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A Geological Report on Several Localities of Madison County, Montana

Hans Fritzsche

A GEOLOGICAL REPORT
ON SEVERAL LOCALITIES
OF MADISON COUNTY, MONTANA.

BY

HANS FRITZSCHE

MONTANA SCHOOL OF MINES, BUTTE.

JANUARY, 1935.

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INTRODUCTION:

In September,1934,the author joined the Montana School of Mines senior class on a two-weeks trip for geological field mapping.The mapping party consisting of 11 students was headed by Dr.E.S.Perry,later on by Prof.Paul A.Schafer and Mr.Uuno M. Sahinen.This paper is to report the field work done.

The area selected for study comprises four different districts situated in Madison County,each of them showing typical geologic features:the South Boulder District,the "Montana type section of Paleozoic and Mesozoic rocks",the Mayflower District with the famous Mayflower mine,the Renova Hot Springs District as an excellent area for studying structural features, and the Silver Star Mining District with its contact metamorphic ore deposits.

The field work was done by plane table and telescopic alidade on a scale of 1000 feet to an inch,distances being measured with a stadia rod and partly by spacing.A Brunton compass was used for measuring dips and strikes.

Previous work done in the district led to the following puplications:

(1) Alexander N. W i n c h e l l ,
Mining Districts of the Dillon Quadrangle,Montana.
Bull.574,United States Geological Survey,1914.

(2) T a n s l e y - S c h a f e r r - H a r t ,
A Geological Reconnaissance of the Tobacco Root Mountains,Madison County,Montana.
Memoir 9,Bureau of Mines an Geology,Butte,1933.

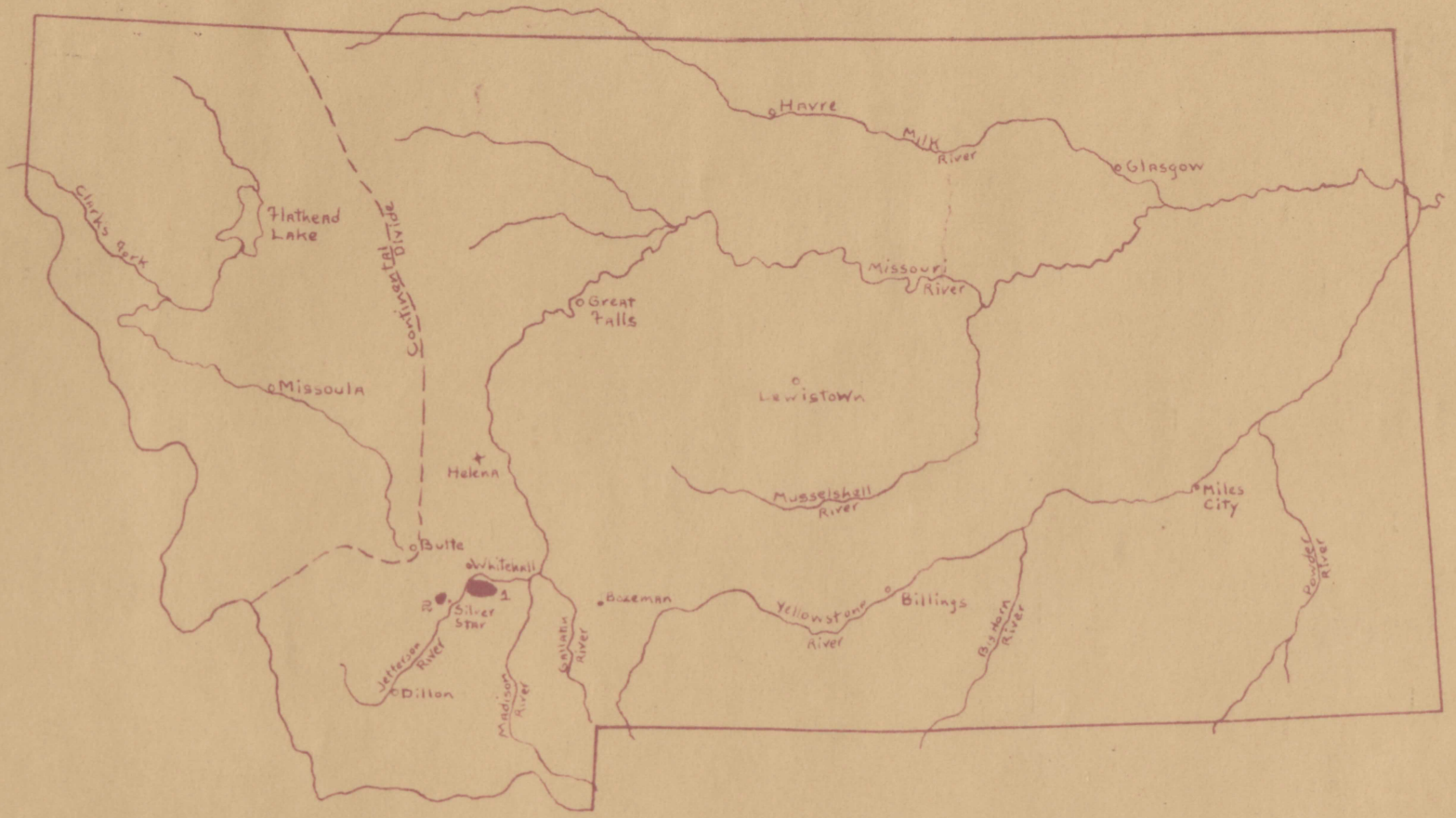
GENERAL PHYSIOGRAPHY OF THE AREA:

Location -

The four districts mentioned are located in Madison County,Montana,near the town of Whitehall.The South Boulder District,about 20 miles south east of Whitehall,stretches along South Boulder Creek,a tributary of the Jefferson River draining the Tobacco Root Mountains to the north.Also on the northern slope of this mountain range are the Mayflower and the Renova Hot Springs District,13 and 8 miles from Whitehall respectively.The Silver Star District lies about 20 miles south of Whitehall,on the eastern foothills of the Highland Mountains,separated from the Tobacco Root Mountains by the Jefferson River valley.

Accessibility -

The town of Whitehall is accessible by two transcontinental rail roads,namely,the Chicaco,Milwaukee,St.Paul and Pacific Railroad,and the Northern Pacific Railroad.Furthermore, the upper Jefferson valley is served by a Northern Pacific



INDEX MAP OF MONTANA
SHOWING AREA INCLUDED
IN THIS REPORT

1. RENOVA, MAYFLOWER AND SOUTH BOULDER CREEK DISTRICT
2. SILVER STAR DISTRICT

branch line fron Whitehall to Alder with depots in Silver Star and Iron Rod among others.Modern highways make the region easily accessible for automobiles,and smaller roads lead to the different mines in the foothills and the mountains.

Topography -

The region described in this report belongs to the Northern Rocky Mountains Province,showing its typical topographic features:Out of wide open valleys rise gently rolling hills grading into plateaus as remnants of ancient peneplanes.Theses plateaus give way to steep slopes leading up to the crest of the mountain ranges.Many gulches and valleys showing glaciation features in their upper parts cut deeply into the plateau-like uplands and carried a huge load of gravel material into the valleys.At present times,most of the gulches are dry or used by intermittent streames,so that erosion is not very active leaving the region in a state of mature topography.

The relief of the whole region is rather high,the elevation above sea-level ranging from 5000 feet on the floor of Jefferson valley to 10,600 feet on the top of the highest peak of the Tobacco Root Mountains.The four small districts described in this report,however,are of moderate relief,being situated on the foothills or the plateau-like forelands.

Photographs, showing Jefferson Valley, looking north-east.

a -- Jefferson Valley floor
b -- gravel benches (alluvial fan)
c -- Tobacco Root Mountains
d -- Renova Hot Springs District
e -- Mt. Jefferson (10600 feet)

Vegetation -

The vegetation of the area is very poor,consisting of willows and poplars in the valleys,sagebrush and some spare grasses in the foothills and some stands of fir,pine on the slope of the mountains up to about 9500 feet elevation.The only fertile soil of the area is on the bottom of Jefferson valley and some of the larger gulches.

Climate -

The area has semi-arid climate with very little precipitation (10 to 15 inches a year),and a wide annual range in temperature (from + 100 to - 50 degrees Fahrenheit).Due to the high altitude the climate is very healthful.

Drainage -

The region,situated east of the Continental Divide,is drained by many creeks and gulches to the Jefferson River,besides Madison and Gallatin Rivers the headwater of the Missouri River Which empties into the Gulf of Mexico.

GENERAL GEOLOGY OF THE AREA:

In this chapter the geology of the whole region will be described in a general way,whereas detailed descriptions of each district will be given later on.

The region embraces metamorphic,igneous and sedimentary rocks.The metamorphic rocks consist of the Pony and Cherry Creek series of gneisses and schists,of partly igneous and partly sedimentary origin,and are known to be of Pre-Beltian age. The sedimentary rocks range from the Pre-Cambrian Belt series through an almost complete sequence of Paleozoic and Mesozoic formations up to Quarternary deposits.The igneous rocks vary widely in composition and occurance,comprising Cretaceous andesitic and basaltic lavas,the quartz-monzonite of the Boulder Batholith,masses of syenite porphyry and many dikes and sills.

Historical and structural Geology -

The geologic history can be traced back to Pre-Beltian times.An inconformity between the Pony and Cherry Creek series indicates that the Pony gneisses of mostly igneous origin had been folded,eroded and depressed below sea-level,before the Cherry Creek sediments were deposited.After another time of intense folding causing the entire metamorphism of the Cherry Creek beds,the Belt sediments were laid down the material of which was contributed by a nearby land-mass and originated at least partly from probably Pre-Cherry Creek igneous rocks,as many inclusions of the Belt arkose indicate.The Belt series,being but gently warped and eroded were covered by a vast thickness of Paleozoic and Mesozoic sediments.In late Cretaceous time the Laramide disturbande,followed and certainly partly enforced

forced by large igneous intrusions,caused the Rocky Mountain uplift,crumpling and faulting the rocks,elevating them and exposing the surface to vigorous erosion.Thus the land surface was eroded to a nearly level plain when in early Tertiary times a period of intense faulting produced the main features of the present basin-and-range topography.The wide valleys,for instance of Jefferson and Madison River are troughs,the down-thrown parts of big faults,the upthrown parts of which are represented by the mountain ranges such as the Tobacco Roots.There are a number of minor faults in the area causing the complicated structure to be discussed in detail later on.

The Tertiary was a time of large igneous extrusions. Faulting and lava flows damed the streams forming intermontane lakes in which the accumulation of lake beds took place.In the middle and southern part of the Tobacco Root Mountains there is evidence of an old miocene erosion surface,called by Tansley and Schafer the "Laurin-Norris erosion surface" (lit.2).It cannot be traced,however,into the northern part of the Tobacco Root Mountains where due to differential uplift erosion has been much more active.

The lake beds were gently tilted due to little faulting at the end of the Tertiary period.Local glaciation occured in Pleistocene times leaving sporadic glacial and post-glacial deposits such as moranes and loess beds.Together with the removal of the ice a vigorous erosion began,cutting deep gorges and canyons,thus dissecting the mountains and carrying huge masses of alluvial fan into the Jefferson valley.

THE SOUTH BOULDER DISTRICT:

Physiography -

The South Boulder Creek is the main stream draining the Tobacco Root Mountains to the north. It empties into the Jefferson River, near Jefferson Island, about 10 miles east of Whitehall. The creek is some 20 miles long and occupies a valley which is in its narrow upper part 3000 feet deep, the relief, however, being lower at the mouth of the creek.

The creek cuts at right angles through an almost complete sequence of Paleozoic and Mesozoic rocks, thus giving an ideal type section of Montana formations. The rocks are especially well exposed on the western side of the valley. The slopes of South Boulder Creek are intersected by many small water courses cutting their way through the softer members of the series and leaving steep limestone and quartzite ridges standing up conspicuously.

The climate is exactly that as mentioned above for the whole area. So is the vegetation; the eastern slope of the creek bears some fairly sized stands of pine; some fertile soil in the bottom of the creek is used by several ranches. A rough, ungraded road winds up the valley connecting with several mines located way up in the mountains.

General Geology -

The rocks as exposed along South Boulder Creek form the southern limb of a wide syncline the axis of which is striking east-west and whose center is occupied by a vast sheet of Cretaceous lava flows.The northern limb of the same syncline has apparently been eroded away;the area is covered by Tertiary lake beds and by recent stream deposits.At the southern margin of the syncline the dip of the beds is about 45° north,the angle decreasing gradually towards the center.No evidence of faulting or minor folding has been seen,although the thickness of the Madison limestone as measured last year appears rather high.

The bulk of the rocks exposed in South Boulder Creek are sedimentary except the metamorphic Pony series and the already mentioned lava flows.Mapping was started at the southern fringe of the syncline,at the contact beween Pony gneiss and the Flathead formation.The Cherry Creek and Belt series are entirely missing.

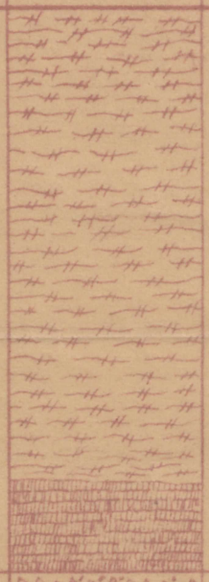
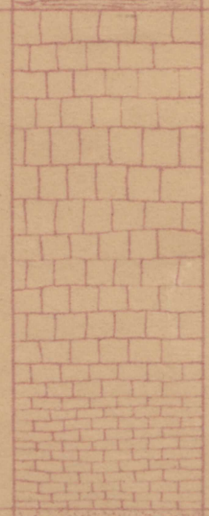
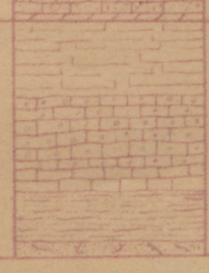
Description of the rock formations -

Cambrian:

The Cambrian consisting of the Flathead and Gallatin formations has a total thickness of 1800 feet.The basal member is the Flathead quartzite,a pinkish,compact,and brittle rock,known as a conspicuous marker through the whole area,as shown later on.It is overlain by the greenish,thinly bedded Flathead shale,which in turn gives way to the Flathead limestone

Columnar Section Of The South Boulder Area

Scale
1 Inch = 1000 Feet

Period	Formation Name	Columnar Section	Thickness In Feet	Character Of Rocks
Upper Cretaceous	Livingston		3050	Andesite - Basalt
Upper Cretaceous	Livingston		1450	Agglomerate
Cretaceous	Colorado		100	Black Shale
	Kootenai		400	Sandstone + Arenaceous Shale
Jurassic	Ellis & Morrison		500	Variegated Shales Buff Sandstone Massive Blue Limestone
Permian	Phosphoria		100	Phosphates + Oolites
Pennsylvanian	Quadrant		500	White + Tan Quartzite Grey Limestone Red Shale
Mississippian	Madison		2600	Massive Limestone Thin-bedded Limestone
Devonian	Three Forks		400	Green + Red Shale
	Jefferson		900	Massive Black Limestone
Cambrian	Gallatin		500	Mottled Ls + Dolomite
	Flathead		1300	Shaly Limestone Oolitic Limestone Tan Quartzite + Gray Shale

This 1300 feet thick Flathead formation is followed by the Gallatin,represented by a mottled,grey,and dolomitic limestone with a trilobite bed at the base.

No Ordovician and Silurian beds have been identified, although there is no inconformity between the Cambrian and Devonian sediments.

Devonian:

The Devonian consists of about 900 feet of Jefferson limestone,characterized by the dark grey to blck color and the fetid odor;it is in part dolomitic.Above the Jefferson is the Three Forks formation,comprising 400 feet of red and green , blocky shales with interbedded limestone.A few trilobites and brachiopodes have been found in the Devonian;the fossils,however,were so poorly preserved that further identification was impossible.

Carboniferous:

The Mississipian formation is represented by a vast thickness (2600) of the mountain forming Madison limestone which is sandy and light colored in it s lower part.The upper part is a grey to blue,massive limestone,partly very dense and hard,and very easily to be recognized by its vertical cliffs, as shown on the photograph.The thickness of the Madison limestone in South Boulder Creek is by far exceeding the average thickness of this formation in Montana which fact may be explaned by local faulting.Various beds within the Madison are full of fossils,mainly brachiopodes,corals and crinoides.

Plate number

Photograph, showing part of South Boulder Creek, looking north.

j -- Jefferson limestone
t -- Three Forks shale
m -- Madison limestone
a -- Alluvium

HF, Sept., 1934.

The following Quadrant formations has always been believed to be of Pennsylvanian age;an exact correlation,however, has never been possible.According to detailed field work done last summer by Prof. H.W. Scott in various parts of Montana,the red,shaly and calcareous beds on top of the Madison limestone and the following white limestone belong to the Amsden formation which is in the transition zone between Mississipian and Pennsylvanian.The remaining Quadrant quartzite,white,pink and tan in color is Pennsylvanian.

Permian:

The immense Permo-Triassic period is not represented but by 100 feet of the Phosphoria formation,containing black shales,chert,and three distinguished zones of oolitic phosphate rock weathering to a steel-grey color.In other parts of Montana,the phosphate content,probably derived from reptilien bones,makes some beds of the formation worth to be mined.

Jurassic:

Of Jurassic age are the Ellis and Morrison formations consisting of about 500 feet of blue limestones,sandstones,and variegated shales with a conspicuous oyster bed,occuring above the sandstone.

Cretaceous:

The rocks of the Cretaceous are of igneous and sedimentary origin.The lower Cretaceous is represented by the

Kootenai,Colorado,and probably Montana formations.The Kootenai contains 400 feet of shaly red beds and massive sandstones,including a limestone bed with abundant fossil gastropods. Above the Kootenai are 100 feet of fine-grained,dark,marine shale of the Colorado,and above this in turn there was found a thin outcrop of brownish sandstone which is believed to belong to the Montana formation although it could not be traced over a far distance.

The upper Cretaceous consists of a thick series of agglomerates and lavas which have been correlated with the Livingstone group.About 1400 feet of agglomerates lie conformably above the lower Cretaceous strata.They are made up of rounded pebbles of the neighbouring lava flows,of sand and mud,the pebbles ranging in size from small particles to one foot and more in diameter.The lavas,covering the center of the wide syncline are of basaltic and andesitic composition;there are various types;some of them contain large oriented feldspar phenocrysts making for the name of "outmeal lava".

Mapping was not carried on further,because the area is covered with Tertiary and Quarternary deposits.

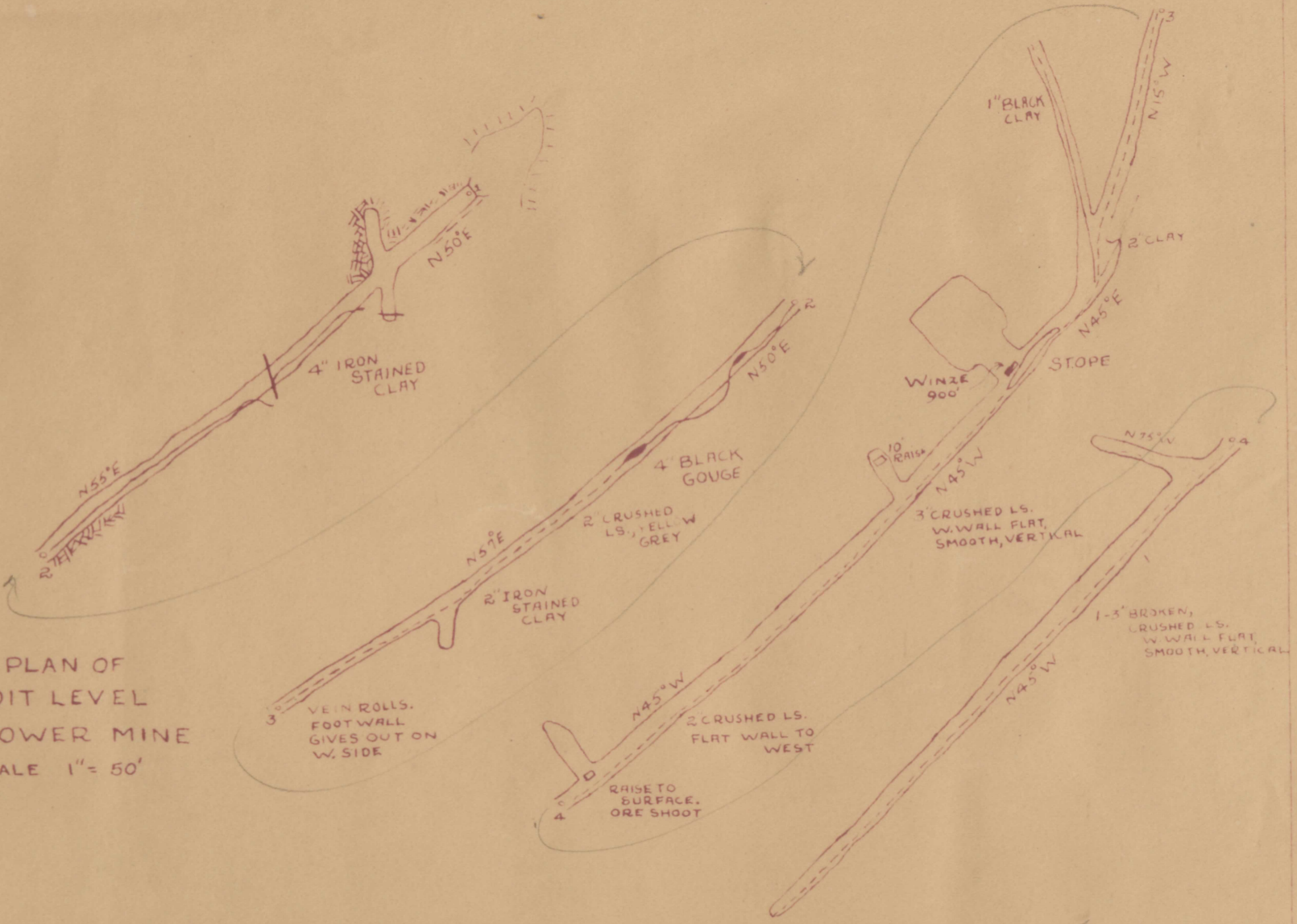
THE MAYFLOWER DISTRICT:

The Mayflower district,once the location of a bustling mining camp and one of Montanas most famous gold producers,is now a deserted place,8 miles west of South Boulder Creek and about the same distance south of the Jefferson River.It is almost unaccessible by automobile since cloudbursts hardly left anything of a road over which gold ores valued as high as $ 2,000,000 have been hauled.Yet the district gives an excellent occasion for studying geology.Because of bad weather conditions no outside work could be done.The work was confined to the survey of the adit level of the old Mayflower mine which has been closed down some 30 years ago.

General Geology:

Since no outside mapping has been done,the geology will not be discussed in detail.The rocks found in the district are Belt arkose which will be descibed later on,the already mentioned Flathead quartzite,shale,and limestone and the Livingstone lavas.

The major structural feature is the Mayflower fault which offsets Flathead limestone against Livingstone lavas thus indicating a movement along the fault plain of 6000feet. About one quarter of a mile east of the old Mayflower mine,the Flathead formation,too,is cut out,leaving Cretaceous lavas faulted against Pre-Cambrian arkose.The fault strikes N 50° E and dips nearly vertically,is even overturned in places.It is cut at almost right angles by minor faults which are shown up perfectly by the dissected quartzite ridge.



should be as one continuous adit

Economic Geology:

The Mayflower mine is an example of an unusually rich deposit on a comparatively small room,for development work exceeding a 1000 feet stretch either east or west has been unsuccessful.The ore shoots occur near the fault in the Flathead limestone.Very little is known about origin and character of the primary ore,because the old workings are unaccessible.As reports say,the ore above the 300 feet level wsas entirely oxidized and enriched by secondary processes,whereas commercial sulfides and tellurides were minded down to the 800 foot level. The mine was developed from a 700 feet long adit a plan map of which is enclosed in this report.

THE RENOVA HOT SPRINGS DISTRICT:

Physiography -

The Renova Hot Springs District as shown on the accompanying map embraces the western corner of the Tobacco Root Mountains,an area of about ten square miles.It shows plateau-like topography with steep slopes on the western margin and is intersected by several narrow,deep gulches.The northern foreland,however,is filled up with Tertiary lakebeds and alluvial deposits thus making for a rather moderate relief.

Climate and vegetation are similar to those mentioned for the entire area.The population consists of a few ranchers and prospectors.The district is accessible for automobil by

several ungraded roads following the course of the gulches and leading to the various mines.

General Geology -

The oldest rock found in the district in place is the Belt arkose covering the main part of it.The Belt arkose is of brown color and generally fine-grained,its various components are mainly of sedimentary origin;in places,however,it contains big inclusions of undoubtedly igneous material.It weathers easily,giving its soil a conspicuous brownish color.

Other sediments bucuring but already described are the Flathead quartzite,shale and limestone and the Madison limestone found as fault drag.Right above Renova Hot Springs a shale member of about 250 feet thickness was noted between Belt arkose and Flathead quartzite.Although faulting is very abundant in the area,the occurance of this shale can hardly be explaned by structural disturbance.This Pre-Flathead shale,however,has never been found in the close vicinity.

Igneous rocks of the district are syenite porphyry and Livingstone lavas,the latter of the same type as described for South Boulder Creek.The syenite porphyry forming a large intrusive mass with smaller knobs as outlayers,consists of a light-colored ground-mass with phenocrysts of orthoclase weathering out perfectly.Generally,the syenite porphyry resists weathering more than the surrounding arkose does,thus standing out as long rounded hills.As a rather peculiar fact may be mentioned that

Photograph, showing Renova District, looking east.

a -- Belt arkose
s -- syenite porphyry
l -- Livingstone lavas

MF-- Mayflower fault

Note the difference in vegetation on Belt arkose and syenite porphyry.

HF, Sept., 1934.

the vegetation of both,arkose and syenite porphyry,is so different,that their contact can be noted from far away.Close to the main syenite porphyry body several dikes of white,massive,b barren quartz have been mapped.

The northern slope of the district is covered by Tertiary lakebeds and alluvial stream deposits.The so-called "Bozeman lakebeds" consist of fine,white material of supposed volcanic origin,deposited in Tertiary times in intermontane lakes. Generally,the light,porose rock is similar to a tuff;there are many places,though,where the lakebeds contain true gravels and sand.

The structure of the Renova district is very complicated,the results of faulting and folding being abundant. The sedimentary beds seem to have been warped to an anticline with the Belt arkose as a core.Following the main uplift of the Tobacco Root Range intense cross faulting dissected the beds into small segments.Here again,the Flathead quartzite acts as an excellent marker,revealing the structural features perfectly due to its resistance to weathering.

The Mayflower fault enters the district from the east, setting Flathead quartzite against Livingstone lavas;it is difficult,however,to trace the fault,because the structure is concealed by talus gravel and stream deposits and by the syenite porphyry masses.The doubted line on the map shows the apparent location of the fault.West of the Florence mine the Belt arkose

is faulted agaist Paleozoic limestone part of which has been determined as Madison.

Economic Geology -

The district has never been of outstanding importance, although several mines have been worked to a certain extent, so among others the Gold Hill,Colorado,Sunrise and Florence mine.The deposits occur in strong fissure zones within the Belt arkose,the Sunrise and Colorado ore at the contact of arkose and syenite porphyry which is significantly carrying gold tellurides.The ore of the other mines is apparently derived from the same source.

THE SILVER STAR MINING DISTRICT:

The Silver Star District is one of the oldest quartz mining districts in the State of Montana,the Broadway,Green Campbell and Iron Rod mines having been operated from the early sixties up to 1912.There was a time,when the town of Silver Star was the most important place between Virginia City and Helena. The total production of the Silver Star and Iron Rod Districts, consisting mainly of gold and of less amounts of silver and copper,may be valued at $ 1,000,000.

Physiography -

The photograph on the next page shows the topography of the Silver Star District.Jefferson valley floor,gravel ben-

ches

Photograph, showing Silver Star District, looking west.

a -- Alluvium, Jefferson valley
g -- gravel benches
l -- limestone hills
s -- gneiss and schist ridges.

HF, Oct., 1934.

benches,limestone hills and steep gneiss and schist ridges mark the different topographical stages as progressing from east to west.The maximum relief of the district is 1750 feet between the Jefferson valley and the western margin near the Aurora mine. Several deep canyons are cut into the rock,thus revealing some of the complicated structure of the district.

The vegetation is very poor,bare,naked slopes and ridges being conspicuous.Several years ago,mining activity came back to life,although the operation of about 7 mines does not exceed a very small scale.The various mines which are from 3 to 5 miles distant from the town of Silver Star,are accessible by some small,ungraded roads being hardly passable at winter time.

General Geology -

The rocks of the district are numerous and partly hard to be recognized because of various kinds of metamorphism and alteration.The oldest rocks are gneisses and schists the age of which has not been determined exactly;yet,originating mainly of igneous material,they may be compared with the Pony series of the Tobacco Root Mountains.Naturally,it is difficult to correlate metamorphosed rocks over large distances for the change of conditions,such as pressure,etc.

These Pre-Beltian metamorphic rocks consist of light colored and pink granitic gneisses with numerous interbedded black bands of hornblende schists.The black bands,when traced,

reveal perfectly the major structural features of the gneiss zone,as shown on the map.

The sedimentary sequence begins with Paleozoic limestones which cannot be determined exactly because of their high alteration.Yet,according to their structural relations they should be Jefferson.The Three Forks formation is present with green and red blocky shales with interbedded limestone.Very conspicuous are the cliffs of Madison limestone which is more blue in color than usually.In places with but little alteration some poor fossils have been found,however,well enough preserved to assure the age of the beds.The Madison is overlain by both, Amsden red beds and limestone and Quadrant quartzite.Above the Quadrant quartzite,Permian phosphoria beds crop out in a very thin band,difficult to be recognized.

Next in the series range agglomerates of probably Livingstone age;regular lava flow structure,however,has not been found by the author.The agglomerates are mostly fine-grained, of brown,green and purple color and do not contain as big boulders as are typical in South Boulder.In one creek,there is a very thin layer of Tertiary lekebeds,too small,however,to be shown on the map.Big parts of the district are covered by talus gravel,and large gravel benches have been towered in Jefferson valley.Some of the wider creek bottoms contain alluvial material.

The most common igneous rock of the district is the quartz-monzonite (granite) of the Boulder Batholith.

Photograph, showing part of Silver Star District.

a -- Green Campbell Gulch, about 1 mile west of Barkell Hotel
b -- Three Forks shale
c -- Madison limestone
d -- gneiss and schist mountains.

HF, August, 1934.

Along its fringe the batholith shows in several places a border phase of dioritic composition.Near the Hot Springs,about ½ a mile west of Barkell Hotel,an igneous rock of andesitic type may be noted.According to surface indications,however,it seems to be but a different part of the main batholith.In the gneiss and schist zone,several stocks of rhyolite porphyry and diorite porphyry occur,and many dioritic, basaltic and doleritic dikes are conspicuous.

As already mentioned,the rocks are extensively altered.The main metamorphism is found at the contact of the quartz-monzonite and the Paleozoic limestones.Recrystallization into a pure,white marble is predominant.Furthermore,such typical contact minerals as epidot,garnet,hedenbergite are developed and occur partly in considerable amounts.The alteration,especially silification of part of the limestone in the area is doubtlessly caused by hot springs action.There is still an active hot spring in the district which probably gets to the surface along the contact zone between the batholith and the sedimentary rocks.

The present geologic structure is produced by the Green Campbell fault and by the intrusion of the Boulder Batholith.The Green Campbell fault sets Pre-Beltian gneisses and schists against Post-Madison limestone which is considered as Quadrant;however,this coarse,crystalline,yellow rock has not yet been correlated sufficiently.

The complicated structure of the Paleozoic beds,proved

Photograph, showing part of Silver Star District:

a -- Contact zone of quartz-monzonite and limestone
b -- Paleozoic limestone
c -- quartz-monzonite of the Boulder Batholith

Locality: ¼ of a mile west of Broadway mine.

HF, August, 1934.

by many faults,changes of dip,repetition of beds,etc.,makes it obvious that the igneous body cannot rest very deep below the surface.Therefore the Paleozoic and Mesozoic rocks may be taken as just remnants of the roof of the batholith.

As to the relative age of main faulting and intrusion there may be pointed out that the faults seem to set through the quartz-monzonite and,in some places,cut it off,as near the Green Campbell mine.The entire lack of any mineralization in the Green Campbell fault is another reason for dating the intrusion as previous to the main faulting period.Yet,in order to be sure of this statement,one had to trace the gneiss,granite contact farther west.

Economic Geology -

There are different types of ore deposits in the Silver Star District:

The ores of the Broadway,Hudson and Keystone mine are of contact-metasomatic origin.The occur in long,lenticular lenses along the granite-limestone contact zone and consist of gold-carrying jasperoid,limonite,hematite,chrysocolla,malachite, silica,and the contact minerals already mentioned.In the Keystone mine,a big sulfide body has been found,mainly pyrite,chalcopyrite,but with a very low gold content.

The ore of the Green Campbell and Edgerton-Eagle mines is partly sulfidic,partly oxidized and has a chloritic gangue. It is a replacement deposit in a fault fissure.

All the other deposits of the district as shown on the map are true fissure veins with a remarkably deep zone of oxydation (Iron Rod mine: more than 700 feet)The oxydized ore consists of quartz,hematite-limonite,cuprite,chrysocolla,malachite, cerussite and some galena.There is little information as to the character of the primary ore.According to the oxydized minerals and the limonite boxwork,the primary sulfides are thought to be mainly galena and chalcopyrite.

CONCLUSIONS:

The area shortly described in this report gives an excellent occasion for studying Montana geology.I want to thank Dr.E.S.Perry and the whole mapping party for their congenial help during the field work and while I was preparing this paper.

Hans Fripsche