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Geology of the Jordan Narrows Quadrangle, Utah

by

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THE GEOLOGY

OF THE

JORDAN NARROWS QUADRANGLE

UTAH

A Thesis

submitted to

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In partial fulfillment

of the requirements for the degree

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by

Grant G. Pitcher

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ABSTRACT

The Jordan Narrows quadrangle, named for the water gap made by the Jordan River through the Traverse Range, lies between west longitudes 112° and 111°52'30" and north latitudes 40°22'30" and 40°30'.

Paleozoic sediments exposed include 800+ feet of Great Blue limestone, 1,200± feet of Manning Canyon shale, and more than 3,767 feet of Oquirrh formation of which 854 feet are Morrowan, 1913± feet Atokan, and more than 1,000 feet Desmoines. Tertiary latite flows up to 255 feet thick overlie the deformed Paleozoic sediments with angular unconformity.

L. W. Slentz mapped the Tertiary Salt Lake group, and C. B. Hunt the Quaternary geology of Northern Utah Valley. Their work is included on the geologic map accompanying this report.

Paleozoic rocks in the West Traverse Range lie on the northeast limb of a northwesterly trending anticline. The Paleozoic rocks in the East Traverse Range, which are greatly brecciated, do not form a recognizable structure. Block faults separate the East and West Traverse Ranges. Salt Lake and Jordan Valleys on the north and Utah Valley on the south are grabens of a large magnitude, making the Traverse Range a structural horst.

Prominent terraces around Steep Mountain in the East Traverse Range are the result of erosion and deposition along the shores of Lake Bonneville while it was at the Alpine, Bonneville, and Provo levels.

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Location of the Area

The Jordan Narrows 7 1/2 minute quadrangle is bounded by the 112° and 111°52'30" west longitudes and by the 40°22'30" and 40°30' north latitudes (see fig. 1), and is located in the northeast part of the Basin and Range Province. It includes most of the Traverse Mountains, an east-west group of hills joining the Wasatch and Oquirrh ranges, and is mid-way between the cities of Salt Lake City and Provo. The Jordan River, on its northward course from Utah Lake to Great Salt Lake, transects the Traverse Range at the Jordan Narrows.

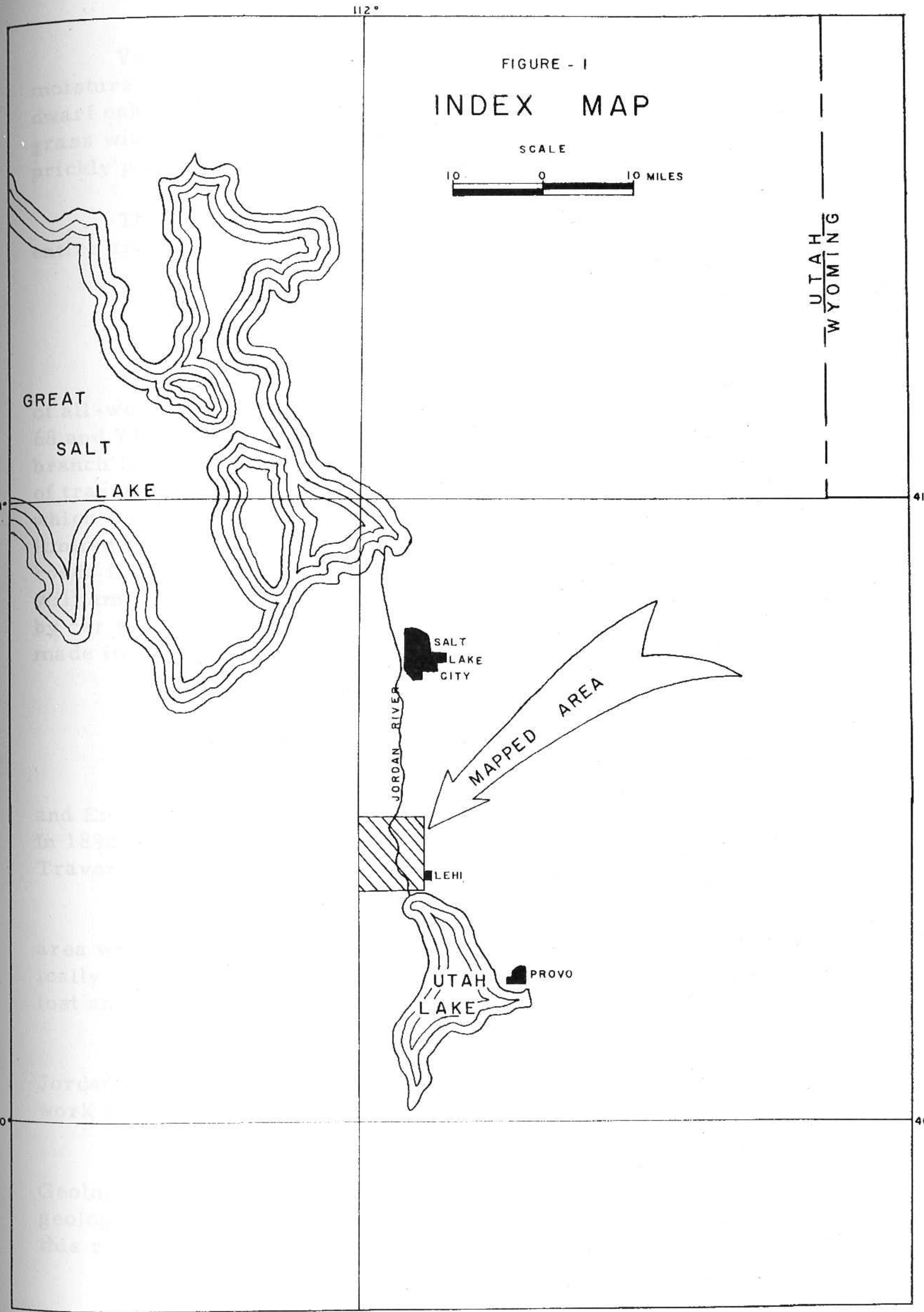
Geography

For a description of the Traverse Mountains the writer refers to R. E. Marsell who made this observation in 1932 (p. 11):

> "When viewed from Salt Lake Valley, the Traverse Mountains appear to the south as a low, flat-topped mass of sprawling, rounded hills and ridges that form an east-west barrier of moderate relief separating Utah and Salt Lake Valleys. On the east they abut against the bold western escarpment of the Wasatch Range; on the west their boundary is less certain and must be fixed somewhat arbitrarily, for they gradually merge with the Oquirrh Mountains without a distinct line of separation. The continuity of the barrier is interrupted near its center by the Jordan Narrows water gap, thus dividing the mountains into two masses, which, for the sake of clarity in this report, will be referred to as the East Traverse and West Traverse Mountains."

This distinction between the East and West Traverse Mountains will also be used by the writer in this report. The low, sprawling nature of the mountains makes a sharp contrast with the high jagged peaks of the Wasatch Mountains and denotes a more mature stage of erosion.

The climate of the area is semi-arid, with an annual rain-fall of 13.78 inches at Lehi, Utah. The average temperature, as taken from the government station at Lehi for a period of 40 years, is 51.6°F.


112°
FIGURE - 1
INDEX MAP
SCALE
10 0 10 MILES
UTAH
WYOMING
GREAT
SALT
LAKE
41°
41°
SALT
LAKE
CITY
JORDAN RIVER
MAPPED AREA
LEHI
UTAH
LAKE
PROVO
40°
40°
112°

Vegetation in the Traverse Mountains is sparce except where the moisture lingers on the north slopes and in the valleys. Here patches of dwarf oak thrive profusely. The rest of the area is covered by short June grass with a scattering of sage brush, and a few junipers, quite a few prickly pears, and patches of mountain mahogany.

The Jordan River is the only perennial stream and it drains the entire area.

Accessibility

Valley portions of the quadrangle are covered with a close network of all-weather roads including U. S. Highway 91 and Utah State Highways 68 and 78. The main line of the Denver and Rio Grande Railroad and a branch line of the Union Pacific Railroad cross the quadrangle. All means of transportation converge toward the Jordan Narrows water gap through which they pass. The hilly country of the Traverse Range, is of more limited accessibility than the valley. On the West Traverse Range jeep roads form a network in and about Utah State National Guard Camp Williams. On the East Traverse Range a few grazing trails are passable by car in good weather. During the winter months, minor roads are made impassable by the blanket of snow that covers the area.

Previous Work

Geologic work in this area dates as far back as 1876 when Hague and Emmons made a study of the geology for King's 40th parallel report. In 1890 G. K. Gilbert's monograph on Lake Bonneville included the Traverse Ranges.

R. E. Marsell was the next to do significant geologic work in the area when in 1932 he mapped the entire Traverse Range both topographically and geologically. Unfortunately, all copies of his maps have been lost and thus are not available to present workers.

In 1955 Dr. L. W. Slentz included the Tertiary rocks of the Jordan Narrows within the mapped region of his doctorate thesis. His work in this area is included within the compilation of plate I.

C. B. Hunt, H. D. Varnes and H. F. Thomas wrote U. S. Geological Survey Professional Paper 257-A (1953) on the Quaternary geology of northern Utah Valley. Part of their work is included within this report on plate I and in the discussion of the Quaternary geology.

R. A. Madsen (1952) mapped the geology of the Beverly Hills area which is located in the south-west corner of the quadrangle.

D. R. Murphy, wrote concerning the fauna of the Morrowan rocks of Central Utah, and Blair Maxfield has done a study on the lithology of the Morrowan rocks of the same area.

These and other selected references, are listed at the end of this report.

Methods of Investigation

Geologic mapping was begun in September 1956, after the writer had made a reconnaissance in May of the same year. A total of about 34 days was spent in the field, mapping and collecting samples.

Laboratory work included the etching out of the silicified fossils with hydrochloric acid and the cutting of thin sections for microscopic identification. The fossils were then identified and the collecting localities given permanent Brigham Young University collection numbers.

The bed-rock geology was recorded directly on 1:20,000 aerial photographs and then transferred onto a U. S. Geological Survey topographic base map with a scale of 1:24,000 by means of a rectoplanograph. Certain approximate strike and dip values, that were unattainable because of poor exposure in the field, were calculated by photogeologic methods.

The work of L. W. Slentz and C. B. Hunt was then added to complete the map found on plate I.

Purpose and Scope of Present Investigation

It is the purpose of this investigation to reevaluate the geology in light of recent findings in the surrounding areas by compiling all known available work that has been done and by remapping all the bedrock geology of the Jordan Narrows quadrangle, a base of which has become available since the time of the earlier investigations. This, the writer hopes, will bring to focus a better picture as to the age and structural relationships of the East and West Traverse Mountains.

STRATIGRAPHY

General Statement

Within the mapped area sedimentary rocks aggregate to a total thickness of approximately 6,500 feet (see fig. 2). This is divided into the Great Blue limestone, the Manning Canyon shale and the Oquirrh formation in the Paleozoic era, the Salt Lake group in the Tertiary period and the Pre-Lake Bonneville, Lake Bonneville and Post-Lake Bonneville deposits in the Quaternary period.

Mississippian System

Great Blue Limestone -- The Great Blue limestone crops out over eight square miles in a group of hills in T. 5 S., R. 1 W. called the Beverly Hills. Only the upper part of the formation is exposed within the quadrangle. The lower part of formation lies south of the mapped area and is mostly covered by younger lake beds. The contact with the Manning Canyon shale is indistinct and is covered by lake deposits. The Allred clay deposit, however, seems to indicate the approximate position of the contact.

The Great Blue limestone was named by Spurr (1895, pp. 374-376) from outcrops in the Oquirrh Mountains in the Mercur mining district of Central Utah. In his type locality, Spurr measured 3,525 feet (Spurr, 1895, p. 375). Other measurements of this formation have been made by Gilluly, who measured it north of Spurr's type locality and found it to be 3,600 feet thick (Gilluly, 1932, p. 29), and by the writer, who measured the formation north of the town of Ophir, Utah, with the help of Deverl J. Peterson, Morris Peterson and John Carter in the summer of 1955 and found it to be 3,398 feet thick. The formation can be subdivided into three units: a lower limestone (500 feet), the Long Trail shale member (85 feet), and a thick upper limestone (2,813 feet). A section could not be measured within the Jordan Narrows quadrangle because of its poor exposure in this area. The writer agrees with the computation of R. A. Madsen (1952, p. 13) that only the uppermost 800 feet of the formation crops out in the Beverly Hills.

The Great Blue limestone that lies within the quadrangle includes a variety of limestone lithologies. The lower half is a light to medium gray, medium bedded, limestone, and is overlain by about 200 feet of

	Formation	Thickness	Description	Fossil Locality	Section
QUAT.			Gravel, sand and silt.		
TERT.	Salt Lake group	600+	Marlstone, siltstone, limestone, tuff and conglomerate.		
PENNSYLVANIAN	Oquirrh formation	1,000±	Desmoines series Light brown to tan quartzite with some medium gray orthoquartzite interbedded with a few light to medium gray beds of limestone.		
PENNSYLVANIAN	Oquirrh formation	1,913 ±	Atokan series Medium to dark gray, sandy limestone that weathers light gray, interbedded with light brown to tan cross-bedded orthoquartzite.	10966	
PENNSYLVANIAN	Oquirrh formation	854	Morrowan series Limestone; medium to dark gray, medium to thick bedded, fetid in part, sandy, with some cherty beds.	10973 10972 10971 10970 10969 10968 10967	
PENNSYLVANIAN / MISSISSIPPIAN	Manning Canyon shale	1,200 ±	Shale; light brown to black with some quartzite and limestone beds. Springeran probably begins at the bottom of the prominant bed of scintillating quartzite.		
MISSISSIPPIAN	Great Blue limestone	800 +	Limestone; medium gray, weathering light gray, mediumto thick bedded and platy in places, sandy.	10976 10975 10974	

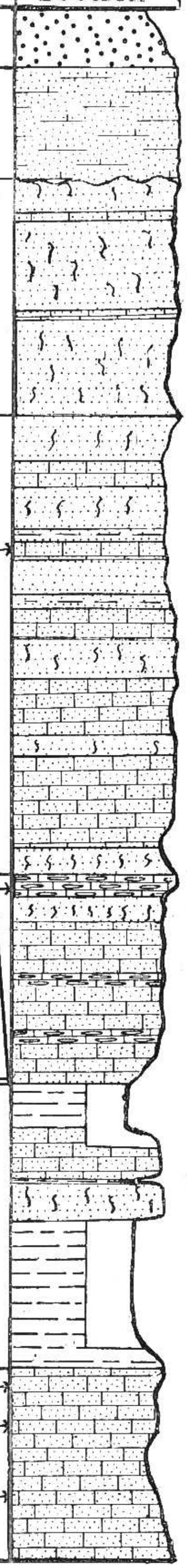


Figure 2, Stratigraphic Column

more cherty, silty, medium bedded limestone which weathers light tan to light gray. The upper one-quarter consists of medium to dark gray, medium to thick bedded, argillaceous, limestone that weathers light to medium gray. In this uppermost sequence some chert is found in the form of nodules and stringers that lie parallel to the bedding. Some of these upper beds contain abundant silicified fossils and are the source of the Great Blue limestone fauna, listed below.

The formation has been firmly established, as is herein substantiated, as being upper Mississippian (Chesterian). Fossils were collected from Brigham Young University localities 10976, 10975, and 10974 as indicated on plate I.

The following faunule was collected from a five foot ledge of slightly arenaceous, medium bedded, medium gray, limestone at locality 10976 located in the N. E. 1/4 of Sec. 17, T. 5 S., R. 1 W.

> _Fenestrella rectangularis_ Condra and Elias
> _Fenestrellina cestriensis_ Ulrich
> _Archimedes terebriformis_ Ulrich
> _Rhomboporella typica_ Bassler
> _Orthotetes kaskaskiensis_ McChesney
> _Chonetes chesterensis_ Weller
> _Kaskia chesterensis_ S. Weller and J. M. Weller

At locality 10975, located in the N. E. 1/4 of Sec. 17, T. 5 S., R. 1 W., the following faunule was collected from a medium to dark blue-gray limestone about 50 feet stratigraphically below 10976:

> _Orthotetes kaskaskiensis_ McChesney
> _Rhomboporella typica_ Bassler
> _Streptorhynus_ ? sp.

At locality 10974, located in Sec. 16, T. 5 S., R. 1 W., the following faunule was collected from a dark blue-gray fossiliferous, limestone which strikes east-west and dips 50° to the north:

> _Rhombopora lepidodroides_ ? Meek
> _Fenestrellina cestriensis_ Ulrich
> _Fenestrella rectangularis_ Condra and Elias
> _Rhomborella typica_ Bassler
> _Chonetes chesterensis_ Weller
> _Dictyoclostus inflatus_ McChesney
> _Sevillia sevillensis_ J. M. Weller
> _Kaskia chesterensis_ S. Weller and J. M. Weller
> _Kaskia_ n. sp.

The Great Blue limestone, near the Manning Canyon shale contact, strikes north 70° west and dips 20° to 25° to the north. Along the outcrop in the N. W. 1/4 of Sec. 16, T. 5 S., R. 1 W. there occur five mappable, high angle faults which probably came into being late in Cretaceous time (Gilluly, 1932, p. 91). In the N. E. 1/4 of Sec. 17, T. 5 S., R. 1 W. a zone of breccia approximately 1000 feet long and 75 to 100 feet wide crops out. This zone trends north 45° west, and near its southward extension it is hydrothermally altered half way through the zone. When R. A. Madsen mapped this zone in 1952, he labeled it as a northward extension of a thrust fault which he mapped to the south of the area.

Mississippian - Pennsylvanian System

Manning Canyon shale -- The Manning Canyon shale, within the area, forms an impressive valley approximately 3000 feet across at the foot of Cedar Point in Secs. 8 and 9 of T. 5 S., R. 1 W. The only outcrops which are visible are those in and around the commercial clay pits and prospects, in which clay of good firing quality is being mined. In these exposures the formation is highly contorted and some beds have been overturned. The average strike of the recognizable beds is north 90° west with dips ranging from 50° to the north to overturned beds which dip 80° to the south. A conservative estimate as to the thickness of this formation would be 1,200± feet.

As a section of the Manning Canyon shale could not be measured in this area, the writer refers to a section measured by Keith W. Calderwood, H. J. Bissell, and Grant Smith on October 14, 1950 on the west side of the Cedar Valley Hills, west side of Lake Mountain, Utah. This is 10 miles south of the Jordan Narrows quadrangle.

The section is taken from Keith W. Calderwood's thesis (1951, p. 63), and is as follows:

"Oquirrh formation. - Orthoquartzite, very fine-grained, dense, buff to medium light brown and reddish, brown, slightly to moderately calcareous; well-bedded in 1/2" to 18" beds, streaked with black argillaceous and possibly manganiferous layers.

Conformable contact.

Manning Canyon Shale:

Bed No.	Description	Thickness in feet
9.	Limestone, shaly, sandy to silty, also calc. sandstones. Limestones are dark blue-gray on fresh surface, weather gray-brown. Sandstones are shaly and weather reddish-brown to flesh-colored.	95'

Bed No.	Description	Thickness in feet
8.	Base of a ledge of mudstones, argillaceous calcareous shales, sandy and silty limestones, silstones, and inter-bedded orthoquartzites. Numberous reed (?) impressions, mud-cracks, and other indications of shallow-water environment. Upwards in this unit are limestones, dark blue-gray, brown sandy rough-weathering, with shaly fragments and sub-graywacke-like limestone overlying them, these in turn overlain by shaly limestones, dense black, but which weather pink and lavender.	173'
7.	Shale, especially at base, giving way upwards to shaly limestone. Shales are tan, yellow-brown, buff and tan, some are dark gray. Limestones are dark gray, weather pale blue-gray to gray-blue. Some dense banded orthoquartzites, flesh-colored to reddish-brown (on weathered surface) is present	139'
6.	Medial limestone of the Manning Canyon: consists of limestone, dark gray to medium dark-gray, dense, hard, weathers pale somber-gray to gray-blue and light to light medium-gray; nonfossiliferous in lower part, but contains few brachiopods in upper part, well-bedded in 4" to 4 feet beds, acerage 18" to 24".	93'
5.	Series of arkosic orthoquartzites, subgraywackes, orthoquartzites and chloritic to micaceous shales, grit, and arkose. (This unit represents a sharp change in facies and may likely represent the Mississippian-Pennsylvanian contact.)	128'
4.	Shale, brown, red-brown, purplish-brown, containing lingulid brachiopods: soft, argillaceous clay shales. Some beds contain seams of calcite and gypsum. Some yellow, ochre, and limonite-stained shales are present: most beds in this unit are clay shales.	92'
3.	Base of ledge of scintillating brown-weathering, gray, pink and flesh-colored orthoquartzites: seamed with white quartz. Well bedded in 6" to 2' layers. Arkosic in part, locally cross-bedded	94'
2.	Top of black shales, base of a semi-slope of scintillating very dense, hard, very fine-grained orthoquartzite,	

Bed No.	Description	Thickness in feet
	flesh-colored to tannish-gray, with much white quartz seams and small veinlets, with interbedded black shale similar to the underlying shales	140'
1.	Base: consists of shale, brown and black, fissile, and interbedded 1 - 3" beds of dense black siliceous lime-stone. All beds weather black and very dark brown. Some siliceous ironstone concretions are present, and weather brown, are confined to the shales	176'
	Total	1130'

Conformable contact.

Great Blue limestone. - Upper part consists of massive limestones containing abundant chert nodules."

Calderwood's units 5, 6, and 7 coincide with the recognizable outcrops of quartzite, limestone and shale at the Clinton clay deposit in Sec. 9, T. 5 S., R. 1 W. It is this orthoquartzite, which in this area is dark brown and scintillating, along with the Medial limestone member, that forms the more resistant elongated ridge in the center of the valley. The shales that are mined for the clay at this deposit are stratigraphically just above the Medial limestone. The mined shale is pinkish-red to reddish-brown but changes color to a black to dark brown about 50 feet down the dip, thus limiting the depth of the prospect.

No fossils were found in this formation by the writer, but Lepidodendron was reported to have been found in the shales within the Medial limestone member by Richard Moyle (personal communication). According to the above measured section the Mississippian-Pennsylvanian contact is at least this low in the section, and could be as low as the above mentioned scintillating orthoquartzite.

The Manning Canyon shale lies conformably on the Great Blue limestone and is overlain conformably by the Oquirrh formation. Both contacts, however, are obscured by lake and alluvial deposits in the area mapped.

Pennsylvanian System

Oquirrh formation -- The Oquirrh formation was named by Gilluly (1932, pp. 34-35) for a thick sequence of alternating limestones and sedimentary quartzite which are in excess of 15,000 feet in the Oquirrh Range. This formation is reported to be 26,000 feet thick in the Wasatch Range (Baker, 1947), of which 16,200 feet is assigned to the Pennsylvanian and 9,800 feet to the Permian (Bissell, 1952, p. 581). The Oquirrh formation represents by far the thickest stratigraphic unit in the quadrangle. All of the Paleozoic sediments that are exposed in T. 4 S. and in Secs. 4, 5, and 6 of T. 5 S., 1 W. are Oquirrh sediments. This represents about three-quarters of all the area in which Paleozoic sediments crop out. The best exposure of the Oquirrh formation in the quadrangle is on Cedar Point in Sec. 5, T. 5 S., R. 1 W. This also is the location of the measured section, contained in the appendix. The formation is cut off abruptly at the breccia zone to the northeast of Cedar Point. This breccia zone strikes north-south and dips 50° to the east, while the beds at this point strike approximately east-west and dip 60° to the north.

The writer was able to divide the thick sequence of Oquirrh, which in this area is over 3,767 feet, into three mappable units on the basis of lithologic breaks and similarities with adjoining areas. The lower, Morrowan limestone series has been recognized by the work done by Blair Maxfield (1957, p. 38), but the upper two divisions were distinguished by their similarities to the lithology of the respective Atokan and Desmoines series in the Oquirrh and Wasatch Ranges. The Atokan series being the sandy limes and orthoquartzites above the Morrowan, and the Desmoines series being the upper most sequence of predominant quartzites.

The Morrowan rocks form an outcrop pattern approximately two miles long, around the base of Cedar Point, where they form the first limestone ledges north of the valley formed by the Manning Canyon shale. The series is cut by two high angle faults in Secs. 4 and 5, T. 5 S., R. 1 W. The larger of the two, in Section 5, has at least 200 feet of displacement, with the down faulted block on the east. The measured section that was completed by Blair Maxfield in 1954 (see appendix) in this locality, reveals a thickness of 854 feet of Morrowan Rocks. A small outcrop of Morrowan rocks at the western tip of the East Traverse Range was identified as Morrowan by its fossil content and also by its similarity with the lithology of Maxfield's uppermost cherty limestone unit.

The lithology of the Morrowan series is mostly medium to dark gray, argillaceous, medium to thick bedded, cherty, limestones with some interbedded sandy limestone that weathers light tan. Fossil collections were made at localities 10973, 10972, 10971, 10970, 10969, 10968, and 10967 respectively (see plate I).

Collection 10973 is located at the western tip of the East Traverse Range in the NE 1/4 of Sec. 24, T. 4 S., R. 1 W. It was taken from a medium gray, thin to medium bedded, cherty, limestone that is interbedded with sandstone. This cherty limestone bed serves as a traceable unit, and, because of its similarity stated above, is tentatively designated as upper Morrowan. This bed has been overturned as a result of the fault east of the outcrop. The collected faunule is as follows:

Composita ozarkana Mather
Punctospirifer kentuckyensis Dunbar and Condra
Neospirifer cameratus ? Dunbar and Condra
Derbyia crassa Waagen
Linoproductus ovatus Hall

Locality 10972 is in the West Traverse Range. The faunule was collected from a light to medium gray, chery limestone that is very fossiliferous. The following were identified:

Fistulipora incrustans Moore
Stenopora sp.
Rhompopora lepidodendroides Meek
Derbyia crassa Waagen

At locality 1091 the collection was taken from a limestone that is dark gray and fetid on a fresh break but weathers light gray. The bed is between two brown well cemented quartzites. The faunule is as follows:

Rhomboporella typica Bassler
Ameura ? n. sp.
Streptorhynus ? sp.

Fossil collection 10970 was taken from the same horizon as 10972 only along strike about a half a mile to the west. Its faunule is as follows:

Derbyis crassa Waagen
Rhombopora lepidodendroides Meek

At locality 10969 the field sample taken from a light to medium gray argillaceous limestone revealed only fragments of brachiopods and crinoids. However, the bed below the locality collected from contained

Lophophyllidium ? sp.

Locality 10968 was taken from a bed of light gray-weathering, crinoidal, limestone from which the foraminifera

Millerella sp.

was identified by Dr. J. K. Rigby.

At locality 10967 the following faunule was identified:

Derbyia crassa Wasgen
Punctospirifer kentuckyensis Dunbar and Condra
Neospirifer cameratus ? Dunbar and Condra
Rhomboporella typica Bassler
Ameura sangamonensis Weller
Lophophyllidium ? sp.

The Atokan series, 1913± feet thick where measured in Sec. 5, T. 5 S., R. 1 W., is designated as such, by its lithic similarities with the measured sections of the Atokan within the Oquirrh and Wasatch Ranges. These sections were measured by J. K. Rigby, John Carter and the writer in 1955 in the Oquirrh Mountains north of the town of Ophir, and by H. J. Bissell in the Strawberry Valley Quadrangle in 1952 (P. 585) on the eastern fringe of the Wasatch mountains. The Oquirrh Mountain section totaled 946 feet of medium to light gray, medium bedded limestones with some chert interbedded with light b own quartzite. The Strawberry Valley section measured 3,000 feet of arenaceous, cherty, limestones with interbedded orthoquartzites. (See fig. 3.)

The Atokan outcrop pattern in the West Traverse Range is "S" shaped, due to a change of strike in the northern part of Sec. 5, T. 5 S., R. 1 W., and again in the southern part of Sec. 32, T. 4 S., R. 1 W. The series also crops out above the Morrowan rocks in the East Traverse Range as beds which are overturned along the fault that was traced through the SE 1/4 of Sec. 13, T. 4 S., R. 1 W. The beds now strike north 10^{o} west and dip 50^{o} to the west. The beds to the east of the fault strike north 10^{o} west but dip to the east.

The Atokan rocks consist of intercalated and lentincular beds of reddish-brown sandstone, orthoquartzite, which is cross-bedded, and medium to dark gray, sandy, clastic limestones that weather light to medium gray. Some of the light gray weathering rock, which appears to be a clastic limestone in the field, should rightly be called a calcareous sandstone. A sample of this type of rock was collected near the fault in Sec. 13, T. 4 S., R. 1 W. and thin sections were studied under the microscope. Over 80 percent of the sample is made up of well rounded sand grains that are cemented by a calcareous material. Some fragments of crinoids and brachiopods are included.

Fossils were collected by the writer at locality 10966 from a medium to thick bedded, medium gray, arenaccous limestone that contained the fusulinid

Profusulinella sp.

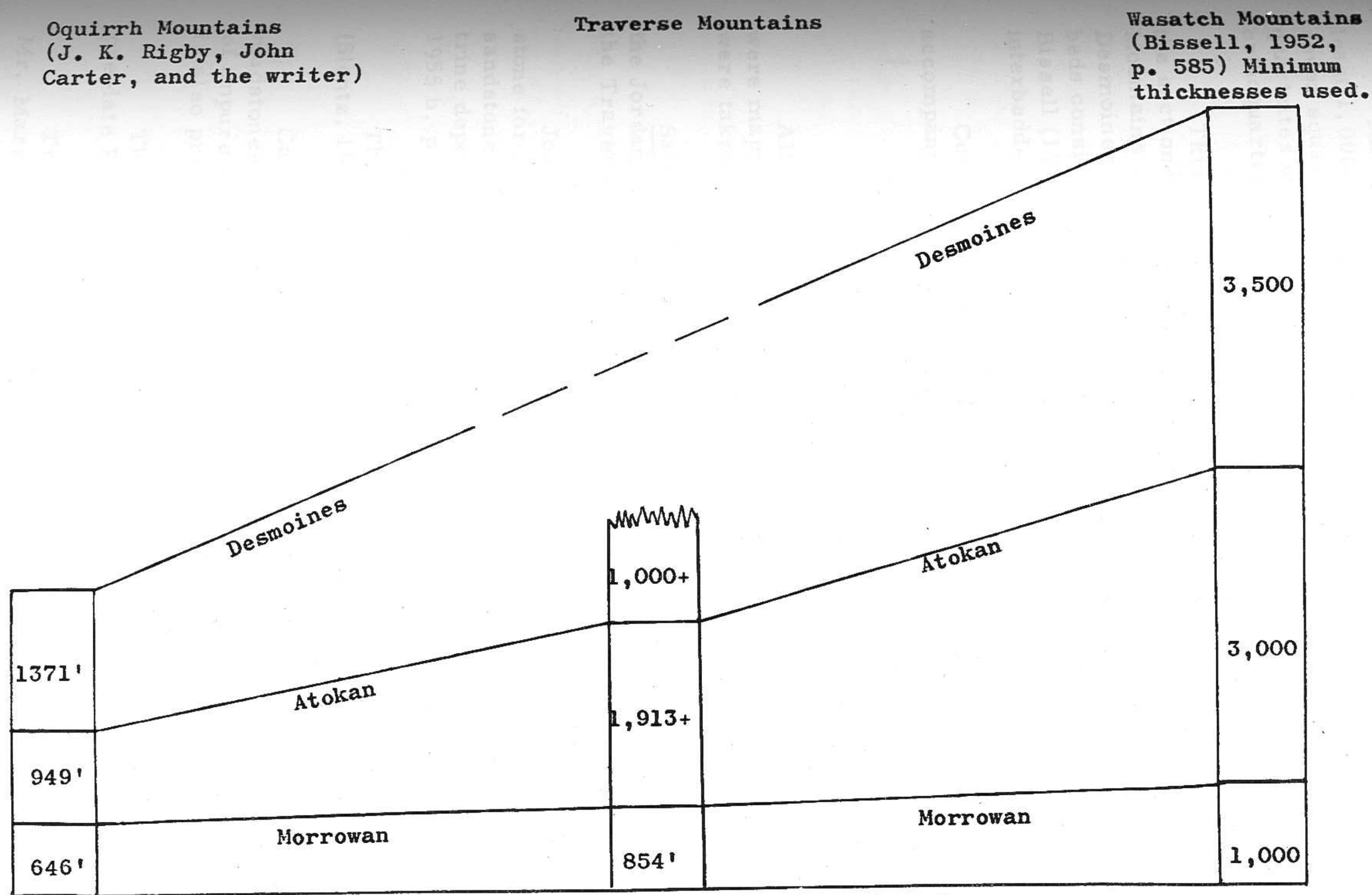


Figure 3, showing Oquirrh formation Correlation

An incomplete section of the Desmoines series, composed of at least 1,000+ feet, as calculated by photogeologic methods, crops out as seven square miles of highly jointed beds of light to reddish-brown quartzites with few recognizable interbedded limestones. Some of these orthoquartzites show excellent cross bedding.

This series is correlated on the basis of its lithic similarities to the sections, above mentioned, measured in the Oquirrh and Wasatch Mountains. The writer, with others, in 1955 measured 1,371 feet of Desmoines rocks near Ophir, Utah in the Oquirrh Mountains. These beds consisted mostly of quartzite with interbedded limestone. H. J. Bissell (1952, p. 585) measured 3,500 feet of orthoquartzites with some interbedded limestones in the Strawberry Valley Quadrangle to the east.

Correlation of these three measured sections is found on the accompanying correlation chart (fig. 3).

Tertiary System

All of the sedimentary rocks of Tertiary age included in this report were mapped by L. W. Slentz in 1955, and the brief descriptions of each were taken from his thesis.

Salt Lake group -- The Salt Lake group is composed of four units; the Jordan Narrows unit, with three mud flows, the Camp Williams unit, the Travertine unit, and the Harkers fanglomerate unit.

Jordan Narrows unit -- The Jordan Narrows unit is a white marlstone for the most part with oolitic, argillaceous, and cherty limestones, sandstones, clays and rhyolitic tuffs. These are all fresh water lacustrine deposits. Its thickness is unknown but exceeds 300 feet. (Slentz, 1955 b, p. 25).

The upper age limit put on this unit by Slentz is mid-Miocene (Slentz, 1955 a, p. 16).

Camp Williams unit -- Lithologically it is composed mostly of mudstones and siltstones that are poorly consolidated and lesser amounts of impure sandstone. A basal conglomerate primarily of igneous detritus is also present. The unit measures 100 feet thick.

The age of this unit can be dated only as post-early Oligocene and pre-late Pliocene (Slentz, 1955 b, p. 26).

Travertine unit -- For description of this unit, Dr. Slentz quotes Mr. Marsell (1932, p. 51) as follows:

"The rock in hand specimen varies from dense, massive, flinty travertine to coarse, crustiform, or even cavernous, limestone, often resembling tufa. The color is white or pale cream. The rock is harder and resists weathering better than the Pliocene marlstones, which it superficially resembles. The hot springs which built up the travertine deposits also formed lens-like masses and veins of manganese ore."

The Travertine unit overlies both the Camp Williams and Jordan Narrows units. It ranges in thickness from 20 feet or greater to a very thin veneer.

Its age has been well established as late Pliocene by the identification of a jaw bone and teeth found by Mr. Marsell in 1932 (Slentz, 1955 b, p. 27).

Harkers fanglomerate unit -- Fanglomerate, poorly consolidated except for local lenses. Torrential bedding and cut-and-fill structures are common. The overall color is gray and the cement and martrix tuffaceous.

In the Jordan Narrows proper the unit is in fault contact only with the Camp Williams unit. Its thickness is unattainable in this area, but in its type locality in Harkers Canyon, it is 300 feet thick (Slentz, 1955 b, p. 28).

Mud Flows -- Three mud flows appear in the area (see plate I). They are made up of from 10 to 20 feet of volcanic detritus ranging from fine sands to boulders several feet in diameter. They are labeled on plate I as Tmrf-1, Tmrf-2, and Tmrf-3.

The flow is postulated as taking place within the Jordan Narrows unit (Slentz, 1955 a, p. 22).

Quaternary System

The Quaternary geology of northern Utah Valley that is contained within plate I was done by C. B. Hunt, except in a few places where the writer extended the work into areas not included in Hunt's map. Complete descriptions are found in U. S. Geological Survey Professional Paper 257-A (1953), which Hunt co-authored with H. D. Varnes and H. F. Thomas.

Only brief descriptions of the units shown within the mapped area will be given herein.

Pre-Lake Bonneville deposits (Pleistocene) -- The pre-Lake Bonneville fans along the south side of the Traverse Mountains are composed of poorly sorted materials, angular boulders, cobbles are both igneous and sedimentary with the latter being mainly fragments of the adjoining Oquirrh formation.

Gilbert recognized that the fans were pre-Lake Bonneville (Gilbert, 1890, pp. 220-222) because the lake has impressed its shore mark on those fans that rise above the high-water mark of the lake (Hunt, 1953, p. 14).

Lake Bonneville group -- The Lake Bonneville group is composed of three units; the Alpine formation, the Bonneville formation, and the Provo formation.

Alpine formation -- The Alpine formation is the oldest of the Lake Bonneville group and around the sides of the valley it overlaps onto the pre-Lake Bonneville fans.

> "The formation contains a high proportion of fine-textured sediment mostly silt. Sorting is excellent; the bedding is very distinct and in the finer-grained sediments individual beds commonly are only a fraction of an inch in thickness. The upper part of the formation is light gray but it is horizontally striped by thin beds that are rusty colored; the lower part of the formation is somber gray." (Hunt, 1953, p. 17.)

On the basis of prevailing texture the formation is divided into three members the gravel member, the sand member, and the silt and clay member (Hunt, 1953, pp. 17-20).

> Bonneville formation -- "The Bonneville formation includes those deposits that accumulated in the lake during its highest state, the stage that Gilbert (1890, pp. 93-125) referred to as the Bonneville stage."
>
> "This stage, however, is barely represented as a stratigraphic unit in the lake sediments. The Bonneville formation has been recognized only as a thin and discontinuous beach deposit along the high shore line and in a spit at the Point of the Mountain. Elsewhere in the valley, the formation has not been recognized and beds assigned to the Provo formation rest directly upon the Alpine formation." (Hunt, 1953, p. 20.)
>
> Provo formation -- "Most of northern Utah Valley is covered by the Provo formation, which includes the deposits that were laid

down while Lake Bonneville stood at what Gilbert (1890, pp. 126-134) called the Provo stage. The formation is divided into four members distinguished by their prevailing texture -- gravel, sand, silt, or clay." (Hunt, 1953, p. 21.)

Post-Provo deposits (Pleistocene (?) and Recent) -- These include the flood plain materials and alluvial fans such as the fan at Lehi that was built by Dry Creek on the lake-bottom clay or silt beds belonging to the Provo formation (Hunt, 1953, p. 29).

IGNEOUS ROCKS

Volcanic material covers approximately 8 square miles of the area mapped including the north-eastern half of the West Traverse Range in Secs. 16-22, 27-29, 32-33, T. 4 S., R. 1 W., and the western half of the Beverly Hills in Secs. 7 and 18, T. 5 S., R. 1 W. These volcanic flows were poured out onto an undulating topography and accumulated in some places to a thickness exceeding 255 feet. Within the mapped area there are two recognizable flows, plus an area of volcanic breccia in the south-west part. The oldest flow, a light colored latite, is seen throughout the area only as large cobbles and boulders that were engulfed in the basal section of the later flow, andin small exposures near the contact of the volcanic rock with the Paleozoics in Secs. 29 and 32, T. 4 S., R. 1 W. The second flow, an iron stained latite, is far more extensive and covers the greatest part of the 8 square miles. A volcanic breccia crops out in the southern part of Sec. 7, T. 5 S., R. 1 W. and includes fragments of the two earlier flows as well as pieces of Paleozoic sediments.

These igneous rocks have been studied in previous investigations by Gilluly (1932), Marsell (1932), and K. C. Bullock (1951).

Gilluly (1932, p. 57) gives the following description from the Fairfield quadrangle, which lies adjacent to the Jordan Narrows quadrangle on the west:

> "Most abundant lava in the Fairfield quadrangle is biotite-hornblende latite. In thin-section plagioclase is seen to be faintly zoned ($Ab_{70}An_{30}$). The principle mafic mineral is hornblende of basaltic variety. Most commonly the groundmass is hyalopilitic."

In describing the igneous rocks of the Traverse Range, Marsell (1932, p. 63) states:

> "In thin-section the andesite is coarsely porphyritic. The chief mineral is oligoclase with a composition of $Ab_{72}An_{28}$. The feldspar shows prominent zonal growth. Biotite is the chief femic mineral accompanied by smaller amounts of hornblende and augite. All of the minerals have been considerably altered, the ferromagnesian in particular."

The writer collected samples of the two main flows and DeVerle P. Harris identified them microscopically as follows:

"The oldest flow has a texture that is porphyritic with phenocrysts ranging from 2 to 10 mm. in size. Essential minerals are andesine, which displays good carlsbad and albite twinning, orthoclase in small amounts, hornblende, and biotite. The only accessory mineral found was magnetite. It occurs as small phenocrysts and is fairly abundant. The matrix is too fine-grained to lend itself to description from thin-sections. The flow is classified as a porphyritic andesite on the basis of its essential and accessory minerals that appear as phenocrysts."

"The later iron stained flow is red to purple in color with white to cream colored phenocrysts. Its texture is porphyritic with an aphanitic groundmass. The phenocrysts measure from 1 to 10 mm. in size. Essential minerals are andesine with its twinning, some orthoclase, altered biotite, and amphibole with magnetite inclusions. It is probable that the amphibole is basaltic hornblende (lamprobolite). Accessory minerals within the rock are magnetite and hematite. The matrix is too fine-grained to lend itself to identification but is heavily stained with secondary Fe_2O_3. This staining, however, does not seem to affect the phenocrysts. The rock is identified as a porphyritic andesite."

As seen from the above identifications, microscopic study alone suffices to classify the flows as andesites, but chemical analysis demonstrates that the potassium oxide equals or exceeds the sodium oxide, and should, therefore, be classified as latities. Following is a chemical analysis from Bullock (1951, p. 32):

"Partial analysis of latites from Central Utah, and an average latite."

	1	2	3
SiO_2	62.53	61.09	57.65
CaO	4.61	4.70	5.74
Na_2O	3.59	3.00	3.59
K_2O	2.85	3.77	4.16

1. Biotite-hornblende latite from the Beverly Hills - Erma Chadbourn, analyst.
2. Augite-biotite-hornblende latite from Oak Spring Canyon, Fairfield Quadrangle -- J. G. Fairchild, analyst. Gilluly, U.S.G.S., Prof. paper 173, p. 46, 1932.
3. Average latite. Daley, R. A., Igneous Rocks and the depths of the Earth, p. 13, New York, 1933."

Most of the lava throughout the area is deeply weathered and altered considerably. In some hand specimens flow-structures are visible.

The source of the flows in the mapped area are generally believed to be from Step and South Mountains, which are located near the junction of the Traverse and Oquirrh Ranges. These mountains represent the only recognizable vents in the vicinity.

From the available evidence in the surrounding areas given by Gilluly (1932), Bullock (1951), and Slentz (1955) the age of this volcanic activity can not be narrowed down to one specific epoch. The fact that they were being extruded during a prolonged period of time is evidenced by the extensive area which they covered, as it seems certain that they covered all the Traverse Range as well as parts of the Oquirrh and Wasatch Ranges. The maximum age limits placed on the igneous activity by Dr. L. W. Slentz (1955 b, p. 32), are latest Eocene to late Miocene. This is based on his studies of the contemporaneous Jordan Narrows unit discussed earlier.

STRUCTURE

General Statement

The Traverse Range has been involved in several phases of the Laramide orogeny, as well as the Basin and Range disturbance. The chief structural elements, folds, questionable thrusts, and normal and high angle faults, plus the possible presence of an ancient erosion surface indicate the area has been subjected to intense diastrophism. Major thrust faults, as have been mapped in the adjacent Wasatch Mountains to the east, were not in evidence at the surface in the Jordan Narrows quadrangle. The brecciation of the Paleozoic rocks, however, suggest that such thrust faults might be found at shallow depths beneath the East Traverse Range. The relationship of the area to surrounding areas is shown on figure 4. The structure of the area will be approached by discussing it in three parts; the structure of the West Traverse Range, the structure of the East Traverse Range, and lastly a section on the relationship between the two.

West Traverse Range

Folds -- The strata composing the West Traverse Range are the eastward most expression of the large northwest trending anticlines and synclines of the Oquirrh Mountains. The folding, however, must have been more intense in this area than in the more gentle asymmetric folds of the Bingham syncline, as evidenced by the overturned beds that occur in the Fairfield quadrangle adjacent to the mapped area (see fig. 4). These overturned beds form the northeast limb of an overturned anticline which trends northwest parallel with the larger folds, and terminates on the north at South Mountain (Gilluly, 1932, plate 12). As this limb is traced southward towards the mapped area the strata change direction of dip from southwest dipping beds that are overturned to vertical to northeast dipping beds that are in normal sequence. Within the Jordan Narrows quadrangle, along the ridge northwest from Cedar Point, this limb dips to the northeast and has a normal sequence of Morrowan rocks at the base, overlain by the Atokan series.

The nose of another anticline is seen in Sec. 5, T. 5 S., R. 1 W., where the beds change dip to a westerly direction. This nose, however, is not large and its areal extent is questionable.

The rocks within the mapped area a mile north of Cedar Point in T. 4 S. strike east-west and dip steeply to the north with the exception of

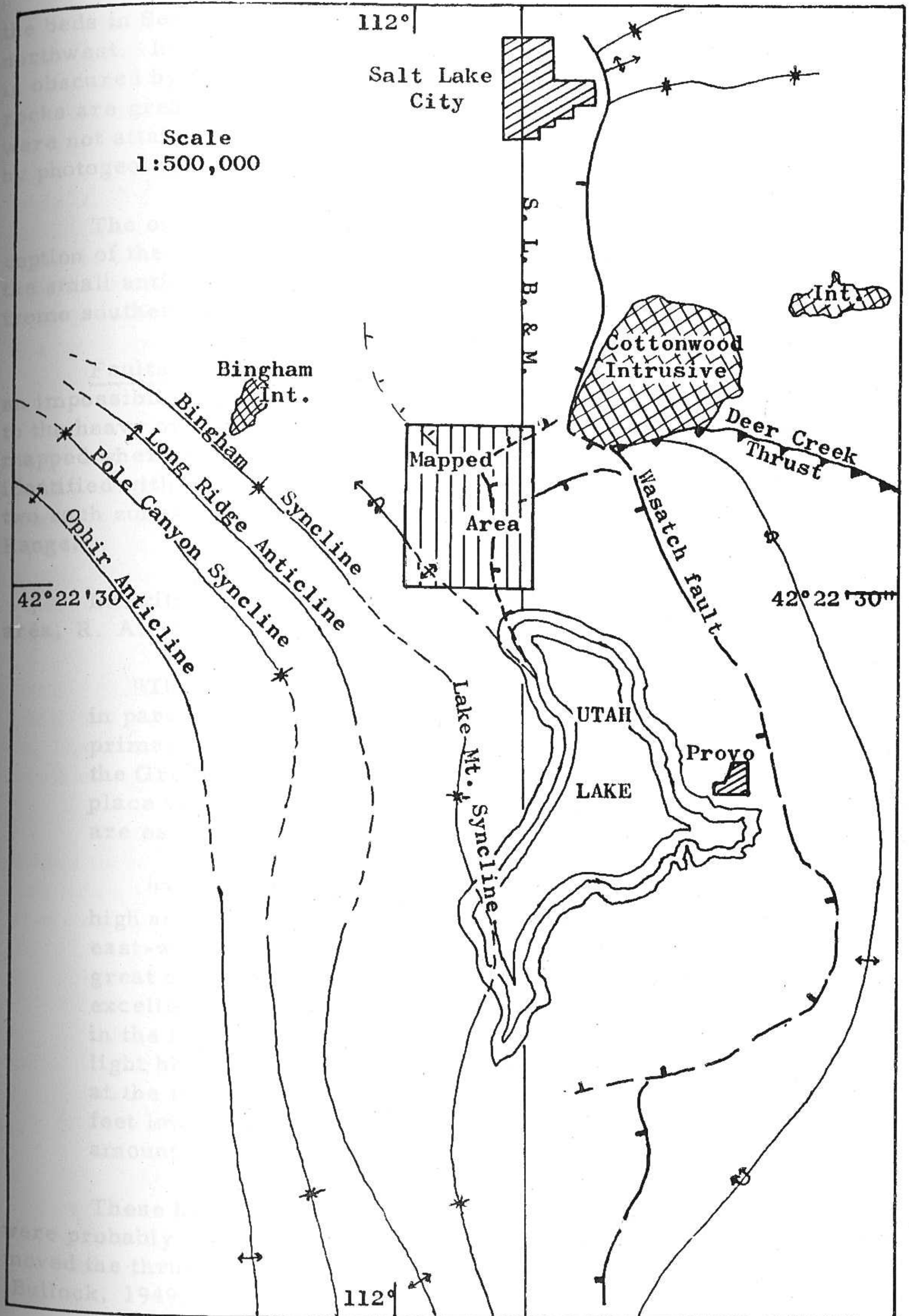


Figure 4. Tectonic Map of Central Utah (Revised from Bissell 1953)

the beds in Sec. 18, T. 4 S., R. 1 W. where they strike northeast and dip northwest. In the northern part of the West Traverse Range the structure is obscured by the covering of latite which blankets the area. All of the rocks are greatly shattered and jointed so reliable dip and strike figures were not attainable in many places. Approximate values were arrived at by photogeologic work in the laboratory.

The only other fold within the West Traverse Range, with the exception of the tight contorted folding within the Manning Canyon shale, is the small anticline that is formed by the Great Blue limestone in the extreme southern part of the map.

Faults -- To map all of the minor faults within the range would be an impossibility. This is due to the extreme jointing within the beds and to the heavy overburden in the interior. The main faults, however, were mapped where recognized, and zones of brecciation that could not be identified with a type of fault were mapped as distinct zones. There are two such zones represented on plate I connected with the West Traverse Range.

In writing about the high angle faults that occur in the Beverly Hills area, R. A. Madsen says the following (1932, pp. 32-33, figs. 13-14):

> "There are several high angle faults in the area which are in part covered by younger sediments and their existance is known primarily from the dislocation of a prominent cherty limestone in the Great Blue formation which was used as a key bed. In every place where evidence is found, the faults are very high angle and are essentially parallel, trending about north 30° west."

> "The most evident fault, and probably the largest one, is a high angle reverse fault which crosses the east end of the long east-west trending Great Blue limestone ridge. There is a great amount of brecciation in this area, and also there are excellent slicken sides. Intense silicification has taken place in the limestones along the fault. The same slabby, dense, light blue and brown laminated limestone that is displaced at the top of the ridge can be found approximately two-hundred feet lower, thus indicating a throw equivalent to at least that amount."

These high angle faults, described above, dip towards the west and were probably caused by compressive forces of the Laramide orogeny that moved the thrust sheets, known to be in the surrounding areas, to the east (Bullock, 1949, p. 49).

In the extreme southern part of the map an inferred fault is traced from Saratoga Springs, which is located south of the area. This fault represents the western margin of the Utah Valley graben and terminates the pediment which extends out from Lake Mountain (see fig. 5).

Another interesting structure on the west side, is that portrayed in Secs. 7 and 8 T. 5 S., R. 1 W. by the "S" shaped pattern of the Oquirrh formation and Manning Canyon shale. One possible explanation for this could be that it is the result of an eastward thrust movement. This would explain the high angle reverse faults, described above, and contorted beds within the Manning Canyon shale. A thrust fault was mapped in this area by R. A. Madsen (1952).

East Traverse Range

Folds -- The only fold that is discernable in this part of the area is a very tight one formed in overturned beds on the edge of the bedrock exposure in the S. E. 1/4 of Sec. 13, T. 4 S., R. 1 W. The fold can be traced by following the change of strike of an outstanding cherty limestone which crops out at fossil locality 10973 and swings around to Steep Mountain.

This area is so highly shattered and faulted that the author searched a full day and found only one outcrop that a dip and strike could be taken on. Even with photogeologic methods trends could not be recognized. For this reason the writer could not discern any major folds.

Faults -- The number of faults that cut the East Traverse Range is judged to be almost double to that described for the West Range. That is, they are so plentiful that one can pick up a piece of fault breccia almost wherever he chooses. For this reason only the major faults that could be traced are located on plate I. Areas of intense brecciation are located and labeled as distinct zones.

The faults that were traced had no topographic expression, in fact, in places the only way a fault was recognized was by a mylonite zone in the shattered bedrock.

One main fault that was traced is located in Sec. 13, T. 4 S., R. 1 W. This fault trends almost north-south and has a slight west dip. The beds on the west of it are overturned and now dip west and the beds on the east of it dip east. This accounts for the fact that Morrowan fossils were found at the bottom of the ridge in westward dipping beds.

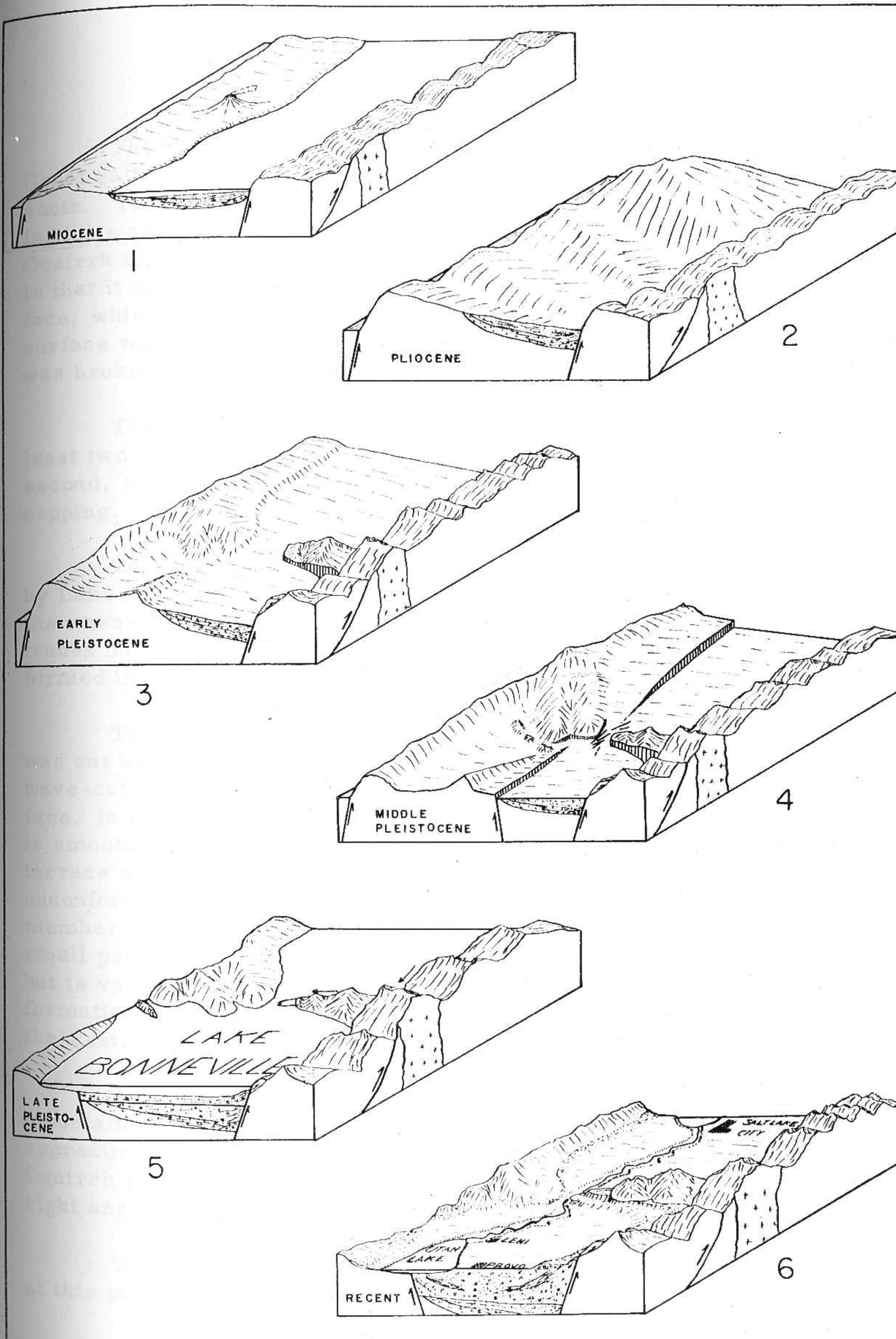
At the Rideout prospect, quartzite gouge is being mined from a definite fault zone, but a trend could not be established from this one outcrop. However, Gilbert (1928, p. 27) described the Range as being bounded by faults on all sides. His conclusion has been supported by later studies, such as the gravity survey made by Dr. K. L Cook and Dr. J. W. Berg, Jr. of the Geophysical department of the University of Utah. By personal interviews with these men, the writer found that their survey was of a general nature and covered Salt Lake and Utah Valleys. Their conclusion was that great amounts of light material, such as that of alluvium compared to bedrock, has accumulated to the immediate north and south of the Range in question. This, plus the fact that the writer was able to trace the bedrock along its strike to the north only as far as the highway, plus the knowledge that the well drilled just to the north of the highway in Sec. 2, T. 4 S., R. 1 W. went 825 feet before bedrock was encountered, plus the presence of the deep tepid lakes near the prison, plus the intense fault breccia exposed around the tip of the Range, could be enough evidence to support Gilbert's original hypothesis.

Correlation of East and West Ranges

In correlating the history of the Ranges, it is not hard for one to conceive that at one time the two were of the same unit and structure. It is the belief of the writer, however, that when the Oquirrh Mountain fault block was tilted 4^{o} to the east (Gilluly, 1928, p. 1121) by "Basin and Range" faulting, the area now occupied by Salt Lake and Utah Valleys continued to subside to form large grabens, leaving the Traverse Range a horst. At this time a graben also formed between the two Ranges leaving them completely separated structurally (see fig. 5).

Slentz (1955) mapped several faults in the Jordan Narrows within the Salt Lake group (see plate 1) which could be merely expressions of the fractures within the bedrock below. The breccia zones on each side of the valley also support this theory.

The conclusion, that the writer comes to is that the two Ranges were of the same structural unit at one time but are now separated by a series of graben faults within the Jordan Narrows.



DEVELOPMENT OF JORDAN NARROWS AREA DURING LATE CENOZOIC TIME
FIGURE 5

GEOMORPHOLOGY

The east-west trending Traverse Range forms the boundary between Great Salt Lake and Jordan Valleys on the north, and Utah Valley on the south. The range is in a late mature stage of erosion, and its low, sprawling hills are in profound contrast with the rugged youthful topography of the Oquirrh and Wasatch Mountains. One possible explanation for this contrast is that it might be a downfaulted remnant of the ancient Weber Valley surface, which was described by A. J. Eardley (1944, p. 853). This ancient surface was formed in Miocene time on the Wasatch hinderland before it was broken by the Pliocene faulting along the Wasatch front (see fig. 4).

The reason that the range stands as high as it does is due to at least two factors; first, the area is structurally a bedrock horst, and second, the area was once covered by lava which formed a protective capping.

Topographically, the most outstanding features are the ones formed by Lake Bonneville at the Alpine, Bonneville and Provo levels. These include the wave-cut terrace and cliff at Steep Mountain, the large spit that protrudes out from the East Traverse Range, and the off-shore bars that are formed in the Beverly Hills area.

The wave-cut terrace, located on the north side of Steep Mountain, was cut by the lake while it was at its Alpine level. It was found to be a wave-cut terrace when the writer mapped the bedrock outcrops along its face. In places of good exposure, one can see that the top of the bedrock is smooth and undulating. The gravels that were later laid down on the terrace during the Bonneville stage are from 75 to 100 feet thick and lie unconformably upon the bedrock. The lowest gravel or conglomerate member allows the water to drain to the face of the terrace and form a small perched water table. Vegetation grows on the moist gravels above but is very sparce on the lower rocky half. The beds of the Oquirrh formation along this terrace strike approximately north-south and dip to the west.

Above the terrace stands Steep Mountain, a steep, smooth faced mountain that trends east-west and whose northern slope is 35°, which is approximately the angle of repose for a talus slope. The highly jointed Oquirrh formation that makes up the mountain strikes north-south, at right angles with the topographic trend.

The reason, the writer believes, for such sharp features to occur at this point, is the fact that the waves which carved the terrace and the wave cliff had the advantage of the full fetch of the lake, plus the east-west longshore current to take the highly jointed materials away as it was eroded.

The spit to the west of the above features was formed as a result of a longshore current that once travelled south and west along the east and south shore-line of the lake. The main body of the spit was undoubtedly formed while the lake was at the Alpine level. Mr. D. J. Jones and Mr. R. E. Marsell wrote the following concerning the spit (Jones and Marsell, 1955, pp. 94-95).

> "The top of the spit is about 45 feet below the high level of the Bonneville shoreline (5,135'), and although Gilbert (1890) and other workers consider it to have been deposited at the Bonneville stage, the present writer believes it is Alpine in age. Lithologically, the deposits consist of alternating layers of coarse sand and gravel, with steep forset dips on the southern end. Dips on the topset layers are toward the southeast, suggesting that the deposit is merely a remnant of a much larger spit which has been largely removed by post-Alpine erosion, and whose axis of deposition lay west of the present spit remnant."

However, inasmuch as the Alpine spit was modified by the higher Bonneville stage, which included both the erosion of and the deposition on the older core, the writer believes it should be mapped in its present form as a Bonneville spit. The spit is well developed with a depression in its center. This same type of depression is also seen in the off-shore bars in the Beverly Hills.

The Provo level, like the Alpine and Bonneville levels, also has made an impression upon the topography. The wave-cut terrace mentioned above is now exposed as a wave-cut cliff of the Provo level. An extension of the above described spit was also formed during this time. These spits are a great potential source of gravel for the surrounding areas.

These features have been made even more outstanding by the erosive action of the Jordan River in the vicinity of the Narrows.

SUMMARY OF GEOLOGIC HISTORY

During the later part of the Mississippian period, the area was under water receiving limy to sandy lime deposits. Towards the end of the period, and through into the Pennsylvanian, the sediments became chiefly clastic, clays and sands with some limes. As land plants are found in these sediments it is supposed that the rate of sedimentation overtook the rate of depression for this period of time.

The Pennsylvanian period began while the above conditions prevailed, but the Morrowan epoch brought a renewed downwarping. The area began to receive limey to sandy limes once again. The seas were shallow and warm, evidenced by the type of fossils found and the interbedded clastic beds along with the sandy limes. The sinking must have been fairly rapid as the area received approximately 26,000 feet of sediments during the period and into the Permian.

Gilluly (1932, p. 91) says this concerning the Pennsylvanian.

> "The Pennsylvanian was an epoch of very marked depression. At first the depression was probably rather slow, although the area was probably always below wave base. Later, despite the deposition of vast amounts of sand, aggregating thousands of feet in thickness, which must necessarily have been laid down rapidly and in a relatively shallow sea, there were interbedded marine lime sediments, which testify to the area having been constantly submerged. This must mean a very rapid depression."

No sedimentary record of the interval between the Pennsylvanian and Tertiary is to be found within the area, but sediments of Permian, Triassic and Jurassic are found 20 miles to the east in the Park City district. This suggests that at least during part of this time the Traverse Range was receiving deposits. It was probably emergent during most of Cretaceous time, however.

At the end of Cretaceous time, or in early Tertiary time, the area was subjected to forces from the southwest, folding the strata into asymmetrical northwest trending folds. A certain amount of thrusting took place at this time. (See fig. 6.)

After the erosion had dissected the folded rocks into a mountainous topography, volcanism ensued, probably in Eocene time, and the entire

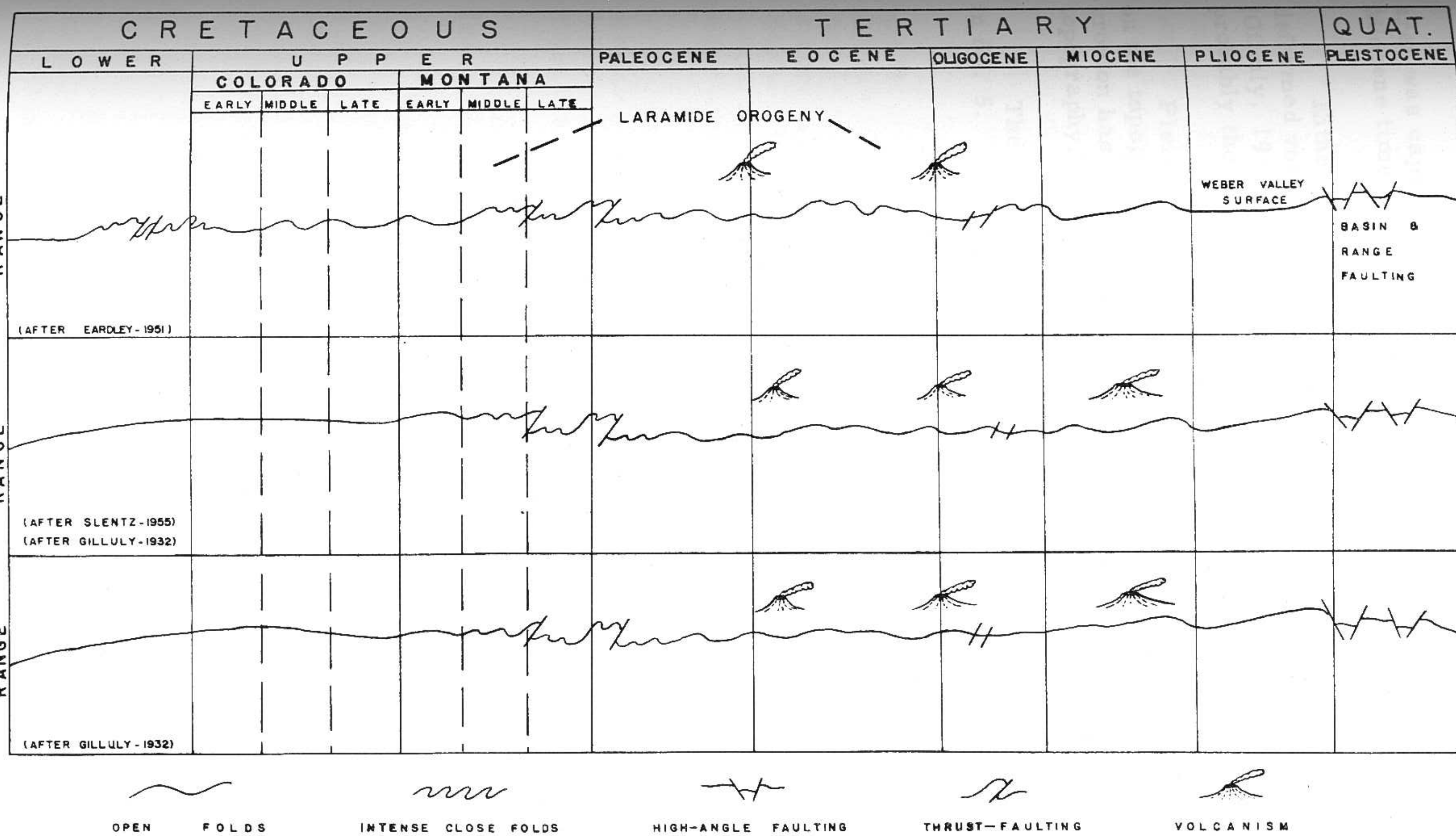


FIGURE – 6

GRAPHIC SUMMARY OF THE OROGENIC HISTORY OF THE WASATCH, TRAVERSE, AND OQUIRRH RANGES area was capped by the latite flows. This volcanism continued until late Miocene time (Slentz, 1955 b, p. 32).

Either in late Miocene or in the Pliocene epoch, according to the deformed volcanics, faulting began which has continued to the present day (Gilluly, 1932). It is this later faulting, the writer believes, that was probably the greatest cause for the shattering of the rocks within the area.

Pleistocene time brought in Lake Bonneville which had its effect on the topography throughout the area. Since the lake disappeared stream erosion has carved the Jordan Narrows and modified the previously formed topography.

The development of this area during Late Cenozoic time is shown in fig. 5.

ECONOMIC GEOLOGY

Clay

A great deal of interest has been placed in the economic possibilities of mining the clays from the Beverly Hills area. Trenches and shafts have been cut throughout the valleys where the Manning Canyon shale is known to be present.

The two clay pits within the area are the Clinton and Allred deposits. The Clinton deposit is located about five miles west and two miles north of Lehi, Utah, in Secs. 8 and 9, T. 5 S., R. 1 W., S. L. B. M., and is operated by the Utah Fire Clay Company of Salt Lake City, Utah.

The pit has been in operation for 50 years. It is one of the largest deposits currently being worked in Utah County, and the pit itself is approximately one-half mile long and 50 to 100 feet wide. The clay-shale which is mined along its strike, is exposed only in the pit, mostly along the floor and at the ends where the current excavation is going on (Hyatt, 1956, p. 37). Since 1904 there has been an estimated average annual production of 12,500 tons, or a total production of more than one-half million tons.

The clay is obtained from vertical to near-vertical Manning Canyon shale beds that are stratigraphically just above the Medial limestone member. Both open pit and underground mining methods have been utilized, although the major tonnage has come from the former method.

The chief use of the clay from this locality is for the making of brick. Two minor uses are hollow brick tile and flue liners.

The Allred deposit is located in the S. W. 1/4 Sec. 9, T. 5 S., R. 1 W., S. L. B. M. and is about six miles west of Lehi, Utah. It is owned by Mr. Aaron Allred of Lehi, Utah, but is leased by the Interstate Brick Company.

The pit is located stratigraphically in the Manning Canyon shale near its contact with the Great Blue limestone. "The clay material in this deposit is gray, soft, plastic, non-calcareous, and has obscure bedding." (Hyatt, 1956, p. 37.)

The clay face is exposed on the west side of a small pit about 50 feet wide and 100 feet long. The Allred deposit has not been worked for some time.

Gravel

The deposits of gravel that are presently being mined within the area are located at the Point of the Mountain in Secs. 13, 23, and 24 of T. 4 S., R. 1 W. These deposits are owned by five separate concerns. The relative positions of these properties to each other are shown in fig. 7. Reserves for the area approach a billion cubic yards. The gravel is used for road building and for various construction uses such as in concrete.

The source of the gravel is from a spit formed by the longshore current action of Lake Bonneville.

Water

Two water wells have been drilled within the quadrangle. They are located in Secs. 2 and 10, T. 4 S., R. 1 W. and of the two only the one in Section 10 produces water. The other, a dry hole, bottomed in bedrock at a depth of 825 feet. Its log is as follows:

Well located at a point North 400 feet and West 1,280 feet from the Northwest corner, section 12, T. 4 S., R. 1 W., S. L. B. M.

Depths in Feet	Log
0- 3	Top Soil
3- 82	Blue Clay
82-119	Hard Pan and Sand
119-135	Gray Hard Pan
135-200	Conglomerate
200-205	Gray Clay
205-248	Conglomerate and Gravel
248-309	Conglomerate
309-340	Gravel, Little Water
340-397	Sand and Gravel
397-427	Sand and Gravel
427-463	Gravel and Clay
463-503	Gambo Clay
503-552	Sticky Clay
552-582	Sand and Clay
582-603	Sticky Clay
603-665	Gravel and Clay
665-707	Sticky Clay
707-722	Clay and Gravel-End Pipe
722-825	Bed Rock

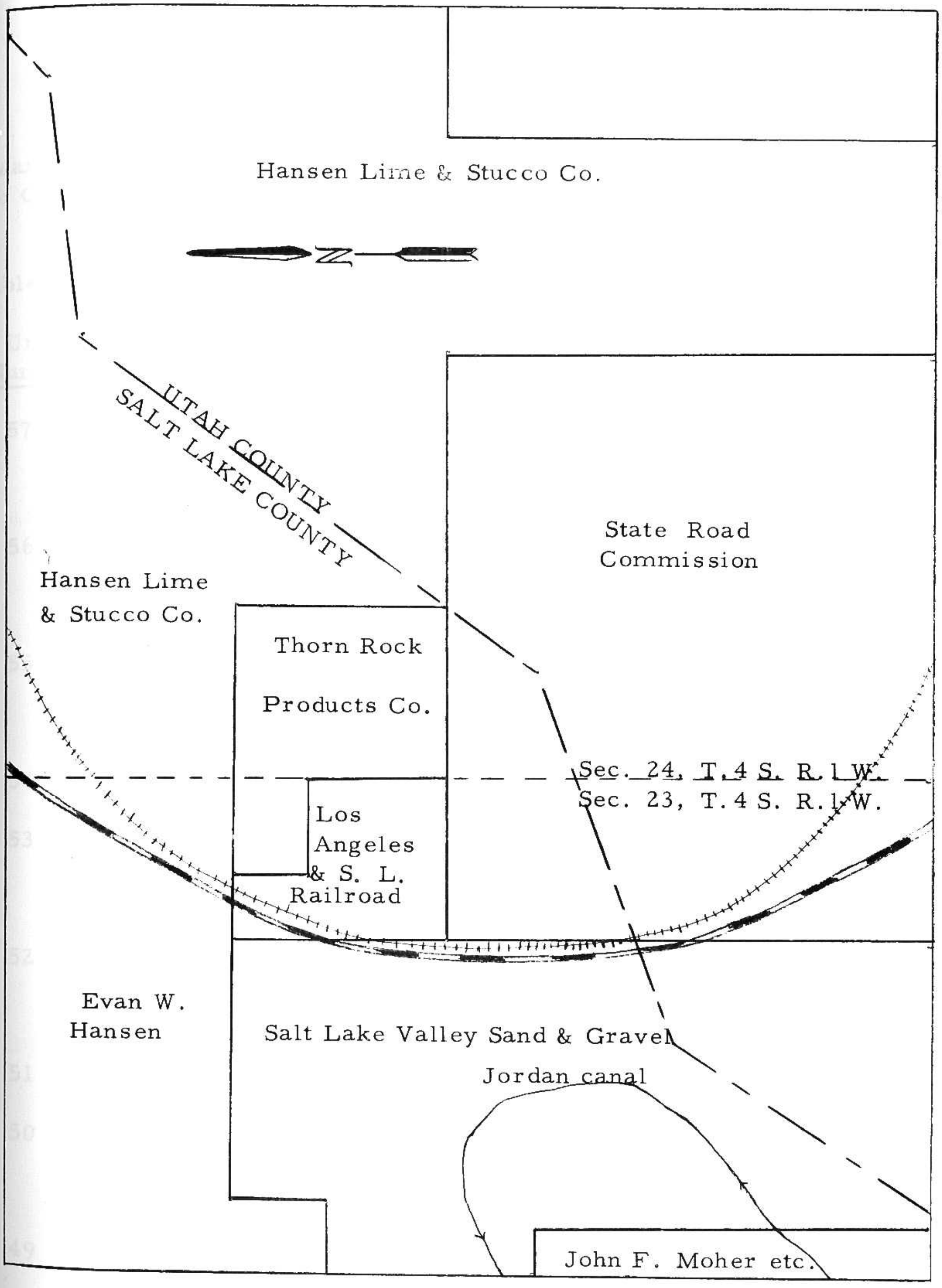


Figure 7, Position of Property Holdings at Point of Mountain, May, 1957

APPENDIX

The following is the section of Morrowan rocks measured by Blair Maxfield and John Jones on the 12th of December, 1954, on the south side of Cedar Point in Sec. 5, T. 5 S., R. 1 W. (after Maxfield, 1957, p. 38).

Atokan series - Brown to tan, cross-bedded, quartzite, in conformable contact.

Unit Number	Description	Thickness	Accumulative Thickness
57	Limestone; cherty, thick bedded, light to medium gray. The bed forms a prominent ledge and is used as a key bed. . .	6	854
56	Limestone; cherty, medium bedded, medium to dark gray. The bed contains fossils and is a slope former . . .	20	848
55	Sandstone; calcareous, thick bedded, cross-bedded, light tan to light gray-tan. The bed is a ledge former	7	828
54	Slope Cover	27	821
53	Limestone; cherty, thin to medium bedded, light to medium gray, contains fossils. Bed is a slope former	18	794
52	Limestone; thick bedded, light to medium gray, contains fossil hash. Is a ledge former.	5	776
51	Slope cover	29	771
50	Limestone, sandy, medium bedded, medium gray to gray tan. Forms a small ledge.	22	742
49	Slope cover	35	720

Unit Number	Description	Thickness	Accumulative Thickness
48	Sandstone; calcareous, thick to massive bedded, cross-bedded. Forms a small ledge	39	685
47	Limestone; chert bonds, medium to thick bedded, light to medium gray, contains fossils. It is a ledge former	15	646
46	Slope cover.	24	632
45	Limestone; thick to massive bedded, dark gray to gray black. Forms a ledge	10	608
44	Limestone; cherty, thick to massive bedded, dark gray to gray black. Forms a ledge	15	598
43	Slope cover	18	583
42	Limestone; medium bedded, medium to blue-gray, fine grained, contains fossil hash. Forms a small ledge.	5	565
41	Sandstone; calcareous, thick bedded, cross-bedded, gray-tan to tan, fine grained. Forms a ledge	17	560
40	Limestone; medium blue gray to medium gray, abundant chert in form of nodules and stringers	30	553
39	Sandstone; medium gray to brown, fine grained, cross-bedded	4	523
38	Limestone; gray-black, dense, arenaceous, medium grained, thin bedded .	14	519
37	Limestone; black to medium blue gray, areneous, chert in nodules and bonding, sand stringers	34	505

Unit Number	Description	Thickness	Accumulative Thickness
36	Sandstone; calcareous, gray-brown to tan, cross-bedded, fine grained . .	27	471
35	Limestone; medium gray-black to medium gray, contains fossil hash, thin bedded, clastic, chert nodules . .	21	444
34	Limestone; gray brown to light gray, fine grained, chert nodules	11	423
33	Limestone; gray-black to dark blue-gray, chert bonds	18	412
32	Sandstone; calcareous, gray brown to light tan, fine grained, case hardened	11	394
31	Limestone; dark to medium gray, contains fossils, thin bedded	9	383
30	Limestone; dark gray-black to medium light gray, thin beds of fossil hash, abundant chert bending	64	374
29	Limestone; black to medium blue-gray, argillaceous, massive bedded, fine grained, chert stringers	10	310
28	Limestone; dark gray to black to light gray, clastic, massive bedded, fetid smell on fresh break	9	300
27	Slope cover	14	291
26	Limestone; dark brown to gray-black to white, medium grained, contains fossils, chert bonds	14	277
25	Limestone; black to medium blue-gray, fine grained, abundant chert nodules and bonds.	42	253
24	Limestone; medium to dark blue-gray, thin to medium bedded, fossil hash, chert bonds near top.	15	211

Unit Number	Description	Thickness	Accumulative Thickness
23	Limestone; light to medium gray, fetid smell, fossil hash, thick to massive bedded	5	206
22	Slope cover.	10	201
21	Limestone; dark gray-black to medium gray, fossil hash, thin to massive bedded	6	191
20	Sandstone; calcareous, brown gray to tan, fine grained, cross-bedded . . .		185
19	Slope cover	64	181
18	Limestone; black, argillaceous, fine grained, contains chert bonds.	16	117
17	Limestone; dark gray-black to light gray, fossil hash, massive bedded, chert nodules	6	101
16	Slope cover	6	95
15	Limestone; dark gray-black to medium gray, thin to massive bedded, fossil hash in upper part.	10	89
14	Slope cover	4	79
13	Limestone; sandy, dark gray-black to tan, minor cross-bedding, thick bedded	4	75
12	Slope cover.	9	71
11	Limestone; dark gray to medium blue-gray, thin bedded with calcite stringers.	4	62
10	Limestone; medium blue-gray, thin to massive bedded, fetid smell, some fossils	6	58

Unit Number	Description	Thickness	Accumulative Thickness
9	Slope cover	4	52
8	Limestone; dark blue-gray to medium blue-gray, thin bedded, fossil hash. .	4	48
7	Limestone; sandy, dark gray-black to tan, medium bedded.	2	44
6	Slope cover	7	42
5	Limestone; siliceous, minor cross-bedding, chert bonds, fine grained, brachiopods in lower part, thick bedded, dark to medium blue-gray	10	35
4	Slope cover	8	25
3	Limestone; argillaceous, dark gray-black to medium gray-blue chert nodules . .	8	17
2	Slope cover	3	9
1	Limestone; argillaceous, dark gray-black to blue-gray, thin bedded, some fossils	6	6
	Total ---	854	

Manning Canyon shale -- in conformable contact.

The following is a partial stratigraphic section of the Atokan series measured by Monte Beers and the writer on the 27th of April, 1957, on Cedar Point in Sec. 5, T. 5 S., R. 1 W.

Unit Number	Description	Thickness	Accumulative Thickness
17	Base is massive, light to medium gray, arenaceous limestone bed that is in fault contact with the unit below. Some repetition is possible. The limestone is overlain by a series		

Unit Number	Description	Thickness	Accumulative Thickness
	of medium to thick bedded, light brown to tan, cross-bedded orthoquartzites that are interbedded with reddish brown platy shales and light to medium gray arenaceous limestones	250	1913
16	Limestone; thin to medium bedded, light to medium gray, arenaceous, is jointed and contains calcite stringers. The fusulinid _Profusulinella_ sp. was found	15	1663
15	Quartzite; light brown to gray on fresh break, weathers light brown. The bed is cross-bedded and stained with iron. It is a ledge former. It is highly jointed and fractured because of minor faulting	64	1648
14	Mostly orthoquartzite that is light brown to tan, cross-bedded and highly jointed. It is interbedded with 15 to 20 foot beds of reddish brown shale and light to medium gray, arenaceous limestone. Some manganite is formed within the joints of the beds	50	1584
13	Shale; brownish red to pinkish brown, platy, highly jointed with some manganite . It is a slope former and samples were collected from a two foot hole. .	13	1534
12	Quartzite; massive, ledge forming orthoquartzite that is light brown to tan, medium to massive bedded. It is highly jointed and shows indications of some faulting . . .	56	1521
11	Shale; brownish red to pinkish brown, platy, highly jointed with some manganite. It is a slope former and samples had to be dug for through the soil	20	1465

Unit Number	Description	Thickness	Accumulative Thickness
10	Limestone; light to medium gray, medium to thick bedded, arenaceous, and contains bands of chert. It is a ledge former that contains the fusulinid Profusulinella sp. proving it to be Atokan.	14	1445
9	Quartzite; massive cliff former that is light brown to tan. It is thin to massive bedded with good cross bedding, highly jointed and shows indication of minor faulting. Forms the first large cliff above the main slope of hill	133	1431
8	Interbedded blue thin limestones (1 to 2 feet), some of it very dense, siliceous, with 6 inch to 4 foot beds of flesh-colored and pink orthoquartzite, silty to very fine-grained, dense, hard, highly jointed, blocky, buff to tan weathering to brown weathering; some sandy, clastic limestones, and calcareous quartzitic buff to tan sandstones that are iron stained. Clastic limestones contain thin zones of crinoid hash in places. Some faulting is evident and repetition is possible. The unit forms a talus-like slope. . .	513	1298
7	Predominently sandstones and orthoquartzites, with some interbedded light to medium gray limestones. Orthoquartzite is thin to medium bedded, light brown to buff with some cross-bedding. The limestone is cherty in places, medium bedded, clastic with some beds of fossil hash and contains Derbyia and many crinoids. The quartzites weather blocky and form much talus cover. All of unit is on a slope. The average strike is N. 75° W. and dip 28° N.	221	785

Unit Number	Description	Thickness	Accumulating Thickness
6	Orthoquartzite; medium to thick bedded showing cross-bedding, weathers light brown to tan. Interbedded light to medium gray, medium bedded, medium grained limestones that are crinoidal. Limestones lack the abundant chert seen below. Calcite stringers are abundant. Beds strike N. 80° E. and dip 27° N.	124	564
5	Predominantly limestone that is thin to medium bedded (1" to 14"), arenaceous throughout but not very siliceous. It contains beds of crinoid hash with Dictyoclstus and Spirifer fragments. It is abundant in chert both in nodules and in stringers. Inter-bedded with the limestone are beds of light brown to tan sandstone and orthoquartzites. The unit is a slope former and strikes N. 65° E. and dips 31° N	150	440
4	Predominantly limestone that strikes N. 65° E. and dips 30° N. It is thin to medium bedded, arenaceous throughout and weathers light gray to tan. Fossil hash is encountered in some of the more clastic crinoidal limestones with fragments of Dictyoclostus and Spirifers present. Chert nodules are abundant. Unit is a slope former.	108	290
3	Calcareous sandstone and orthoquartzite in lower five feet, medium gray and blue-gray, dense to very fine-grained, hard, resistant, cross-bedded, weathers pale yellowish-brown; overlain by dark gray limestone hash beds, then this by cherty dark limestone; the chert is in the form of nodules and bands. The hash beds are fetid. The beds strike N. 78° E. and dip 18° N.	75	182

Unit Number	Description	Thickness	Accumulative Thickness
2	Limestone; medium gray, thin to medium bedded, arenaceous, cherty in nodules and bands. Some zones (6" to 14") of fossil hash. Bottom 20 feet is interbedded sandstone that weather light brown and blocky. The unit is a slope former except for the top 4'.	72	107
1	Sandstone; light brown to tan, medium grained, some beds calcareous. Slope former. The beds strike N. 60° E. and dip 20° N	35	35
	Total ---	1913	

Morrowan series -- Medium gray, cherty limestone with chert. Forms a prominent ledge.

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UNITED STATES
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7.5 MINUTE SERIES (TOPOGRAPHIC)

GEOLOGIC MAP OF THE JORDAN NARROWS QUADRANGLE

by

GRANT G. PITCHER

1957