GEOLOGY OF THE WEST TINTIC MINING DISTRICT AND VICINITY JUAB COUNTY, UTAH

By

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A thesis submitted to the faculty of the University of Utah in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Geology
University of Utah
June, 1954

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ACKNOWLEDGMENTS

The author is deeply indebted to Dr. Norman C. Williams, who suggested the thesis problem and guided it to conclusion. His advice on special problems encountered in the field and in preparation of the manuscript was an important factor in the completion of the report.

The writer would also like to express his gratitude to Dr. W. L. Stokes for his identifications of fossil collections and stratigraphic advice; and to Dr. F. W. Christiansen and Professor Max Erickson of the thesis committee.

Many thanks are also due Hal Morris of the Eureka branch of the U. S. Geological Survey, who contributed valuable stratigraphic assistance on a trip through the area, and who was a constant source of information.

Financial aid was received from a Union Pacific Railroad assistanceship grant.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

Purpose and Scope

Geologists have been concerned for many years with the significance of the zone of uplift, intrusion, and mineralization which extends westward from the Uinta Arch through the Park City, Alta, and Big Cottonwood stocks to the Bingham stock, and thence via a sharp turn to the south into the Tintic and West Tintic districts. It is the intent of the present investigation to contribute to the knowledge of the West Tintic portion of this mineralized belt.

This study is one of several being undertaken in the Sheeprock Mountains and adjoining areas under the direction of Dr. N. C. Williams. Very little previous detailed geologic work has been done in this area, and this study constitutes the first detailed mapping program. Interpretations of geologic history are offered, but may be subject to modification as more data accumulates from the studies being conducted in adjoining areas.

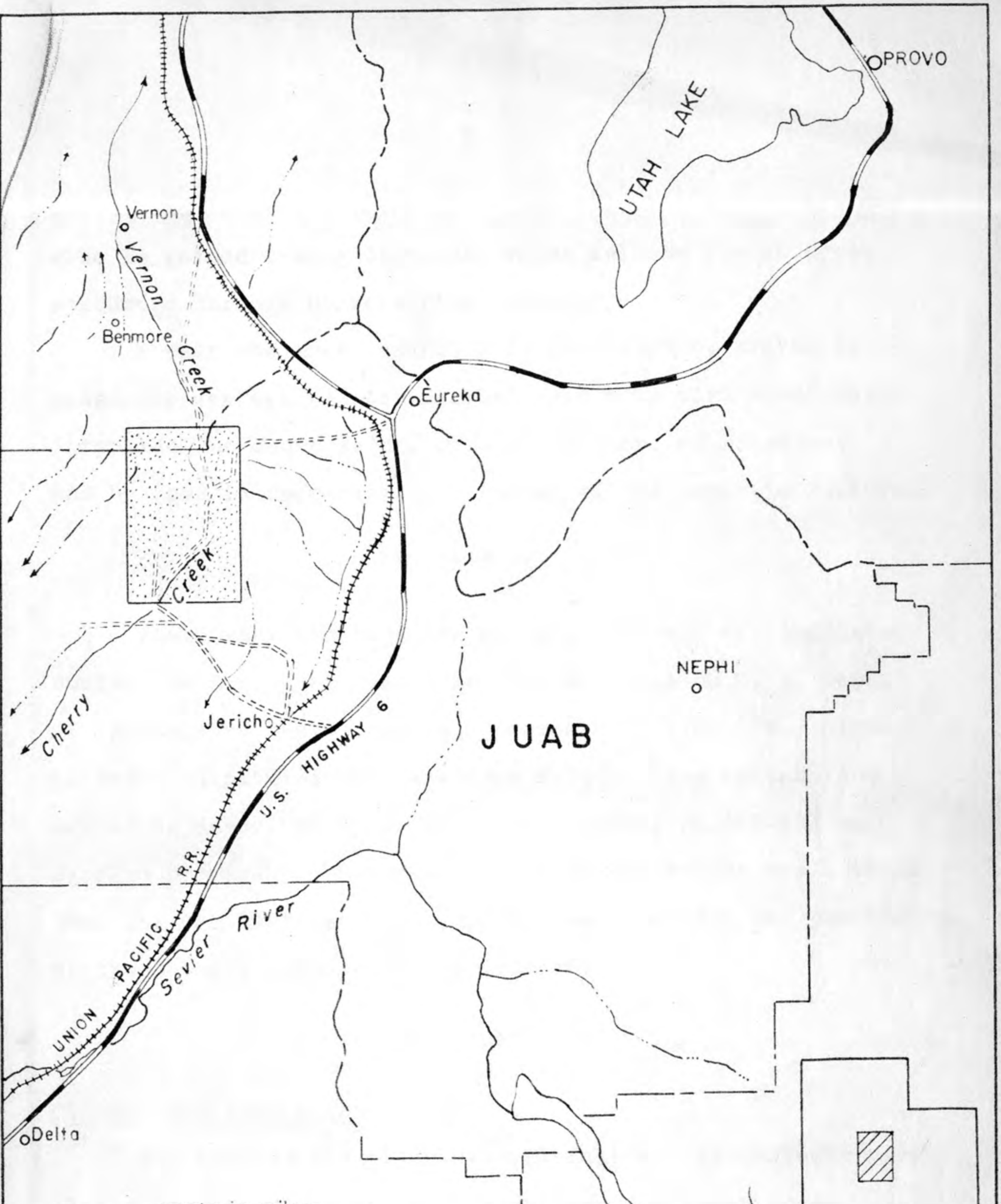
General Statement

The West Tintic and Sheeprock Mountains are more or less north trending ranges which converge at their southern ends. They are topographically separated by a low saddle from which the head waters of southward flowing Cherry Creek and northward flowing Vernon Creek originate. These ranges are typical in general appearance of the north trending ranges of the Basin and Range province. The normal faulting which may have elevated and tilted these ranges is, except for the Vernon Creek fault, obscured by a thick cover of alluvium, and only their relief suggests their fault-block nature.

Location and Accessibility

The region described is located in the southern Sheeprock and West Tintic Mountains of northeastern Juab County, Utah (Plate I). A portion of Tooele County is included in the northwest portion of the area. The region embraces an area of approximately 65 square miles, and includes all or portions of T.9 and 10S, R.4 and 5W, S.L.B. and M. The area can be reached by various dirt and gravel roads during most of the year; however, travel becomes hazardous to impossible after rainstorms, and during part of the winter the roads are completely drifted in by snow. A gravel road trending westward from Eureka through the small railroad station at Tintic is the most convenient means of access, but a road extending northward from Jerico on U. S. Highway 6, although a somewhat longer route, is usually kept free of snow during the winter

Plate I



INDEX MAP-SHOWING LOCATION OF
WEST TINTIC DISTRICT, JUAB CO., UTAH

months and is better maintained than the others. Access may also be gained over a dirt road which follows Vernon Creek southward through Benmore from Vernon.

Within the area described in this report, travel by passenger car can be accomplished over many dirt roads which interlace the countryside. Travel by jeep, or horseback, and by foot is necessary to see many of the geologic features.

Field Work

Field work was begun in August, 1953 and was completed during the Spring of 1954. Mapping was done on U. S. Dept. of Agriculture aerial photos at a scale of 1:20,000. Since no detailed planimetric base maps existed, the radial line method as described by A. J. Eardley (1941, pp. 55-69) was used to prepare the base map. Base of operations was a cabin near the War Eagle workings, which was used with the permission of the present leasors of the property.

Geography

Climate and Vegetation

The area is one of sparse rainfall and accordingly very little vegetative cover, with sagebrush and cedar trees (junipers) predominating. A few spruce and pines, although quite rare, are found at higher elevations in some localities.

Many small springs and grasses in the valleys support grazing in the summer months. Alfalfa and rye are raised in West Cherry Creek Valley.

Topography and Drainage

The West Tintic and Sheeprock Mountains are maturely dissected fault block mountains with the higher more rugged topography in the southern West Tintic Range and in the northern Sheeprock Range.

Drainage of the area is accomplished by Cherry Creek, which drains southward to the Sevier Desert; Vernon Creek, which drains northward into Rush Valley, and by numerous streams flowing westward into Tintic Valley and then southward to the Sevier Desert. Dendritic drainage formed over the thick homogeneous sequence of limestones and in the igneous rocks is the typical drainage pattern. Parallel drainage is well shown in the Precambrian sequence where long consequent streams are joined at right angles by subsequent streams cut into softer argillites between resistant quartzites.

Cherry Creek is the principal perennial stream draining the region, and is fed by a spring three-quarters of a mile above the reservoir. Many other small springs intermittently contribute to the water supply.

Previous Geologic Work

The only published research consists of a general study by G. F. Loughlin of the U. S. Geologic Survey in 1920, and a study of the West Tintic district by Bronson F. Stringham in 1942. The work by Loughlin was one of a series of reconnaissance studies made by him of the mining districts between the Tintic and Thomas Ranges. Stringham's work was essentially a mineralogical study of the West Tintic Mining District, with a brief resume' of the geologic structure and stratigraphy. Stringham's paper included a geologic and topographic map of the district.

Economic Geology

The area considered in this report and surrounding localities have long been of great interest to the geologist and prospector in the search for lead, zinc, copper, silver and gold. Most important by far is the Tintic district, 25 miles to the east, which has been a leading producer of these metals in Utah since 1865, and has a total production of approximately $415,000,000 (Hal Morris, personal communication).

The West Tintic District has also shown significant production since 1870. This area has been intensely prospected as evidenced by the many small prospect pits and mine shafts.

Of these the Scotia, Iron King, and Tintic Western (now Desert Tungsten) were the leading producers. The very unsatisfactory record of production is due to the inclusion of earlier profits with the production of the Tintic district. Loughlin (1920, p. 439) estimates production from the Scotia mine since 1880 to be about 3,000 tons of ore valued at approximately $150,000.

The Erickson, Columbia and Blue Bells Districts, which lie farther north in the Sheeprock Mountains, have lead, silver and zinc production records from about 1890 to 1910. The inability to continue operations here, as in the West Tintic district, being due to unsatisfactory means of transporting the ores to the mills.

In more recent years the region has once again become one of economic interest with the discovery in the northern Sheeprock Mountain of beryl disseminated through a granite intrusive. Brush Beryllium Corp. initiated an extensive diamond drill program there during 1953 to ascertain the value of this deposit.

The discovery of scheelite with ultra-violet light in the West Tintic District in 1940 stimulated exploration of the old mine shafts and prospect pits. During World War II the U. S. Bureau of Mines established a development project on some property controlled by Desert Tungsten Co. This program included removal of alluvium and trenching with bulldozers to facilitate mapping by members of the U. S. Geological Survey. This work was followed by a diamond drilling program. The ore was found to be scheelite disseminated along the limestone-monzonite contact at an average tenor of .5%. The results of this project have been published in "Report of Investigations 4640."

Ore was first mined and shipped in May, 1942 to a chemical treatment plant west of Salt Lake City. These operations only continued during World War II, and Desert Tungsten Co. isn't mining in the area at the present time; however, one small operation is still being carried on. The ore mined is a tactite which is sent to Barstow, California to be milled, and later sent to Bishop, California for further refining. Some ore has been shipped to the plant west of Salt Lake City, which separates the scheelite by flotation processes. The main advantage of this flotation process is in its high rate of recovery, which amounts to better than 80%. Profits from this project, as from earlier operations, are reduced by the great distance the ore is transported.

This area of study, then, is one of varied and somewhat complex mineralization. The deposits so far have been of too low grade to offset the costs of transportation, but with a greater demand for the metals and improved means of shipping and treating the ores, this area could become of significant economic importance to Utah.

STRATIGRAPHY

General Statement

A thick series of Precambrian metasediments is well exposed in the western portion of the area. Excellent exposures of formation ranging in age from Ordovician through Denovian crop out across the West Tintic Mining District. Fossils and primary structures in this area have been to a great extent destroyed by hydothermal solutions from the intrusive to the west.

In the scope of the present study, the writer was unable to determine the sequence of any great thickness of beds in the West Tintic Range due to poor exposures and complications in structure. However, some fossils indicate a Carboniferous age for most, if not all, of the sediments composing the West Tintic Range in the area studied.

Precambrian System

Undifferentiated quartzites and shales

Loughlin (1920, pp. 432) first recognized and described "The thick formation of quartzites, shales and shaly conglomerates which forms the bulk of the Sheeprock Range...". He attributes a Precambrian age to this sequence, and describes a formation which bears a strong resemblance to a glacial till which, according to Eardley (1940, p. 823)..."is in all respects, except for composition of pebbles and boulders, the same as the tillites of the central and northern Wasatch." This Precambrian tillite was not observed in the area of this report; however, its mention here is interesting and important to the Precambrian history of the region.

The base of the Precambrian strata is in thrust contact with underlying Paleozoic sediments with varying degrees of discordance. The quartzites are generally massive, gray, white and brown, and weather brown to purplish-brown. They are fine to medium grained with a few beds ranging from coarse sand to grit sized particles. Near the thrust plane the quartzite has been thoroughly brecciated and recemented. The shales are brown, green, and black, chloritic and sericitic, and are generally metamorphosed to slates, phyllites, and hornfels. Many beds contain cobbles and pebbles of well rounded quartzite. Their proximity to the thrust fault is indicated by their extremely crumpled nature.

A Precambrian age assumption is justified by the fact that Cambrian strata are found in sedimentary contact conformably overlying these metasediments in the northern Sheeprock Mountains (Walker Baker, personal communication).

Ordovician System

Pogonip formation

Westward from the Orient mine, approximately 1000 feet of bleached and metamorphosed limestone and dolomites out-crop between the monzonite intrusive on the south and the Precambrian quartzites on the north. Because of their proximity to the intrusion, these sediments have been altered and metamorphosed until their primary features have been to a great extent destroyed. Therefore, no detailed measured section could be made. However, correlations of overlying formations (Plate III) indicate that these lime-stones and dolomites, including the shale member which will later be described, are equivalent to the Pogonip formation of Lower Ordovician age, with the lower portion possibly ex-tending into Upper Cambrian time. No distinctive sedimentary change nor diagnostic fossils were found to determine the Cambrian-Ordovician contact.

Eureka quartzite

Stringham (1942, p. 271) described a bed of quartzite and a unit of dense, greenish brown shale which he referred to as the Orient quartzite and Orient shale, respectively. Near the outcrop of these units he found fossils which were identified as Ordovician in age. Poorly preserved fossils

Plate II A

A. <u>Halysites sp</u>. found near chert zone on Brown's Ridge.

Plate II B

B. View looking north along strike of Ordovician and Silurian dolomites which form Brown's Ridge. The beds in the foreground are dipping to the east, and the beds in the distance are overturned to dip to the west.

found on the east side of Brown's Ridge at a horizon 1280 stratigraphic feet above the quartzite have been identified as Upper Ordovician, or possibly Silurian. The occurrence of these fossils, the favorable correlations with nearby areas (Plate III), and lithologic similarity to the Eureka quartzite of Middle Ordovician age favor such a correlation, with the underlying Orient shale being equivalent to the upper shale member of the Pogonip formation of the House Range.

The quartzite is white to gray, fine to medium grained, and limonite stained on weathered surface. It contains a few thin shale partings and is notably clean. At one vertical outcrop a very accurate measurement of a 38-foot thickness was made.

The metamorphosed Orient shale is dense, black to olive green and brown, which on weathered surfaces is greenish brown. The upper contact against the quartzite is sharp, but the lower contact is everywhere covered, and its measured thickness of 200' could be subject to considerable error.

The absence of fossils in the quartzite and shale is rather unusual, since these formations in other localities are very fossiliferous. Walker Baker (personal communication) reports finding many graptolites in this shale in the northern Sheeprock Mountains. Their absence here may possibly be due to their destruction by hydrothermal alteration.

Fish Haven dolomite

Conformably overlying the Eureka quartzite is 1280 feet of dark gray dolomite here designated as Fish Haven dolomite. Much of this formation is bleached white, and contains tremolite aggregates attesting to contact metamorphism. Unaltered outcrops are dark gray and weather light blue gray. The dolomite is brecciated over a great part of its thickness, cherty near its base, and with a cherty zone and chert bed at its upper contact. In its upper portion, beds of black dolomite with thin, gray, coarse-grained laminations become prominent. Where folding has occurred, these beds resemble the regionally used lithologic term, "curly bed."

The unusually large thickness of 1280 feet is undoubtedly due to inclusion of part of the overlying Laketown dolomite in the unit. Hal Morris (personal communication) states that the upper contact of the Fish Haven is taken at a marked chert zone in the Tintic district, but does not feel that overlying and underlying lithology here sufficiently resembles Tintic district sequences to justify a contact at the chert zone. However, because of the absence of any distinctive marker beds below this horizon, the Fish Haven-Laketown contact is arbitrarily taken at the base of the chert bed. Halysites sp. and some poorly preserved semi-globose forms of brachiopods of Upper Ordovician, or possibly Silurian, age were found near this chert zone.

Silurian System

Laketown dolomite

Silurian time is represented by 945 feet of medium gray dolomite, which weathers light gray, and contains some cherty zones and a chert bed at its base. As has been mentioned, this thickness may not represent the entire formation, as part of the dolomite mapped as Fish Haven is part of the Laketown.

Their combined thickness of 2220 feet is also large, as compared to 1605 feet in the Thomas Range to the west (Bauer 1952), and in the Tintic district to the east where the combined Fish Haven dolomite and Bluebell dolomite, which includes Silurian and some Devonian, total only about 1300 feet. Dr. Stokes (personal communication) suggests a local thickening of the Laketown dolomite here as a possible explanation.

Devonian System

General statement

Devonian terminology in this report is taken from Gold Hill, where excellent descriptions of lithology by Nolan (1935) suggest correlation with measured sequence in this area. The author realizes that many formational names, including Devonian terminology, are used only in Gold Hill, and are not generally accepted in most surrounding areas; but, on the basis of the favorable correlation of mappable units possible with that area, such a correlation was made here.

Sevy dolomite

Overlying the Laketown dolomite, with no apparent discordance, is 700 feet of dolomite and dolomitic limestones. They are light gray, weathering light gray to creamy white, and are fine-grained, platy, break with conchoidal fracture, with some thin beds and particles of pink chert. The upper contact is arbitrarily taken where blue gray weathering dolomite becomes the dominant lithology.

Simonson dolomite

Conformably overlying the Sevy dolomite is 435 feet of dolomite and dolomitic limestones, which are dark gray, weathering blue gray to dark gray, and bleached white in some portions. Black laminated dolomite occurs in beds about 2 feet thick, becoming more prominent upward. The dolomite becomes quite sandy in the middle portion of the formation, with sand decreasing upward and chert increasing upward. Cladopora sp. fossils are found at the upper contact, where they constitute a distinct marker bed. The top of the formation is arbitrarily taken where the dolomite becomes massive and contains a higher percentage of chert.

Guilmette formation

Conformably overlying the Simonson dolomite is 270 feet of medium to dark gray dolomite, weathering gray to blue gray, with some bleaching and with some cherty beds.

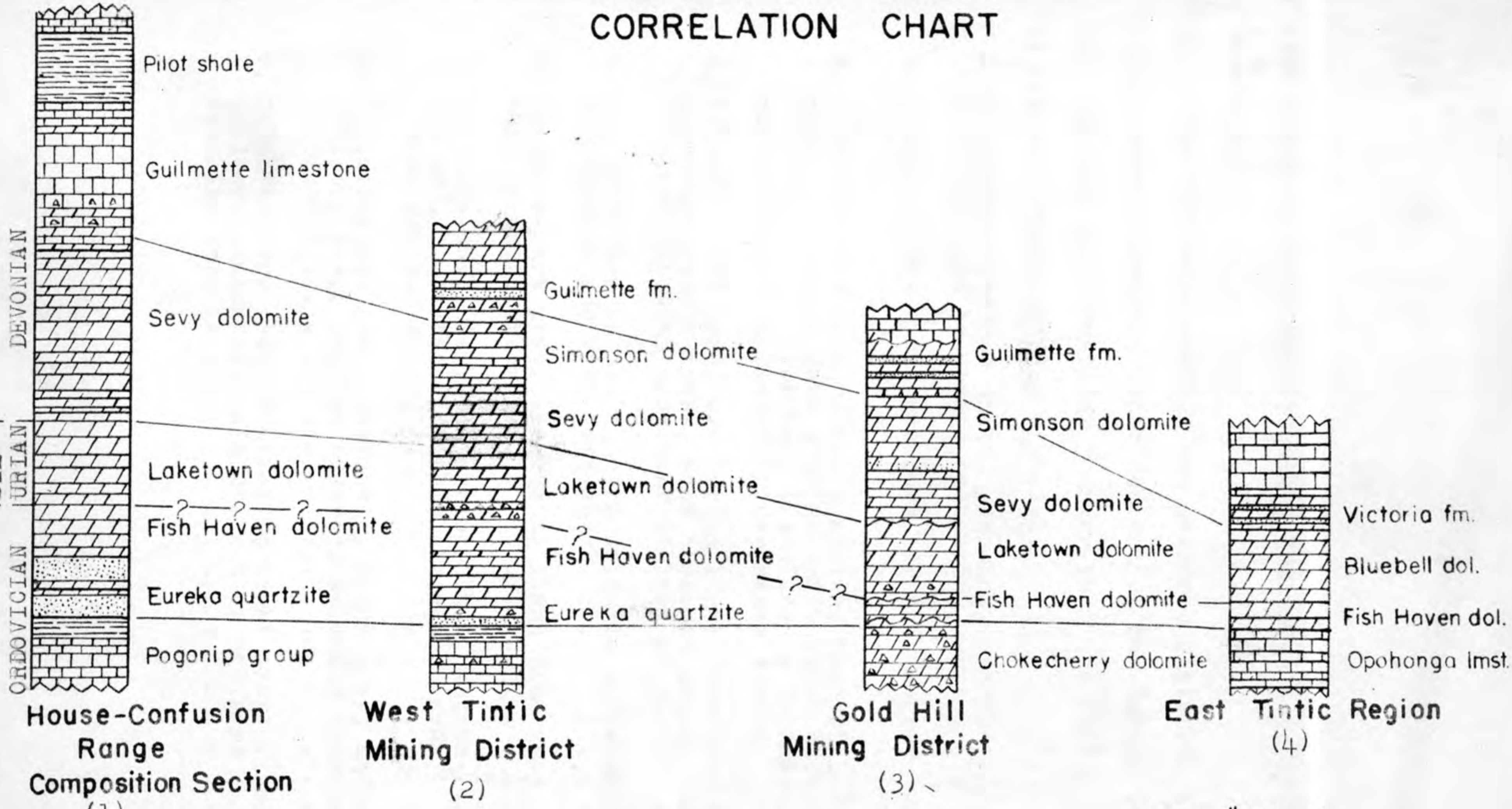
This is, in turn, overlain by a 50-foot unit of white to light gray quartzite. It is fine to medium grained, with bedding prominent, and with crossbedding in some beds. Stringham (1942, p. 271) referred to this unit as the Allah quartzite, and in this paper it will be referred to as the Allah quartzite member of the Guilmette formation.

Overlying the quartzite is a 60-foot unit of platy, light blue-gray weathering limestone, with thin, irregular white calcite seams parallel to the bedding. This limestone becomes cherty, and grades into 250 feet of dolomite which is dark gray, weathering light gray, and locally bleached. The lower portion contains some well bedded limestone in beds about 1 foot thick.

The above described units will be tentatively designated as the Guilmette formation of Devonian age.

Bedrock above the last described unit is, to a great extent, obscured by pediment gravels and colluvium, and the upper contact of the Guilmette formation has not been found here. Exposures show the beds above to be limestones and dolomites with some local bleaching. One bed of chert 20

CORRELATION CHART



scale: 1" = 2000'

1. Guidebook to Geology of Utah, No. 6
2. This paper
3. U.S.G.S. Prof. Paper 177
4. Measured Section in Allen's Ranch Quadrangle (U.S.G.S. unpublished literature)

feet thick outcrops approximately 300 yards east of the Pyramid workings.

The following section was measured eastward, stratigraphically upward, from the upper contact of the Eureka quartzite, and includes all formations younger than the Eureka quartzite in the West Tintic Mining District.

		feet
1.	Limestone-bleached white, granular, recrystallized, contains pink to orange weathering chert	55
2.	Dolomite-dark gray, weathers light blue-gray, some bleaching.	30
3.	Limestone-bleached white, granular, recrystallized, with portions of dark gray dolomite which have not been thoroughly bleached, tremolite in dolomite, some dolomite breccia bleaching decreases upward. . . .	210
4.	Dolomite-dark gray, weathering light blue-gray, with numerous breccia zones, some bleached zones, beds of black dolomite prominent in last 80 feet. . . .	155
5.	Dolomite-same as No. 4, with dolomite extremely brecciated, and with some chert.	100
6.	Dolomite-dark gray, weathering light blue gray, much dolomite breccia.	130
7.	Dolomite-dark gray, weathering black, medium-grained, laminated with thin streaks of gray coarse-grained dolomite.	40
8.	Dolomite-dark gray, weathering light gray, medium-grained, large portion covered, dolomite breccia in float	160
9.	Dolomite-dark gray, weathering light gray, fine-grained, laminated, thin chert beds and some dolomite breccia	175

		feet
10.	Dolomite-alternating blue-gray weathering and black laminated beds, which resemble "curly bed" where folded, beds about 1' thick, some dolomite breccia, branching structures in black dolomite, some chert	225
	Fish Haven-Laketown Contact?	1280
11.	Chert zone-contains horn corals and chert bed 10' thick	55
12.	Dolomite-medium gray, weathering light gray, with <u>Halysites sp.</u> and semi-globose forms of brachiopods in float. (fossil outcrop not located.)	30
13.	Dolomite-medium gray, weathering light gray, fine-grained	110
14.	Dolomite-dark gray, weathering light gray, cherty.	60
15.	Dolomite, bleached white, granular, soft	40
16.	Dolomite, dark gray, weathering light gray, chert, some dolomite and chert breccia.	205
17.	Dolomite-medium gray, weathering light gray, with many bleached zones.	235
18.	Dolomite-medium gray, weathering light gray, becoming cherty.	210
	Laketown-Sevy contact	945
19.	Limestone-medium gray, weathering light gray to cream color, some platy beds (4" to 10" thick) small amount of pink chert parallel bedding, very fine-grained with conchoidal fracture.	300
20.	Covered-Scotia Gulch.	300
21.	Limestone-light gray dolomitic, mostly bleached white, some blue gray weathering dolomite, becoming more prominent upward	100
	Sevy-Simonson Contact	700

		feet
22.	Dolomite-dark gray, weathering blue gray and black, medium-grained, black laminated beds 2' thick, becoming more prominent upward. Some limestone beds	300
23.	Same as No. 22, with chert beds and cherty dolomitic limestone, *Cladopora sp.* at top of unit in zone about 10 feet thick	130
	Simonson-Guilmette contact	430
24.	Dolomite-light blue gray, calcareous bleached white in many zones, some very cherty zones, *Cladopora sp.* 35' from top of unit	275
25.	Quartzite-fine to coarse-grained, white to very light gray, prominent bedding, some crossbedding, highly fractured. (Allah quartzite)	50
26.	Limestone-light gray, weathering light blue gray, platy with irregular thin white calcite banding parallel bedding, becoming cherty and dolomitic upward	60
27.	Dolomite-dark gray, bleached, with interbedded limestone beds 1 foot thick, some cherty beds, and poorly preserved horn corals	250
	Outcrops mostly covered by alluvium.	635

Carboniferous System

General Statement

Since many of the outcrops in the West Tintic Range failed to yield fossils, and because outcrops which were fossiliferous were separated by structural complications and by extrusive cover, a complete sequence of beds was not worked out. Diagnostic fossils found indicate an Upper Mississippian and Lower Pennsylvanian age for much, if not all, of the Paleozoic outcrops. The Great Blue formation of Upper Mississippian age; and Lower Pennsylvanian sediments equivalent to lower portions of the Oquirrh formation have been recognized.

Great Blue formation

The Great Blue formation has been identified at various localities in the West Tintic Range. Loughlin (1920, p. 438) found fossils near the reservoir at the head of Cherry Creek, which G. H. Girty regarded as Upper Mississippian. No diagnostic fossils were found by the writer in this area which was mapped as undifferentiated, but possibly the Great Blue formation outcrops here.

The Great Blue limestone outcrop north of the junction between the Eureka road and Vernon Creek road (See Geologic Map) has yielded horn corals and crinoid columnals which serve to identify its age.

The following section was measured westward from the Cherry Creek Summit on the Eureka road.

		feet
1.	Limestone-dark gray, weathering blue gray, slightly sandy in some beds	150
2.	Limestone-like No. 1, with some small horn corals, and with thin sandy beds giving a laminated appearance to weathered surface	150

		feet
3.	Limestone-like No. 1, becoming more sandy, with one sandstone bed 8' thick at the top of the unit	45
4.	Alternating sandy limestone and calcareous sandstone beds up to 20 feet thick, sandstone beds form ledges.	150
5.	Same as No. 4, with sand decreasing, and with fossiliferous limestone containing crinoid stems and horn corals.	80
6.	Sandstone, highly calcareous, with sandy limestone at the base of unit.	80
	Total	655

Overlying formations bleached, dolomitized and jasperoidized, indicating faulting.

Approximately 1,000 feet of black shales and gray, brown weathering quartzites form the core of the Maple Peak anticline. No fossils were found in these sediments, but, because of its apparent conformable relation below the Great Blue limestones previously described, plus a very distinct lithologic similarity to the Chiulos member of the Great Blue formation in the Tintic district, it is here tentatively correlated with that unit until further fossil evidence substantiates or disproves the theory.

Hal Morris has seen this unit, and has shown the author the Chiulos member in the field, and the conclusion was reached that these formations are equivalent. The Chiulos member, as described in unpublished literature by members of the Eureka branch of the Geological Survey, is 837 feet thick, and is equivalent to the Long Trail shale member of the Great Blue formation in the Oquirrh mountains.

The following section in the Chiulos member was measured westward along the Eureka road below the Devil's Gate Conglomerate outcrop:

		feet
1.	Shale-black, dense, very fissile and papery, sometimes fracturing into smooth conchoidal nodules. .	280
2.	Quartzite-gray, weathering gray to greenish brown, fine grained, with beds approximately 1 foot thick, contains some interbedded shale and brown sandy beds	185
3.	Much the same as No. 2, with shale and sandy lithology increasing upward.	340
4.	Shale-black, weathering brown, with much black carbonaceous matter in some beds	100
5.	Quartzite-gray to black, beds about 1' thick, weathers gray, and forms a sharp vertical ridge between the softer shales.	25
6.	Shale-black, papery same as No. 1, with interbedded brown, gray and black quartzite beds decreasing upward.	210
	Total	1140'

Fossils have been found in the small Great Blue limestone outcrop east of the Precambrian klippe near McIntyre Ranch. Horn corals, including <u>Faberophyllum sp.</u>, are abundant. Dr. Stokes states that these fossils indicate that the formation is "almost surely Great Blue in age-lower part?"

Mississippian undifferentiated

West of the Cherry Creek-Vernon Creek summit and north of the high limestone ridge there, a thin bedded, platy limestone containing a light yellowish, argillaceous material on the bedding planes marks the folding in that area. The formation is lithologically similar to the Opohonga limestone and Pinyon Peak limestone of the Tintic district. The only fossil found in the formation was a coiled gastropod similar to Euomphalus sp., which is probably Mississippian in age. Southward, structural complications were encountered, which terminated further calculation of sequence. Horn corals of Mississippian (?) age were found in the sandy limestone on the south side of the high ridge. Until structural problems are solved in this area, and more diagnostic fossils are found, this outcrop of limestones will be tentatively designated as Mississippian undifferentiated limestones.

Oquirrh formation

An isolated exposure of shaly, medium gray, blue gray weathering limestone just north of the red conglomerate outcrop on the Eureka road has yielded the following fossil assemblage:

Cup Corals

Crinoid dolumnals

Schizophoria texana

Linoproductus cf. L. prattenianus

Chonetes sp.

Spirifer rocky montanus

Spirifer occidentalis

Dictyoclostus cf. D. hermosianus

Buxtonia?

Composita?

Dr. Stokes states that this assemblage indicates early Pennsylvanian age appropriate to the lower Oquirrh formation.

Unfortunately this fossiliferous formation has been isolated by faulting to the south, and is covered by extrusives to the north, and its relation to overlying and underlying strata could not be worked out.

The large Oquirrh formation outcrop in the southernmost West Tintic contains many structural complications which were not solved in this study. Only a very few poorly preserved fossils were found, including some badly distorted Productid brachiopods of Late Mississippian or Early Pennsylvanian age. If the structure is simple folding as mapped, then an Oquirrh age is valid. Faulting is suspected, however, to complicate the structure here.

Cretaceous System

Devil's Gate conglomerate

Mesozoic history is represented only by a small outcrop of red conglomerate, made up of angular to subangular fragments of gray Paleozoic limestones, which are an average of 1" to 3" in diameter, with some blocks up to 2 feet in diameter (Plate IV, B). They are well cemented in a red calcereous matrix.

Since very little quartzite occurs in the formation, and none resembling Precambrian quartzite was found, it is logical to assume an age older than the period of thrusting, since the thrust at one time extended over this area. Also, it rests unconformably upon rocks of Upper Mississippian age and is overlain by extrusives of Eocene age (Plate IV, A). It is possible that this formation represents debris derived from the folding Paleozoic sediments prior to thrusting, and may be equivalent to the Indianola (?) sediments of the Canyon Range described by Christiansen (1952, p. 725).

Quaternary System

Quaternary colluvium

Slopes of many of the lower ridges are covered by a thick deposit of material which has been shed from the

Plate IV A

A. View looking north at Devil's Gate conglomerate resting unconformably upon shales and quartzites of Upper Mississippian age.

Plate IV B

B. View showing large angular fragments of Paleozoic limestones in the Devil's Gate conglomerate.

adjoining higher peaks and ridges. This is especially prominent in Cherry Creek Canyon where debris from Maple Peak and the higher peaks of the West Tintic Range has obscured much of the structure. A few recent landslides were also noted in this area.

Quaternary pediment gravels

A conspicuous high level surface, sloping gently away from the mountain ranges, represents a dissected pediment surface formed at some earlier time. The sedimentary deposit consists of poorly sorted and poorly rounded pebbles and cobbles of quartzite limestone and igneous rocks, with finer clastics filling the interstices, and weakly held together by a calcarceous cement. The deposit is wedge-shaped, and thickens mountainward.

Quaternary alluvium

Quaternary alluvium consists of the finer sands and silts which occupy the extreme bottoms of the small valleys, derived in a large part from dissection of the previously described pediment surface. Below the reservoir, Cherry Creek has cut deeply into these alluvial deposits, probably due to recent rejuvenation.

IGNEOUS ROCKS

Intrusive Rocks

The large intrusion in the West Tintic Mining District has been described by Loughlin (1920, p. 436) as a "stock-like body of monzonite." Its areal extent is uncertain, since it is covered to the south by Quaternary pediment gravels. It has been suggested by Stringham (1942, pa. 274), that the intrusion is quite large and extends some distance southward beneath the alluvial cover.

The abundance of small intrusives and the mineralization and bleaching of sedimentary rocks at some distance from the monzonite outcrop gives rise to the suspicion that the main intrusion underlies much of the mining district at no great depth.

The monzonite is gray to gray-green, and weathers tan to light gray. It is even-grained, with pink orthoclase and lathes of plagioclase identifiable in hand specimen. Plates of biotite and euhedral hornblende crystals up to one-eighth of an inch long are abundant.

In addition to the monzonite, several smaller intrusives cut both Paleozoic and Precambrian strata, the largest of these being the large oval-shaped granite porphry body northeast of the Orient mine and the granite porphry at the Oro Plata mine.

Other small dikes and apophyses of diorite and aplite in composition, are also present.

Stringham (1942, p. 290) presents evidence to support a theory of a slowly cooling magma of monzonitic composition. At intervals during the cooling process, successive differentiates of increasing silica content were intruded into the country rock. The final stages of this process occurred with the injection of aplite and quartz-barite dikes followed by metamorphism and mineralization.

A description of petrography and mineralization in the West Tintic Mining District has been made by Stringham (1942).

Extrusive Rocks

Extrusive rocks cover approximately 18 square miles of the area of study. Rhyolites cover the largest portion, with significant amounts of latites and andesites in the southern part. All samples show extensive weathering, with the feldspars especially disintegrated.

The rhyolite in general is weathered white, and contains large amounts of quartz which can be easily identified in hand sample. A rhyolite sample taken from West Cherry Creek Valley consisted of approximately 25% quartz and 40% pink orthoclase. Thin sections show the phenocrysts to be badly fractured, indicating movement of the partially crystallized flow

(Plate V). Near the contact fragments of shale and quartzite are common as inclusions in the flows.

Another type of rhyolite in West Cherry Creek Valley is the purple flow which forms the "chicken rock" west of Hassel's Ranch. This flow is characteristically platy with alternating purple and white plates. It is generally very fine-grained to glassy, with small intensely weathered phenocrysts of feldspar.

A large part of the southern area is covered by a gray andesite flow. The plagioclase is andesine, and generally occurs in well-formed lathes. Elongate, euhedral phenocrysts of hornblende show a preferred orientation.

Except for field relationships, no detailed study of extrusives in the East Tintic Mountains was made, but a very noticeable resemblance to the extrusives of the West Tintic District exists.

It is probable that the extrusives in the two areas were extruded during the same period of vulcanism. Hal Morris (personal communication) states that the extrusives in the East Tintic Mountains have been very accurately dated as "late middle to early upper Eocene" in age.

Plate V

Photomicrograph of rhyolite flow from West Cherry Creek Valley, showing fractured phenocrysts of quartz and orthoclase.

X 100

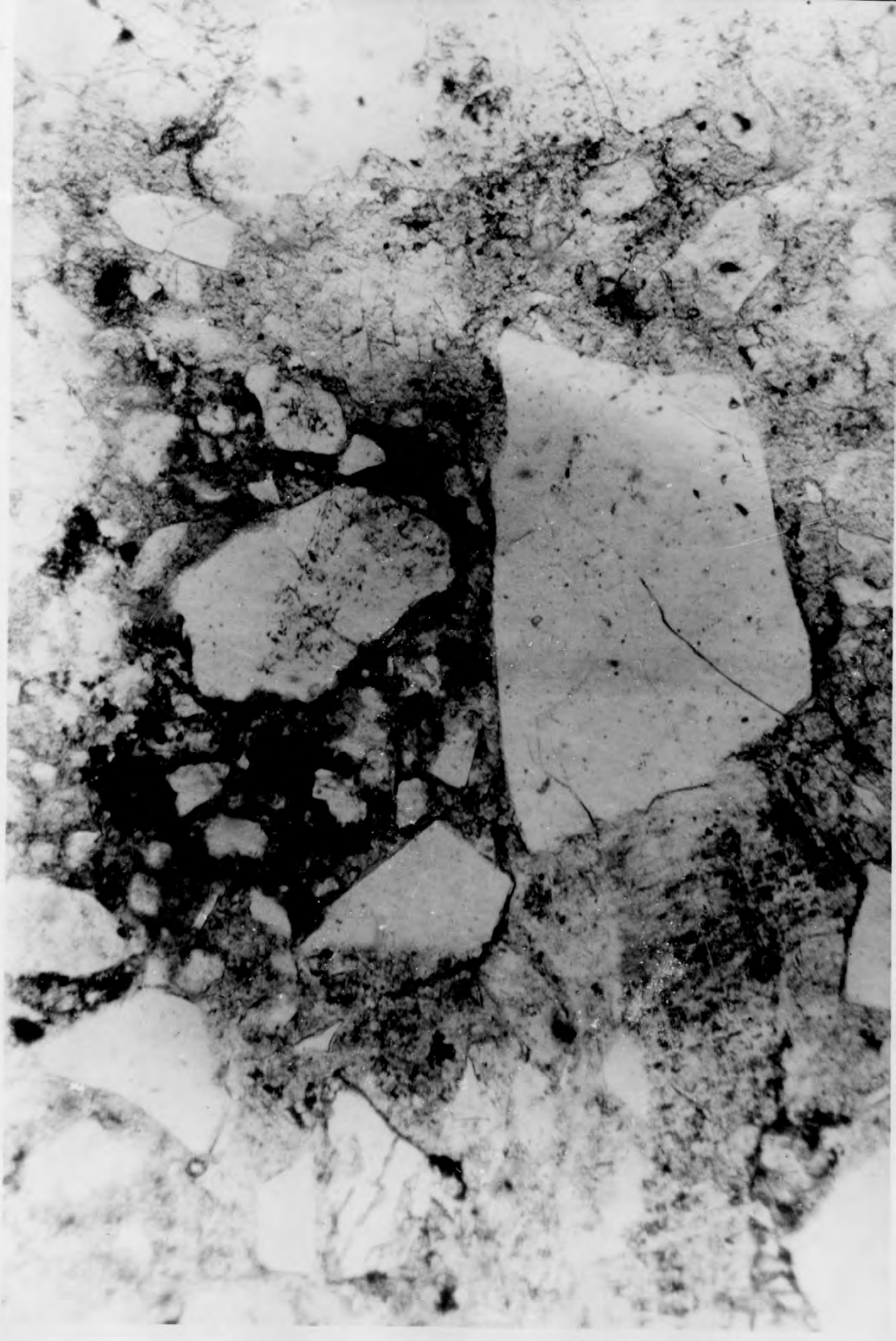
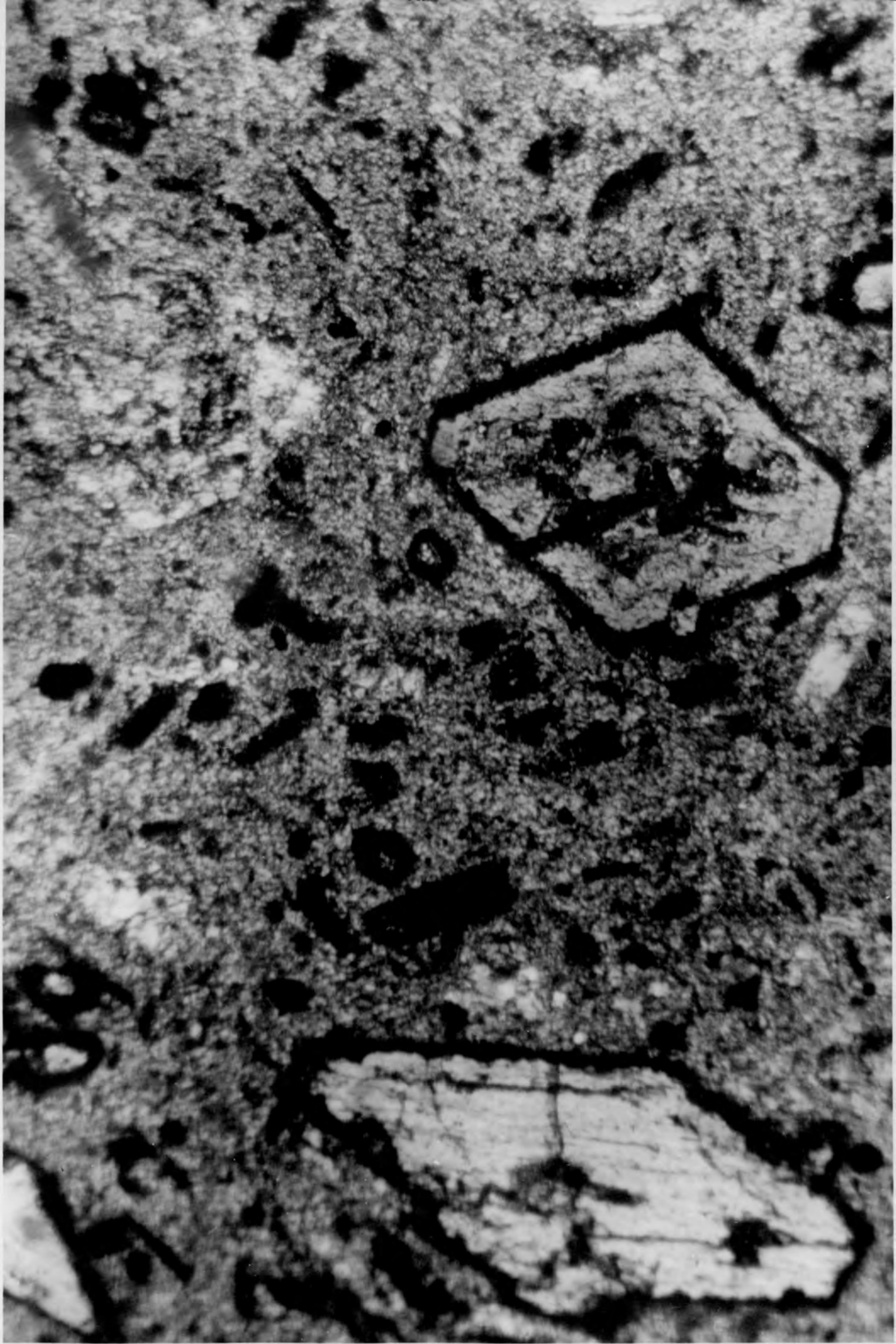


Plate VI

Photomicrograph of andesite flow in southern West Tintic Valley, showing large euhedral phenocrysts of hornblende in a fine-grained groundmass.

X 100



STRUCTURE

Regional Structure

In general the structure of the region consists of folded Paleozoic formations exposed beneath Proterozoic quartzites and argillites which compose the allochthon of the West Tintic thrust. Some shear faulting occurred along with the folding and thrusting. These structures have been cut by intrusives, covered by extrusives, and have been further modified by Basin and Range faults to produce the present north trending ranges.

Folds

Brown's Ridge homocline

Different interpretations of the structure in the West Tintic Mining District have been made. Loughlin (1920, p. 437) in his investigation of the Paleozoic limestones and dolomites of the West Tintic Mining District postulated tight folding.

He states:

> The available data suggest a major anticline with nearly vertical limbs, whose axis is about halfway between the middle of the limestone area and its eastern contact with the quartzite series.

Stringham (1942, p. 272) interpreted the structure to be a steeply dipping homocline with overturning evident.

However, no evidence was found to indicate which part was overturned.

Evidence discovered during this study indicates the northern part is overturned. The dip of the dolomites forming Brown's Ridge increases from 60 degrees to the east at the southern end, to vertical in the central portion, and then to an overturned position of 60 degrees to the west at the northern end of the ridge. (Plate II, B., and Section BB' of Geologic Map.) Since the Eureka quartzite of Middle Ordovician age crops out to the west of Brown's Ridge, and Upper Ordovician, Silurian and Devonian rocks have been found east of the ridge, it is apparent that younger beds are crossed in an easterly direction and the northern portion of the exposed structure has been overturned.

The westerly continuation of the fold is terminated at the monzonite contact, and on the east the Paleozoic sediments are hidden by quartzite and argillites of the West Tintic allochthon.

Maple Peak anticline

The structures of the West Tintic Mountains are mostly covered by debris shed from Precambrian quartzites on the higher parts of the West Tintic Mountains. However, hogback ridge forming quartzites alternating with black shales west of Devil's Gate, trace out the nose of the northward-plunging

Plate VII A.

A. View looking south along the axis of the Maple Peak Anticline. Maple Peak is in the background.

Plate VII B.

B. View showing quartzite beds overturned in core of the Maple Peak Anticline.

Plate VIII A.

A. View showing minor anticlinal fold in quartzites in the Maple Peak anticline.

Plate VIII B.

B. View looking north at fossiliferous limestones of Lower Pennsylvanian age exposed beneath Eocene extrusives.

anticline, and indicate the probable structure of the West Tintic Mountains. One especially prominent ridge forming quartzite in the core of this structure can be identified on both limbs of the anticline, and shows it to be essentially an overturned isoclinal fold, with both limbs dipping approximately 45 degrees to the east (Plate VII, A.). Cross bedding and graded bedding show that the western limb is the overturned limb. Minor drag folds and fracturing are common in the incompetent black shales. Westward from the anticlinal axis the overturned limb gradually steepens, and finally assumes a normal position, dipping 30 degrees to the west. The western limb is cut by the Vernon Creek fault, and the eastern limb is covered by extrusives (see cross section AA' Plate XII).

McIntyre Valley folds

West of the Vernon Creek fault, at the Cherry Creek-Vernon Creek divide, the limestone beds are folded into a syncline and adjoining anticline. The syncline plunges approximately 30 degrees to the north under the alluvium. The syncline forms a topographic, canoe-shaped, synclinal valley, the core of which has been eroded out of a shaly limestone of Mississippian age. The anticline is only partly exposed just east of the West Cherry Creek summit; however, here the shaly limestone beds are seen to wrap around the northward-plunging nose of the anticline.

Determining the nature of these structures can best be accomplished in the shaly limestone. The high east trending ridge which is part of the folded belt is capped by a dolomite thrust breccia, which obscures the folds.

Folds in the southern West Tintic area

As has been mentioned, structures in the Oquirrh formation at the southern end of the West Tintic Mountains are somewhat uncertain, due to possible faulting in the shale beds. As determined by dips and strikes, the structure seems to be similar to that of the McIntyre Valley folds and Maple Peak anticline to the north, with an anticline and adjoining syncline containing minor warps and flexures.

Faults

West Tintic thrust

Loughlin (1920, p. 438) first noted and described the discordant relation between the upturned, northward-striking limestone and dolomites and the overlying, relatively gently-dipping shales and quartzite. He mentions, in addition to many examples of discordance, that,

> To regard the contact as an unconformity would necessarily imply an immense thickness of Precambrian limestone in the West Tintic district and nowhere else in the Great Basin region.

The base of the thrust is well exposed in the West Tintic district. Further north and east the actual thrust contact is obscured by alluvium and extrusives.

The thrust plane in the West Tintic district dips northward at varying low angles. However, further north the dip is generally about 25 degrees to the west. The chaotic dips, together with the pre-thrust relief as indicated by the exposed limestone ridges, support Stringham's explanation (1942, p. 273), that the surface over which the Precambrian beds were thrust was a very irregular one, and the intense brecciation and slickensiding of the quartzite is due to their constant adjustment to the underlying topography.

Evidence that the thrust sheet originally extended over the entire region is abundant. Precambrian quartzite caps Maple Mountain and also the lower hills to the south. The high limestone ridges at the Cherry Creek summit are capped by dolomite and jasperoid breccia, which Hal Morris (personal communication) identifies as a "sole breccia." The higher ridge actually has a small remnant of quartzite resting on the breccia. Great blocks of thoroughly brecciated and recemented quartzite scattered over the region attest to the former presence of the thrust sheet. The Paleozoic sediments, too, are in many areas badly brecciated, indicating that the thrust plane was formerly not too far above the present exposed erosion surface.

The age of the thrusting is somewhat uncertain. Christiansen (1952, p. 732) assigns the Canyon Range thrusting to Early Cretaceous. Eardley (1951, pp. 273 and 325) has used the term, "Cedar Hills orogeny" for this Cretaceous disturbance, but places it in Middle Cretaceous time, the dating of the orogeny being dependent upon the age of the Indianola group. Tentative dating of the West Tintic thrust, in this paper, will be Middle Cretaceous.

Actual fault movement cannot be accurately calculated, but a considerable horizontal movement is shown by the presence of Precambrian remnants in the West Tintic Range.

Vernon Creek fault

The straight escarpment forming the eastern edge of McIntyre Valley marks the trace of a large north trending fault of the Basin and Range type. This fault is an especially prominent feature on aerial photographs, where it can be traced northward. Its existence southward in Cherry Creek Valley is obscured by thick alluvial cover.

Since the Great Blue formation is in fault contact with older Mississippian beds at the Cherry Creek-Vernon Creek divide, the western block with the older formations must be the upthrown block to explain the sequence of beds. The scarp forming the western edge of McIntyre Valley would, therefore, be an obsequent fault scarp.

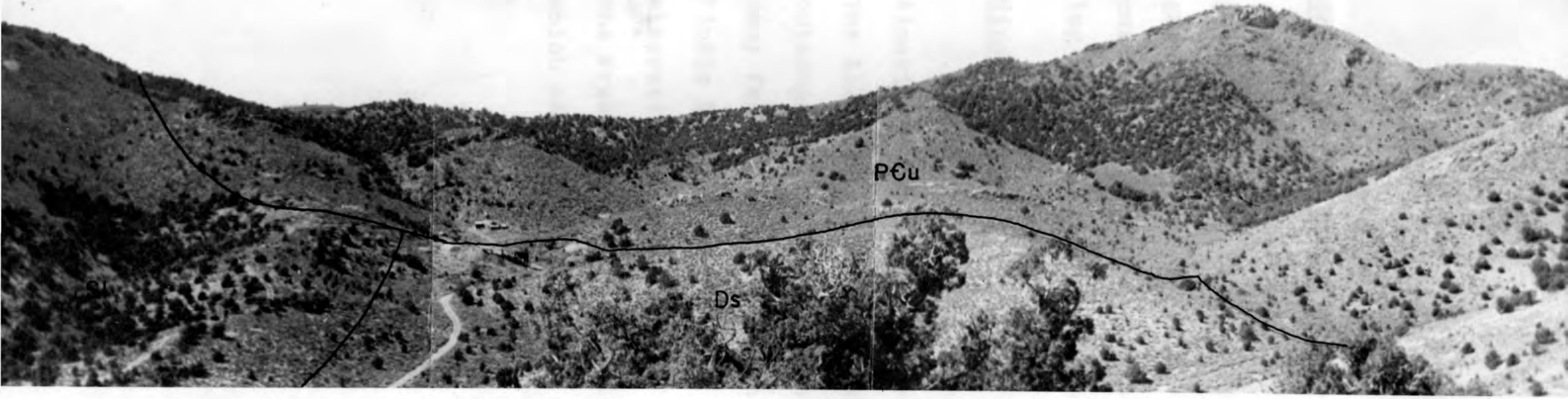


Plate IX

View looking north at the base of the West Tintic thrust in the Scotia area. The Laketown dolomite (Sl) and Sevy dolomite (Ds) strike north and are overturned at this locality to dip steeply to the west. The overlying quartzites and shales (PCu) are dipping northward at varying low angles.

Southern West Tintic fault

A sudden termination in the beds and an alignment of partially preserved fault facets is apparent on aerial photographs, and at one location the actual fault surface is exposed dipping 45 degrees to the south. The age of this faulting has not been determined.

Minor faulting

Small faults are seen to offset the strata where distinctive marker beds can be followed for any great distance. The Allah quartzite especially shows this. This formation outcrops well, and is offset by numerous faults. Without doubt, many faults exist in the thick dolomite sequence in the West Tintic Mining District, as evidenced by the mineralization and alteration of these rocks. Minor faults occur over most of the area. These minor faults seem to be of a shearing type, which occurred at the time of the folding and thrusting.

A. View showing quartzite klippe resting on Great Blue limestone, with Vernon Creek fault at the base of the enscarpment.

B. View showing vertical ridge forming limestones of Lower Pennsylvanian age offset by minor faulting.

GEOMORPHOLOGY

The Sheeprock and West Tintic Ranges are maturely eroded fault block type mountains, typical of the Basin and Range physiographic province.

Faulting is evidenced by the long, conspicuously straight escarpment at the base of which Vernon Creek flows. This escarpment is an obsequent fault line scarp since the down-thrown side forms the escarpment. The Paleozoic outcrop in the extreme southern end of the West Tintic Range is shown to be abruptly terminated by a fault, as shown by alignment of partially preserved facets.

Many stream courses are subsequent, to a great extent governed by structure. Cherry Creek and Vernon Creek flow along the Vernon Creek fault. Scotia Gulch and Bates Gulch follow the strike of Paleozoic formations in the West Tintic district.

Drainage patterns are also determined by type of rock being dissected. Dendritic drainage is common in the extrusive and intrusive rocks. In the western portion of the area, the long, straight main canyons such as the Great Eastern, Indian Hollow and Buck Hollow, flow in the general direction of the dip of the Precambrian formations and are therefore consequent. They are joined at right angles by many subsequent stream courses which have cut into the less resistant argillites of the Precambrian sequence, forming a modified parallel drainage pattern.

The topography is a direct result of the type of rock exposed to erosion. Igneous rocks weather rapidly and, with few exceptions, form low rolling hills and broad valleys. This is probably due to the effect of widely varying temperatures of this desert climate on the heterogeneous mineral assemblage in the igneous rocks. Limestones are relatively resistant, and form high smooth ridges. The Precambrian quartzites, although badly brecciated by thrusting, have been thoroughly recemented, and are extremely resistant to erosion. They form the high rugged mountains of the region. Many great blocks of this quartzite are strewn over the area, which possibly represent residual remnants which have remained while less resistant rocks were removed. (N. C. Williams, personal communication.)

A few evidences of mass wastage were noted. The large quartzite mass down the west slope from Maple Peak has slumped down from above, as shown by the gully and hollow above it. On the west limb of the West Tintic Anticline, a mud flow of very recent occurrence was observed.

The pediment surface sloping gently away from the high mountains has previously been described (p. 23 of this paper).

GEOLOGIC HISTORY

General Statement

The sequence of events in the area is well defined by structural relations; however, it was found necessary to correlate with events of adjoining areas for tentative dating of the orogenic periods. This is due to the fact that no significant amount of Mesozoic strata is present by which structural, sedimentary, or stratigraphic relationships might date the events.

Precambrian History

Very little time was spent by the writer in attempting to interpret Precambrian history, as it would add little to the purpose of this report. Proterozoic history of the region has been well summarized by Eardley (1940, pp. 840-841).

> It is concluded that sediments accumulated in subsiding troughs to thicknesses of more than 12,000 feet. The troughs were in part narrow and long. One trough called the Sheeprock-Cottonwood apparently extended northeastward from the Sheeprock Range to the Cottonwood uplift and hence eastward along the site of the Uintah Mountains. It was bordered on the northwest by the northern Utah highland and on the southwest and south by a highland along the margin of the Colorado Plateau.
>
> The crystalline highlands were vigorously eroded by glaciers and running water. Mechanical weathering dominated. The sediments accumulated thickest in the centers of the troughs and in overlapping fashion on the highlands.

Paleozoic History

Lower Paleozoic history as indicated by sediments present in the area was a time of little tectonic activity, except for the gentle subsidence of the Cordilleran miogeosyncline. Deposition over most of early Paleozoic time consisted essentially of the chemical type with approximately 6000 feet of dolomites and limestones being deposited, with only the Eureka quartzite, Orient shale and Allah quartzite representing a near shore environment.

In Upper Mississippian time the region became one of slightly less stable tectonic environment, with the limestones becoming sandy, and with the deposition of limestone, shales and sandstones continuing into Pennsylvanian time.

Mesozoic History

Since the only Mesozoic strata represented is a minor outcrop of conglomerate, sedimentary history during this era is obscure. It is probably that Mesozoic sediments were deposited in the region which were later removed by erosional forces following the periods of uplift. Christiansen (1952, p. 725) describes 12,500 feet of Cretaceous clastic sediments in the Canyon Range, and it seems logical to assume that deposition was occurring at the site of the present West Tintic and Sheeprock ranges, possibly on a similar scale. An alternative interpretation can be made, however, with this region being one of uplift from which sediments were derived.

Eardley (1951, p. 274) has used the term Cedar Hills orogeny for the Mid-Cretaceous phase of deformation which immediately preceded deposition of the thick coarse clastics of the Indianola group and Kelvin formation of central and north central Utah. The uplift, folding and thrusting in the West Tintic area is likely part of this phase of deformation, and occurred at the same time as the Canyon Range thrust, although Christiansen (1952, p. 732) assigns an earlier Lower Cretaceous age to the thrusting.

Cenozoic History

As interpreted from structural relations in the area, a wide range in time is possible for the emplacement of the intrusions. Loughlin (1920, p. 434) placed the time of the monzonite intrusion in the Tertiary. Since the intrusives cut Precambrian strata, they are certainly younger than the thrusting (Middle Cretaceous), and they are older than the overlying extrusives which are Eocene in age. A logical time for intrusion, therefore, would be during the Laramide orogeny. In this paper a pre-extrusive Tertiary age will be assigned to the intrusions.

In middle to upper Eocene the area was covered by thick flows of rhyolite and andesite.

Basin and Range faults have differentially tilted and uplifted the Sheeprock and West Tintic Ranges to produce the present topography. Rejuvenation has continued into fairly recent time, as shown by the dissection of the Quaternary pediment surface.

BIBLIOGRAPHY

Bauer, H. L. (1952) Fluorspar deposits at the North End of Spor's Mountain, Juab County, Utah, M.S. Thesis, University of Utah.

Campbell, G. S. (1951) Stratigraphy of the House and Confusion Ranges, Millard County, Utah, Guidebook to Geology of Utah, No. 6, pp. 19-25.

Christiansen, F. W. (1952) Structure and Stratigraphy of the Canyon Range, Central Utah, G.S.A. Bull. Vol. 63, pp. 717-740.

Eardley, A. J. and Hatch, R. A. (1940) Proterozoic Rocks in Utah, G.S.A. Bull., Vol. 51, pp. 823-843.

Eardley, A. J. (1942) Aerial Photographs: Their Use and Interpretation, Harper Bros., pp. 55-69.

Eardley, A. J. (1951) Structural Geology of North America, Harper Bros., pp. 273 and 325.

Gilluly, J. (1932) Geology and Ore Deposits of The Stockton and Fairfield Quadrangles, Utah, U.S.G.S. Prof. Paper 173, pp. 6-40.

Lindgren, W., and Loughlih, G. F. (1919) Geology and Ore Deposits of the Tintic Mining District, Utah, U.S.G.S., Prof. Paper 107.

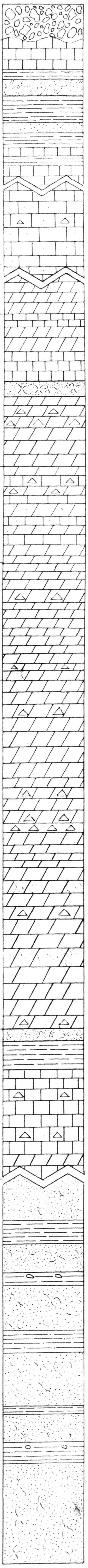
Loughlin, G. F. (1920) The Ore Deposits of Utah, U.S.G.S., Prof. Paper 111, pp. 423-439.

Nolan, T. B. (1935) The Gold Hill Mining District, Utah, U.S.G.S., Prof. Paper 177, pp. 12-43.

Proctor, P. D. & others, Generalized Section of Paleozoic Formations Exposed in the Allen's Ranch Quadrangle, Utah, (unpublished)

Stringham, B. F. (1942) Mineralization in The West Tintic Mining District, G.S.A. Bull., Vol. 53, pp. 267-290.

Wilson, S. R. (1950) Investigation of the West Tintic Tungsten Deposit, Juab County, Utah, Bur. of Mines Report of Investigations 4640.



ERA	PERIOD	EPOCH	FORMATION	THICKNESS (FEET)	DESCRIPTION
MESO	CRET.		Devils Gate conglomerate	130	Conglomerate, red, angular to subangular fragments of Paleozoic limestone well cemented in red calcereous matrix
			Unconformity		
PALEOZOIC	PENNSYLVANIAN	LOWER	Oquirrh formation	2500+	Limestone, dark gray, weathering blue-gray Shale, black to brown, calcereous, contains Productid brachiopods Quartzite, gray, limonite staining on weathered surface, calcite in fractures, medium grained, commonly quite porous
	MISSISSIPPIAN		Great Blue limestone and undifferentiated limestones	1500+	Limestone, dark gray, weathering light blue-gray, abundant horn corals and crinoid stems, sandy, cherty
			?—?—?—?		
	DEVONIAN	MIDDLE	Guilmette formation	700±	Dolomite, dark gray, weathering light gray, fine to coarse grained, with interbedded platy blue-gray limestone Allah quartzite member, fine to medium grained, white to light gray, prominent bedding, some crossbedding Dolomite, cherty, contains Cladopora sp.
			Simonson dolomite	430	Dolomite, dark gray, weathering blue-gray and black, sandy, some chert, Cladopora sp. at top of unit, black laminated beds characteristic of formation
			Sevy dolomite	700	Dolomite, medium gray, weathering light gray to cream color, very fine grained, conchoidal fracture, platy bleached white locally, some thin chert seams on bedding planes, grades upward into overlying lithology
	SILURIAN		Laketown dolomite	945	Dolomite, medium gray, weathering light gray and blue gray, cherty, 10 foot thick chert bed at base Halysites sp.
			?—?—?—?		
	ORDOVICIAN	UPPER	Fish Haven dolomite	1280 ?	Dolomite, dark gray, weathering blue-gray, cherty at base, black laminated dolomite at top, brecciated, bleached, with tremolite near base
			Eureka qtzite	38	Quartzite, white to light gray, fine to medium grained, limonite coloring on weathered surface, few thin shale partings
		LOWER	Pogonip formation	200 1000	Orient shale member, black, olive green, to brown, weathering brown, dense, metamorphosed to hornfels Limestone, cherty, granular bleached and extensively metamorphosed
PRECAMBRIAN	YOUNGER PRECAMBRIAN		Undifferentiated	7000+	Quartzite, white to gray, brown to buff to purplish brown on weathered surface, fine to medium grained, massive, brecciated and recemented near thrust plane Shale, brown to green, metamorphosed slates and phyllites, sandy, with pebbles to cobbles of well rounded quartzite in some beds

Stratigraphic Column of the West Tintic District And Vicinity, Juab Co., Utah

VERTICAL SCALE: 1" = 500 FEET