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GEOLOGY OF THE WASH CANYON AREA, SOUTHERN WASATCH MOUNTAIN, UTAH

by

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GEOLOGY OF THE WASH CANYON AREA, SOUTHERN WASATCH MOUNTAINS, UTAH

A Thesis

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MASTER OF SCIENCE

by

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ABSTRACT

The Wash Canyon area covers 16 square miles in central Utah including parts of the Middle Rockies and Great Basin provinces. The mountain portion is part of the Southern Wasatch mountains, and the basin portion is in Juab Valley.

Approximately 6,000 feet of Paleozoic marine sediments are exposed in the area. In some sections the sequence is covered with an unknown thickness of Tertiary, Quaternary, and possibly Upper Cretaceous material, mostly coarse clastics.

Pre-Laramide normal faults cut the area in a general east-west direction but most of the deformation resulted from the Laramide orogeny. The sole of the Nebo thrust probably underlies the Wash Canyon area and represents movement during Late Cretaceous time. The area experienced north-south folding during Eocene and Oligocene time, and north-south normal faulting from Pliocene to Recent time. The Wasatch fault is a part of this last event.

Water, gravel and calcite deposits are the only economic resources in the area at present. Early prospecting for lead and silver failed to locate any important metallic mineral deposits.

ACKNOWLEDGMENTS

The writer expresses thanks to Dr. Harold J. Bissell who suggested this thesis area and provided valuable assistance on stratigraphy, paleontology and writing of the text.

Cleon V. Smith helped measure sections and made suggestions when he shared camp with the writer in 1955.

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Appreciation is also extended my wife, Sherry, for her encouragement, and for typing assistance.

INTRODUCTION

Location and Accessibility

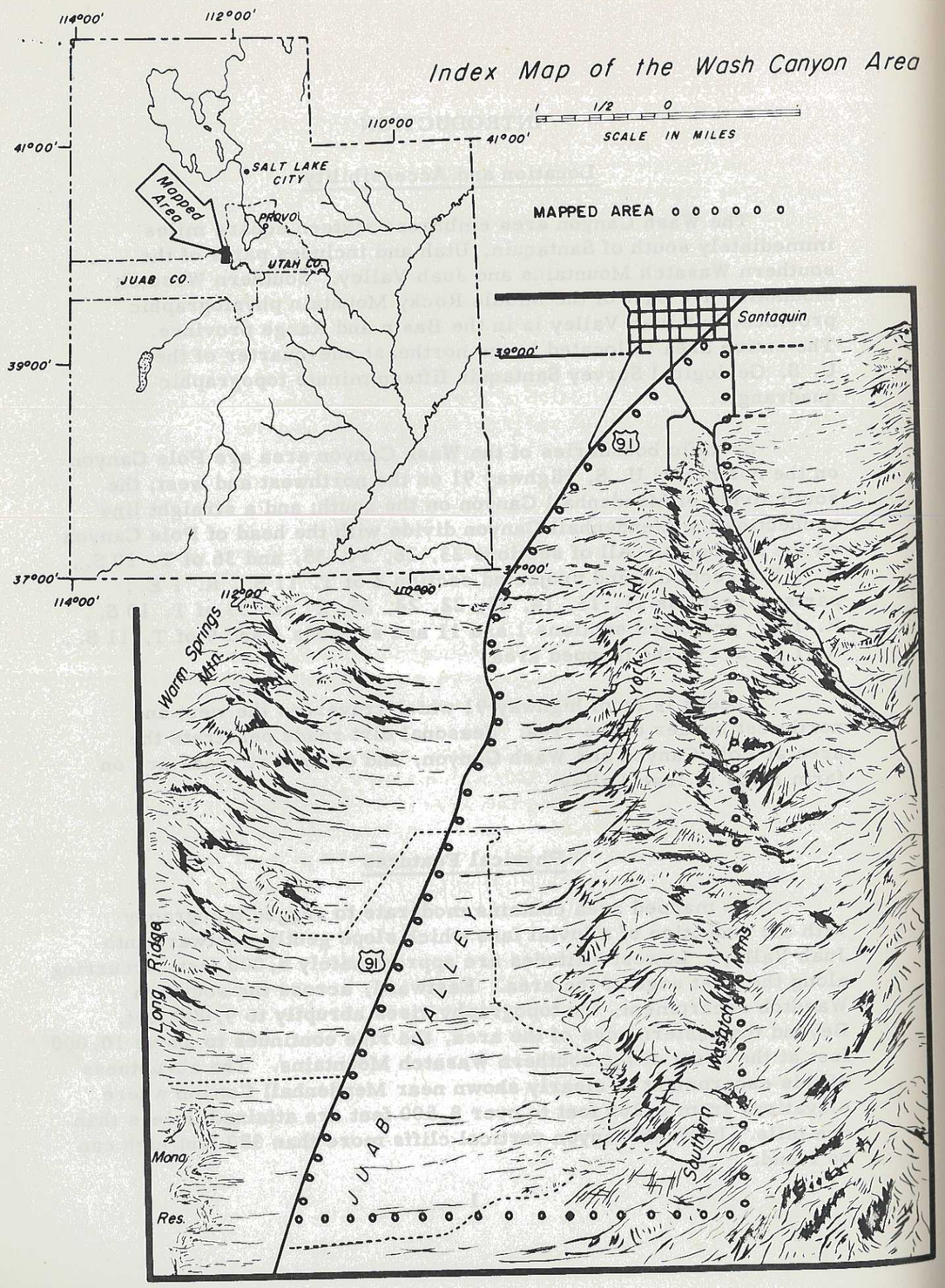
The Wash Canyon area embraces sixteen square miles immediately south of Santaquin, Utah and includes parts of the southern Wasatch Mountains and Juab Valley. Southern Wasatch Mountains are part of the Middle Rocky Mountain physiographic province, but Juab Valley is in the Basin and Range province. The entire area is located in the northeast one-quarter of the U. S. Geological Survey Santaquin fifteen minute topographic quadrangle.

Specific boundaries of the Wash Canyon area are Pole Canyon on the northeast; U. S. Highway 91 on the northwest and west; the south divide of Mendenhall Canyon on the south; and a straight line connecting the Mendenhall Canyon divide with the head of Pole Canyon on the southeast. All of sections 23, 26, 34, 35, and 36 of T. 10 S., R. 1 E.; section 3 and projected section 2 of T. 11 S., R. 1 E.; parts of sections 11, 13, 14, 15, 22, 24, 25, 27 and 33 of T. 10 S., R. 1 E.; projected sections 1 and 11 and sections 4 and 9 of T. 11 S., R. 1 E. are in the mapped area.

Access is from highway 91 which traverses the west and northwest border of the area. Seasonal dirt roads penetrate the area at Pole Canyon and Wash Canyon, and other dirt roads are on farm lands in Juab Valley.

Physical Features

The mapped area contains moderate to rugged topography with the exception of alluvial fans which slope gently westward into Juab Valley. Lowest altitudes are approximately 5,000 feet, occurring along the west edge of the area. Eastward, across the southern Wasatch escarpment, the topography rises abruptly to 9,000 feet. Beyond the eastern edge of the area, the rise continues to above 10,000 feet at the crest of the southern Wasatch Mountains. The abruptness of this escarpment is clearly shown near Mendenhall Canyon where elevations from 6,200 feet to over 8,500 feet are attained in less than one mile. In Wash Canyon vertical cliffs more than 350 feet high can be found.



Approximately one-half the area is an island-like ridge herein called York Hill surrounded by relatively flat ground. Extreme youth is shown in the canyons that dissect the uplands. Quaternary and Recent fan deposits occupy the mapped part of Juab Valley forming bajada-like deposits which maintain about 5° slopes. Upper Pole Canyon and part of Wash Canyon have subdued relief due to underlying shale formations.

Permanent springs occur in Mendenhall, Wash, and Pole Canyons; and a basin south of Wash Canyon commonly retains a small pond after rainstorms. Several small stock-watering reservoirs have been made in Pole Canyon, but they are occassionally dry in the summer. An irrigation reservoir situated at the north end of the area impounds a few hundred acre-feet of water from Santaquin Canyon.

Previous Work

Loughlin (1913, p. 447) made a very short report on the southern Wasatch Mountains and briefly described the "Intercalated Series" near Wash Canyon.

The first important work concerning the geology of the region which includes the Wash Canyon area was done also by Loughlin (1920). His chapter on the "Santaquin and Mount Nebo Region" briefly describes faults and mines in the area but geologic formations were grouped simply as Cambrian, Mississippian and younger, and Tertiary. Loughlin published a map (1920) which shows very generalized geology from Santaquin to Mona along the west face of the Wasatch Mountains. The map shows outcrops of volcanic conglomerate which are less extensive than he indicates, but considering the general nature of his work on stratigraphy, Loughlin's work is to be considered a valuable contribution.

Eardley published two extensive reports on the southern Wasatch Mountains (1933, 1934). The Wash Canyon area is well described from a reconnaissance viewpoint. Interpretation of stratigraphy in the reports differs from the present study, but these are due mostly to the lack of information available at that time and because of the scale of mapping.

Fig. 2. Aerial view of York Hill showing Juab Valley in foreground and the Wasatch Mountains behind. Photo by H. J. Bissell.

Field and Laboratory Studies

Field work for this report was done during the period July 20, 1955, to June 12, 1956, and was resumed briefly in October and November of 1959.

Data gathered from walking out formation contacts were plotted on acetate sheets used as overlays on aerial photos. The photos were taken in 1939 on a scale of 1:20,000. The 1951 U. S. Geological Survey Santaquin topographic quadrangle on a scale of 1:62,500 was used for a topographic base map. Scale changes were made in a Kail Plotter and by photographic enlargment.

Thin sections were prepared to aid in the descriptions of samples taken from measured sections, and some thin sections were cut in an effort to locate foraminifera. Most of the equipment used on all phases of this report was provided by the Department of Geology at Brigham Young University.

GENERAL GEOLOGY

Sedimentary Rocks

Slightly more than 6,000 feet of sedimentary strata are exposed in the Wash Canyon area. Most abundant are Paleozoic limestones and dolomites with two important Paleozoic shales and a Cambrian quartzite. Quartzites that are present as units in carbonate formations complete the Paleozoic section. No Mesozoic rocks are recognized in the area, but Tertiary rocks including conglomerates, a limestone and a shale. Quaternary fans, alluvium and landslide material are present.

Igneous Rocks

No igneous rocks are known to occur in the present area but two Tertiary lamprophyre dikes and a Cambrian diabase flow have been identified within three miles of the area. Loughlin (1920, p. 327) and Eardley (1933, p. 315) describe a lamprophyre dike in Bear Canyon to the south, and Santaquin Canyon to the northeast. Abbott (1951) and others have discussed a diabase flow contained in the Tintic quartzite at North Canyon which probably extends into the buried portions of Tintic quartzite in the Wash Canyon area.

Conglomerate consisting of volcanic materials is widely distributed in the area and is included with sedimentary rocks in this report.

STRATIGRAPHY

Precambrian

No Precambrian rocks are exposed in the Wash Canyon area, but a mile to the south, near North Canyon, several hundred feet of Late Precambrian rocks occur (Smith, 1956, p. 6).

Cambrian System

Cambrian formation names used in the Wash Canyon area are those given by Loughlin and Lindgren (1920) in the Tintic district, which lies 20 miles due west. General thinning from west to east across this 20 miles reduces the Cambrian section from a total thickness of 7800 feet at Tintic to 2900 feet of the same formations at North Canyon where the section was measured by C. V. Smith and the writer (1956).

Tintic Quartzite

Tintic quartzite is exposed in small areas on both sides of Mendenhall Canyon. Only a few hundred feet of the upper part of the formation are found and these are poorly exposed. A more complete section of Tintic quartzite is exposed at North Canyon and was measured by Cleon Smith and the writer; complete descriptions of this section are given by Smith (1956, p. 7). The total measured section at North Canyon is 929 feet thick.

At Mendenhall Canyon the Tintic quartzite is yellow-brown, weathering rust-brown. It is mostly medium-grained with some fine-grained units. The few outcrops indicate medium bedding with thin shaly partings near the top. The contact between the Tintic quartzite and overlying Ophir formation was established on the highest important quartzite unit, about three feet thick, in the sequence where interbedded shales and quartzites comprise the section. Tintic quartzite is likely early Albertan age (Rigby, 1959, p. 13). No fossils were found by the present writer.

SYSTEM	SERIES	FORMATION	THICK	REMARKS
QUATERNARY		ALLUVIUM	?	Alluvium and colluvium
TERTIARY	MIOCENE ? OLIGOCENE	VOLCANIC CONGLOMERATE	?	Pyroclastic breccia and conglomerate
	EOCENE ? PALEOCENE	FLAGSTAFF LIMESTONE	0-100	White algal limestone
		PRICE RIVER* NORTH HORN	?	Red weathering conglomerate
CRETACEOUS	MONTANAN			
PENN.	MORROWAN	OQUIRRH FORMATION	200	Interbedded limestone and quartzite
	SPRINGERAN	MANNING CANYON SHALE	600	Brown and green shales
MISS.	CHESTERAN	GREAT BLUE LIMESTONE	300	Gray weathering dark ls.
	MERAMECIAN	HUMBUG FORMATION	712	Interbedded sandstone and limestone
	OSAGEAN	PINE CANYON LIMESTONE	851	Cherty fossiliferous limestone
	KINDERHOOK	GARDNER DOLOMITE	510	Thin bedded fossiliferous limestone
CAMBRIAN	CROIXAN	AJAX FORMATION	336	Thin bedded gray limestone
		OPEX DOLOMITE	166	Massive weathering dolomite
	ALBERTAN	COLE CANYON DOLOMITE	603	Alternating light and dark dolomite
		BLUEBIRD DOLOMITE	82	Dolomite with numerous "twiggy bodies"
		HERKIMER LIMESTONE	233	Limestone with argillaceous banding
		DAGMAR LIMESTONE	40	Light weathering laminated dolomite
		TEUTONIC LIMESTONE	347	Limestone with argillaceous partings
		OPHIR FORMATION	231	Olive sericitic shale
		TINTIC QUARTZITE	929	Massive pink to brown quartzite

Figure 3. Summary chart of the stratigraphy of the Wash Canyon area, southern Wasatch Mountains, Utah.

Ophir Formation

Excellent exposures of Ophir formation occur one mile south of the Wash Canyon area at North Canyon. Within the mapped area a moderately good section of this formation is found on the north side of Mendenhall Canyon adjacent to the road leading to Wash Canyon. Other exposures are noted along a narrow strip at the base of the steeply rising mountains which trend out of the area on the east side. Small outcrops also occur along the mountain front south of Mendenhall Canyon. General lithologic characteristics of the Ophir formation in these areas are essentially the same as those in the measured section at North Canyon.

The Ophir formation is easily divided into three units: a lower shale, a middle limestone, and an upper shale, totaling 231 feet.

The lower shale lies conformably upon the Tintic quartzite, and the contact between the two formations is arbitrarily drawn where shale predominates over quartzite and the latter eventually disappears. The lower shale is 122 feet thick and is dominantly olive-green to brownish-green micaceous shale. Sericite is very conspicuous on most of the Ophir shales. According to Eardley (1932, p. 316), beds more than one-half inch in thickness are actually well-cemented sandstones. One slab containing inarticulate brachiopods was found near the top of the lower shale, but since the slab was found in float, the stratum from which it came was not located. The writer recognized Micromitra sp. and Obollela sp. from the slab, but the specimen is no longer retained.

The middle limestone member is 55 feet thick and consists of dark blue limestone which weathers medium-bluish gray. Ragged, yellowish brown argillaceous bands lying parallel to the bedding are common. The upper 25 feet is oolitic sandy limestone and is less resistant than the lower part. The upper shale member is 54 feet thick and is a green, fissile shale with conspicuous sericite flakes. Contact with the overlying Teutonic limestone is abrupt but conformable. The Ophir formation is early Albertan age (Rigby, 1959, p. 13).

Teutonic Limestone

The Teutonic limestone is Middle Cambrian in age (Lindgrin, 1920, p. 398), and is the oldest all-carbonate formation in the area. Best exposures of this formation in the mapped area are in a band above the one described for the Ophir formation between Mendenhall

Canyon and the eastern edge of the area. Some outcrops appear on the south side of Mendenhall Canyon but jointing and warping tend to alter their normal characteristics.

At North Canyon 347 feet of the Teutonic limestone were measured, revealing distinct but conformable contacts with the shale below and with the much lighter-weathering Dagmar limestone above.

The Teutonic limestone is more than half dolomite where the section was measured, with 161 feet of limestone found mostly at the base compared to 196 feet of dolomite. In general appearance the Teutonic limestone is medium to dark blue, fine-grained, and contains locally abundant white "twiggy bodies." Bedding is thick to massive, resulting in numerous vertical cliffs. Mottling and twiggy bodies occur throughout the formation, and in the lower 100 feet discontinuous bands of brown argillaceous material are common. In the upper 80 feet, light gray oolite beds with no "twiggy bodies" were more characteristic. No fossils were collected from the Teutonic limestone.

Dagmar Limestone

The Dagmar limestone is dated as Middle Cambrian (Lindgren, 1920, p. 398). This formation is one of the most easily recognized carbonate formations in the area, appearing as a distinct creamy white band about 40 feet thick between darker beds. Although the section described is in North Canyon, good exposures also are found from Wash Canyon to the south side of Mendenhall Canyon.

The formation in Wash Canyon and North Canyon is resistant, aphanitic to fine-crystalline dolomite rather than limestone; fresh surfaces are light gray to brownish gray, while weathered surfaces are very light gray. Paper-thin laminae lying parallel to bedding planes characterize the Dagmar limestone. No fossils were found.

Two sharp contrasts are found in the Dagmar limestone of this area compared to that of the type section at Tintic. The formation thins from west to east (100 feet to 40 feet) and grades from limestone at Tintic to dolomite at Wash Canyon.

Herkimer Limestone

The Herkimer limestone was named by Loughlin and Lindgren in the Tintic district and was dated by them as Middle Cambrian age (Lindgren, 1920, p. 398).

In the Wash Canyon area the Herkimer limestone is found on both sides of Mendenhall and Wash Canyons. The west face of York Hill likely contains beds of this formation but their presence can only be approximated because of the brecciated nature of the rocks in this area. The Herkimer limestone is much darker than the underlying Dagmar limestone revealing a very sharp, conformable boundary between the two formations. The contact between the Herkimer limestone and overlying Bluebird dolomite is established where the upper limestone grades conformably into dolomite.

At North Canyon, 233 feet of Herkimer limestone was measured. The lower ten feet and the top 92 feet of the formation consist of limestone and the remainder is dolomite. The section measured at North Canyon is easily divided into three units: a lower dolomite, 62 feet thick; a middle dolomite, 79 feet thick; and an upper limestone, 92 feet thick. The lower dolomite shows a medium gray fresh surface and weathers light gray. It is fine-crystalline, medium bedded, massive weathering with a brown sandy-appearing surface. Oolites and "twiggy bodies" are locally abundant. The middle dolomite is essentially the same as the lower unit but much less resistant to erosion and forms a bench. The upper limestone is an excellent marker bed, readily identified when approached on foot. This upper unit has a characteristic thin bedding which upon weathering breaks up in the form of an unusual "chicken-wire"* talus. On a fresh surface the limestone is medium-dark blue, fine grained, and very thin-bedded. Weathered surfaces are blue with brownish pink argillaceous bands, laminae, and thin layers lying essentially parallel to the bedding.

No fossils were taken from the Herkimer limestone.

Bluebird Dolomite

In the Wash Canyon area the Bluebird dolomite is exposed on the south side of Wash Canyon and in scattered outcrops on both sides of Mendenhall Canyon. Near the base of the west face of York Hill, Bluebird outcrops are found intermittently and they represent the oldest sediments along this area that can be positively identified. Older units are likely present but they are obscured by intense brecciation associated with faulting.

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*Term used by H. J. Bissell while making reconnaissance investigations with Cleon V. Smith and the writer, July, 1955.

Eighty-two feet of the Bluebird dolomite were measured at North Canyon where excellent exposures occur. The entire formation is medium blue, massive bedded, unfossiliferous dolomite. The texture is medium-grained to medium crystalline with an abundance of "twiggy bodies" in some units. The top ten feet of Bluebird dolomite contain enough "twiggy bodies" to serve as a good marker bed in the zone of contact between the Bluebird dolomite and the overlying Cole Canyon dolomite. The contact is conformable and is clearly seen in the field at the base of the first light gray band of the Cole Canyon striped beds.

Cole Canyon Dolomite

The Cole Canyon dolomite, with its characteristic alternating light and dark beds, is easily identified from a distance or close up. Banding is most pronounced near the base and the contact between Cole Canyon dolomite and the underlying Bluebird dolomite is set at the base of the lowest white band.

Exposures of Cole Canyon dolomite in the Wash Canyon area were found in a continuous band from the south ridge of Mendenhall Canyon, through Wash Canyon, and beyond the area east of the head of Pole Canyon. Another strip of Cole Canyon is found along the face of York Hill from Wash Canyon to the vicinity of York.

The writer and C. V. Smith measured 603 feet of Cole Canyon at North Canyon compared to only 500 feet of this formation described by Loughlin (1919, p. 398) at Tintic, and 230 feet measured by D. J. Peterson (1956, p. 15) on west Loafer Mountain.

No fossils were found in the Cole Canyon dolomite.

Opex Formation

The thin bedded dolomite above the Cole Canyon is called Opex formation after the Opex described by Loughlin at Tintic (1919, p. 398). The rock is medium-blue dolomite with numerous, ragged black chert bands. The lower contact is placed at the top of the highest light-colored bed of the Cole Canyon dolomite. Morris (1957) suggests a slight disconformity for this contact. The upper contact is an abrupt change to limestone limiting the Opex formation at North Canyon to 166 feet. No upper unconformity was observed in this section but Brown (1950, p. 25) states that an unconformity is visible near Payson, eight miles north of the present area.

Distribution of the Opex dolomite is limited to a small locality along the ridge between Wash and Mendenhall Canyons, and to a band along the west face of York Hill. These exposures are poor but the formation can be located by its position above the Cole Canyon dolomite.

No fossils were found in the Opex dolomite in this area, but the formation is assigned the Upper Cambrian age by U. S. Geological Survey (Morris, 1957).

Opex-Ajax Unconformity

In the Wash Canyon area there is no direct evidence of an unconformity between the Opex dolomite of Middle or Late Cambrian age and the Ajax limestone of Late Cambrian time. The measured section at North Canyon also failed to show an unconformity, but Brown (1950, p. 6) states that an unconformity can be seen near Payson eight miles north of the present area. If such an unconformity is present in the Wash Canyon area, it probably occurs as a disconformity, possibly blended.

Ajax Limestone

The Ajax limestone in the Wash Canyon area consists of a thin-bedded blue-gray limestone with a thick dolomite unit near the top; its total thickness is 336 feet. Above the dolomite unit is a three-foot bed of light-gray calcareous quartzite overlain by 15 feet of thin-bedded blue limestone. Thick-bedded lower Gardner* dolomites appear in sharp contrast above the limestone. No upper unconformity was recognized, but an erosional disconformity exists because Ordovician, Silurian and Devonian rocks are missing in the section.

Exposures of the Ajax limestone are mapped at the head of Mendenhall Canyon and along the west face of York Hill. Location of the outcrop on York Hill is approximate, due to excessive jointing and weathering habit which obscure the general character of the rock.

The Ajax limestone was generally assigned to the Ordovician system until Morris found Late Cambrian fossils recently (Morris, 1957). This writer found a few echinoderm columnals in the Ajax.

*Location of contact suggested by Dr. Bissell.

Mississippian System

General Statement

Five Mississisippian formations are recognized in the Wash Canyon area. The three oldest, in ascending order, are Gardner dolomite, Pine Canyon limestone, and Humbug formation that were named and described in the Tintic district (Loughlin, 1919, pp. 399-400). The two younger formations are correlated with the Great Blue limestone of the Mercur mining district, and the Manning Canyon shale of the Ophir and Mercur area (Spurr, 1895, p. 374 and Gilluly, 1932, p. 31). The Manning Canyon shale apparently includes the Mississippian-Pennsylvanian contact as discussed later.

The Wash Canyon area is approximately on the "Wasatch Line" that separates the Millard Belt from the craton to the east (Kay, 1951, p. 14). Westward into the miogeosyncline there is an overall thickening of Paleozoic formations, and in the 20 miles from Wash Canyon to Tintic the Paleozoic sequence approximately doubles in thickness (see figure 4). The total Mississippian section as measured in North Canyon and Wash Canyon is approximately 2400 feet thick and is mostly limestones and sandstones with minor dolomite and shale. The base of the Mississippian section lies unconformably upon Cambrian beds.

Gardner Dolomite

Gardner dolomite is the oldest Mississippian formation in the Wash Canyon area and is dated Kinderhookian to lower Osagean (Bissell, 1959a, p. 42).

Numerous sections of Gardner dolomite have been described in Central Utah but Morris (1957) suggests "Madison limestone" be used because the original Gardner described by Loughlin (1919) includes Devonian strata. The writer prefers "Gardner" in an effort to conform with several adjacent theses pending the outcome of current discussion about these units. Bissell (1959b, pp. 154-157) discussed reasons for not accepting the name Madison formation as far south as Central Utah. Blending the two formation names to "Gardison" as suggested by the U. S. Geological Survey (Crittenden, 1959, p. 65) seems even less reasonable to the present writer.

Exposures of Gardner dolomite are limited to the west face of York Hill in the mapped area, but to the east beyond this area in

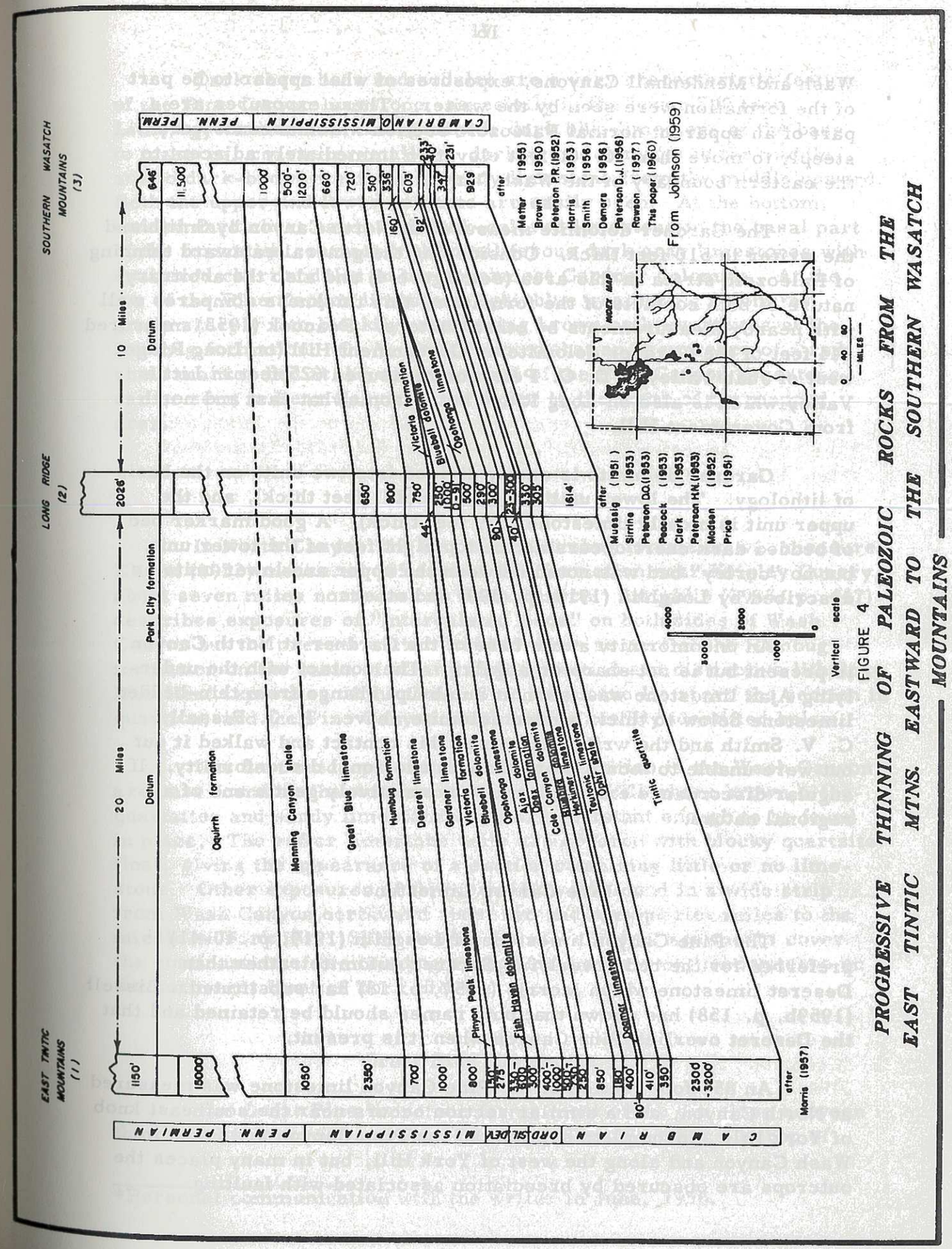

FIGURE 4
PROGRESSIVE THINNING OF PALEOZOIC ROCKS FROM THE EAST TINTIC MTNS. EASTWARD TO THE SOUTHERN WASATCH MOUNTAINS

Wash and Mendenhall Canyons, exposures of what appear to be part of the formation were seen by the writer. These exposures are a part of an apparent normal Paleozoic section which ascends very steeply to more than 10,000 feet elevation immediately adjacent to the eastern boundary of the Wash Canyon area.

The Gardner dolomite measured at North Canyon by Smith and the writer is 510 feet thick. Considering the general eastward thinning of Paleozoic strata in this area (see figure 4) and also the arbitrary nature of both contacts of the formation, this thickness compares well with nearby measurements by other writers. Peacock (1953) measured 744 feet of the Gardner dolomite on Government Hill (on Long Ridge west of Juab Valley). D. O. Peterson measured 625 feet in Little Valley which is also on Long Ridge but is somewhat east and north from Government Hill.

Gardner dolomite is easily divided into two units on the basis of lithology. The lower unit is dolomite (231 feet thick), and the upper unit is mostly limestone (279 feet thick). A good marker bed of bedded dark chert occurs as the top eight feet of the lower unit, but no "curley" bed was noted between the upper and lower units as described by Loughlin (1919, p. 399) and others.

An unconformity at the base of the Gardner at North Canyon is present but is not sharp or angular. The contact with the underlying Ajax limestone was taken at an abrupt change from thin-bedded limestone below to thick-bedded dolomite above. H. J. Bissell, C. V. Smith and the writer examined this contact and walked it out but were unable to locate more than an erosional disconformity. If angular discordance exists, it must be relatively gentle and of a regional nature.

Pine Canyon Limestone

The Pine Canyon limestone of Loughlin (1919, p. 40-41) is preferred for the beds overlying Gardner dolomite rather than Deseret limestone which Morris (1957, p. 18) has substituted. Bissell (1959b, p. 158) has shown that both names should be retained and that the Deseret overlies Pine Canyon when it is present.

An 851 foot section of the Pine Canyon limestone was measured at North Canyon, and a similar section occurs near the southeast knob of York Hill. Incomplete sections of the Pine Canyon are found in Wash Canyon and along the west of York Hill, but in many places the outcrops are obscured by brecciation associated with faulting.

Dark chert beds and nodules are a very characteristic feature of the Pine Canyon limestone, especially in the lower 500 feet. Lithology varies from fine-grained, dark blue limestone at the base to massive, coarse-crystalline, dark gray dolomites in the middle, and to dark-brown weathering sandy limestone from the middle upward. Both the upper and lower contacts are easily seen. At the bottom, bedded dark chert bands and dark-colored limestone in the basal part of the formation contrast with fossiliferous dark gray limestones with scattered chert nodules in the uppermost Gardner dolomite. At the top of the Pine Canyon limestone light-blue weathering dolomites grade sharply into blockily-weathering brown orthoquartzites of the Humbug formation. C. V. Smith* noted that an occurrence of a red shale marker bed at the upper contact of the Pine Canyon limestone can be seen in Bear Canyon three miles to the south of the mapped area.

Humbug Formation

In North Canyon 712 feet of the Humbug formation was measured. Elison (1952) measured 785 feet of this formation near Keigley Quarry, about seven miles northwest of Wash Canyon. Loughlin (1913, p. 447) describes exposures of "Intercalated Beds" on both sides of Wash Canyon but the present writer mapped these as part of the Humbug formation on the basis of stratigraphic position and distinctive lithology. Excellent exposures of the Great Blue limestone lie above the section in question, and the Pine Canyon limestone is readily identified below.

The best outcrops of the Humbug formation in the Wash Canyon area are found on the southwest face of York Hill where brown orthoquartzites and sandy limestone units are resistant enough to be found in place. The softer limestone units are covered with blocky quartzite float, giving the appearance of a section containing little or no limestone. Other exposures of this formation are found in a wide strip from Wash Canyon northward about two and one-quarter miles to the middle of York Hill. Slide debris and more recent sediments cover the continuation of the Humbug except for a poorly exposed outcrop on the northwest front of York Hill.

Great Blue Limestone

The Great Blue limestone forms most of the dip slope between the crest of York Hill and Pole Canyon. The only other outcrop of

*Personal communication with the writer in June, 1956.

Great Blue limestone is a narrow strip from the south side of Wash Canyon, through the canyon and extending to within one-quarter mile of the canyon north of Wash Canyon. Beyond this point Tertiary beds cover the formation. A small block of limestone outcrops nearly a mile west of the mouth of Mendenhall Canyon. This outcrop is mapped as Great Blue limestone (?) essentially on lithologic similarity to beds of the Great Blue limestone.

A common feature of this limestone is a nearly black fresh surface compared to a light, blue-gray weathered surface. Exposures are poor in the mapped area but the lower contact with the Humbug formation is clearly shown on the west face of York Hill near Wash Canyon. Basal Great Blue limestone is considered at the bottom of an eight-foot ledge of light gray lithographic limestone. A few feet below this marker bed the limestone grades into a brown quartzite common to the Humbug formation. Above the lithographic bed fine-grained, blue to blue-black limestones are found interbedded with units of crinoidal bioclastic limestones. Toward the top of the section of Great Blue limestone, thin-bedded, pink-weathering limestone beds are evident. These pink beds are soft and tend to weaken the overall resistance of the formation. These soft beds are seen west of Pole Canyon but not in Wash Canyon, indicating that part of the Wash Canyon section is missing. At Wash Canyon about 120 feet of Great Blue limestone was measured but the light-colored marker bed at the base was not found. West of Pole Canyon the Great Blue limestone is probably more than 300 feet thick. This thickness is only estimated because the shaly beds of upper Great Blue grade into Manning Canyon shale and form slopes.

Great Blue limestone is dated as Chesteran (Davis, 1956, p. 6).

Fossils are locally abundant in the Great Blue limestone. Bryozoans, productid brachiopods, and echinoderm stems are most common but some corals, gastropods and other brachiopods occur. Thin sections cut to verify Great Blue limestone outcrops on the north part of York Hill revealed Chesteran Plectogyra sp. (Woodland, 1958, pp. 15-21), Endothyra sp. and one Millerella sp.

Mississippian-Pennsylvanian Systems

Manning Canyon Shale

Manning Canyon shale is found in a broad strip from Juab Valley west of Wash Canyon through upper Pole Canyon to the west side of Pole Canyon. Only one outcrop on the stream in upper Pole

Canyon was found that actually exposes beds of shale; the remainder of the formation was mapped on the basis of float, distinctive soil type, and stratigraphic position. Throughout the area the Manning Canyon shale forms a strike valley with low relief. Dense vegetation covers the shale in all places except in Juab Valley.

The formation is an olive-green to black carbonaceous shale, weathering to a dull gray-brown soil. A few thin beds of dark limestone and brown subgraywacke appear in the shale adjacent to the Wash Canyon road in section 2, T. 11 S., R. 1 E.

Measurements of the thickness of Manning Canyon shale were attempted at several places but the results ranged from less than 100 feet, south of Wash Canyon, to over 1000 feet in Pole Canyon and on the north side of Wash Canyon. In view of faulting that has cut out part of the formation in some areas and duplicated it in others, the writer suggests that 600 feet or more of the Manning Canyon shale is present.

Age of the Manning Canyon shale is possibly upper Chesteran to lower Springeran (Sadlick, 1955).

Well preserved fossils of the following genera were found in Pole Canyon: Chonetes sp., Linoproductus sp., (?), Dictyoclostus sp., Composita sp., Spirifer sp., Angyomphalus sp., Lophophyllidium sp., Zaphrenthis sp., Pentremites sp., and a broken trilobite pygidium similar to Proetus sp.

Pennsylvanian System

General Statement

The upper part of the Manning Canyon shale (described with the Mississippian System) and the Oquirrh formation are the only Pennsylvanian strata in the area. Loughlin (1919) and Eardley (1933) mapped what is now known as the Oquirrh formation as the "Intercalated Series" in earlier reports. Bissell (1936, p. 239) first applied Oquirrh formation to these rocks in the Wasatch Mountains.

Oquirrh Formation

The Oquirrh formation was named by Gilluly (1932, p. 34) from exposures in the Oquirrh Mountains of central Utah.

Exposures of the Oquirrh formation in the mapped area are limited to two small outcrops, one near the road between Wash and Mendenhall Canyons, and the other at the head of Pole Canyon.

Stratigraphic position and characteristic lithology were used to identify the Oquirrh in this area. Both exposures of this formation lie stratigraphically above the Manning Canyon shale. Thirty-four samples were cut, some in thin sections, in search of fusulines to positively date these small outcrops but no key forms could be recognized. The beds resemble those described by Baker (1947) and Bissell (1952, p. 585) of lowermost Oquirrh formation in central Utah. The writer also notes a resemblance to basal Oquirrh outcrops seen at West Mountain, Lake Mountain, and Provo Canyon in central Utah.

Thickness of the Oquirrh formation in the Wash Canyon area is probably less than 200 feet and represents only a fraction of the total thickness of the formation in the general area. If complete, the Oquirrh section might exceed 15,000 feet in thickness. Baker (1947) measured 26,000 feet near Springville less than 30 miles to the north. Eight miles to the south, Johnson (1959, p. 10) measured 11,500 feet at Mount Nebo with Derryan and older series faulted out.

Age of the total Oquirrh formation extends from Springeran to Wolfcampian but probably only Springeran and Morrowan are represented in the Wash Canyon area. The remainder of the section is cut out by faulting.

Cretaceous-Tertiary Systems

Price River-North Horn Formations (undivided)

The Price River and North Horn formations were named by Spieker and Reeside (1925, p. 445) from exposures in Carbon County. In the Wash Canyon area of the Southern Wasatch Mountains these formations occur mostly as float from low outcrops and therefore attempts to identify them separately were not successful.

Upper Price River formation and the North Horn formation were originally included in the "Wasatch Formation," but have since gained formation rank (Spieker, 1946, p. 122) with type sections in the Price River Canyon area.

Exposures of undivided Price River-North Horn in the Wash Canyon area are restricted to the northern half of York Hill. Even from a distance of several miles red coloration suggests the unit. Detailed study suggests that parts of these formations are present. Some exposures are present in Pole Canyon. An unusual red-colored landslide mass has descended into Juab Valley in the northeast quarter of section 27, T. 10 S., R. 1 E. Most of the debris in this slide has been derived from Price River-North Horn beds farther east.

Lithologically, these formations are coarse material normally forming boulder to cobble conglomerate with a calcareous and red sandy matrix. Individual cobbles and boulders are mostly limestone and dolomite with locally abundant quartzite. Peacock (1953) notes that Cambrian through Mississippian carbonate discrete fragments are abundant in a lower unit, whereas Cambrian and Precambrian quartzites dominate in an upper unit.

The angular to sub-rounded nature of individual fragments, and generally poor sorting suggest rather short distance of transport. Observations by Peacock, however, revealed percussion marks on some stones indicating rolling, bounding and grinding during transit.

Lower contact of the Price River-North Horn formation is in angular discordance with the underlying Pennsylvanian Oquirrh formation. The Flagstaff limestone disconformably overlies it at the top (Spieker, 1946).

In the absence of measurable exposures the Price River-North Horn formation in this area is estimated to be several hundred feet thick.

Age of the Price River formation is Montana and Lance according to Spieker (1946, p. 131); and the North Horn formation extends from Lance to Paleocene, therefore bridging the Cretaceous-Tertiary boundary.

Tertiary System

Flagstaff Limestone

Two small outcrops of algal limestone, less than 100 feet thick, represent the Flagstaff limestone in the Wash Canyon area. The unit is found in the northwest corner of Section 26, T. 10 S., R. 1 E., and is surrounded by coarse red float. Inasmuch as the location is on the south edge of the slide mentioned above, positive identification could not be made of the beds above and below the Flagstaff limestone.

The Flagstaff limestone was deposited in Paleocene time in a fresh-water environment (Spieker, 1946, and Eardley, 1933). Unique, concentric banding in the light gray algal balls of this limestone make it one of the easiest formations to identify in the area.

Volcanic Conglomerate

Extensive deposits of rounded volcanic conglomerate are exposed in the north and northwest portions of the mapped area. The clasts in this deposit have been described as porphyritic augite-andesite and as hornblende-augite-andesite with conspicuous phenocrysts of labradorite and other minerals (Loughlin, 1919, pp. 326-327, and Eardley, 1933). In addition, the present writer noted the presence of small fragments of yellow and mottled purple chalcedony. The size range is also extended from a maximum of two feet to one almost five feet. A single boulder about this size lies near the north quarter-corner of section 23, T. 10 S., R. 1 E.

In the southwest quarter of section 33, T. 10 S., R. 1 E., an outcrop of this conglomerate occurs with the soft tuffaceous silty and sandy matrix still intact. Strike and dip measurements were N. 37° E. and 80° W. Although such a poor outcrop is difficult to measure accurately, nevertheless the steep westward dip bears mention here. Slumping, which is common near faults along the Wasatch Mountains, is likely responsible for disturbing this particular block.

Deposition of the volcanic conglomerate was probably by fluvial agencies based on the rough sorting observed at the exposure where the tuffaceous material is in place.

Age of the conglomerate is definitely more recent than beds of the old "Wasatch formation" but probably before the beginning of north-south normal faulting. The exact date of deposition is probably within the span from late Eocene to possibly early Miocene.

Quaternary System

Lake Bonneville Group

Only an upper terrace of ancient Lake Bonneville is found in the area. For a short time Juab Valley was connected with the lake by a narrow channel near York (Gilbert, 1890). A small wedge of

sediment from York to the northern end of the area is lower than the 5135 foot elevation attained by the lake. This wedge is a nearly flat bar that presumably accumulated by wave action in the Utah Bay of old Lake Bonneville (Gilbert, 1890, and Bissell, 1948), and likely is part of the Bonneville formation. Terraces in Juab Valley are confined to the west side on Long Ridge, even though part of the mapped area on the eastern side of the valley was covered by the lake.

Alluvium

Unconsolidated continental deposits of poorly sorted clay to boulder size material are mapped in this report as Quaternary alluvium. This type of sediment covers the mapped part of Juab Valley, forming a bajada-like feature common to the Great Basin province. Other small deposits are along the Bonneville bar on the northwest edge of the area.

Slide Deposits

Two slides are mapped in the area, one east of York and one at the mouth of Mendenhall Canyon. The slide near York is post-Lake Bonneville and consists mostly of Price River-North Horn debris. Material in the slide at Mendenhall Canyon is derived mostly from Paleozoic carbonates to the east. Snowslides -- but not glaciers -- may be partly responsible for the latter deposit.

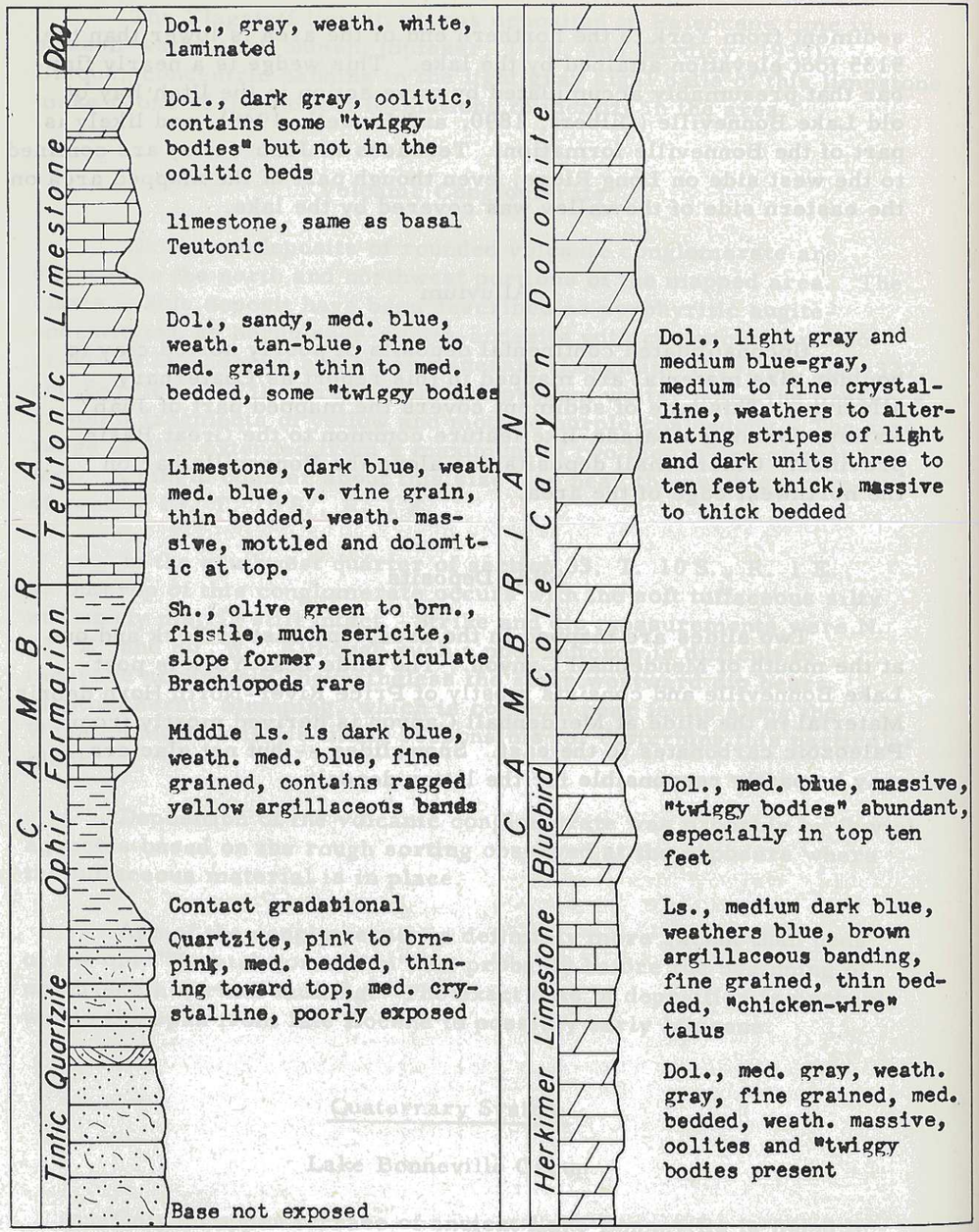

Figure 5

Columnar sections of stratigraphy in Wash Canyon and North Canyon

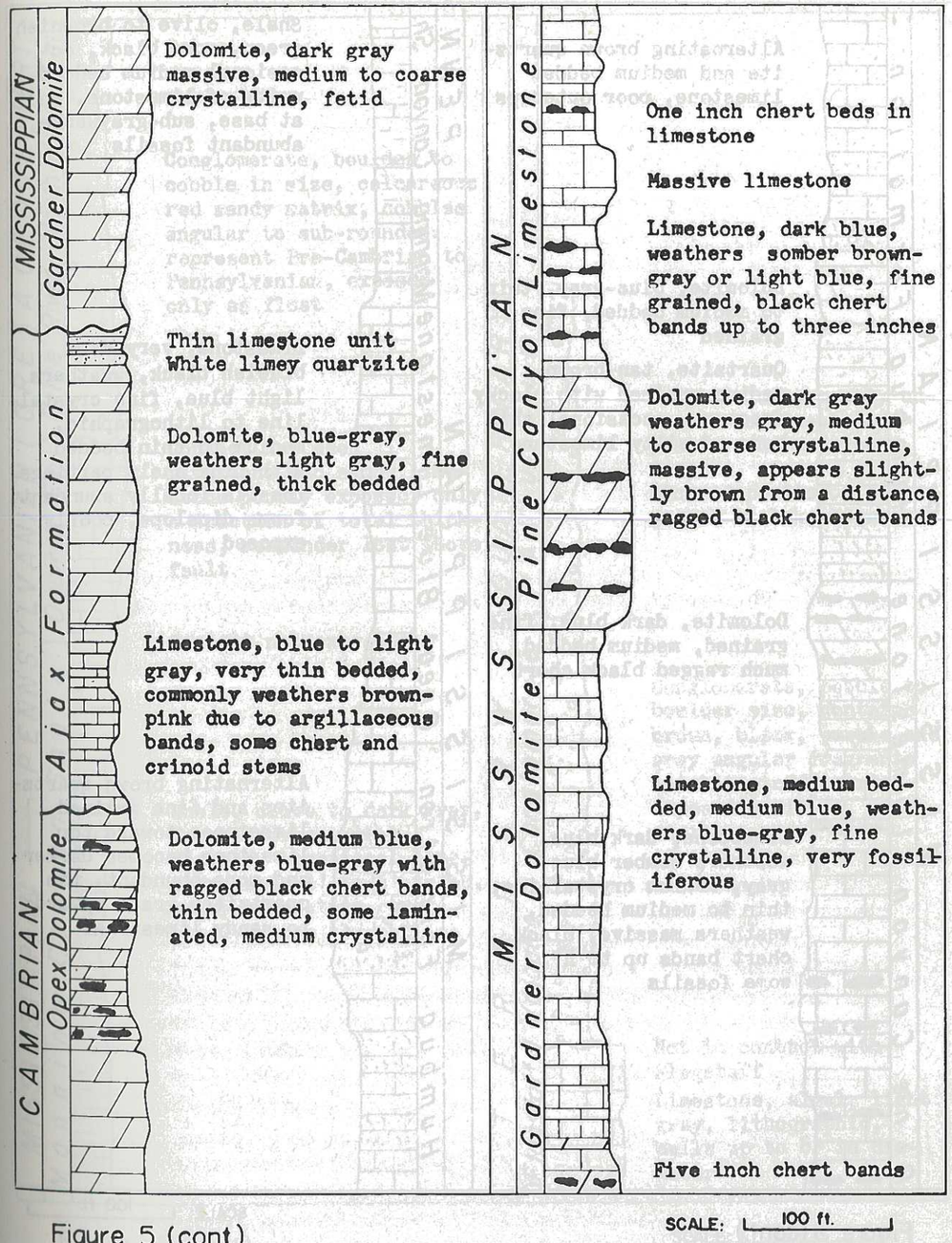

Figure 5 (cont.)

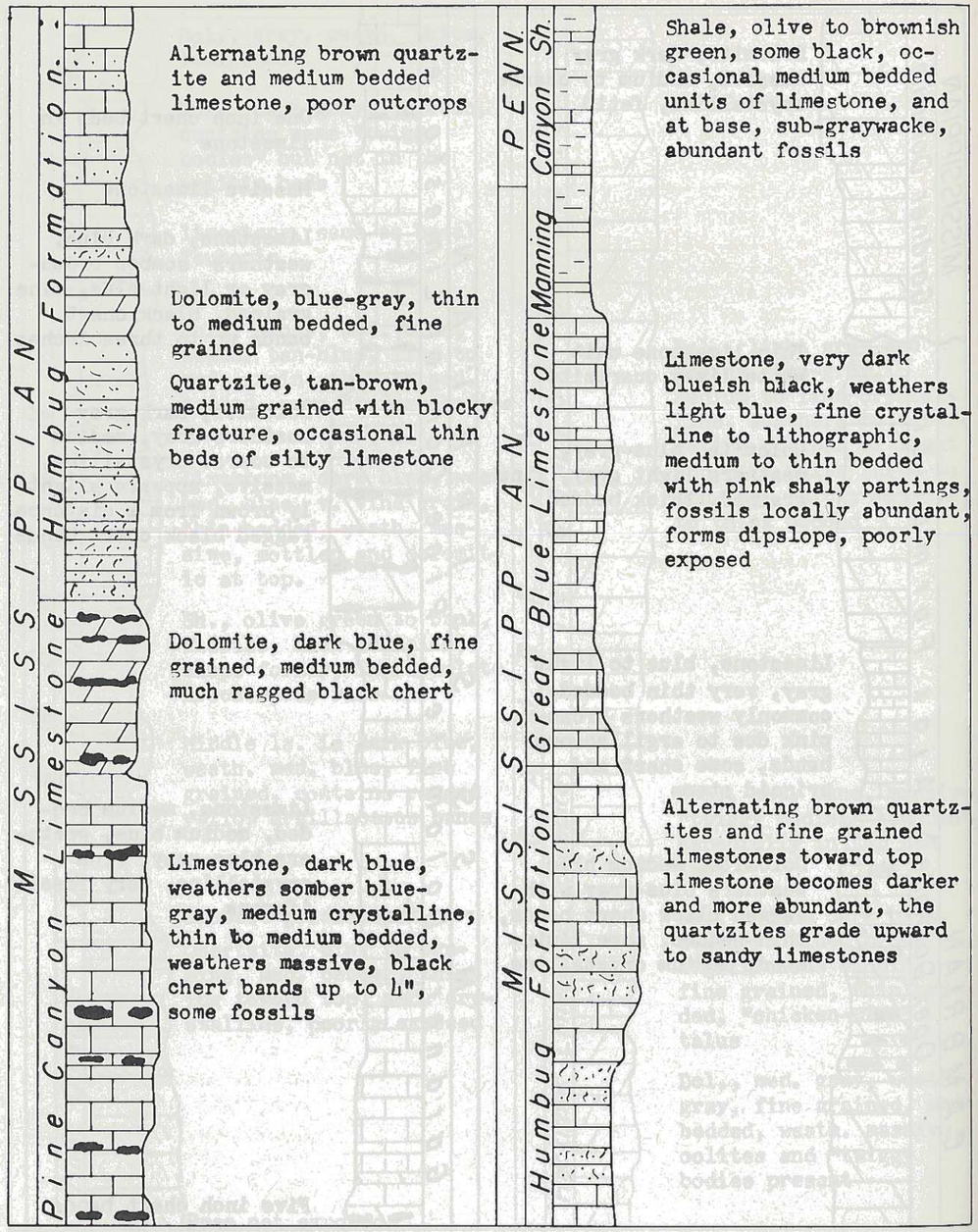

Figure 5 (cont.)

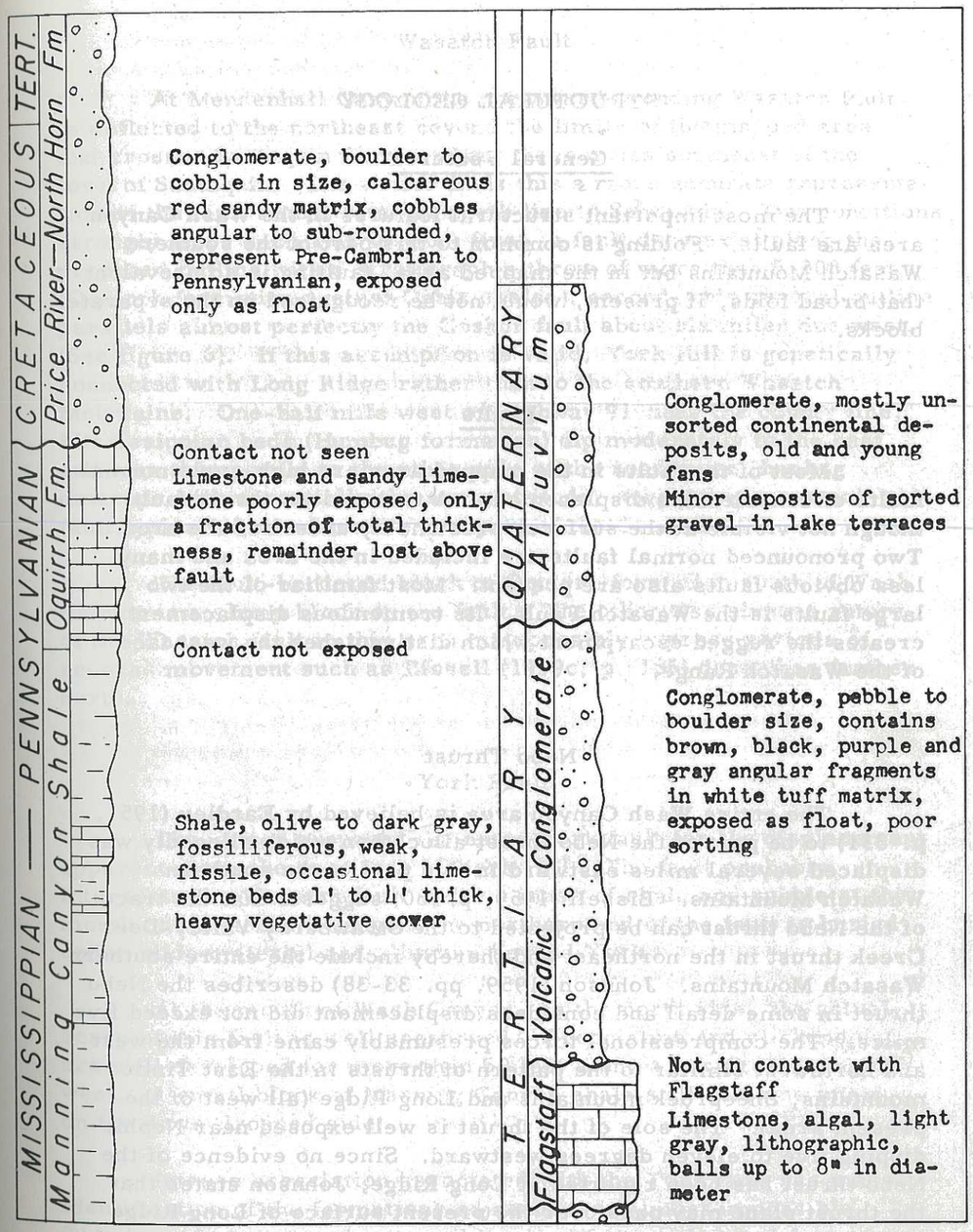

Figure 5 (cont.)

STRUCTURAL GEOLOGY

General Features

The most important structural features in the Wash Canyon area are faults. Folding is common to this part of the southern Wasatch Mountains but in the mapped area, faulting is so prevalent that broad folds, if present, would not be recognized on the separate blocks.

Faults

Most of the faults in the mapped area are high-angle normal faults of considerable displacement. A tremendous thrust fault, though not visible at the surface, presumably underlies the area. Two pronounced normal faults are included in the area and many less obvious faults also are present. Most familiar of the two large faults is the Wasatch Fault. Its tremendous displacement creates the rugged escarpment which distinguishes the west face of the Wasatch Range.

Nebo Thrust

The entire Wash Canyon area is believed by Eardley (1951, p. 331) to be part of the Nebo thrust allochthon which allegedly was displaced several miles eastward in this part of the southern Wasatch Mountains. Bissell (1959, p. 160) suggests that the trace of the Nebo thrust can be projected to the Strawberry Valley-Deer Creek thrust in the northeast and thereby include the entire southern Wasatch Mountains. Johnson (1959, pp. 33-38) describes the Nebo thrust in some detail and considers displacement did not exceed five miles. The compressional forces presumably came from the west and northwest similar to the pattern of thrusts in the East Tintic mountains, Sheeprock mountains and Long Ridge (all west of the present area). The sole of the thrust is well exposed near Nephi, dipping five to eleven degrees westward. Since no evidence of the Nebo thrust has been reported at Long Ridge, Johnson states that the thrust plane may pass over the present surface of Long Ridge and dip to its root zone perhaps in Dog Valley immediately west of Long Ridge.

Wasatch Fault

At Mendenhall Canyon the northward-trending Wasatch fault is deflected to the northeast beyond the limits of the mapped area, and crosses Santaquin Canyon about three miles southeast of the town of Santaquin. The writer finds this a more accurate representation of the fault than a straight north line to Santaquin. Two conditions strongly favor such a deflection; first, a fault does exist along the proposed outline with a stratigraphic throw of more than 5,000 feet (Oquirrh formation against Ophir shales); second, this general outline parallels almost perfectly the Goshen fault about six miles due west. (See figure 6). If this assumption is valid, York Hill is genetically connected with Long Ridge rather than to the southern Wasatch Mountains. One-half mile west of Highway 91 near the county line, Mississippian beds (Humbug formation) dip moderately to the east and less than a mile to the other side of the road more Humbug outcrops with essentially the same attitude, suggesting a normal fault typical of structures in this part of the Great Basin.

The fault-bordered block of Oquirrh formation south of Wash Canyon is a slump block on the fault. The otherwise sinuous nature of the Wasatch fault in this area may possibly express periods of reverse movement such as Bissell (1959c, p. 165) describes farther north.

York Fault

The writer proposes the name York fault for the displacement apparent along the west face of York Hill. The fault probably intersects the Wasatch fault under a mass of shale and rubble at the mouth of Mendenhall Canyon; the northern end of the fault is buried under slide material and alluvium beyond York.

At the mouth of Wash Canyon, on the north side, the actual scarp of this fault is well preserved. Brecciation and slickensides are well developed for more than 50 feet along a surface dipping 60° west. A small block of Manning Canyon shale still remains intact on the down-dropped side.

Intense brecciation associated with the York fault has made identification of the formations adjacent to it almost impossible. This brecciation extends several hundred feet up the west face of York Hill in many places. Maximum stratigraphic displacement on the south end of York fault is from Herkimer limestone (?) to Manning Canyon shale, more than 4,000 feet.

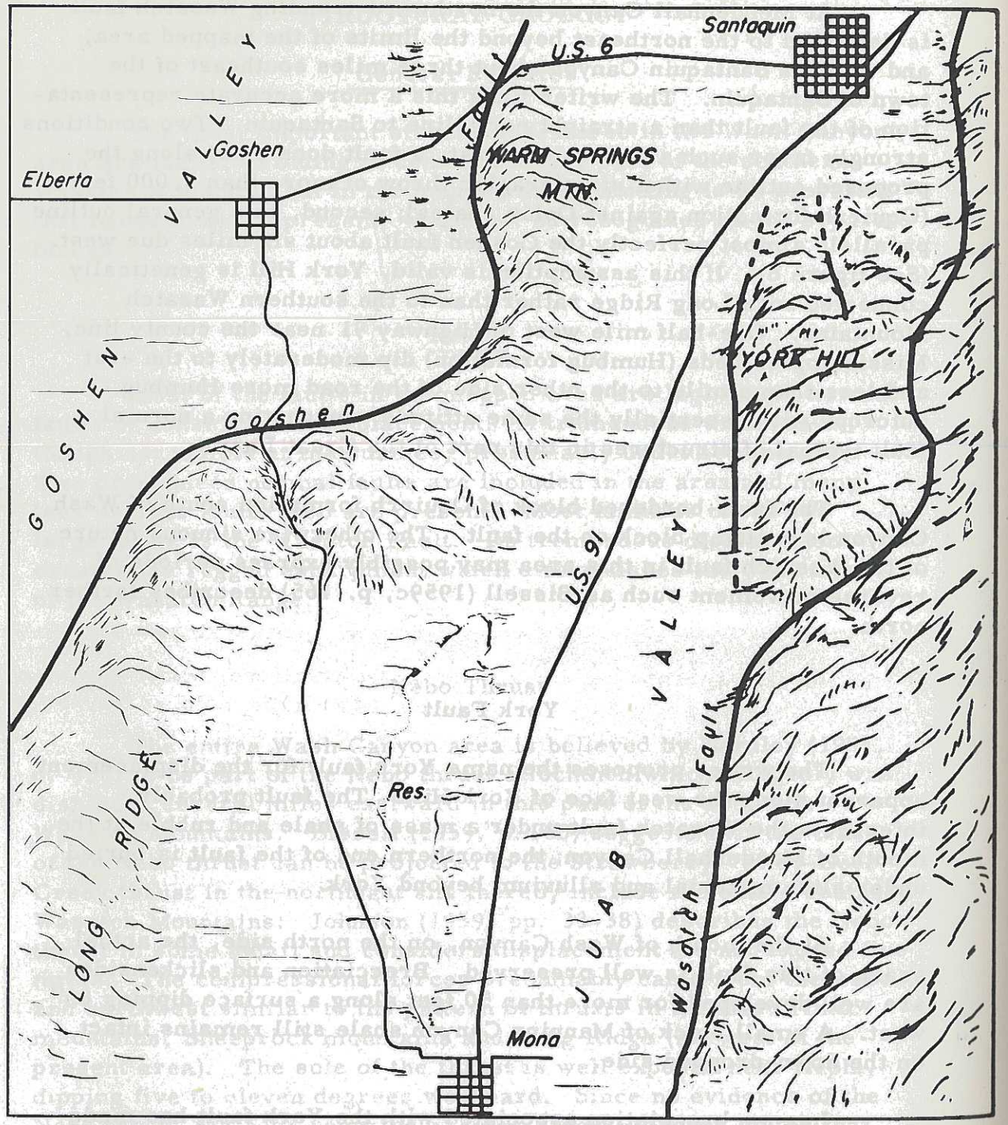

Figure 6

Map showing the rudely parallel relationship between the Goshen Fault and the Wasatch Fault

Folds

The mapped area exclusive of York Hill is on the east limb of a north-south trending anticlinal fold. Paleozoic strata consistently strike approximately north and dip to the east. Variations from one section to another result mostly from the varying attitudes of different fault blocks. York Hill contains an eastward-plunging east-west anticline that is modified by normal faulting and slumping on the south end in Mendenhall Canyon.

Age of Folding and Faulting

Most of the deformation that affected the Wash Canyon area occurred during the Laramide orogeny (Eardley, 1933 and 1951). East-west faults that dissect York Hill, and those that cut through the upper part of Mendenhall Canyon occurred at an unknown date before Laramide time; probably in late Jurassic or early Cretaceous.

Movement on the Nebo thrust took place during Coloradoan and Montanan time (Johnson, 1959, p. 35). North-south folding that is probably present but not evident occurred in Eocene and Oligocene times. Movement on the Wasatch, York and other related faults began during late Pliocene and extends to recent time.

Several scarps with little or no vegetative cover testify to recent movement along north-south faults. One light-colored scarp at the base of the southern Wasatch Mountains is visible from the highway between Nephi and Mona. The writer was able to trace this scarp through the south side of Mendenhall Canyon, across the canyon, and approximately coincident with the Wasatch fault almost to Santaquin Canyon. Other recent scarps are visible within the switchback turn of the road between Wash and Mendenhall Canyons.

ECONOMIC GEOLOGY

General Statement

Water, calcite, and gravel deposits comprise the economic mineral resources in the area. Fifty years ago intensive prospecting for metals, chiefly lead, silver, and zinc, was concentrated on the area but no important strikes were made.

Water Resources

Water resources, though very limited in the area, are in great demand for stock-watering and irrigation. Springs occur in Mendenhall, Wash and Pole Canyons; and a small stream emits from a prospect tunnel at the base of the mountain south of Mendenhall Canyon. The Wash Canyon springs are piped and ditched to a small pond near York. The other springs are wasted through unlined ditches and tortuous natural drainage gullies.

Ground water resources in the mapped area are limited in the writer's opinion to two alluvial fans; one merging from Wash and Mendenhall Canyons and a very small one mostly covered by the slide material north and east of York. York lies between these fans and is underlain by clay and silt to a depth of more than 300 feet.* Several shallow wells have developed ground water in the area, but the best potential well location (along the toe of the Wash-Mendenhall fan) has not been tested. South of the mapped area the North Canyon fan supplies more than five second feet of water from a single well.

Calcite Deposits

Calcite deposits on the west side of Pole Canyon have been worked more than 15 years; at present Dr. M. L. Oldroyd of Payson owns the property. The calcite occurs in veins along a fault zone in the Great Blue limestone. The mineral is shipped by truck to a crusher in Santaquin and bagged for sale to poultry farms. Operations

*Writer's personal communication with Dr. Steele who owns the York farm.

to date have removed about 50 feet of calcite along a 200 foot front in two pits and many times this much calcite remains. Calcite from these operations sold for $13 a ton in February, 1960.

Gravel Deposits

Gravel is being used from two small pits near Highway 91 at the north end of the area. Extensive wave-formed deposits remain along the highway and could be used if the local demand increases.

Metallic Ore Mines and Prospects

Under present conditions, no commercial deposits of metallic ore minerals are known to exist in the area, and possibilities are considered poor. According to Mr. Ed Houton of Mona, who was foreman of the Eva Mine in North Canyon, the Eva Mine was the only mine that produced any quantity of ore in the Mount Nebo district.

Intense prospecting in the Wash Canyon area around 1910 yielded several potential lead-silver deposits, but apparently none of these could produce any quantity of ore. Colorful and encouraging reports of the Santaquin Chief, Big Nebo, and Santaquin King Mines in Mendenhall Canyon appeared in 1912 (Higgins, 1912, p. 12) but seven years later Loughlin noted the mines were idle.

Loughlin's description of the deposits in these mines (Loughlin, 1919, p. 333) is very similar to much of the Santaquin Ridge area northeast of Santaquin (Demars, 1956). The ore minerals are lead carbonate with some silver and zinc assayed at $36 a ton in 1919. Minerals of the Big Nebo mine are found in the Teutonic limestone as fissure fillings. Santaquin Chief deposits are fissure and bed replacement types probably in Gardner dolomite.* Apparently these properties have been abandoned since about 1920 or earlier. In 1959 a road was being extended from Wash Canyon eastward out of the mapped area. One prospect near the road follows a sizeable vein of limonite, but it has been explored less than 20 feet.

*Loughlin and Higgins descriptions of the locations of these mines are somewhat opposed and neither writer adequately describes the location. Old mines and prospects in the general area range from Gardner dolomite down to the Ophir formation.

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R. 1 E.

SANTAQUIN

JUAB VALLEY

AREA WEST OF HIGHWAY NOT MAPPED

UTAH JUAB Co.

Power House

Canyon

Spring

Springs

York Farm

Slide

Braccia

Pole Canyon

Wash

Mandenhall Creek

BM 6204

BM 7757

T. 10 S.

T. 11 S.

R. 1 E.

A

A'

LEGEND

Quaternary

- QRg — Recent Gravel
- QRf — Recent Fan
- QBg — Bonneville Gravel
- Qoa — Alluvium

Tertiary

- Tv — Volcanic Conglomerate
- Tf — Flagstaff Formation

Penn. Cret.

- Kn — Price River – North Horn
- Po — Oquirrh Formation

Mississippian

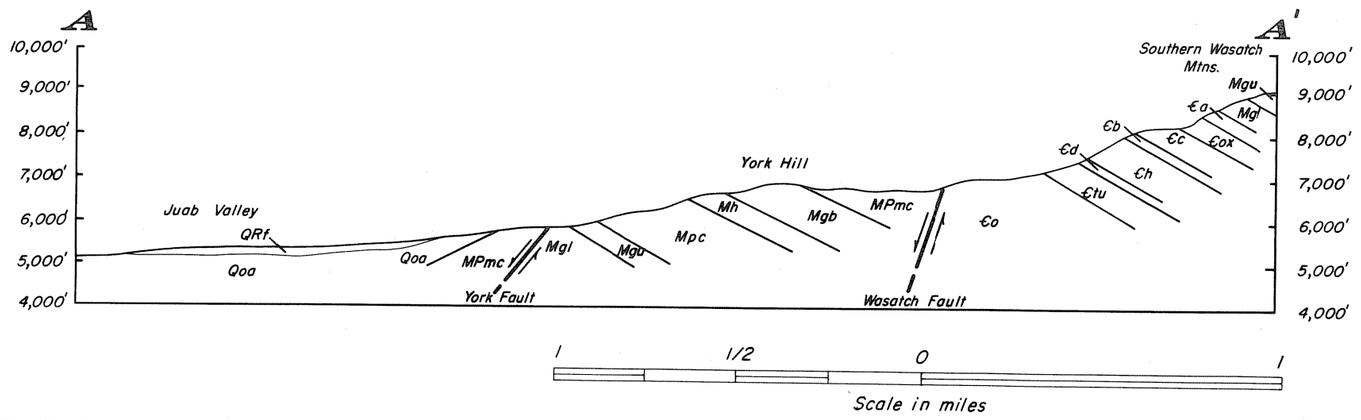
- MPm — Manning Canyon Shale
- Mgb — Great Blue Limestone
- Mh — Humbug Formation
- Mpc — Pine Canyon Limestone
- Mgu — Upper Gardner Dolomite
- Mgl — Lower Gardner Dolomite

Cambrian

- €a — Ajax Formation
- €ox — Opex Dolomite
- €c — Cole Canyon Dolomite
- €b — Bluebird Dolomite
- €h — Herkimer Limestone
- €d — Dagmar Limestone
- €tu — Teutonic Limestone
- €o — Ophir Formation
- €t — Tintic Quartzite

SYMBOLS

- Adit
- Quarry
- 36 — Dip and strike
- Faults, inferred or concealed
- Contacts, inferred or concealed
- Roads, paved, improved or unimproved
- Abandoned Lake Bonneville shoreline
- Hachures point toward younger formations



GEOLOGIC MAP AND CROSS SECTION OF THE WASH CANYON AREA UTAH AND JUAB COUNTIES, UTAH

By

DELL R. FOUTZ

1960