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Geology of the Tertiary Sediments in the Northwestern End of the Wind River Basin

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INTRODUCTION

The lithology of the majority of the beds of the northwestern end of the Wind River Basin varies greatly within short distances. A few individual beds retain their character over a comparatively large area. These beds were traced for more than ten miles along the north side of Wind River Valley.

The topography of the area is strikingly different at various locations, due to glaciation, changes in lithology, and elevation above the Wind River.

Eleven stratigraphic sections were carefully measured and described. These sections were correlated on the basis of trigonometric projection, Stratigraphic sequence, and lithologic similarity. Measurements and traverses were made with a transit to insure accuracy.

It is the writer's hope that this article will prove of value to future students of the area.

The west end of the Wind River Basin is bounded on all sides by rugged mountains having altitudes in excess of 12,000 feet. The Wind River flows southeast through the basin and has, along with its tributaries, produced considerable relief in the Tertiary basin deposits. This area has been modified by glaciation.

The tertiary beds north of the Wind River, where not covered by glacial till, are deeply gullied and are being vigorously eroded, such as east of Stony Point, where a very distinctive "badlands" topography has been developed. To the northwest of Stony Point, where the Tertiary beds are covered with glacial till, this type of topography has not developed, except at the upper reaches of Long Creek where glacial cover is not present. This difference is also partially due to differing lithology. The compact, non-permeable clay east of Stony Point forces the rapid run-off of water with accompanying greater erosion. The sparse vegetable cover is also a contributing factor.

West of Stony Point the Tertiary beds are overlain by more porous glacial sediments, consisting mainly of loosely cemented, arkosic materials. Vegetation, although consisting mainly of range grass and sage, is present. All these factors serve to reduce the rate of erosion west of Stony Point.

Another factor may be that there has been insufficient time since glaciation for the development of 'badland" topography northwest of Stony Point. The Wind River Glacier did not extend east of Stony Point, which probably acted as a barrier because there is no evidence of glaciation between Stony Point and Dubois. If Stony Point had formed a dam which held back glacial ice and later the melt water, erosion to the west would have been greatly suppressed. To the east however, erosion would have continued at an increased rate due to the water flowing over the top of Stony Point. This flow would have removed any thin covering of glacial material and rapidly eroded into the poorly indurated clays.

At the head of Long Creek the "badland" dissection of red and white sediments again becomes evident. The upper portion of Long Creek was well above the impounded water west of Stony Point, and had a relatively steep gradient which permitted this type of dissection to occur. On the Wind River however, the flatter gradient allowed the impounded waters to back up farther, possibly as far as two miles west of the National Forest Boundary. It is recognized that at the time glaciation occurred, the surface of Stony Point was not at its present altitude, but at a much higher altitude, as shown by successive terrace levels north of Stony Point.

If all that has been said here concerning glaciation is true, the main reason for the striking difference in topography is still the differences in lithology, which perhaps has been accentuated by glaciation to the west of Stony Point and lack of glacial cover to the east of this point.

Geologic History

Great thicknesses of sediments accumulated in the Rock Mountain geosyncline during the Paleozoic and Mesozoic eras. Late in the Mesozoic this geosyncline became the scene of large scale folding and uplift, the Laramide revolution, and it resulted in much of the present structure of the Rocky Mountains. Early in the Cenozoic era northwestern Wyoming was a bold, mountainous region. Local faulting and folding continued into the Eocene for a short time and then died out completely.

The Wind River Basin is surrounded by three mountain ranges; the Wind River, the Absaroka, and the Owl Creek Mountains. The Absarokas were not a direct result of uplift, but rather were formed by lava flows in Oligocene time. As time progressed, erosion of the surrounding highlands and deposition in the interior basin continued, until in Miocene time, there was a virtual peneplane in existance. The mountains had been eroded and the basin filled until they stood at nearly the same altitude.

Although occasional monodnocks were in evidence, most of the mountains were buried in their own debris, and the Wind River and other streams wandered widely over this alluvial cover. This surface of combined erosion and deposition was probably 2000 to 3000 feet above sea level due to the great distance from base level and consequently low gradient.

In Pliocene time the uplift was resumed, not as local deformation, but as broad upwarp of the whole region into a flat arch hundreds of miles long. This movement continued intermittently and culminated in late Pleistocene time. The Wind River Mountains and Basin were on a northern crest of the arch and were raised to a crest of over 12,000 feet to form a portion of the continental divide.

As a result of this uplift the Wind River and its tributaries were once more activated and began to remove the loosely consolidated Tertiary sediments. Deeply entrenched stream channels resulted, the mountains were exhumed and stood forth in bold relief. Because of the entrenchment of the streams in the Tertiary fill, they continued to cut down into the mountain ranges, the Wind River forming the imposing Wind River Canyon in the Owl Creek Mountains and the chasm in the Bighorn Mountains.

Assisting the erosion, especially of the Tertiary sediments, during Pleistocene and recent time were numerous valley glaciers which moved down the valleys from the mountains, depositing in places, moraines and till in excess of 200 feet thick.

Stony Point consists of Tensleep below and Phosphoria above, the last named being of Permian age. The overlying Mesozoic sediments must have been eroded shortly after the Laramide uplift with Tertiary sediments gradually covering it as the basin became filled.

Then with the second uplift (Cascadian) the Wind River began to remove the Tertiary sediments. About this time the glaciers moved down the Wind River and DuNoir Valleys. These glaciers picked up and redeposited enormous amounts of materials. They easily eroded the weak Tertiary deposits, but were unable to remove Stony Point, and did not extend east of it. Thus Stony Point acted as a dam for glacial flow. Therefore, in the Wind River Valley below Stony Point there are no glacial deposits and Tertiary sediments are exposed. Conversely, above Stony Point Tertiary deposits are found higher on the sides of the valley for most of the lower Tertiary beds were removed by the glaciers, and what remained were then deeply buried under a thick deposit of glacial material when the glaciers receded.

Immediately overlying the Phosphoria at Stony Point is a thick cover of glacial till which extends north for about one mile. Immediately to the east however, at the same and higher elevations are the deeply eroded, red and white Tertiary Wind River Beds. The only logical explanation must take into account all the factors previously mentioned.

The Wind River became entrenched in glacial and Tertiary material and was able to cut through the hard rock of Stony Point and formed a narrow gorge at this point, widening out both above and below. As the Wind River slowly continues to cut down into the rock at Stony Point it cuts deeper upstream, gradually removing the Teritary fill.

Lithology

The Tertiary sediments below Stony Point are very distinctive. They are predominately red with white beds running throughout. Most of these white beds lens out and they may not be traced for any considerable distance. The red coloration is due largely to surface oxidation and the color is less noticeable beneath the surface. One and one-half feet below the surface the color is a dark grey. On the surface the red beds resemble dried mud. Beneath the surface, where the beds are damp, they are more silty and should be classified as silty mudstones. The white beds are considerably coarser and should be classified as sandstones. These beds are also finer grain and more compact on the surface than underneath. They contain considerable mica, principly muscovite. There are a few conglomerate zones throughout the red beds, but none in the white zones. The fragments in these conglomerates are usually small and average one-fourth to one-half inch in diameter but some are as much as two inches in diameter. The fragments in the conglomerates are mid-Paleozoic in age and so must have been deposited in early or mid-Eocene time.

The sediments east of Stony Point were not studied in detail but were used in determining regional dip. Actual correlation and comparison began with beds north of Stony Point, up Bench Creek.

North and west of Stony Point there is a distinct change in the colors of the beds. The red color is gradually replaced by brown to grey. Texture also changes with very few mudstones west of Stony Point, while to the east they are the most obvious type of sediment. The reason for this difference is partially due to burial of the lower red sediments in the upper part of the valley, but this does not explain the absence of higher red beds which are correlation shows should be present in the area of Mile Long Hill.

This discrepancy may be explained in two or three possible ways. The most likely explanation would be a rapid facies change over a short distance. This is quite common in the basin type of deposition, especially near the margins which is where this area is located. Conditions must have stabilized at a later period if this is the case, for one finds that the higher beds are quite distinct and traceable for several miles.

Oxidation of the sediments is retarded west of Stony Point by the glacial deposits and, to a slight degree, by the more abundant vegetation.

The Wyoming Geological Society Guide divides the Wind River formation into two members, the lower or Lysite and an upper or Lost Cabin member. They divide these members primarily on a floral and faunal basis but list these lithologic variations:

Lower Member:

1. Conglomerates consist of post-Cambrian debris and may be coarse.
2. Brick red and orange-red are the prominent colors.
3. The variegated beds grade laterally into grey and drab colored fine grain beds.
4. Sandstones contain some white mica but practically no biotite.

Upper Member:

1. Conglomerates consist of pre-Cambrian and Cambrian debris.
2. Violet and purple are the commonest colors in the variegated beds which are less common than in the lower member.
3. Variegated beds grade laterally into grey and green-grey beds of similar lithology.
4. Sandstones and siltstones contain abundant black mica and some feldspar grains.
5. Yellowish-brown and orange sandstones are present and were deposited in sheets or channels.

These criteria show that the basis of separation of the two members is due mainly to characteristics of the source rock. This fact suggests that these distinguishing characteristics will not necessarily be present at other localities than this type section. (This type section is in NE¼, Sec. 22, T38N, R89W, over 100 miles east of the area concerned in this report.)

C. Max Bauer[1] states that the Wind River formation is largely, if not wholly, the result of stream deposition on aggrading flood plains. This is reflected in the most striking characteristics of the

1. Wind River Basin, G.S.A. Bulletin, Vol. 45, No. 4, 1934.

formation, these being its mottling, rapid changes in lithology and lensing of strata.

Bauer divides the Wind River formation into two parts on the basis of color. The upper zone is of red and grey strata with some green and yellow. Yellow to orange, coarse, channel sandstones are also present. The lower zone is comprised of grey, yellow and brown strata containing many coarse sandstones and conglomerates. This coloration scheme is nearly the opposite of Love's[2], which shows the extent of facies change in the Wind River beds. At the location of Bauer's investigation the Wind River beds are only 1200 feet thick, but he states that between Crowheart Butte and Dubois the formation may exceed 4000 feet. West of Dubois the formation thins rapidly. At the locality concerned by this article the formation is thought to be approximately 1000 to 1500 feet thick.

As Love mentions in his article on these Tertiary sediments, it is useless to run detailed cross-sections of the Wind River formation due to its rapidly changing lateral lithology. "Detailed lithology is of more detriment than value . . ."

Local Lithology

Due to the poor exposures and rapid facies changes found among the lower beds, there is presented here in detail only those units which are distinctive and present throughout the area studied.

BENCH CREEK SECTION

(S½, Sec. 12, T42N, R107W, Fremont County, Wyoming.)

Unit No.	Lithology	Thickness
10.	Greywacke, cross-bedded, quite friable on weathered surface, light to dark gray, contains many coarse quartz crystals.	13′
9.	Brown sandstone, well indurated, biotite present, orange and black lichens, centipede (?) fossils, entire leaf and two pulmonata gastropod fossils.	1.5′
8.	Greywacke identical to item No. 9 but slightly more consolidated.	18′
7.	Slope. Sandy texture soil	18′
6.	Sandstone, weathers yellow brown, coarse, conglomeratic at base, very poorly consolidated, top portion finer grained. (30′ below leaf bed.)	4′
5.	Slope. Small siltstone and shale outcrops, siltstone predominating.	120′
4.	Siltstone, thin irregular bedding, grey to brown, biotite present.	7′

2. Geology Along the Southern Margin of The Absaroka Range, G.S.A. Special Paper, No. 20.

3.	Shale slope, poorly outcropped, thin limestone bed near top.	9′
2.	Sandstone ledge, grey-brown color, medium grain, well cemented. Numerous vertical joints, biotite abundant, orange lichens. (Item two in Shoshone section.)	4′
1.	Slope, sandy texture, covered in places by slaty plates of shale, abundant petrified wood fragments on surface.	50′
		244.5′

Three additional profiles were measured along Bench Creek and the above units were present in all but one of these where only the top of the section is exposed.

Plate No. 2 shows this section related to the other representative areas.

MILE LONG HILL SECTION
(SW¼,NW¼, Sec. 10, T42N, R108W)

Unit No.	Lithology	Thickness
14.	Greywacke, cross-bedded, coarse grain, many subangular quartz fragments, some biotite. Light grey weathered, dark grey where fresh. Poorly consolidated.	14′
13.	Brown sandstone ledge former, contains biotite flecks, well cemented, very hard, flaggy character. Contains centipede fossils and stem fragments.	1′
12.	Greywacke as in item 14.	12′
11.	Weak siltstone members; not exposed.	16′
10.	Massive yellow to red-brown sandstone, very friable, crumbles in hand, spheroidal weathering, contains much biotite.	12′
9.	Slope, covered. Fine silty sand texture.	30′
8.	Coarse sandstone overlying a 6″ bed of fine conglomerate. Massive with wind blown pockets and rounded features, overlain by 6″ of fissle grey shale.	9′
7.	Conglomerate, sandstone matrix, relatively few pebbles, grades into item 8 at the top. Fragments ¼″ to ½″ in diameter.	6″
6.	Slope, contains two sandstone outcrops which form weak ledges in the immediate vicinity.	75′
5.	Red-brown sandstone, coarse grain, friable and contains buch biotite.	2′
4.	Slope, appears to be weak shale beds.	9′
3.	Medium grain sandstone, grey to slightly pinkish, very good ledge former, contains biotite, much quartz and some stem fragments. Vertical joints, orange lichens. (Unit two in Shoshone section.)	3′-5′
2.	Slope, contains numerous small siltstone outcrops and a distinctive 4″ limestone bed 32′ below item 3.	50
1.	Dark grey shales (3′) with abundant leaf fragments directly overlain by siltstone (2′), in turn overlain by slope and light grey shales containing fossil leaves.	33′
		266.5′-268.5′

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Four sections were measured on Mile Long Hill and the one above is a composite of the four. All the key horizons were present at each of the four localities.

SHOSHONE FOREST SECTION
(NE¼,NE¼, Sec. 2, T42N, R109W)

Unit No.	Lithology	Thickness
13.	Greywacke, much cross-bedding, light to dark grey, contains rounded to semi-angular quartz crystals and feldspar fragments.	15′
12.	Sandstone, compact, medium grain, brown to grey, flagstone fracture, biotite present in small amounts, orange lichens. Contains centipede, stem fragment and Pulmonata gastropod fossils.	9″
11.	Greywacke identical to unit 13.	10′
10.	Slops, sandy with weak siltsone outcrops.	22′
9.	Silty, yellow conglomerate containing many small pebbles and sand size fragments, especially near the top of the unit.	12′
8.	Cliff forming, brownish-yellow sandstone, develops spheroidal weathering. Upper 2′ is finer grain and more massive″ much biotite.	14′
7.	Alternation of siltstone and shales, some of the shales being very pure and hard.	51′
6.	Brown sandstone, ledge former, develops windblown, rounded appearance, indistinct bedding.	6′
5.	Slope, scattered siltstone outcrops, occasional small shale zones break into siltstone. Leaves in some of the shales.	100′
4.	Sandstone, brown, spheroidal weathering, coarse grain, poorly cemented.	5′
3.	Slope, sandy soil.	4′
2.	Sandstone bed, medium grain, light grey on weathered surface, darker where fresh. Well jointed, some iron staining, contains much quartz and some biotite, orange and black lichens, rarely a fossil stem fragment.	4′
1.	Siltstone with occasional silty shales, mostly covered.	54′
		297.75′

See Plate II for a correlation of the previous sections.

Conclusions

The course of the Wind River trends slightly in an up dip direction. The valley extends N70°W, while the regional strike of the beds is between N55°W and N65°W. The same bed which is present at an altitude of 7980 feet north of Stony Point is at an altitude of 8540 feet just west of the Shoshone National Forest boundary on the north side of highway 277.

There are several factors which prove that Unit 12 of the Shoshone section is the same bed as unit 9 of the Bench Creek section. The lithology of this bed, as well as those beds immediately above and below, is identical at both places. Also the occurrence of fossil centipedes in this bed at every locality where profiles were measured (ten profiles were measured) would seem to offer sufficient proof in itself due to the rarity of these fossils and their absence in all other beds of the area. These centipedes are associated with Pulmonata gastropods at the Bench Creek and Shoshone sections, thus further relating these beds. Gastropods were not found in any other bed. Numerous localities in between these two sections indicate the trend of this bed and by using the average dip and strike the beds may be projected from one place to another.

On the basis of lithology, the area of this report appears to be largely within the upper zone of the Wind River formation. Final confirmation of this must depend upon the flora of the beds. The fauna is limited, and that which is present is very poorly preserved. These sediments are placed in the upper zone for the following reasons:

1. Abundance of black mica (biotite) in nearly all beds.
2. Relative rarity of conglomerates.
3. Conglomerates composed largely of pre-Cambrian rock.
4. Presence of yellow-brown channel sandstones.
5. Presence of feldspar grains in some of the sandstones.

The lowest beds investigated may be in the upper part of the

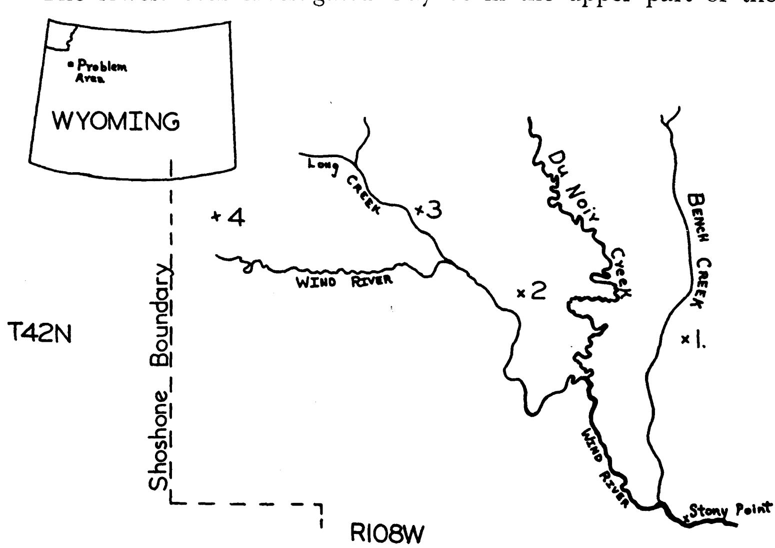

PLATE I.

lower, or Lysite member, because they contain small amounts of white mica and conglomerates are composed of post-Cambrian fragments; especially some Mississippian brachiopods. There are distinctive red and white beds below this point and none above it.

Fossil remains are not abundant in the majority of the sediments. The shale zones, however, commonly contain abundant fossil re-

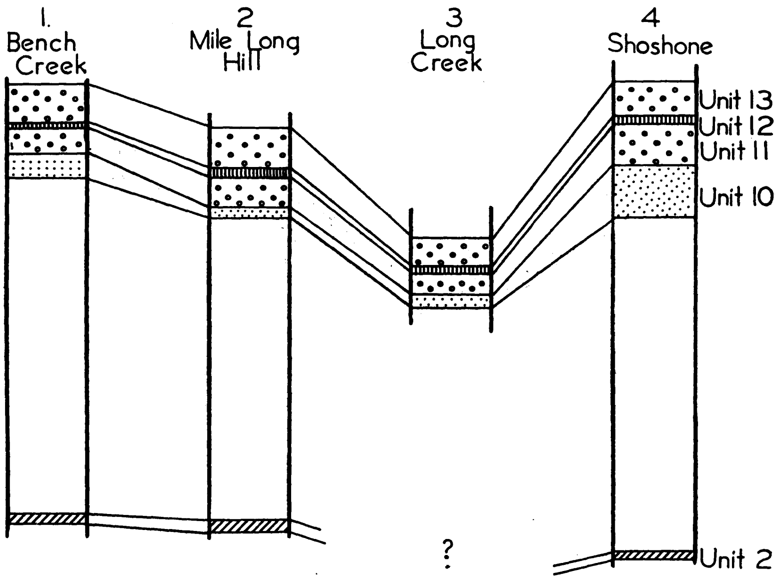

Plate II.

mains, primarily leaves and stem fragments. The leaves are similar to those of temperate and sub-tropical climates of today. They appear to have been deposited in local, swampy depressions, for they lens out rapidly and may not be traced for any great distance. Faunal remains were found in only one bed. This bed is very prominent and continuous over a large area and consequently was used as the main means of correlation. This bed contains fossil Pulmonata gastropods in the Bench Creek area and in the Shoshone section. At every location where this bed is exposed, fossil centipedes are present. These are concentrated in small areas throughout the bed.

The individual units for the most part lense and undergo complete facies changes within very short distances. Certain beds are quite persistent however, and these beds provide a good means of correlation.

Rapid change of facies accounts for the lithologic differences to the east and west of Stony Point. It is glaciation of the area west of Stony Point however, that is largely responsible for the different types of topographic expression in the two areas. This investigation could not have been accomplished without the aid of John Padgham and James Eiffert who cooperated in the field studies. Dr. Hendriks, Dr. Wade, Dr. Rheinhart, and Mr. Upshaw suggested the problem and furnished constructive criticism of procedures and results. The Forestry Service at the Dubois and Horse Creek Ranger Stations permitted the use of their aerial photographs of the region.

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