GEOLOGY OF THE
LOST CREEK-ECHO CANYON AREA,
MORGAN AND SUMMIT COUNTIES, 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, 1959

This Thesis for the Master's degree

by

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June, 1959

Chairman, Supervisory Committee

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ACKNOWLEDGMENTS

The opportunity is taken here to express thanks to Dr. N. C. Williams, who suggested the problem and who offered counsel in the field and in the preparation of the manuscript.

Appreciation is also extended to Dr. Wm. L. Stokes and Dr. D. J. Jones, who offered criticism in the preparation of the manuscript. Dr. Stokes also aided in the identification of some of the fossils.

Conferences with Dr. A. J. Eardley in the office and in the field were especially rewarding throughout the investigation of the problem.

Critical fossil collections of invertebrates and plants were identified, respectively, by Dr. W. A. Cobban and Dr. R. W. Brown, for which help the author is indebted.

Gratitude is expressed to the author's wife for typing the manuscript.

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INTRODUCTION

General Statement

Rocks in the vicinity of Lost Creek and Echo Canyon, Utah, were first studied and named by Hayden (1869, p. 90) and Veatch (1907, pp.. 88-96). In the absence of positive fossil evidence, the earlier correlations were based primarily on lithologic similarities. This, coupled with the fact that description of the original type section (Hayden, 1869, p. 90) was vague and confusing, has further complicated the problem.

Fossils collected during the present study permit correlation of the Upper Cretaceous rocks of the Lost Creek-Echo Canyon area with adjacent areas. The conglomerate sequence and underlying rocks of known Cretaceous age are well exposed and lend themselves to detailed study in the Lost Creek-Echo Canyon area.

Although fossils are rare in the upper part of the Cretaceous section, several localities have yielded fossils which have a direct bearing on the dating of the containing rocks.

The area is located in the zone of transition between the north trending Wasatch Mountains and the east trending Uinta Arch, and, accordingly, is an area of interest from a structural,

as well as a stratigraphic, point of view.

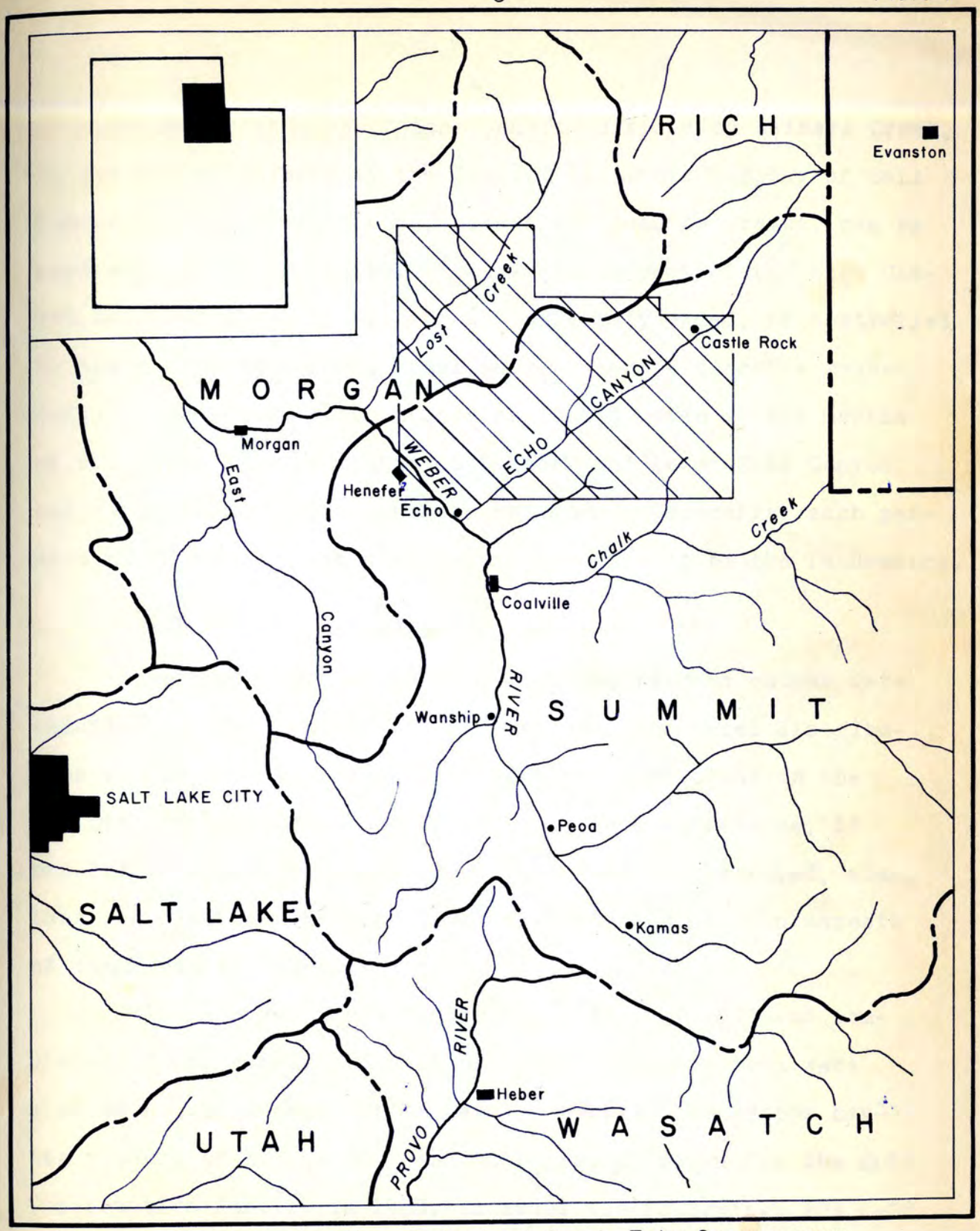
Location and Accessibility

The Lost Creek-Echo Canyon area is 35 miles northeast of Salt Lake City, Utah. It includes approximately 220 square miles within all or parts of Townships 3, 4, and 5 North and Ranges 4, 5, 6, and 7 East, Salt Lake Base and Meridian (Plate I).

Henefer and Echo are the chief communities in the area and both are situated in the southwest corner. Two railroad sidings of the Union Pacific Railroad, Emory (Brimville) and Castle Rock, are situated in the center and northeast corner of the area, respectively.

Echo Canyon and vicinity is accessible from the west via Weber Canyon on U. S. Highway 30-S; from the south via Coalville on U. S. Highway 189; and from the northeast via Evanston, Wyoming on U. S. Highway 189 and 30-S. A main line of the Union Pacific Railroad parallels U. S. Highway 30-S in Weber Valley and Echo Canyon.

Other than the major highways and one graveled road traversing Lost Creek near the western margin of the area, there are no regularly maintained roads in the Lost Creek-Echo Canyon vicinity. Poorly kept stock roads provide access to the more remote localities drained by Lost Creek and Echo Canyon Creek. These primitive roads are sporadically reconditioned by local stockmen and the more remote roads can be traveled only by 4-wheel-drive vehicles.



INDEX MAP showing location of the Lost Creek–Echo Canyon area.

An area northwest of Echo Canyon, drained by Heiners Creek, is controlled chiefly by the Deseret Livestock Company of Salt Lake City, and access roads, normally closed to travel, can be used only with permission. The remaining part of the Echo Canyon and Lost Creek area, although privately owned, is controlled by the Echo Canyon-Chalk Creek Range Owners Protective Association. The Association maintains locked gates at the mouths of all major tributaries to Lost Creek and lower Echo Canyon, and permission to enter must be obtained. Generally, such permission is readily extended by the Association or the landowners.

Purpose and Scope

The primary purpose of this work has been to gather data relative to the identification, contacts, and areal distribution of the late Cretaceous and Tertiary formations in the vicinity of Lost Creek and Echo Canyon, and to resolve, if possible, certain problems of correlation. It is hoped, also, that new light can be shed upon the dating of certain aspects of the Laramide orogeny.

Field work was begun during the summer of 1957 and completed in the summer and fall of 1958. Geologic data were plotted on Soil Conservation Service aerial photographs having a scale of 1:31, 680. The photographs, flown for the Soil Conservation Service in 1938, included the following: BPK 4-26 to 4-34, 4-130 to 4-138, 4-176 to 4-184, 5-175 to 5-181, 10-161

to 10-166, 10-120 to 10-126, 4-74 to 4-78, and 10-104 to 10-109. Data gathered in the field was transferred to Soil Conservation Service planimetric base maps, identified as Utah - 47 and 48, from which a linen tracing of all data was made, a copy of which constitutes the enclosed geologic map (Plate XVII).

Physiography

The drainage ways of the Lost Creek-Echo Canyon area have a dendritic pattern and consist largely of superimposed streams that have eroded locally through the Tertiary sediments. At such locations are exposed older rocks which in this area are Jurassic and Cretaceous in age. In terms of the normal erosion cycle the streams range in age from late youth to early maturity. The Weber River is the trunk drainage to which Lost Creek and Echo Canyon Creek are tributary. The main tributaries to Lost Creek are: Guildersleeve Canyon Creek, Cedar Canyon Creek, Toone Canyon Creek, Hell Canyon Creek, Paradise Canyon Creek, Francis Canyon Creek, and Trail Creek. Significant tributaries to Echo Canyon Creek are: Saw Mill Creek, Heiners Creek, Aspen Creek, Robinson Creek, and Rees Creek. Harris Canyon Creek, Harris Creek, and Grass Creek are tributary to the Weber River, whereas Meadow Creek is a tributary to Chalk Creek which in turn joins the Weber River where it flows into Echo reservoir (Plate I).

Maximum relief in the area is about 3,000 feet and

represents the difference in elevation of the lowest point on the Weber River which is 5,350 feet near Henefer, and the point of highest elevation at 8,350 feet in the southeast corner of the area, on the shoulder of Porcupine Mountain.

Badland topography is characteristic of Echo Canyon and Lost Creek, where tan to redcliffs and ledges form the walls of many of the canyons. In some areas, such as lower Heiners Creek and the head of Toone Canyon, prominent pinnacles rise 30 to 75 feet from the canyon floor. A small basin-shaped area at the head of Toone Canyon, locally called "Chinatown", displays an assemblage of sheer cliffs and conglomerate capped pinnacles and demoiselles equally as colorful as those in the Bryce Canyon area of southern Utah, and have similarly been shaped by rapid headward erosion controlled by joints and differential cementation (Plate II).

Land Utilization

Land in the Echo Canyon and Lost Creek areas is used primarily for summer grazing of cattle and sheep, and this use in many instances constitutes the only revenue to landowners. Locally, small crops of corn, grain, and produce are harvested, but the largest part of the farmable land is planted in hay crops to provide winter feed for stock.

Some timber is harvested locally, but resources are limited and of negligible economic importance.

Recreational facilities are generally lacking in the area.

Chinatown at the head of Toone Canyon. View looking north.

Previous Geologic Work

The earliest geologic exploration in the region comprising Lost Creek and Echo Canyon was carried on by the Powell (1876), Hayden (1871), and King (1877) surveys. These surveys dealt mainly with the broader aspects of the geology of the area.

The Uinta Mountains, and their immediate environs, long of historic interest to geologists, were studied after the turn of the century by Berkey (1905), Weeks (1913), Schultz (1918), and later Bradley (1936) and Forrester (1937).

More recently, detailed studies have been made by Eardley (1944; 1951a; 1952).

The coal deposits of the area were investigated by Taff (1906); Wegemann (1915), who did the first detailed geology of the Coalville anticline; and Clark (1919), while working for the United States Geological Survey prepared a report on the Lost Creek coalfield.

Unpublished work in the immediate area has been done by graduate students of the University of Utah in conjunction with Masters thesis projects. These student projects include theses by Egbert (1955), Johnson (1952), Lankford (1952), Larson (1951), Peterson (1950), Randall (1952), Schick (1955), Stark (1953), and Wood (1953). Some of these investigations were done under the direction of Dr. N. C. Williams of the University of Utah Geology Department who is preparing a report on the area included in the Coalville Quadrangle.

STRATIGRAPHY

General Statement

Tertiary rocks make up the surface of most of the Lost Creek-Echo Canyon area, older rocks are exposed only where erosion has removed the younger rocks. Exposures of the older rocks are too limited in extent and too few in number to permit accurate tracing and correlation from place to place.

Exposures include the stratigraphic succession as recognized in adjacent areas, with minor exceptions, from the Nugget sandstone of Lower Jurassic age, through Cretaceous formations, and into the Tertiary. The upper part of the Kelvin formation and the Aspen shale, although probably present at depth, are not exposed.

The rock types include some carbonate deposits, but clastics representative of various subaqueous and subaerial environments make up most of the section.

Jurassic System

Nugget sandstone. Exposures of the Lower Jurassic Nugget sandstone, approximately 1,100 feet in thickness, are present in the Lost Creek area at two localities: (1) immediately east

of the junction of Trail and Francis Creeks with Lost Creek and (2) south of the confluence of Trail and Francis Creeks. At these localities the Nugget sandstone consists of tan to orange, well cemented, aeolian sandstones having distinct cross-bedding.

The contact of the Nugget with the underlying Chinle (?) is not definitely exposed in the area, but at locality 2, some reddish shaley beds are poorly exposed and may represent the basal part of the Nugget sandstone.

Fossils are rare in the Nugget sandstone, but its identity is readily established on the basis of the characteristic color, lithology, and stratigraphic position with reference to the overlying Twin Creek limestone.

The type section of the Nugget sandstone, initially described by Veatch (1907, p. 56), is near Nugget Station, Wyoming. There it has a measured thickness of 1,900 feet.

Twin Creek limestone. The only exposure of the Twin Creek limestone in the area occurs along the valley of Lost Creek from the mouth of Toone Canyon to the Trail Creek fork. Here, the Twin Creek is a white to gray - weathering shaley limestone containing some redbeds and calcarenites. The arenites normally stand out as topographically resistant ribs, but more commonly, the exposures are obscured by talus slopes of silver-like fragments from the overlying shaley limestone.

The basal contact of the Twin Creek is not sharp and well defined, but appears instead to be gradational, over a thickness

of about 30 feet, from the crossbedded sandstones of the Nugget to the marine limestone of the Twin Creek, indicating that the inundation by the Twin Creek sea was slow enough to allow time for reworking of at least the upper few feet of the Nugget.

Intense folding of the Twin Creek limestone in the area of exposure along Lost Creek makes the exposures unsuitable for accurate section measurement and, consequently, reference is made to the nearest available section, which is 8 miles to the west near the town of Croyden. The section, 3,140 feet thick, was measured and described there by Eardley (1944, p. 836).

A fossil horizon near the upper limit of the Twin Creek contains abundant, well preserved specimens of Pentacrinus asteriscus and pelecypod fragments.

The Twin Creek limestone was first described by Veatch (1907, p. 56) in southwestern Wyoming and is presently considered to be Middle and Upper Jurassic in age (Imlay, 1947, p. 231). It is a correlative, in part, of the Carmel formation in Utah and the "Lower Sundance" of Wyoming (Imlay, 1952, p. 963) (Plate III).

Preuss formation. The only exposure of the Preuss formation recognized in the area is in Toone Canyon, a tributary to Lost Creek. The thickness of this exposure as carefully scaled from aerial photographs is 370 feet. The Preuss conformably overlies the Twin Creek formation and the contact is easily discerned because of a marked color difference and because the less resistant Preuss is readily stripped off the more resistant rocks of

JURASSIC-CRETACEOUS NOMENCLATURE CHART

	S.E. IDAHO Mansfield (1927)	S.W. WYOMING Veatch (1907)	WYOMING THRUST BELT Stokes (1955)	TOONE CANYON (This Paper)	N.W. UINTA MOUNTAINS Stokes, et al. (1955)	ASPHALT RIDGE Stokes, et al. (1955)
CRETACEOUS	Correlation of Late Cretaceous formations shown in detail on Plate					
	Wayan fm.	Frontier fm.	Frontier fm.	Frontier fm.	Frontier fm.	Mancos sh. — Upper Mancos
						Frontier ss.
		Aspen fm.	Wayan fm.	Aspen sh.	Aspen fm.	Lower Mancos
		Bear River fm.		Kelvin fm.	Kelvin fm.	Dakota ss.
	Gannett gp. — Tygee ss.	Beckwith fm.	Gannett gp. — Draney ls.			Cedar Mountain fm.
	Draney ls.		Bechler cg.			Buckhorn cg.
	Bechler cg.		Peterson ls.	Morrison fm.	Morrison fm.	Morrison fm.
	Peterson ls.		Ephraim cg.			
	Ephraim cg.					
JURASSIC	Stump fm.		Stump fm.	Stump fm.	Stump fm.	Curtis fm.
	Preuss ss.		Preuss fm.	Preuss fm.	Preuss fm.	Entrada fm.
	Twin Creek ls.	Twin Creek fm.	Twin Creek fm.	Twin Creek ls.	Twin Creek fm.	Carmel fm.
	Nugget ss.	Nugget fm.	Nugget fm.	Nugget ss.	Nugget fm.	Navajo fm.

the Twin Creek limestone.

The Preuss consists of thin-bedded, red sandstones and siltstones which weather rapidly to form soft slopes which retain the characteristic red color.

The type section of the Preuss formation is in southeastern Idaho near the northern border of Bear Lake County, where it was first named by Mansfield and Roundy (1916, p. 81). It is a correlative of the Entrada sandstone in southern Utah and the lower Beckwith formation of southwestern Wyoming as described by Veatch (1907, p. 57) (Plate III).

Stump formation. The Stump formation crops out only in a small area about one mile east of the mouth of Toone Canyon where approximately 420 feet are exposed. The basal contact of the Stump formation with the characteristic red sands and silts of the underlying Preuss formation is easily recognized, although poorly exposed in the described area.

In nearby areas such as Peoa (Morris, 1953, p. 20) south of the Wanship reservoir, the Stump formation is divisible into 3 units: (1) an upper member of greenish gray glauconitic limestone, (2) a middle member which consists of light red and yellow shale and soft sandstone, and (3) a lower member consisting of gray to yellow-gray sandstone.

The cephalopod, Pachyteuthis densus, is a characteristic fossil in the Stump formation (Thomas and Kreuger, 1946, p. 1278) in nearby areas, but none were found at the Toone Canyon outcrop.

The Stump correlates with the Curtis formation of east-central Utah and with part of the lower Beckwith formation in southwestern Wyoming (Veatch, 1907, p. 57). The type section of the Stump is near Stump Peak in Caribou County of southeastern Idaho (Mansfield and Roundy, 1916, p. 81).

Morrison formation. Conformably overlying the Stump is the Morrison formation. The Morrison formation is poorly exposed in Toone Canyon and its identification is based upon; 1) its stratigraphic position, 2) a characteristic white nodular limestone bed, and 3) a color similarity of a red bed with one described in the Morrison formation at its place of outcrop in the Peoa section (Morris, 1953, p. 21). A thickness of 480 feet for the exposed Morrison formation in Toone Canyon was scaled from aerial photographs.

A pronounced color change marks the basal contact of the Morrison formation with the underlying Stump formation. The upper contact is not as well defined, however, and must be chosen arbitrarily inasmuch as there is a gradation into the conglomeratic Kelvin formation. The contact selected is just below the lowest coarse conglomerate bed in the Kelvin formation.

The white nodular limestone in the Morrison formation is probably a correlative of one of the white marker beds described by Granger and Sharp, (1952, p. 14) east of Salt Lake City.

W. T. Lee (1920) named the type section of the Morrison formation for its exposure near Morrison, Colorado.

Cretaceous System

Kelvin formation. The lower Kelvin formation is exposed in Toone Canyon, but the upper part of the sequence has been omitted by folding and faulting. An approximate thickness of the Kelvin is 2700 feet (Morris, 1953, p. 22).

The basal contact of the Kelvin formation, where exposed in the Peoa section, is arbitrarily taken as the base of a chert conglomerate (Mount, 1952, p. 9), which conformably overlies the Morrison formation.

Conglomerates with fragments ranging in size from small pebbles to very large pebbles fairly well cemented in a red sandy matrix, together with interbedded sandstones and siltstones comprise the Kelvin formation at its exposure in Toone Canyon.

Mathews (1931, p. 48) named and described the Kelvin formation for its exposure in Emigration Canyon east of Salt Lake City. At the type locality the Kelvin formation is predominantly a conglomerate sequence; it becomes less conglomeratic and characteristically has a higher percentage of sandstone and siltstone to the east. The Kelvin is considered to represent a series of coalescing alluvial fans which had a western source in the highlands formed during the Cedar Hills orogeny (Eardley, 1951, p. 325). The Kelvin is a likely correlative of the Ephraim and Bechler conglomerates of southwestern Wyoming.

Aspen shale. The Aspen shale is not exposed in the immediate area of study, but is probably present at depth. It is,

however, well represented about 12 miles to the south in the vicinity of Coalville, Utah where it has a measured thickness of 99 feet (Wood, 1953, p. 16). Where the Aspen formation is exposed, south of the mapped area of the present study, it is readily distinguished from the underlying and overlying formations by its dark gray color, shaley character, and abundant teleost fish scales.

Veatch (1907, p. 64) named the type section of the Aspen formation for its exposure near Aspen Station of the Union Pacific Railroad in southwestern Wyoming.

The Toone Canyon area would be very near shore in relation to the Aspen sea and, consequently, the shale facies noted to the south in the vicinities of Coalville and Rockport (Veatch, 1907, pp. 103-105), may well be absent or at best, relatively thin. It may, accordingly, lack the characteristic fish scales, in the vicinity of Toone Canyon. Correlatives of the Aspen formation are the Mowry shale and part of the lower Mancos formation in other areas.

Frontier formation. Exposures of the Frontier formation are restricted to the southern margin of the mapped area along upper Grass Creek and Meadow Creek. These are incomplete sections, but contiguous areas contain complete sections that have been studied by previous recent investigators (Wood, 1953, pp. 16-23). Wood measured 2,132 feet of beds northeast of Coalville, which he assigned to the Frontier formation.

Studies of the beds immediately overlying the Aspen shale in the Coalville area were made by a number of geologists including: Stanton (1893), Veatch (1907), and Wegemann (1915); Veatch (1907, p. 103) correlated the Coalville section with the Frontier formation of southwest Wyoming.

The age of the Frontier formation was established by early workers (Stanton, 1893, p. 40; Veatch, 1907, p. 69; and Wegemann, 1915, p. 164) as Coloradoan, on the basis of the fossil fauna and flora.

Locally, the upper part of the Frontier sequence is missing because of erosion or nondeposition associated with local folding prior to late Coloradoan time. Evidence of this local deformation is particularly evident east of the Wanship reservoir in Crandall and Dry Canyons where the Frontier formation, standing nearly vertical, is truncated by the essentially horizontal beds of younger age.

Wanship formation. Overlying the Frontier formation with local angular discordance is a sequence of sandstones and shales which was named by N. C. Williams for its outcrop east of Wanship, Utah. Though not as yet formally proposed, the term is generally accepted by workers in northeastern Utah.

An uninterrupted section of the Wanship formation is not present within the mapped area, but the entire unit is represented in a composite of various exposures. Wood, (1953, p. 30-31) measured the following section with plane table and alidade across lower

Grass Valley and Dry Hollow, which lie immediately south of lower Echo Canyon:

Almy formation. (Echo Canyon conglomerate of this paper)

Wanship formation (Contact recognized by change in color and lithology from buff and light gray sands, to reddish conglomerates) Top

Unit	Description	Feet
8	Sandstone, buff to gray to white, calcareous, friable, medium to coarse grained, porous, thin bedded. Weathers brown. Interbedded with arenaceous shales and pea- to nut-sized conglomerates. Poorly exposed	1,250
7	Covered. Probably interbedded sandstones and arenaceous shales similar to unit 8	1,250
6	Sandstone, tan to gray, massive, medium to fine grained very calcareous, friable, slightly porous. Contains a few chert nodules. Contains Inoceramus sp. Forms hogback ridge separating Carruth and Lewis Canyons	205
5	Sandstones, buff, thin bedded, with interbedded shales. Poorly exposed	1,080
4	Sandstone, white to gray, very calcareous, well cemented. Medium to fine grained and massive. Weathers gray to tan. Forms hogback ridge between Dry Hollow and Grass Valley Canyon, and between Lewis Canyon and Weber Valley	230
3	Shales and thin bedded sandstone, with coal at the base. Poorly exposed	105
2	Covered, but probably shale and thin bedded sandstone	770
1	Conglomerate, brown, poorly sorted, ferruginous. Pebbles are pea sized to 6 inches in diameter, and are composed of quartzite and sandstone. Sandy, calcareous matrix	60
	Total	4,950

As herein defined the Wanship formation comprises a basal conglomerate member overlain by a sequence of shale and sandstone units. The basal conglomerate member of the Wanship formation in many areas is the best means of identifying the lower limit of the formation and especially so where the similar lithologies of the underlying Frontier formation are also exposed.

East and southeast of Wanship, Utah, a marked angular unconformity is exposed between the Wanship and Frontier formations, whereas, in the area east of Coalville, Utah the angular discordance is noted generally only over distances of more than a mile.

The basal Wanship conglomerate is unit 7 described by Wegemann (1915, p. 163) from his stratigraphic section at Coalville, Utah (Williams, personal communication).

Trexler (1957, p. 1874) described four units which comprise the Frontier formation in the Coalville area as follows (descending order):

(4) 2440 feet of marine sandstone and shales with a 635-foot nonmarine sequence in the lower half; an early Niobrara (Coniacian) Fauna.

(3) 800 feet of nonmarine sandstone and claystones with a 75-foot bed of conglomerate 200 feet from the base.

(2) 795 feet of marine sandstone and shale dated as early Carlile (Turonian) and late Greenhorn (Turonian) ages; coal is associated with sandstones near the base.

(1) 400 feet of dominantly nonmarine sands and clays (Probably Cenomanian).

The uppermost of these units (unit 4) consists of 2,240 feet of marine sandstone and shale containing an early Niobrara fauna

with a 635 foot non-marine sequence in the lower half. Underlying unit 4 is a 800 foot thickness of non-marine sandstone and claystone (unit 3) having a 75 foot bed of conglomerate 200 feet above the base. It is very probable that the upper part of Trexler's unit 3, that part which includes the 75 foot conglomerate bed, and his unit 4 are in reality the lower Wanship formation including the basal conglomerate.

Assuming that Trexler's unit 4 is part of the Wanship formation, then his early Niobrara age assignment correlates with a late Niobrara age assignment of the beds directly overlying the Wanship formation and, together, these age determinations establish a Niobraran age for the Wanship formation.

Fossil leaves (Plates V and VI) indicating a late upper Cretaceous age (R.W. Brown, personal communication) were collected by the writer near the upper contact of the Wanship formation in a road cut on U. S. Highway 189 and 30-S in SE¼, Sec. 10, T. 4 N., R. 6 E. These include:

Osmunda? sp.
Fern, indeterminate
Sequoia reichenbachi (Geinitz) Heer
Thuja? sp.
Dryophyllum subfalcatum Lesquereaux
Ficus planicostata Lesquereaux
Myrtophyllum torreyi (Lesquereaux) Dorf
Viburnum marginatum Lesquereaux
Credneria? sp
Fragments of dicotyledonous leaves, undetermined.

Generally, the Wanship formation is a correlative, at least in part, of the Mesaverde group to the southeast and of part of the Hilliard formation to the northeast (Plate IV).

TENTATIVE UPPER CRETACEOUS CORRELATION of the ECHO CANYON-COALVILLE AREA

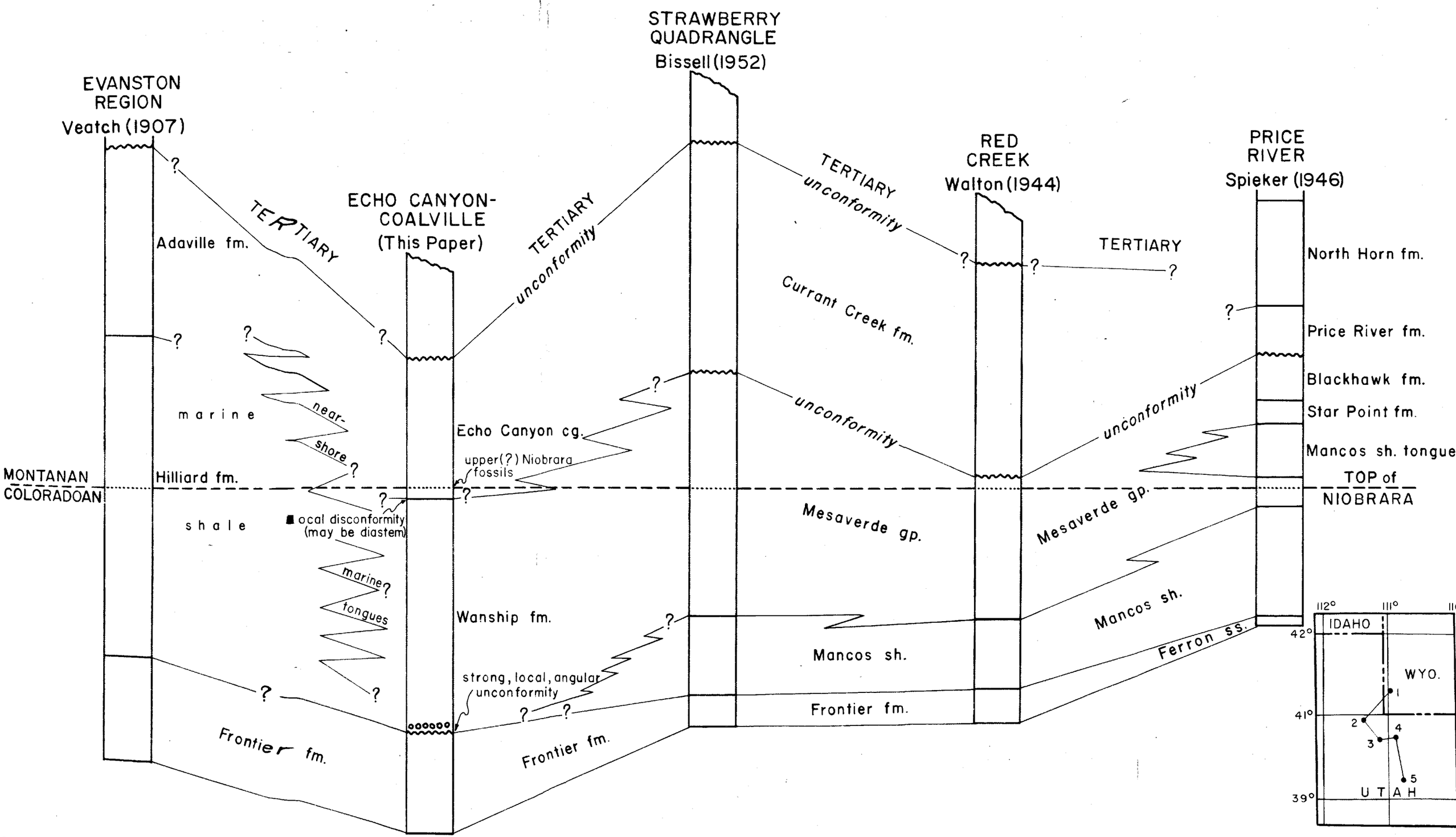
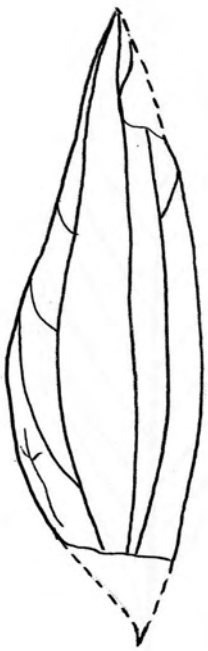
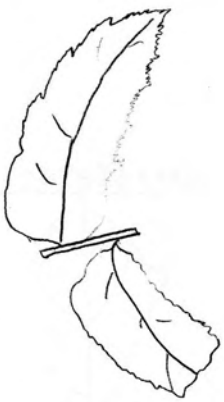


Plate V

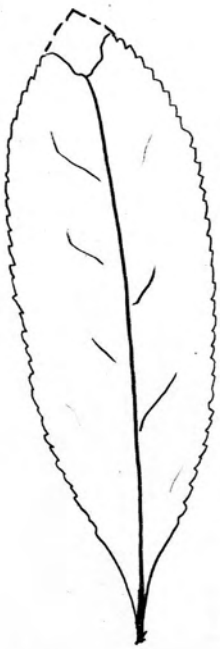


Ficus planicostata
Lesquereaux



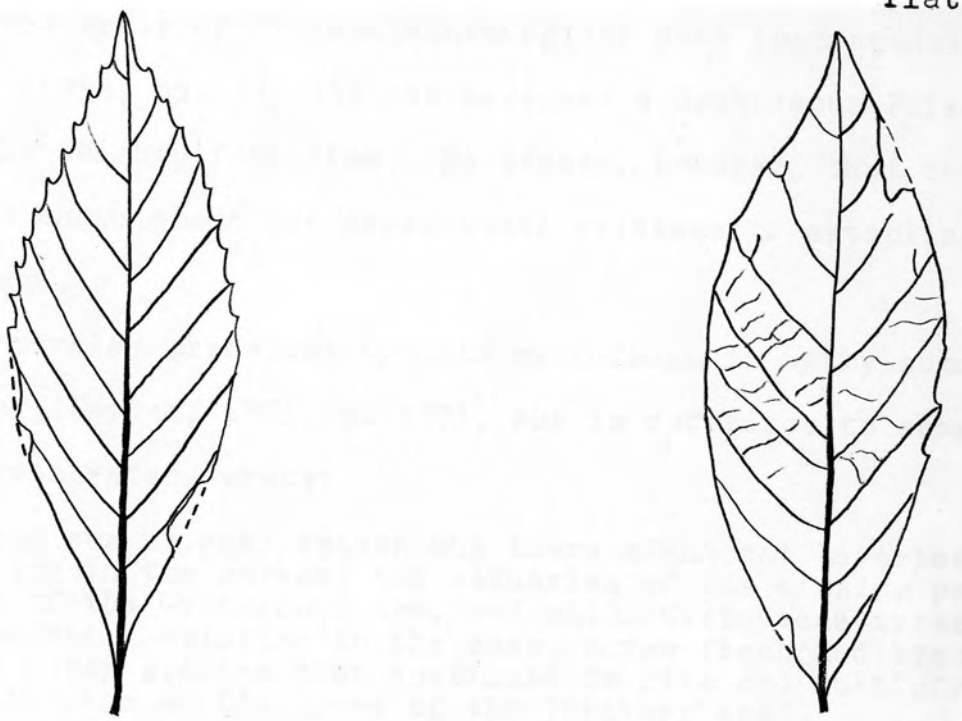
Osmunda? sp.

Sequoia reichenbachi
(Geinitz) Heer

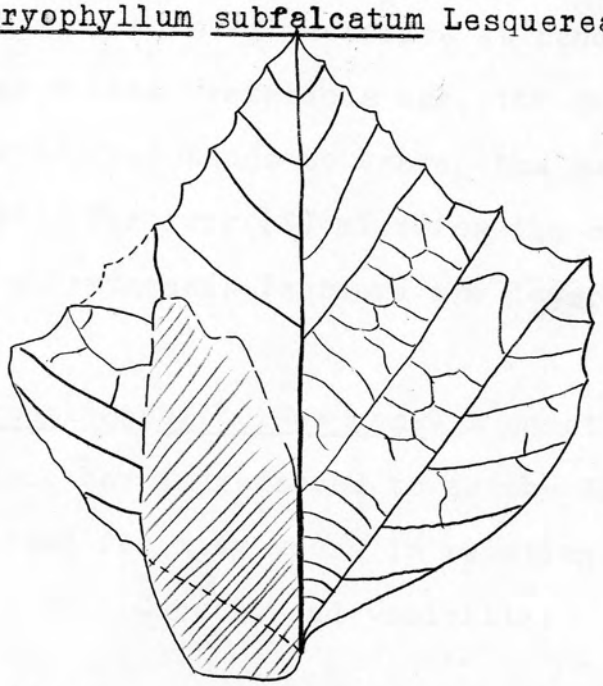


Myrtophyllum torreyi
(Lesquereaux) Dorf

Plate VI



Dryophyllum subfalcatum Lesquereaux



Viburnum marginatum Lesquereaux

On the basis of micropaleontological data (ostracods), Lankford (1952, pp. 33, 35) has assigned a Cretaceous-Paleocene age to the Wanship formation. He states, however, that too little is known about the microfaunal evidence to establish a precise age.

The problem presented by this microfauna is aptly summed up by Meek (Hayden, 1871, p. 377), who in reference to some Tertiary invertebrates, wrote:

> "I can see no good reason why there might not have been living in the streams and estuaries of the closing period of the Cretaceous age, and while Cretaceous types were still existing in the seas, a few fresh and brackish water species that continued to live and multiply during the earlier part of the Tertiary age".

Inasmuch as the macrofossil evidence at hand is predominantly in favor of a late Cretaceous age, the quotation from Meek is applicable to, and tends to answer the question posed by, the presence of early Tertiary (?) microfossils collected by Lankford which led to a Cretaceous-Tertiary age determination for the Wanship formation.

Echo Canyon conglomerate* (New name) A question involving the age of the formation, herein referred to as the Echo Canyon conglomerate, has existed for many years in relation to the general area of Lost Creek, Echo Canyon, and Coalville.

*This name will be formally proposed in a paper now in preparation for publication in the Bulletin of the American Association of Petroleum Geologists under joint authorship with N.C.Williams.

Hayden (1869, p. 90) first described the sequence of rocks which includes the Echo Canyon conglomerate as the Wasatch group. His type section extended from Carter, Wyoming southwest to the narrows of Weber Canyon west of Croyden, Utah; a distance of about 65 miles. Subsequently, Veatch (1907, pp. 88-96) subdivided the Wasatch group into the Almy, Fowkes, and Knight formation and concurred with the earlier group designation of Hayden.

Eardley (1944, p. 842) defined two members, separated by an angular unconformity, in the Almy formation, where it crops out in Echo Canyon. He named the lower member the Pulpit conglomerate and the upper member the Saw Mill conglomerate.

In a restudy of the type Wasatch and in a description of the Wasatch hinterland, Eardley (1951, p. 1435; and 1952, p. 54-55) redefined the two conglomerates separated by an unconformity in Echo Canyon and referred to them as the Almy formation unconformably overlain by the Knight formation; thus he made a correlation with units defined by Veatch.

It is assumed that the redefinition of the two conglomerates in question by Eardley terminates the names, "Pulpit" and "Saw Mill" members of the Almy formation, in favor, respectively, of the Almy and Knight formations. If this is true, and in view of new fossil evidence which establishes a Cretaceous age for the lower conglomerate sequence, then a new name is warranted. The name Echo Canyon Conglomerate is therefore proposed.

Previous workers, including Stanton (1891, pp. 38-44),

Veatch (1907, p. 89), Wegemann (1915, p. 171), and Eardley (1952, pp. 54, 55) have placed the Cretaceous-Tertiary boundary no higher than the base of the first significant conglomerate which crops out in the Echo Canyon-Coalville area.

The thickness of the Echo Canyon conglomerate was scaled from aerial photos as 3,100 feet. The basal contact is drawn at the bottom of the first significant conglomerate bed above the underlying Wanship formation. Locally, there is a disconformity at or near the base of the Echo Canyon conglomerate which may represent a diastem (Williams, personal communication). This disconformable relationship is locally evident east of Echo reservoir. The basal contact is also emphasized by a marked change in lithology from the gray, pea-sized conglomerates and sands of the upper Wanship formation, to the coarse conglomerates of the Echo Canyon conglomerate. The lower Echo Canyon conglomerate contains some variegated red sandstones, siltstones, shales, and conglomerates. The contact with the underlying Wanship formation is apparent east of Echo reservoir about one-half mile south of the damsite.

The upper limit of the Echo Canyon conglomerate is defined by the unconformity in Echo Canyon (Plate VII), where the beds are truncated by the nearly horizontal conglomerates of Tertiary age.

Conglomerates and variegated red, gray, and buff shales, siltstones, and sandstones are characteristic of the lower half

Panoramic view looking north up Saw Mill Creek. Shows the Knight formation lying unconformably upon the Echo Canyon conglomerate.

of the Echo Canyon conglomerate. The upper half of the sequence is predominantly a massive, reddish conglomerate containing some relatively thin beds of gray to red siltstone and shale.

The sandstones which contain the marine fossils of Cretaceous age are interbedded with conglomerates of continental origin and they probably represent a final, local advance of the Cretaceous sea which reached westward before being driven out by an extensive flood of gravel derived from a western highland.

The designated type section of the Echo Canyon conglomerate commences at the basal contact, east of Echo reservoir, continues in a northerly direction towards Pulpit Rock, and then to the uppermost sediments in the trough of the Stevenson Canyon syncline at which point the older rocks are covered by the essentially horizontal Tertiary conglomerates.

Heretofore described as an unfossiliferous Tertiary sequence, the Echo Canyon conglomerate has yielded an assemblage of marine invertebrates from thin sands interbedded with conglomerates within 400 feet of its base. This new fossil evidence suggests a late Coloradoan (Niobraran)age. Specimens were identified by W. A. Cobban (Personal communication) and include:

Inoceramus labiatus (Schlotheim)
Inoceramus deformis Meek
Ostrea anomioides Meek
Ostrea congesta?)
Ostrea lugubris :were identified by the author and checked
Turitella?)by Wm. L. Stokes.

For the purpose of correlation the top of theColorado is

drawn above the uppermost horizon from which Cretaceous fossils were collected. It is probable, however, that the Colorado-Montana time plane is actually higher in the thick Echo Canyon conglomerate and that the upper part of the sequence, at least, is Montanan in age. An estimate of the original thickness of the Echo Canyon conglomerate would be very difficult to make, for it was deeply eroded prior to deposition of the Knight formation in Tertiary time.

Likely correlatives (Plate IV) of the Echo Canyon conglomerate to the south are the Currant Creek formation (Walton, 1944, p. 117; and Bissell, 1952, p. 613) and possibly, the Price River formation of Spieker (1946, p. 130). To the northeast near Evanston, Wyoming Veatch (1907, p. 72) describes an upper Niobrara fauna from the middle of the Hilliard formation that may be a correlative of the fossil assemblage described from the lower Echo Canyon conglomerate.

Walton (1944, p. 109, 120) states that the Mesaverde group near Tabby Mountain on the south flank of the Uinta Arch is Niobraran in age and suggests that the overlying Currant Creek formation is roughly equivalent to the Price River and North Horn formations. Later, Bissell (1952, p. 614) could find no additional evidence for a different age and correlation of the Currant Creek formation, and concurred, accordingly, with the designation of Walton.

Spieker (1946, p. 131) assigned the Price River formation

to a fixed age in the Montanan, at least the lower part, and states that it is probably late Montanan. Later, Spieker (1949, p. 24), comments that invertebrate evidence shows the Price River formation to be late Montanan at its type locality.

On the basis of like lithologies and the fossil evidence already cited, a correlation of the Echo Canyon conglomerate with parts of the Currant Creek and Price River formations seems reasonable (Plate IV).

Tertiary System

Knight formation. Overlying all older formations with marked angular discordance is the Knight formation which is present as a more or less continuous blanket over most of the Lost Creek-Echo Canyon area. Rocks older than the Knight formation are exposed only in Weber Valley, Echo Canyon, and Lost Creek and their deeper tributaries.

A minimum thickness of 1,500 feet is estimated for the Knight formation within the mapped area, although it probably attains a much greater thickness in contiguous areas.

The basal contact of the Knight formation (Plate VIII) with older rocks is usually recognizable wherever it is exposed, and is especially striking in areas such as Toone Canyon where dipping beds of Jurassic age are truncated by the flat-lying Knight conglomerate.

A detailed description of the Knight formation is beyond

Nearly vertical Kelvin formation truncated by the flat-lying Knight formation on the south-facing slope of Toone Canyon. View looking north.

the scope of this paper and is unwarranted inasmuch as rapid facies changes and lens-outs make it almost impossible to follow any one lithologic unit for a very great distance. The major lithologic constituent of the Knight formation is conglomerate. Minor units of sands and shales occur at intervals through the section and near the base of the formation coal beds occur and have been mined in Lost Creek and several of its tributaries. In general appearance, color, and lithology, the Knight formation (consisting of massive conglomerates, sandstones, and thin shales, all with a characteristic reddish cast) is very similar to the underlying Echo Canyon conglomerate.

Veatch (1907, p. 92) named the type section of the Knight formation where it is exposed near Knight Station on the Union Pacific Railroad in southwestern Wyoming.

Although it is fossiliferous in the Evanston area of southwestern Wyoming (Veatch, 1907, p. 93), the Knight formation, as exposed in the Lost Creek-Echo Canyon area, has yielded no diagnostic fossils.

Quaternary Deposits

Recent accumulations of sedimentary debris include: alluvium, colluvium, river terrace gravels, landslides, and pediment gravels.

The most extensive recent deposits are the alluvial flood plains in the Weber Valley, Lost Creek, Echo Canyon, and their deeper tributaries, which are utilized largely for agricultural purposes.

Weathered slopes are almost everywhere partially covered by colluvium consisting of poorly sorted sands, gravels, cobbles, and boulders which have remained essentially near their source, as the source formation (Knight) has been eroded away.

STRUCTURE

Regional Structure

A definite northeasterly orientation of the major structure elements is noted in the Lost Creek-Echo Canyon area.

The structure of the Lost Creek-Echo Canyon vicinity is related both to the structures of the Wasatch Mountains on the west and to the Uinta Mountains on the southeast, and is more or less a transitional feature between the two mountain ranges.

Intersection of the Wasatch and Uinta Mountains results in an area of transition involving complex geologic time relationships. Study of these relationships within the area of transition leads to a more precise chronology of the structural history of the area than do studies made in adjacent areas (Williams, 1955, p. 127).

The Wasatch Mountains trend essentially north and consist of a series of complex transverse folds, the axes of which are oriented east-west (Eardley, 1944, p. 860). The Wasatch range extends from central Utah into Idaho.

Intersecting the Wasatch Mountains from the east is the broad, westward plunging Uinta Arch which is flanked on the

north by the Bridger basin and on the south by the Uinta basin. The Uinta Arch is approximately 160 miles long, 40 miles wide, and trends in an easterly direction.

Folds

Stevenson Canyon syncline. Almost coincident with Stevenson Canyon is the axis of a syncline referred to as the Stevenson Canyon Syncline (Eardley, 1944, p. 855). This fold is a broad, essentially symmetrical structure in which several thousand feet of the Echo Canyon conglomerate are the youngest rocks involved. The axis of the fold can be traced for approximately 15 miles northeasterly from the head of Stevenson Canyon. The width of the syncline is approximately 6 miles. The projection of the structure to the northeast is obscurred beneath a blanket of the Tertiary Knight formation.

The Stevenson Canyon syncline is flanked on the southeast by the Coalville anticline and on the northwest by the Henefer anticline (Eardley, 1944, p. 855).

Coalville anticline. The northeast end of the Coalville anticline projects into the southern boundary of the mapped area for a distance of about one mile, and the asymmetry of the structure, more pronounced to the south, is readily recognized. The northwest limb of the structure dips at angles less than 40°, but the southeast limb dips more steeply and is locally overturned to the southeast. Trending northeasterly, the Coalville anticline is about 4 miles wide and 9 miles long.

The oldest beds exposed in the Coalville structure are those of the Kelvin formation of early Cretaceous age. The Tertiary Knight formation covers much of the structure, but is not involved in the folding which affected the older formations.

Toone Canyon anticline. Lost Creek and its tributaries have cut through the Knight conglomerate to expose an anticlinal structure which plunges to the southwest near the mouth of Toone Canyon. This structure is herein referred to as the Toone Canyon anticline.

Similar in some respects to the Coalville fold, the Toone Canyon anticline is asymmetrical, having a steeply dipping southeast limb which is overturned in Toone Canyon. Rocks of the northwest limb dip from 30° to 50° northwesterly.

Outcrops of the Preuss, Stump, and Morrison formations curve around the nose of the structure in the mouth of Toone Canyon and serve best to define its configuration. A core of Twin Creek limestone is present in the fold and northward, where upper Lost Creek traverses the fold, the older Nugget sandstone crops out in the flanks. Perhaps the red beds underlying the Nugget also are breached, but this cannot be proven because of heavy overburden. The Toone Canyon anticline is 5 miles long and 1½ miles wide in the observable area, but to the northeast it is largely obscured by the Tertiary sediments and may be considerably longer.

The incompetency of the Twin Creek limestone is well displayed in the Toone Canyon anticline. Erratic dips are common

and "Z" folds are well shown at the mouth of Hell Canyon (Plate IX). The erratic dips in the Twin Creek limestone serve to complicate and somewhat confuse the interpretation of the general anticlinal structure. The position and lineation of the Toone Canyon anticline suggest that it is a continuation of the Henefer anticline to the southwest (Eardley, 1944, p. 855). This is conjectural, however, inasmuch as the Toone Canyon structure plunges beneath the flat-lying Knight formation and only dips, corresponding to the southeast flank, appear beyond the Knight formation in the area of the Henefer anticline.

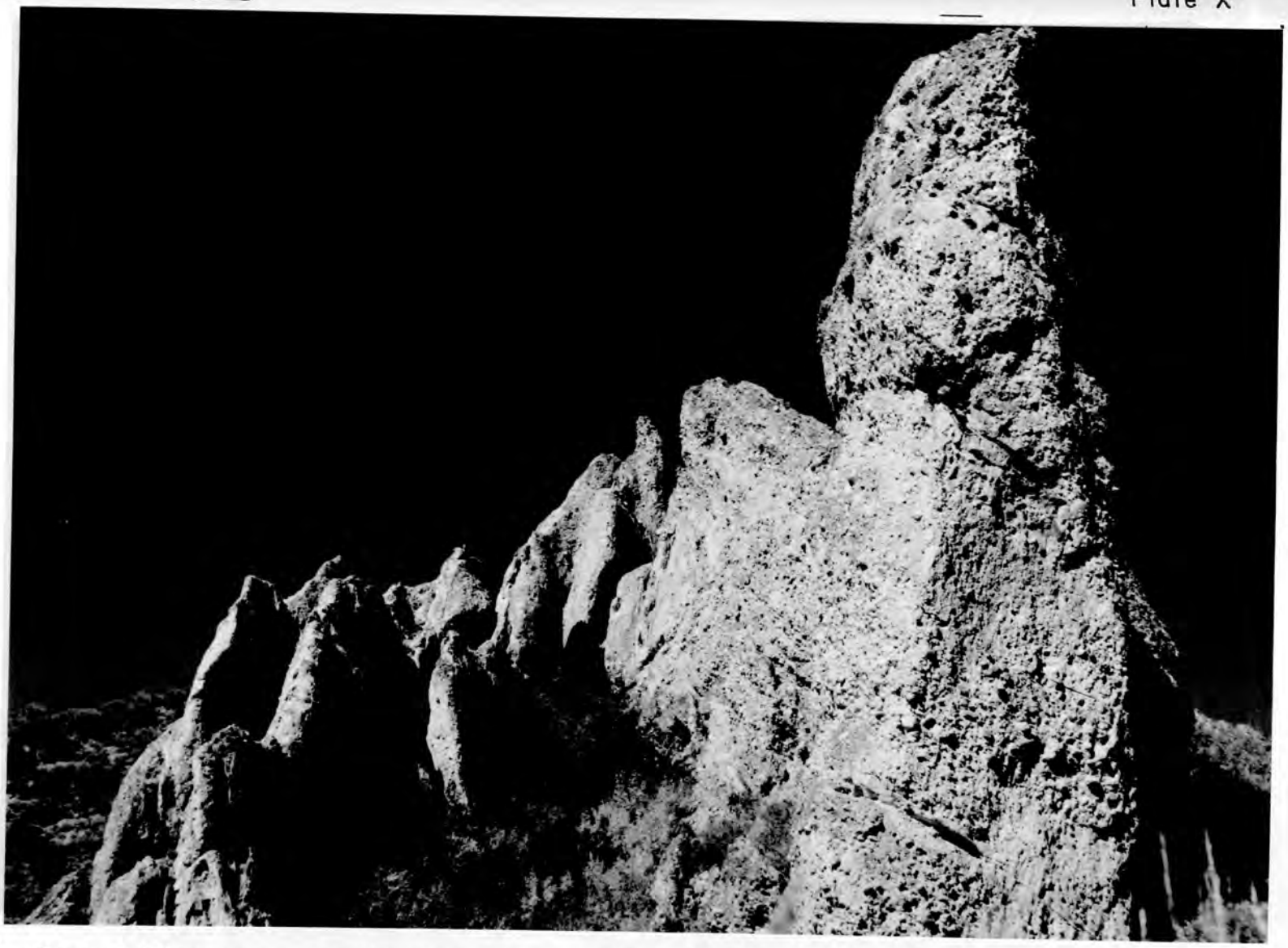
Faulting

Only one fault of significant magnitude was recognized in the area (Plate X). This structure can be traced approximately 8 miles and is essentially parallel to Lost Creek from Cedar Canyon to the junction of Trail and Francis Creeks. Movement of the fault was a scissor-like action with the pivot at the southern end and a maximum displacement approaching 1000 feet at the northern end. The east side of the fault is downthrown; the upthrown side has been stripped of its Tertiary cover exposing the folded Jurassic and Lower Cretaceous rocks in the Toone Canyon anticline.

Unconformities

Basal Wanship unconformity. In the vicinity of Meadow Creek the Wanship formation lies on the Frontier formation with only a

"Z" fold in the incompetant Twin Creek limestone on the northeast facing slope of Hell Canyon at the mouth. View looking southwest.



Drag-folding in a conglomerate bed in the Knight formation in Toone Canyon on the east side of the Toone Canyon fault. View looking northeast.

slight discordance (less than 5°); however, near the town of Wanship, Utah, to the south, Frontier and Kelvin beds dip almost 90° and are truncated by the gently tilted basal Wanship conglomerate (Morris, 1953, p. 46). This high angular discordance is pronounced only locally. In the Coalville anticline the angular discordance is small, and can be detected only by careful measurement over a distance of several miles. The basal Wanship conglomerate, however, serves as an excellent marker above the unconformity throughout the area.

Basal Knight unconformity. The essentially flat-lying Knight formation, where present, lies unconformably upon the tilted edges of all older formations. A classic example of the angular unconformity is in Echo Canyon, one quarter mile northeast of the mouth of Saw Mill Canyon (Plate XI). There the nearly horizontal Knight formation lies unconformably upon the beds of the Echo Canyon conglomerate which dip up to 25° northwest. Richardson (1941, p. 33) recognized the unconformity concerning which he stated, "The significance of the unconformity in the red beds, which may be only local, remains to be determined". Subsequently, Eardley (1944, p. 843) described the unconformity as a division between the two members of the Almy conglomerate.

Generally, the basal Knight unconformity is easily recognized especially where the Knight formation truncates rocks of dissimilar lithology or structural attitude. In other areas such as along the axis of the Stevenson Canyon syncline, where

Classic angular unconformity looking northeast up Echo Canyon. The Knight formation above and the Echo Canyon formation below the plane of the unconformity.

the Knight overlies the Echo Canyon conglomerate and has the same attitude, difficulty is encountered in distinguishing between the two formations or in defining the unconformity.

The plane of the unconformity is essentially smooth. Only locally are there small valleys and hills attesting to a pre-Knight topography, consequently, the unconformity can only be approximated in areas where beds above and below the unconformity are lithologically alike and flat-lying. This approximation is also confirmed by the fact that the overlying Knight formation is usually less resistant than the underlying conglomerate and a bench or terrace-like topographic expression of the contact is developed (Plate XII).

Post Knight Deformation

Regional warping of the Knight formation was not critically studied, however, locally, dips up to 20° are noted in the formation indicating that it has been deformed into broad folds. This Post-Eocene folding may be associated with the Basin and Range disturbance in the northern Wasatch Mountains which Eardley (1944, p. 865) suggests as probably beginning toward the end of the Pliocene.

Terrace-like topographic expression of the basal Knight unconformity on the west side of Saw Mill Creek.

GEOMORPHOLOGY

Drainage

The meandering Weber River (Plate XIII) is the master stream of the region and Lost Creek and Echo Canyon Creek are its main tributaries in the studied area. The nearly horizontal conglomerate has influenced the development of a dendritic drainage system over most of the area. Little or no structural control is suggested by the tributary drainages, though the barbed nature of Aspen Creek near Emory hints of a slight deformation which probably originated during the establishment of the present drainage pattern. The area as a whole is in the early mature stage of the idealized fluvial cycle.

Landforms

For the most part, a modified badland topography typifies the Lost Creek-Echo Canyon area. Resistant units of the Knight formation defend sharp cliffs and ledges and, locally, as in Chinatown, rapid erosion has produced steep cliffs and numerous statue-like pinnacles. Intense red coloration of the Knight siltstones, sandstones, and conglomerates together with the effects of mass-wasting have produced a Bryce Canyon in miniature.

Plate XIII

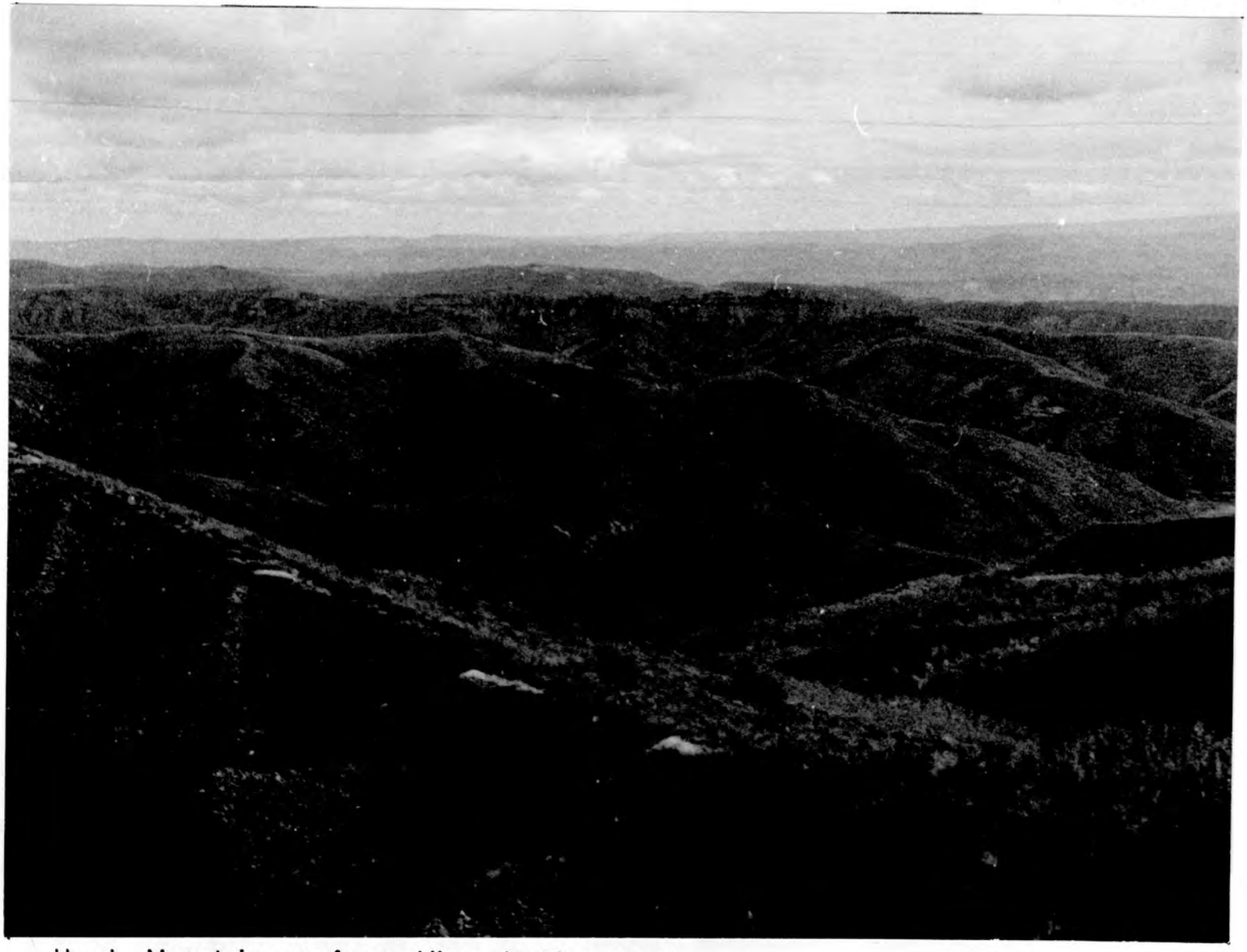
View looking southeast along the Weber Valley. Echo City, Pulpit Rock, and the mouth of Stevenson Canyon are in the background. Note also remnant of the Weber Valley surface in background.

Erosion Surfaces

The Herd Mountain surface described by Eardley (1944, p.873) is very apparent in the Lost Creek-Echo Canyon area (Plate XIV). Eardley (1952, p. 59) suggests that this erosional surface was formed contemporaneously with the Gilbert Peak surface described by Bradley (1936, p. 181) and that the earlier name probably should be used in preference to the later one.

In Miocene time the Herd Mountain surface was regionally elevated and subjected to erosion by a rejuvenated drainage system (Eardley, 1952, p. 59). As erosion of the Herd Mountain surface culminated, the general drainage pattern had attained its present character.

Evidence of pediments and ancient stream terraces are present along Lost Creek, Echo Canyon Creek, Meadow Creek, and at the mouths of the immediate tributaries to the Weber River. These features are remnants of the Weber Valley surface formed subsequent to the deep dissection of the Herd Mountain surface.



Herd Mountain surface. View looking east.

GEOLOGIC HISTORY

General Statement

An interpretation of the post Jurassic geologic history only of the Lost Creek-Echo Canyon area can be made; earlier events that are recorded in the older unexposed rocks cannot be reconstructed from local evidence. Descriptions of these older rocks in adjacent areas indicate that Paleozoic through early Mesozoic time was a period of steady, quiet, though varied, deposition that continued until the close of the Jurassic period.

Pulses of the Laramide orogeny affected the area from early Cretaceous to Tertiary time. The main pulse is recorded by the basal Knight unconformity which embraces the span from late Montanan (?) to early Eocene time.

Jurassic

Early Jurassic time was characterized by a regional accumulation of eolian sands under an arid climate. Subsequent to the accumulation of the Nugget sands, the Twin Creek sea, probably an arm of the Sundance sea, encroached upon the area from the north. As the sea advanced, it locally reworked the surface sands of the

Nugget and deposited the Twin Creek limestone.

The Preuss and Stump formations represent the shoreline fluctuations of late Jurassic sea ways, whereas the Morrison formation represents an accumulation of lacustrine and fluvial sediments from a western and southwestern source which was deposited on a wide alluvial plain after withdrawal of the late Jurassic sea. Deposition of the Morrison formation seems to coincide with some phases of the Sierra Nevadan Revolution (Stokes, personal communication).

Early Cretaceous

The Cedar Hills orogeny, an early Cretaceous disturbance (Eardley, 1951, p. 275), is represented by the coarse clastic sediments of the Kelvin formation which were derived from a source area believed to lie just west of the present Wasatch front.

After Kelvin time there ensued a period of quiescence followed by the influx of the Aspen sea. Bentonites and other volcanic materials in the Aspen shales are believed to have been derived from a distant, rather than local, source (Cobban and Reeside, 1952, p. 1023).

Coloradoan

The Frontier formation rests upon the Aspen shales and consists of an impressive thickness of sands and interbedded shales and some coal beds. Deposition of the Frontier continued

without marked interruption until about mid-Coloradoan time. At this time the accumulation of Frontier sands was halted by crustal unrest corresponding to an early pulse of the Laramide orogeny which produced local folds and warping. The best known structural effect of this episode of deformation is seen in the Cherry Creek-Dry Creek vicinity near Wanship, Utah. This period of folding, however, is reflected only slightly in the vicinity of Coalville where the beds of the Frontier were gently folded, and then truncated by erosion.

After a period of erosion and, perhaps, more intense deformation to the west, the sea reoccupied the area and reworked the beveled exposures of the Frontier and older formations and the basal Wanship conglomerate was deposited.

Sediments of the basal conglomerate grade upward into another relatively uninterrupted sequence of lacustrine and marine sediments represented by the bulk of the Wanship formation.

A rapid change in sedimentation occurred at the close of Wanship time and the Echo Canyon conglomerate was deposited concordantly upon the Wanship formation. The Echo Canyon conglomerate reflects a significant orogenic disturbance westward of the Lost Creek-Echo Canyon area, but no significant discordance was recognized separating the Echo Canyon conglomerate from the underlying formation in this area.

Fossils found near the base of the Echo Canyon conglomerate indicate that the conglomerate accumulation probably commenced in

late Colorado time. Oscillations of the late Cretaceous sea just prior to its final withdrawal are recorded in the thin, Inoceramus-bearing sandstones, interbedded with the coarse detritus of the lower Echo Canyon conglomerate (Plate XV).

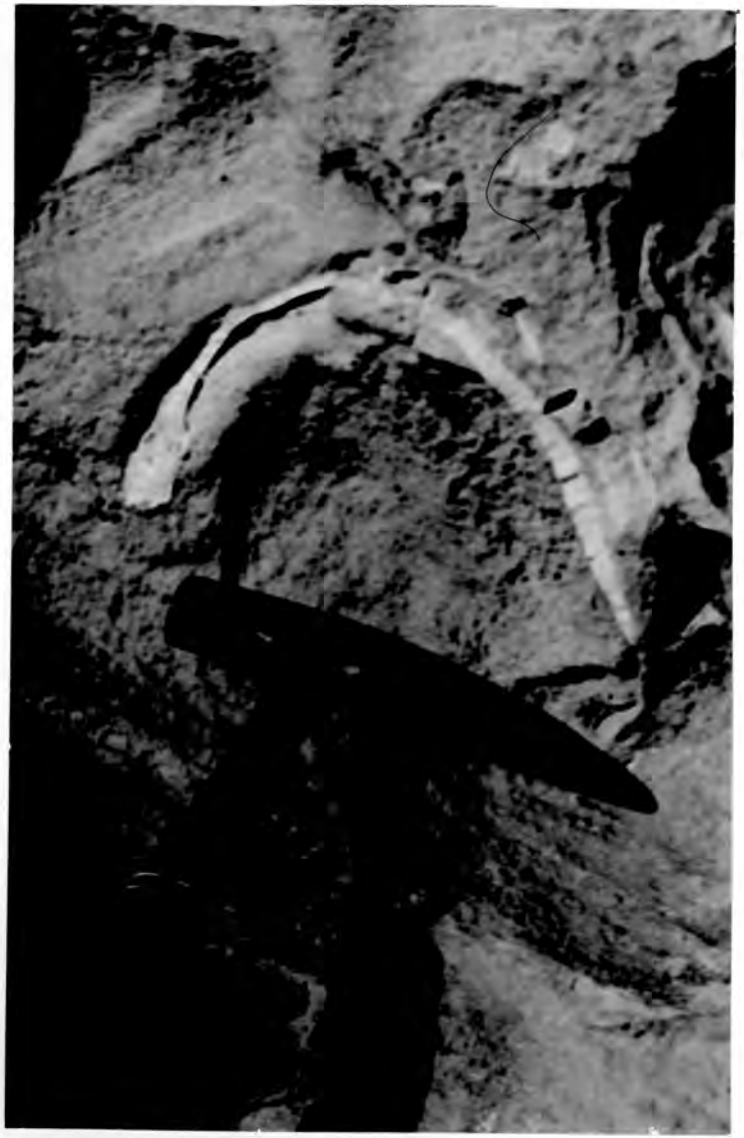
Montanan (?)

On the basis of correlations with lithologically similar sections of known Montanan age in nearby areas (Plate IV) it is reasonable to assume that most of the Echo Canyon conglomerate was deposited in Montanan(?) time. This pre-Paleocene period of coarse clastic deposition was probably responsible for a greater thickness of conglomeratic material than is represented in the Echo Canyon section and probably continued through most of Montanan(?) time.

Post-Echo Canyon conglomerate - Pre-Knight

After the accumulation of the Echo Canyon conglomerate and prior to the deposition of the next younger beds, a period of intense deformation ensued. The Echo Canyon conglomerate and older formations in the Lost Creek-Echo Canyon area, as well as in the Central Wasatch Mountains, were most severely deformed. Most of the structural effects observable in these formations were imparted during this interval, and this period of deformation represents the most intense episode of folding during the Laramide orogeny (N. C. Williams, personal communication).

Subsequent to folding there was a period of erosion which



Sand bed in the Echo Canyon conglomerate where it crops out 2 miles northwest of Echo. Specimen is Inoceramus deformis?.

left the area, locally at least, with a low relief. Upon this surface the Knight detritus was deposited and the basal Knight unconformity attests to this period of erosion and subsequent deposition. Some of the clastic materials of the Tertiary Knight formation may represent erosional destruction of highlands produced during the post-Echo Canyon conglomerate period of folding.

Paleocene

Rocks of Paleocene age were not recognized within the mapped area of Lost Creek and Echo Canyon, although previous workers in nearby areas (Veatch, 1907 and Eardley, 1944) have described rocks of early Tertiary age.

With the assignment to the Cretaceous of rocks previously considered to be Paleocene, no known Paleocene rocks are present in the area. However, rocks classified as Eocene in the present study may actually include some Paleocene beds.

Eocene

The scope of this report did not permit a detailed study of the conglomerate sequence which unconformably overlies the Echo Canyon conglomerate and all older rocks in the area. Stratigraphic position together with identification and correlation by previous workers (Veatch, 1970, p. 88; and Eardley, 1952, p. 55; and Jones, et al., 1954, p. 2221) suggest that this accumulation of clastics is probably the Knight formation, the detritus from which was derived primarily from a westward source as is indicated by the

gradation of constituent materials which are progressively finer toward the east. The Uinta arch, uplifted prior to this time, may have contributed some material to the Knight formation from the south.

Late Tertiary

The Herd Mountain and Weber Valley surfaces remain as the only evidence of late Tertiary geologic history in the area. The Herd Mountain surface was in existence at the beginning of Miocene time (Eardley, 1952, p. 59) when subsequent uplift subjected the area to renewed erosional activity. The present drainage system, as well as extensive pediments in the broader valleys, had been established at the culmination of erosion of the Herd Mountain surface. The pediments comprise the Weber Valley surface (Eardley, 1952, p. 60) which probably was formed by late Pliocene or early Pleistocene time.

Quaternary

Dissection of the Weber Valley surface after its establishment in late Pliocene time has continued to the present. Evidence of alpine glaciation, which was active in the Uinta Mountains to the southeast, was not recognized in the Lost Creek-Echo Canyon area, although present stream courses may have been influenced at the time.

ECONOMIC GEOLOGY

General Statement

Four actual or potential mineral resources occur in the Lost Creek-Echo Canyon area. Coal was exploited in the late 1800' and early 1900's, but except for sporadic production, no coal has been produced for many years. Clay and limestone are presently being quarried and the petroleum possibilities remain to be investigated.

Coal

Coal was mined from the Knight formation along Lost Creek and several of its tributaries in the early 1900's. The coal is ranked as sub-bituminous, but its high moisture content and tendency to slack upon drying have limited its use to local consumers.

In 1914 Clark (1918) made a study of the Lost Creek coalfield as such. He maintained in his final report that the low grade of the coal in addition to its limited occurrence would prevent its development as a shipping coal and that future development would depend solely upon local consumption.

Immediately south of the area, in the vicinity of Coalville, coal has been mined successfully for many years from the Frontier

and Wanship formations. Wegemann (1915) did the first detailed geologic work on the Coalville area. At the present time only two mines, the Chappel and the Blackhawk, are being worked, and only to the extent of supplying local demand.

Clay

East of Henefer a fairly good grade of brick clay is quarried from a red clay facies of the upper Wanship formation. A limited operation is underway at the present time (1959) and it is the only undertaking of its kind in the mapped area at the time of this report.

Limestone

No use is being made of the Twin Creek limestone at its exposures in Toone Canyon; however, less than a mile west of the area mapped for this report the Ideal Cement Company has a plant which has a capacity of approximately 2 million barrels per year of high quality portland cement. This operation utilizes raw materials, shale and limestone, quarried from the Twin Creek limestone west of Croyden.

The Devil's Slide cement plant has been operated by the Ideal Cement Company since about 1942.

Petroleum

Petroleum possiblities of the Lost Creek-Echo Canyon area remain as yet to be determined. Several tracts have been leased

by independent petroleum companies, but no exploratory drilling has been done in the area of this report. Several structures worthy of consideration from an exploratory standpoint are present, however, an imposing thickness of Mesozoic and Cenozoic sediments seems to be the chief deterrent factor in setting up an exploratory drilling program.

As needs for petroleum increase and nearby areas in southwestern Wyoming are more vigorously searched, the Lost Creek-Echo Canyon area will warrant more careful consideration.

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Era	Per.	Epoch	FORMATION	SECTION	THICKNESS	DESCRIPTION
CENOZOIC	TERTIARY	Eocene	Knight formation		2000'	Conglomerates, red to brown, pebble to boulder sizes, variegated shales and sandstones, coal near base of formation
			unconformity			Local angular discordance
			Echo Canyon conglomerate		3100'	Conglomerates, red to tan, pebble to boulder sizes, shale and sandstone beds, fossiliferous
						Inoceramus labiatus, I. deformis, Ostrea anomioides, O. sp.
						Fossil leaves
						Clay facies, red, local
MESOZOIC	CRETACEOUS	Upper				Vertebrate fossil
						Sandstones, buff to white, variegated shales and siltstones, pea-sized conglomerates in sandy matrix near top of formation, fossiliferous
			Wanship formation		4950'	*Inoceramus sp.*
						Basal conglomerate
			unconformity			*Ostrea sp.*
			Frontier formation		2132'	Sandstone, buff to white, interbedded dark gray to gray shale and coal seams, fossiliferous
			Aspen formation		99'	
		Lower				Beds unexposed
			Kelvin formation		2700'	Conglomeratic at base, reddish sands and silts
	JURASSIC	Upper	Morrison formation		480'	Siltstones, concretionary limestone, pebble conglomerate, predominantly red sandy matrix
			Stump formation		420'	Sandstone, pale green to tan, glauconitic, calcareous
			Preuss formation		370'	Siltstone, brick red, shaley
			Twin Creek formation		3140'	*Pentacrinus asteriscus*
						Limestone, dark gray, siliceous, shaley to massive, some redbeds near top of formation, fossiliferous
		Lower	Nugget sandstone		1100'	Sandstone, pale orange to tan, massive, crossbedded, fine to medium grained
						Base not exposed
				Total = 20,491		

STRATIGRAPHIC SECTION of the LOST CREEK, ECHO CANYON, COALVILLE AREA