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A Geological Report on Several Localities in the Northwestern Tobacco Root Mountains

Rudi Forhan

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A GEOLOGICAL REPORT ON SEVERAL LOCALITIES IN THE NORTHWESTERN TOBACCO ROOT MOUNTAINS

Geologic Field Mapping

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Butte, Montana

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INTRODUCTION

To better acquaint seniors in Geology and Mining with actual field practice, the Montana School of Mines offer a course in Geologic Field Mapping, during the three weeks preceeding the opening of the fall semester. The first two weeks are spent in actual field mapping of the geologic formations near Whitehall, Montana, while the third week is spent back on the campus compiling data and finishing maps started in the field.

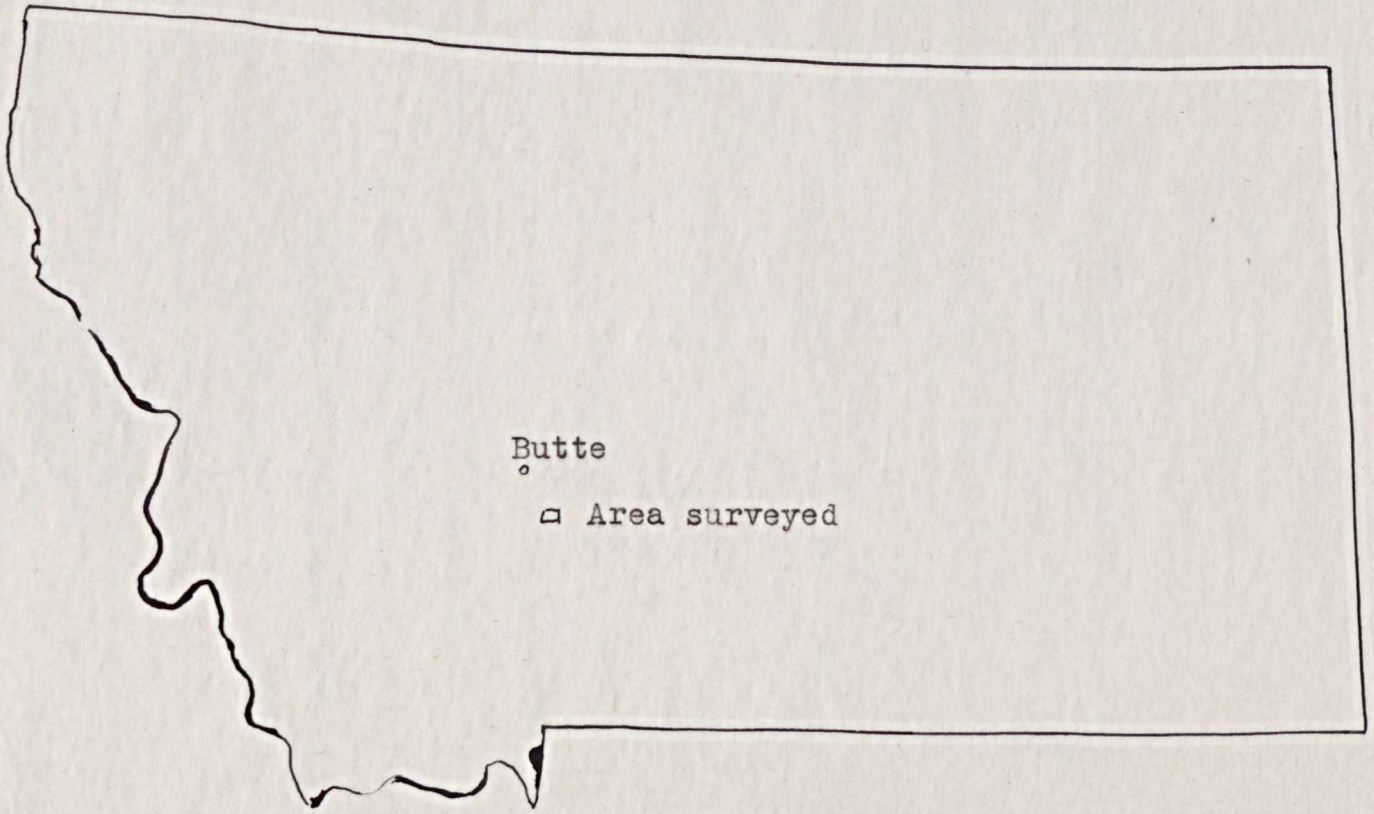
In the field the instruction was under the direction of Dr. E. S. Perry, head of the Department of Geology, assisted by Dr. G. A. Kiersch, Professor A. M. Hanson, both of the Department of Geology, and Mr. Uuno Sahinen, Montana Bureau of Mines and Geology. Our crew, consisting of Nelson A. Jones, William M. Hand, Robert G. Thompson, and Myself, Rudi Forhan, was under the able guidance of Professor A. M. Hanson.

The field trip began on Tuesday, September 2, and ended on Saturday, September 13, two weeks later. Leaving Butte on Tuesday morning by private automobile the party drove to Whitehall, 32 miles southeast of Butte. The entire field party, with the exception of the instructors and six men, stayed in the Blue and White Tourist Cabins in Whitehall. The remainder of the first morning was spent in readying the cabins for the project ahead. Just before lunch, the group assembled for a lecture by Dr. Perry on the uses of the alidade and stadia rod, the main instruments to be used in the field mapping. The

afternoon was spent in and around Whitehall doing preliminary mapping with the plane table and doing pacing surveys. The second day was spent in becoming acquainted with the geologic column to be mapped in other areas. For this we proceeded to the South Boulder region, where formations from the Pony series (of Pre-Cambrian time) to the Livingston formation (of Cretaceous time) have been exposed in a long valley. Exposures are good, and specimens of all the formations may be found. On the third and fourth day, two crews unde the direction of Professor Hanson mapped the area between Renova Hot Springs and Bone Basin, tying in with two crews under the direction of Dr. Kiersch. In the crew with Prof. Hanson were Jones, Hand, Thompson and Forhan in the first crew, and Alto, Downing, King, and Leskela in the second crew.

Beginning on Monday of the final field week, the entire party assembled at the Mayflower mine to map the formations to the northeast and east of the mine. The two crews under the direction of Professor Hanson mapped the area east of the mine and finished up by again making survey closure with Dr. Kiersch's party. On September 12, due to inclement weather, the entire party journeyed to Morrison Cave (Lewis and Clark State Caverns) and spent an enjoyable day viewing the strange and beautiful limestone formations. On the final day the morning was spent in the field finishing up "loose ends", while in the afternoon the party checked gear and equipment and prepared to return to Butte.

Plate 1



Index Map of Montana

GENERAL GEOLOGY OF THE TOBACCO ROOT MOUNTAINS

The Tobacco Root Mountains, one of the typical Montana ranges, is surrounded by the agricultural districts of the Madison, Jefferson, and Ruby River valleys. The many excellant exposures of geologic phenomenon as well as the convenient location (within 35 miles of Butte) make the untimbered flanks of the northwestern part of the range an ideal place for student work in geologic field mapping.

The mountains are a mountain uplift of roughly ninety miles in circumference, forming a prominent barrier with summit levels as high as 10,000 feet above sea level. The uplift probably began in the late Cretaceous and continued throughout the Tertiary coincident with the mountain-making revolution which caused the formation of the Rocky Mountains. The central core of the range is an igneous mass probably associated with the major faulting and folding which has distorted the sediments into a complicated pattern. The Paleozoic rocks, with the ever prominent Madison limestone as the chief ridge former, crop out on the flanks of the range in steeply tilted attitudes. In some districts faults of thousands of feet of vertical displacement have brought the Pre-Cambrian rocks to the same horizontal plane as the Cretaceous lavas, the youngest rock series known to be involved in the orogeny.

There are several mining districts in the region which have been famous for rich mineral deposits. The batholith

was probably the source of the minerals which were later concentrated in veins or ore shoots in such districts. Among the larger mines of this range are the Mammoth, the Mayflower, the Gold Hill and those of the Pony district. Practically all of the present day mining now is confined to small prospects and leases.

THE SOUTH BOULDER SECTION

Inasmuch as the section exposed in the South Boulder District is a complete one, complete in the respect that it shows all formations the survey party was to map in the general area, it was used as a type section. The section is complete and uninterrupted with the exception of one small fault which repeats three beds. Rocks from the Pony of the Cryptozoic to Quaternary Lake beds are exposed. The following is a description of the beds as noted by the students in the field.

CRYPTOZOIC EON

Pony Series

The Pony series forms the bottommost of the Montana rocks. It has two main divisions, the Cherry Creek and the Belt.

The Cherry Creek formation is a series of dolomitic limestone beds 800-1000 beet thick which have been dynamically metamprphosed into marbles. Talc deposits are known to occur in these marble beds in lengths up to 300 feet. Such deposits have been found around Ennis, Montana.

The Belt series is subdivided into three formations, the total thickness of all together measuring about 5000 feet. At the bottom is a formation of gray, red fine grained shale with a characteristic concentric ring structure. Above this lies a bed of arkose of a drab green color which in turn is overlain by a thick bed of conglomerate with lava inclusions the size of ones' fist.

PALEOZOIC ERA

CAMBRIAN

The Flathead quartzite is a cross bedded, coarse grained sandstone (highly indurated) with a thickness of 75-100 feet. The composition is pure quartz with the individual beds ranging from 6" to 1' thick. It has a pink color, is hard, and has a vitreous, or glassy look. The formation weathers slowere than its surroundings to form ledges, ridges, etc.

The Wolsey shale is a sandy shale to a clear green fissil shale which grades into limey beds. The shale is green, argillaceous, micaceous shale. Peculiarities are markings that resemble worm tracks. The thickness of the bed is approximately 300 feet.

The Meagher limestone, called by commercial building stone firms "Montana Black and Gold", is a dolomitic limestone bed approximately 800 feet thick. In the field it has a dark gray and buff appearance, although not all of this formation is of the mottled variety. There is a small inclusion of an oolitic bed in the formation. The upper ten to twenty feet carries remains of trilobites. Also distinctive in this bed is a zone of flat conglomerates at an angle to the bedding, giving rise to the name, edge-wise conglomerate.

The Park shale is a fissil, green micaceous, argillaceous shale resembling the Wolsey shale. This bed is 75 feet thick

thick, and usually has to be distinguished by stratigraphic sequence.

The Pilgrim dolomite is a massive dolomite which is invariably a cliff former, or a gulch or terrace former. In it's blocky nature, it tneds to slab off and usually covers over the Park shale. In the field it has a mottled tone, of gray, giving rise to what the students in the field call "The Zebra Limestone". The bottom 30-40 feet of this formation resembles the Meagher. It contains some partial remains of trilobites.

The Dry Creek formation consists of impure shales and sandstones. This type of rock weathers easily to form gulches and valleys. It may be recognized by rubble in the soil of ared, rusty, sandy nature the size of a dollar or half-dollar.

DEVONIAN

The Jefferson dolomite is a formation 1000 feet thick with the lower division, 300 feet, a muddy gray color. The upper 700 feet is characteristic--black, sugary, crystalline dolomite, commonly with a fetid odor when broken open. Geodes are commonly found in this formation containing drusy quartz crystals. Its outstanding feature is its black sugary look.

The Three Forks shale is 300 feet thick, weathers easily to form valleys and terraces, and creeks generally follow the Three Forks shale outcrop. It is a grayish-green shale whith sandy and limey beds one inch to one foot thick, commonly fossiliferous.

MISSISSIPPIAN

The Madison formation varies in thickness in Montana. In the western half of Montana it is 2000 feet thick, in the Eastern half it is 1000 feet thick, while in British Columbia it ranges up to 6000 feet thick. It is a pure limestone bed with two main divisions. The lower 1000 feet is a very dense fine grained black limestone with shaly partings between the beds from one-half to one-sixteenth inches thick. This formation looks like fine grained basalt, and is called the Lodgepole formation.

The upper member is called the Mission Canyon and is a white massive crystalline limestone, with crystals the size of a match. In some places the formation is crinoidal to a marked degree. There is also a zone of fossiliferous gray chert in the Mission Canyon. This is a mountain making formation.

The Amsden formation is a shale resembling the Madison in the hand specimen, but the division between the two beds is a bed of red shale 10 to 20 feet thick called the Amsden Red Bed, and is commonly covered. The formation is 300 feet thick.

PENNSYLVANIAN

The Quadrant quartzite resembles the Flathead quartzite to a marked degree. It is dense, hard, vitreous, and a cliff former as weal as a ridge former. It weathers to large and small blocks and boulders. The division between the Amsden formation and the Quadrant quartzite is not prominent.

PERMIAN

The Phosphoria formation is a bed of sandstone and shale from 300 to 600 feet thick, containing a black fissil oil shale of 20 to 30 feet. In this shale, the oil occurs in the solid form, as Kerogen, which when heated distills off petroleum oil from 10 to 20 gallons per ton. The formation gets its name from a 3 to 8 foot bed of collophanite which runs four-fifths pure $Ca_3(PO_4)_2$ and 40 per cent Bone Phosphate of lime. This thin bed is black looking on the unweathered fractures, but with weathering bleaches to a light or bluish gray, which is definitely oolitic.

JURASSIC

The Ellis formation is a variable formation of shale, limestone and sandstone. It is hard to distinguish in the hand specimen, and must therefore be tabulated by its sequence. There are some fossils found in this formation, consisting in the main part of the star crinoid, belemnites and oysters.

The Morrison formation, a series of variegated shales, is

similar to the Ellis formation and must be identified by sequence. It is a sandy formation in places, weathers easily (therefore is not a ridge-former) and occurs in gray, red, green, blue, yellow, and buff.

LOWER CRETACEOUS

The Kootenai sandstone is a formation 1800 feet thick. This formation has a basal sandstone ledge 50 to 75 feet thick. It is composed of medium grained white quartz and black chert, giving rise to the field term "Salt and Pepper Sandstone". The formation is underlain by a coal seam from six inches to six feet thick. Above the basal sandstone is a red shale which gives rise to the term "Kootenai Red Beds", which in turn is overlain by a limestone member characterized by gastropods the size of the head of a pencil. They form almost a coquina in places. The formation around this "Gastropod Limestone" weather out to give a good outcrop. The formation is easily recognized in the hand specimen.

UPPER CRETACEOUS

The Colorado shale, a gumbo gray shale, greenish gray to black is 100 to 200 feet thick. There was no Colorado shale present in the South Boulder area.

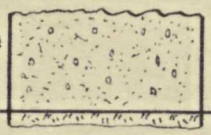
The Livingston formation is a series of volcanics, agglomerates and lava flows, andesitic in character. The formation has a characteristic appearance not easily mistaken, with good

sized phenocrysts. The formation may be from 3000 to 5000 feet thick, which is divided into three subgroups. The lower group consists of lava flows 500 feet thick overlain by 1000 feet of agglomerate and topped by lava flows. The uppermost lavas have big phenocrysts of feldspar in a fine grained matrix, giving rise to the term "Oatmeal Rock".

QUATERNARY

The Lake Beds are Tertiary in age and in this area cover an area of 50 by 100 miles. They consist of white chalky looking earthy material which is ideal for agricultural purposes.

STRATIGRAPHIC COLUMN OF SOUTH BOULDER AREA

AGE	PERIOD	FORMATION	COLUMN	THICKNESS	LITHOLOGY
Mesozoic	Quaternary	Alluvium and Tertiary Lake Beds			Thick bed of chalky and loosely cemented material containing rocks, sand and gravel.
	Upper Cretaceous	Livingston		2000'	A series of volcanics and agglomerates.
		Colorado		210'	Thin gray shales.
	Lower Cretaceous	Kootenia		580'	Gray shales and sandstone containing fine pieces of chert.
	Jurassic	Morrison		210'	Variegated shales.
		Ellis		110'	Sandstone, limestone and shale.
Paleozoic	Permian	Phosphoria		130'	Black sandstone and shale.
	Pennsylvanian	Quadrant		170'	Hard vitreous quartzite.
	Mississippian	Amsden		230'	Blue limestone under-laid by a red shale at the base.
		Madison: Mission Canyon		1310'	Very pure, hard and massive limestone of light color.
		Madison: Lodgepole		900'	Very dense, black and fine grained limestone.
	Devonian	Three Forks		520'	Sandy, grayish-green, fossiliferous shale.
		Jefferson		870'	Black, sandy and crystalline dolomite which is usually fetid.
	Cambrian	Dry Creek		160'	Reddish-brown, sandy shale.
		Pilgrim		310'	Modeled limestone in two tones of gray.
		Park		130'	A green, micaceous and argillaceous shale.
		Meagher		410'	Modeled black and light colored magnesium limestone.
		Wolsey		310'	Green argillaceous shales containing worm tracks.
		Flathead		130'	A relatively pure, hard, pink, and glassy quartzite.
Archeozoic	Pre-Cambrian	Pony		5000'	Banded schists and gneisses containing garnets, biotite and hornblende..

THE RENOVA-BONE BASIN AREA

The area in the Renova-Bone Basin district mapped in this report covers roughly seven sections with Renova at roughly one mile distant off the map in a due north direction from the northwest corner of the map, (Plate II).

Sedimentary rocks exposed in this area are of the type described under "The South Boulder Section". The Belt Arkose covers a broad belt extending from the outcrop of the Flathead quartzite on the last ridge of mountains to the points where it is covered by the clay sediments of the Tertiary Lake Beds. On the foothills outcrops of the arkose, the Flathead quartzite, the Wolsey shale, the Meagher limestone and the Jefferson dolomite dip at angles from 45 to 60 degrees toward the southwest.

Many faults cut the area of the traverse. On the approximate two mile area covered, nineteen faults were noted. Mineralization occurred on one of these faults, showing production of gold in the Gold Hill Mine. On the map is noted one large fault line which covers sections 3, 9, and 10 of Range 4 West, Towhship 1 South, this fault is the continuation of the Mayflower fault which produced mineralization to be taken up under the head of "The Mayflower Mining District".

THE MAYFLOWER MINING DISTRICT

Location

The Mayflower Mine is located in a dry gulch about five miles due east of Renova. It may easily be reached by automobile by a fair road. The mine itself is on one of the prominent limestone ridges which form the rolling foothills of the mountains.

History

One of the first paying properties of the late William Andrews Clark I, Montana mining magnate, the Mayflower contributed greatly to the building of the Clark fortune. During the 1880's and '90's this mine produced several millions of dollars from its gold telluride ores. The fabulous richness of the ore caused such a wave of prospecting that hundreds of prospect pits were sunk within a mile radius of the Mayflower in hopes of another strike. Since 1900 little except leasing has been done on any of the mines in the district.

GEOLOGY

The major structural feature of the district is the Mayflower fault, said by some to be a "high angle thrust fault" dipping 70 degrees to the west. The host rock for the rich mineralization of the fault was Belt arkose. The displacement of the fault is calculated at 8000 feet.

ECONOMIC GEOLOGY

One of the richest present day gold mines in the state of Montana is the Golden Sunlight, which it is said, is a whole mountain of two dollar gold ore.

The Mayflower is one of the richest "dead" gold mines in Montana. It produced over $1,500,000 in the years preceeding 1900.

As seen in the South Boulder section, the phosphate in the Phosphoria is mined, but is of little commercial importance in the area surveyed.

An Eastern building stone firm at one time quarried the "Montana Black and Gold" and shipped it east for building purposes, but transportation costs were too high to make the venture a success.

CONCLUSION

In this paper it has been attempted to give a general description of the areas which were covered during the field trip, and although it has been nothing elaborate, it is beleived by the author to have fulfilled its purpose, which is primarily to familiarize the student with the methods of gathering geological data in the field and assembling it into a brief, concise report.