Black Hills, South Dakota: [specimens] 14800-14953. No. 82 July 27 to August 2, 1889

Van Hise, Charles Richard, 1857-1918
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U. S. GEOLOGICAL SURVEY

FIELD SECTION BOOK

No. 82.

July 27 to August 2, 1889.

Black Hills, S. Dakota.

C. R. Van Hise.

14800 14953

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 x 2½ x ¾ inches will be allowed, but in all other cases *large sized specimens*, trimmed to a size of 3 x 4 x 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.

#82

14938 skipped

Professors Hall & Van Hise

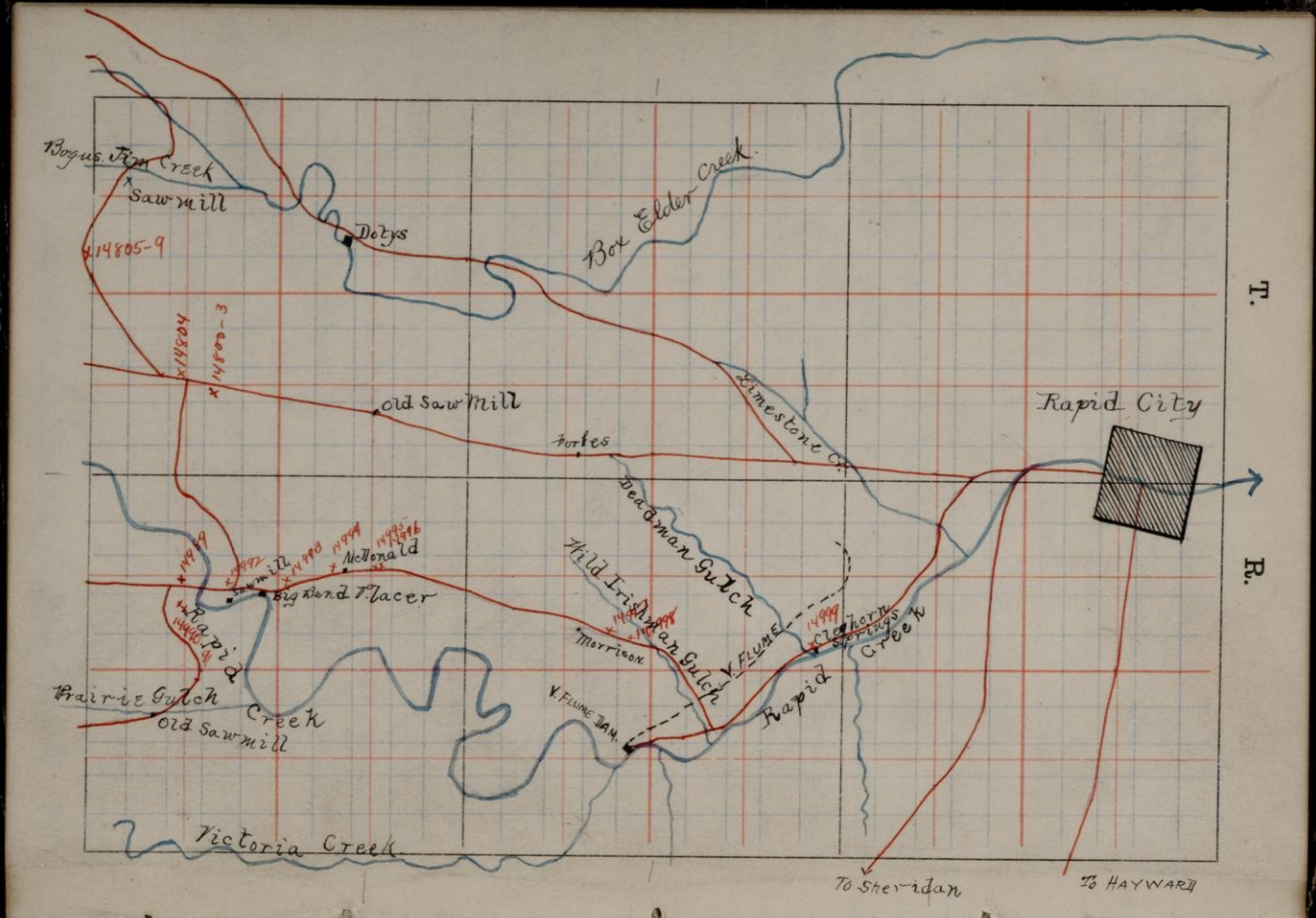
(For approximate location of numbers see "County and Wagon Road Map of the Black Hills.")

Rapid City, South Dakota, Saturday, July 27, 1889.

We started west from Rapid City (situated in the Cretaceous according to Newton) and cut across in order the upturned edges of the full Paleozoic series. These rocks were the only ones exposed upon the road for a considerable distance.

We first found the pre-Cambrian rocks on the left southwest side of the wagon road some miles west of Rapid City. This ridge is composed of quartzite which in places is conglomeratic. It also contains schistose phases and schists. The dip of the latter appears to be at a high angle to the west, although this is on the side of a hill and may be due to a tilting over of the rocks. The strike is some 15° or 20° East of south.

14800 Quartzite
14801 Conglomeratic phase of same.


Bogus Jim Creek
Sawmill
Delys
Box Elder Creek
#14805-9
#14804
#14805-3
Old Saw Mill
Forbes
Limestone Cr.
Rapid City
T.
R.
Deadman Gulch
Mild Irishman Gulch
McDonald
Sawmill
Big Bend Placer
Rapid Creek
Prairie Gulch
Old Sawmill
Morrison
V Flume
V Flume Dam
Clayhorn
Rapid Creek
Victoria Creek
To Sheridan
To HAYWARD

14802 Schistose quartzite.
14803 Schist.

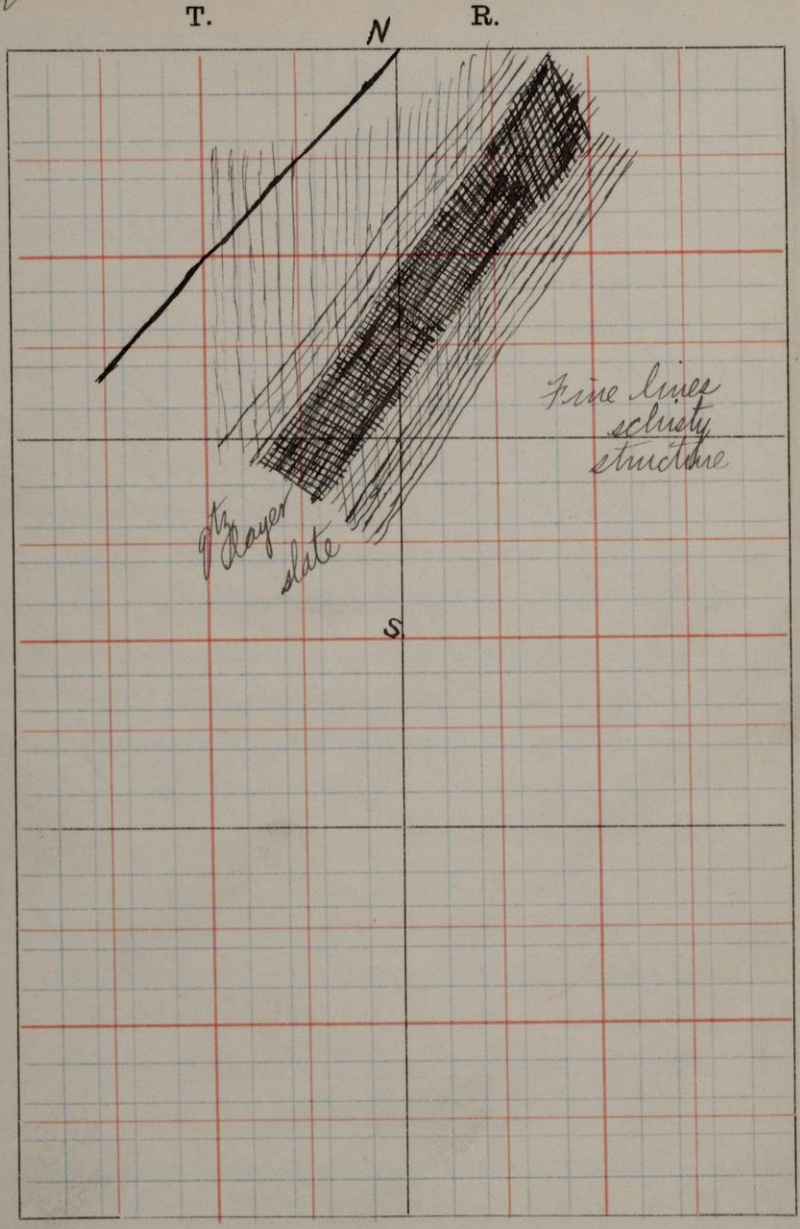
14804 Quartzite on right hand side of road a little farther on.

This quartzite ridge runs approximately parallel to the road, which swings north to Box Elder Creek. The quartzite is found at the base of the hills on the right hand east side of the road, the top of the hills being capped by horizontal Paleozoic rocks. Even on the west side of the valley, in which the road runs the Paleozoic rocks were frequently seen in horizontal cappings upon the pre-Cambrian.

About ½ mile before Box Elder Creek is reached — that is, south — the following is the succession from top to bottom:

14805 Limestone (Carboniferous?)
14806-7 Sandstones (Cambrian?)
14808-9 Peculiar phases of quartzite and ferruginous schist at bottom of hill. Much of the quartzite is here cherty, as shown by 14808,

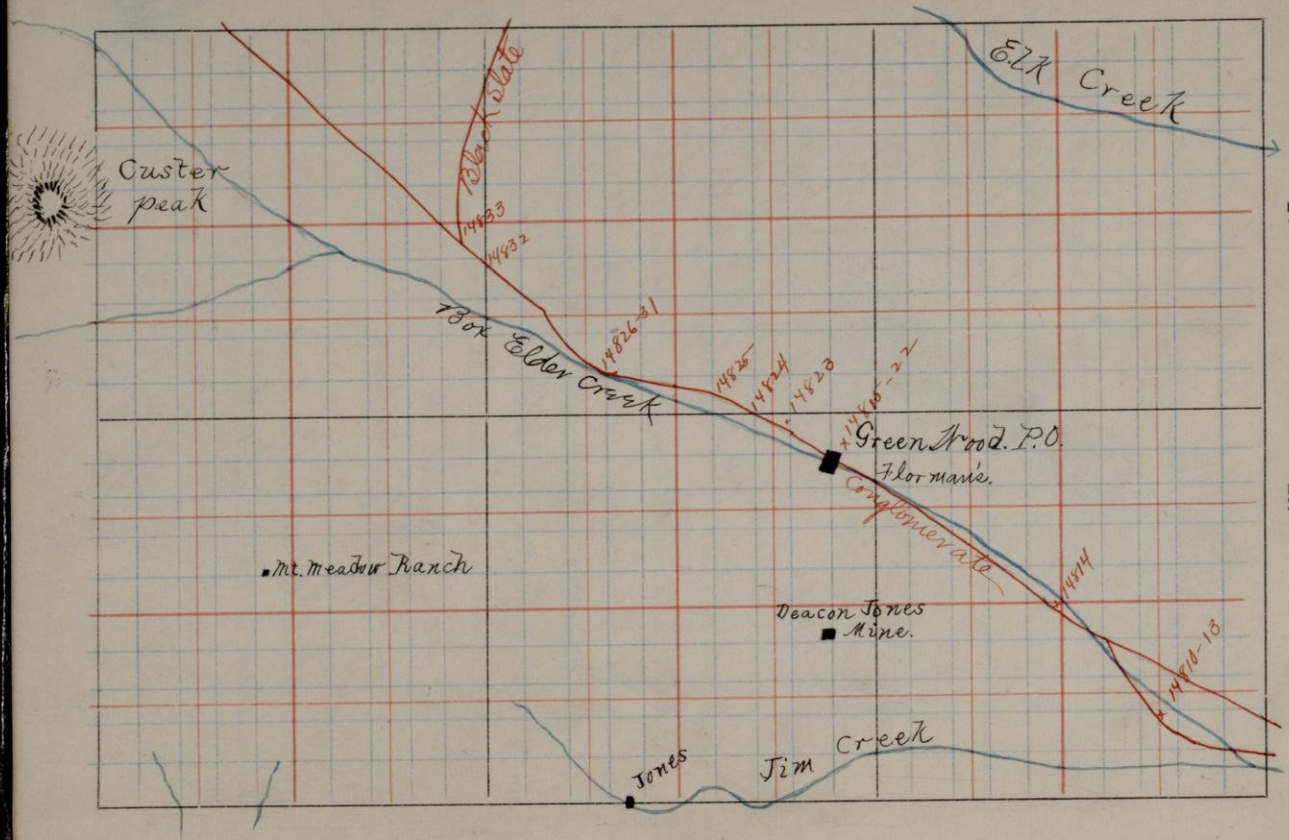
2 1/2



although fragmental phases are intermingled with these cherty ones.

The wagon road now follows up Box Elder Creek in a northwest direction. On this creek, where the crystalline rocks of the Pre-Cambrian first appear the schistose structure differs in its strike and dip from the true bedding. The latter is shown by alternations of quartzite and slaty and schistose beds, while the schistose parting shows no such distinction. The schistose structure does not continue through the quartzitic portions. The strike of the schistose structure is north and south of true bedding, N. 45° E. The true dip is 70° to 75° northwest. The dip of the schistose structure is 85° W.

Following the lines of bedding are also seams of white cherty material. The schistose structure sometimes breaks across a bed of quartzite, but when it becomes more massive fails to continue.


Elk Creek
Custer peak
Black Tail
14833
14832
14826-31
Box Elder Creek
14825
14824
14823
14816-22
Green Wood. P.O.
Flormaie.
Conglomerate
Mt. Meadow Ranch
Deacon Jones Mine.
14814
14810-13
Jones
Jim Creek
T.
R.

The Pre-Cambrian schists here, with uneven upper surface and vertical cleavage, are covered by the nearly horizontal Cambrian sandstone. The latter, however, bows up over the schists exactly as figured by Irving of similar rocks at Black River Falls. The relations at this place on Box Elder Creek are shown by figure on page 2½.

14810 (specimen lost) Cambrian quartzite, a short distance east of above place. The rock is heavily bedded and perfectly horizontal. The specimen is taken from the most indurated phase which could be found in the exposure.

14811 Schistose quartzite, from the Pre-Cambrian at the point fully described above. The longer dimensions of the specimen is parallel to the schistose structure. Across this at about 45° is seen very faint lines of bedding.

14812 Slaty phase of the rock at the same point, parallel to the schistose structure.

The combination of bedding and schistose structure causes the rock to break down in polygonal, or rather diamond shaped blocks, due to the fact that the true bedding and schistose structure cut each other at an angle of 45°.

14813 A weathered specimen which shows nicely both the schistose structure parallel to its longer dimensions and the bedding lines cutting this at an angle of 45°.

Farther up Box Elder Creek, shortly after the junction of the two wagon roads the schistose structure was found to be N. 45° W. Apparent strike of bedding is here north and south; both are very obscure and doubtful.

14814 White sugary phase of quartzite farther along the road toward Greenwood.

A little bit farther on a measurement was made and the pebbles and bedding lines were found to run N 20° to N. 30° E, the

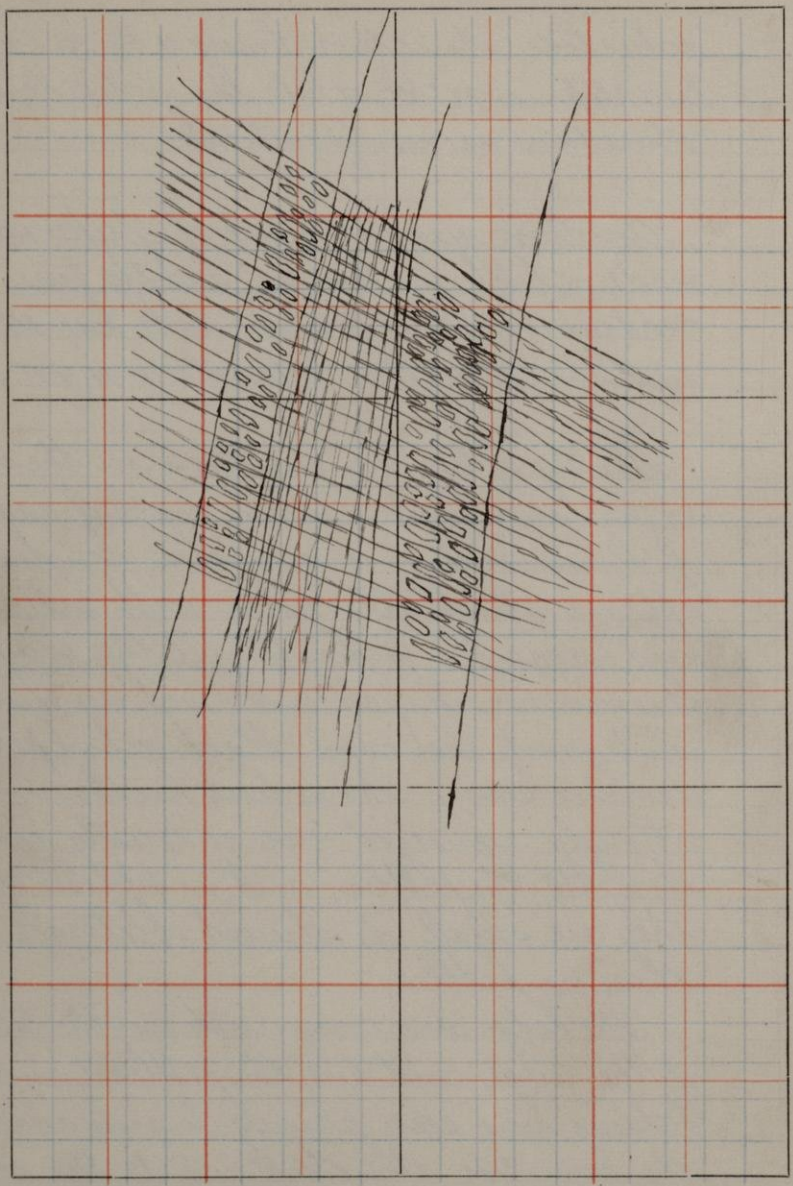
schistose structure being N. 55° W. The true dip is 75° W. while the schistose structure is nearly vertical.

Another measurement of strike was made a little farther on and the true bedding was here found to be here 10° E. and the schistose structure N 45° W.

Shortly after the junction in the roads — that is, about 5 miles south of east of Greenwood — a schistose conglomerate appears which alternates with silicious and sericitic schists all the way to Greenwood. The pebbles observed are mostly white quartz, but some black schist pebbles were also seen. The schist has been strongly squeezed — so intensely as to elongate the pebbles, and, in places where they are small, to almost obliterate them as pebbles

The ledge was examined on the top of the ridge, and here the pebbles and bedding were seen plainly to run across the schistose structure, while the rows of pebbles — that is, the conglomeratic

T. R.



beds — followed along parallel to the bedding. The elongation and distortion of the pebbles is plainly parallel to the schistose structure. The two lines of structure were observed to cross each other as plainly as could be, and is roughly represented on sketch on opposite page.

Several measurements of both the strike and that of the schistose structure were made, the first being determined by lines of pebbles.

Strike

(1) N. 10° E.
(2) N. 20° E.
(3) N. 30° E.

} Dip about 70° W.

Strike of schistose structure

(1) N. 45° W.
(2) N. 55° W.

} Dip vertical.

Sunday, July 28, 1889.
Greenwood (Laflin P.O.) to Deadwood.

At Greenwood most of the specimens were collected from the conglomerate already described. Here, as in the places just mentioned, the strike of the bedding and schistose structure are widely discordant. The pebbles are mostly of a white variety of quartz, some of which are plainly from fragmental quartzites, but some of which appear to be from white quartz veins. Also the conglomerate contains rare pebbles of ferruginous schist.

14815 Conglomeratic schist, showing both false bedding and schistose structure

14816 Conglomeratic schist, showing its manner of weathering.

14817 Green phase of conglomeratic schist of fine grained character.

14818-19 Conglomerate. In this conglomerate, although not shown in the specimens,

some pebbles are as much as a foot long.

14820 is one of these elongated large pebbles from this conglomerate.

14821 Ordinary pebbles from the conglomerate.

14822 a portion of a ferruginous pebble.

14823 a breccia found a short distance from Greenwood on road towards Deadwood. This breccia seems essentially like the conglomerate above described, only the pebbles are largely from a ferruginous formation instead of from pure fragmental quartzite.

14824 Black slate from a point a little farther on.

14825 Greenstone (diorite?) from a ridge a little farther along the road.

About 2 miles along the road from Greenwood toward Deadwood was found

ferruginous schists and white quartz interlaminated with it, which Newton mentions as occurring here and which he compares to the Lake Superior jaspers. He thinks these rocks are exactly like those jaspers so far as he can tell from the descriptions, only the quartz is white instead of red. All of this seems to me true to a remarkable degree, the rocks here appear to be exactly like the iron formation rocks of the Lake Superior district with the exception mentioned, and in the Lake Superior country I have seen the rocks in the ferruginous formation in which the quartz does not have the reddish color. The strike of the lamination of this rock is here N. 17° W.; the dip is 78° W.

14826 Ferruginous schist representing the normal character of the exposures at this locality.

14827 Shows a coarse sugary phase of quartz which is taken to be of a non-fragmental character and which is also

abundant

14828-29 Ferruginous bands in schist. These specimens represent the most ferruginous phases that could be found.

14830 A ferruginous band in which a good deal of secondary alteration has taken place.

14831 Green slate found in the valley near the wagon road between exposures of the ferruginous schists above described, which are found at a little distance on both sides of the road.

From the point at which these ferruginous schists are found to Perry village, "Uncle Sam Mine", the rock along the road is mostly slate like that before found, or a coarser siliceous slate. This slate also extends beyond Perry and at that place in the black slate the gold is mined.

Besides the later eruptives described by Newton, there are evidently old eruptives

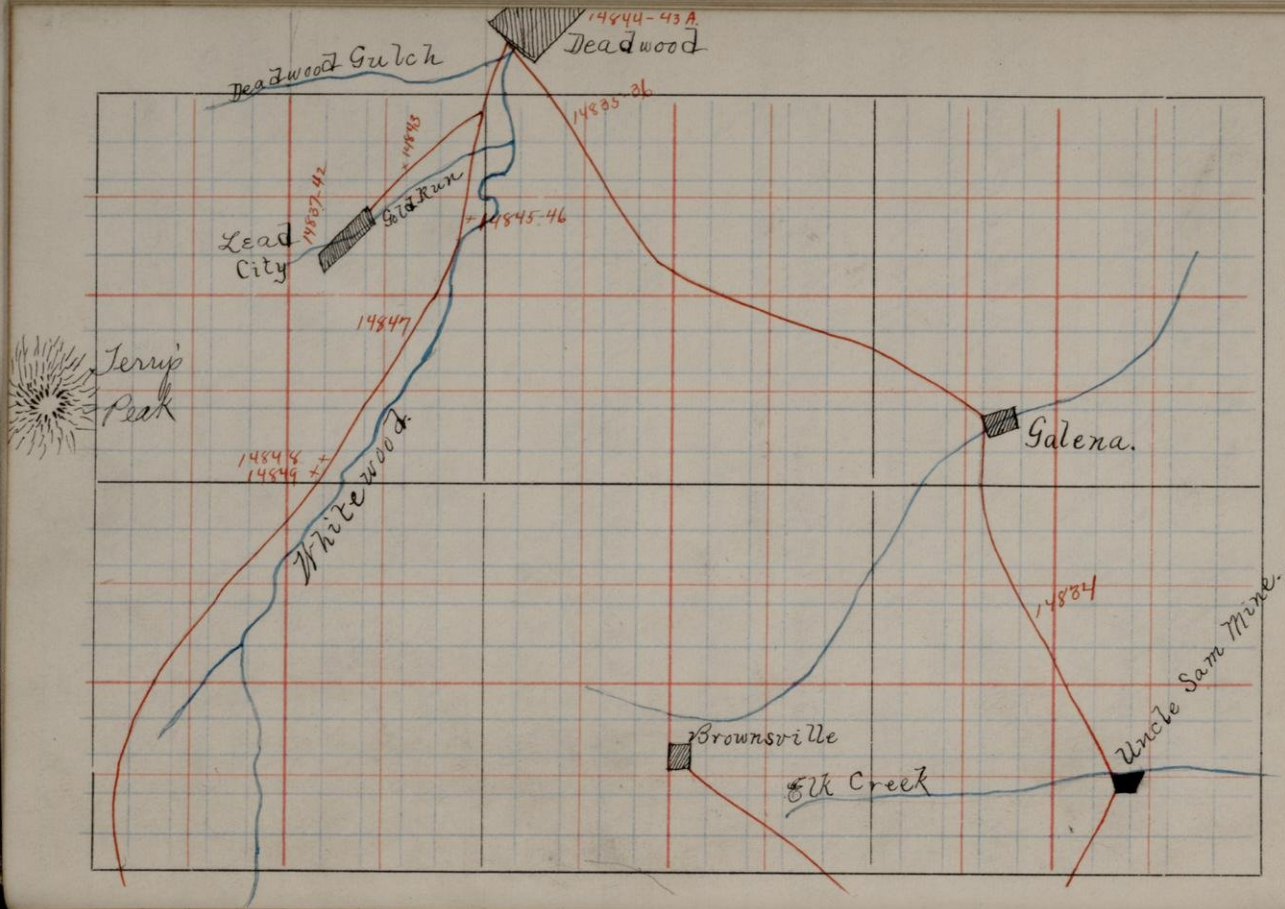
in the slates, one, 14825, having already been noted. Also what was taken to be schistose eruptives were found at several other points.

14832 represents a coarse phase of schistose eruptive, found a short distance before a road branches off to Brownville.

14833 Silicious slate; one of the coarser phases of. Taken a short distance beyond Brownville road.

14834 Diorite? From a high hill above spring, about half way between Uncle Sam Mine and Galena.

The white vitreous quartz like that in 14827, belonging to the supposed iron formation, is found in large blocks and in test-pits just west of 14834.
In this association of the iron formation rocks with old schistose ~~rock~~ eruptives we have another analogy between this county and the Lake Superior region.


14844-43 A.
Deadwood
Deadwood Gulch
14835.36
14845
14837.42
Gold Run
14845.46
Lead City
14847
Terry Peak
14847
14849 ±±
Whitewood
Galena.
T.
R.
14834
Uncle Sam Mine.
Brownsville
Elk Creek

14835 Rhyolite dyke largely exposed on side of road and cutting slates, about 1½ or 2 miles from Deadwood.

14836 The hardest phase of slate here found, which appears to be garnetiferous.

Beautiful dykes of rhyolite of various dimensions were seen cutting through the slates for the remainder of the distance to Deadwood. One particularly clearly defined is about 10 feet across. Most of them follow in a general way, as far as could be observed, the schistose structure of the slates.

The last part of the road to Deadwood was down a gulch in which placer mining had been extensively carried on. This gulch is steeply inclined all the way to Deadwood. After the gulch was struck the distance down the valley must have been at least 8 miles.

From the point at which the rhyolite was first seen it appeared to be almost

as conspicuous a rock as the slates. This is also true on the road from Deadwood to the Home Stake Mine. In this region this rhyolite must form a very considerable part of the body of the rock. At the Home Stake rhyolite and trachyte were seen in nearly horizontal flows resting upon the upturned edges of the slate. The clearness of the various flows is not uniform, and in places in the railroad cut back of the Home Stake the layers bow over the hills approximately parallel to their contours. In places the lava is beautifully brecciated. The flowage lines of this rhyolite are the most beautiful I have seen in a volcanic rock. In places the rock shows something of a columnar structure.

14837-38 Ordinary coarse phase of the rhyolite.

14839-40 Non-quartzose phases of the lava (trachyte) which shows beautifully the irregular banded and contorted flowage structure

14841 Trachyte showing dendritic markings. The very common thing in this exposure — the markings, being often in very beautiful forms along the irregular joints of the rock.

14842 Rhyolite breccia.

14843 Hornblende schist (schistose greenstone), from the wagon road about half way between Deadwood & the Home Stake Mine.

The ore of the Home Stake Mine is no more than a much oxidized and often more or less silicified variety of the slate. It is, however slate which is below flows of rhyolite. These flows are not now particularly thick but may have been of much greater thickness in the past. The ore is now certainly where there has been extensive percolation, an oxidation. The question arises whether the gold was originally contained in the late eruptives and has since been transferred to the slates, or whether the eruptive has perhaps only

been helpful in the oxidation of the sulphides originally contained in the slates by furnishing hot solutions. As bearing on this question is the presence & absence of similar eruptives where the ores are sulphides; i.e., are not free milling.

Monday, July 29, 1889.
Deadwood to Rochford.

This morning we first drove east on road going out of Deadwood to a place where the Paleozoic rocks were exposed. Mr. Knutzen of the Dakota School of Mines showed us a place where Carpenter had found marble pebbles in sandstone. So far as I could see the facts are that interstratified layers of limestone in the sandstone have oftentimes a nodular character.

14843A. represents this nodular limestone.

14844 Sandstone (Cambrian) of this locality. Is quite like a quartzite in places and is full of scolithus borings which are shown in the specimen.

Returning to Deadwood and going south toward Rochford the Slaty series is found to be very schistose and crystalline

14845-46 schists, represent two phases of this rock

at the same ledge.

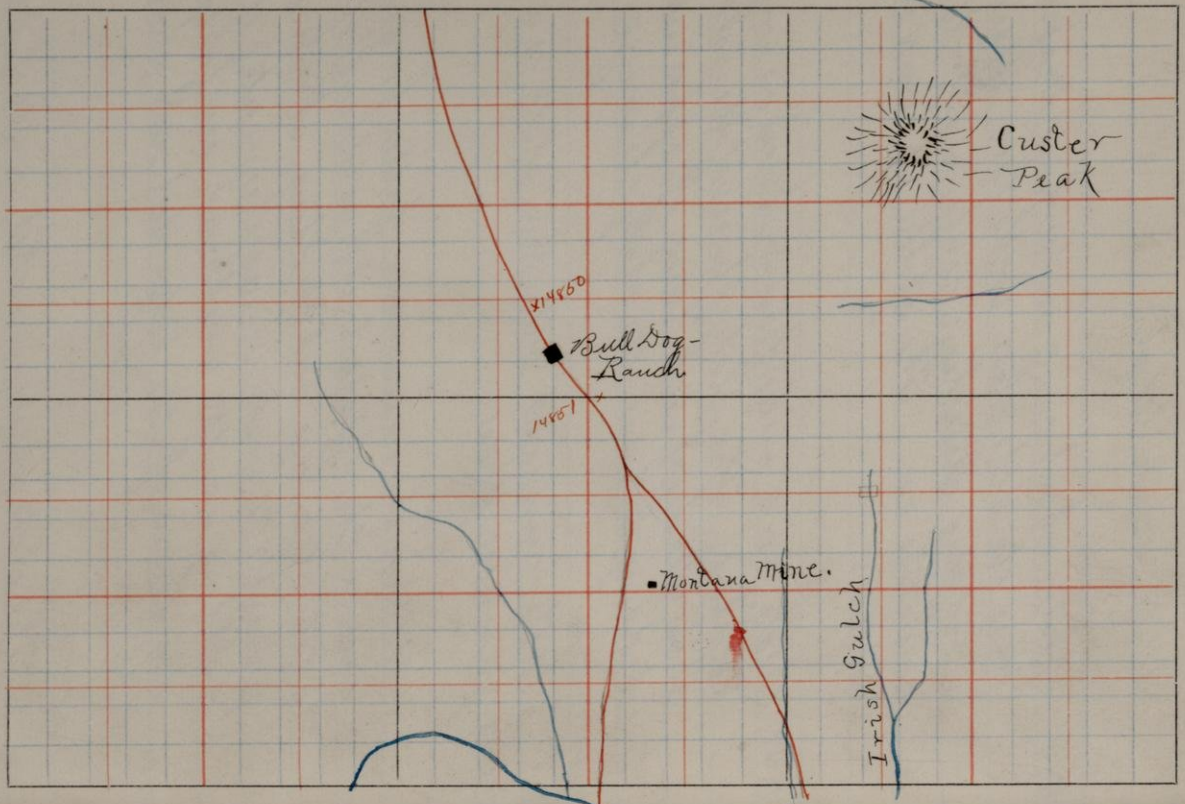
14847 Slate, about 2 or 3 miles from Deadwood. Here the schistose rocks have apparently a bedding structure conformable to the schistose one. The strike is here N 23° W; dip 60° E.

14848 Slate, 4 or 5 miles from Deadwood on way to Rockford. The slaty phases of the rock here show clearly faint lines of apparent bedding across the slaty cleavage.

Interlaminated with this slate is a more
14849 quartzose phase.

Although numerous fallen fragments showed the apparent discordance of the slaty cleavage and bedding, it was not possible to make measurements of true bedding as the weathered surfaces on the faces of the ledge did not show this.

The slate series, so-called, south of Deadwood is more crystalline and hornblendic


Custer
Peak
14850
Bull Dog-
Ranch
14851
Montana Mine.
Irish Gulch
T.
R.

than in the drive of yesterday from Greenwood to Deadwood.

Perhaps 7 or 8 miles from Deadwood on the road to Rochford the slates disappear and the sandstone of the Potsdam are found. The high hills of this sandstone on the left of the road were often capped with a layer of more or less columnar trachyte, which here gives crests with perpendicular walls to slopes of a more gentle nature and which are grass covered.

14850 Slate, about one mile north of Bull Dog Ranch.

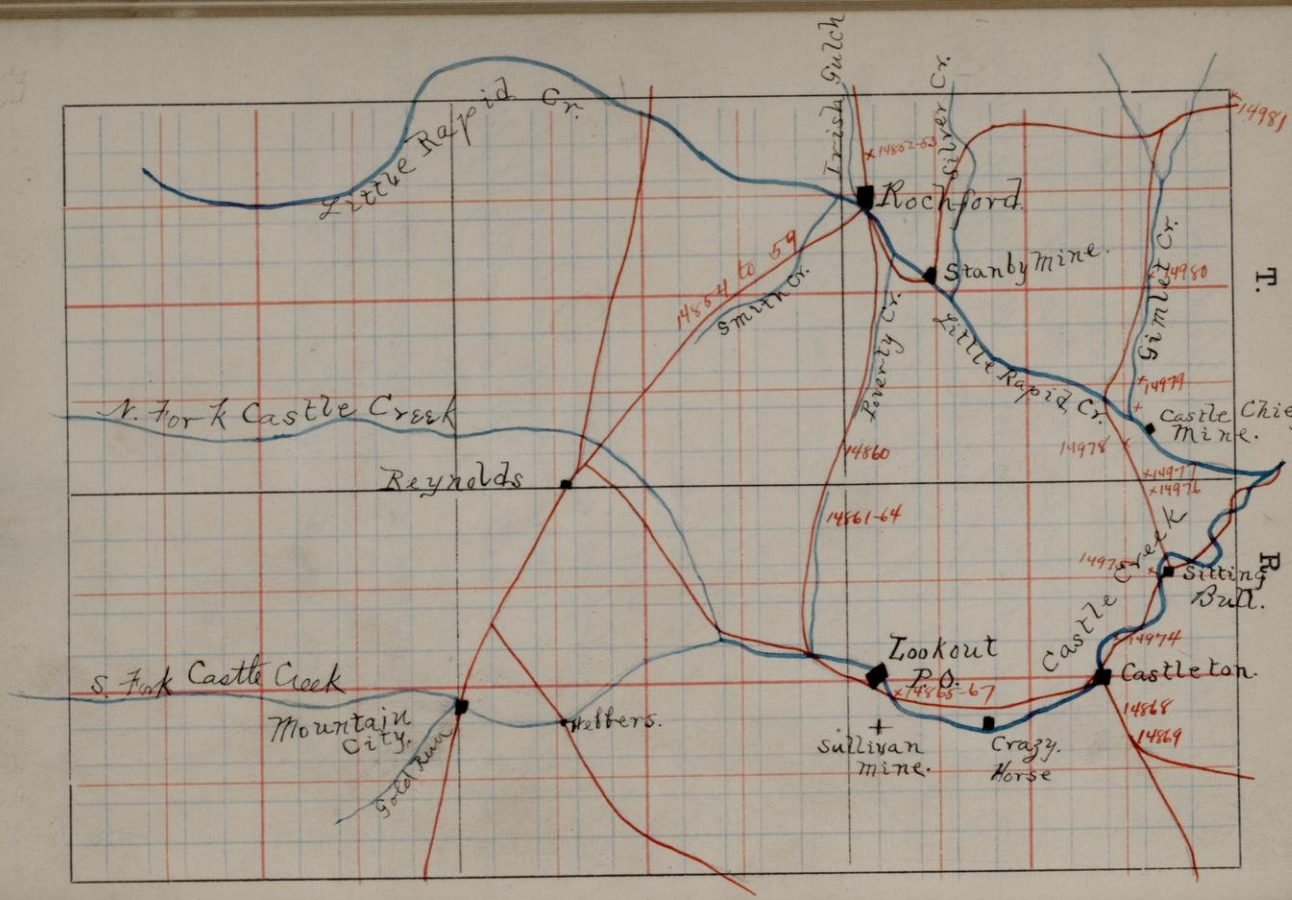
14851 Schist forming crowning point of a long continuous ridge. The ridge runs parallel to the schistose structure of the rock, the strike of which is N. 5° W; dip 85° W. 14851 is about 2 miles south of 14850.

14852-53 Pyritiferous and graphitic slate, on road about ½ mile north of Rochford.

after reaching Rockford we drove southwest of this place for about 2½ or 3 miles in the Older series of the Archaean rocks as mapped by Newton. We could not see that they were materially different from the slate series in which we have been all day. The rocks are here not at all more crystalline than those in the slate series about Deadwood.

14854 Coarse schist.
14855 Fine fissile slate
14856 Coarse schist.
14857 Garneti-ferous slate
14858 Slate, showing bedding inclined to cleavage.
14859 Very coarse actinolitic or anthophyllitic schist, associated with 14858.

The above specimens are taken from southwest to northeast coming into Rockford on the road just mentioned.


Little Rapid Cr.
Trisha Gulch
Silver Cr.
Rochford.
14862-63
14981
Stanby Mine.
14854 to 59
Smith Cr.
Liberty Cr.
Little Rapid Cr.
Gimlet Cr.
14980
14979
Castle Chief Mine.
N. Fork Castle Creek
Reynolds
14860
14978
14977
14976
14861-64
Castle Creek
14975
Sitting Bull.
Lookout P.O.
14865-67
Castleton.
14974
S. Fork Castle Creek
Mountain City.
Gold Run
Hebbers.
Sullivan Mine.
Crazy Horse
14868
14869
T.
R.

Tuesday, July 30, 1889
From Rockford to Hill City,

14860 Schist, from top of high hill on divide between Rockford and Look Out postoffice. Strike N. 30° W.; dip, vertical. Garnetiferous and hornblendic?

14861 Slate } From deep in valley, about
14862 Schist } one mile south of 14860.
Strike of schistose structure, N. 30° W. Strike of lines of bedding across it difficult to accurately determine, but about N. 65° W. Dip of schistose structure about vertical, and of true bedding also nearly vertical, about 80° N.

14863 Garnetiferous schist. Although this rock is in the slate series it appears clearly to be garnetiferous. This is one of the distinctions upon which rocks are excluded from the slate series according to Newton.

14864 Green schist (Schistose greenstone?).
14863-64 are taken before Look Out postoffice is

reached.

A short distance west of Look Out postoffice the road turns east. After passing the postoffice a little way is found
14865-66 a coarse crystalline phase of schist

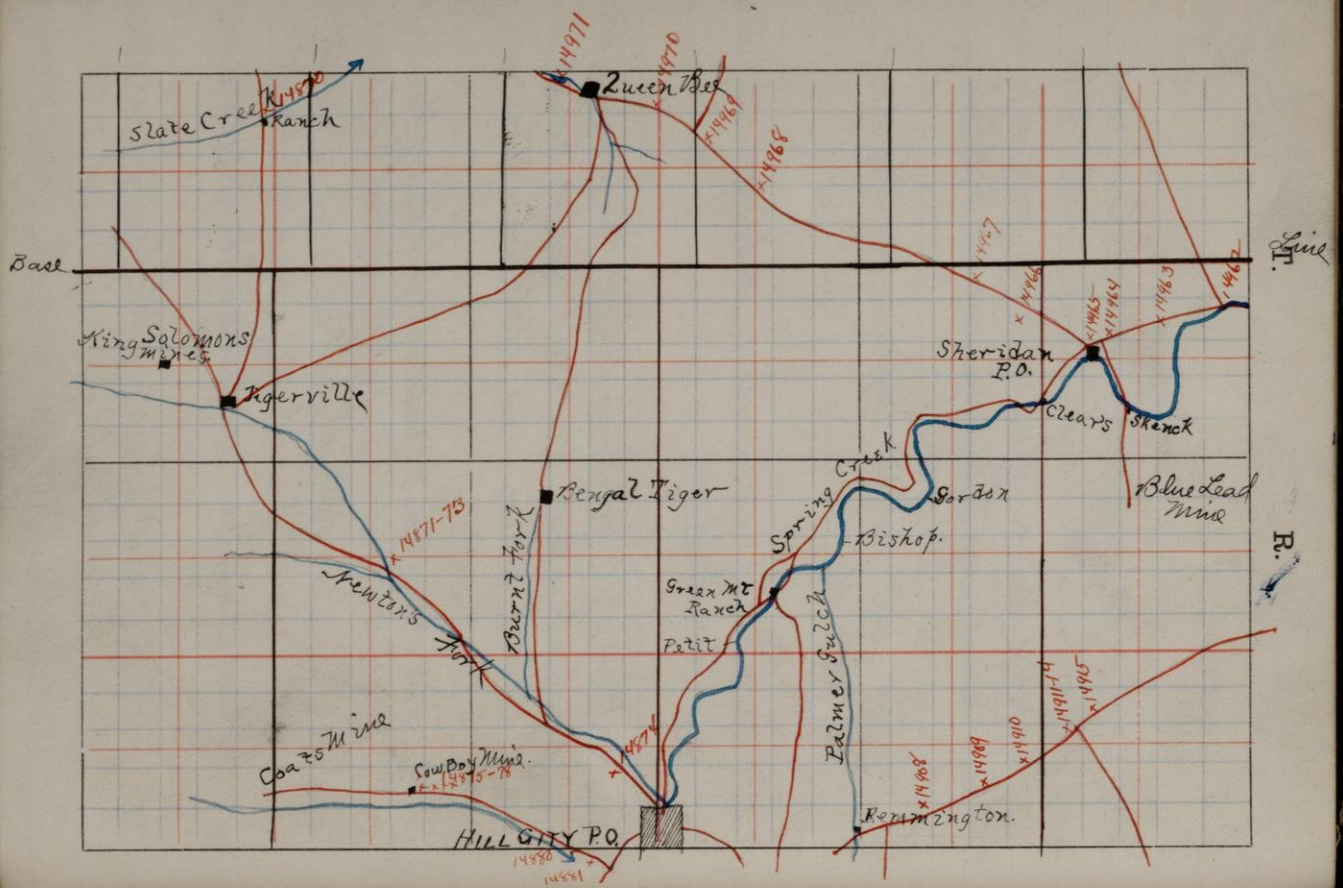
The slate again appears on the next ridge to the east.

14867 Slate again shows a schistose structure and true bedding.

This slate continues all the way to the point at which the road turns south at
14868 Castleton, where 14868, slate, was taken.

The cleavage here takes place with about equal readiness parallel to bedding and to the cleavage structure. As a result of this it is practically impossible to obtain any but rectangular specimens

At a small place a little farther on the cleavage of the slate was found to be N 15° W; the dip 70° W. At the same ~~time~~


Base
Line
T.
R.
Slate Creek Ranch
Queen Bee
King Solomons Mines
Tigerville
Bengal Tiger
Sheridan P.O.
Clears
Skenck
Blue Lead Mine
Spring Creek
Gordon
Bishop.
Grass Mt Ranch
Petit
Newtons
Burnt Fork
Palmer Gulch
Coz to Mine
Sow Boy Mine
HILL CITY P.O.
Remmington.
14971
14970
14969
14968
14967
14966
14965
14964
14963
14962
14871-73
14874
14875-78
14880
14881
14988
14989
14990
14991

place the true bedding is N. 65° E. On account of the small size of exposure this determination may have quite a large error.

14869 Slate at this point.

Throughout the forenoon's drive; i. e., to the creek about half way between Castleton and Tigerville the rocks showed both slaty cleavage and true bedding. The first part of this distance may possibly be in the older series as marked by Newton, but no difference could be observed between the rock there and what has been seen before. To this point the lines traveled have not carried us to a rock more crystalline than those about Deadwood which are included in Newton's slate series.

14870 Slate, from ranch half way between Castleton and Tigerville.

The slates continue practically unchanged all the way to Tigerville.

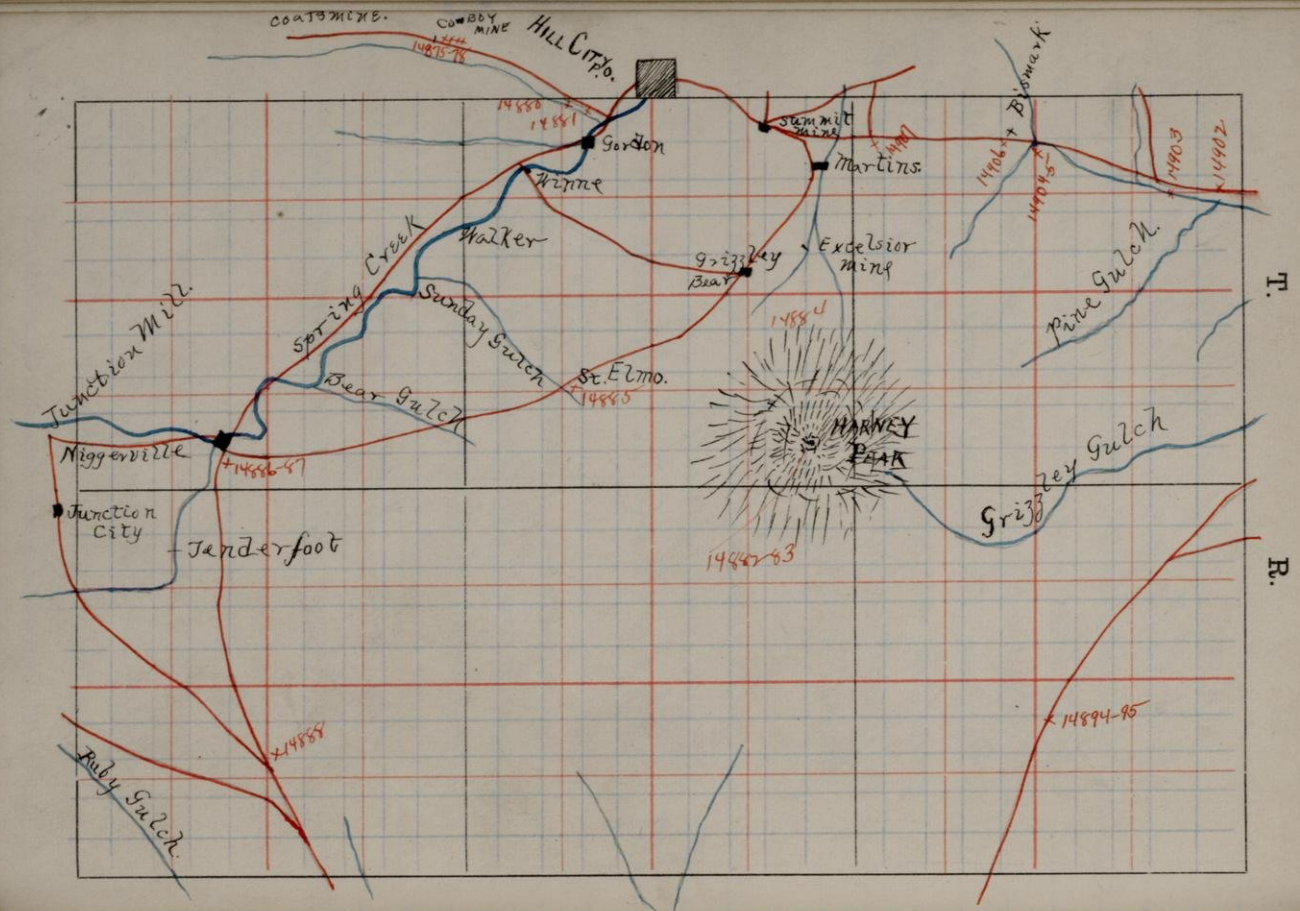
Shortly after passing this place, however, about half a mile towards Hill City, the ledges in places becomes more massive. One of these massive ledges was found to be apparently almost conglomeratic. However, the coarse phases and the micaceous quartzite are interlaminated with as finely a fissile slate as any which has been found.

14871 Conglomeratic phase of rock at this point.
14872 Micaceous quartzite
14873 Finely fissile slate. All from the same place.

Continuing toward Hill City the slates again become predominant, and here they again show bedding across the cleavage.

About ½ mile before Hill City was reached
14874 the slate in places contains coarse mica

After reaching Hill City we drove west about two miles into the area which is mapped as belonging to the older series. The schists were found to be decidedly more crystalline than in any area before


Coal Mine.
Cowboy Mine
Hill City P.O.
14880
14881
Gordon
Wynne
Summit Mine
Martins.
Bismark
14806
14804
14903
14902
Walker
Spring Creek
Grizzley Bear
Excelsior mine
Junction Mill.
Sunday Gulch
St Elmo.
14885
Bear Gulch
Pine Gulch
14884
Harney Peak
Grizzley Gulch
Miggsville
14886-87
Junction City
Tenderfoot
14887-83
14888
Ruby Gulch
14894-95
T.
R.

traversed. At the westernmost point reached the rock is a coarse mica schist which in places carries coarser layers which are strongly garnetiferous. In this schist is located the Cow Boy and other tin mines. The schists in which the tin is said to occur is apparently but an altered phase of the country rock — places in which there have been more or less percolation. Near the western point reached a coarse granite vein is found in the schist.

The following specimens are taken from west to east from farthest point reached — 2 miles from Hill City.

14875-76 Coarse phase of schist, from farthest point.
14877 Fine phase of mica-schist.
14878 Granite vein in same
14879 Decayed mica-schist, showing cross bedding
14880 Decayed garnetiferous schist from test-pit at Cow Boy Mine.
14881 Mica-schist near Hill City.

Throughout the course traveled this day the slates have all shown either a vertical dip or a dip to the east. This

eastern dip varies from about 75° to 85°, although in places being flatter than this. It appears to be the case, so far as I observed, that the slates and schists of Newton are not separated by any sharp break, but that the slates become coarser and more crystalline and gradually pass into the schists. This appearance, however, may be deceptive, but if there are two series, the line of separation must be more irregular and vary in places a good deal from the line as mapped.

Wednesday, July 31, 1889.
From Hill City to Custer City.

Our road from Hill City to Custer City carried us within about 2 miles of Harney Peak. We left the road here and ascended the peak.

Returning to the road, it swings around the highest land, which is inaccessible to roads — we followed it to Custer City. Practically the whole distance, with perhaps the exception of 2 or 3 miles just after leaving Hill City and another 2 or 3 before getting into Custer City, was along the border of the granite area as outlined by Newton. Our trip to Harney Peak carried us well in to the granite area.

The facts of distribution, so far as I could observe them in this trip, were as follows: Within a short distance of Harney Peak as traveled the rock is almost wholly granite. Not only is this so, but the peaks about seem plainly to be

granite. The day was hazy so that it was difficult to see clearly the character of rocks at any considerable distance. However, from the points and peaks about Harney the granite does not entirely exclude the schistose rocks.

14883 Here 14883 was obtained. The granite of the peak is mostly so coarse that the individual constituents could easily be determined without instruments, the individual constituents averaging from ½ inch to an inch across, while many coarser masses and vein-like areas are much coarser, the mineral constituents being several inches in diameter.

14882 was selected as a fine-grained phase.

Almost immediately upon leaving the bare granite peaks the schist becomes more noticeable, and when a mile away from Harney Peak to the northwest the schist has become predominant, although carrying numerous granite veins or dykes.

It does not seem to me even certain that the schist does not approach in considerable quantity nearer than this to the peak.

The road followed from Martin's to within 3 miles of Custer was particularly favorable to a study of the relations of the granite and schists. To the left of the road a short distance are the high peaks of the granite core, where at least the granite is in equal and probably in a quantity which preponderates over the schist, although it is impossible to tell what part of the unexposed area is granite and what part schist. Upon the right of the road the schist is clearly predominant, although it contains numerous large dykes or veins of granite many of the 15, 20, 50 or even 100 feet across. These granite dykes upon account of their more resistant properties stand out in the schists as strongly marked ridges, and it is this feature which strongly suggests that the depressions in the main granite area are occupied in part at least by

schists. The projecting ridge-like character of the granite in the schist area is finely shown along the road 2 to 3 miles northwest of Custer. Here they run nearly parallel to the road, — i.e., northwest and southeast — in other words, parallel to the side of the main granite body adjacent.

The relations of the granite and schist seem to me not to be expressed by the sharp lines shown upon Newton's map, but rather by transitions of a certain kind.

In the central core of Harney Peak the granite contains a little schist. In passing away from the peak the granite contains more and more schist. After a time the schist and granite are in equal quantity. Then the schist is predominant and the granite in it is in large ridges. These ridges become smaller and fewer as the granite core is receded from, although they retain a dyke or vein-like character.

Finally the granite dykes or veins are inconspicuous. As they thus become infrequent it also appears to be the case that they lose their exact lithological likeness to the main granite core and become more pegmatose, that is, become more like vein quartz which contains a little quartz and feldspar.

The fact that the schist is contained in irregular areas in the granite, never in ridges or in any regular form, while the granite in the schist is always in ridge-like forms is very significant it seems to me.

The foregoing facts would seem to be best explained by supposing the schist to be earlier than the granite and supposing the granite to be eruptive. Harney Peak is the center where is a great granite boss. Even this granite, however, catches within it some schist. (This fact is noted by Newton.) In passing away from this center this granite mass becomes less and less solid and here and

there are large irregular schist areas. Far enough away from this center the schists as a whole are not shoved aside, but are cut by numerous large dykes which are connected with the main granite mass, although perhaps not at surface. Then the granite ridges in the schist would be regarded as eruptive, although as the dykes reach a considerable distance from the center leaching action becomes more prominent, and here the dykes partake more largely of a vein character. Emmons and Carpenter regard them as water-deposited. That water action has a good deal to do with the formation of these very quartzose ridges, is still farther suggested by the fact that at a greater distance from the granite area are large veins of pure white quartz which contain practically no feldspar and mica.

The schists are naturally metamorphosed by the granite, and when the granite masses are large they may even dissolve considerable areas of the schist,

or when the included schist is not wholly dissolved, there may be gradations between the two rocks. Such a gradation of the granite into schist is shown by 14890-91. along the contact of the granite and schist numerous garnets were observed. This is a contact mineral and further suggests the intrusive nature of the granite.

If the granite ridges included in the schists are really in the nature of veins, they ought to show something of the parallel arrangement so characteristic of vein formation; whereas they show nothing of the sort, but, on the other hand, when of any considerable size, are exactly like the granite of the main area. Away from the granite, where the rock is very quartzose, the vein character of the rock may come in as above suggested.

All the foregoing accords with what has been before said in regard to the origin of the slates and their relations

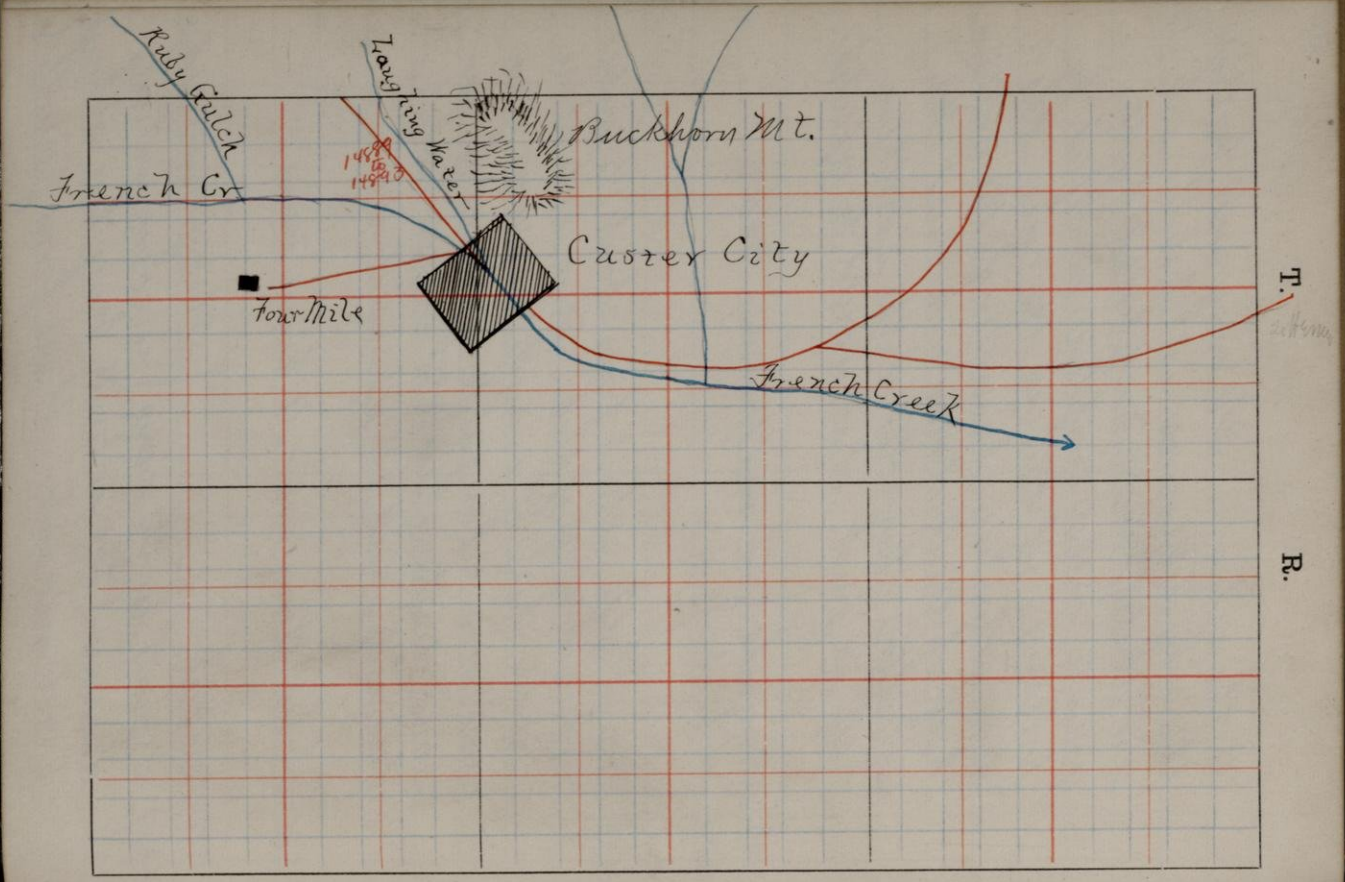
to the schists. It may well be that the only difference is that the schists are slates metamorphosed by the granite, or else emptives modified by pressure. If this is the case, the non-schistose character of the northern half of the Archaean area and the schistose character of the southern half is just what would be expected.

14882 Granite } From Harney Peak.
14883 Schist }

14884 Hornblende schist, from about 1½ miles northwest of top of peak. This schist is cut by veins of granite like 14878. One was seen alongside of the cliff for some distance in the schist, about 4 feet wide, and very persistent.

14885 Schist from near St. Elmo Mine.

14886 Schist. } This granite ledge
14887 Granite in the same } is comparatively narrow, the schists being here strongly predominant. These form junction


Ruby Gulch
French Cr
Laughing Water
Buckhorn Mt.
Custer City
Four Mile
French Creek
T.
R.

of road at point about 3 or 4 miles northwest of Custer

14888 Hornblende gneiss, about half way between Tenderfoot and Custer.

14889 Hornblende schist, in contact with granite vein; about 2½ miles northwest of Custer.

14890-91 Schist and granite together along the contact zone, from the same place.

14892 Feldspar } From coarse phase of granite
14893 Mica } at this same ledge.

This ledge of granite projects prominently above the surface of the country, so that the eye follows it for a long distance. On both sides it is faced by schists, the ledge being from 6 to 20 feet wide. It shows no vein structure whatever. The granite in places contains schists within it, the relations being of the most complicated nature. One of the specimens shows the merging of one into the other.

Thursday, August 1, 1889.
From Custer City to Etta Mine.

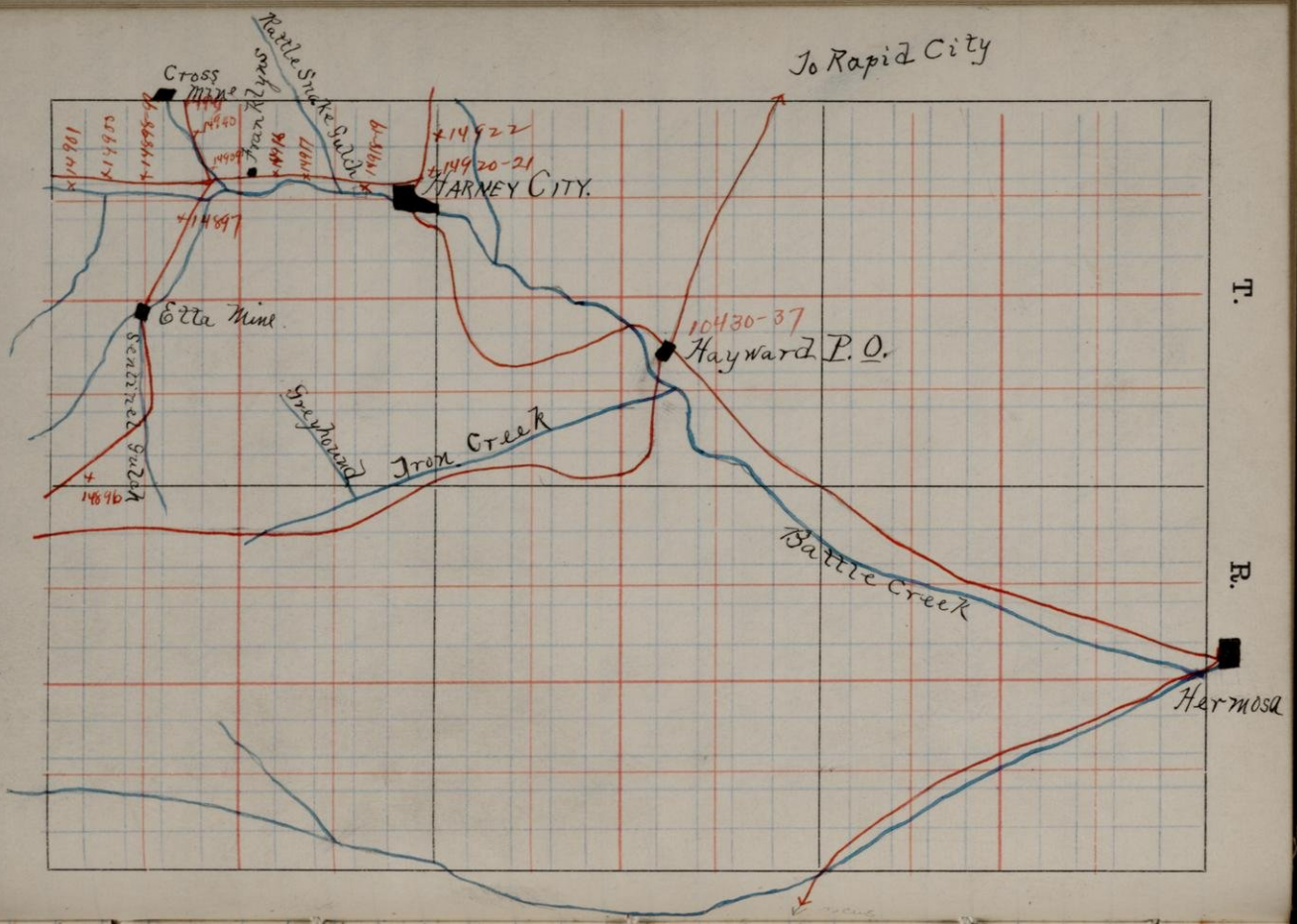
The forenoon was spent in driving along the curving road, running on the ~~west~~ east side of the high granite peaks, to Etta Mine. For several miles the same phenomena seen going into Custer were repeated; that is, numerous granite ridges were found cutting through the schiste. In one place, about 2 miles from Custer, 15 parallel ridges were counted upon both sides of the road within an extreme distance of 40, or at most, 60 rods. The ridges here vary somewhat in direction from those west of Custer, judging from general directions and without instrumental measurements. The direction appears to be nearer east and west.

The road from Custer is first nearly east. As the road swings northeast we found ourselves in the almost slate-granite area, and this rock is predominant until the Etta Mine is reached. On the way were here and there small

masses of schist in the granite, and the unexposed areas may be more largely composed of schist than one would expect; but so far as exposed the area is essentially a granite one for this distance.

West of the granite area in the journey of yesterday the schists dipped west away from the granite. During the morning the schists dipped southeast and east, that is, again away from the granite.

Upon passing the Etta our road took us into a schist area and here the schists were almost vertical, although dipping for the most part at a high angle toward the schist area. Even here, as everywhere before, near the granite the schist has its readiest cleavage parallel to the granite area. Just before and after passing the Etta mine the schists dipped away from the granite. These dips away from the granite are usually at a low angle, this being normal for the


To Rapid City
Cross Mine
Rattle Snake Gulch
Frank Lyon
HARNEY CITY.
Etta Mine
Hayward P. O.
Scanlon Gulch
Greyhound
Iron Creek
Battle Creek
Hermosa
T.
R.

region. All of the above facts strongly suggest a laccolite structure for this region.

14894 Fine-grained granite, from about the middle of the east side of the main granite area.

14895 From a small layer of schist in the above

14896 Coarse hornblende schist. From first considerable area of this kind of rock found in passing from granite core in perhaps 2 or 3 miles south of Etta Mine.

14897 Hornblende-mica-schist. Just after passing Etta Mine — at the fork in the streams.

14898-99 Garnetiferous and biotitic schists, about one mile west of point at which the road turns west along Battle Creek.

The afternoon was spent in the region northwest of the Etta Mine, the course of travel being, after crossing

Battle Creek, west nearly to Palmer's Gulch; thence north to the road which runs northeast from Summit Mine for about 3 miles; thence back to Etta Mine. Numerous specimens were taken until the point was reached where we turn south from the Rockerville road.

A short distance west of the Etta Mine the schists were found to be dipping away from the granite core at a low angle. This continued to be the case for the entire distance traveled. These low dips were, however, most marked on the road running west to Palmer's Gulch. At one place measured they were as low as 30° to the north, and at other places were observed even flatter than this, although the average dip to the north along this road is about 45°.

The roads followed have bounded the granite core as mapped by Newton. From the foregoing we see that the schists dip away from it on three sides,

the west, east and north. Upon the south side this relation may also prevail although the road was not so located that this point could be readily determined. It is possible, and indeed probable that the several large detached granite areas south and southeast of the main area have interfered with the regular laccolite structure on this side. Along the road west from the Etta the schists were as crystalline as could well be the case — coarse hornblende and mica schists. At the turn north and the drive northeast the schists were observed to become gradually less crystalline in appearance, and at the last point examined — the place turning south — the rock had become in places a micaceous quartzite which appears to be conglomeratic. At one other place, Bismark Ranch, a possible conglomeratic character was noted. However, the least crystalline phases of rock found in the course traveled is still very crystalline. Large granite veins

were observed in the crystalline schists along the road west to Palmer's Gulch, and even at the most northeasterly point reached; but on the northern road they were smaller and less important.

The indications are that, as suspected and before stated, the crystalline schists are found about the granite instead of as mapped by Newton. This point is to be farther examined.

14900 Coarse mica-schist
14901 Hornblende-schist
14902 Fresh mica-schist.
14903 Granite forming vein in the schist.
The above are taken in order between the turn west at Battle Creek and Bismark Ranch.

14904-5 Staurolitic and garnetiferous mica-schist. From just east of Bismark Ranch. The three minerals, mica, garnet and staurolite are associated

in a peculiar manner.

14906 Mica-schist containing elongated boulder-like masses of a coarser schist in a finer variety. Is it possible that these laminated elongated masses represent pebbles of boulders?

14907 Hornblendic mica-schist. From point where we turn north toward the Remington Ranch.

14908 Mica-schist. From point at which turn was made to the east near Remington Ranch.

14909-10 Schists, taken between last point and point to the east at which we turned south

14911-12-13 Quartzites and conglomerates. From point at which the southern turn was made.
14914 This rock is cut by a granite vein, 14914

14915 Mica-schist. From short distance east of specimens 14911-14. These rocks are

as schistose as are the schists 14909-10, although between them are the less crystalline phases 14911-13.

Friday, August 2, 1889.
From Etta Mine to Rockerville & Rapid City.

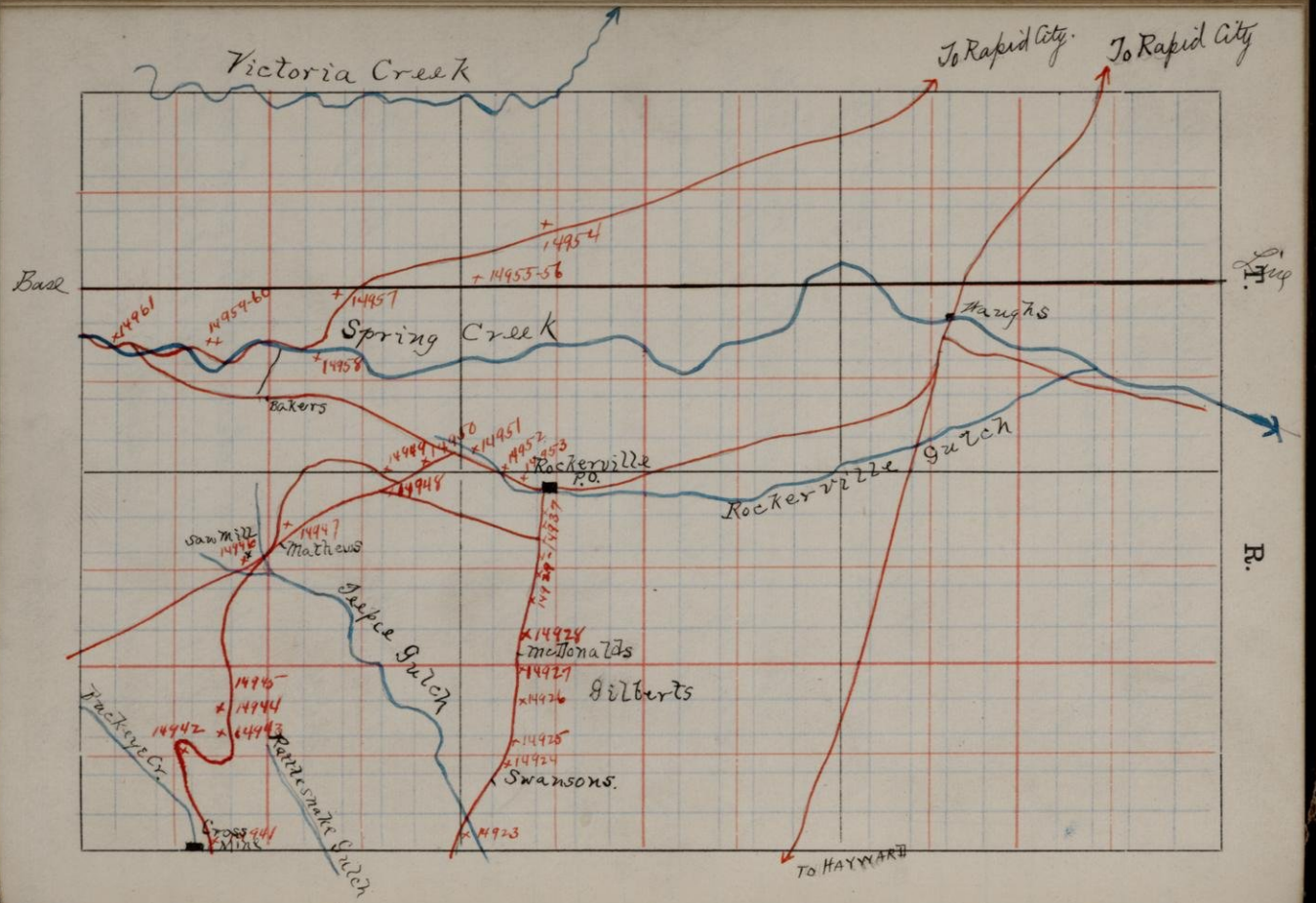
This day I went on foot from Etta Mine by the east road to Rockerville. Professor Hall with the team went on the west road, meeting me at the latter place.

14916 Garnetiferous mica-schist. A short distance east of Franklyn's.

14917 Staurolitic mica schist, a little farther along.

14918-19 Two phases of staurolitic and mica-schist which are adjacent to each other and interlaminated.

14920 Garnetiferous hornblende-schist or


Victoria Creek
To Rapid City.
To Rapid City
Base
T.
Twp
R.
Spring Creek
Bakers
Haughs
Rockerville P.O.
Rockerville gulch
Saw Mill
Mathews
Triple Gulch
McDonalds
Gilberts
Swansons.
Jackson Cr.
Rattlesnake Gulch
Cross Mine
TO HAYWARD

gneiss. At point at which road turns north toward Rockeville at Harney City. The exposure contains small grains
14921 of quartz & granite 14921. These two are interlaminated and the whole makes a typical gneiss like those found in the Lake Superior region. The strike of this gneiss is N. 70° W; dip 60° N.

14922 Hornblende schist. about 1/3 mile north of Harney City.

14923 Staurolitic and garnetiferous schist. One mile north.

Between 1 1/4 & 1 1/2 miles north of Harney City the strike and dip were taken and found to be: Strike N 65° W; dip 75° to 80° W. In this vicinity was seen a coarse granite vein or dyke about 20 feet wide.

14924 Mica-schist. a little further on the road; at Swanson's Ranch.

14925 Mica-schist. About 1/3 mile or a mile north of Swanson's. Strike N. 40° W; dip, 80° NE.

14926 Granite. From vein about half way between Swanson's and McDonald's.

14927 Mica-schist. Just south of McDonald's Ranch. Strike N. 40° W; dip 80° NE.

14928 Garnetiferous mica-schist. Just north of McDonald's.

Here is the first place in which cleavage in two directions is noted. The cleavage and cross-lamination are here beautifully shown by the specimen. The grain cleavage is N. 35° W. and dip vertical. The cross-lamination is almost perpendicular to this, as shown by the specimen.

14929 Ordinary phase of mica-schist at the same place. This also faintly shows the cross-bedding.

14930 Garnetiferous mica-schist. a little farther on. This is picked out as being a phase particularly rich in garnet.

14931 Mica-schist. a little farther on.
14932 Mica-schist containing pebbles.
14933 Mica-schist, showing both bedding and cleavage
14934 Compact phase of mica-schist. From the same place as 14933.
14935 Mica-slate. a little farther on.
14936 Mica-slate. About ½ mile south of Rockenville.
14937 Mica-slate at Rockenville.

The above specimens 14931-37, inclusive, are all taken between McDonald's Ranch and Rockenville

(14938 skipped) The following specimens were collected the same day by Hall.

14939-40 Garnetiferous mica-schist. ¼ mile north of intersection of roads north of Etta Mine.

14941 Mica-schist. ½ mile north of junction

of these roads

14942 Mica-schist. ⅔ mile north of intersection, on divide between the two gulches

14943 Garnetiferous mica schist. Just after entering Rattlesnake Gulch.

14944 Quartzite. Found in a broad belt forming the highest hill crossed. The ridge seems to run about in the direction of the schistose structure.

14945 This quartzite is flanked by mica schist.

14946 Mica-schist, From junction of the two streams which make Teepee Gulch, about 50 rods below Matthew's saw mill.

14947 Mica-schist. about 100 rods east of saw mill, near the road.

14948-49 Coarse hornblende schists. At intersection of road about 1½ miles west

of Rockerville. A broad ridge of this rock is on the north side of the road.

14950 Mica-schist. About half way between location of 14948-49 and the Sheridan stage road

14951 Mica-schist. At top of hill west of Rockerville on the Sheridan road.

14952 Coarse schistose greenstone. Short distance west of Rockerville. The ridge is several rods wide along the road.

14953 Mica-schist or slate. At the west side of Rockerville.

Immediately upon leaving Rockerville the Cambrian sandstone is encountered. This with the limestone above here finely show the "inner escarpment" of Newton. From Rockerville to Rapid City the parallel arrangement of the ridges in correspondence to the formations are nicely shown

running approximately north & south.

The 3 sections made north from the Harney Peak area, as outlined by Newton, into the slates does not at all bear out the statement that the slate series here comes next to the granite. Upon the contrary the rocks here for several miles adjacent to the granite are as completely crystalline schists as any which have been found in the so-called Archaean area. They contain numerous large garnets, staurolite, large flakes of mica, are hornblendic, and near to the granite area might well be called in places a hornblende-gneiss. However, in passing away from the granite the rocks become less and less crystalline, until they pass into the ordinary mica-slates of the slate area. This transition is particularly well shown by the section from Harney City to Rockerville. The above sections but further illustrate what was before mentioned

as probable from other evidence, that the schists surrounded the granite instead of being a separate series. Also the crystalline schists adjacent to the granite on the east and west sides grade into the slates.

The abrupt slopes or cliffs of the schist ridges face inward toward the granite. As a general thing the slope of these same exposures away from the granite are quite gentle to rather steep, depending upon the dip of the schistose structure of the rocks away from the granite. This is just what would be expected if the granite is a great intrusive boss in the schist. The granite and schist in this respect but repeat what is shown by the Pre-Cambrian rocks and the Paleozoic formations as described by Newton. The latter are mentioned by him as having a series of inward facing walls and gentle outward slopes. This relation of the schist and

granite was best shown on the north side of the granite area.