accumulated data; Bob F. Perkins, Southern Methodist University, for reading and criticizing the manuscript. Especial appreciation is expressed to: Roger M. Matson, Gulf Oil Corporation, who was the writer's field assistant during the first summer of investigation and whose physical assistance and thought-provoking questions contributed materially to the progress of the study;

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CHAPTER II

HISTORY OF STRATIGRAPHIC INVESTIGATION

The development of knowledge concerning the stratigraphy of the area of study may be divided into three general categories which are separated to some extent chronologically, and by their aims, methods and results. The first knowledge of the geology of the region was obtained from the reports brought back by the early explorers and, somewhat later, by the Survey expeditions dispatched by the United States Government. Following the early exploration the work of the United States Geological Survey parties in the various mining camps has contributed greatly to the fund of knowledge available. Finally, extensive stratigraphic work has been carried on by several major oil companies in the region. This information is for the most part unavailable to the general public, and hence cannot now be employed. In addition to these categories of investigators, scattered local areas have been mapped and described by geologists working independently of major supporting organizations.

Practically all parts of the region have been studied in part by the various early government surveys in the West. However, no one of these examined and described the entire region. The first expedition to report on the geology within the region was that directed by Stansbury in 1849. This expedition explored the general area of Great Salt Lake and northeastern Utah and, although no geologist accompanied the party, collected scattered fossils which were later identified by James Hall. Included among the specimens were some belonging to the

"Silurian or Devonian." In 1859 and 1860 a preliminary survey party of the Army Corps of Topographic Engineers, commanded by Captain J. H. Simpson, made a traverse from western Utah across central Nevada to California in search of a wagon road. Although this was primarily a topographic survey their reports carry notations of the presence of Devonian and other Paleozoic rocks. Following the Civil War more extensive explorations were financed by the government. Four major surveys were made during the late 1860's and 1870's. However, of these, the Hayden Surveys and King's Fortieth Parallel Survey have contributed most significantly to the early geologic knowledge. The Wheeler Survey of southern Nevada and western Utah was initiated primarily for topographic exploration, but after two years in the field a geologist, G. K. Gilbert, was appointed to accompany the survey. During this time Gilbert developed some of the concepts concerning the region's stratigraphic and structural history for which he was later to become noted. The Powell Surveys were confined principally to the Colorado Plateau area and their results concern the present investigation only in the Wasatch Front area.

The Hayden Survey party, in 1871, passed through Cache Valley in the vicinity of Logan, Utah, where geological observations were made. The northern part of the Logan area was included within the Green River Division of the Hayden Survey, and in 1877 was described by Peale who worked from Logan Canyon northward. Peale, who was the mineralogist with the Hayden group, had at an earlier date described the southwestern Montana area in the vicinity of Three Forks. He is credited with recognizing and naming the Devonian Three Forks and Jefferson formations of that area.

The area which King's Fortieth Parallel Survey examined is bounded on the north by a line running approximately through Logan, Utah, and on the south by a line immediately south of Provo, Utah. Other than the mention by the Stansbury expedition of Carboniferous rocks in northeastern Utah, King's party was apparently the first to do stratigraphic work in the region. That part of the region lying within the present study area was explored and mapped during the 1868 and 1869 field seasons, and the resuls were presented in a series of reports published in the middle and late 1870's. King is credited with naming the "Wahsatch" formation which included rocks of Ordovician to Mississippian age. The stratigraphy has subsequently been restudied, however, and this name abandoned (see Chapter III).

After the surveys had been completed workers commenced investigating the geologic aspects of certain specific problems or localities. The results of these studies have continued to appear in the literature since the late 1800's. Of significance among these are: G. K. Gilbert's works on Lake Bonneville and on Basin and Range structure; Arnold Hague's work in the Eureka District, Nevada; Walcott's study of the Cambrian fauna of Blacksmith Fork and the House Mountains, Utah; Richardson's study of the Paleozoic stratigraphy of northern Utah and adjacent areas of Idaho; Butler's report on the Frisco Mining District, Utah; Lindgren and Loughlin's investigation of the Tintic Mining District, Utah; Spencer's work in the Ely District of Nevada; Nolan's studies in the Deep Creek Range and the Gold Hill Mining District, Utah; Mansfield's investigations in northeastern Utah; Gilluly's mapping of the Stockton-Fairfield Quadrangles, Utah; Calkin's and Butler's report on the Cottonwood-American Forks Mining Area in the Wasatch Mountains; Merriam's detailed study of the Devonian of the Roberts Mountains Region, Nevada; J. Stewart William's investigation of the Logan Quadrangle, Utah; and the current work of the United States Geological Survey in the Tintic, Wasatch Front and Confusion Range areas. The stratigraphy in many of these studies has, of necessity, been incidental to other aspects, and hence few detailed regional stratigraphic observations have been made. Because of the restricted nature of most of these investigations, the burdensome stratigraphic nomenclature of the region has developed. It is hoped that the present and subsequent regional studies will aid in simplifying the complexities of terminology that serve so frequently to obscure the regional relationships.

CHAPTER III

REGIONAL STRATIGRAPHY

GENERAL STATEMENT

The purpose of this chapter is to acquaint the reader with the stratigraphy of the Devonian System throughout the area of central and western Utah and eastern Nevada and, as a further aid to regional interpretations, the general stratigraphy of the systems which immediately overlie and underlie the Devonian. The various lithic units are not discussed in exhaustive detail. Rather, an attempt is made to provide a framework on which to base the regional interpretations covered in Chapter IV.

A further function of this chapter is to indicate correlations which may exist between various formations and to suggest simplifications of the stratigraphic nomenclature arising from synonomies of formational names.

SUMMARY OF RESULTS OF PREVIOUS WORK

Relatively little was known concerning the regional stratigraphic relationships of the Devonian and other Paleozoic Systems in central and western Utah before the period of intensive petroleum exploration immediately following World War II. Prior to that time most stratigraphic information was of a local character, having been obtained as a by-product of the mapping of various mining districts by the United States Geological Survey and others. A variety of local names was applied since in mapping these districts very little or no attempt was made to correlate local stratigraphic units with those outside the area of study. The knowledge of regional stratigraphic relationships was not regarded as immediately important because the primary objective in most cases was the determination of extent and content of ore mineral occurrences in the area of study. This practice, as it was applied to several districts within the region (e.g., Tintic, Frisco, and American Fork), has resulted in considerable unnecessary confusion regarding the nomenclature and correlations of all the stratigraphic units involved.

PRE-DEVONIAN STRATIGRAPHY

Introduction

The Pre-Devonian stratigraphy is discussed briefly and only insofar as necessary to acquaint the reader with the areal distribution of the Paleozoic systems which directly underlie Devonian strata. Incident to the principal purpose of this discussion is the indication of the scope and importance of unsolved problems concerning the early and middle Paleozoic regional stratigraphy.

Figure III-a shows the areal distribution of the various stratigraphic units which immediately underlie the Devonian. The distribution of the various systems in roughly linear and parallel belts is apparent from the diagram. The significance of the distribution pattern in terms of the geologic history will be discussed later in the section concerning paleogeography (Chapter IV). Figure III-a is intended only to assist the reader in visualizing the position of the units which will be discussed below.

Cambrian

Devonian strata are known to rest on rocks of Cambrian age in

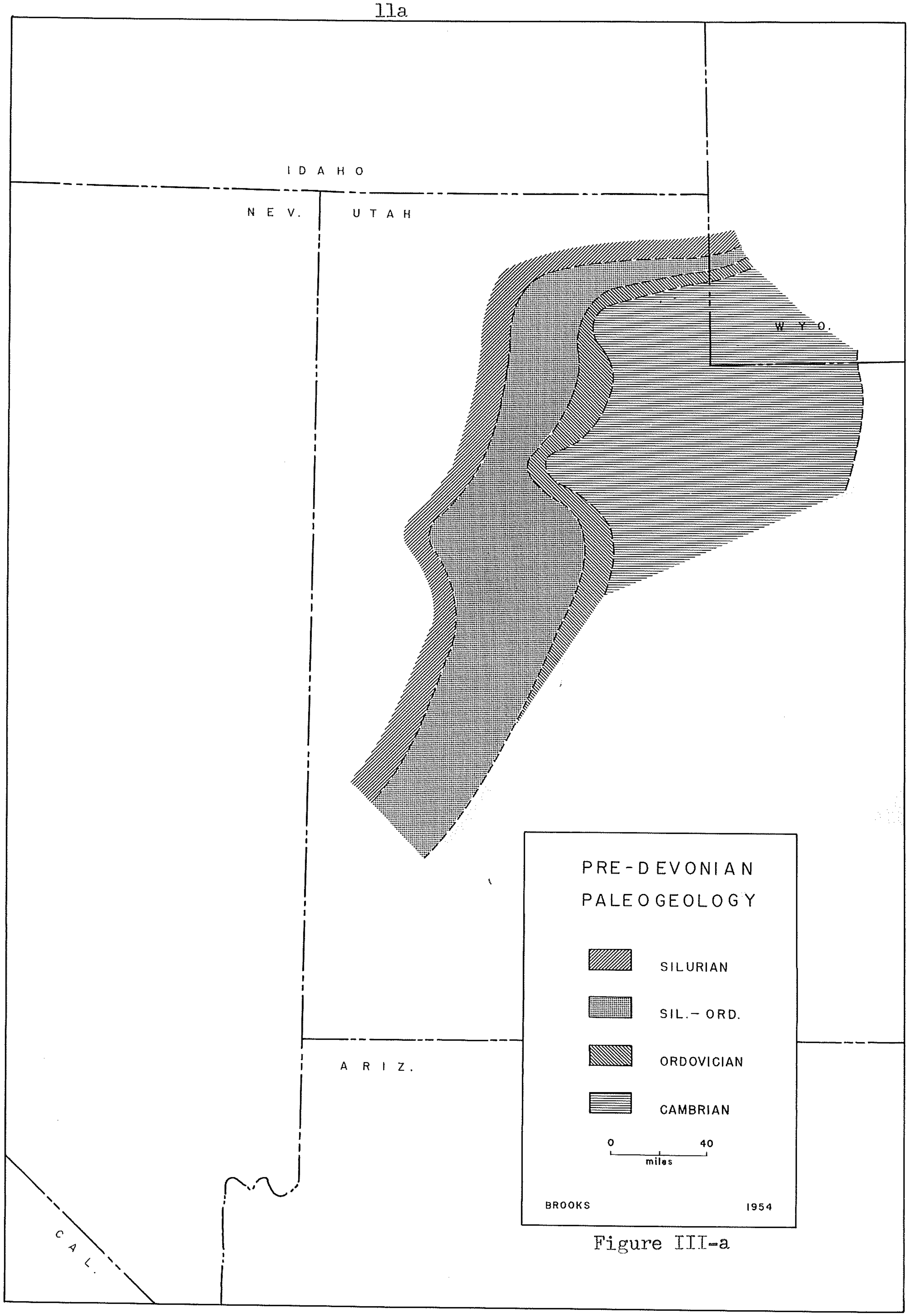
IDAHO
NEV.
UTAH
WYO.
ARIZ.
CAL.
PRE-DEVONIAN
PALEOGEOLOGY
SILURIAN
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Figure III-a

the area of the western terminus of the Uinta Mountains, along the Wasatch Front and in the northern portion of the Wasatch Mountains. At Durst Mountain, in the northern Wasatch, Eardley (1944, pp. 827-830) has described a sequence of light gray, platy limestones with prominently developed, irregular partings of tan to red silt and clay which he refers to the Bowman limestone of Upper Cambrian age. The contact between the Bowman and the overlying limey sandstones and shales of the Three Forks formation is covered at this locality, but parallelism of overlying and underlying beds virtually precludes the possibility of any marked discordance. Farther south, near the Wasatch Front, the basal clastics of what was formerly referred to as the Jefferson(?) limestone (Calkins and Butler, 1943, pp. 18-22) rest with slight discordance on rocks of the Middle and/or Upper Cambrian[1] Maxfield limestone. This relationship is well exposed in Big Cottonwood Canyon, where Devonian beds rest with slight angularity on the dark gray, dense, white-weathering dolomite of the Maxfield. Elsewhere in the area Calkins and Butler have noted that the Maxfield is missing and the Devonian rocks immediately overlie the Middle Cambrian Ophir shale. Thirty miles to the west, in the Oquirrh Range, the same Devonian beds exposed in the Wasatch Mountains rest on the Lynch dolomite, which was tentatively assigned an Upper to Middle(?) Cambrian age by Gilluly (1932, pp. 7-20). This age determination has recently been questioned by Steele (personal communication) and others working in the Oquirrh and Wasatch Ranges. Farther to the south along the

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1. Calkins and Butler (1943), Plate 5 gives age of Maxfield as Upper Cambrian, while text p. 18 gives age as probable Middle Cambrian.

Wasatch Front, immediately northeast of Provo, the same beds present at Big Cottonwood are in contact. Here, however, the entire sequence has been deformed so that the nature of the original relationships is not clearly ascertained. To the east, at the western end of the Uinta Mountains, Devonian strata rest disconformably(?) on rocks of the Tintic quartzite of Middle(?) Cambrian age. Heavy cover precludes determination of the exact nature of the relationships.

Ordovician

Ordovician rocks are known to lie immediately beneath Devonian rocks at one locality within the region. At the Becks Spur section, near the northern limits of Salt Lake City, rocks which have been tentatively referred to the Swan Peak quartzite by Edvalson (1947, pp. 39-40) lie disconformably beneath the shale member of the Becks formation, defined by Edvalson. The Swan Peak at this locality is composed of light gray to white quartzose sandstone and orthoquartzite which are massively bedded at the lowest portion of their exposure, but near the upper limit become thinly bedded, flaggy and calcareous.

Silurian(?) or Ordovician(?)

Between the probable Ordovician occurrence just discussed and the belt of what is definitely Silurian farther to the west and north is a limited area in which, because of obliteration by structural disturbances, poor exposure, or inconclusive faunal evidence, the rocks immediately underlying the Devonian are not specifically dated. The sections included in this belt are Promontory Range, Stansbury Island, Southern Stansbury Range and Dugway Mountains.

The locality at which the section on the Promontory Range was measured is structurally complicated. Lithologies suggestive of the Ordovician Fish Haven dolomite were noted a short stratigraphic distance below the Devonian, but were present in insufficient quantity and continuity to warrant a definite recognition of their presence.

Dark grey dolomites bearing a prominent fauna of Halysites and other corals underlying the Devonian at Stansbury Island probably belong to the Laketown dolomite of Middle Silurian age. The Halysites and other chronologically significant corals have not been specifically determined, however, and hence are only tentatively assigned to the Silurian.

At the Southern Stansbury Range section, Devonian rocks are immediately superjacent to dark grey to black, saccharoidal dolomites which bear a prominent coralline fauna of Halysites, Favosites and Columnaria. This unit also appears to be Laketown. Pending better faunal determinations, however, the rocks are only tentatively referred to the Silurian.

The base of the Dugway Mountains Devonian section is not exposed and relationships with underlying rocks, therefore, could not be determined. Endeavors to find the basal Devonian contact elsewhere in the range were unsuccessful. Because of their relative location to the west of known Cambrian and probable Ordovician occurrences, it is likely that the rocks subjacent to the Devonian here will prove to be of Silurian age.

Silurian

Examination of the westerly and northerly portion of the region of study shows the strata directly beneath the Devonian rocks to be the

Laketown dolomite of Silurian age. However, at the western periphery near Lone Mountain, Nevada, the Silurian is represented by the Lone Mountain and the underlying Roberts Mountains formations. The contact between the Silurian and the overlying Devonian beds shows parallelism in practically all cases. In some instances, particularly where the contact is exposed for some distance laterally, as at Deep Creek (Nolan, 1935, pp. 17, 18) the upper surface of the Laketown dolomite is observed to be irregular, a relief of 2 to 6 feet being common. It is concluded, therefore, that at least locally, the upper beds of the Laketown were exposed to erosion before the basal Devonian strata were deposited. The Silurian-Devonian contact exposed in the Lone Mountain, Nevada, section at the extreme western edge of the region of study is, however, tentatively established only on faunal evidence (Merriam, 1940, p. 13), the boundary lying somewhere within the Lone Mountain formation, as redefined by Merriam (p. 13). At this locality vertical lithic continuity is present from uppermost Silurian rocks into lowest Devonian beds.

The Laketown dolomite in its type area (Richardson, 1913, pp. 407, 410) in Laketown Canyon, east of Laketown, Utah, is composed of about 1,000 feet of light grey, saccharoidal, massively bedded dolomite, which varies in crystallinity from medium to coarse and which bears a characteristic coralline fauna dominated by the genus Halysites. In many portions, the Laketown is sandy and this property is sufficiently common, particularly in northeastern Utah, to be recognized as one of the characteristics of the formation. In western Utah and eastern Nevada, however, the Laketown has developed somewhat different properties. While these variances are not of sufficient magnitude to warrant the recognition of a different formation, they are of enough importance to receive mention. The Laketown, characteristically of a uniform light gray color to the northeast, is, in western Utah and easternmost Nevada, composed of a light gray dolomite unit at the base, which grades rather abruptly into a dark gray to black dolomite unit at the center. This in turn gives way rapidly to a light gray unit at the top of the formation. Except for these distinct color changes the Laketown conforms in characteristics to those noted at the type section. The lateral variance of these color units is of further interest. Toward the western portion of the area the upper and lower, light gray members become dominant at the expense of the dark gray middle member. At Lone Mountain and in the Southern Ruby Mountains this unit is not recognizable. To the east, however, the light gray bounding units gradually decrease in expression, while the dark gray increases, until finally at the easternmost exposures the formation is represented entirely by dark gray to black dolomites. The northeastward extent of this sequential pattern in the Laketown is at present undetermined.

DEVONIAN STRATIGRAPHY

Introduction

In the region as a whole, definite chronologic boundaries cannot be established for the Devonian System. The principal difficulties stem from the fact that in much of the succession fossiliferous limestones have undergone thorough dolomitization. In the process practically all elements of the fauna have been replaced or recrystallized. For this reason it is often impossible to remove fossils from the enclosing matrix. In many cases, also, the specimens which are obtainable have been rendered virtually useless by the obliteration of characteristic features or by the complete destruction of the original entity. Often only the calcitized or dolomitized "ghosts" of fossils remain, particularly in the Jefferson limestone and its correlatives. Another difficulty with regard to faunal control arises from the barren or nearly barren character of the basal Sevy dolomite and its correlatives, and the only slightly more fossiliferous nature of the uppermost Three Forks formation and its correlatives. It is thus apparent that the establishment of accurate age relationships within the sequence is difficult and often impossible.

Throughout the region, except in the Lone Mountain-Roberts Mountains area of the extreme west, the base of the Devonian System is recognized as lying above the disconformity separating the Middle Silurian Laketown dolomite, or various rocks older than the Laketown, from the overlying Sevy dolomite of Early or Early Middle Devonian age. At its type locality the Lone Mountain formation (redefined) embraces sediments of Late Silurian and Early Devonian age, and the boundary is tentatively established by Merriam (1940, pp. 10-14) on a faunal basis.

The upper limits of the Devonian system have traditionally been accepted as the contact between the Three Forks formation of Late Devonian age and the overlying Madison limestone of Early Mississippian age. The Cyrtospirifer fauna, regarded by Fenton and Fenton (1924) as representing the Late Devonian Hackberry stage, is recognized at many places throughout the area within the upper 100 feet of the Three Forks formation and its equivalents. This age for the Cyrtospirifer fauna has recently been questioned, and it has been suggested that the fauna is Early Mississippian (for a thorough discussion of the question see Stainbrook, 1947, 1950, and Crickmay, 1952). If it is assumed that this suggestion is correct, then the upper portion of the Three Forks formation and its equivalents is lowest Mississippian, and the unit thus straddles the arbitrarily established systemic boundary. This in no way disturbs the fundamental relationships of the problem, since lithic units are notoriously disrespectful of the time framework later to be superimposed on them for purposes of reference. However, the acceptance of this suggested partial Mississippian age renders invalid the application of the term "system" to the group of rocks in question. For this reason the term "Devonian Sequence" is applied and is defined as follows. The Devonian Sequence comprises those lithic units lying above the stratigraphic position of the Silurian Laketown dolomite or the Silurian portion of the Lone Mountain formation (redefined), and below the contact of the Three Forks formation and its lithic equivalents with overlying rocks of Mississippian age. This application of "Devonian" is believed valid and useful, since all lithic units included in the sequence have either had the preponderance of their deposition in Devonian time or may be correlated with units that are principally of Devonian age.

The formations discussed in the following paragraphs are taken up in the approximate order of their ages from oldest to youngest, and correlative units are discussed sequentially in the order of priority of their formational names.

The table (Figure III-1) on the following page illustrates the principal nomenclatures used for the Devonian of the region. A map (Figure III-2, p. 19b) shows the approximate location of the prominent physiographic and political features to which frequent reference is made. Three stratigraphic cross sections (Figures III-3, III-4 and III-5) showing the lithic correlations of the Devonian Sequence in Utah and Nevada are included at appropriate places in the chapter.

Devonian Formations

Sevy formation

The Sevy dolomite was named by Nolan (1930) for its prominent exposures along the walls of Sevy Canyon on the west side of the Deep Creek Range, south of the Gold Hill Mining District, near the Utah-Nevada line. The formation in the type area rests on an erosional surface at the top of the Silurian Laketown dolomite and lies conformably beneath the Middle Devonian Simonson dolomite into which it grades. The writer concurs with Nolan's comment that the unit in the type area is remarkably homogeneous. However, lateral changes are apparent within the formation regionally. For this reason the term "formation" is applied in preference to "dolomite." The Sevy in the type area is characteristically light gray to cream colored on fresh fracture and commonly weathers almost white. It is dense to cryptocrystalline in texture, is extremely compact and commonly breaks with conchoidal fracture. Typical beds are 6 to 18 inches in thickness but the bedding is not distinctively developed. In many portions of the section the character of the parting is less striking upon initial inspection than are the laminations which persist throughout the vertical extent of

FIGURE III-1

COMPARATIVE NOMENCLATURE OF DEVONIAN SEQUENCE
EASTERN NEVADA, CENTRAL AND WESTERN UTAH

ROBERTS MOUNTAINS REGION, NEVADA (Merriam, 1940)	SOUTHWESTERN UTAH-EASTERN NEVADA (Spencer, 1917; Nolan, 1930)	NORTHEASTERN UTAH (Richardson, 1913; Williams, J.S., 1948)	WASATCH FRONT (Williams, N.C., 1953; present writer, 1954)
Devils Gate formation	Pilot shale	Three Forks formation	Pinyon Peak limestone
			Victoria formation
	Guilmette formation	Jefferson formation	(Non-deposition)
Nevada formation (redefined)			
	Simonson dolomite		
Lone Mountain formation (redefined) ?	Sevy dolomite	Water Canyon formation	

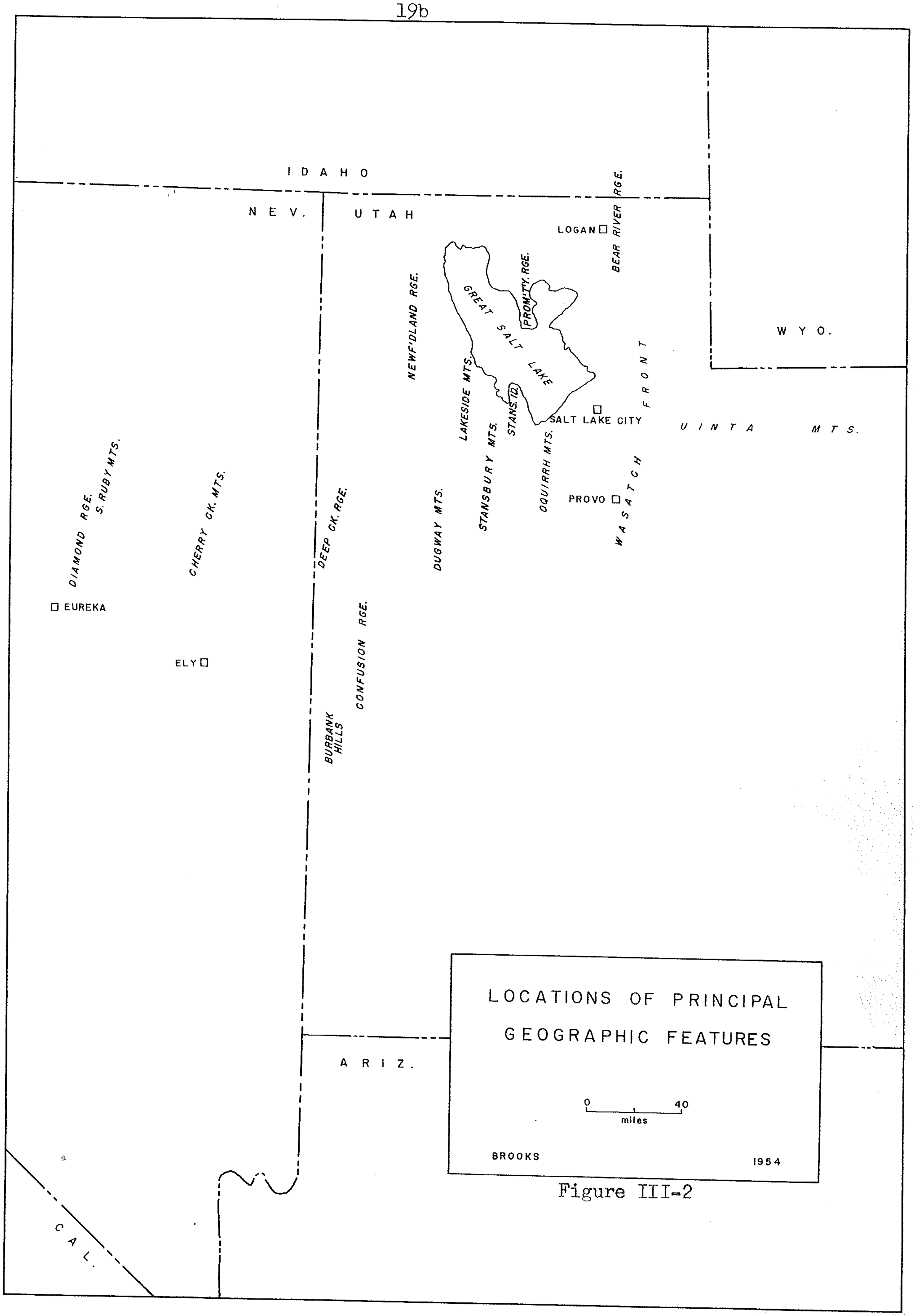
IDAHO
NEV.
UTAH
LOGAN
BEAR RIVER RGE.
PROMONTY. RGE.
GREAT SALT LAKE
NEWF'DLAND RGE.
WYO.
FRONT
LAKESIDE MTS.
STANS. ID.
SALT LAKE CITY
UINTA MTS.
STANSBURY MTS.
OQUIRRH MTS.
PROVO
WASATCH
DIAMOND RGE.
S. RUBY MTS.
CHERRY CK. MTS.
DEEP CK. RGE.
DUGWAY MTS.
EUREKA
CONFUSION RGE.
ELY
BURBANK HILLS
ARIZ.
CAL.
LOCATIONS OF PRINCIPAL GEOGRAPHIC FEATURES
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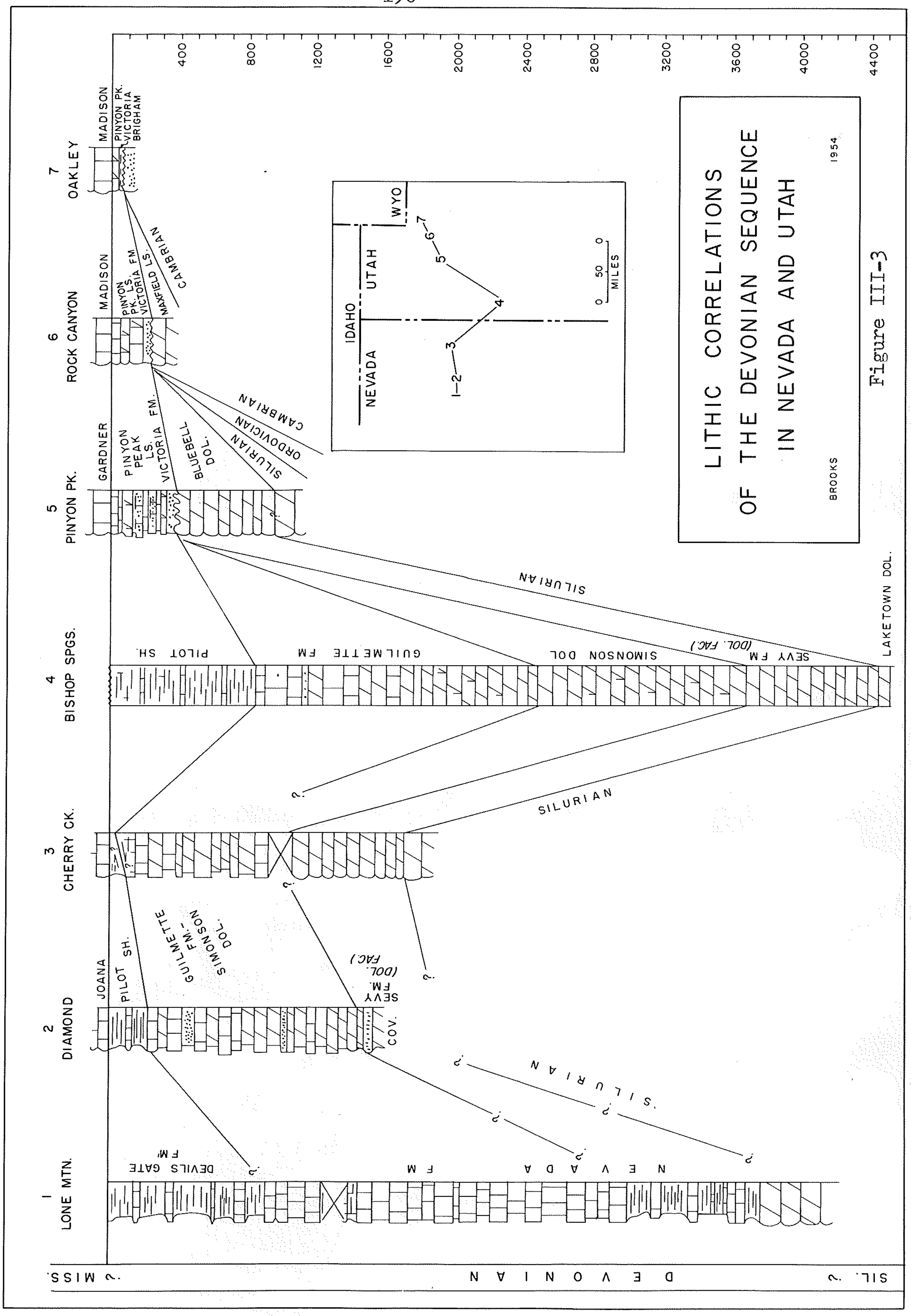
Figure III-2


LITHIC CORRELATIONS OF THE DEVONIAN SEQUENCE IN NEVADA AND UTAH
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1954
1 LONE MTN.
2 DIAMOND
3 CHERRY CK.
4 BISHOP SPGS.
5 PINYON PK.
6 ROCK CANYON
7 OAKLEY
400
800
1200
1600
2000
2400
2800
3200
3600
4000
4400
MADISON
PINYON PK.
VICTORIA
BRIGHAM
PINYON PK. LS.
VICTORIA FM
MAXFIELD LS.
CAMBRIAN
GARDNER
PINYON PEAK LS.
VICTORIA FM.
BLUEBELL DOL.
SILURIAN
ORDOVICIAN
PILOT SH.
GUILMETTE FM
SIMONSON DOL
SEVY FM
(DOL. FAC.)
LAKETOWN DOL.
JOANA
PILOT SH.
GUILMETTE FM.–SIMONSON DOL.
SEVY FM. (DOL. FAC.)
COV.
DEVILS GATE FM.
NEVADA FM
IDAHO
UTAH
NEVADA
WYO
0 50 0 MILES
? MISS.
DEVONIAN
SIL. ?

Figure III-3

the unit. The laminations are parallel to the parting and are noticeable as darker lines against the very light basic color of the unit. On weathered outcrops, the inter-laminar areas of dense, light gray dolomite are commonly etched out, the laminations being relatively less resistent to weathering. The laminations which appear to represent slight variations in the basic dolomitic composition are typically separated by 1/4 to 1 inch thick intervals of dolomite. As indicated by Nolan, the basal beds of the formation are conglomeratic, being composed of pebbles of the underlying Laketown dolomite and also including pebbles of the same lithology as the enclosing Sevy which show random bedding orientation, as indicated by the laminations. Nolan explains the apparent anomaly of pebbles of a formation occurring in the basal conglomerate of the same formation by suggesting the initial precipitation of the sediment on a relatively shallow bottom which was subject to periodic disturbances by storms of large magnitude which broke up the partially or completely lithified sediment immediately below the depositional interface. The angular to subangular pebbles thus produced were, in the period of quiet following the storm, incorporated into the conglomerate. Apparently not present at the type area, but common in other localities, is a relatively thin bed (5 to 10 foot average) of pure, smoky gray, quartzose sandstone which occurs near the top of the formation. This bed has been recognized to the southeast in the Confusion Range, to the west in the Diamond Range, and is probably represented in the Burbank Hills section of Rush (1951a, pp. 12-13). The apparent absence of this unit in the Deep Creek Range may have a possible explanation in the arbitrary definition of the boundary between the Sevy and the overlying Simonson by Nolan. It may be noted that dolomites with sandy partings occur within the basal few feet of the Simonson. Possibly these are the genetic equivalent of the sandstone bed discussed above.

A further characteristic of the Sevy and its correlatives is their slope-making physiographic expression, which is particularly noticeable since the underlying Laketown formation and the overlying Simonson dolomite express themselves physiographically in ridges and benches.

The thickness of the Sevy indicated by Nolan, and corroborated by the writer, is approximately 450 feet in the type area. However, unlike the laterally persistent characteristics of the Sevy, the thickness varies significantly in western Utah and eastern Nevada. The Sevy thickens rather rapidly southward from the Deep Creek Range. In the Confusion Range the thickness of the unit in the Bishop Springs Number 1 well was 770 feet; while only a few miles to the south of the Confusions in the Burbank Hills, Rush (1951a) records a thickness in a measured surface section of 1176 feet for a unit which is probably the Sevy (he applies no formation names); and the Burbank Number 1 well in the same area penetrated 1032 feet of what was recognized as Sevy in the subsurface.

The Sevy is not well exposed on the wooded slopes of the Cherry Creek Range to the west, but was measured at approximately 775 feet. The upper beds of the formation are exposed on the east side of the Diamond Range, but it was not possible to determine total thickness of the unit.

In the Dugway Mountains in central Utah the Sevy was not exposed at the locality where the Devonian section was measured. However, at Pinyon Peak, near Tintic, Utah, 651 feet of what appears to be Sevy is exposed.

Age and Correlation:

The Sevy is almost universally barren of fossils and hence an exact age determination is difficult. Because of the complete lack of diagnostic fossils, and because the Sevy grades upward into the Simonson dolomite which bears a Middle Devonian fauna, Nolan (1935, p. 20) regards the Sevy as "Devonian and probably Middle Devonian." Little better evidence concerning the age of the Sevy is to be found within the depositional basin in which the type area occurs. However, it is the author's opinion that a sound basis for establishing its age occurs in the facies of the Sevy which occurs in north central and northeastern Utah. At these localities the Water Canyon formation (Williams, J. Stewart, 1948, pp. 1138-1139), which is herein considered to be a clastic facies of the Sevy, constitutes the basal formation of the Devonian Sequence. Its lithologic character (to be discussed more fully below) and stratigraphic position almost certainly make it an equivalent of the Sevy. Williams cites Bryant, who affixes the age of the formation as Lower Devonian on the basis of fish fragments, and Dorf, who corroborates the Lower Devonian age of correlative beds at Beartooth Butte, Wyoming, on the basis of the presence of the Psilophyton flora. In view of the evidence it seems valid to assign a Lower Devonian age to the Sevy formation. A more complete discussion of the nomenclatural problems of this portion of the Devonian Sequence follows in the section of the thesis which concerns the Water Canyon formation.

A question concerning correlation with the Burbank Hills section to the south of the type area is apparent upon the comparison of the published section from this locality (Rush, 1951a) with the sections noted in the Burbank Number 1 well, the Bishop Springs Number 1 well (Confusion Range), and the section of Nolan (1935) in the Deep Creek Range. Rush describes a section of 1176 feet of light gray, medium grained dolomite which he refers to the Silurian on the basis of correlation with the Roberts Mountains section of Merriam (1940). The unit as described by Rush is barren of fossils, but overlies Halysites bearing dark gray Silurian dolomites, presumably the Laketown dolomite, and underlies 1940 feet of predominantly dark gray, medium to coarsely crystalline dolomites and limestones which bear a Middle and Late Devonian fauna and which Rush correlates on the basis of this faunal evidence with the Devil's Gate section of Merriam. Some difficulty of interpretation is encountered here, since Rush (1951b, p. 45), in discussing the same units in the same area, describes the "Silurian" rocks as passing transitionally into the overlying Devonian. If the Devonian of Rush is presumed to be correlative with the Late Devonian Devil's Gate, and if the sequence of light colored dolomites underlying it is of Silurian age, it is difficult to reconcile the "transitional" character of their contact. Concerning the contact Rush (p. 45) further notes that in the Snake Range a few miles to the west of Burbank Hills, there are two exposures showing disconformable relations between the two systems, but that no similarly disconformable situation had been noted elsewhere within the area. He therefore concludes that the disconformity is a purely local feature and that the typical relationships within the area are transitional. In view of the above facts, it seems legitimate to question Rush's Silurian age designation of the unit. The Standard Oil Company of California Burbank Number 1 well, drilled in the area of Rush's investigation, penetrated 1032 feet of what was definitely Sevy formation, and below this unit passed through 1485 feet of Laketown dolomite (Silurian) and Fish Haven dolomite (Ordovician) before encountering the Eureka quartzite (Ordovician). Rush (1951a, p. 12) has measured a thickness of 2190 feet for the rocks between the unit in question and the Eureka. However, he points out that a part of the section is known to be repeated by faulting. Comparison of lithologic descriptions and thicknesses of the well and surface sections indicates that the two are essentially identical. Since the stratigraphic section from the Burbank Number 1 well has been shown to closely correlate with that from the Gulf Oil Corporation Bishop Springs Number 1 well, in which the lithologies have in turn been correlated with the Deep Creek section of Nolan (1935), it seems that the Sevy formation may be carried southward with validity to the Burbank Hills. In view of the correlation between the surface "Silurian" rocks and subsurface Sevy at Burbank Hills, and in view of the probable validity of the subsurface recognition of the Sevy, it is suggested that the upper division of Rush's (1951a, p. 12) Silurian unit be recognized as the Sevy formation and be referred, therefore, to an Early and Middle(?) Devonian age. This would obviate the aforementioned difficulty of explaining a transition zone from Upper Silurian rocks into Upper Devonian rocks in a section in which no Early Devonian rocks and only a few possibly late Middle Devonian rocks have been recognized. A second point which should be emphasized in this regard is that in a region with such demonstrable lateral stratigraphic continuity the sudden disappearance of so distinctive a formation as the Sevy in the distance of a few miles is not to be expected. Since no evidence has been presented that would provide a plausible explanation for such an anomaly, either through structural complications or through rapid change in sedimentary environment, the more logical and certainly the more parsimonious explanation is one which recognizes the Sevy as occurring in the Burbank Hills, and redefines the Silurian of Rush (1951a, p. 12) to restrict it to those rocks above the Fish Haven dolomite and below the Sevy formation as herein recognized.

Although the Sevy lithology is widespread throughout western Utah and eastern Nevada the writer has not seen it and is not aware of it having been reported farther west than the Diamond Range, northeast of Eureka, Nevada. Northwest of Eureka in the Lone Mountain-Roberts Mountains area of Merriam (1940), there is apparently no exact lithic equivalent of the Sevy. It is possible that all or a portion of the Lone Mountain dolomite may constitute a Sevy equivalent. However, their stratigraphy is alike only in that they are both predominantly dolomitic in composition and light gray to white in color. The Lone Mountain is commonly medium to coarsely crystalline, typically saccharoidal and is regarded by Merriam (p. 22) to represent "dolomitization during or immediately following deposition of the lime mud." By contrast the Sevy is dense to cryptocrystalline and is virtually barren of fossils. It is therefore believed to be a syngenetic or primary dolomite. A marked difference between the depositional environments of the Sevy in the Diamond Range and eastward, and equivalent strata in the Lone Mountain-Roberts Mountains to the westward, is thus indicated.

Further difficulty is encountered in exact temporal correlation of the Sevy and the Lone Mountain. Although the upper portion of the Lone Mountain is tentatively regarded as Early Devonian (Merriam, 1940, p. 13; also personal communication, letter, April 7, 1954), the lower portion grades into rocks, of probable Middle Silurian age, suggesting a Middle to Late Silurian dating for the lower portion of the formation. With regard to the Sevy, however, the exact time of commencement of sedimentation throughout the region is not known. Recently Osmond (1954) has noted Halysites in the lower Sevy in east central Nevada, indicating a probable late Silurian age for the lower part of the formation in Nevada. It is not unlikely, however, that the Sevy may transgress time lines to the eastward so that in west central Utah the formation is representative of deposition restricted in age to the Early Devonian. The Sevy is separated from the Middle Silurian Laketown dolomite by a disconformity, demonstrating a depositional hiatus of unknown duration. Thus the time represented by the deposition of the Sevy is not as great as that represented by the Lone Mountain, which constitutes the record of one environmental episode in the history of a basin of continuous deposition in central Nevada during Silurian and Devonian time. It is then apparent that the oldest deposits of the Sevy could not be a time correlative of the oldest portion of Lone

Mountain. It is possible, however, that the Lower Sevy may represent parasynchronous deposition with the upper portion of the Lone Mountain in a depositional basin of somewhat different sedimentary environment.

Water Canyon formation

The Water Canyon formation was named by J. Stewart Williams (1948, pp. 1138-1139) for its well developed occurrences at the fork of Green and Water Canyons northeast of Logan, Utah, in the Logan Quadrangle, Utah. He recognized the formation as comprising a lower, predominantly dolomitic member 393 feet thick and an upper member composed principally of interbedded clastics (mostly sandstones and siltstones) and carbonates, to which he (p. 1139) assigned a thickness of 150 feet. According to Williams the Water Canyon lies disconformably on the eroded surface of the Silurian Laketown dolomite and is overlain also disconformably by the dark gray to black dolomitized limestones of the Jefferson formation. The writer has seen the formation in Water Canyon and to the southward in Blacksmith Fork Canyon. At the latter locality the sequence was measured and sampled. Unfortunately the lower portion of the section and its contact with the Laketown and the upper contact with the Jefferson were not well exposed, so that an exact determination of thickness could not be made. At other localities the writer has observed the disconformable basal relationships of the unit. However, the marked disconformity at the top of the sequence, described by Williams, has not been seen. Support for the existence of the disconformity is found in the southwest portion of Logan Quadrangle in the vicinity of Dry Lake, where the only representative of the Devonian System is the lower member of the Water Canyon which lies disconformably beneath the Mississippian Madison limestone. No conclusive evidence has been reported for the existence of any younger Devonian units in this vicinity. It thus seems likely that in post-Water Canyon and pre-Madison time, uplift and erosion occurred and that its effect is recorded farther to the east in the area east of Logan and that the disconformity reported by Williams in this area is an expression of that positive tectonism. The presence of increasing quantities of clastics in the upper member of the Water Canyon in the area east of Logan may be construed as evidence of a change in sedimentary environment caused by positive tectonic activity in adjacent areas and as heralding the approach of positive tectonism in the Logan area proper.

The lower member of the Water Canyon formation is made up in large part of light gray to white, dense to cryptocrystalline dolomites which show frequent laminations and which are medium to massive in their bedding. They appear to be barren of fossils, are laterally and vertically quite homogeneous, and are thus considered as probably of primary dolomitic origin (a further discussion of primary dolomites is given in Chapter IV). Interbedded with the dolomitic strata are occasional partings and beds of dolomitic sandstones and siltstones. These, also, are typically light gray in color, although some are tan to red. Frequently associated with the latter are mud cracks, ripple marks and beds of intraformational breccia.

The upper member of the Water Canyon formation is intergradational with the lower member and is distinctive because of the increased content of clastics and the relative decrease in dolomites. The clastics are similar to those found in the lower member. The sandy limestones and dolomites at the base of the upper member contain fish fragments which are discussed below with regard to their age significance. Notable, also, in the sequence is the continued appearance of occasional red shales with associated mud cracks. The section is terminated at the top by a zone of intraformational breccia. It was not determined whether the breccia was due to mechanical destruction by waves shortly following deposition or whether groundwater removed soluble materials in underlying rocks at a later time, allowing the collapse of superjacent strata. It is likely that the clastics described above may represent an equivalent of the quartzite which occurs at the top of the Sevy in central and western Utah and eastern Nevada.

The Water Canyon strata are uniformly rather unresistant to weathering, and for this reason the formation is not prominently exposed. For detailed lithic descriptions the reader is referred to the measured sections in the Appendix and to the detailed sections given by Williams (J. Stewart, 1948, p. 1139).

Age and Correlation:

On the basis of the fish fauna mentioned above the formation has been dated by Bryant (Williams, J. Stewart, 1948, p. 1139) as Lower Devonian. Williams (p. 1139) discusses further faunal evidence which confirms a Lower Devonian age for the Water Canyon.

Rocks of the Water Canyon formation are developed throughout much of northeastern Utah. The southern limit of exposure of the Water Canyon apparently lies south and east of the Logan Quadrangle, for the formation is not present to the east at Laketown or Randolph nor is it recognized at Durst Mountain in the northern end of the Wasatch Range to the south. To the northeast, the Wyoming Shelf of Andrichuk (1951) shows no apparent correlative (Brooks and Andrichuk, 1953).

In north central Utah the Water Canyon is recognized in two ranges. In the Lakeside Mountains the Water Canyon lies disconformably on the Silurian Laketown dolomite and disconformably beneath the limestones and dolomites of the Devonian Jefferson formation. Young (1953), who has mapped the southern portion of the range in detail, reports a Water Canyon thickness of about 250 feet and reports fish fragments similar to those described by Williams (1948, p. 1139) from the Logan region. On this basis Young confirms the age as Lower Devonian. The lithology here, as at Logan, is predominantly one of light gray, dense, frequently laminated primary dolomites with some clastics, particularly in the upper portions.

West of the Lakeside Mountains, in the Newfoundland Range, the Water Canyon was recognized by the writer in reconnaissance observations. It occurs there with an estimated thickness of 500 feet and with the same lithology elsewhere ascribed to the Water Canyon. Regretably it was impossible to return to the range for a more detailed examination of these and higher Devonian rocks. To the extent of the writer's knowledge no information is available from the literature concerning the Newfoundland Range; hence the estimated data must suffice.

The Water Canyon formation, as mentioned previously, is here considered to be equivalent with the Sevy dolomite of Nolan (1930,

1935) of central and western Utah and eastern Nevada. Particularly convincing evidence for correlation is found in the strikingly similar lithology. Light gray, dense, primary dolomites are characteristic of both formations. Nowhere else in the Paleozoic sequence of the northeastern and central Great Basin is there exposed so thick and homogeneous a sequence of rocks of this very distinctive lithic type. The occurrence of this diagnostic rock unit at the same position in the stratigraphic sequence and with about the same thickness seems more than coincidence. The writer therefore concludes that the Water Canyon formation and Sevy dolomite are parts of the same stratigraphic unit. In recognition of their equivalence it is suggested that Sevy, being the prior name, be applied to this lithic unit throughout the region and that the name Water Canyon be abandoned. It is further suggested that the term "dolomite facies" be applied to those parts of the Sevy formation which are uniformly of dolomitic composition and that the term "clastic facies" be applied to the parts of the formation which contain significant portions of clastic material. In general the dolomite facies occurs in western Utah and eastern Nevada and the clastic facies in north central and northeastern Utah and adjacent areas in which the Sevy occurs. The recognition of these facies is made in the belief that in a unit so lithologically distinctive as the Sevy even minor lateral variations in composition are worthy of attention as indices of environmental change. For purposes of definition the dolomite facies extends as far north and east as the Newfoundland and Lakeside Ranges. In this vicinity changing tectonic environment produces the clastic facies which is present northward and eastward throughout the remainder of the area of study.

Lone Mountain formation (redefined)

The Lone Mountain limestone was originally defined by Hague (1892, p. 57) to include all the beds between the top of the Eureka quartzite (Ordovician) and the base of the Nevada limestone (Devonian). However, the stratigraphy of the region was restudied by Merriam (1940), who redefined (pp. 13-14) the Lone Mountain limestone of Hague. The term Lone Mountain formation was retained by Merriam for the upper portion of the original formation, while the lower part of the Lone Mountain limestone was divided into two formations--the Hanson Creek formation of Late Ordovician age and the overlying Roberts Mountains formation of Early and Middle Silurian age. The Lone Mountain formation (redefined) embraces that group of strata above the top of the Roberts Mountains formation, which is predominantly medium to dark gray limestone, and below the base of the Nevada limestone which is composed, at its base, of tan-weathering, dark, blue-gray platy limestones with prominent tan argillaceous partings. The Lone Mountain at the type area is reported by Merriam (p. 13) to be 1570 feet thick, with which the writer's own measurement essentially concurs. It is composed rather uniformly throughout its vertical extent of medium to light gray, almost white weathering, medium to very coarsely crystalline dolomites. Its bedding is massive, but rather poorly developed and is only occasionally finely laminated with irregular to curly light and dark gray laminae. In some portions the unit appears slightly sandy, but this is not a prominent feature. One of its most striking characteristics, as seen from a distance, is its relative resistance to erosion. This feature is well displayed on the southwest flank of Lone Mountain, where the formation supports a prominent ridge which stands distinctively above the saddle made by the lower argillaceous limestones of the basal Nevada formation.

Age and Correlation:

As indicated in the discussion of the Sevy formation, the exact relationship of the mid-Paleozoic succession of central Nevada to that toward the east in eastern Nevada and western Utah is not clearly understood. It is possible that the upper portion of the Lone Mountain formation (redefined) represents a chronologic equivalent of the lower part of the Sevy formation. However, despite their similarly light gray to white color, other characteristics are sufficiently different to make their correlation questionable. If the overlying and underlying formations could be correlated with eastward equivalents, correlation of the Lone Mountain and Sevy would appear more plausible. However, since the entire middle Paleozoic sequence in central Nevada displays variant characteristics with its counterpart to the east, little credence is lent to the lithic correlation of the Sevy and Lone Mountain. They are not, therefore, presently correlated.

Jefferson formation

The Jefferson formation of northeastern Utah was originally included in the Wahsatch limestone, defined by King (1876, pp. 478-480). However, later work by Richardson (1913) showed that the Wahsatch limestone of King actually contained beds of Ordovician to Mississippian age. Moreover, the name was preoccupied by Tertiary beds occurring within the same region. Consequently the term Wahsatch was abandoned for these Paleozoic rocks. Richardson, among his other revisions of the Wahsatch, recognized two formations of Devonian age which he correlated with the Jefferson limestone (Peale, 1893) and the Three-forks shale (Peale, 1893) of southwestern Montana. Richardson applied the above names in the Randolph Quadrangle of northeastern Utah.

The Jefferson was described by Richardson as about 1200 feet thick, composed of massive, fine grained, dark colored dolomite which characteristically weathers brown. It was considered by him to lie conformably beneath the Three Forks formation and to lie disconformably on the Laketown (dolomite). Evidence for the disconformable basal relationships was found in the absence of faunas representative of the Early Devonian and Late Silurian. Apparently no physical criteria for disconformity were noted. The formation has been further studied in this area by Mintze (1913), Mansfield (1927), Richardson (1941) and Williams (1948) farther to the west in the Logan Quadrangle.

The writer has observed the Jefferson at several localities within the area. It is commonly composed of dark gray to black dolomites and dolomitic limestones which weather dark gray and typically have a brownish cast. The bedding is medium to massive, and, relative to the overlying Three Forks formation and the underlying Sevy or Laketown, whichever is locally present, is resistant to erosion. The Jefferson commonly expresses itself topographically in a series of "stairstep" cliffs in areas of low dip, the intermediate short slopes being formed by thinner beds which commonly lie between the massive layers. In areas of steep or vertical dip the Jefferson commonly holds up prominent crests which rise distinctively above the saddles made by the adjacent weaker units. Locally, beds of mottled black and dark grey dolomite are present, and at some horizons thin beds of intraformational breccia also occur. Fine laminations in shades of dark grey are frequently present. In addition, variance in shades of grey between superjacent and subjacent beds gives the formation a prominent, laterally persistent, banded appearance. This feature and the aforementioned "stairstep" cliffs make the Jefferson a very distinctive unit in the region and constitute very useful criteria for recognizing the formation. Many portions of the Jefferson show evidence of the presence of an extensive fauna. However, most of the fossils have been recrystallized and appear only as white calcite or dolomite fossil "ghosts." In these specimens practically all identifiable features have been destroyed and they are thus rendered useless for detailed paleontologic study. The formation, particularly in the upper part, is commonly dotted with solution pits of all sizes, many of the smaller of which have been subsequently filled with white calcite or dolomite giving a spotted appearance to those portions of the exposure. These solution cavities have dimensions of several feet and, particularly as exposed in Logan Quadrangle, appear as caves along the outcrop. Such features in the Logan vicinity appear to be due to the irregular presence, near the top of the formation, of relatively soluble limestones which have been removed by chemical weathering, leaving the less soluble surrounding limestones and dolomites still in place. Also associated with this zone in the Logan area is an 8 foot bed of collapse or solution breccia in which angular to subangular blocks of black, resistant limestone with maximum dimensions of 1 to 4 feet are found in random orientation in a loosely consolidated matrix of argillaceous, limey material. The post-depositional nature of the breccia is indicated by the uniform basal surface of the overlying bed which clearly must have been deposited on the then even surface of the underlying bed. Subsequent solution by groundwater apparently caused the slow collapse of the now brecciated subjacent bed.

Age and Correlation:

The difficulty in finding and collecting identifiable faunal material from the Jefferson has been discussed above. However, within the area some faunal collections have been made by others. Mansfield (1927) reports the following species from the Jefferson of the Montpelier Quadrangle, Idaho, (immediately north of the Logan Quadrangle) in the northern end of the Bear River Range, from which much of the stratigraphic data applied to the Logan Quadrangle is obtained: Atrypa reticularis, Productella close to P. subaculeata, Favosites cf. F. limitaris (most abundant), Diphyphylum sp., Cystiphylum sp. From Laketown Canyon Richardson (1941) collected: Productella sp., Spirifer englemanni, Nuculites sp., Aviculopecten? sp., fish bone fragments. These are from a bed about 150 feet above the base of the formation. Williams (J. Stewart, 1948, p. 1140) records the following from a dolomite about 100 feet below the top of the Hyrum dolomite member, which is regarded herein as correlative with the entire Jefferson formation (see below): "Pachypora limitaris", Atrypa cf. A. nevadana Merriam, A. aff. A. missouriensis Miller, A. cf. A. montanensis Kindle, Spirifer utahensis Meek, S. engelmanni Meek, Martinia "maia (Bill)". Reviewing the evidence concerning the age of the Jefferson in the type area Merriam (1940, pp. 67-68) concludes that the "...insecure evidence at hand would indicate that the known Jefferson species of the type area are, with possible exception of Favosites cf. limitaris and Atrypa cf. missouriensis, of Devils Gate age, but older than the Cyrtospirifer zone of the Devils Gate, which last is equivalent to the greater part of the Three Forks formation overlying the Jefferson." It should be noted that an important factor in the above determination is the presence of Spirifer utahensis, S. engelmanni, and S. argentarius. These forms have been considered as co-existent in the Spirifer argentarius zone of Merriam (1940). However, as Merriam has noted, a certain amount of confusion exists regarding the exact stratigraphic and geographic location of the occurrence of Spirifer engelmanni and S. utahensis. Walcott (1884) reported their occurrence at Devils Gate Pass. This location has been questioned by later workers who conclude that Walcott's collection in reality came from an undetermined horizon of the Devonian occurring on the east side of the Diamond Range, some miles to the east of Devils Gate Pass. Merriam, himself, states (1940, p. 59) that he, "...recognized neither of the species within the limits of the present survey." (For a complete review of this problem see Merriam, 1940, pp. 59, 87, 88, 89). It thus appears that the association of these two forms with the Spirifer argentarius zone may be subject to question and, therefore, that their exact chronologic position may not be stated with precision. The presence of Atrypa aff. A. missouriensis Miller, and A. nevadana Merriam in the assemblage reported by Williams (1948, p. 1140) also heightens the uncertainty of the exact zonal and chronologic affinities of the Jefferson formation of the area.

Atrypa aff. A. missouriensis Miller is commonly associated with the Heliolites horizon of middle Middle Devonian (Merriam, 1940, p. 58), although Merriam (p. 84) recognized that "...these forms persist sporadically at least as high as the middle portion of the Devils Gate formation" (presumably the Spirifer argentarius zone). However, Atrypa nevadana Merriam, is associated, apparently exclusively, with the Spirifer pinyonensis zone (Merriam, p. 54) and Merriam (p. 84) states that, "On the basis of (Atrypa) alone at least four zones could be established: (1) Lower Nevada (Spirifer pinyonensis zone) with Atrypa nevadana; (2) Upper Nevada (Heliolites zone) with beds of Atrypa cf. missouriensis;...."

It is apparent, then, that the fauna present in the Jefferson in northeastern Utah does not warrant restricting the age of the formation to upper Middle Devonian. A more realistic approach would seem to be one which recognizes the Jefferson as a Middle Devonian unit, the sedimentation of which may have commenced as early as the lowest portion of Middle Devonian time and which conceivably could have lasted through all of the medial Devonian epoch. Reference to the faunal lists from Laketown Canyon (Richardson, 1941) and from the Logan area (Williams, J. Stewart, 1948) will indicate a possible corollary to the above observation. The assemblage of Williams is found about 100 feet below the top of the unit; that of Richardson (1941) is found about 150 feet above the base of the formation. If these assemblages are taken as satisfactory time indicators then it may be inferred from the quoted data that the time of origin of the Jefferson at Logan is somewhat earlier than at Laketown and that the environment in which the

Jefferson was deposited was transgressive southward from a seaway to the west.

It should be clearly understood, with regard to the discussion above concerning the regional synchroneity of fossil assemblages, that the absolute time parallelism of assemblages, particularly of predominantly benthonic forms such as the brachiopods, is open to question. It is entirely conceivable that a considerable span of time may have been consumed in the migration of faunas, even throughout the extent of a more or less open seaway, such as the one just discussed. The attachment of detailed chronologic significance to any group of animals should be approached with extreme caution. Such caution seems especially justified in the above case, where the faunal evidence is meager and inconclusive.

Williams (J. Stewart, 1948, pp. 1139-1141) considers the Jefferson formation in the Logan area to be composed of two members. The lower or Hyrum member, according to Williams, is 1108 feet thick and consists mostly of the dark and medium gray secondary dolomites and limestones that characterize the Jefferson described above. The upper or Beirdneau member is 740 feet thick (Williams, p. 1140) and is composed predominantly of tan and light gray sandstone, siltstone, shale, and occasional limestone beds. This latter sequence, although considered a member of the Jefferson by Williams, is here, because of its lithology and stratigraphic position, regarded as a facies of the Three Forks formation. The writer therefore proposes that the application of the term Jefferson formation be restricted to the Hyrum member of Williams (1948), that the term Three Forks formation be applied to the Beirdneau member of Williams and that the terms Hyrum member and Beirdneau member be abandoned.

The Jefferson is recognized as far west and south as the Lakeside Range (Young, 1953, and writer's measured section, Appendix) and is lithologically homogeneous throughout the region. On the basis of its lithology and stratigraphic position the Jefferson is here considered correlative with the Simonson dolomite and Guilmette formation of west-central Utah and eastern Nevada, and with at least the upper portion of the Red Warrior limestone of the Frisco Mining District. Synchronous deposition with some indeterminate portion of the Nevada limestone of the Lone Mountain-Roberts Mountains, Nevada, area is also indicated, but it should be noted that there is relatively little lithologic similarity between the Jefferson and the Nevada. The latter is limestone throughout, is locally siliceous, and possesses practically none of the characteristics mentioned previously as typical of the Jefferson and its equivalents.

Red Warrior limestone

The Red Warrior limestone was recognized in the Frisco Mining District by Butler (1913), who, lacking faunal evidence, was unable to determine its exact age. Since it graded into the overlying Mowitza shale, of proven Upper Devonian age, he assigned it to Devonian(?) and Silurian(?). The structural geology of the Frisco District is extremely complex, the area being transected by numerous faults, so that Butler was able to arrive at only a probable thickness of 1500 feet.

The writer visited the Frisco District and spent some time investigating the area in an attempt to find a section or sections which could be measured with some exactness in the hope that more valid stratigraphic relationships might be determined. A section of the Mowitza shale (to be discussed later) was measured, but it was concluded that Butler's measurement of the Red Warrior could not be improved on. Therefore, no attempt was made to measure a complete section of this unit. A considerable portion of the Red Warrior was observed, however, and it is felt by the writer that it is likely correlative with the Guilmette-Simonson interval and with the Jefferson formation to the north. The same lithologies common to the Jefferson interval are conspicuous in the Red Warrior and its stratigraphic position and intergradational relation with the Mowitza lend validity to the correlation. As could best be determined the formation rests on the Morehouse quartzite which was dated by Butler as Ordovician and Silurian(?). However, the Morehouse is regarded by the present writer and other recent workers as being correlative with the Cambrian Prospect Mountain quartzite. Its lithology and thickness are much more akin to those of the Prospect Mountain than to those of the Ordovician Eureka quartzite, with which it should be correlated if the age assigned by Butler were correct. The writer was not able to clearly establish the nature of the Red Warrior-Morehouse contact. Presumably it may be considered as disconformable, since no marked discordance of beds is evident. However, because of the highly faulted nature of the district, the possibility of a thrust fault relationship cannot be ignored.

In summary, the Red Warrior is approximately 1500 feet thick and is composed of banded medium and dark grey limestones and secondary dolomites. It grades upward into the Upper Devonian Mowitza shale and

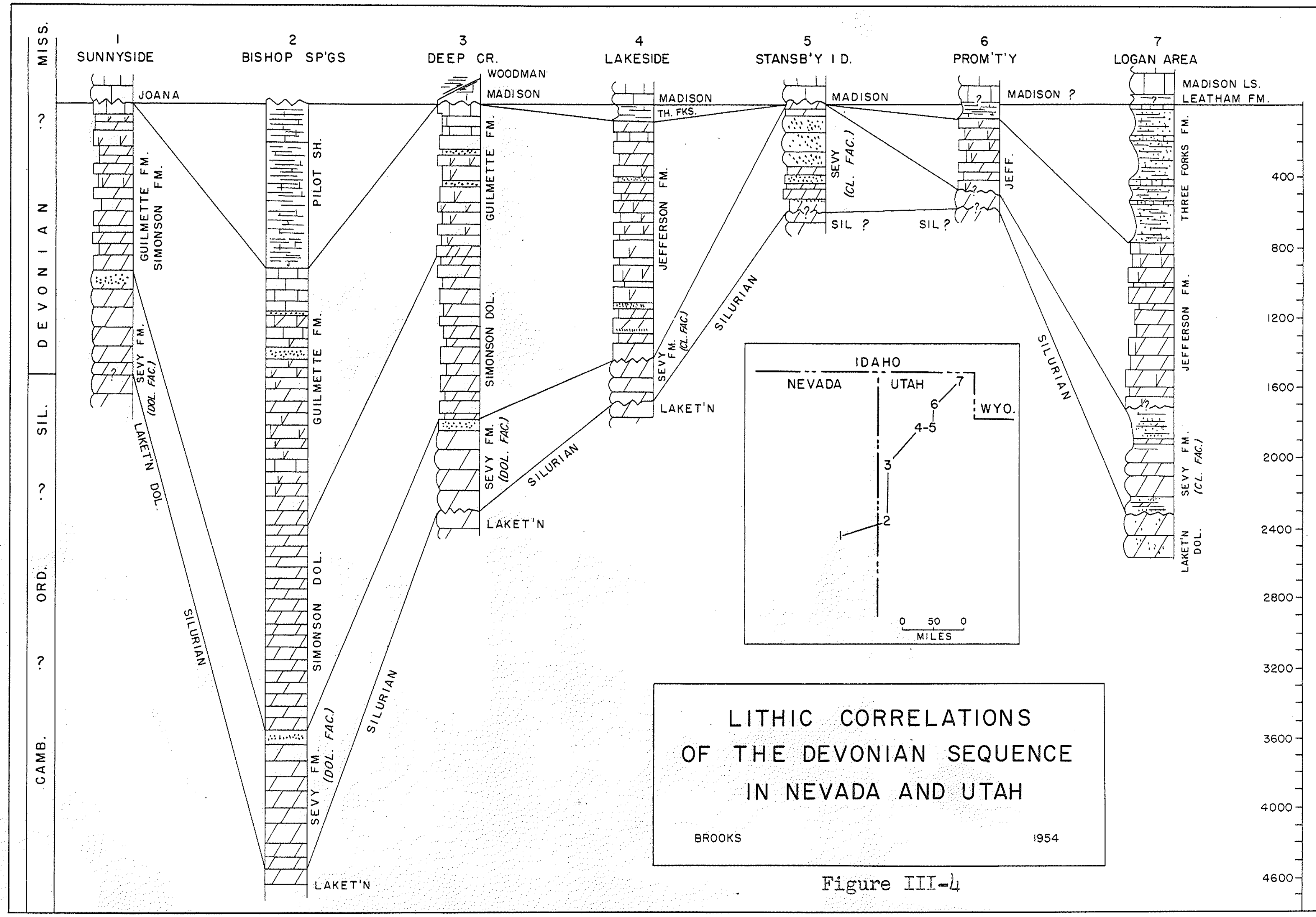

MISS.
?
DEVONIAN
SIL.
?
ORD.
?
CAMB.
1 SUNNYSIDE
2 BISHOP SP'GS
3 DEEP CR.
4 LAKESIDE
5 STANSB'Y I D.
6 PROM'T'Y
7 LOGAN AREA
JOANA
GUILMETTE FM.
SIMONSON FM.
SEVY FM. (DOL. FAC.)
LAKET'N DOL.
PILOT SH.
GUILMETTE FM.
SIMONSON DOL.
SEVY FM. (DOL. FAC.)
LAKET'N
WOODMAN
MADISON
GUILMETTE FM.
SIMONSON DOL.
SEVY FM. (DOL. FAC.)
LAKET'N
MADISON
TH. FKS.
JEFFERSON FM.
SEVY FM. (CL. FAC.)
LAKET'N
MADISON
SEVY (CL. FAC.)
SIL ?
MADISON ?
JEFF.
SIL ?
MADISON LS.
LEATHAM FM.
THREE FORKS FM.
JEFFERSON FM.
SEVY FM. (CL. FAC.)
LAKET'N DOL.
SILURIAN
SILURIAN
SILURIAN
SILURIAN
SILURIAN
SILURIAN
IDAHO
NEVADA
UTAH
WYO.
1
2
3
4-5
6
7
0 50 0
MILES
400
800
1200
1600
2000
2400
2800
3200
3600
4000
4600
LITHIC CORRELATIONS
OF THE DEVONIAN SEQUENCE
IN NEVADA AND UTAH
BROOKS
1954

Figure III-4

lies with undetermined relationship on the Cambrian Morehouse quartzite.

Simonson dolomite

The Simonson dolomite was named by Nolan (1930) for its exposures in Simonson Canyon and adjacent areas along the west flank of the Deep Creek Range in west central Utah. The writer has examined the type area of the Simonson and concurs with Nolan's (1935, p. 19) description of the formation, nearly the same lithologies and thickness having been noted. The Simonson, according to Nolan (p. 19, 20) is 963 feet thick and is composed almost entirely of medium to coarsely crystalline secondary dolomite. The beds are medium to massive and vary from medium to dark gray, producing the same banded appearance that characterizes the Jefferson. Quite commonly also, the fine color laminations noted in the Jefferson are present in the Simonson, these commonly being composed of 1/16 to 1/4 inch laminae of alternating black and dark gray dolomite. Also developed in the formation are scattered discontinuous beds of dolomitic breccia. These, like those in the Jefferson of northern Utah, are believed by the present writer to represent post-depositional differential solution and removal, with subsequent collapse of the overlying beds. Evidence for this interpretation is found in the lack of associated foreign clastic material, the essentially similar composition and appearance of pebbles and matrix and the lateral gradation into normally bedded carbonates.

As Nolan (p. 19) indicates, the lower limit of the formation is arbitrary. The intergradation of lithologies between the Simonson and the underlying Sevy dolomite gives every indication of continuous deposition with only a fluctuation of the two environments which resulted in the interbedding of the two distinctive lithologies. The upper limit, also, is arbitrary, the base of the superjacent Guilmette formation having been established by Nolan (p. 19) at the bottom of a laterally continuous zone of dolomite breccia. There is no physical evidence for disconformity at this horizon and Nolan (p. 19) states that faunal evidence provides little indication of temporal difference between the top of the Simonson and the base of the Guilmette. In addition, Simonson lithologies appear in scattered beds in the lower Guilmette. It is therefore concluded that the gradational upper limit of the Simonson indicates merely a gradual change in environment through time. The Simonson is widespread over western Utah and eastern Nevada and may be recognized as far west as the Diamond Range, northeast of Eureka, Nevada.

At many localities, however, the formation is not as readily distinguishable from the overlying Guilmette as it is at the type area. Therefore, in some sections the writer has considered the Guilmette-Simonson, jointly, as one stratigraphic interval. The interval is so labelled on those sections (see Appendix).

Age and Correlation:

The Simonson is dated (Nolan, p. 20) on the basis of rather meager faunal collections which contained several Middle Devonian species, the most significant being Stringocephalus burtoni Defrance. No stratigraphic position for these collections is given by Nolan, but it is presumed that the specimens came from rather high in the Simonson, since Stringocephalus occurs about 100 feet from the base of the overlying Guilmette and since, according to Merriam (1940, pp. 68-69), this "zone" in Nevada has a rather limited vertical range. Since the Simonson is about 1,000 feet thick and since the Stringocephalus "zone" is considered (Merriam, p. 9) as middle Middle Devonian, it seems reasonable to infer that the initial deposition of the Simonson sediments may date back to the early portion of Middle Devonian time or, possibly, somewhat earlier. Because the underlying Sevy is here considered as Lower Devonian in age and in view of the gradational character of the Simonson-Sevy contact it seems probable that the change in environment which produced the cessation of Sevy sedimentation and the commencement of Simonson deposition occurred within a late Early Devonian to early Middle Devonian time interval.

In cognizance of the somewhat uncertain dating of the Jefferson formation (see above) it would be unrealistic to discuss the Simonson as an absolute time correlative of the Jefferson. It does, however, seem completely within the limits of validity to point out the striking similarity of rock types between the Jefferson and the Simonson. The same dark gray, banded cliff forming strata appear in each unit along with other features such as fine color laminations, saccharoidal texture, drab gray-brown weathering features, all of which make it easy for the observer to conclude that the two formations are genetically related. It is therefore the writer's belief that the Simonson and Jefferson are lithic and, at least partially, temporal correlatives.

Northwest of Eureka, in the Lone Mountain-Robert Mountains area, sediments that are the chronologic equivalent of the Simonson exist in the Nevada formation (redefined). However, the lithologic characteristics of the two units are markedly different. The Nevada is entirely limestone, in part siliceous; while the Simonson is predominantly dolomite and is not siliceous. The color of the Nevada is considerably lighter than that of the Simonson and the subtle banding and lamination characteristic of the Simonson is not present. Moreover, the typical texture of the Nevada is considerably finer, frequently being fine to cryptocrystalline. Although the Simonson and the Nevada formation are not lithic equivalents, they do represent deposition during the same general portion of Devonian time and thus, like most other parts of the mid-Paleozoic in their respective provinces, demonstrate marked lateral variance in sedimentary environment.

Guilmette formation

The Guilmette formation also was named by Nolan (1930) and is discussed by him in detail (1935, pp. 20-21). The type area is in Guilmette Canyon on the west face of the Deep Creek Range east of Ibapah, Utah. The present writer has examined and measured the Guilmette at this locality and has made no observations that differ significantly from those of Nolan.

In the type area the lower limit of the Guilmette formation was established at the base of a laterally continuous zone of dolomite breccia. It should be emphasized that, regionally, this boundary is arbitrary, since the breccia zone is not everywhere present and since the lithologies of the Simonson and Guilmette intergrade and are quite similar. Because of this lithological similarity the two formations become virtually indistinguishable at some sections which are removed from the type area (e.g., Diamond Range, Nevada).

The Guilmette is composed predominantly of carbonate rocks of which the larger proportion is dolomite. Also occurring in the Guilmette are several well developed beds of clear, light gray, tan weathering quartzose sandstone, which range in thickness from 5 to 15 feet. The dolomites of the formation are quite similar to those in the underlying Simonson or to those of the Jefferson formation. They vary from medium to dark gray and when viewed from a distance give a banded appearance to the outcrop. Also common is the fine lamination in shades of gray which characterizes the rocks of the Simonson and Jefferson. The Guilmette expresses itself topographically in the same "stairstep" cliff pattern noted as typical of the Simonson and Jefferson. The most distinctive feature of the Guilmette, which lends validity to Nolan's recognition of it as a formation in the Deep Creek area, is the presence of more extensively developed beds of light bluish gray, finely crystalline to cryptocrystalline limestone than are found in the underlying Simonson. These appear rather abruptly some distance above the base of the unit and provide a particularly good criterion for subsurface recognition of the formation. The Guilmette appears conformable beneath the Woodman formation of Mississippian age. However, Nolan (1935, pp. 21-22) indicates that an unconformity of some significance exists between the Guilmette and the Woodman. He lists the following items of evidence to support of the belief: (1) the thickness of the Guilmette as measured at three localities in the type area varies from 1,400 to 890 feet, (2) at the type area the shales of the Woodman overlie the Devonian directly, whereas a few miles to the north, at Dutch Mountain (north end of Deep Creek Range), rocks of the Mississippian Madison limestone lie between the Woodman and the Guilmette,

(3) rocks containing fossils of Upper Devonian age are not present in the type area but are known to be present elsewhere in the region. Further significant evidence lies outside the area of Nolan's study to the southeast in the Confusion Range. At this point rocks of the Pilot shale overlie the Guilmette and contain the Cyrtospirifer fauna of Late Devonian age (Zeller, personal communication, letter, May 15, 1953). At the north end of the Confusion Range the Pilot is considerably thinner and is in angular relationship with the overlying Joana (or Madison) limestone of the Mississippian. Farther north the Pilot is cut out completely along with a part of the upper Guilmette, the Joana resting directly on rocks of an undetermined horizon of the Guilmette. This evidence lends strong support to Nolan's postulated unconformity. It should be emphasized, however, that the Deep Creek Range and the Confusion Range are both complicated structurally, particularly by thrust faults and associated adjustment faults, which may well cause the section to appear to thicken or thin more in a short lateral distance than is actually the case. The amount of such alteration is particularly hard to detect since the Guilmette, being of a uniformly heterogeneous nature, does not contain good marker beds or distinctive sequences and the magnitude of structural displacements is therefore less evident.

Age and Correlation:

Regarding the age of the Guilmette Nolan (1935, p. 21) reports Stringocephalus burtoni Defrance from a horizon about 100 feet above the base of the formation, which indicates that Guilmette sedimentation began in Middle Devonian time. To the writer's knowledge there has been no further information reported from the type area to indicate the duration of Guilmette sedimentation. However, to the southeast in the Confusion Range-Burbank Hills area apparently conflicting evidence has been introduced by Ogden (1951, pp. 78-81), Rush (1951a, pp. 13-18) and Zeller (personal communication, letter, May 15, 1953). From the Confusion Range Ogden has noted the Phillipsastrea fauna in the upper beds of what must be the Guilmette formation (although no Devonian formational names are applied by him). He also reports from the middle and upper part of the 800 foot thick overlying shale sequence (presumably the Pilot shale) the occurrence of the Cyrtospirifer fauna of Late Devonian age. These data seem essentially correct, since Zeller (above) reports the Cyrtospirifer fauna 40 to 60 feet below the top of the Pilot in the Confusion area. To the southwest in the Burbank Hills Rush (1951a, pp. 13-18) describes a Paleozoic section to which he also applies no formational names but in which all lithologies typical of the Middle Paleozoic sequence of the area are represented. He makes three references to the presence of fossil assemblages pertinent to this discussion regarding the age of upper Guilmette sediments. With reference to the Phillipsastrea and Cyrtospirifer "zones," Rush (1951a, p. 15) states, "To the west the exposures rise to a high point just above the unit here described as the stromatoporoid-Cladopora beds after the units of Merriam (Merriam, 1940). On the descending westward slope are the Phillipsastrea(?) and Cyrtospirifer zones of the same author." Farther on (p. 16) he states, "The evidence indicates that of the faunal zones present in the section, the Cladopora-stromatoporoid beds, the Spirifer argentarius zone, possibly the Phillipsastrea zone, and the Cyrtospirifer zones, with the addition of the members of the goniatite fauna, Manticoceras, are represented here." Since Rush delimits the Devonian portion of the Burbank Hills section at the top of the limestone and dolomite unit (apparently the Guilmette) it is to be presumed that the fossils mentioned have come from below the top of this formation. The overlying tan shales (almost certainly the Pilot shale) are included by Rush in the Mississippian. Rush's failure to indicate the exact stratigraphic horizon from which the two Upper Devonian (Phillipsastrea and Cyrtospirifer) collections were made is unfortunate, particularly so since the faunal data from what must be the same formations a few miles to the north in the Confusion Range (refer to Ogden, above) give a somewhat conflicting age. The only information regarding the horizon from which Rush's fossils were collected is found in his columnar section (1951a, p. 14), where he records the collection of Leiorhyncus and Manticoceras about 100 feet below the top of the limestone dolomite unit (the Guilmette formation). In view of the somewhat nebulous wording which Rush uses in refering to the fossil assemblages present in the Burbank Hills area and in view of the essential agreement of evidence supplied by two separate workers to the north in the Confusions area, it appears probable that the recognition of Phillipsastrea in the upper beds of the Guilmette in the Confusion Range by Ogden (1951) is essentially correct and that Guilmette sedimentation may be regarded as having lasted into the early portion of Late Devonian time.

Because of the lithologic similarity already noted and because they are approximate time equivalents, the Guilmette is here considered to be correlative with the upper portion of the Jefferson formation, of the northeastern Utah area, and with the upper portion of the Red Warrior formation of the Frisco Mining District. As previously indicated, the Simonson dolomite and the Guilmette do not represent radically different environments but rather a slight environmental change which may well have had its principal manifestation in post-depositional alteration. Because of their similarity and because it is difficult in some cases to adequately distinguish the two units, they are here referred to jointly as representative of one environmental episode and are regarded as the lithic correlatives of the Jefferson formation. It is possible that Jefferson sedimentation may have commenced somewhat later than that of the Simonson. However, the lithologies of the units indicate deposition in the same regional sedimentologic environment and they are therefore lithically correlated.

The Guilmette is the time equivalent of the upper part of the Nevada formation (redefined) and the lower portion of the Devils Gate formation, of the Roberts Mountains region. It may be traced as a lithic unit as far west as the Diamond Range and although it is not the exact lithic equivalent of the Nevada and Devils Gate the contrast which was so pronounced between the earlier Devonian deposits of the two adjacent areas (Lone Mountain and Diamond Range) is less impressive in the younger Devonian strata. While the later Devonian environmental conditions were not identical in the two areas, they were much less different than they had been earlier.

Nevada formation (redefined)

The Nevada formation (redefined) is the name applied by Merriam (1940, pp. 14-16) to a portion of the beds originally included in the

Nevada limestone of Hague (1892, p. 65). The formation of Hague was defined to include the strata between the light colored dolomites of the Lone Mountain limestone and the White Pine shale. Merriam (1940, pp. 14-16) redefines Nevada formation as comprising those beds above the Lone Mountain formation (redefined) and below the Devils Gate formation. The lower boundary of the formation, despite the gradational character, is easily recognized, since the lithologies of the two units are quite distinctive. The upper limit of the Nevada, however, is arbitrarily established by Merriam at the top of the Stringocephalus "zone" (probably the teilzone of this genus), "...in view of the abundance, broad geographic distribution, and apparent limited vertical range of this genus." (Merriam, p. 14). The lithic criteria for the location of this formation boundary are virtually non-existent, Merriam himself stating (p. 17), "Lithologically the lower part of the Devils Gate sequence presents few features which distinguish it from the upper portion of the Nevada (restricted)." It thus appears that the Nevada (restricted) is a bastard unit, having a lithic lower boundary and a faunal upper limit. For this reason it is suggested that a restudy and redefinition of the Nevada (redefined) and the overlying Devils Gate would be appropriate. However, such an undertaking is outside the scope of this study, since not enough work has been done in the territory surrounding the type area of the Nevada to provide a sound basis on which to establish conclusions.

The Nevada is composed predominantly of limestone, although its lithology is by no means homogeneous. The lower 500 feet of the formation are thin bedded, argillaceous to arenaceous, light gray to tan,

tan weathering limestones which commonly have very well developed partings of tan clay and fine silt. This portion of the Nevada is somewhat less resistant to erosion than the overlying beds and the underlying massive dolomites of the Lone Mountain formation and therefore often appears topographically as a saddle. As a rule these beds are quite fossiliferous, bearing the assemblages which contain as prominent species Spirifer kobehana and Spirifer pinyonensis. Appearing gradationally upward are the notably more massive limestones and occasional dolomites of the "typical" Nevada. The limestones are commonly light gray in color, frequently siliceous, finely crystalline to cryptocrystalline and quite massively bedded. Appearing locally, particularly in the upper portion of the formation, are beds of coarsely saccharoidal dolomitic limestone, which vary from medium to light grey, and beds of dark gray to black massive limestone. The latter two rock types are sufficiently common that the gross lithology of the Nevada may be considered as heterogeneous, its predominant lithology being that of the lighter gray, more finely crystalline, siliceous limestones. The Nevada is abundantly fossiliferous at several horizons.

Age and Correlation:

The age relationships of the Nevada have been studied in detail by Merriam (1940) and nothing further of faunal or chronologic significance can be added by the writer. Merriam's information demonstrates that the sedimentation of the Nevada commenced in Early Devonian time, as indicated by the presence of Spirifer kobehana and associated species reported from the basal beds. However, Merriam (p. 13) indicates that it is likely that the upper portion of the Lone Mountain formation is also of Early Devonian age and it follows, therefore, that the Nevada sedimentation may have begun in a later portion of the Early Devonian Epoch, possibly middle or late Early Devonian. As previously indicated, the upper limit of the formation has been arbitrarily established at the highest occurrence of the genus Stringocephalus (middle Middle Devonian).

The Nevada is recognized by the writer as the temporal equivalent of the lowest portion of the Guilmette formation, the Simonson dolomite and presumably the upper part of the Sevy dolomite, although it is possible that the time equivalent of the Sevy may lie entirely within the upper portion of the underlying Lone Mountain formation. It is re-emphasized that the Nevada is not recognized as the exact lithic equivalent of the Guilmette, the Simonson or the Sevy, but that it represents a significantly different depositional environment of approximately equivalent age.

Devils Gate Formation

Approximately the lower 900 feet of the Devils Gate formation, as presently defined, are of essentially the same lithology as the upper beds of the underlying Nevada limestone, with no indicated intervening break in the sedimentary record. The predominant lithologies represented in this portion of the Devils Gate are light gray, massively bedded dolomites and siliceous limestones interbedded with dark gray to black, massively bedded limestones and dolomites. In general the rocks tend to be more dolomitic than do the rocks of the lower and middle portions of the Nevada formation, but are not significantly different from the upper part of that formation. At about 900 to 1000 feet above the base of the Devils Gate the beds become noticeably thinner and are commonly separated by partings of tan clay and siltstone. The color of the limestones changes from the lighter grays below to a dark bluish gray above. The beds are quite persistent laterally and are generally no more than 2 to 5 inches in thickness. There is a progressive increase upward in the amount of argillaceous material, the upper portion of the unit becoming quite shaly. At Devils Gate Pass the formation terminates abruptly beneath an alaskite porphyry sill. However, Merriam (1940, p. 17) reports that, at Lone Mountain, the tan to gray shales of the upper Devils Gate formation pass gradationally into the shales of the lower Diamond Peak series of Mississippian age.

Age and Correlation:

The Devils Gate formation commences, by definition, at the upper limit of occurrence of the genus Stringocephalus (Middle Devonian) and contains in its middle and upper part in ascending order the Spirifer argentarius zone (late Middle Devonian), the Phillipsastrea zone (early Late Devonian) and the Cyrtospirifer zone (latest Devonian) (Merriam, 1940, pp. 58-61). It is clear that the sedimentation of the Devils Gate was continuous with that of the underlying Nevada and that the arbitrary faunal base of the Devils Gate dates its lower beds as Middle Devonian in age, while its uppermost beds are of latest Devonian age.

The description of the lithology of the Devils Gate formation indicates that there is a noticeable lithologic change within the formation. Therefore, for the purposes of this study, the lower part of the Devils Gate (about 900 feet at the type area) is recognized as being genetically related to the underlying Nevada limestone and for purposes of statistical evaluation is incorporated with the Nevada. The upper beds of the Devils Gate are dense platy limestones and calcareous shales, and represent a variant lithic type to that of the lower beds. Therefore, the upper member of the Devils Gate is considered a correlative of the shales that occur at the top of the Devonian Sequence elsewhere and thus in statistical evaluations is dealt with as a separate lithic unit.

It is appropriate to re-emphasize the previously mentioned need for a restudy and re-evaluation of the stratigraphic units established by Merriam in the Roberts Mountains region. In cognizance of Merriam's (p. 17) acknowledged establishment of a formation limit on faunal rather than lithologic criteria, the writer believes that the lower limit of the Devils Gate formation might be advantageously moved upward to the aforementioned horizon of lithologic change. The beds previously included in the lower Devils Gate would then be included in the Nevada limestone. However, as previously stated, since the writer's acquaintance with the area in which these formations occur is relatively limited, such a change is not formally proposed.

The rocks of the previously defined lower part of the Devils Gate are approximately equivalent in age to the major part of the Guilmette formation to the east and to the upper beds of the Jefferson formation in northeastern Utah. The lithologies of the Guilmette and lower Devils Gate are different, although not radically so, and appear to have been deposited in somewhat similar environments. The beds of the lower Devils Gate have been noted at the type section in Devils Gate

Pass, at Lone Mountain and in the Southern Ruby Mountains (Sharp, 1942). The Middle and Upper Devonian section exposed along the east flank of the nearby Diamond Range contains rocks which the present writer recognizes as belonging to the Guilmette formation and the Simonson dolomite rather than to the Devils Gate or upper Nevada.

Three Forks formation

The Three Forks formation was originally included in the Wahsatch limestone (King, 1876, pp. 477-479), which was considered by King to include rocks of Ordovician, Silurian, Devonian and Mississippian age. Richardson (1913, p. 407) subdivided the Wahsatch limestone into several formations, among which was the Threeforks limestone. His recognition of this formation, and the underlying Jefferson, is based on correlation with those two formations at their type locality in southwestern Montana. The Three Forks has been recognized as the Threeforks limestone, the Threeforks shale (Wilmarth, 1938, p. 2144) and the Three Forks formation (Andrichuk, 1951, p. 74). The last name is used here in recognition of the lateral variability in lithology of the unit.

The Three Forks is exposed at several localities in the region and, due to its non-resistant nature, normally appears as a slope or saddle maker. The lithology of the Three Forks is heterogeneous, but in gross aspect it is a shale. Platy limestones are separated by prominent partings of clayey and silty shale and sandstone. Proportions of these components vary laterally, but in no place is the formation represented by one lithic type exclusively. The characteristic color is light gray to tan with pink mottlings, particularly in the clastics. Although generally poorly exposed, the formation is readily recognized

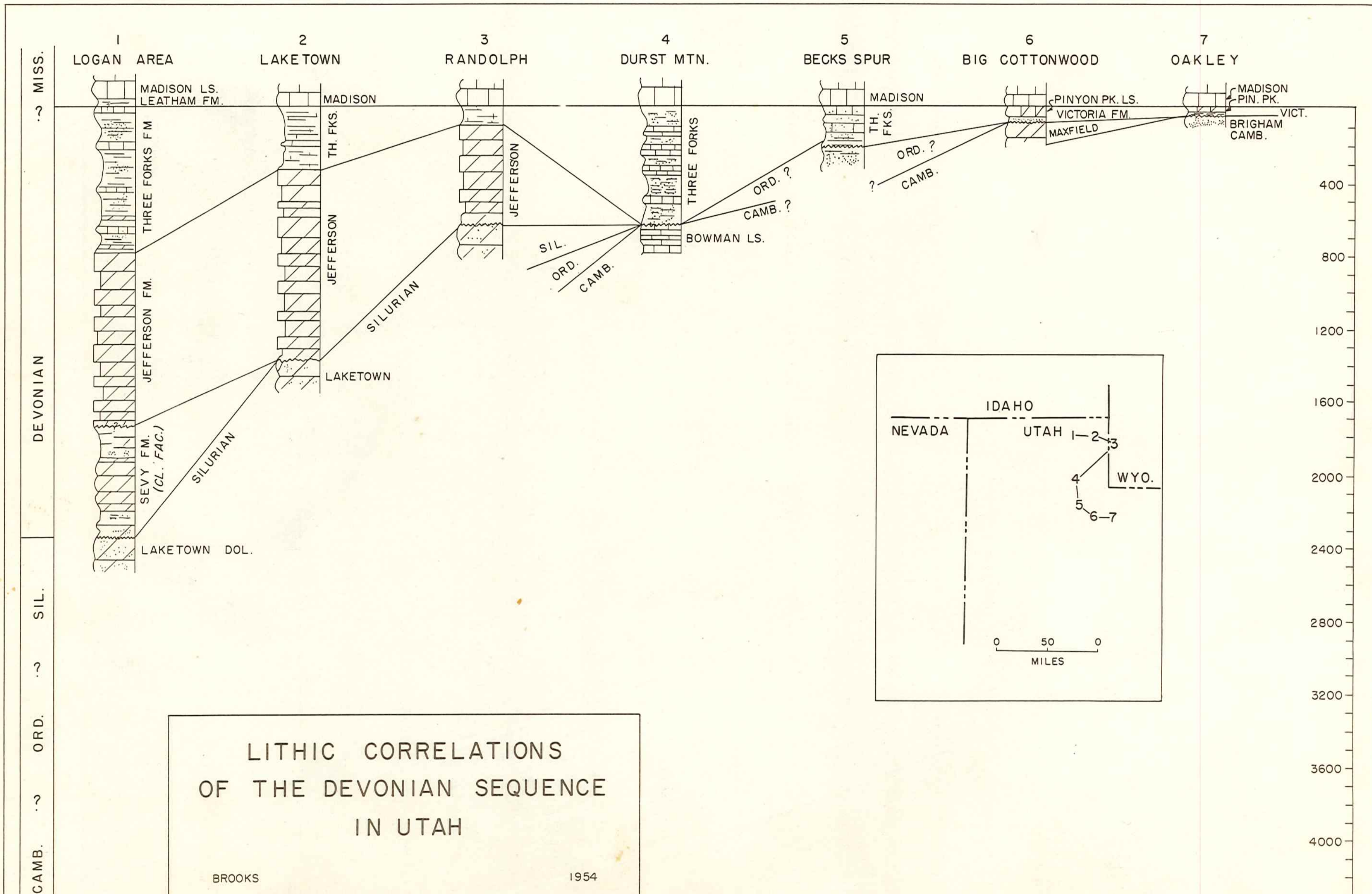

? MISS.
DEVONIAN
SIL.
?
ORD.
?
CAMB.
1
LOGAN AREA
2
LAKETOWN
3
RANDOLPH
4
DURST MTN.
5
BECKS SPUR
6
BIG COTTONWOOD
7
OAKLEY
MADISON LS.
LEATHAM FM.
THREE FORKS FM
JEFFERSON FM.
SEVY FM.
(CL. FAC.)
LAKETOWN DOL.
SILURIAN
MADISON
TH. FKS.
JEFFERSON
LAKETOWN
SILURIAN
JEFFERSON
SIL.
ORD.
CAMB.
THREE FORKS
BOWMAN LS.
ORD. ?
CAMB. ?
MADISON
TH. FKS.
ORD. ?
? CAMB.
PINYON PK. LS.
VICTORIA FM.
MAXFIELD
MADISON
PIN. PK.
VICT.
BRIGHAM
CAMB.
400
800
1200
1600
2000
2400
2800
3200
3600
4000
IDAHO
NEVADA
UTAH
1—2—3
4
5—6—7
WYO.
0
50
0
MILES
LITHIC CORRELATIONS
OF THE DEVONIAN SEQUENCE
IN UTAH
BROOKS
1954

Figure III-5

by its stratigraphic position and by its distinctive buff to red soil colors. The underlying Jefferson formation grades rapidly into the Three Forks with no evidence of interruption of deposition. At most localities the Three Forks lies beneath the Mississippian Madison limestone. However, in the vicinity of Logan, Utah, a thin unit of black, carbonaceous shales and limestones termed the Mississippian Leatham formation intervenes (Holland, 1952). The contact of the Three Forks with overlying units has been called disconformable by various workers in the area (Williams, J. Stewart, 1948, p. 1140; Holland, 1952, p. 1719). However, at individual outcrops the evidence for disconformity is meager if it exists at all. To the writer's knowledge there are no localities where a clearly developed erosion surface is exposed at this horizon. Regional studies, discussed in Chapter IV, provide evidence for the existence of an erosion interval at this horizon in adjacent areas, and because of this evidence the possibility of a disconformity at the top of the Three Forks is not discarded.

Age and Correlation:

The Three Forks formation throughout the extent of its occurrence is assigned to the Late Devonian. Basis for this determination is found in the reported presence of the Cyrtospirifer zone in the upper portion of the formation at the type locality (Berry, 1943) and in the Three Forks in northeastern Utah (Mansfield, 1927, and Richardson, 1941). However, as has been previously discussed, the taxonomy and the chronologic position of the Cyrtospirifer genus has been questioned (Stainbrook, 1947, 1950; Crickmay, 1952). Thus the age of the Three Forks is not conclusively established.

The Three Forks occurs throughout the area of northeastern Utah and adjacent areas in Idaho and Wyoming. The present writer has examined it at the Crawford Mountains (Randolph section of this paper), Laketown Canyon, Durst Mountain and in the Logan Quadrangle, where the Beirdneau member of the Jefferson formation (Williams, J. Stewart, 1948, pp. 1139-1141) is regarded as synonymous with Three Forks. It occurs also in the Lakeside Mountains, though poorly developed. Here lithologies which are recognizable as those of the Three Forks constitute approximately the upper 100 feet of the "Jefferson formation." Young (1953) considers the entire group of beds above the Water Canyon formation and below the Madison limestone as the Jefferson. However, he points out that this section correlates with that of Williams (1948) in the Logan Quadrangle. He thus gives tacit recognition to the existence in the Lakesides of the Beirdneau member of the Jefferson which is herein regarded as synonomous with the Three Forks.

In central and western Utah and eastern Nevada the Pilot shale is a lithic correlative of the Three Forks. At the Frisco Mining District the Nowitza shale constitutes the Three Forks correlative, and in central Nevada the upper portion of the Devils Gate formation may be correlated with the Three Forks. In the vicinity of the Oquirrh Range, the Tintic Mining District, and along the Wasatch Front the Pinyon Peak limestone and the underlying Victoria formation, while varying somewhat in lithology from that of the typical Three Forks, are regarded as correlatives of that formation, some change in facies having taken place. An equivalent of the Three Forks is also recognized at Becks Spur, a salient of the Wasatch Range extending westward north of Salt Lake City. The name Becks formation has been proposed for these beds by Edvalson (1947). However, the similarities of lithology and position demand that the Becks formation also be included among the Three Forks synonyms.

Howitza shale

The name Howitza shale is applied to the calcareous shale interval at the top of the Devonian only, so far as known to the writer, in the Frisco Mining District. It was applied here by Butler (1913, p. 34) to the "50 foot thick interval of calcareous light tan and gray shales which lie above the Red Warrior limestone and below the Topache limestone." The lithology of the formation is quite similar to that generally present in the Upper Devonian shale interval elsewhere in the region. Thin bedded platy limestones, commonly light gray to tan in color, with grey and light tan claystone, siltstone, and sandstone partings, provide a unit which is predominantly shaly in aspect. The area is badly disturbed by faulting but it is believed that the 62 foot thickness measured by the writer is essentially correct. The formation makes a topographic saddle or slope between the Red Warrior and Topache, with both of which it is apparently conformable.

Age and Correlation:

The Howitza contains a fairly well preserved fauna of Upper Devonian age. Although the faunal list cited by Butler (1913) does not mention the genus *Cyrtospirifer*, the writer collected fragmental specimens which appear to belong to this genus from the upper part of the formation. Thus the upper portion of the Howitza is regarded as having been deposited during the teilzone of *Cyrtospirifer*. This is in accord with evidence suggested by its stratigraphic position. The Topache limestone is almost certainly correlative with the Mississippian Madison limestone and the Red Warrior, as indicated earlier, with the Jefferson. It then seems valid to correlate the Nowitas with the Three Forks on the basis of its similar lithology and stratigraphic position and to also regard it as an approximate temporal equivalent of the Three Forks, since it is of probable latest Late Devonian age.

Pilot shale

Confusion has existed in the minds of many geologists who have worked with the stratigraphy of western Utah and eastern Nevada as to the application and significance of the formational names "Pilot shale," "White Pine shale," and "Chainman shale." The original descriptions of the units have been misinterpreted in some cases and perhaps the complete stratigraphic relationships were not entirely understood by the geologists who originated the names. While it is in no way the intention of the present author to attempt a clarification of the Mississippian stratigraphy in the area, some exploration of this interval and the names applied to it is necessary to a clear understanding of the stratigraphy of the uppermost portion of the Devonian interval, particularly with respect to the usage of the above formational names.

In the area of the Burbank Hills and the Confusion Range in southwestern Utah the Devonian Guilmette formation is overlain by an interval of tan, calcareous and locally arenaceous shales which contain occasional thin beds of gray limestone. This sequence, having a maximum thickness of about 1100 feet, is overlain by the Joana (or Eldridge) limestone, a formation of massively bedded, fragmental limestones about

200 feet thick. The Joana lies beneath a second shale interval which is about 2000 feet thick in the Standard of California, Desolation No. 1 well. The lithology of the upper shale interval changes vertically. Approximately the lower 800 feet is black, highly carbonaceous and fissile. This lithology grades upward through progressively more calcareous shales into a succession of alternating dark gray limestones and shales. The shales in the upper part of the unit are more calcareous and silty than those at the base and occasionally deviate from the predominating black color to dark shades of green and brown. The same sequence of formations may be clearly recognized as far west as the Diamond Range and is represented in intervening areas where original relationships have not been destroyed by subsequent erosion or structural complications.

Spencer (1917) recognized the above sequence in the Ely district and applied the following names. (The descriptions are Spencer's, summarized from Wilmarth, 1938). In ascending order they are: (1) The Pilot shale, considered by Spencer (pp. 24, 26) to be Mississippian, is poorly exposed and "...From a few pits and tunnels it appears to be composed entirely of soft, highly carbonaceous shale, drab to nearly black. Thickness 100 to 400 feet. Underlies Joana limestone and overlies Nevada limestone (Devonian). No fossils found, but is believed to be of Mississippian age."; (2) The Joana limestone, described by Spencer (pp. 24, 26) as, "Massive, uniformly bluish gray beds, which in a few places contain nodules of chert. Thickness 100 to 400± feet; latter thickness on Pilot Knob Ridge. Underlies Chainman shale and overlies Pilot shale. Named for Joana mine, on south side of Robinson

Canyon, 2 miles above Ely."; (3) The Chainman shale (pp. 24, 26) which is, "Essentially soft, fissile, clay shale grading locally into fine grained sandy shale. Contains much carbonaceous matter and beds are almost uniformly of very dark hue...Locally there are intercalations of gray limestone in upper part of formation. Alternations of limestone and shale in upper part show transition into overlying Ely limestone... Thickness 200 to 250 feet. Near Veteran the formation has apparent thickness of 1,000 feet, but this is attributed to duplication by folding and crumpling. Is top formation of Mississippian. Fossils listed. Overlies Joana limestone...."

The aforementioned nomenclatural confusion probably arises from the original description by Hague (1892, pp. 253, 266-267) of the shale interval above the Devonian limestones and dolomites. The interval was termed the White Pine shale by Hague, was considered Lower and Middle Mississippian and was described by him (Wilmarth, 1938, p. 2324) as, "Black argillaceous shales, more or less arenaceous, with intercalations of red and reddish-brown friable sandstone, changing rapidly with locality. Plant impressions. Thickness 2,000 feet. Conformably overlies Nevada limestone and is overlain by Diamond Peak quartzite. Named for exposures in White Pine mining district (now known as Hamilton), White Pine County, Nevada." In comparing this description with those of Spencer (above) it is evident that Hague included within the White Pine both the Pilot and the Chainman and the intervening Joana of Spencer (1917). This opinion has also been expressed by Easton et al. (1953, p. 147) who suggest a nomenclatural revision which would retain formation rank for the White Pine and reduce the Pilot, Joana and Chainman to member rank within the White Pine. The advisability of this revision is questioned since the lithologies of the Pilot, Joana and Chainman are in most places distinctive. Furthermore, in the Confusion Range, Utah, an unconformity exists between the Pilot and Joana. In some areas of the Confusion Range the unconformity is angular and in other cases the Pilot has been completely removed and the Joana rests on the Devonian Guilmette formation. An erosion interval of considerable duration, at least locally, is thus indicated. Finally, the thicknesses of the three formations are representative of major depositional episodes. For these reasons it is herein suggested that the formations of Spencer (1917) be retained and that the name White Pine either be abandoned or elevated to the rank of a group which would include in ascending order the Pilot shale, Joana limestone and Chainman shale.

The name Pilot shale should, then, be applied to that sequence of tan to light grey, calcareous and locally arenaceous shales which lies conformably on the limestones and dolomites of the Devonian Guilmette formation and unconformably, at least locally, below the Joana limestone and its equivalents. The maximum known thickness of the Pilot is about 1000 feet, but local variations in thickness of some magnitude occur. The formation is typically expressed as a saddle or a slope, with only poor exposures, the rocks where exposed often showing distinctive mottlings in shades of red.

Age and Correlation:

The age of the Pilot is as yet indeterminate. Spencer (pp. 24, 26) considered it as Mississippian, although in view of the lack of fossil evidence his suggested dating is open to question. More recent workers have studied the problem with conflicting results.

Rush (1951a, pp. 14-18) considers the Pilot in the Burbank Hills, Utah, to be of Mississippian age (although he applies no formation names, his reference is of necessity to the Pilot on the basis of stratigraphic position). Direct evidence for this age determination is weak, since Rush (p. 18) reports only Spirifer centronatus, Composita cf. C. humilis, Leptaena sp., Syringopora sp. Further evidence which bears on this point is found in Rush's (p. 16) reference to the fauna from the top of the underlying carbonate sequence (presumably the Guilmette): "The evidence indicates that of the faunal zones present in that section, the Cladopora-stromatoporoid beds, the Spirifer argentarius zone, possibly the Phillipsastrea zone, and the Cyrtospirifer zones, with the addition of members of the goniatite fauna, Manticoceras, are represented here." The reference to "...that section..." is to the faunal zonation of Merriam (1940) in the Roberts Mountains region. With regard to the faunal zones which "The evidence indicates...are represented here," it is unfortunate that Rush gives no exact measurements of the positions at which these were encountered. This lack of information, together with his somewhat nebulous wording, leave some doubt regarding the accurateness of his correlations. Further doubt is raised by information supplied by other workers in adjacent areas. Ogden (1951, p. 81) writing concerning the Mississippian and Pennsylvanian stratigraphy of the Confusion Range (a few miles northeast of the Burbank Hills), concludes that, "The Devonian fossil assemblages indicate that at least the two upper faunal zones of the Devonian of central Nevada are present in western Utah. The occurrence of Phillipsastrea in the upper part of the thick, dark gray, dolomitic limestone is evidence for tentative correlation with the Phillipsastrea zone of the Roberts Mountains section. Merriam (1940, p. 60) compares this zone with the Martin limestone of Arizona and the Shellrock stage of Iowa. Cyrtospirifer collected from the upper shaly unit of the Devonian indicates a close relation between this unit and the Cyrtospirifer zone of Merriam." The "upper shaly unit" to which Ogden refers is the Pilot and the "thick, dark gray, dolomitic limestone" the Guilmette. Ogden's published statement regarding the faunal zones present in the Pilot is corroborated by Zeller (personal communication, letter, May 15, 1953) who reports the occurrence of Cyrtospirifer 40 to 60 feet below the top of the Pilot. In opposition to the views of Ogden and Zeller, Sadlick (personal communication, letter, April 5, 1954) has concluded that the Pilot is of Mississippian age, "...mainly on the basis of a cephalopod tentatively identified as Imitoceras abundans which occurs commonly in the Chouteau and its equivalents in the type Mississippian section. There also is a trilobite, Proetus missouriensis, which I have compared with plesiotypes from the Louisiana limestone. ...However, I believe that enough evidence is present to date the collection somewhere in the interval between the Louisiana and Choteau formations."

It is apparent that there are ample quantities of conflicting or at least confusing evidence concerning the age of the Pilot. In recognition of the present uncertainty which enshrouds the inter-relations and positions of the faunal zones which arbitrarily determine the Mississippian-Devonian boundary, no definite age is here assigned to the Pilot. Future regional biostratigraphic studies which take into account paleoecology as well as taxonomy will likely provide more reliable conclusions.

Physical stratigraphic evidence, while not considered to have detailed chronologic significance, may bear on the point. The present writer considers the Pilot to be a lithic correlative of the Three Forks formation of northeastern Utah. Evidence for this correlation is found in the similar stratigraphic position of the two units, both being above the distinctive carbonate sequences of the Jefferson formation and its equivalents and beneath the equally distinctive limestones of the Madison and its equivalents. Further evidence for correlation is their lithologic similarity, both formations consisting of calcareous shales, with locally abundant sandy and silty material. Pink and red mottlings are characteristic of both, as is the intercalation of the shales with thin beds of limestone, siltstone, sandstone and dolomite. Also common to both is the slope or saddle making physiographic expression. Both have about the same maximum thickness, about a 1000 feet. Although the Cyrtospirifer fauna has been recognized from both the Three Forks and the Pilot, the Upper Devonian age of the former has not been questioned, probably because of the clarity of its initial definition. If the Three Forks and the Pilot are accepted as lithic correlatives and are also regarded as approximate temporal correlatives, it would seem only logical to regard at least the lower portion of the Pilot as Devonian.

In addition to correlation with the Three Forks, the Pilot is correlated with the Nowitsa shale, the Hayon Peak limestone, the

Victoria formation, and the upper portion of the Devils Gate formation.

Victoria formation

The Victoria formation was defined in 1919 by Loughlin as "Alternating beds of limey quartzite and siliceous limestone, some of them conglomeratic. Thickness 0 to 85 feet. Underlies Gardner dolomite and unconformably overlies Pinyon Peak limestone (Devonian). No fossils, but believed to be lower Mississippian. Named for Victoria mine." (Wilmarth, 1938, p. 2247). Apparently Loughlin's recognition of the stratigraphic sequence was incorrect. Present workers of the United States Geological Survey have retained many of the original names proposed by Loughlin, but have changed the order in which they occur. Lovering (personal communication, letter, March 29, 1954) confirms the Survey's present recognition of the Victoria as lying unconformably on the Bluebell dolomite and conformably beneath the Pinyon Peak limestone, which lies beneath the Mississippian Gardner. The Pinyon Peak, Victoria and the upper part of the Bluebell (herein regarded as correlative with the Sevy formation) are considered Devonian in age by the U. S. Geological Survey. It is difficult to see how this part of the stratigraphic sequence was inverted by Loughlin since on the northeast flank of Pinyon Peak (northeast of the Tintic District) the succession presently recognized by the Survey and accepted by this writer is clearly exposed below the Gardner limestone, which caps the mountain.

The original application of the term quartzite as part of the formational name of the Victoria is unfortunate, since the lithology of the formation is one of interbedded medium gray limestones and quartzose sandstones, some of which are sufficiently indurated to be termed quartzites. In recognition of the variant lithology, it is suggested that formation replace quartzite as the latter part of the name of the Victoria. The unit on the northeast flank of Pinyon Peak measures 37 feet in thickness. It should be noted, however, that this measurement applies only to the predominantly clastic sequence immediately above the contact with the underlying Bluebell. Since the Victoria and the Pinyon Peak intergrade, a thickness of approximately 90 feet would result if the upper limit of the Victoria were established at the top of the highest clastic bed in the intergradational contact zone. The disconformity at the base of the Victoria is not readily visible at all localities, but evidence for it is substantiated by Lovering (personal communication, letter, March 29, 1954) who reports that solution channels in the top of the Bluebell are filled by basal deposits of the Victoria. Further evidence is found in the absence of beds of the Jefferson formation, which occur elsewhere below the equivalents of the Victoria.

Age and Correlation:

No fossils have been reported from the Victoria but its Devonian age is proved by the presence in the overlying Pinyon Peak limestone and the underlying Bluebell dolomite of Devonian fossils. Because of the disconformity at its base and its intergradational contact with the overlying Pinyon Peak, it is concluded that the age of the Victoria is much closer to that of the Pinyon Peak (Upper Devonian) than to that of the Bluebell.

The correlations of the Victoria are deferred until the lithology and age of the Pinyon Peak have been discussed.

Pinyon Peak limestone

The Pinyon Peak limestone was defined by Loughlin (Lindgren and Loughlin, 1919) at Pinyon Peak, a prominent mountain a few miles northeast of the Tintic Mining District, Utah. The conflict regarding the stratigraphic position of the formation has been discussed above and it need only be pointed out here that the Pinyon Peak limestone is now considered to lie conformably below the Mississippian Gardner dolomite and to grade downward into clastic beds which are recognized by present workers as the Devonian Victoria formation. Loughlin described the unit as, "Shaly limestone, 0 to 150 feet thick. Conformably overlies Bluebell dolomite and unconformably underlies Victoria quartzite. Exposed along upper eastern slope of Pinyon Peak from its blunt eastern spur southwestward to its base. Not seen in north spur of the peak. Only recognized Devonian rock in Tintic district. Fossils indicate Upper Devonian (Threeforks?) age, but this correlation is not certain." (Wilmarth, 1938, p. 1668). The thickness given by Loughlin is considerably less than that measured by the writer (496 feet). This discrepancy may be in part associated with the confusion over proper stratigraphic sequence. The lithology of the Pinyon Peak, as observed by the writer, is one of medium gray to black limestones and dolomitic limestones, with occasional beds of light gray to buff sandstone and sandy limestone which increase downward as the formation grades into the underlying Victoria. Texture varies from dense to coarsely crystalline and bedding is thin to massive.

Age and Correlation, Pinyon Peak limestone and Victoria quartzite:

Fossiliferous beds are abundant in the upper portion of the Pinyon Peak, but preservation is poor in most cases. The upper 50 to 75 feet are particularly fossiliferous. The fossils are silicified and are commonly weathered out along the bedding planes. Unfortunately they are fragile and collection of complete forms is difficult. Therefore, only field identifications were made by this writer. These observations corroborate the faunal correlation with the Three Forks formation originally suggested by Loughlin, fossils of the Cyrtospirifer zone having been tentatively identified.

The Pinyon Peak and Victoria are considered together to be correlative with the Three Forks formation and with the Pilot shale. The shaly character prominent in the Three Forks and Pilot is not developed in the Pinyon Peak-Victoria sequence. The variant lithologies are considered to represent different facies of the same depositional unit and are thus correlated. The Pinyon Peak and Victoria are also correlated with the Becks formation. Correlation with the Pinyon Peak has been suggested by M. C. Williams (1953, pp. 2740-41) for the sequence occurring conformably beneath the Madison limestone in the Wasatch and western Uinta Mountains. It is herein suggested that the thin succession of shales occurring at the base of this unit constitute an equivalent of the Victoria and it is suggested that this name be applied. Application of Pinyon Peak is restricted to those carbonates lying above the presently designated Victoria and below the Madison limestone.

Lithologically the Pinyon Peak and Victoria of the Tintic District are not significantly different from their correlatives to the east in the Wasatch and Uinta Mountains. The principal change that has taken place in this direction is one of thinning. From an approximate thickness of 500 feet in the vicinity of Tintic the sequence thins to about 150 feet on the Wasatch Front and to approximately 40 feet in the western Uintas. It is significant to note that, in spite of the considerable thinning, the lithologies remain relatively similar. Transitional sections between those in the Tintic District and those in the Wasatch Mountains immediately underly the Madison at Becks Spur and at Ophir. The Becks Spur section especially suggests intergrading from the thicknesses and lithologies at Tintic to those on the shelf east of Salt Lake City. The names Becks formation (Edvalson, 1947) and City Creek formation (Granger, et al., 1952, p. 8) have been applied here, but their abandonment in favor of less localized names is suggested and will be discussed below. The Pinyon Peak and Victoria are recognized at Ophir and, although the clastics at the base of this section are not as prominently displayed as elsewhere, the 15 to 20 feet of dolomitic sandstone constitute a correlative to the Victoria. This section is basically similar to those in the Wasatch, showing only a relatively small amount of thickening. The apparent anomaly of more westerly position of this section in relation to that at Tintic will be discussed more fully in Chapter IV.

No question regarding the age of the Pinyon Peak and Victoria at Tintic and Becks Spur has been raised. They are considered by all workers to be of Late Devonian age. However, the acceptance of lithic correlation from these localities to the sections in the Wasatch Mountains and eastward has not been universally accepted because the units in the latter localities have been dated as Early Mississippian by Helen Duncan (Granger, et al., 1952, p. 9). The present writer believes that the similarities of stratigraphic position and lithology between the Tintic-Becks Spur sections and those southeast of Salt Lake City is ample evidence for physical correlation. It is further emphasized that the writer has collected and identified fossils of the Cyrtospirifer zone from the Victoria formation in the western Uinta Mountains (M. C. Williams, 1953, p. 2741). While the recognition of these fossils plays no part in the now recognized physical correlation, it is significant in illustrating the close temporal relations between the more eastward sections and those intermediate sections west of the Wasatch Front which also bear the same fauna. Miss Duncan makes no reference to the horizon(s) from which her Mississippian coral collections were made. However, it is inferred that they are from the Pinyon Peak. If such is the case, and if her age assignment is valid, the Pinyon Peak-Victoria sequence represents a time transgressive lithic unit. The unit is of Devonian age to the west and of latest Devonian and earliest Mississippian age to the east.

Westward and northward from the Tintic and Becks Spur transitional sections between the Victoria-Pinyon Peak sequence and the Three Forks and equivalents are not readily available. However, the Durst Mountain Three Forks section is considered representative of the change. Here the typical shales of the Three Forks-Pilot type are readily recognized, while interbedded with them are occasional limestones and sandstones, not unlike those found in the transitional Tintic or Becks Spur sections. Moreover, the thickness has increased appreciably over that at Becks Spur but is only 100 to 125 feet greater than that at Tintic. While the contrast between the Victoria-Pinyon Peak lithologies and those of the "typical" Three Forks to the west and north is real, they are not, in the present writer's opinion, radically different lithic types. Rather they represent two slightly variant lithotopes, which differ principally in percentage content of detrital material.

Devils Gate formation (upper member)

The division of the Devils Gate formation into units having lithic affinity has been discussed previously and the arguments for this functional division are not reiterated here. Although the change from the lower "Nevada-like" portion of Devils Gate to the upper, more shaly portion is transitional it takes place within a comparatively short vertical interval. The formation, as Merriam (1940, pp. 16-17) points out, is nowhere completely exposed. However, as can best be estimated, the upper member is approximately 1500 feet thick. It is composed of platy, dark gray limestones with prominent partings of tan clay and silt shale and occasional fine sandstone. These partings, and the surrounding limestone, commonly are distinctive mottled in shades of pink. Many of the shales, particularly in the higher portions of the formation, occur in beds several feet thick, which, though appearing massive, are papery when broken open. The upper member of the Devils Gate has been recognized in the vicinity of the type area, in the Southern Ruby Mountains where it is 300 feet thick (Sharp, 1942, map) and at Maggie's Creek, where 544 feet were measured, but where the lower limit is not exposed.

Age and Correlation:

On the basis of the presence of the Cyrtospirifer fauna, Merriam (pp. 16-17) has assigned the upper Devils Gate to the Late Devonian. However, since the upper limit of the formation is arbitrarily established by Merriam at the highest occurrence of Cyrtospirifer and since the contact with the overlying formation is gradational, it is possible that the uppermost portions of the Devils Gate may actually belong to the Mississippian.

The upper Devils Gate, on the basis of similar lithology and stratigraphic position, is believed to be correlative with the Pilot shale and its equivalents.

Becks formation

The name Becks formation was applied by Edvalson (1947, p. 39) to a 217 foot sequence of medium grey limestones and dolomitic limestones and tan shales and sandstones which outcrop at Becks Spur (Salt Lake Salient of Eardley, 1951) and elsewhere in the Wasatch Mountains in the vicinity of Salt Lake City. Edvalson recognized two members, an upper limestone member, 178 feet thick, which yields fossils of the Cyrtospirifer zone, and a lower unit, 39 feet thick, composed of interbedded calcareous shales and sandstones.

Age and Correlation:

As previously indicated, the Becks formation contains in its upper part fossils of the Cyrtospirifer zone. It is therefore assigned to the Late Devonian. This age assignment is corroborated by Helen Duncan and Jean Berdan of the United States Geological Survey (Granger, et al., 1952, p. 8) and by the writer's own observations and collections.

The Survey has applied the name "City Creek limestone" to the unit, for its occurrences in City Creek Canyon. Edvalson mentions the somewhat thinner occurrence of the formation at this locality (about 195 feet) and also correlated it with the beds immediately underlying the Madison in the Wasatch Front (the Pinyon Peak and Victoria referred to above). The Survey has not made this correlation. However, the present writer is in complete agreement with Edvalson's correlations, since they are made on the basis of valid physical criteria.

As pointed out under the discussion of the Pinyon Peak and Victoria it seems proper to recognize the obvious correlation between the sections in the Tintic District and those at Becks Spur and to thus apply the name Pinyon Peak limestone to the upper limestone member of the Becks formation and the name Victoria formation to the lower clastic member of the Becks. It is suggested that the names Becks formation and "City Creek" limestone be abandoned, and that the names Pinyon Peak limestone and Victoria formation be applied in their place.

The correlations of the Becks Spur section with surrounding Devonian sections have been discussed previously and are not repeated here.

<u>Jefferson formation</u> (Beirdneau member)

Mention was made during the discussion of the Three Forks formation that the Beirdneau member of the Jefferson formation of J. Stewart Williams (1948, p. 1140) in the Logan Quadrangle was considered by the present writer to represent the Three Forks in the vicinity of Logan. Little additional discussion is needed except to point out that although the Beirdneau is considerably thicker than "type Three Forks" it is typical in every way of the regional expression of the Three Forks, i.e., in lithology, stratigraphic position and in temporal affinities. The name Beirdneau member is, therefore, declared to be a synonym of Three Forks formation and, Three Forks being the prior name, the abandonment of the name Beirdneau is suggested. It is further suggested that the interval referred to by Williams as the Hyrum member be subsequently referred to as the Jefferson formation and that the name Hyrum member be abandoned.

POST-DEVONIAN STRATIGRAPHY

Mississippian

Madison limestone

The Madison limestone lies above the highest formations of the Devonian Sequence throughout the area except where subsequent erosion or structural deformation has removed or obscured it. The lithology of the Madison is distinctly different from that of the underlying strata and the formation is readily recognizable, both from the lithology and from its common expression as an unusually massive, gray cliff. The Madison is a medium to dark grey, medium to coarsely crystalline, fossil fragmental limestone. Locally the basal few feet of the formation may contain a noticeable fraction of clastic material, typically sand. In some areas the Madison is dolomitic but commonly it is nearly pure limestone. Beds are extremely massive and are frequently angularly jointed. Distinction from the underlying units is made on variance in lithology, greater fossil content, and the massiveness of beds which is usually quite distinctive in the field as a nearly vertical cliff.

Age and Correlation:

The Early Mississippian age of the Madison is amply supported by faunal evidence (Weller, et al., 1948, pp. 133-37). The division of the unit into several formations, with the elevation of the name Madison to group rank, such as has been made to the north, has not been accomplished in this region and it continues to be recognized as a formation. The Madison is believed to be correlative with the Topache limestone of the Frisco District and with the Joana limestone of eastern Nevada.

Leatham formation

A thin unit of black shales which intervenes between the Three Forks formation and the Madison limestone in the vicinity of Logan, Utah, has been recognized by Holland (1952) as the Leatham formation. Although shale, the lithology of the Leatham is distinctly different from the clastics of the underlying Three Forks. Its black carbonaceous to calcareous character and complete lack of the buff to gray color and pink mottlings are clearly different from the underlying rocks.

Age and Correlation:

The faunal list presented by Holland clearly supports the Early Mississippian age of the Leatham. However, because of its apparently localized occurrence, question is raised as to the advisability of its recognition as a formation. Suggestion is made that it might logically be classed as a member of the Madison formation.

CHAPTER IV

DEVONIAN SEDIMENTARY AND TECTONIC HISTORY AND PALEOGEOGRAPHY

INTRODUCTION

Three regionally distributed lithic intervals are recognized for purposes of examining the regional aspects of the stratigraphy and the sedimentary and tectonic environments of the Devonian Sequence in central and western Utah. Each of these is discussed individually and, finally, the entire system is examined. The intervals are arbitrarily designated by the name of the oldest formation included within the sequence in the region of study. The intervals are, in ascending order: Sevy, Jefferson and Three Forks.

Sevy Interval

The Sevy interval includes all the rocks which lie beneath the Jefferson formation or its equivalents and which rest on rocks of Silurian age or older. It constitutes the basal portion of the Devonian Sequence in northern and western Utah and eastern Nevada. It does not, so far as is known, occur in the sections of the Wasatch Front, or those immediately adjacent to it. The Sevy therefore is associated only with the belt of thicker sediments away from the stable shelf. The lithology most representative of the interval is that of dense, light gray primary dolomites. Relatively minor clastics are common near the top in western Utah and eastern Nevada. These are more prominently developed in northern and northeastern Utah.

The formations which are included in the interval are: the Sevy dolomite of central and western Utah and eastern Nevada, the Water Canyon formation of northern and northeastern Utah, the Bluebell dolomite of the Tintic District, and some as yet undefined portion of the Lone Mountain formation of central Nevada. Referring to the discussion of these units in Chapter III, it is seen that they are universally of Early Devonian age wherever it has been possible to date them.

Jefferson Interval

Included in this interval are all the rocks lying above the Sevy interval or, toward the shelf, those above the basal Devonian disconformity and beneath the Three Forks interval or, locally, beneath the disconformity at the top of the Devonian Sequence. Areally rocks of the interval have much the same general distribution as those of the Sevy interval with the exception that they extend, in some areas, farther toward the stable shelf than do those of the earlier interval. Lithologically the interval is predominantly secondary dolomite and limestone and with some beds of sandstone.

Formations included within the interval are: the Jefferson formation of north central and northeastern Utah (excluding the now abandoned Jefferson? of the Wasatch Front), the Simonson dolomite and the Guilmette formation of central and western Utah and eastern Nevada, an indeterminate portion of the Red Warrior limestone of the Frisco District, the upper part of the Nevada limestone (redefined) and the lower part of the Devils Gate formation.

The interval embraces rocks of essentially Middle Devonian age, although in places the upper beds are of Late Devonian age. So far as known, the only place that rocks of Early Devonian age may occur in the Jefferson interval is in the Lone Mountain section where the lower beds of the Nevada limestone (redefined) are believed to have been deposited during this time.

Three Forks Interval

Rocks of this interval are the uppermost and most widely distributed laterally of the Devonian Sequence. They lie above the Jefferson interval and beneath the Madison limestone or its equivalents and are present throughout the area of study except at a few localities, such as the Deep Creek Range, where former exposures have been removed by erosion. In lithology the interval is composed of tan, calcareous shales in the western and northern part; while a lower shale and sand unit and an upper limestone unit constitute the interval on the stable shelf to the south and east.

Participating in the interval are: the Three Forks formation, which occurs in north central and northeastern Utah, the Pilot shale of central and western Utah and eastern Nevada, the Nowitza shale of the Frisco District, the Pinyon Peak limestone and the Victoria formation of the Tintic District and the Wasatch Front area and the upper portion of the Devils Gate formation occurring in central Nevada.

In age the Three Forks interval is principally Upper Devonian. The age of the beds of the upper part is, however, as yet uncertain since the faunal criteria for the Mississippian-Devonian boundary are not conclusively established. It is herein considered, therefore, that the beds in question may represent earliest Mississippian sedimentation.

SEDIMENTARY AND TECTONIC HISTORY

Sevy Interval

Isopach and Lithofacies Distribution

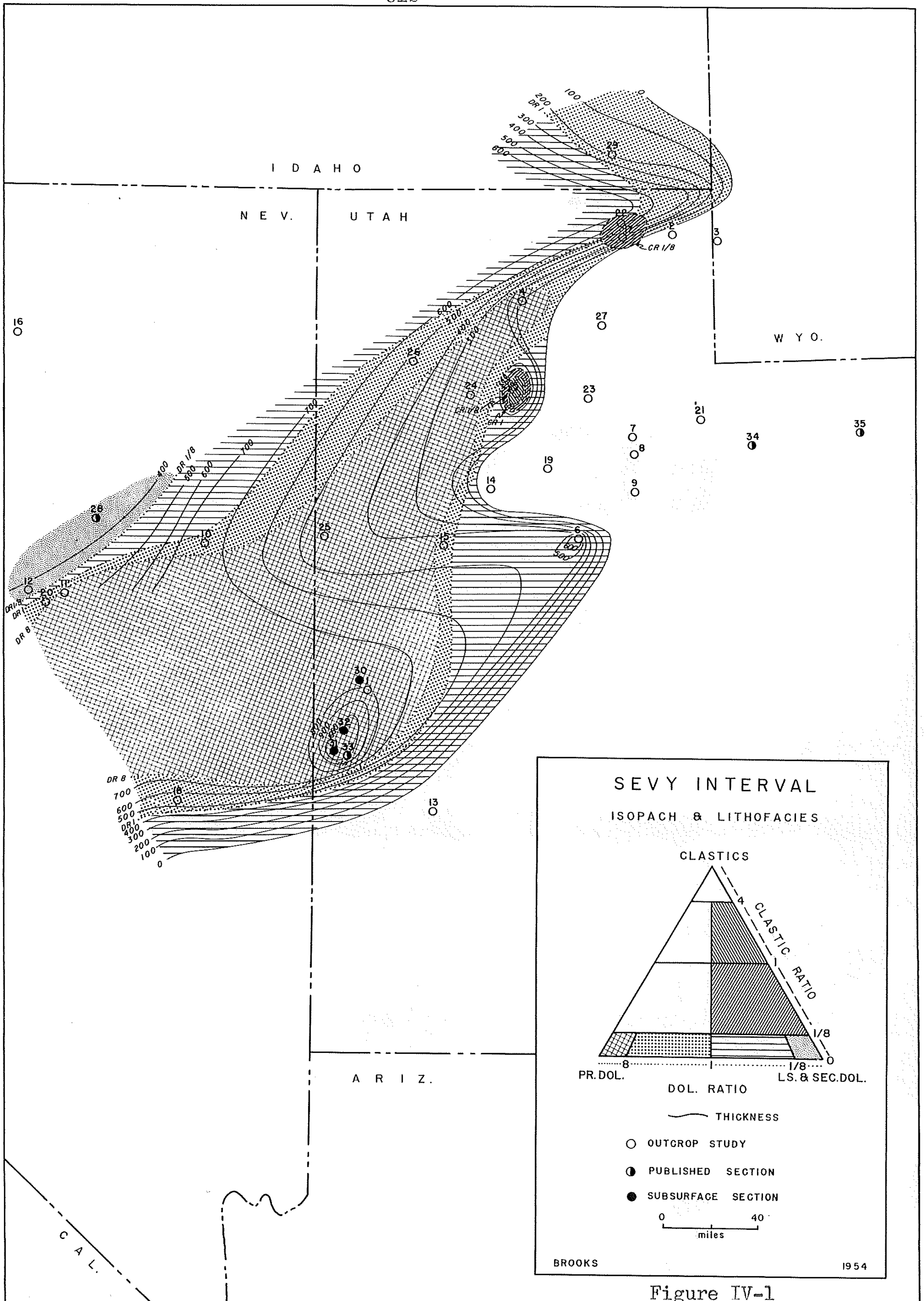
The distribution of thicknesses and lithologies for the Sevy interval is shown in Figure IV-1. It will be noted that the regional pattern is one of rather uniform thickening westward and that this trend is varied by the local presence of deeper basins and embayments. The map indicates that progressive thickening continues to the Cherry Creek section (number 10) in eastern Nevada and that the interval then thins to the west. The basis for the indicated thinning is not entirely conclusive. Reference to the discussion of the Lone Mountain-Roberts Mountains region sections indicates that the relations of the Sevy interval with the rocks at this locality are not clearly understood. An arbitrary division of the section in the central Nevada area was made by the present writer and it is acknowledged that this may be open to question. Therefore, no particular significance is attached to the thinning of the interval toward central Nevada.

In the vicinity of the Burbank Hills and the Confusion Range (sections 1, 30, 31, 32 and 33) isopach maps show a basinal development (Confusion Basin) with rather rapid thickening from about 500 to 600 feet in surrounding areas to in excess of 1000 feet in the center of the basin. Distribution of isopach lines delimits the basin rather clearly on the north, east and south. Western limits of the basin are more arbitrary and it is recognized that some enlargement to the west may occur.

Northeast of the Confusion Basin the Sevy interval thins but

KEY TO SECTION LOCATIONS

Map Number	Section Name	Map Number	Section Name
1	Confusion Mountains	19	Ophir
2	Laketown	20	Devils Gate Pass
3	Randolph	21	Oakley
4	Promontory Range	22	Logan
5	Stansbury Island Range	23	Becks Spur
6	Pinyon Peak	24	Lakeside Mountains
7	Big Cottonwood	25	Deep Creek
8	American Fork	26	Newfoundland Range
9	Rock Canyon	27	Durst Mountain
10	Cherry Creek	28	Southern Ruby Mountains
11	Diamond Range	29	Ten Mile Pass
12	Lone Mountain	30	Bishop Springs No. 1 Well
13	Frisco Area	31	Burbank No. 1 Well
14	South Stansbury Range	32	Desolation No. 1 Well
15	Dugway Range	33	Burbank Hills
16	Maggies Creek	34	Duchesne River
17	Blacksmith Fork	35	Whiterocks
18	Sunnyside		


IDAHO
NEV.
UTAH
WYO.
ARIZ.
CAL.
SEVY INTERVAL
ISOPACH & LITHOFACIES
CLASTICS
CLASTIC RATIO
PR. DOL.
LS. & SEC. DOL.
DOL. RATIO
THICKNESS
OUTCROP STUDY
PUBLISHED SECTION
SUBSURFACE SECTION
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BROOKS
1954

Figure IV-1

then thickens rapidly into basinal proportions in the vicinity of the Tintic District, where the sediments reach a thickness of over 600 feet. The map indicates that the position of this section represents an eastward embayment and that the thickening into it from the eastern zero edge is quite rapid. Although no control points are available immediately to the south and west it is inferred that the change of thickness in this direction is less rapid and the basin thus assumes an oval shape with the axis trending northeast-southwest. Thrust faulting from the west or southwest may provide an explanation for this sudden basining. This possibility is explored in more detail later.

At Stansbury Island, also, local basining occurs, the Sevy interval increasing here to a thickness of about 500 feet. While the thickening from the zero edge immediately to the east is quite rapid that to the west is only slightly more gradual and the basin is almost equidimensional.

A large embayment occurs in northeastern Utah, the isopach lines all curving uniformly into the area from the southwest and then rapidly reversing trend and curving out toward the northwest. This major embayment, the axis of which runs generally east-west, was an actively negative tectonic area through much of Paleozoic time. It is herein termed the Northeastern Utah Embayment.

The lithology of the Sevy interval is remarkably homogeneous throughout the region. Rocks of the Sevy interval, typically and predominantly composed of dense, light gray primary dolomites, in some areas have included significant quantities of clastic material, particularly in the upper portion. It is these clastic elements in addition to some limestones and secondary dolomites that provide the limited lithologic variations shown on Figure IV-1. Because of the dominance of carbonate sediments the lithofacies map is constructed with these as the base of the lithologic triangle, all clastics being considered together to constitute the triangle's apex.

The lithofacies distribution pattern of the Sevy interval is dominated by the large area of primary dolomite which occurs in the Confusion Basin and spreads northward from it. The nearly pure primary dolomite of this area is replaced along the margins by sections which contain a somewhat higher quantity of limestone and associated secondary dolomite. At two localities clastic sediments are present in sufficient quantity to be expressed as variations in the lithofacies pattern. At Stansbury Island (section 5) a thick sequence of pure orthoquartzite appears at the top of the Sevy interval and this, plus an increase in the amount of limestone and secondary dolomite, is responsible for the local variance from the regional lithofacies pattern. Presumably this abrupt change is associated with the equally abrupt basining. In the vicinity of Logan (sections 17 and 23) a less noticeable expression of the increased clastic content occurs. Here, as at Stansbury Island, the clastics are in the upper part of the Sevy interval. But, unlike Stansbury Island, the clastics are chiefly clay shales, siltstones and occasional sandstones.

The appearance of detrital sediments in the upper part of the interval has been of sufficient magnitude to affect the lithofacies patterns at only the two localities discussed. They are, however, generally present at the top of the interval elsewhere in central and western Utah and eastern Nevada. The clastic interval occurs as a bed of pure quartzite 5 to 15 feet thick within the upper few feet of the Sevy interval. It is well exposed, for example, in the Diamond Range (section 11) and at Sunnyside (section 18). Its lateral distribution is widespread and of interpretational significance although it is not expressed on the lithofacies map.

Sedimentary and Tectonic Environments

The Sevy interval throughout the region is represented largely, and particularly in the lower part, by the accumulation of a considerable thickness of dense, unfossiliferous, light colored, finely laminated dolomite. Dolomites of this lithology are significantly different and readily distinguishable from the secondary dolomites present in the younger Devonian intervals. Because of their uniformly unfossiliferous character and because dolomites of this lithology elsewhere are frequently associated with evaporitic sediments they are considered to be of primary origin. The most positive and concise contributions to the literature regarding primary dolomites have been made by Sloss (1947), who describes dolomites of this type in association with barred basins and, more recently (1953), discusses their environmental significance in greater detail.

Because the physical characteristics of the rocks in question are those ascribed above to primary dolomites and because they are almost completely lacking in fossils they are believed to have originated as dolomitic precipitates.

The acceptance of a primary origin requires examination of the sedimentary environment required to produce such a precipitate. Sloss (p. 145) described the type of environment in which primary dolomites commonly originate as penesaline and comments that "Penesaline sediments imply the maintenance of conditions characterized by concentrations of marine salts sufficient to be toxic to normal life and yet insufficient to permit the precipitation of chlorides. Such conditions are interpreted as the result of restriction of a marine basin in an arid climatic regime. Persistence of penesaline conditions requires a nice balance between inflow of normal sea water and evaporation."

It is apparent that some deviation from normal open marine processes of sedimentation is necessary to produce a widely distributed thick sequence of sediments of this distinctive type. The acceptance of the environment suggested by Sloss requires the semi-isolation of a large basin over a long interval, with constant environmental conditions maintained despite the relatively variant amounts of subsidence displayed in various portions of the basin. The means of accomplishing such isolation could logically have been either one of two types or a combination of the two. The development of large and laterally continuous organic reefs along the oceanward periphery may have been the cause. The writer has seen no development of a reef trend at this horizon in the Devonian. However, such a structure would have likely existed in the area to the south and west of the Confusion Basin where extensive investigation was not made. No evidence of the development of reefing was seen in the vicinity of Eureka, Nevada, where the transition from the primary dolomite lithology of the Sevy interval to the variant lithology of the Roberts Mountains region is accomplished in a short distance and where the presence of reef elements would have been detected if present. A second explanation, considered by the writer as less likely to have operated as the sole restrictive factor, is the presence of a linear, positive tectonic element along the westward and southwestward side of the basin which was the side toward the ocean. Such an element would have been remarkably constant in behavior since there is no evidence of it having undergone the pulsational positive and negative impulses that are frequently the habit of such elements. There is no indication of a land area to the west which would have shed clastics into the adjacent seaways nor is there evidence of any periodic subsidence which would allow normal open marine circulation for short periods of time producing limestones and associated sediments of normal marine type. If a tectonic barrier was the restrictive agent it was one of remarkable stability and uniformity of position with relation to sea level throughout its length. The existence of a barrier of such length and uniformity is possible but is considered doubtful.

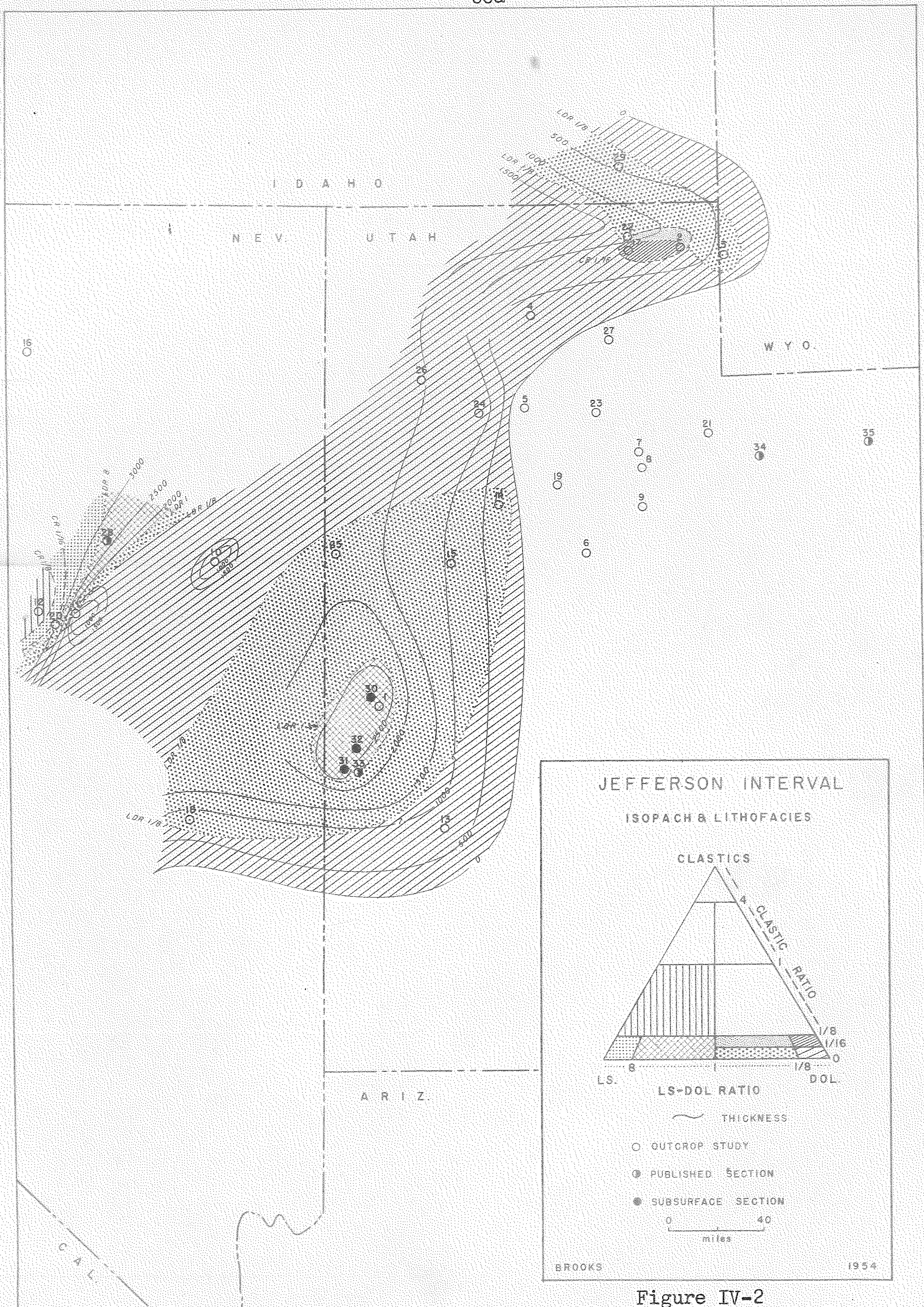
The combination of a tectonic arch and an organic reef which was supported by the arch appear to this writer to provide the most tenable explanation. A tectonic arch which is undergoing mild but continuous subsidence is frequently the site of reef development, since it provides an elevation sufficiently near the surface that reef-forming animals can survive and yet is subsiding at a rate which enables the reef to grow vertically. Because evidence which would provide a conclusive answer is completely lacking it is theorized that the major restriction to the south and west of the Confusion Basin may have been that of a reef growing on a linear, mildly negative arch which separated the basin from the open ocean circulation to the south and provided a continuous penesaline environment throughout the deposition of most of the Sevy interval. Restriction to the east and north is, of course, provided by the adjacent cratonic landmass which, judging from the almost complete lack of clastic sediments along the periphery, must have been one only very slightly above sea level. A further inference from the lack of peripheral detrital sediments is that sediments of the Sevy interval may originally have extended somewhat farther onto the craton and that they have been removed by erosion subsequent to their deposition and previous to the deposition on that area of the higher Devonian sediments. Restriction along the northwest side of the basin in north central and northeastern Utah was provided by a tectonic positive, the Northern Utah Axis, which became increasingly active during the later part of the Sevy interval and was actually exposed to erosion during this time, shedding sediments into the adjacent basins. The clastics of the Water Canyon in the Northeastern Utah Embayment and the thick quartzite section of the Sevy interval at Stansbury Island are the result of positive movements in the axis to the northwest. It is likely also that the quartzite typically occurring at the top of the Sevy in the Confusion Basin is a result of the sediments provided by this source area. The extreme cleanness and lateral uniformity of the sediments indicate mildness of uplift in the source area and a long period of sorting and reworking on the depositional interface by bottom currents before lithification was accomplished. The positive tectonism in the northern part of the region continued and was eventually felt in the depositional basins of north central and northeastern Utah which were themselves elevated and subjected to erosion for a period of unknown duration before renewed marine deposition of the Jefferson interval took place. To the south and southwest, however, there is no indication of emergence since sediments of the Sevy interval grade upward into those of the Jefferson with no evidence of discontinuity.

The Sevy interval may then be summarized as one in which, in its early history, marine deposition in a mildly restricted basin took place throughout most of northern, central and western Utah and eastern Nevada. The restriction of the depositional area resulted in the precipitation of primary dolomites throughout this portion of the interval. In the later part of the interval north central Utah and the Northeastern Utah Embayment received clastic sediments from a low lying adjacent land area to the northwest. Positive tendencies continued in the northern Utah area which was ultimately elevated and subjected to erosion. Deposition of primary dolomites in the still restricted Confusion Basin continued with the introduction of only minor amounts of clean quartz sand near the end of deposition. Maximum accumulation of penesaline sediments occurred in the Confusion Basin which was continuously subsiding throughout the interval. Termination of the interval in this area resulted from a cessation of restriction and the commencement of normal open circulation with subsequent deposition of normal marine sediments.

Jefferson Interval

Isopach and Lithofacies Distribution

Distribution of isopach lines indicates an area of gradual


I D A H O
N E V.
U T A H
W Y O.
A R I Z.
C A L.
JEFFERSON INTERVAL
ISOPACH & LITHOFACIES
CLASTICS
CLASTIC RATIO
LS.
DOL.
LS-DOL RATIO
THICKNESS
OUTCROP STUDY
PUBLISHED SECTION
SUBSURFACE SECTION
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BROOKS
1954

Figure IV-2

thickening westward from an eastern limit which follows much the same position as that of the Sevy interval. Local areas of increased thickening and thinning are present. The Confusion Basin of the Sevy interval again appeared as an area of maximum accumulation. The Northeastern Utah Embayment continued as an actively negative element and in this area Devonian seas spread farther to the east than had been the case in the Sevy interval. Areas of thinner sedimentary sequences are encountered at Cherry Creek and the Diamond Range. These presumably represent areas of less negative tectonism than that encountered in adjacent areas. The apparent thinning at Cherry Creek may, however, be due to an incompletely exposed section of rocks of the Jefferson interval. Rapid thickening occurs to the west between the Diamond Range and the Lone Mountain-Roberts Mountains region. Isopach lines are not continuous across north central Utah since no control points are available here and it is considered possible that the "high" in that area earlier may still have exerted an influence during the Jefferson interval.

Carbonate sediments again predominate and for this reason constitute the base of the lithologic triangle, clastics being considered collectively at the apex. Limestones and secondary dolomites are the predominant carbonates, primary dolomites being present as occasional interbeds and only in relatively insignificant amounts. Therefore, the ratio of limestones to dolomites is plotted and the resulting limestone dolomite ratio forms the basis of division for the basal part of the lithologic triangle. Because the quantities of clastic sediments are small a clastic ratio of 1/16 is used in the hope of better defining the areas of slightly increased clastics.

It is significant that in the three major basinal areas present in this interval, where the thicknesses are preceptibly increased, the quantity of limestone also increases. On the surrounding, more stable areas dolomitization of all carbonate rocks was virtually complete. Closer inspection shows, in addition, that the degree of dolomitization appears to be inversely proportional to the amount of thickening. In the Central Nevada Basin, where the greatest amount of thickening of this interval occurs, the section assumes an almost completely undolomitized aspect. In the Confusion Basin, where sediments are slightly thinner, dolomitization has had a somewhat greater effect. Greatest quantities of dolomite in a basinal area are to be noted in the Northeastern Utah Embayment, where thickening, relative to other basinal areas, has been somewhat less.

The general uniformity of sediments of the interval throughout the Utah and eastern Nevada area has been noted previously and the dissimilarity of the eastern rocks with those of central Nevada indicated. Such variances in carbonate sequences find no adequate means of quantitative portrayal and therefore the change is not shown on the map (Figure IV-2). However, it is likely that the environmental change which is effected in the Central Nevada Basin may well be the fundamental cause for the abrupt increase in limestone and the exclusion or lack of dolomitization. The basin in central Nevada should not necessarily, for this reason, be considered a completely comparable case to those to the east and northeast.

The single area where detrital sediments are present in sufficient quantities to be expressed on the map is that of the Northeastern Utah Embayment. The scattered beds of quartzose sandstone present throughout the rocks of the Jefferson interval in the region are slightly more numerous here. In no area is there an indication of increasing quantities of clastic sediments toward the zero isopach.

Sedimentary and Tectonic Environments

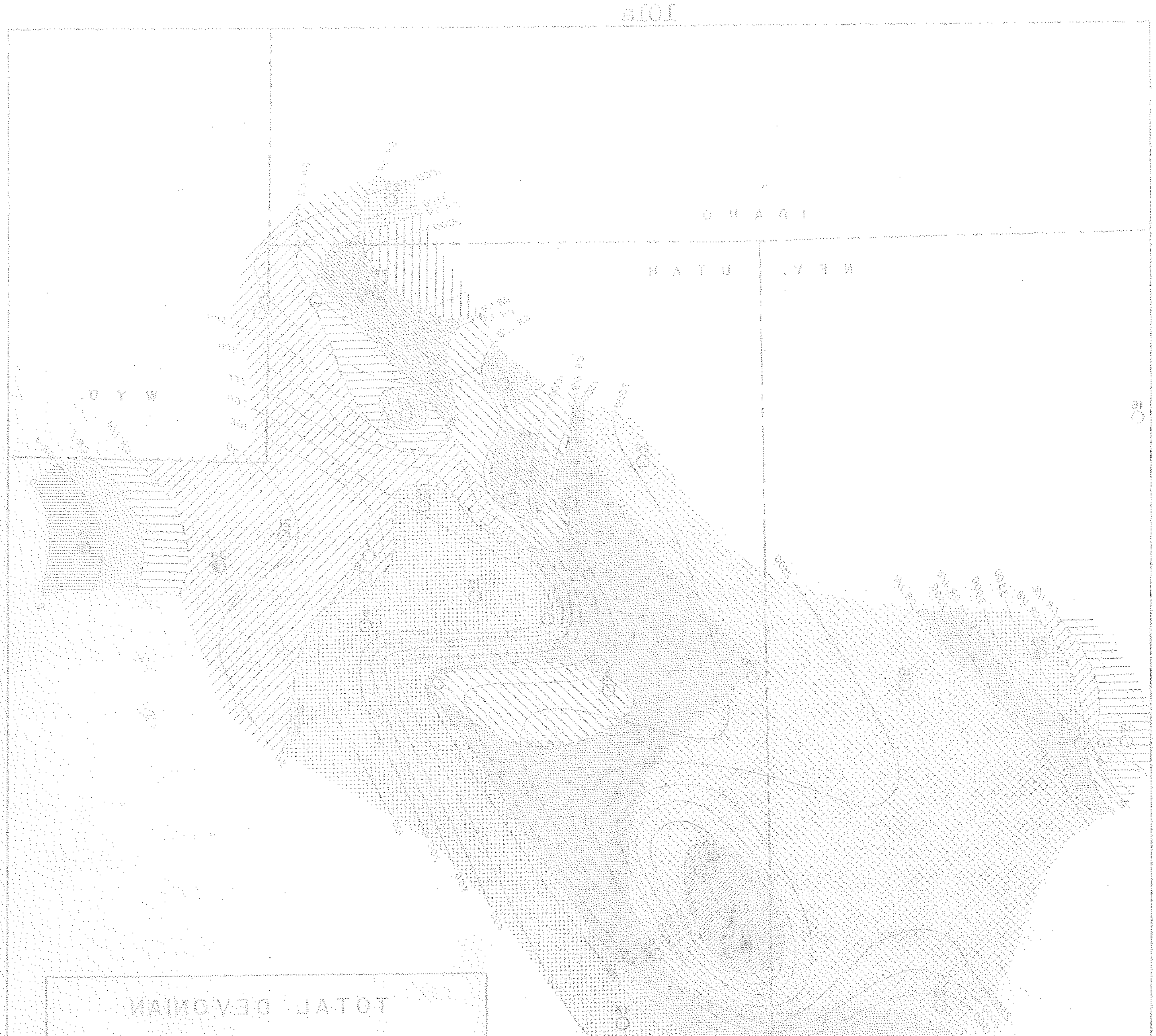
The sediments of the Jefferson interval throughout Utah and eastern Nevada are largely normal marine and fossil fragmental limestones, the majority of which have undergone dolomitization subsequent to their deposition. The uniformity of lithology of these rocks is indicative of a homogeneous sedimentary environment. An abrupt change of conditions is indicated in central Nevada where the dolomitized limestones common to the east give way to unaltered or somewhat silicified limestones of the Central Nevada Basin.

The carbonates of the eastern areas are representative of deposition on a stable to mildly unstable depositional interface. They were formed under conditions of an open ocean environment in which bottom currents had free access to most areas. The abundant fossils, though poorly preserved, give ample testimony to optimal conditions for certain invertebrates. Infrequent beds of quartzose sandstone also attest to the slowness of deposition and to the presence in most areas of bottom currents which reworked and cleaned the detrital deposits. Beds of primary dolomite occur occasionally and suggest restriction on a local scale.

Evidence for a secondary origin of the dolomites is found in the presence of fossil assemblages which are, locally at least, extensively developed. It is considered unlikely that the benthonic forms which constitute the preponderance of these assemblages could have existed on the toxic bottoms associated with the formation of primary precipitates of dolomite.

The presence of many pores, vugs and other types of voids is also taken as evidence for post-depositional dolomitization, since the volume loss in the replacement of calcite by dolomite is cited by Grabau (1924, p. 762) as 12.30 per cent. The voids are considered to be, at least in part, the result of the loss in volume during dolomitization. Further evidence is found in the lateral and vertical gradation of the dolomite into areas of dolomitic limestone or, in some cases, pure limestone. The method by which dolomitization was accomplished cannot be conclusively established. Van Tuyl (1916, pp. 251-421) has reviewed exhaustively the problem of the methods of origin of dolomites. He concludes that the majority of secondary dolomites originated while the lithified or partially lithified sediment was beneath the ocean. Evidence for this is the more uniformly high concentration of magnesium in ocean water than in ground water and in the constantly saturated condition which exists in rocks lying beneath an ocean floor. The almost universal dolomitization of the Jefferson interval and the lack of evidence that it is generally associated with post uplift ground water action leads to the conclusion of submarine alteration.

An explanation for the increase in volume of limestone in relation to dolomite in the Confusion Basin and the Northeastern Utah Embayment is not apparent. However, the more rapid subsidence and sedimentation in these areas may be wholly or partially responsible. The


IDAHO
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WYO.
ARIZ.
TOTAL DEVONIAN
ISOPACH & LITHOFACIES
CLASTICS
PR.DOL.
LS.&SEC.DOL.
DOL RATIO
THICKNESS
OUTCROP STUDY
PUBLISHED SECTION
SUBSURFACE SECTION
BROOKS
1954

Figure IV-1

an unstable intracratonic basin in which sedimentation and subsidence occurred at a moderate rate under infraneritic to epineritic environments. Evidence is not available to indicate conclusively whether the changes are the result solely of rapid lateral changes in depositional environment or whether subsequent thrust faulting has brought the variant facies into closer juxtaposition than they were at the time of origin. It is conceivable that rapid changes in facies may occur as the result of rapid changes in depositional environment along tectonic hinge areas and such explanation may suffice for the area in question. However, it should be pointed out that in neither the Lone Mountain-Devils Gate section nor in that in the Diamond Range is there evidence of a transitional sequence. It would appear that, if rapid environmental change alone were the cause of the juxtaposition of these different sediment types, some response to this change should be observable in the sections in question. The absence of any such evidence plus the existence of known thrust faults within the region suggest that thrusting may have acted to shorten the horizontal interval between the two sections. The magnitude of the suggested thrusting cannot presently be determined. Similarly the deformation is thus far dated only as post-Mississippian.

Sedimentary History and Paleogeography

The history of the Devonian Period in the eastern Great Basin is one of a gradually transgressing sea which spread northward and eastward onto successively older rocks (Figure IV-5) and eventually, in Middle or Late Devonian time, joined the arm of the sea that had advanced southward from the Arctic. A continuous epicontinental seaway

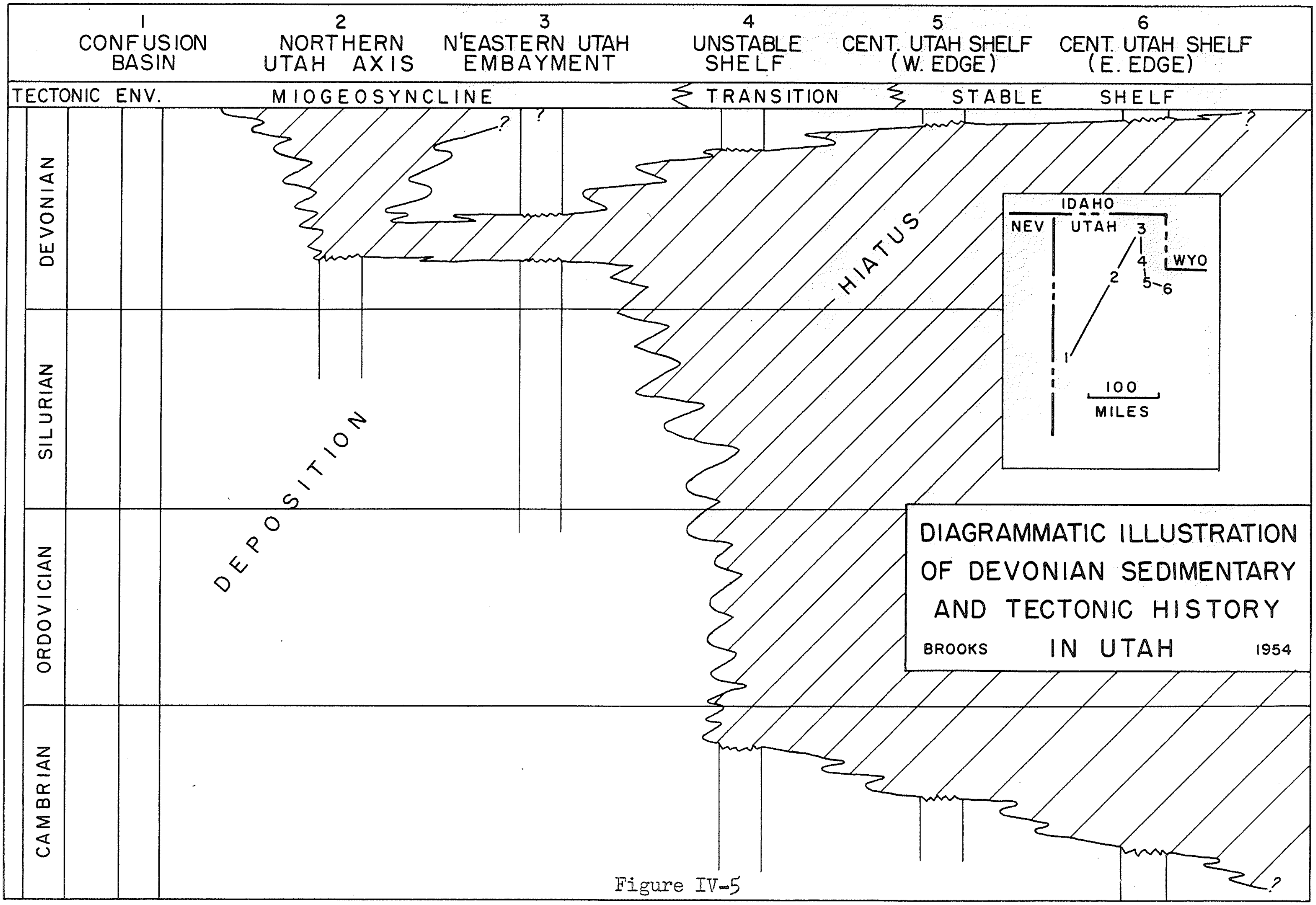
1
CONFUSION BASIN
2
NORTHERN UTAH AXIS
3
N'EASTERN UTAH EMBAYMENT
4
UNSTABLE SHELF
5
CENT. UTAH SHELF (W. EDGE)
6
CENT. UTAH SHELF (E. EDGE)
TECTONIC ENV.
MIOGEOSYNCLINE
TRANSITION
STABLE SHELF
DEVONIAN
SILURIAN
ORDOVICIAN
CAMBRIAN
DEPOSITION
HIATUS
IDAHO
NEV
UTAH
WYO
100 MILES
DIAGRAMMATIC ILLUSTRATION OF DEVONIAN SEDIMENTARY AND TECTONIC HISTORY IN UTAH
BROOKS
1954

Figure IV-5

from the Arctic Ocean to the Pacific was thus formed by the end of the period.

Sedimentation was continuous from Silurian to Devonian in the Central Nevada Basin and in the deepest part of the Confusion Basin. These areas were apparently sufficiently negative to remain below sea level during the period of uplift and erosion which affected much of the region following the deposition of the Silurian Laketown dolomite. From these areas Early Devonian seas spread northeastward and before the end of Early Devonian time had inundated most of western Utah and eastern Nevada and had reached as far as northeastern Utah where Lower Devonian deposits are present in the vicinity of Logan (see Figure IV-1). Inundation was limited, however, to the miogeosynclinal areas. The stable shelf to the east received no sediments. The adjacency of a source area to the Northeastern Utah Embayment during this time is demonstrated by the presence of clastic sediments in the lower and upper part of Lower Devonian section in that area. Except for the Central Nevada Basin the deposits of the Lower Devonian are those of a penesaline environment created in a large barred basin. The thickest and most homogeneous accumulations of the primary dolomites which resulted are found in the center of the Confusion Basin. The detrital sediments present in the Logan area suggest that an adjacent source area was active in the early and late parts of depositional interval. While penesaline conditions were no doubt effective in this area throughout the Lower Devonian interval, the purely penesaline primary dolomites are well developed only in the medial portion when clastic material was not supplied in significant quantities. Following the deposition of the Sevy interval positive tectonism took place in northeastern Utah and the areas adjacent to the Northern Utah Axis were exposed to subaerial erosion. The sedimentary record suggests that the Northeastern Utah Embayment was raised to a position very near sea level from which slight emergence may have taken place. The presence of mud cracks, ripple marks and red shales indicates a period of littoral to very shallow epineritic conditions in the area.

The uplift in northern and northeastern Utah drained the seas southward to the Confusion Basin where their continuous presence is indicated by the intergradational character of the contact with the overlying sediments of the Jefferson interval. The restrictive element which had produced the penesaline environment during the Sevy interval disappeared at this time and its disappearance is reflected in the normal marine character of the Jefferson sediments. An environment of unimpeded circulation is clearly indicated.

The Central Nevada Basin, unlike the basins to the east, is not represented by dense dolomite deposits of the Sevy interval. The Silurian boundary is not clearly established here, but some portion of the Lone Mountain formation and the lower part of the Nevada limestone represent the Sevy interval. These units indicate a different environment from that of the Confusion Basin, and their restricted nature is not indicated. The detrital sediments and thin carbonates of the lower Nevada limestone grade into the nearly pure carbonate beds of the middle and upper Nevada and the lower portion of the Devils Gate indicating continuous deposition. This situation is analogous to that in the Confusion Basin and indicates the position to which the seas retreated from the northeast at the end of the Sevy interval.

The seas spread northward again during the Jefferson interval and inundated much the same area as that covered by the Sevy seas (see Figure IV-2). The unrestricted conditions mentioned as marking the terminus of Sevy deposition in the Confusion Basin are typical of the Jefferson interval throughout its lateral and vertical extent. Deposition of the basal deposits of the Jefferson interval of necessity took place at an earlier time in the Confusion and Central Nevada Basins than in areas to the north. Whether all parts of the Northern Utah Axis within the region of this study were covered is not clear. No sediments of the Jefferson interval are found on the Sevy deposits at Stansbury Island, but it has not been discerned as to whether this represents deposition of younger rocks with their subsequent complete removal or whether the area continued as an exposed positive. In any event there is no indication of a marked restriction of the Northeastern Utah Embayment during this time, and so it may be assumed that the portion of the Northern Utah Axis lying between the Embayment and the Confusion and Central Nevada Basins was not sufficiently great to form a continuous barrier of long duration.

The shelf area to the east remained as an exposed area of very low elevation which supplied few clastic sediments to the miogeosynclinal basins to the west and north. The exact position of the strand line during this and the Sevy interval is not well delimited since no detrital near shore sediments are found. It is believed that the nature of the cratonic area, coupled with some subsequent removal by erosion, may explain the lack of this sediment type.

Sedimentation was continuous from the Jefferson into the Three Forks interval. Near the end of the interval seas spread eastward and covered a large part of the Central Utah Shelf (see Figure IV-3). Deposition of shelf type sediments on this area indicates its essential stability. Less stable conditions existed in the miogeosyncline where the gross sedimentary aspect is that of an epineritic environment on a mildly unstable shelf. The two facies of the upper Three Forks interval are thus indicative of the influence of tectonic environment on sedimentary accumulation.

Positive trends became stronger at the end of the interval and local areas were uplifted and eroded. While these areas were in the miogeosyncline it is not believed that the entire miogeosynclinal area was subjected to uplift at this time. Continuous sedimentation into overlying units took place in the Central Nevada Basin. It is not clearly established as to whether all the Confusion Basin was exposed, but it is known that local areas to the north and southwest of the basin center underwent erosion (Deep Creek, section 25; Sunnyside, section 18). There is nothing to suggest an erosional hiatus between the upper sediments of the Three Forks interval of the Central Utah Shelf and the beds of the overlying Madison limestone. The close of the Three Forks interval may then be considered as a time in which positive elements were active in the miogeosyncline causing removal of section in certain areas and deposition of detritus in adjacent depositional areas. Widespread presence of Mississippian seas marks the resumption of more negative tendencies throughout the entire region.

CHAPTER V

CONCLUSIONS

Examination of the Devonian Sequence throughout the area of central and western Utah and eastern Nevada demonstrates that regionally correlatable lithic units exist. Because of similar stratigraphic position and similar lithologies the Sevy dolomite and the Water Canyon formation are considered synonymous. Suggestion is made that the name Sevy formation be applied throughout the area. It is also suggested that facies variations within the Sevy be recognized with appropriate descriptive names, e.g., clastic facies. The Bluebell dolomite occurs in the same position and with much the same lithology as the Sevy formation. Therefore they are correlated. Because of similarity in lithology and sequential position the Jefferson formation is correlated with the Guilmette formation and Simonson dolomite and with the upper portion of the Red Warrior limestone. The Three Forks formation, the Pilot shale and the Mowitza shale occupy the same relative stratigraphic interval and demonstrate much the same lithology and are therefore correlated. A different facies of the Three Forks-Pilot depositional episode is recognized in the eastern part of the region of study where the Pinyon Peak limestone and underlying Victoria formation are correlated with the Three Forks or Pilot. The similarity in stratigraphic position supports the correlation. Exact lithic correlatives of these units are not recognized in the Roberts Mountains region. However, the upper part of the Lone Mountain formation (redefined) and the lower part of the Nevada formation (redefined) are considered temporal correlatives of the Sevy formation. The middle and upper parts of the Nevada formation (redefined) and the lower part of the Devils Gate formation are temporal correlatives of the Guilmette formation and the Simonson dolomite. The correlative of the Pilot shale is the upper part of the Devils Gate formation. In this case parasynchroneity is demonstrated as well as similarity of lithology and stratigraphic position.

It is suggested that the names Beirdneau member and Hyrum member of the Jefferson formation (Logan Quadrangle, Utah) be supplanted by the names Three Forks formation and Jefferson formation, respectively, since the rocks in question occupy the same stratigraphic position and possess similar lithologies to these formations.

Three lithic intervals are defined for purposes of regional environmental analysis. They are, in ascending order, the Sevy interval (composed of the Sevy formation and its lithic correlatives), the Jefferson interval (composed of the Jefferson formation and its lithic equivalents) and the Three Forks interval (composed of the Three Forks formation and its correlatives). Isopach and lithofacies analysis clearly demonstrate the areal distribution, variation in thickness, environment of deposition of the rocks of the intervals. From these factual data interpretations of the type and distribution of the tectonic elements within the area are made.

Sediments of the Sevy interval are confined to the western and northern, or miogeosynclinal, portion of the area. They are dominantly primary dolomites which represent deposition in a restricted basin of penesaline environment. The presence of a reef on a tectonic arch south and west of the area of occurrence of these sediments is postulated to explain the restriction of the basin (the Confusion Basin). Clastics present in the interval in the northeastern part of the area indicate presence of adjacent land areas from which detritus was derived. A positive tectonic axis (the Northern Utah Axis) developed late in the Sevy interval and uplift in this and adjacent areas was sufficient to drain the seas from the Northeastern Utah Embayment and from the Northern Utah Axis and the areas were subjected to erosion. Sedimentation, however, continued in the Confusion Basin. The interval was terminated by cessation of restriction which resulted in the commencement of the open marine deposition of the Jefferson interval. Sediments of the Jefferson interval occupy much the same areal position as those of the Sevy and are principally limestones and secondary dolomites which indicate sedimentation in unrestricted basins of normal marine aspect. Seas spread northward over the Northern Utah Axis and into the Northeastern Utah Embayment. Lithologies indicate that uniform depositional conditions existed throughout the area. Thinning of sediments is noted between the Confusion Basin and the Central Nevada Basin and the existence of a less rapidly subsiding platform in this area is inferred. No evidence is found of cessation of deposition between the rocks of the Jefferson interval and those of the overlying Three Forks interval. Slight but continued elevation of adjacent source areas is indicated by the presence of notable quantities of fine detritus in the Three Forks. Continued precipitation of carbonates, in addition to the clays and silts, is demonstrated by the intercalations of shales and limestones in the miogeosynclinal area and by the presence of relatively pure limestone and secondary dolomite sequences on the stable and unstable shelves to the east. The wide distribution of the sediments of the interval indicate the general inundation of the region. Local uplift and erosion after the deposition of the Three Forks interval and before deposition of the overlying Madison limestone occurred in several areas of the miogeosyncline.

Depositional conditions indicated by the Devonian Sequence are those of the stable shelf to the east (Central Utah Shelf) and the mildly unstable shelf in the miogeosynclinal area. Local exceptions are found in the Northeastern Utah Embayment and the Central Nevada and Confusion Basins which demonstrate the intermittent presence of depositional conditions associated with the intracratonic shelf.

BIBLIOGRAPHY

GENERAL BIBLIOGRAPHY

* Indicates references cited.

*Andrichuk, John M. (1951) Regional stratigraphic analysis of the Devonian System in Wyoming, Montana, southern Saskatchewan and Alberta, Am. Assoc. Petrol. Geol., Bull., vol. 35, pp. 2368-2408.

Ashley, G. H., et al. (1933) Classification and nomenclature of rock units, Geol. Soc. Am., Bull., vol. 44, pp. 423-459.

Bacon, C. S., Jr. (1948) Geology of the Confusion Range, west-central Utah, Geol. Soc. Am., Bull., vol. 59, pp. 1027-1052.

*Baker, A. A. (1947) Stratigraphy of the Wasatch Mountains in the vicinity of Provo, Utah, U. S. Geol. Survey, Prelim. Chart 30, Oil and Gas Investigations.

*__________, Huddle, J. W., Kinney, D. M. (1949) Paleozoic geology of the north and west sides of Uinta Basin, Utah, Am. Assoc. Petrol. Geol., Bull., vol. 33, pp. 1161-1197.

Bass, N. W. (1945) Correlation of basal Permian and older rocks in southwestern Colorado, northwestern New Mexico, northeastern Arizona and southeastern Utah, U. S. Geol. Survey, Prelim. Chart 7, Oil and Gas Investigations.

Basset, C. F. (1939) Paleozoic section in the vicinity of Dotsero, Colorado, Geol. Soc. Am., Bull., vol. 50, pp. 1851-1866.

*Berry, G. W. (1943) Stratigraphy and structure at Three Forks, Montana, Geol. Soc. Am., Bull., vol. 54, pp. 1-30.

Bertagnolli, A. J., Jr. (1941) Geology of the southern part of La Barge region, Lincoln County, Wyoming, Am. Assoc. Petrol. Geol., Bull., vol. 25, pp. 1729-1744.

*Bissell, Harold J. (1952) Stratigraphy and structure of northeast Strawberry Valley Quadrangle, Utah, Am. Assoc. Petrol. Geol., Bull., vol. 36, pp. 575-634.

Blackwelder, E. (1910) New light on the geology of the Wasatch Mountains, Utah, Geol. Soc. Am., Bull., vol. 21, pp. 517-542.

__________ (1918) New geological formations in western Wyoming, Jour. Wash. Acad. Sci., vol. 8, no. 13, pp. 417-426.

Branson, E. B. and Mehl, M. G. (1930) Primitive fishes from the Devonian of Utah and Nevada (abstract), Geol. Soc. Am., Bull., vol. 41, p. 180.

__________________________ (1931) Fishes of the Jefferson formation of Utah, Jour. Geol., vol. 39, pp. 509-531.

__________ (1941) Geology of the Wind River Mountains, Wyoming, Am. Assoc. Petrol. Geol., Bull., vol. 25, pp. 120-151.

*Brooks, James E. and Andrichuk, John M. (1953) Regional stratigraphy of the Devonian system in northeastern Utah, southeastern Idaho and western Wyoming, Intermountain Assoc. Petrol. Geol., Fourth Ann. Field Conf. Guidebook (June), pp. 28-31.

Burbank, W. S. (1940) Structural control of ore deposition in the Uncompahgre district, Ouray County, Colorado, U. S. Geol. Survey, Bull. 906-E, pp. 189-265.

*Butler, B. S. (1913) Geology and ore deposits of the San Francisco and adjacent district, Utah, U. S. Geol. Survey, Prof. Paper 80.

__________ and Loughlin, G. F. (1916) A reconnaissance of the Cottonwood-American Fork mining region, Utah, U. S. Geol. Survey, Bull. 620, pp. 165-226.

__________ and others (1920) The ore deposits of Utah, U. S. Geol. Survey, Prof. Paper 111.

Butler, R. D. and Singewald, Q. D. (1940) Zonal mineralization and silicification in the Horseshoe and Sacremento districts, Colorado, Econ. Geol., vol. 35, pp. 793-838.

*Calkins, F. C. and Butler, B. S. (1943) Geology and ore deposits of the Cottonwood-American Fork area, Utah, U. S. Geol. Survey, Prof. Paper 201.

Cooley, I. L. (1928) The Devonian of the Bear River Range, Utah, Utah Agricultural College Master's thesis.

Cooper, G. A., et al. (1942) Correlation of the Devonian sedimentary formations of North America, Geol. Soc. Am., Bull., vol. 53, no. 12, pt. 1, pp. 1729-1794.

Crawford, R. D. (1910) Geology and ore deposits of Monarch and Tomichi mining districts, Chaffee County, Colo. Geol. Survey, Bull. 1.

*Crickmay, C. H. (1952) Discrimination of late Upper Devonian, Jour. Paleontology, vol. 26, no. 4, pp. 585-609.

Cross, W. and Spencer, A. C. (1900) Geology of the Rico Mountains, U. S. Geol. Survey, 21st Ann. Rept., pt. 2.

__________ (1904) A new Devonian formation in Colorado, Am. Jour. Sci., 4th Ser., vol. 18, pp. 244-252.

__________ and others (1905) Silverton folio, U. S. Geol. Survey, Geol. Atlas of the U. S., no. 120.

__________ and Ransome, F. L. (1905) Description of the Rico Quadrangle, U. S. Geol. Survey, Geol. Atlas of the U. S., no. 130.

__________ and others (1905) Needle Mountains folio, U. S. Geol. Survey, Geol. Atlas of the U. S., no. 131.

__________________ (1907) Description of the Ouray Quadrangle, U. S. Geol. Survey, Geol. Atlas of the U. S., no. 153.

Dapples, E. C., Krumbein, W. C. and Sloss, L. L. (1948) Tectonic control of lithologic associations, Am. Assoc. Petrol. Geol., Bull., vol. 32, pp. 1924-1947.

____ (1950) The organization of sedimentary rocks, Jour. Sed. Pet., vol. 20, no. 1, pp. 3-20.

Darton, N. H. (1917) A comparison of Paleozoic sections in southern New Mexico, U. S. Geol. Survey, Prof. Paper 108.

__________ (1925) A resume of Arizona geology, Univ. of Ariz. Bull. 119, Geol. ser. no. 3.

Deiss, C. F. (1941) Structure of central part of Sawtooth Range, Montana (abstract), Geol. Soc. Am., Bull., vol. 52, p. 1947.

__________ (1943) Stratigraphy and structure of southwestern Saypo Quadrangle in Montana, Geol. Soc. Am., Bull., vol. 54, no. 2, p. 226.

Donovan, Jack (1951) Devonian rocks of the Confusion Basin and vicinity, Utah Geol. and Mineral. Survey, Guidebook to the Geol. of Utah, no. 6, pp. 47-63.

Dorf, E. (1934) Stratigraphy and paleontology of a new Devonian formation at Beartooth Butte, Wyoming, Jour. Geol., vol. 42, pp. 720-737.

Eardley, A. J. (1933) Stratigraphy of the southern Wasatch Mountains, Utah, Michigan Acad. Sci. Paper, vol. 18, pp. 307-344.

*__________ (1934) Structure and physiography of the southern Wasatch Mountains, Utah, ibid., vol. 19, pp. 377-400.

*__________ (1939) Structure of the Wasatch-Great Basin Region, Geol. Soc. Am., Bull., vol. 50, pp. 1277-1310.

*__________ (1944) Geology of the north-central Wasatch Mountains, Utah, Geol. Soc. Am., Bull., vol. 55, pp. 821-893.

__________ (1947) Paleozoic Cordilleran geosyncline and related orogeny, Jour. Geol., vol. 55, pp. 309-342.

__________ (1949) Paleotectonic and paleogeologic maps of central and western North America, Am. Assoc. Petrol. Geol., Bull., vol. 33, pp. 655-682.

*__________ (1951) Structural geology of North America, Harper and Brothers Publishers, New York, 624 pp.

*Easton, W. H., et al. (1953) Revision of stratigraphic units in Great Basin (Eastern Nevada Geol. Assoc. Stratigraphic committee), Am. Assoc. Petrol. Geol., Bull., vol. 37, pp. 143-151.

*Edvalson, F. M. (1947) Stratigraphy and correlation of the Devonian in the central Wasatch Mountains, Utah, University of Utah Master's thesis.

Emmons, S. F. (1886) Geology and mining industry of Leadville, Colorado, U. S. Geol. Survey, Mon. 12.

Endlich, F. M. (1874), U. S. Geol. and Geog. Survey Ann. Rept. for 1874, pp. 211-214.

*Fenton, C. L. and Fenton, M. A. (1924) The stratigraphy and fauna of the Hackberry stage of the Upper Devonian, Michigan University Contributions, Museum of Geology, vol. 1.

Galbraith, F. W., III (1940) Empire Mountains, southeastern Arizona (abstract) Geol. Soc. Am., Bull., vol. 51, p. 1927.

Gilbert, G. J. (1875) Geology of portions of Nevada, Utah, California, and Arizona, U. S. Geog. Surveys West of the One Hundredth Meridian, vol. 3.

*Gilluly, J. (1932) Geology and ore deposits of the Stockton and Fairfield Quadrangle, Utah, U. S. Geol. Survey, Prof. Paper 173.

Girty, G. H. (1903) The carboniferous formations and faunas of Colorado, U. S. Geol. Survey, Prof. Paper 16.

__________ (1905) Relations of some carboniferous faunas, Proc. Wash. Acad. Sci., vol. 7.

Goddard, E. N. (1940) Manganese deposits at Phillipsburg, Granite County, Montana, U. S. Geol. Survey, Bull. 922-G.

*Grabau, A. W. (1924) Principles of stratigraphy, A. G. Seiler Publisher, New York, 1185 pp.

*Granger, A. E., Sharp, B. J., Crittenden, M. D., Calkins, F. C. (1952) Geology of the Wasatch Mountains east of Salt Lake City, Utah Geol. Soc., Guidebook to the Geol. of Utah, no. 8, pp. 1-37.

________ (1953) Stratigraphy of the Wasatch Range near Salt Lake City, Utah, U. S. Geol. Survey, Circular 296.

Graton, L. C. and Gordon, C. H. (1906) Devonian fauna of the Ouray in New Mexico, Am. Jour. Sci., 4th Ser., vol. 21, pp. 390-395.

*Hague, A. (1892) Geology of the Eureka district, Nevada, U. S. Geol. Survey., Mon. 20.

Haynes, W. P. (1916) The Lombard overthrust and related geological features, Jour. Geol., vol. 24, pp. 269-290.

Hintze, F. F. and Christensen, B. C. (1911) Geology and ore deposits of the Ophir Mining District, Utah, University of Utah Master's thesis.

*________ (1913) A contribution to the geology of the Wasatch Mountains, Utah, Annals, New York Acad. Sci., vol. 23, pp. 84-143.

________ (1950) The Ordovician, Silurian and Devonian systems of Utah, Utah Geol. and Mineral. Survey, The Oil and Gas Possibilities of Utah, pp. 38-66.

*Holland, F. D., Jr. (1952) Stratigraphic details of Lower Mississippian rocks of northeastern Utah and southwestern Montana, Am. Assoc. Petrol. Geol., Bull., vol. 36, no. 9, pp. 1697-1734.

Howard, L. O. (1916) Geology of the Cottonwood district, Utah, Min. and Sci. Press, vol. 112, pp. 557-562.

Huddle, J. W. and McCann, F. T. (1947) Geologic map of Duchesne River area, Wasatch and Duchesne Counties, Utah, U. S. Geol. Survey, Prelim. Map 75, Oil and Gas Investigations.

Irving, J. D. (1905) Ore deposits of the Ouray district, U. S. Geol. Survey, Bull. 260.

Kemp, J. F. and Billingsley, P. (1918) Notes on Gold Hill and vicinity, Tooele County, western Utah, Econ. Geol., vol. 13, pp. 247-274.

Kindle, E. M. and Williams, H. S. (1903) Contributions to Devonian paleontology, U. S. Geol. Survey, Bull. 244.

________ (1908) Fauna and stratigraphy of the Jefferson limestone in the northern Rocky Mountain region, Bull. Am. Paleo., vol. 4, no. 20.

________ (1909) The Devonian fauna of the Ouray limestone, U. S. Geol. Survey, Bull. 391, pp. 1-60.

*King, C. (1876) Paleozoic subdivisions on the fortieth parallel, Am. Jour. Sci., Ser. 3, vol. 11, pp. 475-482.

Kinney, Douglas M. and Rominger, J. F. (1947) Geology of the Whiterocks River-Ashley Creek area, Uintah County, Utah, U. S. Geol. Survey, Prelim. Map 82, Oil and Gas Investigations.

Krumbein, W. C. (1947) Shales and their environmental significance, Jour. Sed. Pet., vol. 17, pp. 101-109.

________ (1948) Lithofacies maps and regional sedimentary-stratigraphic analysis, Am. Assoc. Petrol. Geol., Bull., vol. 32, pp. 1909-1923.

________, Sloss, L. L., and Dapples, E. C. (1949) Sedimentary tectonics and sedimentary environments, Am. Assoc. Petrol. Geol., Bull., vol. 33, pp. 1859-1891.

Lambert, H. C. (1941) Structure and stratigraphy in the southern Stansbury Mountains, Tooele County, Utah, University of Utah Master's thesis.

Laudon, L. R. (1941) Mississippian formations of Sacramento Mountains, New Mexico, Am. Assoc. Petrol. Geol., Bull., vol. 25, pp. 2107-2160.

*Lindgren, W. and Loughlin, G. F. (1919) Geology and ore deposits of the Tintic Mining District, Utah, U. S. Geol. Survey, Prof. Paper 107.

Loughlin, G. F. (1913) Reconnaissance in the southern Wasatch Mountains, Utah, Jour. Geol., vol. 21, pp. 436-452.

Love, D. J. (1939) Geology along the southern margin of the Absaroka Range, Wyoming, Geol. Soc. Am., Spec. Paper 20.

*Mansfield, G. R. (1927) Geology, geography, and mineral resources of part of southeastern Idaho, U. S. Geol. Survey, Prof. Paper 152.

Meek, F. B. (1875) U. S. Geol. and Geog. Survey Bull., 2nd ser., no. 1.

*Merriam, C. W. (1940) Devonian stratigraphy and paleontology of the Roberts Mountains region, Nevada, Geol. Soc. Am., Spec. Paper no. 25.

Moore, R. C. (1949) The meaning of facies, Geol. Soc. Am., Memoir 39, pp. 1-34.

Nickles, J. M. and Bassler, R. S. (1900) A synopsis of American fossil Bryozoa, including bibliography and synonomy, U. S. Geol. Survey, Bull. 173.

Noble, L. F. (1922) A section of the Paleozoic formations of the Grand Canyon, at the Bass Trail, U. S. Geol. Survey, Prof. Paper 131-B.

__________ (1923) Paleozoic formations of the Grand Canyon at the Bass Trail (Arizona), U. S. Geol. Survey, Prof. Paper 131, pp. 23-73.

Nolan, T. B. (1928) A late Paleozoic positive area in Nevada, Am. Jour. Sci., 5th ser., vol. 16, pp. 153-161.

*__________ (1930) Paleozoic formations in the Gold Hill Quadrangle, Utah, Jour., Wash. Acad. Sci., vol. 20, no. 17, pp. 421-432.

*__________ (1935) Geology and ore deposits of the Gold Hill Quadrangle, Utah, U. S. Geol. Survey, Prof. Paper 177.

*Ogden, Lawrence (1951) Mississippian and Pennsylvanian stratigraphy, Confusion Range, west-central Utah, Am. Assoc. Petrol. Geol., Bull., vol. 35, no. 1, pp. 62-82.

*Osmond, John C. (1954) Dolomites in Silurian and Devonian of east-central Nevada, Am. Assoc. Petrol. Geol., Bull., vol. 38, pp. 1911-1956.

*Peale, A. C. (1893) Paleozoic section in the vicinity of Three Forks, Montana, U. S. Geol. Survey, Bull. 110.

__________ (1916) Three Forks folio, U. S. Geol. Survey, Geol. Atlas of the U. S., no. 24.

Ransome, F. L. (1916) Some Paleozoic sections in Arizona and their correlations, U. S. Geol. Survey, Prof. Paper 98-K.

Raymond, P. E. (1907) On the occurrence in the Rocky Mountains of Upper Devonian fauna with Clymenia, Am. Jour. Sci., 4th ser., vol. 23, pp. 116-122.

__________ (1909) The fauna of the Upper Devonian in Montana, Carnegie Mus. Annals, vol. 5.

__________ (1912) The Clymenia fauna in the American Devonian, 7th International Zool. Cong. Proc., pp. 1-4.

*Richardson, G. B. (1913) The Paleozoic section in northern Utah, Am. Jour. Sci., 4th ser., vol. 36, pp. 406-416.

*________ (1941) Geology and mineral resources of the Randolph Quadrangle, Utah, Wyoming, U. S. Geol. Survey, Bull. 923.

Ross, C. P. (1934) Correlation and interpretation of Paleozoic stratigraphy in south-central Idaho, Geol. Soc. Am., Bull., vol. 45, pp. 937-1000.

Rouse, J. T. (1940) Structural and volcanic problems in the southern Absaroka Mountains, Wyoming, Geol. Soc. Am., Bull., vol. 51, pp. 1413-1428.

*Rush, Richard W. (1951a) Stratigraphy of the Burbank Hills, Western Millard County, Utah, Utah Geol. and Mineral. Survey, Bull. 38.

*________ (1951b) Silurian strata of western Millard County, Utah, Utah Geol. and Mineral. Survey, Guidebook to the Geology of Utah, no. 6, pp. 44-46.

Schuchert, C. (1897) A synopsis of American fossil Brachiopoda including bibliography and synopsis, U. S. Geol. Survey, Bull. 87.

Sharp, R. P. (1940) Stratigraphy and structure of the southern Ruby Mountains, Nevada (abstract), Geol. Soc. Am., Bull., vol. 51, pp. 1945-1946.

*________ (1942) Stratigraphy and structures of the southern Ruby Mountains, Nevada, Geol. Soc. Am., Bull., vol. 53, pp. 647-690.

Simpson, J. H. (1876) Exploration across the Great Basin in 1859, Engineer. Dept., U. S. Army.

Singewald, Q. D. and Butler, B. S. (1941) Ore deposits in the vicinity of the London fault, Colorado, U. S. Geol. Survey, Bull. 911.

*Sloss, L. L. (1947) Environments of limestone deposition, Jour. Sed. Pet., vol. 17, pp. 109-114.

*________, Krumbein, W. C. and Dapples, E. C. (1949) Integrated facies analysis, Geol. Soc. Am., Memoir 39, pp. 91-124.

________ (1952) Interpretive stratigraphy of the Great Basin (abstract), Am. Assoc. Petrol. Geol. Program 37th Ann. Meeting, pp. 23-24.

*________ (1953) The significance of Evaporites, Jour. Sed. Petrol., vol. 23, no. 3, pp. 143-161.

________ (1954) Lemhi arch, a mid-Paleozoic positive element in south-central Idaho, Geol. Soc. Am., Bull., vol. 65, pp. 365-368.

Spencer, A. C. (1900) Devonian strata in Colorado, Am. Jour. Sci., 4th ser., vol. 9, pp. 125-133.

*__________ (1917) The geology and ore deposits of Ely, Nevada, U. S. Geol. Survey, Prof. Paper 96.

*Stainbrook, M. A. (1947) Brachiopods of the Percha shale of New Mexico and Arizona, Jour. Paleontology, vol. 21, pp. 297-328.

*__________ (1950) Brachiopoda and stratigraphy of the Aplington formation of northern Iowa, Jour. Paleontology, vol. 24, pp. 365-385.

Stevenson, F. V. (1943) Onondaga equivalent in New Mexico, Am. Assoc. Petrol. Geol., Bull., vol. 27, pp. 222-223.

Stoyanow, A. A. (1936) Correlation of Arizona Paleozoic formations, Geol. Soc. Am., Bull., vol. 47, pp. 459-540.

Tenny, S. (1873) Devonian fossils from the Wasatch Mountains, Utah, Am. Jour. Sci., 3rd ser., vol. 5.

Thomas, H. D. (1950) Summary of Late Paleozoic stratigraphy of the Green River Basin, Wyoming, Wyo. Geol. Assoc., 5th Ann. Field Conf., Southwest Wyo., Guidebook (Aug.) pp. 17-24.

Tomlinson, C. W. (1917) The Middle Paleozoic stratigraphy of the central Rocky Mountain region, Jour. Geol., vol. 25, pp. 112-134, 373-394.

*Van Tuyl, F. M. (1914) The origin of Dolomite, Iowa Geol. Survey, Ann. Rept., vol. XXV, pp. 251-422.

*Walcott, C. D. (1884) Paleontology of the Eureka district, Nevada, U. S. Geol. Survey, Mon. 8, 298 pp.

__________ (1891) Study of a line of displacement in the Grand Canyon of the Colorado in northern Arizona, Geol. Soc. Am., Bull., vol. 2.

Weed, W. H. and Pirsson, L. V. (1900) Geology of the Little Belt Mountains, Montana, U. S. Geol. Survey, 20th Ann. Rept., pt. 3.

Weeks, F. B. (1907) Stratigraphy and structure of the Uinta Range, Geol. Soc. Am., Bull., vol. 18, pp. 427-448.

*Weller, J. M., et al. (1948) Correlation of the Mississippian formations of North America, Geol. Soc. Am., Bull., vol. 59, pp. 91-196.

Westgate, L. G. and Knopf, A. (1932) Geology and ore deposits of the Pioche district, Nevada, U. S. Geol. Survey, Prof. Paper 171.

Wilcken, P. D. (1936) The Brazer formation in the Beck's Spur area, central Wasatch Mountains, University of Utah, Thesis.

Williams, H. S. (1891) Correlation papers: Devonian and carboniferous, U. S. Geol. Survey, Bull. 80.

__________ (1903) The correlation of the geological faunas: a contribution to Devonian paleontology, U. S. Geol. Survey, Bull. 210.

Williams, J. Stewart (1943) Carboniferous formations of the Uintah and northern Wasatch Mountains, Geol. Soc. Am., Bull., vol. 54, pp. 591-624.

*__________ (1948) Geology of the Paleozoic rocks, Logan Quadrangle, Utah, Geol. Soc. Am., Bull. vol. 59, pp. 1121-1164.

Williams, N. C. (1940) Summary of Wasatch Mountains geology, Compass, vol. 20, no. 2, pp. 75-78.

*__________ (1953) Late Pre-Cambrian and Early Paleozoic geology of western Uinta Mountains, Utah, Am. Assoc. Petrol. Geol., Bull., vol. 37, no. 12, pp. 2734-2742.

Willis, B. (1912) Index to the stratigraphy of North America, U. S. Geol. Survey, Prof. Paper 71.

*Wilmarth, M. G. (1938) Lexicon of geologic names of the United States, U. S. Geol. Survey, Bull. 896.

Wilson, E. D. (1939) Pre-Cambrian Mazatzal Revolution in central Arizona, Geol. Soc. Am., Bull., vol. 50, pp. 1113-1164.

*Young, John C. (1953) Geology of the southern Lakeside Mountains, Utah, University of Utah Master's thesis.

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APPENDIX

CONFUSION MOUNTAINS SECTION

Location: T.18S., R.16W., Millard County, Utah

Composite section-Pilot shale measured in separate traverse and in slightly different location from underlying formations.

MISSISSIPPIAN: JOANA LIMESTONE

25+ Sandstone, gray to red, fine grained, grades upward into gray, calcareous siltstone, which gives way to fossiliferous gray limestone.

Contact of Joana and Pilot, marked by soft, red clay band 3 to 5 inches thick, which is not everywhere present.

DEVONIAN: PILOT SHALE (610 feet)

70 Shale, paper, buff, red weathering, with occasional ¼ inch quartzite beds near top.

33 Dolomite, dense, gray, tan weathering, with floating sand grains, in beds 3 inches to 8 inches, with occasional tan shale partings.

33 Shale, paper, gray to green, weathers dark brown.

33 Shale, same as above, at 20 feet from top a tan platy, more resistant shale makes prominent, laterally extensive outcrops.

3 Limestone, medium gray, dense, near base of gray shale unit.

20 Shale, paper, red to dark gray, thinly laminated, slightly calcareous, weathers into sheets 2 inches by 2 inches.

99 Shale, fragile, gray, calcareous, weathers and breaks into very small equidimensional pieces.

105 Siltstone, gray, platy, tan weathering, calcareous, occasional ¼ inch shale interbeds.

32 Shale, tan to gray, slightly calcareous, 2 foot bed of dark grey dolomite with $CaCO_3$ vugs and veins shows 30 feet down in section, middle 15 feet composed of limestone, rubbly, weathers buff, contains brachiopods.

182 Valley floor completely covered. Interval measured to first occurrence of underlying formation across valley. Structural complications possible, but not noted.

Pilot-Guilmette contact not exposed.

DEVONIAN: GUILMETTE FORMATION (364+ feet)

75+	Limestone, dark gray, dense, weathers buff to gray, massive, fossil zone 25 feet from top.
4	Sandstone, calcareous, banded tan and buff, beds medium.
20	Limestone, dense, finely crystalline, dark gray, weathers gray.
12	Sandstone, calcareous, banded tan and buff, beds medium.
76	Limestone, dense, lithographic, laminated light and dark gray, massive, fossiliferous, weathers light gray to buff, gastropods, bryozoa, and corals.
10	Sandstone, platy, medium bedded, gray, weathers light buff, calcareous, occasional faint pink splotches, scattered chert nodules.
50	Limestone, dense, finely crystalline, dark gray, $CaCO_3$ vugs, very massive bedded, weathers buff.
5	Limestone, sandy, buff to gray, finely laminated, thin bedded, outcrops scattered.
112	Limestone, crystalline, gray, weathers buff, massive bedded, $CaCO_3$ veins, planispiral gastropods.

Section terminated by fault. Relations uncertain.

Total Thickness of Devonian: 974+ feet

LAKETOWN SECTION

Location: T.13N., R.6E., Sec. 31-32, Rich County, Utah

MISSISSIPPIAN: MADISON LIMESTONE

Feet Thick

20+ Limestone, crystalline, medium to dark gray, fossiliferous, makes ridges.

Contact apparently conformable.

DEVONIAN: THREE FORKS SHALE (335 feet)

77 Limestone, platy, soft, typically shows only as a red soil zone, sparse outcrops, and typically occurring as a slope, or valley maker.

40 Limestone, vari-colored, coarsely crystalline, makes bold outcrop in otherwise unresistant valley.

73 Limestone, same as above.

13 Limestone, same as above, except more finely crystalline, strong red-brown color found only in solution cavities and channels, of which there are many.

132 Interbedded shale, conglomerates and resistant red limestone, beds 10 feet approximately.

Jefferson limestone-Three Forks formation contact obscured, but probably occurs in small north to south trending strike valley.

DEVONIAN: JEFFERSON LIMESTONE (1050 feet)

286 Covered

112 Dolomite, dense, finely crystalline black, bedding massive $CaCO_3$ veins, weathers brownish medium gray.

81 Limestone, fine to medium crystalline, medium gray, alternating massive and thin bedded, locally laminated slightly pocked, weathers medium gray.

11 Shale and siltstone, sandy, calcareous, light gray, irregular tan to red laminations.

32 Limestone, dense, finely crystalline, gray to black, massive bedded, occasional shale partings, $CaCO_3$ veins, weathers light gray and frequently coated with white calcareous layer.

8 Siltstone, limey, thin bedded, platy, white, weathers medium gray, some interstitial quartz.

65 Dolomite, limey, medium crystalline, black, massive bedded, weathers brownish gray.

3 Siltstone, limey, thin bedded, platy, white, weathers medium gray, some interstitial quartz.

5 Siltstone, same as above.

57 Dolomite, limey, very coarsely crystalline, medium gray, $CaCO_3$ veins, beds massive, crystals finer at base.

140 Dolomite, limey, black, medium crystalline, beds massive, Syringopora.

15 Sandstone, limey, white to tan, irregular laminations, weathers gray to brown and is iron stained locally.

129 Limestone, coarsely crystalline, medium gray, sugary, weathers medium gray, petroliferous odor.

69 Limestone, crystalline, black fragmental, yellow stains, beds massive.

37 Limestone, same as above.

Jefferson limestone-Laketown dolomite contact marked by probable slight erosion surface.

SILURIAN: LAKETOWN DOLOMITE

5+ Dolomite, limey, finely crystalline, light gray, contact with Jefferson obscured, but float suggests a 1 foot to 3 foot conglomerate zone at base of Jefferson.

Total Thickness of Devonian: 1385 feet

RANDOLPH SECTION

Location: T.20N., R.120W., Sec. 18, Lincoln County, Wyoming

MISSISSIPPIAN: MADISON LIMESTONE

Feet Thick

10+ Dolomite, finely crystalline, black, more resistant than underlying Three Forks formation.

DEVONIAN: THREE FORKS FORMATION (88 feet)

72 Limestone, sandy, shaly, almost entirely covered, makes markedly red soil zone, rock, where exposed, thin bedded, stained red, buff, or gray.

16 Sandstone, buff to gray, hard, beds 1 foot to 2 feet, medium grained.

DEVONIAN: JEFFERSON LIMESTONE (456 feet)

17 Dolomite, sugary, brown-gray, massive, $CaCO_3$ coating on weathered surface.

2 Dolomite, finely crystalline, medium gray, pocked, faintly laminated, in bold outcrop face.

48 Limestone, aphanitic, dove gray, weathers light to medium gray, beds 3 inches to 5 inches.

26 Limestone, dolomitic, finely crystalline, dark gray, sugary, beds massive, scattered small $CaCO_3$ blebs.

73 Limestone, same as above.

30 Limestone, sooty black, massive, finely crystalline, sharply pocked.

123 Dolomite, finely crystalline, dense, medium to dove gray, beds medium to massive, $CaCO_3$ veins and vugs.

97 Dolomite, same as above, *Syringopora*, crinoid stems, solitary corals, brachiopod fragments.

14 Dolomite, limey, more granular and lighter gray than bed above, numerous fossil fragments, beds medium to massive, sharply pocked.

21 Dolomite, medium gray, finely crystalline, dense, scattered $CaCO_3$ veins.

5 Dolomite, limey, medium gray, dense, finely crystalline.

Contact shows no apparent unconformity. Hiatus indicated by faunal break.

SILURIAN: LAKETOWN DOLOMITE

? Limestone, dolomitic, light to medium gray, coarsely crystalline, *Halysites* 5 feet below contact.

Total Thickness of Devonian: 544 feet

PROMONTORY RANGE SECTION

Location: T.6N., R.5W., Box Elder County, Utah

Section measured from bottom to top. Outcrops are irregular and badly covered so that age and stratigraphic relations of lower part of section are obscure.

DEVONIAN (?): WATER CANYON FORMATION (108 feet)

Feet Thick	
45	Dolomite, light gray, weathers almost white, dense to very finely crystalline, hard, bedding medium, non-porous and impermeable except for scattered solution pits along fractures.
45	Dolomite, medium to light gray, weathers medium gray, dense to finely crystalline, beds medium to massive, hard, brittle, fractured.
18	Dolomite, dark gray mottled with black splotches, beds medium to massive, finely crystalline to dense, non-porous and impermeable.

Area badly disturbed, but no physical evidence of disconformity.

DEVONIAN: JEFFERSON FORMATION (450 feet)

45	Dolomite, dark gray, weathers medium gray, medium crystalline, sugary on weathered surface, moderately porous and permeable, beds medium to massive.
64	Dolomite, dark gray to black, weathers medium gray, dense to finely crystalline, beds massive, color mottling on weathered surface, non-porous, compact.
67	Dolomite, black, weathers dark gray, finely crystalline, beds medium to massive, non-porous, faintly laminated.
4	Dolomite, same unit as below, slightly more coarsely crystalline and sugary and slightly lighter gray.
45	Dolomite, black, weathers medium gray, medium to coarsely crystalline, sugary, non-porous, beds massive, scattered $CaCO_3$ stringers.
85	Dolomite, same unit as below.
45	Dolomite, light gray, weathers light gray, finely crystalline, sugary, hard, brittle, slightly porous, beds medium to massive, faint laminations, some $CaCO_3$ blebs (small).

45 Dolomite, same as below.

Contact apparently conformable.

DEVONIAN: THREE FORKS FORMATION (83 feet)

43 Dolomite and Siltstone interbedded. Dolomite, dark gray, finely crystalline to dense. Siltstone, tan, buff or red, in thin persistent laminae, bedding of unit massive but siltstone and dolomite laminae are laterally prominent.

40? Dolomite and Siltstone, same as below, but laminations less prominent and unit is sandier throughout.

Covered, overlying units probably Mississippian Madison limestone.

Total Thickness of Devonian: 641 feet

STANSBURY ISLAND RANGE SECTION

Location: T.6W., R.1N., Sec. 15, Tooele County, Utah

DEVONIAN: SEVY DOLOMITE (?) (535 feet)

Feet Thick	
100	Quartzite, white to tan, with occasional brown iron stain, very clean, no impurities, weathers pink, medium to massive beds, 1 to 3 feet interbeds of white weathering, dense, primary dolomite, some with sand laminations and floating grains, appear and are abundant in upper 25 feet, dolomite is of typical Sevy lithology found lower in the formation.
100	Quartzite, same as above.
110	Quartzite, same as above, with intergrading beds of white, dense dolomite in lower 25 feet.
28	Quartzite and Dolomite, interbedded in 2 to 12 inch beds, 50 per cent quartzite, 50 per cent dolomite. Quartzite, light tan to buff, fine to medium grained, hard, platy to massive, non-porous and impermeable, many vugs 1/4 to 3/4 inch in diameter. Dolomite, medium gray to dark gray (mottled), fine grained, hard, thin to medium bedded, medium porous and permeable, weathers with odd micro-edgewise conglomerate appearence.
88	Dolomite, medium to dark gray, coarse grained, thin bedded, non-porous and impermeable, weathers finely sugary, tan to gray, saddle maker, calcite stringers.
109	Quartzite and Dolomite, interbedded, 60 per cent quartzite, 40 per cent dolomite. Quartzite, tan to buff, medium grained, friable to medium hard, laminated, porous and permeable, thin to thick bedded, ledge maker. Dolomite, light to medium gray, fine grained, hard, medium bedded, non-porous and impermeable, weathers with pitted surface.

Contact apparently conformable on physical evidence.

SILURIAN: LAKETOWN DOLOMITE (?)

88	Dolomite, medium to dark gray, medium crystalline, hard, thin to medium bedded, laminated, non-porous and impermeable.

Total Thickness of Devonian: 535 feet

PINYON PEAK SECTION

Location: T.9S., R.2W., Sec. 33-34, Utah County, Utah

MISSISSIPPIAN: GARDNER LIMESTONE

Feet Thick	
?	Limestone, coarsely crystalline, black, iron stains, fine $CaCO_3$ veins, beds 2 to 10 inches.

Contact apparently conformable.

DEVONIAN: PINYON PEAK LIMESTONE (496 feet)

Includes the Miss. Fitchville Fm. of U.S.G.S. see M.D. Crittenden 1959 Intermt. Assoc. Petrol. Geol. Guidebook. or Victoria Fm. contact selected too low.

79	Dolomite, limey, coarsely crystalline, blue gray, many $CaCO_3$ vugs and veins, some white blebs 2 to 3 inches diameter, extremely fossiliferous, Syringopora, spirifer and pentamerid type brachiopods, solitary corals.
22	Limestone, dolomitic, white, fine to medium crystalline, beds 18 to 24 inches.
9	Limestone, dark gray, finely crystalline, pocked, few fossils--crinoid stems, solitary corals and Syringopora.
36	Limestone, similar to above, contains some large, isolated crystals of $CaCO_3$, more fossil fragments, numerous sub-ovate forms.
16	Limestone, sandy, buff, sand grains rounded and evenly spaced throughout rock, very hard and well indurated.
2	Dolomite, limey, hard, aphanitic, light gray, no fossils.
6	Limestone, black, fine to medium crystalline, massive, solitary coral fauna.
2	Limestone, gray, dense, finely crystalline, peculiar, black, rod-like inclusions--possibly due to alteration along one of the adjacent faults.
32	Limestone, black, dense, weathers light gray, massive, faint yellow mottling, scattered fossils.
17	Limestone, same as above.
71	Limestone, dove gray, dense, conchoidal fracture, pocked, beds 2 to 4 feet, $CaCO_3$ veins. top? Victoria
30	Dolomite, medium gray, fine to medium crystalline, $CaCO_3$ veins.

35 Sandstone, calcareous cement, buff to gray, grains medium and rounded, platy, 1 to 2 inch beds.

29 Dolomite, black, medium crystalline, 3 foot beds.

43 Sandstone and Breccia. Sandstone, same as above, matrix calcareous, weathers buff. Breccia, pebbles 5 inches by 2 feet, limestone or dolomite, sharply angular, light gray to white, dense, matrix, limey, light gray.

23 Limestone, sandy, gray, beds 1 to 3 feet, fine to medium crystalline.

11 Sandstone and Dolomite. Sandstone, partially covered, apparently buff and platy, upper 1/3. Dolomite, finely crystalline, platy, medium gray, weathers light gray, $CaCO_3$ veins, irregularly pocked surface.

33 Breccia of limestone and dolomite pebbles in sandstone, buff, pebbles 2 to 3 inches, beds massive and irregular.

<u>DEVONIAN: VICTORIA FORMATION (37 feet)</u>

37 Quartzite, platy, pink to buff weathering. Unconformably overlies finely crystalline, black, medium gray weathering dolomite.

Contact with underlying Bluebell dolomite probably disconformable. Channels reported locally in top of Bluebell.

<u>DEVONIAN (?): BLUEBELL DOLOMITE (651 feet)</u>

1 Dolomite, limey, light gray-blue, finely crystalline, hard, very dense, massive bedded, few white calcite blebs of 1/32 to 1/4 inch diameter.

152 Dolomite, limey, dark gray with tan mottling, finely crystalline, hard, compact, medium to massive bedded in upper 40 feet, medium to thin bedded in lower 112 feet, which is a slope maker (few outcrops).

58 Limestone, dolomitic, dark gray to black, finely crystalline, hard, moderately compact, medium to massive bedded, calcite veins and spots.

10 Limestone, sandy, light gray with tan cast, finely crystalline, hard, brittle, dense, fine to medium bedded, limonite veins and spots, slope maker.

14 Dolomite, dark gray to black, medium crystalline, very hard, not brittle, medium to massive bedded, small white to pink to tan spots, slight slope maker.

60 Dolomite, dove gray to tan, finely crystalline, hard, medium to massive bedded, fine laminations, slope maker.

47 Dolomite, medium dark gray, medium crystalline, hard, medium to massive bedded, many calcite blebs and stringers, weathers with sharp, pitted pockets, and a sandy crust, cliff maker.

67 Dolomite, dark gray to black, finely crystalline, hard, massive bedded, small calcite blebs and veins, light and medium grey blotchy mottlings on weathered surface, bold cliff maker.

53 Dolomite, light gray with pink cast, finely crystalline, hard, massive bedded, weathers with mottled appearance, calcite blebs and stringers, cliff maker.

28 Dolomite, dark gray, finely crystalline, hard, brittle, fine to medium bedded, fine limonite veins in upper 15 feet, slope maker.

2 Dolomite, dark gray, medium crystalline, very hard, not brittle, medium bedded, small calcite blebs, slope maker.

112 Dolomite, light dove gray, cryptocrystalline, hard, medium to massive bedded, upper 10 feet contains nodules of chert (1 to 6 inches), on weathered surface faintly laminated, cliff maker.

47 Dolomite, light to medium gray, finely crystalline, hard, massive bedded, compact, weathers in beds of light and medium gray, 3 to 4 inches thick, cliff maker.

Contact not exposed.

SILURIAN (?): OPAHONGA FORMATION

62 Dolomite, medium to dark gray with soft pink mottlings, finely crystalline, hard, massive bedded, fossiliferous--*Halysites*, large syringoporids, many fragments of corals and crinoid stems.

Total Thickness of Devonian (?): 1184 feet

BIG COTTONWOOD SECTION

Location: T.2S., R.3E., Sec. 30, Salt Lake County, Utah

MISSISSIPPIAN: MADISON LIMESTONE

Feet Thick

7 Limestone, dolomitic, dark, blue to black, fine to medium crystalline, many $CaCO_3$ vugs, veins and stringers, massive bedded, makes bold vertical cliff 150 feet to 200 feet high, some fossils: Syringopora, crinoid stems, planispiral gastropods.

Madison-Pinyon Peak contact distinguished on basis of increased fossil content, type of fossils and slight lithologic change. Appears conformable.

DEVONIAN (?): PINYON PEAK LIMESTONE (?) (81 feet)

Fitchville Fm & not P.PK.

5 Dolomite, limey, medium-dark gray, finely crystalline, weathers light gray, bedding thin to medium.

5 Dolomite, limey, same as above, showing color lamination and fossil fragments.

7 Dolomite, limey, same as above, some pink to tan weathering, many crinoid stem fragments.

10 Dolomite, similar to above, but is grittier and is pure dolomite, bedding medium, Syringopora, Zaphrentid-type corals, scattered stylolites.

22 Dolomite, limey, dark blue, granular, medium to coarsely crystalline, $CaCO_3$ vugs--1 inch to 3 inches diameter and associated veins, beds 4 inches to 15 inches, colonial and solitary corals scattered.

32 Dolomite, blue to gray, beds 2 feet plus, scattered iron and chert nodules, $CaCO_3$ vugs--1/2 inch to 1 inch diameter, some brachiopods and corals, Neospirifer sp., weathers light gray.

DEVONIAN (?): VICTORIA QUARTZITE (?) (11 feet)

6 Limestone, shaley, makes slight saddle in ridge crest, beds 1/4 inch to 3/4 inch, fine-pebble, dirty, quartz conglomerate make 6 inch bed at base of shale, calcareous cement.

3 Dolomite, limey, thin bedded, medium gray, becoming somewhat siliceous at base--grading into sandstone below.

2 Sandstone, quartzose, tan weathering, calcareously cemented, medium bedding.

Slight angular unconformity between Victoria and underlying Cambrian (?) unit--probably Lynch dolomite.

<u>CAMBRIAN (?): LYNCH DOLOMITE (?) (10+ feet)</u>

10+ Dolomite, dark gray, dense, finely crystalline, weathers light gray, medium bedded.

Total Thickness of Devonian: 92 feet

AMERICAN FORK SECTION

Location: T.3S., R.3E., Sec. 19, Utah County, Utah

MISSISSIPPIAN: MADISON LIMESTONE

Feet Thick

? Limestone, dolomitic, white, finely crystalline, finely laminated, at 7 feet grades upward into dark, crystalline, very fossiliferous limestone, showing some white $CaCO_3$ vugs and veins.

Contact of the Madison limestone and Pinyon Peak limestone apparently conformable.

DEVONIAN (?): PINYON PEAK LIMESTONE (?) (128 feet)

Fitchville.

40 Dolomite, dark gray, fine-medium crystalline, deeply pocked by weathering, some $CaCO_3$ vugs and veins, few fossils, grades homogeneously into lighter weathering band in lower one-half, scattered intraformational breccia zone in lighter zone, near base, bedding medium throughout.

19 Dolomite, limey, dark blue to black, medium to massive bedded, markedly lighter gray on weathered surface, exposures are irregular and blocky, scattered fossils, mostly corals and crinoids, outcrops for 50 feet in a series of bold "stairstep" cliffs.

26 Dolomite, same as above.

2 Dolomite, white-weathering, dense, light gray, probably primary.

2 Covered.

2 Conglomerate (intraformational), contains subangular pebbles of light gray dolomite in slightly darker matrix.

10 Dolomite, medium gray, finely crystalline, light to medium gray weathering, rubbly on weathered surface, scattered crinoid stems in lower part, medium bedded.

27 Dolomite, limey, medium gray, light gray weathering, finely crystalline, no fossils, occasional bands of what appear to be organic fragments, some $CaCO_3$ veins, bedding thin, bedding planes usually deeply weathered, accentuating thinness of bedding, and giving laminated appearance.

8 Covered.

Contact of Pinyon Peak limestone (?) and Maxfield limestone covered. Variations in dip suggest slight angular unconformity.

CAMBRIAN: MAXFIELD LIMESTONE

? Limestone, medium gray, finely crystalline, thin bedded, with tan siltstone partings.

Total Thickness of Devonian: 128 feet

ROCK CANYON SECTION

Location: T.6S., R.3E., Sec. 28, Utah County, Utah

MISSISSIPPIAN (?): MADISON LIMESTONE (?)

Feet Thick

? Limestone, dove gray, medium bedded, finely crystalline.

2 Limestone, white, massive.

? Contact of Madison limestone and Pinyon Peak limestone marked by distinctive change in color and lithology along a slightly undulating surface above which small lenses of the lower unit are included in the lowermost part of the upper. Attitudes of beds are same above and below.

DEVONIAN (?): PINYON PEAK LIMESTONE (234 feet) Fitchville Fm.

29 Dolomite, limey, dark gray, medium-finely crystalline, massive bedded, weathers light to medium gray with slight bluish cast, blocky and angular on exposure, some porosity due to small solution cavities.

20 Dolomite, same as above.

20 Dolomite, same as above, except crystals are finer.

20 Dolomite, limey, dense, crystals invisible to unaided eye, black, weathers light gray, frequently coated with a buff to gray veneer of $CaCO_3$, massive outcrops, thin-bedded, solution pits scattered.

10 Dolomite, same as above.

20 Dolomite, breccia, finely crystalline, medium to dark gray dolomite fragments, quite angular, cemented by light gray to white limey and calcitic material, breccia in 1 foot to 3 foot beds separated by 5 foot to 8 foot beds of non-brecciated medium gray, finely crystalline, limey dolomite.

Covered interval at base.

29 Dolomite, medium gray, light gray weathering, finely crystalline, medium to massive bedded dolomite.

35 Covered interval.

9 Dolomite, dense, very finely crystalline, dark gray, probably primary, weathers medium to light gray with slight bluish cast, massive bedded, outcrops are bold and

rounded, occasional Syringopora.

3 Dolomite, same as above.

DEVONIAN (?): VICTORIA QUARTZITE (4 feet)

4 Sandstone, quartzose, calcareously cemented, some sand grains varying up to grit size, few scattered pebbles from 1/2 inch to 1 inch diameter, sand making up matrix is of white quartz, weathers buff to gray, less resistant than surrounding limes making chimney in cliff of vertically dipping beds.

Contact with Lynch dolomite (?) exposed at base of above sandstone. Vertically dipping beds show no discordance in attitude, but relations are not definite due to disturbed condition of beds.

CAMBRIAN (?): LYNCH DOLOMITE (?)

10+ Dolomite, medium gray, coarsely crystalline, massive bedded.

Total Thickness of Devonian: 238 feet

CHERRY CREEK SECTION

Location: T.24N., R.63E., Sec. 17, White Pine County, Nevada

Top of section is disturbed by faulting so that relations in the Guilmette formation and the relationships between it and the overlying Pilot shale are obscure.

DEVONIAN: GUILMETTE FORMATION-SIMONSON DOLOMITE (784 feet)

Feet Thick

Note: Because of intergrading boundary and similar lithologies Simonson and Guilmette are not here considered as separate formations.

Feet Thick	
30+	Limestone, dolomitic, black, fine to medium crystalline, beds massive, bryozoa and brachiopods scattered, many calcite stringers, uneven surface between beds, probably penecontemporaneous deformation.
75	Dolomite, light gray, medium crystalline, beds massive, fine laminations.
25	Dolomite, same as above, with local breccia cemented by $CaCO_3$.
35	Dolomite, black and medium gray beds alternate, fine to medium crystalline, beds medium to massive, fine black and dark gray color laminations, chert nodules, intraformational breccia near base.
37	Dolomite, same as above, but no breccia.
30	Dolomite, slightly limey, light gray, finely crystalline, beds massive.
100	Dolomite, medium crystalline, beds massive, local calcite splotches, beds alternate black and dark gray.
55	Dolomite, same as above, with laminations.
45	Dolomite, same as above.
20	Dolomite, medium gray, medium crystalline, beds medium, faint laminations.
72	Dolomite, light gray, finely crystalline, medium beds, laminations.
240	Dolomite, white to light gray, in 4 to 8 foot beds, finely crystalline, "twiggy" beds near base, 26 inch shale zone near base.

20 Breccia (possibly a fault breccia), angular, light gray, dolomite fragments in calcite cement.

Contact apparently gradational.

DEVONIAN: SEVY DOLOMITE (764 feet)

200 Dolomite, limey, light gray, medium crystalline, beds massive and finely laminated.

124 Dolomite, same as above.

155 Dolomite, white, finely crystalline, beds medium to massive, probable primary dolomite.

115 Dolomite, same as above.

50 Dolomite, same as above.

60 Dolomite, same as above, only medium crystalline.

60 Dolomite, light gray, finely crystalline, thin to medium beds, laminated.

Contact covered.

SILURIAN: LAKETOWN DOLOMITE

120 Dolomite, black, fine to medium crystalline, beds massive, abundant *Halysites* and *Syringopora*.

Total Thickness of Devonian: 1548+ feet

DIAMOND RANGE SECTION

Location: T.20N., R.54E., Eureka County, Nevada

Top of Guilmette lies beneath tan to gray, calcareous shale with apparent conformity. Shale is considered to be Upper Devonian Pilot shale. The shale was not exposed where undisturbed by faulting and was therefore not measured. It is overlain by thinly developed Mississippian Joana limestone, which lies beneath the black, fissile, carbonaceous Mississippian White Pine shale.

DEVONIAN: GUILMETTE FORMATION-SIMONSON DOLOMITE (993 feet)

Feet Thick

Note: Because the Guilmette formation is not readily distinguishable from the Simonson dolomite at this locality, both names are applied.

Feet Thick	
120±	Limestone, makes massive cliff, inaccessible for sampling.
50	Dolomite, medium gray, fine to medium crystalline, beds medium, slightly sandy and faintly laminated, rests beneath an irregular surface below limestone unit above.
50	Dolomite, medium to light gray, medium crystalline, beds massive.
50	Dolomite, slightly sandy and limey, medium grey, medium crystalline, beds medium laminated, poorly preserved fossils.
50	Dolomite, same as above.
50	Dolomite, sandy lenses with scattered calcite crystals, medium gray, medium crystalline, beds medium, calcite stringers.
36	Dolomite, limey, medium gray, medium coarsely crystalline, beds massive, calcite stringers.
14	Dolomite, black, medium crystalline, beds massive, "twiggy" beds.
45	Dolomite, light gray, fine to medium crystalline, beds massive, calcite vein and pore fillings.
38	Dolomite, black, medium crystalline, beds massive, slightly vuggy, limonite stains.
72	Dolomite, limey, medium grey, medium crystalline, beds medium, calcite vugs.
44	Dolomite, white, medium crystalline, fine to medium beds, poorly preserved fossils.

36 Dolomite, light gray, finely crystalline, beds medium, calcite vugs and indistinct fossils.

52 Dolomite, light grey, fine to medium crystalline, beds medium, calcite stringers.

76 Limestone, dolomitic, light grey, finely crystalline, beds massive, calcite stringers and fillings.

40 Dolomite, limey, dark gray, medium crystalline, medium beds, weathers mottled.

90 Dolomite, dark gray, fine to medium crystalline, thin to massive beds, slightly sandy stringers.

80 Dolomite, black, medium to coarsely crystalline, beds massive, weathers sugary, calcite vein fillings.

Contact gradational.

DEVONIAN: SEVY DOLOMITE (130+ feet)

100+ Dolomite, limey, white, finely crystalline, beds massive, finely laminated.

30+ Quartzite, medium to light gray, pure, beds massive.

Covered.

Total Thickness of Devonian: 1123+ feet

LONE MOUNTAIN SECTION

Location: T.20N., R.52E., Eureka County, Nevada

DEVONIAN: NEVADA LIMESTONE (redefined) (2428 feet)

Feet Thick	
65	Limestone, dolomitic, dark gray, weathers medium gray with tan cast, fine to medium crystalline, medium hard, compact and brittle, beds massive, occasional thin interbeds, non-porous and impermeable, transected by fine $CaCO_3$ veins and stringers, bedding surfaces weather irregular, somewhat pocked, other surfaces blocky, scattered indiscernable organic remains (calcified) probably crinoid stem fragments and small solitary corals.
50	Covered interval, makes tan soil zone.
60	Limestone, same as above cover, except lighter gray and weathers lighter, no fossils.
70	Limestone, same as above, but medium crystalline, sequence from top varies down section from light to dark shades of gray, faint, rude, color laminations (light and dark), variations in color and crystallinity occur in 6 to 10 inch units.
80	Limestone, same as above, but lighter and weathers very light gray, appears slightly sandy on weathered surface.
60	Limestone, same as above, but slightly sandier.
160	Limestone, same as above, but darker and less sandy.
70	Limestone, dark gray, finely crystalline to dense, medium hard, brittle, flaggy to shaley, non-porous and impermeable, $CaCO_3$ veins, highly fossiliferous, Atrypa, Athyris, crinoid stems, bedding becomes heavier toward base of unit, also blockier.
27	Limestone, black, very finely crystalline to dense, non-porous and impermeable, thin to medium beds, $CaCO_3$ stringers, scattered brachiopod and crinoid remnants.
130	Limestone, medium gray with tan cast, very finely crystalline, dense, irregular, faint blue and tan mottlings on weathered surfaces, hard, brittle, sharply angular joints and fractures, non-porous and impermeable, no fossils.
145	Limestone, same unit as above, but some beds become thin and are separated by silty partings in lower 40 feet rather

than units being entirely massive as higher, highly fossiliferous limestone near base.

55 Limestone, siliceous, dark gray, finely crystalline to dense, beds medium to massive and finely laminated (light and dark gray), hard, brittle, compact, weathers medium gray and is angular and fractured on weathered surface, few fossils, crinoid stems in thin beds, limestone conglomerate in basal 5 feet.

80 Limestone, slightly sandy, thin beds, shale partings containing oval chert nodules, black, finely crystalline to dense, scattered crinoid stems.

50 Limestone, dark gray, with faint pink cast on weathered surface, finely crystalline to dense, beds massive, hard, scattered crinoids, poorly preserved. Lies on wavy, undulating surface of underlying bed, probably pene-contemporaneous deformation.

50 Limestone, medium gray, finely crystalline to dense, very hard, beds thin, 2 to 3 inches, non-porous and impermeable, badly fractured, very thin shale partings, no fossils.

23 Limestone, grades down from unit above into a highly fossiliferous unit, principally solitary corals, colonial corals and crinoid stems (extremely abundant) biostromal.

145 Covered.

100 Limestone, fossil fragmental, dark gray, almost a coquina of crinoid stems, beds massive, slightly porous and permeable, hard and brittle.

120 Limestone, dark gray, weathers medium gray, finely crystalline, beds massive, blocky on weathered surface, dense, non-porous and impermeable, no fossils, hard and brittle.

20 Limestone, shale partings up to 12 inches. Limestone, similar to above, in beds up to 4 feet. Shale, calcareous, brittle, medium gray, no fossils.

370 Limestone, very shaley, medium gray with pink and yellow mottling, fine grained, extremely fossiliferous, many brachiopods, many $CaCO_3$ veins and stringers, slightly porous and permeable, beds medium, shalier near base.

498 Limestone, extremely abundant brachiopods, colonial corals, solitary corals, abundant _Favosites_, similar to above interval, weathers tan, producing tan soil zone.

Sharp lithologic break with underlying Lone Mountain formation, but no apparent disconformity.

DEVONIAN (?) AND SILURIAN (?): LONE MOUNTAIN FORMATION (redefined) (1531 feet)

Note: Upper part of Lone Mountain formation now known to be of Lower Devonian age. Lowest part of Lone Mountain formation is of probable Silurian age. Exact location of Silurian-Devonian boundary not presently known.

280 Dolomite, medium dove gray, finely crystalline to dense, medium hard, brittle, beds massive, non-porous and impermeable, weathers rounded to angular, no fossils, open vugs, some filled with $CaCO_3$.

12 Dolomite, same as above, strong oil smell and appearance.

250 Dolomite, same as above oil stained zone, some curly laminations.

400 Dolomite, same as above, several thin beds which show faint oil stains, as above.

301 Dolomite, same as above, but with 1 foot intraformational conglomerate at top, some evidence of fossil remains, destroyed by dolomitization, increasingly sugary toward base.

104 Dolomite, same as above, medium gray, coarsely crystalline, sugary, occasional limonite stains.

358 Dolomite, same as above, bed of badly dolomitized colonial corals 100 feet above base, appear similar to *Syringopora*.

500 Dolomite, similar to above, much more finely crystalline and medium instead of light gray.

SILURIAN: ROBERTS MOUNTAINS FORMATION (? feet)

80 Dolomite, dark dove grey, finely crystalline, brittle, hard, dense, non-porous and impermeable, beds massive, weathers dark gray, no fossils.

Total Thickness of Devonian: 2428+ feet

FRISCO AREA SECTION

Location: T.28S., R.11W., Beaver County, Utah

Whole area is badly faulted with east to west trending faults. The one exposed section of Mowitza shale was offset by at least two faults, the movement and displacement along which was not discernable since the exposure was badly covered. A pace traverse showed the Mowitza to be 62 feet thick; however, this in no way represents an accurate figure.

MISSISSIPPIAN: TOPACHE LIMESTONE

Feet Thick

50+ Beds above Mowitza are gray limestones bearing a typical fauna of the Mississippian Madison limestone.

DEVONIAN: MOWITZA SHALE (approximately 62 feet)

62± Limestones, platy, light to medium gray, with calcareous shale partings, Cyrtospirifer fauna.

DEVONIAN: RED WARRIOR LIMESTONE (approximately 1500 feet)

Note: Because of complex structure section not measured. Butler (1913) reports approximately 1500 feet. Age is not definitely established, but because of lithologic similarity with Devonian units at other localities and because there is no evidence of unconformity between Red Warrior and Mowitza, the Red Warrior is tentatively considered Devonian.

1500± Thick sequence of alternate beds (each 10+ to 20 feet thick) of medium gray and almost black secondary dolomites. Poorly preserved fauna of planispiral gastropods, spiral gastropods and lingula type brachiopods is not identifiable, since it is preserved in outline only, but is suggestive of Devonian fauna from the Jefferson formation.

Basal contact not seen.

Total Thickness of Devonian: approximately 1562 feet

SOUTH STANSBURY RANGE SECTION

Location: T.4S., R.7W., Tooele County, Utah

Section begun at base of prominent sequence of cliff-making units with edgewise conglomerate at base, overlain by a crystalline, dark gray limestone with oolites, and, a little higher in the section, fauna which appears to be Madison (Mississippian) in age.

Disconformable?

DEVONIAN (?): GUILMETTE FORMATION-SIMONSON DOLOMITE (137± feet)

Feet Thick	
	Note: The Simonson and Guilmette, as recognized in the Deep Creek Mountains, are often not distinguishable elsewhere as separate formations. They are, therefore, referred to jointly here until a more satisfactory name can be supplied.
7	Limestone, dark to medium gray, finely crystalline, beds medium, with some color bands, weathers light to medium gray, brittle, sharp, angular, $CaCO_3$ filled fractures.
16	Limestone, same as above, only weathers dark gray, and is black on fresh fracture, slope-maker, covered.
16	Limestone, same as above, fractured and veined with $CaCO_3$, slope-maker, covered.
16	Limestone, same as above, highly shattered, slope-maker, covered.
16	Dolomite, medium gray, finely crystalline, slightly vuggy, thin beds, brittle.
16	Dolomite, black, finely crystalline, beds medium to massive, hard and brittle, weathers with small, light gray spots, calcite veins, badly covered.
16	Dolomite, same as above.
3	Dolomite, same as above, badly covered.
5	Dolomite, (probably primary), light gray, dense to very finely crystalline, beds massive, hard, brittle, weathers white, sharp surfaces, slope badly covered.
?	Quartzite and Dolomite. White quartzites and black, crystalline dolomites in float, but not seen in place, entire sequence badly covered.

10 Dolomite, black, finely crystalline, beds massive and banded, brittle, weathers dark blue gray.

6 Dolomite, same as above, some iron stain, scattered fossils--solitary corals, crinoids, all calcified.

10 Limestone, dolomitic, black, finely crystalline to dense, beds massive, brittle, weathers light gray, angular fragments.

Contact obscured. Prominent lithologic change, but no observations on relations with overlying sequence.

SILURIAN (?): LAKETOWN DOLOMITE (?)

28 Dolomite, black, medium crystalline, vuggy and with iron and dark brown to black chert, beds massive, weathers dark gray, very abundant fauna--corals (solitary with calyx up to 4 inches--average about 1 inch), colonial corals (*Favosites*, *Columnaria*(?), *Syringopora*), crinoids and brachiopods(?), all calcified. Fauna is very likely Silurian.

Total Thickness of Devonian: 137± feet

DUGWAY RANGE SECTION

Location: (Not surveyed), Tooele County, Utah. Section located on east flank of Dugway Range, 5 miles south-southeast from Granite Mountain and immediately south of secondary road which runs west from Dugway Proving Grounds and crosses range just south of Granite Mountain.

MISSISSIPPIAN (?): MADISON LIMESTONE (?)

Feet
Thick

9+ Limestone, black, finely crystalline, medium beds, calcite stringers.

Possible disconformity--irregular surface with 2 to 3 feet relief with sharp lithologic break.

DEVONIAN: GUILMETTE FORMATION (?) (612 feet)

20 Limestone, medium gray, finely crystalline, beds massive, alternating with sandstone partings.

47 Dolomite, dark gray, medium crystalline, beds massive, rounded weathering surfaces, white "twiggy" calcite bodies, shale interbeds.

12 Sandstone, limey, pink to gray, weathers gray, medium to massive beds.

25 Dolomite, dark gray, finely crystalline, beds massive, laminated medium and dark gray.

15 Sandstone, limey, weathers brown, pink on fresh surface, beds medium to massive, fine grained, locally shaley.

Saddle with some evidence of disturbance to indicate faulting. Sequence, however, seems to carry across disturbed zone.

45 Limestone, shaley (clay sized particles), light gray to tan.

60 Limestone, dark gray, medium crystalline, beds massive, makes vertical cliff, calcite veins, fossils--gastropods, corals, algal growths.

8 Limestone, dolomitic, dark gray, fine to medium crystalline, beds thin to massive, weathers sharp, irregular calcite veins, cherty in lower part, gastropods and brachiopods.

45 Dolomite, sandy, medium gray, coarsely crystalline, beds massive, angular jointing, weathers with tan cast, algal growths in concentric rings.

20 Limestone, dolomitic, dark gray, medium crystalline, beds medium, white calcite "twiggy" bodies.

8 Dolomite, light gray, fine to medium crystalline, beds medium, weathers light.

70 Dolomite, slightly limey, black, medium crystalline, beds medium, calcite veins, tan cast, 6 foot bed of slightly lighter limestone near middle.

22 Dolomite, slightly limey, medium gray, medium crystalline, beds massive, tan cast, lower part "twiggy" and with calcite vugs.

8 Sandstone, medium gray, medium grained, beds massive, weathers faintly tan and is laminated with gray.

60 Dolomite, black, medium crystalline, thin to massive beds, brittle, resistant.

70 Dolomite, locally sandy, medium gray, fine to medium crystalline, beds massive, calcite vugs.

12 Dolomite, sandy--alternate 2 to 4 foot beds of light gray, finely crystalline dolomite with local sandy laminae and dark gray, medium crystalline units which are occasionally "twiggy", makes prominent cliff.

65 Quartzite, dolomitic, weathers tan, beds massive, makes bold cliff, fairly clean, grains medium, scattered chert, scattered 1 foot beds of dolomite.

Guilmette-Simonson contact arbitrary.

<u>DEVONIAN: SIMONSON DOLOMITE (?) (380+ feet)</u>

50 Dolomite, limey, black, fine to medium crystalline, beds massive.

130 Dolomite, same as above, scattered, badly dolomitized crinoids and brachiopods.

20 Quartzite with lime cement, iron stained almost black.

50 Dolomite, limey, medium gray, finely crystalline, beds massive, weathers with tan cast, some calcite fracture fillings.

30 Dolomite, same as above, slightly darker, some chert nodules.

15 Dolomite, limey and sandy, medium gray, medium crystalline, thin beds, "twiggy" bodies.

85 Dolomite, limey, alternate light and dark gray, often "twiggy" and laminated.

Covered, Quaternary alluvium.

Total Thickness of Devonian: 992+ feet

MAGGIE'S CREEK SECTION

Location: 5+ miles north, Carlin, Nevada, on west wall of Maggie's Creek Canyon, Elko County, Nevada.

MISSISSIPPIAN (?): MADISON LIMESTONE (?)

Feet Thick	
10+	Limestone, drab gray, medium to coarsely crystalline, very thin bedded and shaley, some $CaCO_3$ veins, many organic fragments but few complete fossils, many silicified crinoid stems.

Contact appears conformable.

DEVONIAN: DEVILS GATE FORMATION (544+ feet)

15	Shale and Limestone interbedded. Limestone, dark gray, finely crystalline, in thin beds, Shale, dull pink, clay or fine silt, indurated and brittle. Very few scattered outcrops, lithology shows only in float in distinct belt at top of canyon wall.
36	Covered interval.
18	Shale, pink, fine silt to clay sized particles, beds mostly thin, some to 1 inch maximum, non-porous and impermeable, color laminations of thin red bands with pink interbeds quite persistent, no fossils apparent, hard and brittle.
20	Shale, same as above, but some gray beds appearing which are slightly calcareous.
15	Shale, same unit as above, but gray calcareous beds increasing, few scattered 1 to 3 foot outcrops, beds tending to become more platy and flaggy instead of shaley.
12	Limestone, dark gray, weathers medium gray, fine grained, shaley in 1/2 inch to 2 inch beds, but makes massive outcrops, non-porous and impermeable, $CaCO_3$ veins, vugs and stringers, moderately brittle, no fossils.
380	Covered. Abundant float indicates shale and shaley limestone lithology.
48	Limestone, black, finely crystalline, in 2 to 4 inch beds, interbedded with calcareous shale, light gray, silty, friable to silty, brittle, weak, fossils sparse.

Covered in canyon bottom by Quaternary alluvium.

Total Thickness of Devonian: 544+ feet

BLACKSMITH FORK SECTION

Location: T.10N., R.1,2E., Secs. 12, 7, Cache County, Utah (Composite section, Water Canyon formation measured at separate location as indicated.)

MISSISSIPPIAN: LEATHAM FORMATION

Feet Thick

? Limestone, dark gray, marly, nodular.

No physical evidence of unconformity.

DEVONIAN: JEFFERSON LIMESTONE (Beirdneau member) (982 feet)

9 Limestone, dark gray to black, dense, hard, brittle, massive.

14 Limestone, medium to dark brownish-gray to black, dense to medium crystalline, locally silty and floating sand grains, beds flaggy to obscure, probable Cyrtospirifer fauna.

30 Limestone, dark gray to black, dense to very finely crystalline, beds flaggy to massive, locally laminated, locally arenaceous.

5 Shale, olive, brown, black, dolomitic, waxy, papery to platy, hard, brittle.

93 Siltstone, dolomitic, and Dolomite, silty, alternating in 1/2 to 2 inch beds, slabby, gray to tan, occasional fine sandstone, occasional 1 to 2 inch paper shale partings, ripple marks in upper part.

10 Dolomite, medium to dark gray, cryptocrystalline, beds massive, hard.

55 Siltstone, dolomitic, and Dolomite, silty, interbedded, medium gray, hard, brittle, flaggy, weathers tan to gray.

8 Siltstone, tan to gray, dolomitic, thinly laminated, some thin cross laminations, ripple marks.

5 Sandstone, dark brownish gray, very fine crystalline, brittle, platy, ripple marks, paper shale interbeds.

23 Dolomite and Dolomitic Siltstone alternating in 3 to 5 foot beds, gray to tan, flaggy.

14 Dolomite, medium gray, cryptocrystalline, silty, locally sandy, hard, laminated, local development of tan limestone near center.

18 Dolomite, medium to light gray, silty, calcareous, beds thin, and Siltstone, light gray, dolomitic, laminated, platy, and Shale, olive tan, dolomitic, papery.

12 Siltstone, light gray, siliceous, dolomitic, calcareous, beds laminated, slabby.

8 Dolomite, medium gray, silty, calcareous, cryptocrystalline, locally sandy with ripple marks.

10 Sandstone and Siltstone, tan to gray, very fine, calcareous, platy.

52 Dolomite and Siltstone, medium to dark gray, beds 3 feet, crypto- to very fine crystalline, with Limestone, gray, dense in thin beds near top.

8 Siltstone and Sandstone, fine, tan to light gray, limey, dolomitic, flaggy.

36 Dolomite, silty, and Siltstone, dolomitic, alternating in 3 to 4 foot beds, medium to dark gray, very finely crystalline, flaggy.

76 Sandstone and Siltstone, poorly exposed, light gray to tan, dolomitic, locally beds of dolomite to 1 inch thick.

50 Sandstone and Quartzite, tan to light gray, fine to medium grained, some cross-bedding, flaggy.

5 Quartzite, white to tan, medium to coarse grained, locally conglomeratic, hard, massive beds.

30 Siltstone and Sandstone, interbedded in 2 to 3 foot beds, thinly laminated, medium gray to white to light buff, small cross-laminations, quartz grains in sand well rounded, calcareous, dolomitic.

33 Sandstone, white, fine grained, siliceous, dolomitic, very hard, very fine pebble conglomerate locally.

38 Siltstone, light tan to gray, medium to coarse grained, well rounded grains, thinly laminated, siliceous, dolomitic.

25 Limestone, medium to dark gray, dense to very finely crystalline, hard, massive, scattered beds tan siltstone.

118 Siltstone and fine Sandstone, light gray to tan, siliceous, dolomitic, limey, streaks, laminated, platy, local partings tan paper shale, cross-lamination, ripple marks, mud cracks at several horizons.

9 Siltstone, Dolomite, Limestone, interbedded and intergrading. Siltstone, light gray with greenish cast, dolomitic, hard, brittle, thinly laminated, platy. Dolomite and Limestone, medium to light gray, finely crystalline, hard, brittle, thinly laminated. Scattered beds of intraformational breccia.

3 Covered.

57 Quartzite and Sandstone, white to light gray, medium to coarse grained, sub-rounded, hard, massive, slabby and flaggy partings, local streaks of grit sized fine conglomerate, occasional fine cross lamination.

34 Siltstone, light gray to tan, platy, dolomitic, shale partings, weathers tan, thinly laminated, ripple marks and mud cracks in upper part.

28 Dolomite, medium to light gray and tan, fine to very fine crystalline, laminated, but massive in outcrop, becomes silty and argillaceous in upper part and grades into overlying bed.

66 Siltstone, light smokey tan to buff, dolomitic, calcareous, beds flaggy and laminated with tan to green, waxy, clay shale partings, locally with ripple marks and mud cracks, occasional reddish to purplish shale beds.

Contact distinguished by sharp lithologic change, apparently conformable.

<u>DEVONIAN: JEFFERSON FORMATION (Hyrum member) (943 feet)</u>

7 Limestone, dark gray to black, dense, beds massive.

28 Limestone, Shale and Siltstone, interbedded. Limestone, tan to light gray, fine crystalline, silty, argillaceous. Shale, gray-green, limey, papery with similar fine silt beds 1/16 to 1 inch thick.

4 Limestone, dark gray to black, dense to cryptocrystalline, hard, massive.

8 Breccia, collapse, 1 to 4 foot blocks black dense limestone and platy silty limestone at random orientation in calcareous matrix, abrupt vertical terminations with smooth bedding surfaces above and below indicating post depositional brecciation.

4 Limestone, dark gray to black, dense, hard, massive.

11 Shale, gray to tan, limey, argillaceous, paper, with 4 foot bed of Limestone, dark gray to black, dense, hard, in lower part.

14 Dolomite, limey, black, dense to cryptocrystalline, hard, flaggy.

29 Limestone, dolomitic, medium to dark gray, dense to fine crystalline, beds very thin (1/2 inch) and platy, local zones intraformational breccia.

89 Dolomite, medium gray, fine to medium crystalline, sucrosic, hard, beds 1/8 to 1/4 inch, scattered zones intraformational breccia.

41 Dolomite, dark gray to black, medium to coarse crystalline, sucrosic, beds 1/4± inch.

15 Dolomite, light gray, dense to very fine crystalline, sucrosic, floating sand grains near middle, probably primary.

20 Dolomite, medium gray, dense to cryptocrystalline, sucrosic, hard, brittle, very thin beds, platy.

17 Dolomite, dark gray to black, medium to coarse crystalline, sucrosic, hard, massive, color laminations in shades of gray.

5 Quartzite, white to light pink, very hard, compact.

49 Dolomite, medium to dark gray to black in alternating beds, very fine crystalline, sucrosic, hard, beds irregular and massive.

4 Covered.

3 Sandstone, white to pinkish tan, sub-rounded, calcareous, massive.

114 Dolomite, dark gray to black, color varies with bed, fine to coarse crystalline, sucrosic, strong H_2S odor, scattered brachiopods in upper portion.

2 Dolomite, light gray, fine crystalline, sucrosic, hard, massive.

6 Sandstone, light tan, fine grained with local streaks of coarse grains, hard, laminated, siliceous, dolomitic.

87 Dolomite, dark gray to black in alternating beds, fine to coarse crystalline, sucrosic, hard, brittle, massive, algal forms in lower part, scattered solitary corals and crinoid stems.

86 Dolomite, dark gray to black, medium to coarse crystalline, sucrosic, beds very thin and platy, outcrops massive, locally dense, bryozoa locally abundant.

10 Breccia, intraformational small to large angular cobbles, fine crystalline, black dolomite in medium to dark gray limey matrix.

39 Dolomite, dark gray with bands of medium and light gray, fine crystalline, hard, brittle, beds indistinct, massive.

14 Dolomite, light gray, medium crystalline, beds 2± inches, weathers white, hard, intraformational breccia in upper 1 foot, similar to above breccia.

84 Dolomite, medium to dark grey to black, fine to medium crystalline, sucrosic, hard, beds indistinct, massive, fossil "ghosts," mostly brachiopods.

24 Dolomite, medium and dark gray in alternating 3 foot bands, fine to medium crystalline, sucrosic, hard, beds thin.

38 Dolomite, light gray, dense to cryptocrystalline, hard, beds thin.

1 Dolomite, dark gray, fine crystalline, no beds.

7 Dolomite, light gray to white, dense, finely laminated, argillaceous streaks.

82 Dolomite, dark gray, sooty black, cryptocrystalline, calcareous, beds thin, flaggy, outcrops massive, weathers banded, medium and dark gray.

Contact not exposed, top of Water Canyon taken at top of tan dolomite-shale sequence below lowest bed of black, sucrosic dolomite of Hyrum member of Jefferson.

DEVONIAN: WATER CANYON FORMATION (320 feet)

Location: T.10N., R.1,2E., Secs. 1,12,6, Cache County, Utah

16 Dolomite, tan, dense, argillaceous, silty, thin beds.

14 Dolomite, light gray, cryptocrystalline, calcareous, massive.

5 Limestone, light gray, cryptocrystalline, with scattered zones intraformational breccia.

15 Dolomite, tannish grey to greenish gray, fine crystalline, silty, calcareous, flaggy.

10 Limestone, light gray, cryptocrystalline, very thin beds (1/4± inch), argillaceous.

5 Dolomite, limey, light gray to pink, fine crystalline, beds 1/8± inch.

3 Limestone, buff, medium crystalline, shaley, 2 to 4 foot beds.

11 Limestone, tan to red, very finely crystalline to cryptocrystalline, highly argillaceous, occasional 1/2 to 1 foot beds of fragmental limestones, beds in upper part platy.

18 Breccia, (probably collapse) limestone fragments tannish gray, medium crystalline in matrix of tan to reddish argillaceous material, fragments 1/2 inch to 4 inches.

10 Limestone, dark gray at base, changing rapidly to pinkish tan and brown, finely crystalline, argillaceous, beds 1/8 inch to 1/4 inch.

6 Breccia, red argillaceous to silty cement enclosing fragments of tan and gray limestone and dolomite, fragments angular to subangular and 1/4 inch to 2 inches in maximum diameter.

2 Limestone, tan to red, very finely crystalline, slightly argillaceous and dolomitic, platy beds.

5 Dolomite, tan to red, very finely crystalline, slabby beds, limey, hard, brittle, color becomes lighter upward.

8 Limestone, medium gray with brownish cast, mottled in shades of gray, uneven bedding surfaces, platy beds, occasional streaks intraformational breccia.

58 Dolomite, medium gray, medium crystalline, medium hard, platy, occasional light gray beds.

5 Dolomite, light gray to white, cryptocrystalline to very finely crystalline, platy, color banded.

4 Dolomite, pinkish gray, mottled with purple patches, dense to cryptocrystalline, platy.

7 Dolomite, light gray to white, very fine to cryptocrystalline, hard.

8 Dolomite, pink to heliotrope, slabby, medium crystalline.

110 Dolomite, light gray to white, dense to cryptocrystalline, hard, platy, weathers light gray to white, fish fragments in float 20 feet above base.

Contact disconformable.

SILURIAN: LAKETOWN DOLOMITE (? feet)

Total Thickness of Devonian: 2245 feet

SUNNYSIDE SECTION

Location: T.7N., R.62E., Sec. 34, Lincoln County, Nevada

MISSISSIPPIAN: MADISON LIMESTONE

Feet Thick

10+ Limestone, light gray, coarsely crystalline, beds massive, weathers sugary.

Overlying Mississippian Madison (Joana) limestone is in disconformable contact with Devonian rocks. Disconformity is marked by a surface of relief with channels up to 6 to 8 feet. Probably some Guilmette is missing.

DEVONIAN: GUILMETTE FORMATION (228 feet)

55 Limestone, light gray, finely crystalline, beds medium to massive, fossils--corals, brachiopods (Atrypa sp.).

60 Limestone, medium gray, finely crystalline, beds medium, calcite veins.

50 Limestone, light grey, finely crystalline, beds medium to massive, weathers sharply pocked.

45 Limestone, same as above, but medium gray.

18 Limestone, dolomitic, light gray with pink cast, medium crystalline, beds medium, weathers sugary, calcite veins and fillings.

Boundary between Guilmette and Simonson is arbitrary since sequence is integrading.

DEVONIAN: SIMONSON DOLOMITE (751 feet)

55 Dolomite, limey, medium gray, fine to medium crystalline, medium beds, faint color laminations (medium and dark gray).

67 Dolomite, dark to medium gray, finely crystalline, medium beds.

48 Dolomite, dark to medium gray, medium to coarsely crystalline, fine to medium beds, laminations, weathers sugary.

63 Dolomite, light gray, medium crystalline, beds massive, finely laminated, weathers sugary.

54 Dolomite, medium gray, medium crystalline, fine to medium beds, weathers sharply pocked with gray color mottling.

50 Dolomite, dark gray, finely crystalline, medium beds, calcite vugs, red and brown mottling.

45 Dolomite, same as above.

60 Limestone, light gray, medium crystalline, medium bedded, "twiggy" units of $CaCO_3$, weathers sharply angular, slightly vuggy.

52 Dolomite, light gray, finely crystalline, beds massive, finely laminated, weathers white.

46 Dolomite, medium gray, finely crystalline, beds massive, brittle.

55 Dolomite, light gray, finely crystalline, beds fine to massive, faint gray laminations.

48 Dolomite, medium gray, fine to medium crystalline, beds massive, irregular color mottling, brittle.

50 Dolomite, light gray, medium crystalline, thin to massive beds, finely laminated, calcite veinlets.

58 Dolomite, limey, light gray, coarsely crystalline, beds massive, small flakes and crystals of calcite etched out by weathering. At base is 12 foot unit of material badly silicified along a fault zone but is probably a quartzite, elsewhere covered.

DEVONIAN: SEVY DOLOMITE (582+ feet)

55 Dolomite, limey, white, coarsely crystalline, beds massive, brittle, weathers sugary. Unit includes 25 feet of quartzites interbedded with dolomites near middle of interval at 990 to 1020 feet. Quartzites gray with subangular grains.

70 Dolomite, light gray, finely crystalline to dense, beds massive, weathers light gray with buff cast.

41 Dolomite, same as above.

53 Dolomite, same as above.

63 Dolomite, same as above.

51 Dolomite, same as above, but white and laminated.

61 Dolomite, same as above, but light gray.

41 Dolomite, same as above.

52 Dolomite, same as above, but fine to medium crystalline.

43 Dolomite, same as above, but medium gray, weathers sharply pocked.

52 Dolomite, same as above.

Remainder of Sevy covered.

Contact covered.

SILURIAN: LAKETOWN DOLOMITE

Top of section covered but probably no more than 50 feet are unavailable.

54 Dolomite, light gray, medium to coarsely crystalline, beds massive, weathers sugary.

Total Thickness of Devonian: 1561 feet

OPHIR SECTION

Location: T.5S., R.4W., Sec. 23 and 24, Tooele County, Utah

MISSISSIPPIAN: MADISON LIMESTONE

Feet Thick

5+ Limestone, dense, crystalline, medium gray, massive, fossiliferous.

Conformable.

DEVONIAN (?): PINYON PEAK LIMESTONE (?) (179 feet)

Fitchville Fm.

41 Limestone, crystalline, sugary, sandy, light gray, faint lamination, cliff maker, massive.

71 Dolomite, limey, black, finely crystalline, weathers black, large white calcite blebs (2± inches diameter) numerous and evenly distributed throughout bed-- "eye bed."

42 Dolomite, limey, crystalline, light gray beds medium to massive, sugary, calcite blebs in lower part.

16 Limestone, dolomitic, light gray, dense, massive, cliff maker.

9 Sandstone, limey, gray, interbedded with limestone.

Wavy surface--probably disconformity.

CAMBRIAN (?): LYNCH DOLOMITE (?)

37 Dolomite, limey, medium gray, dense, massive.

Total Thickness of Devonian: 179 feet

DEVILS GATE PASS SECTION

Location: T.20N., R.53E., Eureka County, Nevada

Section measured from bottom to top and is given in this order.

DEVONIAN: DEVILS GATE FORMATION (918+ feet)

Feet Thick	
93	Limestone, dolomitic, medium to light gray, weathers white, finely crystalline to dense, massive beds, hard, non-porous and impermeable, no fossils.
200	Limestone, light gray, fine to medium crystalline, sandy, chert lenses along bedding planes, beds massive, weathered surface pocked, some lamination, no fossils, partly covered, less sandy toward top, 2 foot thick conglomerate 150 feet above base of interval.
90	Limestone, alternate black and medium gray, dense, finely crystalline, beds thin to medium, brittle, hard, some brachiopods (possibly *Spirifer argentarius*).
66	Limestone, medium gray, fine to medium crystalline, very massive outcrops--bold 20 foot cliffs, slightly porous and permeable, very hard, dense, $CaCO_3$ veins and stringers abundant, some remnants of corals.
48	Shale and Limestone. Shale, tan to gray, fine silt size, papery, in 2 to 6 inch beds. Limestone, black, finely crystalline to dense, some $CaCO_3$ veins, locally brecciated, in 1 to 4 inch beds, scattered solitary corals.
22	Limestone, black, finely crystalline to dense, hard, massive beds, weathers light to medium gray, some $CaCO_3$ veins.
74	Shale, calcareous, black, weathers pink, finely silty, occasional limestone beds, black, to 4 inches thick, shale papery and crumbly, poorly preserved organic remains.
10	Limestone, black, weathers gray with pink cast in splotches, finely crystalline, dense, beds massive, hard, silicified corals.
89	Limestone, same as below.
14	Limestone, same as below.
212	Shale, black, weathers gray to tan, fine grained, beds flaggy, makes unusually prominent outcrop for shale, hard,

brittle, fine silt to clay size, some color laminations on weathered surface, no fossils.

Alaskite porphyry sill cuts out top of formation.

Total Thickness of Devonian: 918+ feet

OAKLEY SECTION

Location: T.4N., R.11W., Sec. 33, Summit County, Utah

MISSISSIPPIAN: MADISON LIMESTONE

Feet Thick

? Limestone, dark gray, beds massive, medium crystalline, fossiliferous.

Contact is unconformable (Williams, N. C., 1953, p.2741).

DEVONIAN (?): PINYON PEAK LIMESTONE (?) (approximately 30 feet)

30± Siltstone, Limestone, Dolomite. Siltstone, gray to tan, calcareous, platy. Limestone and Dolomite, medium grey, medium crystalline, beds medium to massive, no fossils found, badly covered.

DEVONIAN: VICTORIA FORMATION (?) (11 feet)

2 Limestone, gray, platy, locally slightly silty, weathers grey to buff, $CaCO_3$ solution cavity fillings.

2 Dolomite, limey, dove gray, occasional well rounded, floating sand grains, weathers buff, beds thin to medium, some prominent brown bands 1 inch to 2 inches parallel to the bedding.

4 Shale, limey, gray, fine grained, weathers medium gray, scattered ironstone concretions, very thin bedded.

3 Shale, limey, paper, fossiliferous, occasional 3 inch beds of siltstone, weathers buff, abundant brachiopods and fish teeth, Cyrtospirifer fauna.

Tan paper shale rests unconformably on gray to pink quartzite--probably Cambrian.

CAMBRIAN (?): TINTIC QUARTZITE (?) (50 feet plus)

50+ Quartzite, gray to pink, jasper pebbles on top bedding surface.

Total Thickness of Devonian: approximately 40 feet

Note: This section also described by N. C. Williams (1953, pp.2740-41).

LOGAN SECTION

Location: T.12N., R.2E., Sec. 16 and 21, Cache County, Utah

Note: This section measured and reported by J. S. Williams (1948, pp. 1138-41) is summarized here.

MISSISSIPPIAN: MADISON FORMATION

Unconformity.

DEVONIAN: JEFFERSON FORMATION (Beirdneau member) (740 feet)

Feet Thick	
390	Sandstone and Siltstone, smoke gray, intraformational breccia common, ripple marks, mud cracks, halite casts.
350	Sandstone, tawny olive to light gray, intraformational breccia common, occasional beds siltstone, shale, quartzite, limestone.

(Hyrum dolomite member) (1108 feet)

98	Limestone, medium gray to black, massive with Sandstone, buff, thin bedded, fine grained, 25 feet thick in upper part.
85	Dolomite, dark gray weathering, finely crystalline, medium bedded, some sandy laminae, some mottling in shades of gray.
165	Limestone and Sandstone. Limestone, black, compact, thin to medium bedded. Sandstone, olive ocher, fine grained, thin bedded throughout limestone.
435	Dolomite as above, with scattered thin sandstones.
15	Breccia, black dolomite in sandstone.
235	Dolomite, weathers mouse gray, slightly darker on fresh surface, fine texture, sandy, beds medium, occasionally mottled and laminated, scattered platy sandstones.
75	Limestone and Sandstone. Limestone black, Sandstone smoke grey, in thin interbeds.

Disconformity.

DEVONIAN: WATER CANYON FORMATION (543 feet)

Location: T.12N., R.2E., Sec. 20 and 24, Cache County, Utah

150 Upper Member - Dolomite, buff to light gray, fine grained, occasionally silty and with purple cast, occasional buff sandstones.

393 Lower member - Dolomite, light to medium gray, weathers white, dense, laminated, occasional thin bedded buff sandstone and siltstone, intraformational breccia, mud cracks.

Disconformity.

<u>SILURIAN: LAKETOWN DOLOMITE</u>

Total Thickness of Devonian: 2391 feet

BECKS SPUR SECTION

Location: T. 1N., R.1W., Sec. 24, Salt Lake County, Utah

MISSISSIPPIAN: MADISON LIMESTONE

Feet Thick

10+ Limestone, silty, black, medium grained, $CaCO_3$ vugs and veins, makes bold, black, somewhat rounded outcrops.

Contact Madison limestone and Beck's formation marked by slight red clay zone and by pronounced lithologic change.

DEVONIAN: BECK'S FORMATION (192+ feet)

1 Sandstone, argillaceous, calcareous, red, soft and relatively unlithified.

22 Limestone, thin bedded, finely crystalline, with occasional narrow, coarsely crystalline beds, dark gray, fossiliferous, crinoid stems, weathers medium gray on irregular outcrop surfaces, $CaCO_3$ veins abundant.

68 Limestone, same as above, except beds are thicker.

58 Limestone, medium bedded, finely crystalline, medium gray, beds 6 inches to 8 inches, weathers light gray to white, many fossil fragments--especially crinoid stems.

43 Limestone, same as above, except thin bedded, 5 feet of shaley limestone 15 feet above base.

At this point the section is offset by a northwest to southeast trending fault and section terminates.

ORDOVICIAN (?): SWAN PEAK QUARTZITE (?)

24 Interbedded sandstone, tan limestone, limestone breccia and yellow to tan shale, beds are 1 inch to 3 inches thick and all weather red to tan, quartz grains in sandstones are rounded and both sandstones and shales are calcareously cemented.

Total Thickness of Devonian: 192+ feet

Note: A complete section from this locality described by Edvalson(1947, p. 39).

LAKESIDE MOUNTAINS SECTION

Location: T.1N., R.9W., Sec. 13, Tooele County, Utah

Note: This section measured and reported by Young (1953). The writer measured and described the section at the same locality and is in accord with Young's reported information. Therefore, section is given below in summarized form only.

MISSISSIPPIAN: MADISON LIMESTONE

Feet Thick	
?	Limestone, dark gray, fragmental, massive, fossiliferous.

No evidence of disconformity.

DEVONIAN: JEFFERSON FORMATION (1469 feet)

47	Dolomite, silty, light brown to gray to dull orange-gray, very light tan, dense, non-resistant, most of interval below bed here described is covered but float indicates similar lithologies that gradually grade into underlying unit.
1286	Dolomite, medium to dark gray, massive, medium to coarse crystalline, resistant, makes series of imposing cliffs, occasional limestones with same characteristics and sandstones, clean, gray to tan.
137	Dolomite, shaley, non-resistant, dark gray to black, medium crystalline, with sandstones, tan, particularly near base.

Disconformity.

DEVONIAN: WATER CANYON FORMATION (242 feet)

242	Dolomite, light gray to white, dense to medium crystalline, massive, silty near base, contains fish fragments near base.

Disconformity.

SILURIAN: LAKETOWN DOLOMITE

?	Dolomite, medium to dark gray, coarse crystalline, massive.

Total Thickness of Devonian: 1711 feet

DEEP CREEK SECTION

Location: Composite section, all segments from west side Deep Creek Range, Tooele County, Utah, about opposite Ibapah.

Note: These sections measured and reported by T. B. Nolan (1930), (1935, pp. 18-21). Writer has examined and remeasured sections and is in accord with Nolan's reported observations; therefore, his sections summarized briefly.

MISSISSIPPIAN: WOODMAN FORMATION

Feet Thick

? Sandstone, limey, and Limestone, sandy, brown, beds thin.

Unconformity, angular in places, Mississippian Madison and Devonian (?) Pilot commonly missing.

DEVONIAN: GUILMETTE FORMATION (888+ feet)

888+ Dolomites and Limestones, medium to dark gray, drab gray and brown weathering, weather banded in shades of gray, massive, occasional sandstone beds, light gray to tan, *Stringocephalus* zone about 100 feet above base.

DEVONIAN: SIMONSON DOLOMITE (963 feet)

963 Dolomite, medium and dark gray, color varies from bed to bed, often finely laminated in shades of gray, medium to coarsely crystalline, scattered intraformational breccias, local limestone and sandstone beds.

DEVONIAN: SEVY DOLOMITE (450 feet)

450 Dolomite, light gray to white, dense, laminated, massive.

Disconformity--erosion surface evident.

SILURIAN: LAKETOWN DOLOMITE

? Dolomite, medium to dark gray, coarsely crystalline, massive, *Halysites*.

Total Thickness of Devonian: 2301 feet

NEWFOUNDLAND RANGE SECTION

Location: Section exposed along south end and west side of range, about 15 miles north of Knolls, Utah.

Note: Reconnaissance section only, all thicknesses estimated and lithologies generalized.

MISSISSIPPIAN: MADISON LIMESTONE

Feet Thick

? Limestone, medium to dark gray, massive, fragmental, fossiliferous.

Probable thrust fault.

DEVONIAN: PILOT SHALE (10 feet)

10 Limestone, silty, with shale partings, tan, with pink mottling, 1/8± inch beds and partings, no way of determining amount missing, only exposure.

Conformable.

DEVONIAN: GUILMETTE FORMATION AND SIMONSON DOLOMITE (undifferentiated) (1500± feet)

1500± Dolomite and Limestone, dark to medium gray, beds massive with variance from bed to bed in shade of gray giving banded appearance, lower beds laminated medium and dark gray, medium to coarse crystalline, occasional clean light gray to tan sandstones.

Conformable.

DEVONIAN: SEVY DOLOMITE (500 feet)

500 Dolomite, light gray to white, dense to finely crystalline, massive, somewhat darker toward top and with some sandstones in upper part.

Probably unconformable.

SILURIAN: LAKETOWN DOLOMITE

? Dolomite, medium gray, medium to coarse crystalline.

Total Thickness of Devonian: 2010± feet

DURST MOUNTAIN SECTION

Location: T.5N., R.3E., Sec. 18 and 19, Weber County, Utah

MISSISSIPPIAN: MADISON LIMESTONE

Feet
Thick
(est.)

? Limestone, dark gray, dolomitic, beds massive, fossiliferous.

Contact apparently conformable.

DEVONIAN: THREE FORKS FORMATION (650 feet estimated)

250 Shale, limey, tan, red, gray, occasional sandstone and siltstone beds 1 to 2 inches thick, very non-resistant, largely covered, makes red soil zone.

90 Limestone, shaley, light gray, beds thin, poorly exposed.

200 Sandstone, buff to red, fine grained, with occasional beds of medium to coarse grains, beds thin, flaggy and shaley, calcareous cement, scattered 2 to 6 inch beds of limestone and dolomite, silty, shaley partings throughout, badly covered, makes red soil zone.

75 Covered, but float appears same as above.

35 Limestone, shaley, silty, medium gray, beds thin, fine to medium crystalline, cherty, scattered fossil fragments (none identifiable).

Disconformity, Contact covered.

CAMBRIAN: MAXFIELD LIMESTONE (?)

? Limestone, silty, light gray, beds thin with tan silty partings, tan and gray mottled appearance.

Note: For further discussion of this section see Eardley (1944), pp. 830-31.

Total Thickness of Devonian: 650 feet estimated

SOUTHERN RUBY MOUNTAINS SECTION

Summarized from Sharp (1942, pp. 660-67)

MISSISSIPPIAN (?): undifferentiated

Feet Thick	
?	Limestone, massive, cherty, crinoidal.

Contact apparently conformable.

DEVONIAN: DEVILS GATE FORMATION (upper division) (300 feet)

300	Limestone, arenaceous, argillaceous, platy, gray, weathers brown or red.

DEVONIAN: DEVILS GATE FORMATION (lower division) (900 feet)

900	Limestone, dark gray, well bedded, fossiliferous.

DEVONIAN: NEVADA LIMESTONE (redefined) (1900 feet)

1900	Dolomite and Limestone, gray, bedded, laminated, mottled.

Contact gradational.

SILURIAN: LONE MOUNTAIN FORMATION (redefined) (1350 feet)

1350	Dolomite, massive, white, medium to coarsely crystalline.

Total Thickness of Devonian: 3100 feet

TEN MILE PASS SECTION

Location: T.8S., R.40E., Sec. 10,11, Caribou County, Idaho

Note: Reconaissance section, thicknesses estimated and general lithologies noted.

MISSISSIPPIAN: MADISON LIMESTONE

Feet Thick (est.)

? Limestone, medium gray, medium to coarse crystalline, massive, fossiliferous.

Contact appears conformable.

DEVONIAN: THREE FORKS FORMATION (425 feet estimated)

425 Interbedded, Dolomite, Limestone, Siltstone, Shale. Dolomite, light gray to light tan, dense to fine crystalline, silty, argillaceous, commonly in thin, flaggy beds with shale partings, predominant in upper part. Limestone, light gray to buff to cream, dense to medium crystalline, silty, argillaceous, flaggy, more common in lower part of section. Siltstone, tan, gray, light pink, argillaceous, calcareous, dolomitic, commonly with shale partings. Shale, tan, gray, pink, greenish, argillaceous, papery, commonly occurs as partings between beds of above. Formation is non-resistant and commonly shows as tan to reddish soil on a slope beneath the cliffs of the Madison formation.

Contact conformable, lithologies change rapidly.

DEVONIAN: JEFFERSON FORMATION (400 feet estimated)

400 Dolomite and Limestone with scattered clastic zones and solution breccias. Dolomite and Limestone, varies from medium to dark gray, fine to coarse crystalline, frequently sucrosic, weathers banded, beds massive, make resistant cliffs. Dolomite predominates.

Contact covered, but sharp lithologic change.

DEVONIAN: SEVY DOLOMITE (250 feet estimated)

75 Dolomite, medium gray to tannish gray, fine to medium crystalline, locally sucrosic, thin bedded, laminated.

175 Dolomite, light gray to tannish gray, dense, laminated, weathers white, massive.

Contact abrupt, probably disconformable.

SILURIAN: LAKETOWN DOLOMITE

? Dolomite, light to medium gray, medium to coarse crystalline, sucrosic, sandy, massive.

Total Thickness of Devonian: 1075 feet estimated

GULF OIL CORPORATION, BISHOP SPRINGS NUMBER 1 WELL

Location: T.16S., R.17W., Sec. 8, Millard County, Utah

Lithologies and thicknesses summarized on basis of well samples examined by C. J. Little, Gulf Oil Corporation.

Well spudded in Devonian (?) Pilot shale about 195 feet below Pilot-Joana limestone (Mississippian) contact.

DEVONIAN (?): PILOT SHALE (940 feet)

Feet Thick	
625	Siltstone, cream, red, buff and gray, calcareous, brittle, secondary calcite abundant, limonite stained, moderately hard, interbedded with Shale, black, fissile, slightly calcareous, brittle, slightly pyritic, mottled toward bottom.
15	Limestone, dark brownish-gray, fine crystalline, hard, slightly argillaceous, cherty.
30	Chert, black, gray, brown, pure, secondary.
65	Limestone, gray and brown, micro to fine crystalline, silty to argillaceous, occasionally nodular, with scattered interbeds of Shale, black, carbonaceous, calcareous, slickensided, silty.
45	Siltstone, buff, very calcareous, soft with rare thin beds of Limestone, brown and gray, very silty, slightly argillaceous, very finely crystalline.
65	Limestone, brown, gray and mottled cream-gray, very finely crystalline to dense, very silty, soft argillaceous, interbedded at base with Siltstone, pink, slightly calcareous, argillaceous with few floating sand grains.
40	Shale, gray, dense, very silty, pyritic, heavily fractured, fractures filled with white, secondary calcite.
55	Limestone, dark gray-brown, finely crystalline, white calcite fracture fillings with scattered interbeds of Siltstone, buff to pink, calcareous, hard, and with 5 foot thick bed of Quartzite, clear to smokey, medium grained, well-rounded to subrounded, partly cemented with gray dolomite.

DEVONIAN: GUILMETTE FORMATION (1882 feet)

40	Dolomite, dark gray-brown, fine to medium crystalline, hard, slightly vitreous with 10 feet Shale, dark gray,

calcareous, sandy near middle.

17 Limestone, dark gray to chocolate brown, silty to sandy, dense.

80 Dolomite, gray-brown, medium crystalline, hard interbedded with light gray to cream, dense to cryptocrystalline.

50 Limestone, chocolate brown and cream, finely sucrosic, silty.

30 Dolomite, dark gray, medium to coarse crystalline, vitreous with black, carbonaceous shale partings.

140 Limestone and Dolomitic Limestone, dark brown to dark gray, dense to cryptocrystalline, brittle, silty, becomes pure dolomite near base.

90 Dolomite and Dolomitic Limestone, dark to light brown, medium to very finely crystalline.

475 Limestone, light to dark brown and gray (interbedded), dense to finely crystalline, vitreous, widely scattered beds of dark brown dolomite.

15 Shale, dirty gray, very fine grained, calcareous, hard, brittle, silty.

55 Limestone, brown, finely crystalline, brittle, vitreous, slickensided, fractured.

15 Shale, dirty gray, carbonaceous, calcareous, hard.

15 Limestone, gray-green, hard, dense, silty to argillaceous.

50 Limestone, dark to light brown, dense, fractured, grades into Dolomitic Limestone, dense, gray-green, silty which grades into Limestone, brown, medium crystalline, fractured.

11 Dolomite, gray, dense to finely crystalline, and Sandstone, gray, very fine to fine grained, unsorted, calcareous.

4 Shale, gray, silty, carbonaceous, calcareous.

284 Limestone, brown to gray, with occasional blackish green beds, colors alternate with beds, dense to finely crystalline, slightly silty.

Reverse fault at this point, possibility of some section missing.

83 Limestone, brown, finely crystalline, vitreous, porcelaneous, occasional interbeds of Siltstone, buff, sandy, calcite, and Dolomite, dark gray, fine crystalline.

130 Limestone, cream-brown and brown, finely crystalline, slightly porcelaneous, slightly dolomitic, scattered shale zones toward base.

17 Limestone, dark gray, finely crystalline, and Dolomite, light gray, fine crystalline.

213 Limestone, gray-brown and cream-gray-brown, finely crystalline, porcelaneous, brittle, flakey, fractured and locally brecciated, shaley at bottom.

68 Limestone and Dolomitic Limestone, thin-bedded, gray to tan, finely crystalline, porcelaneous.

DEVONIAN: SIMONSON DOLOMITE (732 feet)

127 Dolomite, dark to light brown to dark grayish-brown to black, finely crystalline, porcelaneous, carbonaceous and slightly argillaceous.

20 Limestone, dark grayish-brown, finely crystalline, pyritic, slightly silty.

35 Dolomite, brownish-cream, medium crystalline, vitreous, carbonaceous, slightly shaley.

91 Dolomite, dark gray, finely crystalline, porcelaneous, widely scattered thin beds of Dolomite, light brown, medium crystalline, and Limestone, light cream-brown, dense.

19 Dolomite, cream-brown grading to gray-brown, cryptocrystalline, porcelaneous, hard.

10 Dolomitic Limestone and Limestone, gray, cryptocrystalline, sucrosic, argillaceous.

40 Dolomite, dark grayish-brown grading to light chocolate brown, medium crystalline, vitreous, sucrosic.

20 Dolomite, light chocolate brown to smokey gray, cryptocrystalline to finely crystalline, vitreous, hard.

30 Dolomite, gray-brown, fine to medium crystalline, vitreous, porcelaneous.

30 Dolomite, light smokey gray, crypto- to fine crystalline.

10 Dolomite, grayish-brown, medium to coarse crystalline, porcelaneous.

60 Dolomite, brown to cream, crypto- to fine crystalline, porcelaneous, slightly sucrosic.

60	Dolomite, gray to cream, coarse crystalline, porcelaneous.
15	Dolomite, bluish-smoky gray, cryptocrystalline, porcelaneous.
165	Dolomite, cream to cream-brown, coarse crystalline, hard, vitreous, porcelaneous, with rare thin beds of Dolomite, cryptocrystalline.

DEVONIAN: SEVY DOLOMITE (770 feet)

10	Dolomite, cream-brown, dense to cryptocrystalline, porcelaneous interbedded with Sandstone, smokey gray, medium grain, generally well-rounded, dolomitic.
15	Dolomite, gray and cream-brown, dense, vitreous, porcelaneous.
5	Quartzite, colorless, medium grain, completely silicified.
20	Dolomite, cream and brown, medium to coarse crystalline, hard, interbedded with minor beds of Dolomite, light brown, cryptocrystalline, porcelaneous.
40	Dolomite, brown, dense to cryptocrystalline, porcelaneous, interbedded with Sandstone and Quartzite, smokey gray, coarse grain, well-rounded and minor thin beds of Limestone, brown-gray, cryptocrystalline, vitreous, dolomitic.
200	Dolomite, light cream-brown and occasional smokey gray, dense to cryptocrystalline, vitreous, very porcelaneous, slightly sucrosic, with occasional black, carbonaceous, slickensided shale partings.
105	Dolomite, smokey gray, grayish-brown and cream-brown, cryptocrystalline, porcelaneous, vitreous, rarely pyritic, sucrosic.
130	Dolomite, brown and cream-brown, crypto- to fine crystalline, porcelaneous, vitreous, sucrosic, darker at bottom.
10	Dolomite, light smokey gray-brown, fine crystalline, very porcelaneous, brittle, grades to Dolomite, light cream-brown, cryptocrystalline, porcelaneous.
120	Dolomite, cream gray to smokey gray, crypto- to medium crystalline, porcelaneous, sucrosic locally.
25	Dolomite, interbedded dirty gray, brown-gray and cream-brown, medium crystalline, slightly vitreous, hard.
90	Dolomite, cream and light smokey gray, crypto- to fine crystalline, vitreous, porcelaneous with widely scattered

thin beds of Dolomite, cream, lithographic, very porcelaneous becoming dark gray, fine crystalline, vitreous at bottom.

SILURIAN: LAKETOWN DOLOMITE

? Dolomite, cream grading to dark gray, coarse crystalline, mottled, slightly vitreous, becoming sucrosic and pyritic at bottom.

Total Thickness of Devonian: 4324 feet

STANDARD OF CALIFORNIA, BURBANK NUMBER 1 WELL

Location: T.22S., R.19W., Sec. 3, Millard County, Utah

Lithologies summarized on basis of well samples examined by C. J. Little, Gulf Oil Corporation.

Well spudded in Devonian (?) Pilot shale.

DEVONIAN (?): PILOT SHALE (915 feet)

Feet Thick	
390	Shale, dark gray, dense, increasingly calcareous down section grading into shaley and silty limestone.
70	Interbedded Limestone, mottled cream-brown, fine crystalline, silty, and Shale, as above and Siltstone, grey, very fine grain, calcareous, hard.
150	Shale, dark gray, calcareous, very silty, hard.
305	Thinly interbedded Limestone, brownish-gray, cryptocrystalline, carbonaceous, and Shale, dark, very calcareous, hard, silty in part, and Siltstone, buff, gray, fine grained, calcareous, quartzitic.

DEVONIAN: GUILMETTE FORMATION (2109 feet)

90	Thinly interbedded Limestone, brown and gray, cryptocrystalline, and Dolomite, dark grey, finely crystalline, and Siltstone and Sandstone, pink, tan, calcareous, quartzitic.
350	Dolomite, dark gray, finely crystalline, scattered thin limestone beds, dark, dense to cryptocrystalline.
1669	Limestone, dark gray and brown, cryptocrystalline to dense, silty, becomes argillaceous in lower portion.

DEVONIAN: SIMONSON DOLOMITE (586 feet)

10	Dolomite, dark to medium gray, medium to finely crystalline, siliceous.
135	Dolomite, dark, brownish-gray to light gray in alternating beds, coarsely to finely crystalline.
25	Limestone, medium to dark, brownish-gray, finely crystalline to cryptocrystalline.
416	Dolomite, dark and medium brownish-gray beds, generally fine to medium crystalline, interbedded with light gray beds commonly medium to coarsely crystalline.

DEVONIAN: SEVY DOLOMITE (1032 feet)

7 Dolomite, light gray, dense, finely laminated, porcelaneous.

5 Quartzite, light gray to clear, pure, rounded to subangular quartz grains, quartz cement.

1020 Dolomite, primary, cream to creamish-brown and brownish-grey, dense to cryptocrystalline, porcelaneous, vitreous, very uniform.

SILURIAN: LAKETOWN DOLOMITE

? Dolomite, white to cream, very coarsely crystalline.

Total Thickness of Devonian: 4642 feet

STANDARD OF CALIFORNIA, DESOLATION NUMBER 1 WELL

Location: T.15S., R.17W., Sec. 8, Millard County, Utah

Lithologies summarized on basis of well samples examined by C. J. Little, Gulf Oil Corporation.

Well spudded in Permian lower Supai formation (1170 feet) penetrates Pennsylvanian Bird Springs formation (1370 feet), Mississippian Chainman shale (2046 feet), Mississippian Joana limestone (34 feet), Devonian (?) Pilot shale (1100 feet) and bottoms in Devonian Guilmette (480+ feet).

DEVONIAN (?): PILOT SHALE (1100 feet)

Feet Thick	
610	Shale, dark gray, dense, increasingly calcareous down section grading into shaley and silty limestone.
70	Interbedded Limestone, mottled cream-brown, fine crystalline, silty, and Shale, as above, and Siltstone, gray, very fine grain, calcareous, hard.
150	Shale, dark gray, calcareous, very silty, hard.
270	Thinly interbedded Limestone, brownish-gray, cryptocrystalline, carbonaceous, and Shale, dark, very calcareous, hard, silty in part, and Siltstone, buff, calcareous, quartzitic, and Sandstone, buff, gray, fine grained, calcareous, quartzitic.

DEVONIAN: GUILMETTE FORMATION (480+ feet)

100	Limestone, very thinly interbedded, brown and gray, cryptocrystalline, and Dolomite, dark, fine crystalline, and Sandstone and Siltstone, pink, quartzitic, calcareous.
300	Dolomite, dark, fine crystalline with rare, very thin beds of Limestone, dark, lithographic to cryptocrystalline.
80+	Limestone, dark gray and brown, lithographic to cryptocrystalline, silty becoming increasingly argillaceous down section.

Bottom of hole.

Total Thickness of Devonian: 1580+ feet

BURBANK HILLS SECTION

Location: T.23S., R.17W., Sec. 20, Millard County, Utah

Note: This section described by Rush (1951a, pp. 13-16). Since the lithologies are much the same as in adjacent sections (see Confusion Mountains, Burbank Number 1 Well or Bishop Springs Number 1 Well) only thicknesses are given here. Rush applies no formation names. Those used are given by writer on correlation of Rush's lithologic descriptions with those of formations in adjacent areas.

MISSISSIPPIAN: JOANA LIMESTONE

Conformable.

MISSISSIPPIAN: PILOT SHALE (1190 feet)
(Rush's age determination questioned by writer.)

Conformable.

DEVONIAN: GUILMETTE FORMATION AND SIMONSON DOLOMITE (undifferentiated) (1940 feet)

Conformable.

SILURIAN: SEVY DOLOMITE (1176 feet)
(Rush's age determination questioned by writer.)

DUCHESNE RIVER SECTION

Generalized description from Baker, Huddle and Kinney (1949).

MISSISSIPPIAN: MADISON LIMESTONE

Conformable.

DEVONIAN (?): JEFFERSON (?) DOLOMITE (40 feet)
(Pinyon Peak limestone and Victoria formation of present writer)

Feet Thick	
40	Limestone, dense, dolomitic, light gray, with sandy silt beds.

Unconformity.

CAMBRIAN

WHITEROCKS RIVER SECTION

Generalized description from Baker, Huddle and Kinney (1949).

MISSISSIPPIAN: MADISON LIMESTONE

Conformable.

DEVONIAN (?): JEFFERSON (?) DOLOMITE (15 feet)
(Pinyon Peak limestone and Victoria formation of present writer)

Feet Thick	
15	Sandstone and sandy shale, thin-bedded, fine- to medium-grained, tan to reddish, includes thin bed of dark grey limestone.

Unconformity.

CAMBRIAN