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Van Hise, Charles Richard, 1857-1918

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U. S. GEOLOGICAL SURVEY
FIELD SECTION BOOK

No. 84

August 7 to 18, 1889.

Sherman, Wyo., Medicine Bow Range,
Laramie and Green River City, Wyo.

C. R. Vankiel.

15551-15734

SURVEY OF THE PRE-CAMBRIAN ROCKS OF THE N. W. STATES.

INSTRUCTIONS.

1. Ordinarily at least two pages of this book will be devoted to one section. On the left hand page place a map of as much of the section as has *actually been seen*. Denote rivers, lakes, marshes, etc., by the usual topographical signs. Denote the ledges of rock, when no structure is made out, by cross-hatching, making the cross-hatching cover as nearly as possible the areas occupied by the exposures. If the rock is a massive one, but still more or less plainly bedded, use the same sign with a dip arrow and figure attached, showing the amount and inclination of the dip. Denote slaty or other very plainly bedded rocks by lines running in the direction of the strike, with figures and a dip arrow attached as before. In all cases where there is the least doubt about the true bedding directions, indicate it by a query. To each exposure on the face of the map attach the number of the specimen representing it. In mapping the section count each of the spaces between the blue lines as 100 paces, and twenty of these spaces as one mile, or 2,000 paces. Usually the southeast corner will be placed at the bottom of the page, or at the first black line above the bottom of the page, and at the right hand side. If, however, for any reason, it is desirable to show portions of an adjoining section, the southeast corner may be shifted up, or the map may be turned around and the north placed at the left hand side of the page.

2. On the right hand page place the notes descriptive of the exposures. Begin in each case with the number of the specimen, placing the number on the left hand side of the red line, after which give in order on the right of the same red line the position of the ledges as reckoned in paces from the southeast corner of the section, and the dip and strike when observable, for instance: 4025 250 N., 300 W., *Strike, N. 6° E., Dip, 50° E.* Then follow with as full a description of the ledge as possible.

3. The ruling of the left hand page is also arranged so that a smaller scale can be used. Each one of the black lines may represent a section line and the red lines quarter sections and "forties." The scale of the maps may thus be reduced, if desirable, to two inches to the mile (the ordinary town plat scale.)

4. Collect a specimen from each separate ledge of rock, or wherever there is a change of rock on any one ledge. In case of trips made on foot or in canoes, for long distances, neighboring ledges, unquestionably of one kind of rock, need not be sampled, the position and extent of the ledge being marked on the map, with a note that it is of a rock identical with specimen so-and-so. Under the same conditions small sized samples, trimmed to a uniform size of $2 \times 2\frac{1}{2} \times \frac{3}{4}$ inches will be allowed, but in all other cases *large sized specimens*, trimmed to a size of $3 \times 4 \times 1$ inches, must be selected, in accordance with § 3, chapter IV, p. 44, Regulations of the U. S. Geological Survey. In all cases collect chips for slicing. All specimens are to have numbers painted on them, in white on a black background, in the field.

5. On the last twenty-five pages of the book give, as may seem desirable, a general account of the examination of the region mapped in the previous pages, correlation of observations, sketches, cross sections, etc., etc.

84

1

Sherman, Wyoming Terr., Wednesday, August 7, 1889

I first walked west along the Union Pacific road for about a half a mile to the point where the granite was quarried for the Cakes & Amie monument at Sherman. Here the granite is fresh. It seems to be chloritic and micaceous.

15550

15552

15553

} Finer grained phases of the granite at this point.

Upon the southwest face of the exposure is a coarser phase, the change from one phase to the other being somewhat sudden.

This isolated exposure rises almost perpendicularly above the undulating country for a height of 50 feet. The weathering gives it a decided appearance of stratification in a nearly horizontal direction. This may be due to accident, but it does not appear impossible that the weathering represents some sort of flow structure, or at least some separation of the constituents into layers, although it might be that these lines but represent a series of horizontal joints.

15554

Epidotic granite. From ledge a little nearer station and upon north side of road.

15555

Specimen showing abrupt change between

coarse and fine grained phases of granite. The fine grained material is found in most irregular strings and masses in the coarser phase.

15556 Coarse pegmatitic granite, about $1\frac{1}{2}$ mile northeast of Sherman. From ridge 15 or 20 feet wide running for a long distance across the country in a nearly northwest and southeast direction. No exposures are seen to the right and left of the ridge. The exposure has strongly the appearance of a dyke.

15557 Fine grained granite in bottom of dry creek about $\frac{1}{4}$ mile farther on than 15556; i.e., about $1\frac{3}{4}$ miles northeast of Sherman.

15558 Coarse granite just before reaching "mountains" about 2 miles northeast of Sherman.

Going a little farther the almost continuous exposures of the so-called mountains begins.

15559
15560 Here the rock is a coarse porphyritic granite. It was not possible to get any very fresh specimens.

The appearance of bedding or flowage structure, or alternation of bands of different minerals or of different degrees

of resistance to weathering, mentioned as being noted in along west of Sherman strongly prevails in the mountains. Here the dip of the somewhat regular jointing is to the southwest at an angle estimated to be 15° to 20° .

When examined closely the splitting above described is found to be parallel to an arrangement in alternate bands of coarse & fine material. Also in places the coarser porphyritic feldspars seem to have a parallel arrangement. In some places narrow bands of finer - and consequently more resistant material - stands out in edges, parallel to the splitting. The parting or jointing so characteristic of this locality is then parallel to a probable flowage structure.

15561 Granite. About $\frac{1}{3}$ way back to Sherman and about $\frac{1}{2}$ mile east of course out.

15562 Granite. Dyke which in the shape of a ridge runs across the prairie as a continuous exposure for a long distance. Course Northwest and Southeast nearly. The specimen and exposure both distinctly show flowage structure, parallel to the

sides of the dyke, and dipping Northeast, at point specimen was taken.

Other similar ridges are seen running nearly at right angles to the above.

15563

Granite, from one of those dykes running at right angles to 15562. The specimen again shows a sudden alternation of coarse and fine material.

In camp near Medicine Bow Peaks.

August 8, 1889.

Our party, consisting of W. H. Reed, Geo. C. Luther and myself, started from Laramie towards the Medicine Bow Range. The whole day was used in getting near the base of the Archaean. Our course of travel carried us just north of Sheep Mountain, and we camped in the Cretaceous on Little Laramie Creek about a mile and a half or two miles from the beginning of the Archaean rocks.

Photo ⁶⁷³ 2. Sheep Mountain, after storm, Looking East.
 Time 6 P. M. Photograph ⁶⁷⁴ 2. Medicine Bow foot hills after storm; looking northwest. Time 6 P. M.

August 9, 1889.

Little Laramie canyon was followed up for a long distance. The rocks contained in it are coarse and fine banded and contorted gneisses, cut by large and small granite veins, and also by dyke-like masses of hornblende-schist or hornblende-gneiss. In every respect the rocks here exposed are an exact duplicate of the Archaean of the Lake Superior region. ^{sets of specimens} collected from the ^{two regions} could not be distinguished from each other in any way.

- 15564 Banded and contorted hornblende gneiss where Archaean was first struck.
- 15565 Granite vein cutting the same.
- 15566 Another specimen of coarse hornblende-gneiss about a half mile up canyon.
- 15567 Coarse granite from talus from foot of a huge mass of same which forms a bold face of cliff.
- 15568 Hornblende schist or gneiss, which, in dyke-like forms, cuts the coarse gneiss and granite.

About 4 miles up the canyon the road swings off to the right and leaves

Little Laramie Creek. Here photographs 4, 5 & 6 were taken.

Photo. ⁶⁷⁵4. Looking up canon Little Laramie River, course south of West. Time 9:30 A.M.

Photo. ⁶⁷⁶5. Same as 4.

Photo. ⁶⁷⁷6. The same Little Laramie canyon, looking across canon to the south. Time 9:30 ^{am.}

15569

Coarse banded gneiss, about a mile after leaving Little Laramie canyon.

The gneiss is here beautifully banded and contorted, as is shown by photographs 7 & 8, the first of which was taken at the place at which specimen 15569 was obtained, and the second a little farther on.

Photo. ⁶⁷⁸7. Banded and contorted gneiss cut by granite veins, adjacent to ledge of same material. Specimen 15569 here taken. Time 10 A.M.

(Failure)
Photo. 8. Same as 7, a little farther on. Time 10:15 A.M.
The strike of the gneiss was found to be N. 60° E, and the dip at a high angle, about 80° to the northwest.

Shortly after passing 15569 we reached the park east of Medicine Bow peaks. Here photographs 9 & 10 were taken.

Photo. ⁶⁷⁹9. Snow clad summit of Medicine Peak from about 4 miles distant; looking

northwest. Time 10:30 am.

(Failure) Photo. 10. Same as 9.

A ridge projects along the north side of the park entered for some distance. It consists mostly of reddish gneiss (70), which is cut by large masses of hornblende schist (71). The flanks of this ridge are strewn with very large quartzite boulders, with fewer of limestone, but no outcrop of this rock were found.

For some distance after leaving this point there were no certain outcrops of gneiss or granite. Then there appears, in the park by the side of a ranch, an outcrop of slate (72), perhaps $2\frac{1}{2}$ miles from the Medicine Peaks. The strike of this slate is $N. 55^{\circ} E.$; its dip $75^{\circ} NW.$

From this point onward no gneiss or granite was seen. Numerous outcrops of slate, of quartzite and of cherty limestone were passed in our drive towards the little lake at which we camped, near Medicine Peak. In getting to the point of camping photographs 11, 12, 13, 14 & 15 were taken.

Photo. ⁶⁸⁰ 11. Medicine Peak, from 2 miles distant; looking N.W.

Photo. ⁶⁸¹ 12. Looking S.E. down valley of Little Laramie. (Same canyon followed up today.)

Photo. ⁶⁸² 13. Medicine Bow Peaks from about 2 miles distant; looking west.

Photo. ⁶⁸³ 14. Medicine Bow Peaks; looking West. Farther south than last; from about 1 mile E.

(Failure) Photo. 15. Another part of Medicine Bow Peaks from same place as 14; looking S.W.

Specimens of a chert, interlaminate schist, and cherty limestone were taken from about a mile and a half east of Medicine Peak, as follows:-

15573 White chert, apparently brecciated.

15574 Black chert.

15575 Peculiar schist.

15576 Cherty limestone, beautifully showing the characteristic weathering of this sort of rock.

Trip to the Medicine Bow Peak,
Friday afternoon, August 9, 1889.

Photo. ⁶⁸⁴16. Near base of quartzite ridge forming summit of Medicine Bow Peak; looking along range towards southwest. Time 3:15 P.M.

Photo. ⁶⁸⁵17. Elk Mountain from top of Medicine Range; looking northwest. The mountain 34 miles distant. Time 4 P.M.

15577 Westernmost point reached on Medicine Peak. From this point the range drops off into the parks of the northwest, the water to the northwest running into the Medicine Bow River.

15578 Quartzite from the same locality.

15579 Greenstone, from a short distance southeast of quartzites last taken.

Photo. ⁶⁸⁶18. Lakes and mountains to the northeast of Medicine Peak. From the east side of the main crest of the latter. Time 4:30 P.M.

15580 Quartzite a little farther east.

15581 Ferruginous conglomerate on east side of main range of Medicine Bows, about $1\frac{1}{2}$ miles northeast of 15580.

15582 Greenstone, from dyke on east flank of main range a short distance east from 15581.

The top of the ridges of the higher peaks of the Medicine Bows are quartzite such as taken. The trend of the ridge is approximately parallel to the strike of the rocks on the east side of the range.

After passing the diorite dyke from which this specimen is taken, a coarse
 15883 white quartzite 15883 appears, perhaps 100 paces south of the base of the main ridge.

A little farther south the quartzite becomes
 15584 coarser and has a gray tint (15584). At this place the bedding of the quartzite shows very distinctly and is N. 60° E. The heavy beds have a nearly vertical dip, but appear to pitch at a high angle, about 80° to the southeast.

15585 Quartzite containing numerous round white pebbles averaging about a half an inch in diameter. Perhaps 500 paces from the foot of the main range. White quartz pebbles an inch in diameter are seen in places. The pebbly layers alternate with those finer as shown by the specimen.

15586 } Green quartzite, about 750 paces south of
 15586A } base of main range.

A few steps farther south the quartzite

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15588

becomes quite coarsely conglomeratic.

Some of the pebbles are as much as two inches or more in diameter although the specimen is not large enough to show this. The green color in the specimen just before taken, and the layers of pebbles of the conglomeratic phase, both correspond in their direction of strike and dip to the rocks of the region as before determined. This seems to be almost conclusive proof that the strike and dip of the quartzites and slates thus far found represent true bedding, and not foliation produced by pressure; else the rows of pebbles in the quartzites would cut across the strikes and dips as determined. Although on a side hill, it is very plain that the strike of the rows or layers of pebbles of which there are many alternating with layers of finer grained rocks correspond very nearly with the strike as before determined, that is, nearly 60° East. The dip of the beds is here about 80° to the S.W.

This quartzose conglomerate continues for about a half mile south of the foot

of the main ridge. A little valley is then passed and there appears a schistose quartzite or a sericitic schist having alternately thinly laminated and quite coarsely laminated phases.

15589 The coarse phase of rock.

15590 Schistose phase.

After crossing small stream a trap dyke appears; passing which is found peculiar weathering chert, the laminae of which strike N. 57° E. The dip is nearly vertical, but is probably about 80° to the S.E.

15591

A little farther on a contorted green schist appears, which is plainly traced into a more massive phase of the same rock, there being apparently every gradation between the laminated and the more massive phases.

15592 Laminated phase

15593 Massive phase.

15594 is a narrow layer of slaty rock, which may be of a different origin, found between two layers of these altered trap rocks.

The strike of the laminae of the schistose greenstones is about the same as that of the fragmentals in which they are

contained. The strike of the dyke also appears to correspond with the strike of the fragmental rocks. These two facts would seem to indicate that the greenstones were interlaminated between the fragmentals before their upturning and erosion. They may have been contemporaneous interbedded volcanic rocks, or subsequent intrusives which have been thrust between the beds of fragmental rocks parallel to the stratification.

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15596

Cherty quartzites, similar to those mentioned as having a peculiar ridgy weathering, are found a little farther on, probably $\frac{3}{4}$ of a mile south of the foot of the main ridge.

15597
15598

A little farther south appears a peculiar iron stained cherty rock, in which the laminae are much contorted. This rock resembles to a remarkable degree some of the beds of the iron-bearing member of the Lake Superior region. After about 50 feet of this rock is passed a cherty quartzite is found. This layer is about 8 or 10 feet across, and then again appears

the ferruginous rock. The two sets of rocks appear to be interlaminated. They strike and dip the same, their dip being almost exactly vertical. At the place of contact of the two rocks the surface is for a few inches dirt covered.

The ferruginous rock continues for a short distance, after which again appears the peculiar cherty quartz.

15599 Passing south the ridges in this cherty quartz become more and more prominent, until it varies into specimen 15599, which is taken from the location of the Telephone Mine. Here this chert has become distinctly limy, and there appears to be no question that the nearly pure chert with the peculiar weathering is but a very cherty phase of a cherty limestone member, just as at Penokee Gap there is a layer of pure white non-fragmental quartz in the cherty limestone member. Interlaminated with this cherty limestone are black slaty layers which weather red. This suggests that they have a

15600

larger proportion of iron than the most of the bed. Is it possible that a portion of this iron was here originally as carbonate? This black layer is but a few feet thick and the cherty limestone like 15599 reappears.

Saturday, August 10, 1889.
Trip to Brush Creek.

Photo ⁶⁸⁷ 19. Large snowfield on east face of Medicine Peak; looking west. About 1 mile distant.

Time 8⁰⁰ am.

Photo ⁶⁸⁸ 20. The main crest of Medicine Peak from the northeast end; looking southwest from a mound somewhat east of the eastern escarpment.

Time 8:45 am.

Photo ⁶⁸⁹ 21. Main range of Medicine Peaks from rear west side, looking southwest; showing canyon which divides the ridge into two parts. Time 9:30 am. About a mile distant. The main cliff which the picture shows runs nearly north and south.

15601 Plate, about 500 steps northwest of main

ridge of Medicine Peak. Strike of slates,
N. 57° E., did 70° SE.

About 200 steps from the west base of the main range of the peak, and some distance southwest of the last point, is an outcrop of a conglomerate which contains very numerous granite pebbles. These run up to six inches or more in size, although most of them are much smaller. The longer dimensions of the smaller pebbles conform quite closely to the strike and dip of the rock, showing that it has been greatly squeezed. The pressure has not been sufficient to conform the coarser pebbles in this way to the strike and dip of the rock. When the conglomerate becomes fine-grained the squeezing has been such as to give the rock very strongly the appearance of a coarse non-fragmental thoroughly crystalline gneiss. The conglomeratic bands alternate with those which are more finely laminated and non-conglomeratic. This fact gives us a good means of determining strike and dip. The strike is here N. 60° E., and the dip 75° SW. Above the

conglomerate, which is 15 or 20 feet in thickness, follow a succession of quartzose and slaty beds which are non-conglomeratic. Some of the coarser of these imitate true crystalline gneiss to a remarkable degree. The higher layers found - which are perhaps 75 feet above the lowest - are a green finely laminated schist.

15602 }
15603 }

Two phases of the conglomerate.

15604

Coarser granite pebbles from the same.

15605

A quartzose phase a few feet above 15602 & 3.

15606

A quartzose phase which imitates the gneissic structure; a few feet higher up.

15607

Another quartzose phase above 15606.

15608

A slaty phase above 15607, which however shows small pebbles.

15609

Green slate, having very fine lamination; at the top of the series here exposed.

15610

Quartzite. About 50 steps across strike to the northwest of the point at which the granitic conglomerate was taken.

15611

15611 shows a peculiar streak on the outside which is taken to be due to the hardening action of water.

The granitic conglomerate belt was

traced for several hundred paces along the strike to the southwest.

Photo. ⁶⁹⁰ 22. Canyon which cuts main ridge of Medicine Peaks; from the rear west side, looking west of south, from about a half mile distant.

15612

Coarse sericitic schist. Some distance to the southwest of specimens last taken, and about 500 paces across strike to the northwest of the base of the main ridge.

Photo. ⁶⁹¹ 23. From rear west side of main ridge; looking to the southwest; a trap dyke is seen cutting through the snow apparently interlaminated with the layers of white quartzite composing the ledge.
Distance about 200 paces

Photo. ⁶⁹² 24. From the same point, looking about south. The canyon at the left of the picture is the same seen in the previous pictures taken. The water over the divide flows into French Creek, and the water in the little lake in the foreground into Brush Creek.

15613

Red schistose quartzite containing coarse quartz pebbles; near head of Brush Creek. This quartzite becomes conglomeratic a

little nearer the main ridge.

15614 Reddish quartzite, about 250 or 300 steps down creek from last.

15615 White quartzite. About 500 steps down Brush Creek.

At this point the creek turns to the northeast, running for a distance of 500 paces parallel to the strike of the rock. It then turns across the strike of the rock again, at which point appears a coarse conglomerate containing very numerous granite and schist pebbles of various sort, as well as white quartz pebbles. The white quartz pebbles are very much less common than those of the granite. The granite is of various kinds, red and white, and of different degrees of fineness, although of course this is not represented in the specimens. This coarsely conglomeratic rock continues across the strike for a distance of 100 feet, when it becomes finely conglomeratic and has the pseudo-gneissic structure, 15618, which was mentioned as occurring in connection with a conglomerate near the Medicine Peaks. This conglomeratic rock

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15617

15618

gradually runs, when followed down the creek — that is, into lower members of the series, — into a coarse
 15619 quartzite ~~is~~ which, continuing down the creek, becomes less and less
 15620 gray, and finally runs into a beautiful
 15621 white quartzite. This white quartzite continues across the strike of the rock for a distance down the creek of 200 steps or more. The dip of the heavily bedded quartzite layers was here taken and found to be 50° to the southeast.

Are Photo. ⁶⁹³ 25 was taken looking up Bush Creek. This point is about a mile across strike from west side of Medicine Bows. The creek here again turns towards the northwest, and
 15622 across it appears a coarse green trap rock
 15622. The creek was followed in its course to a small lake.

15623 Green schist near southeast end of this small lake, just northeast of Bush Creek, about $\frac{3}{4}$ mile down. This rock has a parting parallel with that of the adjacent quartzite, but it seems to be a great dyke which cuts

almost perpendicular across the strike of the quartzite layers. Heavy exposures of quartzite are found immediately to the northeast of the dyke, having the normal strike and dip, but the latter were at a lower angle, being apparently about 55° to the southeast, 15624.

15624

The fact that the schistose structure of this dyke corresponds with the strike of the quartzite, although it is seen to continue for a long distance across the strike of the quartzite, seems conclusive proof that the Dyke was in the quartzite before it was upturned and squeezed, so that the pressure produced a foliation across the dyke parallel to that of the quartzite. This dyke was seen running for a quarter of a mile in a northwest direction.

15625

Farther northwest it becomes more massive, and from this part of it is taken. Quartzite again is found about 500 steps farther on in a northwest course upon the southwest side

15626

of the dyke, 15626. Parallel with the general direction of the main dyke is

another dyke to the southwest which can be seen running a considerable distance. A portion of this dyke is
 15627 still more massive.

Crossing this dyke to the southwest a conglomeratic quartzite again appears, which contains mostly white quartz pebbles, some of which are an inch and a half or even two inches in
 15628 diameter.

This conglomeratic quartzite continues for some distance, its dip becoming rapidly flatter and flatter. Perhaps a quarter of a mile from the point at which the last measurement was taken the dip has sunk to 35° to the southeast.

The quartzite and quartzite conglomerate was crossed for a distance of about a half a mile in a northwest direction, where a chance was found to take the dip of the rocks, and it was found to be about 30° southeast. A little
 15629 farther on 15629, coarse quartzite, was taken. This point, ~~is~~ the farthest northwest reached, or more accurately

about N. 25° to 35° W, is about $2\frac{1}{2}$ miles from the west flank of the main range.

The gradual flattening of the dip noted in this cross-section seems to agree with the statement made by Hague and by King that the Medicine Bow Peaks are the eastern side of a broad anticlinal arch, although we did not go far enough to the northwest to reach the summit of such an anticlinal if it existed.

Trip to Mill Peak.
Sunday, August 11, 1889.

Photo. ⁶⁹⁴ 26. Medicine Peaks from Mill Peak, about 8 miles distant; looking south of west.
Time 8:40.

- 15630 A brecciated cherty limestone on the west flank of Mill Peak. This brecciated chert, when weathered and coarser, becomes close to a true conglomerate, 15631, the matrix of which carries quite a quantity of oxide of iron as shown by its red color.

15632

A little summit about 500 steps west of the main summit is crowned by a peculiar weathered chert, which resembles the chert which varies into the cherty limestone east of Medicine Peak. It is, however, coarser grained. The breccia like 15631 is also found on this little summit, some of the quartzose fragments of the breccia here being as much as six inches in diameter.

The three specimens already taken undoubtedly represent the same bed, as large masses of the white quartz were found upon the east side of this knob. These masses of white quartz run into those that are more and more brecciated, until they pass to a rock which is very close to a true conglomerate — at least a breccia in which the pebbles are considerably rounded.

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15634

15635

Represent other phases of this peculiar breccia and conglomerate, found on the way to the main peak, mentioned as being 500 steps towards the east. The two last contain coarse white quartz pebbles; the pebbles of the first, however, is mostly limestone. A good many of these are seen

in certain zones. It appears to be the case that before the rock was folded and brecciated, that white quartz veins had within it, and locally breccias of this material were formed, just as the cherty breccia formed in the chert.

At the little point to the west the pebbles of quartz are predominant; but their proportion is less and less towards the main peak, until at its eastern side there are but few white quartz pebbles, the pebbles of the breccia being almost wholly limestone. The photographs below are taken from the crowning peak where the most of the pebbles are limestone, although in one or two cases there are also white quartz pebbles.

Photo. ⁶⁹⁵ 27. One in which the rock is somewhat brecciated and seamed, but has not assumed a true conglomeratic character.

Photo. ⁶⁹⁶ 28. Mass of the breccia in which the fragments are somewhat rounded and the matrix is deeply stained with oxide of iron.

Photo. ⁶⁹⁷ 29. The base is but little brecciated, consisting of the nearly pure white quartz

like 15631, while the upper part is brecciated like 15632. Distance from ledge, about 10 feet; height of vertical part, about the same distance. Time 9:20 A.M.

Photo. ⁶⁹⁸30. Shows the exceedingly ragged and broken forms into which this chert and chert breccia weathers.

15636 The two topmost points of Mill Peak are a little brecciated, the rock being here a quite pure limestone.

A peak on the east flank of Mill Peak, somewhat lower than the two higher peaks just mentioned, has a strongly reddish tone, which is in strong contrast to the whites and grays of the two higher peaks. This rock is a quartzite, or a calcareous quartzite which locally is conglomeratic. Many of the pebbles are of white quartz, but the greater number of the larger ones are of limestone, some of the latter being more than a foot in diameter.

15637

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Represent two phases of the quartzite.
is a conglomeratic phase of the quartzite bearing white quartz pebbles.
is the quartzite carrying cherty limestone

pebbles.

Photo 31⁶⁹⁹ Was taken from a face about 4 feet high by 8 feet broad on this knob. The small pebbles to the right are mostly white quartz, while the larger ones to the left are limestone.

As we descend the east side of Mill Peak the rock becomes less and less quartzose, until near its base (about 1000 paces east of last point) it is a somewhat brecciated and cherty limestone. Strike $N55$ to $60^{\circ}E$; dip 12° to the northwest. This is the first place on Mill Peak where we have any certain evidence of the true strike and dip, but here a large exposure shows it so well that the error in the observation cannot be much. The distance transverse to the strike across the exposure to Mill Peak is fully a mile. The layers throughout this distance are, however, essentially the same cherty limestones, only at the east side of the ridge the limestone is predominant, while on the west side the chert is. The red quartzite conglomerate containing

limestone and limestone pebbles is about in the middle of the series.

15641 A schistose and magnetitic black rock about half a mile northeast of Mill Peak. The strike of this rock corresponds with that seen on Mill Peak, but its dip as ascertained by the small exposure accessible by test-pit is higher, being 40° . As seen in exposure the upper and edges of this rock show corrugations.

It seems probable that this, like other schistose black rocks which have been found in the fragmental series, is a much squeezed dyke cutting across the formation, and the laminae of which have been produced by pressure.

15642 Immediately southwest of this exposure, separated from it by only a few feet, is a sericitic and quartzose schist. This schist is so poorly exposed that strike and dip could not be taken.

15643 Ten or fifteen rods farther towards Mill Peak appears the cherty limestone exactly like that found on Mill Peak. It is taken from a quartzose layer because it shows beautifully a very fine lamination,

presumably bedding.

15644 is taken a few feet farther on from a more calcareous layer. It shows the peculiar ridging which Hague speaks about as characteristic of the limestone on Mill Peak.

Two other schistose dykes were seen a little farther on, in the valley between the last point and Mill Peak. The direction of these dykes is nearly perpendicular to the strike of the cherty limestone.

15645 represents the larger of the two.

Coming back to Mill Peak we again strike the red quartzite, mentioned in the notes of the previous pages as carrying numerous limestone pebbles with few or of white quartz. Here was taken 15646 quartzite containing limestone pebbles, and 15647 portion of a large limestone boulder having a border of red quartzite.

Photo. ⁷⁰³ 32. A large boulder of the above conglomerate tumbled down from the side of a cliff. The white pebbles for about the lower half of the figure are almost wholly white quartz, while in the upper half they are largely limestone,

although veins run across which have white quartz pebbles.

15648

White quartzite from a large ledge about $\frac{1}{3}$ of the way on almost straight line from Null Peak to the main Medicine Peaks.

Photo. ⁷⁰¹33. Snap shot at deer 80 yards away.

Photo. ⁷⁰²34. Contorted cherty limestone, about $\frac{1}{2}$ miles northeast of camp. The limestone as shown in photograph varies in dip from almost horizontal in one position to nearly vertical in another, there being one entire fold and a part of another. Ledge about 10 feet high; from about 20 feet distant.

Time 4 P.M.

Photo. ⁷⁰³35. A part of the same ledge from about 8 feet distant.

15649

Gray cherty limestone, showing fine lamination.

Trip from Telephone Mine down creek
on which we camped.

Monday, August 12, 1889.

He returned to the place where work ended August 9th, at the Telephone Mine, and continued the section begun from Medicine Peak down the creek towards camp.

15650 The next rock exposed below the Telephone Mine is a diorite. This diorite is noticeable as being about the most massive that has been met with in this region, although it still shows distinctly a laminated structure. It can be seen extending for some distance parallel to the strike of the rock and is doubtless a dyke. Upon both sides of it is seen the cherty limestone like that of the Telephone Mine.

15651 This cherty limestone, showing the peculiar ridgy weathering, below this dyke. Strike N. 62° E; dip ¹⁰⁰⁴ 77° SE.

Photo. 36. Small exposure of cherty limestone which nicely shows its peculiar weathering.

From this point the exposures of cherty limestone are almost continuous until the point at which we camped is reached. This is about $1\frac{1}{2}$ miles down the creek almost directly across the strike from the main peak of the Medicine Bows on the east side. The rock at this point becomes a quartzite. The quartzite is very distinctly bedded and coarsely laminated parallel to the bedding. It contains here and there layers which weather brown or red, the interior of which, however, is gray like the unaltered quartzite. Does this phase carry some carbonate of iron? The strike and dip of the rock is normal, that is, it strikes N. 60° E. and dips 80° to the SE. The quartzite is cut by coarse white quartz veins, one of which is 15 or 18 inches wide and persists in the same direction somewhat diagonally across the layers of the quartzite for some distance. 15652-53, normal quartzite which show distinctly the lamination of the rock. 15654, Phase which weathers to red or brown. The specimen, however, shows a core of unaltered material. This quartzite

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ledge is about 50 steps wide.

15655-56 100 steps farther down the stream appears again the cherty limestone. This limestone, like the quartzite, is cut by coarse white quartz veins. It has the normal strike and dip and continues for some distance about a small lake in which the stream flows.

15657 There is then an interval in this direction of several hundred paces, after which a schistose greenstone, having strike and dip as usual, accordant to the stratified rocks, appears.

The country to the right and left of the creek have softly rounded tops and are covered with loose material left by the glaciers.

15658 Along the creek the only material seen for the next $\frac{3}{4}$ mile is greenstone, either massive or schistose. 15658 Massive greenstone, about $\frac{1}{2}$ mile down creek from last.

15659 Schistose greenstone?, $\frac{3}{4}$ mile down creek. This schistose rock continued with frequent exposures from this point.

15660 About $\frac{1}{2}$ mile farther down it has become more slaty, 15660.

15661 Slate, a little farther down. The exposure is continuous from 15660 to 15661.

15662 } micaceous slate just beyond creek which
 15663 } enters the main creek from the north by the ranch house. This slate and 15661 are about the same horizon as 15572, found opposite the ranch in going out.

15664 Coarsely schistose rock which is taken to be a modified greenstone. Farther down the creek.

15665 } Gneisses and schists taken in the order
 15666 } mentioned; down the creek from the last point;
 15667 } the exposures being almost continuous.
 15668 }
 15669 } The rock in this interval is becoming
 15670 } more and more crystalline, and 15670 suggests a thoroughly crystalline gneiss.

15671 }
 15672 } These taken in order continuing down the
 15673 } creek. In this interval the transition to a
 15674 } thoroughly crystalline coarse grained gneiss,
 15675 } with granite veins alternating with layers
 15676 } of coarsely crystalline hornblende schist, is
 15677 } complete. 15674 and 15677 are two coarse
 hornblende schists which are interstratified with the gneisses. 15676 is from one of the broader layers of red granitic material like that seen in 15675.

The last point must be fully $3\frac{1}{2}$ miles down the creek from the main Medicine Range. It is far enough down so that the strike of the rocks hit the ridge upon which specimens of hornblende schist and gneiss (15570-71) were obtained on the way out. Frequently ~~the~~ strike and dip of the rocks from 60 to 75 were taken, and in almost every case they accord with the strikes and dips heretofore obtained; that is, their direction is about $N. 60^{\circ} E$, and the dip from 70° to 85° to the SE. At one place a strike was obtained considerably different from this, but the ledge was not large enough to make it certain that this was not a fallen mass.

The rocks in the section from Medicine Peak down to the granites is apparently conformable from one end to the other, although from Medicine Peak down some distance it is a completely fragmental series, while at the other end it is a completely crystalline series. Moreover, the dips are such as to make the fragmental and sedimentary rocks older than the crystalline rocks. This can hardly be the case and there must be here an overturn or an unconformity at some point.

However, the transition from what was supposed to be fragmental slates to the completely crystalline gneisses and granites seem to be complete. However, the sudden disappearance of cherty limestones and quartzites, that is, of rocks which are certainly of fragmental or sedimentary origin, at the little lake southeast of camp would seem to indicate that here is a break of some sort. However, what the structural relations are between these sedimentary rocks and the crystallines below could not in the limited time available for this work be made out.

The granites and gneisses found in the first days work, and as mentioned in the notes of that day, are as typical Archaean rocks as any that are known in the Lake Superior region. Upon the other hand, the cherty limestone, quartzites and conglomerates are as typical Huronian or Algonkian as any which are in the Lake Superior country. This strong lithological difference with apparent accordance in strike and dip between fragmental and crystalline series, makes the cross-section obtained of the Medicine Bow more like that of the Vermilion Lake than of

any other locality in the Lake Superior region.

Wednesday, August 14, 1889.
Trip into the Archaean east of Laramie to Horse Creek

Photo. ⁷⁰⁵ 37. Escarpment of Carboniferous limestone with an eastern face, looking northwest, about 8 miles east of Laramie. This ridge has towards its west a gentle slope. The upturning of the layers with a western dip is shown both by the manner of erosion — that is, the gentle slope to the west and the escarpment to the east, as well as by the dip of the layers.

Photo. ⁷⁰⁶ 38. Two parallel ridges of limestone; the more remote one the same as in the previous photograph. From a point a little farther on, looking in the same direction.

15678

Coarse labradorite rock is the first phase of crystalline rock struck on entering the Archaean area from Laramie. This appears to be a huge dyke, several hundred feet wide, which runs approximately north and south. Mr. Reed says this dyke continues

to the north for 30 miles; but I do not understand that this implies that he has seen the country for the whole distance, but has found it at intervals for that distance, and it may mean that he has only seen a similar rock in one place 30 miles to the north.

15679 Pink granite, a few paces east from the labradorite rock. The rock again reappears beyond this granite.

On the eastern slope of this hill at one place a small quantity of granite is found to cap the labradorite. This would suggest that the granite was a subsequent flow, or else that the labradorite dyke was an intrusion which did not reach the surface. Is it possible that the labradorite is later, and its intrusion has been the cause of the secondary upthrust which makes the bowing of the fossiliferous formations?

15680 Shows the contact of the granite and labradorite.

Before reaching the Archaean area the stratiform formations are seen, with gentle inclinations, to dip upwards towards

the Archaean. Measurements were made of the inclination in one or two places and they were found to dip from 7° to 10° away from the Archaean core, that is, towards the west. After getting into the main Archaean area as mapped by King numerous hills are capped by stratified rocks. The lower horizons seen are a sandstone and the upper horizons a limestone. The valleys are mostly Archaean granite. At one place what was taken for the horizontal Cambrian sandstone, by aneroid measurement, was found to be more than a thousand feet above Laramie. As at Laramie well-borings have shown that the Triassic is at least 1600 feet thick, this would imply that the Cambrian on the hills, if such exists, is here some 2500 or more feet higher than the Cambrian at Laramie. If this is the case, there must have been an uplift since Cambrian time. King reports that the Cambrian sandstone, where it is close to or in contact with the Archaean rocks, contains granite pebbles. Mr. Reed reports the same thing to occur at many points. In a small gulch

running east near the head of Horse Creek a conglomerate was found which is principally composed of granitic debris. It contains numerous large feldspar crystals and some pebbles large enough to show the complex nature of the granite itself. With these are numerous white quartz pebbles, which may also have been derived from the granite. Above this conglomerate at this place is a quartzite which is as indurated as some of the quartzites which have been found in the Archaean formation.

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} Different phases of the conglomerate.

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} Phases of quartzite.

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Conglomerate from a boulder near where gulch joins the creek. Taken because it shows particularly well feldspar crystals.

Coming from Sherman to Laramie on the cars the same fact mentioned above with reference to the inclination of the stratified rocks away from the Archaean core was noted. The angle of inclination was quite high near the Archaean rocks,

judged from 10° to 15°, and gradually
 decreases in passing away from them.
 A few miles distant the inclination was
 no more than the gradient of the road,
 which falls over a thousand feet between
 Sherman and Laramie. Mr. Reed reports
 that typical Carboniferous fossils have
 been found in the limestone above the
 Archaean area. If this is the case, the
 uplifting of the Archaean core suggested above
 can hardly be doubted; in which case
 this region would be comparable to that
 of the Black Hills and Uintas. The
 question, however, arises whether or not
 the rock deposited just above the Archaean
 would not be conglomeratic and devoid
 of fossils, and like the Cambrian in other
 places, even if it was of later age than
 the Cambrian, for instance, Triassic or
 Cretaceous. If this is possible, and it is
 also possible to explain the inclination of
 the strata away from the core by the
 inclination of the then ocean bed, it
 would not be necessary to believe in an
 uplift since the deposition of the stratified
 rocks. It would seem, however, as though

these hypotheses were somewhat forced and that the uplift is a more plausible explanation.

Thursday, August 15, 1889.
On road to Brown's Park.

Photo. ⁷⁰⁷39. Photograph of Tertiary beds on road from Green River to Brown's Park, about 30 miles from the first place. Looking north from the head of little side gulch.

Friday, August 16, 1889.
On road to Brown's Park.

Photo. ⁷⁰⁸40. Canyon of Sage Creek, looking west.

Photo. ⁷⁰⁹41. The same, looking southwest.

Photo. ⁷¹⁰42. Sage Creek canyon looking nearly west. From crest of ridge on other side.

Photo. ⁷¹¹43. Looking northwest down canyon.

Photo. ⁷¹²44. Canyon of Red Creek, looking northeast from west side of canyon.

Photo. ⁷¹³45. Same as 44, a little farther on.

Saturday, August 17, 1889.

Trip towards the Uintas and Brown's Park.

Photo. ⁷¹⁴46. The upturned edges of sandstone (Cretaceous) in going down Red Creek towards the Archaean area; looking west.

Photo. ⁷¹⁵47. The same a little farther on, showing both upturned layers and peculiar manner of weathering of the sandstone noticed here and on the plains north of here. Probably due to the action of sand driven by the wind.

- 15689 Quartzite, or white quartz, which composes the main portion of the ledge upon entering the older rocks in passing south in Red Creek canyon. This rock is cut by or interlaminated with a black rock 15690, hornblende schist. The latter is taken to be a modified eruptive.

- In passing onward alternations of the white quartz and the dark colored rock are found. At a point perhaps a quarter of a mile farther on, 15691, micaceous quartzite is taken. This quartzite is so cut by the dark hornblendic rock as to indicate that there can be little doubt that it is of an intrusive nature.

It occurs both interlaminated with the beds of the quartzite and cutting across them in the most irregular fashion. shows in a small way the irregular nature of the relations of these two classes of rock.

15692

Photo ⁷¹⁶48 is also here taken, but the position was such that only a very poor view could be gotten of the intricate relations above mentioned.

Interlaminated quartzite and micaceous schist, perhaps half a mile farther down canyon. These three phases are thinly bedded, interlaminated, much contorted and broken. 15693 Quartzite 15694 Fine-grained schist. 15695 Coarse grained phase of same.

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Photo. ⁷¹⁷49. Plicated quartzite irregularly interlaminated with hornblende schist; a little farther down; looking southeast.

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Strongly foliated micaceous quartzite from this place of extreme plication.

15697

Hornblende schist, from narrow dyke in same. The relations of the dyke rock with the quartzite are such as to show that the dykes were intruded within

the quartzite before the folding occurred.

Photo. ⁷¹⁸50. The same plicated quartzite intricately mixed with hornblende rock. A little farther along canyon; looking southwest.

Photo. ⁷¹⁹51. Red heavily bedded quartzite, nearly horizontal, dipping at a low angle, about 10°, to the north, over the steeply inclined white quartzite of the Archaean. Looking northeast.

Although the actual contact between the red quartzite and conglomerate was not hunted out in detail, it, from the general appearance, seems clearly to indicate that the two rocks are unconformable. The red quartzite is taken to belong to the Uinta Series.

The specimens were not collected from the main cliff, but from the stuff that had tumbled down the gulch. This locality is about a mile north of the south side of the Archaean core.

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Two phases of the quartzite.

Two phases of the conglomerate. The first carries, besides the more numerous white quartz pebbles, quite a large number of

red jasper fragments.

15702 Portion of a large white quartz pebble from the conglomerate. The ~~B~~ boulders were observed of this material as large as 8 or 10 inches in diameter. The white quartz pebbles contained in this conglomerate are exactly like the white quartz of the Archaean and there is little question that they were derived from this source.

15703 Banded white quartz from the underlying series; across gulch from the red quartzite and conglomerate.

15704 Hornblende schist; dyke in the last.

15705 }
15706 }
15707 }

3 phases of schist farther down Red Creek.

Photo. ⁷²⁰ 52. Side of canyon of Red Creek; looking northwest. The quartzite and schist are so cut as to appear nearly horizontal, but they are really dipping back into the hill at quite a high angle. Well towards the top of the figure is a large dyke of black hornblende rock which is parallel to the lamination of the quartzite and schist.

Photo. ⁷²¹ 53. An inclined pinnacle of

quartzite left in Red Creek canyon a little farther on.)

Across the canyon are seen the steeply inclined layers of the quartzite, which in the previous photograph, viewed from the east, appear to incline in a horizontal position; looking southwest. The strike of the rock seen in this picture is $N 30^{\circ} E$ magnetic. The dip is 50° to the northwest.

Upon emerging from the Archaean corral at the south side, a plain is seen, across which are the horizontal red rocks of the Uinta series. These rocks also cap unconformably the Archaean rocks in the gulches for some distance back. One of these gulches was followed up to the point of the contact of the Archaean and Uinta series and here several photographs were taken.

Photo. ⁷²²54. Contact of the Archaean and Uinta. The layer ^{of} white rocks at the bottom of the picture are the white quartzites of the Archaean, while the dark colored conglomerates above belong to the Uinta series.

Photo. ⁷²³55. A little higher up, showing the heavily bedded horizontal Uinta series.

Photos. 56⁷²⁴ and 57. Lower down in the gulch so as to take in a larger view of both the Archaean and Uinta. The Archaean are the white rocks on the right and the Uinta are the rocks in the background. This gulch runs up from the plain in a northwest direction and the pictures are taken looking that way. The base of the Uinta series is here a typical coarse bouldered conglomerate, the boulders of which are of all sizes up to two feet or more.

- 15708 Quartzite from above the heavily conglomeratic zone.
- 15709 A fine pebbled phase of conglomerate, showing the angularity characteristic of conglomerates which have formed near their source.
- 15710-11 Fragments of boulders from the conglomerate. These pebbles show a red color upon the outside and are white in the interior. This is general in this conglomerate, and it appears to be the case that by some sort of action the outside of the white quartz fragments have been reddened.
- 15712 White quartz from the Archaean.

Saturday afternoon, August 17, 1889.
Trip down Red Canyon.

15713 Quartzite, about a mile straight south down Red Creek from the point where the Archaean rocks end.

Red Creek then swings into a gorge of the Uinta series, and the first rock here exposed is 15714, quartzite. This quartzite is in places conglomeratic and bears numerous large ferruginous pebbles.

In passing down the canyon the rock is red quartzite interstratified with more arenaceous layers for another mile. At the end of this mile — that is, about 2 miles south of the south side of the Archaean area, 15715 was taken. The dip here is from 5° to 7° to the south.

15716 ⁷²⁵Photo 58. Looking up the canyon of Red Creek in the Uinta quartzite, about 1 1/2 miles below the south side of the Archaean core; looking SE.

An arenaceous phase of rock about half way between the two last — that is, about a mile and a half down creek.

Sunday, August 18, 1889.

Trip up Willow Creek.

- 15717 Heavily bedded white quartzite of the Uinta. The first exposure met with in going up Willow Creek from Brown's Park. A nearly horizontal.
- 15718 Another specimen of the same grayish white quartzite higher up. This quartzite is interlaminated with a red conglomerate.
- 15719 at 15719, containing white quartz pebbles. This quartzite here is more indurated than any found on Red Creek, and the question was raised whether it might not belong to the Archaean core rather than the Uinta, as it is inclined a little higher up, at an angle of 10° or 15° , towards the north, and breaks down in a manner which resembles to some extent the manner of the Archaean quartzite observed on Red Creek.
- 15720 A more arenaceous phase of the quartzite higher up the creek.

Going up the creek still farther, perhaps a mile and a half from the first exposure, heavy beds of conglomerate are interlaminated with the quartzite.

- 15721-22 represent specimens of the finer conglomerate. The white quartz pebbles in the heavier beds of this are 8 or 10 inches in diameter. An occasional black cherty pebble is seen, 15723. The non-conglomeratic beds are from a few inches to several feet in width. They are sometimes very indurated, 15724, and have numerous parallel purple lines which resemble the Devil's Lake (Wis.) quartzite. At other times they are more arenaceous, 15725. The dip of this quartzite and conglomerate at this point is 20° to the north.

Photos. ⁷⁵⁶59 & ⁷⁷⁷60. Two views of the conglomerate, the first one looking southwest, the second one looking northwest at the same bed of conglomerate on the west side of Willow Creek. Time 9:45 a.m.

- 15726 Another specimen of the typical fine grained conglomerate farther up the creek.
- 15727 A conglomerate still farther up the creek which contains pebbles which appear to be heavily ferruginous, perhaps often hematite.
- 15728 Part of a peculiar ferruginous mass

which was found in the ordinary conglomerate.

Three or four miles after the Uinta series was struck the white quartzite of the underlying series was seen to crown the hills for a short distance on the west side of the creek, although the older rock was at a higher level than any of the sandstones and conglomerates. The latter dipped here at a higher angle than any other place, 55° to the north — that is, towards the older white quartzite. This increase in dip appeared to be gradual from the low dips first noted upon entering the canyon up to this point. The white quartzite of the older series was almost wholly without structure, just as in Red Creek it is cut by hornblende rocks. The newer series rock closest to it is merely a breccia which is almost wholly composed of the fragments of the adjacent white quartzite. A little farther away it passes into a true conglomerate interspersed with sandstones.

- 15729 White quartzite of the older series.
 15730 The hornblende schist which cuts the same.
 15731 Breccia or recomposed rock, almost wholly

composed of white quartz debris.

15732 Well indurated quartzite high up on hill.

15733 An unusually arenaceous variety of the sandstone.

15734 The ordinary phase of conglomerate at this point, the pebbles, however, being in the hand specimen necessarily small, so much smaller than the average.

In passing north from this point up the creek the Uinta series was observed to be more arenaceous, although heavy beds of quartzite and conglomerate were found. After an interval of 2 or 3 miles after the first outcrop of the older series rocks, the white quartz was observed again to crown the hills, being at a higher altitude than the newer series rocks, which in the form of the usually interspersed conglomerates and sandstones are the rock along the bottom of the canyon.

Photo. ⁷²⁸ 61. Looking down Willow Creek canyon from the place of contact of the Uinta & white quartz.

Photo. ⁷²⁹ 62. Looking up canyon from same place.

Photo. ⁷³⁰ 63. Looking up canyon from different position. On the left is the white quartz of the older series; on the right is the Uinta conglomerate.

(Failure) Photo. 64. An overhanging cliff of white quartz, looking up. All of these are on the west side of the canyon.

Photo. ⁷³¹65. Conglomerate of the Uinta series, looking west from the bottom of the canyon.

Photo. ⁷³³66. Unconformity of the Uinta and older series; from the bottom of the canyon. The white quartz is the older series, and the dark colored rock the Uinta.

Photo ⁷³²65A. Another view of the same conglomerate

Monday, August 19, 1889.
On road to Green River City.

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Photo 734. A view over the mountains in the early morning; looking northwest. Time 6:30 AM. These are the newer ranges north of the older rocks of the Uinta, and after having left the archaean of that range and having gone north two or three miles without exposure.

Photo ⁷³⁵₆₈. The same thing a little farther on.

Photo ⁷³⁶_{68A}. The same, farther on.

Photo ⁷³⁷₆₉. A view of Table Mountain on the west of the road; looking northwest.

Photo ⁷³⁸⁻⁷³⁹₇₀₋₇₁. Nearer view of a portion of the same.

Archaean { Photo 72. Couple of miles farther on, looking down canyon and wagon road we came up. Southwest direction. Time 9:30 AM.

Photo ⁷⁴⁰₇₃. Looking down same canyon a little farther on.

(End of Uinta Series)



