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Precambrian of Ralston South Boulder and Coal Creek, Colorado: [specimens] 15901-15976. No. 101 1890

Lakes, Arthur, 1844-1917

[s.l.]: [s.n.], 1890

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U. S. GEOLOGICAL SURVEY
FIELD SECTION BOOK

No. 101

July 1890

^{Ralston}
Pre-Cambrian of South Boulder
and Coal Creeks, Colorado.

Arthur Lakes.
15901-15976

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 $2 \times 2\frac{1}{2} \times \frac{1}{4}$ 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.

Report on the Precambrian Rocks
of South Boulder & Coal Creek

Colorado

By Prof A Lakes

July 7th. 1890

Book #101

strike SSW

1st Exposure of Pre Cambrian rocks

1/4 mile from entrance of S Boulder Canon

Fig 1



S. Boulder Canon

Exposure No 1 of Pre Cambrian series

- ✓ No 15911 Rusty conglomeratic or brecciated quartzite from exposure 1 of the quartzite middle upper series 1/2 mile up the creek from entrance of Canon on S. side of river in Railway cut

- ✓ 15912 from same series as 15911
- 13 do.
- ✓ - 14 do.
- ✓ - 15 do, micaceous quartzite
- ✓ - 16 garnetiferous schist a few yards below 14
- 17 below 16
- ✓ - 18 conglomeratic reddish quartzite upper portion of the Schistose or lower pre cambrian series
- 19 Lower portion of the schistose series (garnetiferous schist)
- ✓ - 20 Lower series i.e. Schistose series
- ✓ - 21 Near lower portion of lower schistose series
- 22A Garnetiferous mica surrounded lens of quartz in mica schist series
- 22B same character
- ✓ 23 granitic gneiss obscurely bedded ^{shaly} ~~massive~~ on north bank of river separated from probable contact with the Schists by crown of stream for ^{feet} 100
Bedding & dip conformable with Pre Cambrian

- ✓ 15924 Coarse granitic veins traversing the gneiss granite of 15923 both conformably with probable bedding and also with cleavage
Exposure No 2 of ^{the} Cambrian series
- ✓ 15925 Pinkish White mica schist. Lower schistose series exposed further up stream about quarter to $\frac{1}{2}$ a mile on North or right bank from 1st exposure and $\frac{3}{4}$ mile from entrance. These beds probably 100 feet thick appear to within a few feet of contact with granite gneiss.
- 15926 Same
- 15927 below 925 and nearest to granite purple schist color perhaps due to less weathering than 925
- ✓ 15928 Same
- 29 Same
- 930 Red iron matter in veins & interlamination with Schistose series
- 931 Belongs to lower Schistose series
- ✓ 15932 Conglomeratic quartzite or gneiss? stratum 3 feet thick within 15 feet of the Granite Gneiss. (nearest contact found) The interval occupied by P.C. Schist.
- ✓ - 33 do
- ✓ 15934 ~~Massive~~ granitic gneiss. probably bedded in immediate contact with Schistose series & ~~probably~~ conformable with it

- 15935 Coarse granite vein in the Mammoth
gneiss granites about 3 miles
from entrance of canon near Sawmill
- ✓ 15936 Granite gneiss of same
2nd Trip to South Boulder June
- 15937 Gneiss 100 feet below Pre Cambrian schists
at 2nd Exposure 1 mile up Canon
- 15938 75 feet below P. Cambrian same place as 15937
- 15939 Same as above showing development of Feldspar
- 15940 adjacent to pegmatite vein in gneiss
- 15941 Transition schistose gneiss 50 feet from
P.C. schist
- ✓ 15942 same but nearer P.C.
- ✓ 15943 Transition schistose gneiss 15 feet below
P.C. schist
- ✓ 15944 Coarse brown transition schist Transition
from P.C. schist to Gneiss
- ✓ 15945 Transition schist
- ✓ 15946 Conglomeratic gneiss quartzite 15 feet above
junction with Transition schist & gneiss
- ✓ 15947 Purple Quartzite 3 feet thick midway
among the P.C. schists at bottom of hill in Road
cut at 2nd Exposure
- 15948 Junction of Quartzites with P.C. Schist in Road cut
2nd Exposure

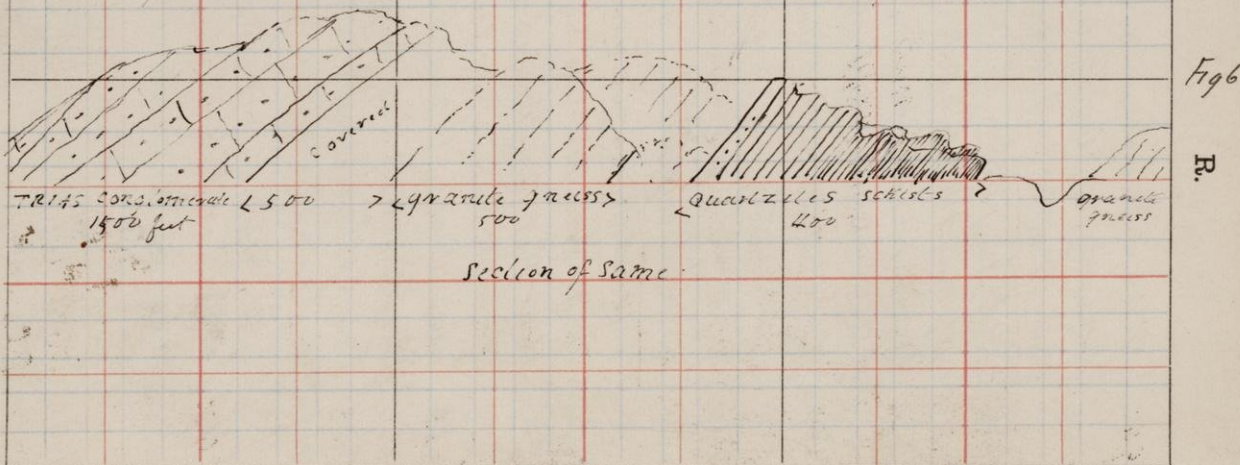
Note: For specimens completely section of No 2 Exposure see 15925
to 15934

Fig 5-

View of relation of intrusive granite to P. Camb & Trias Entrance S. Boulder Canon



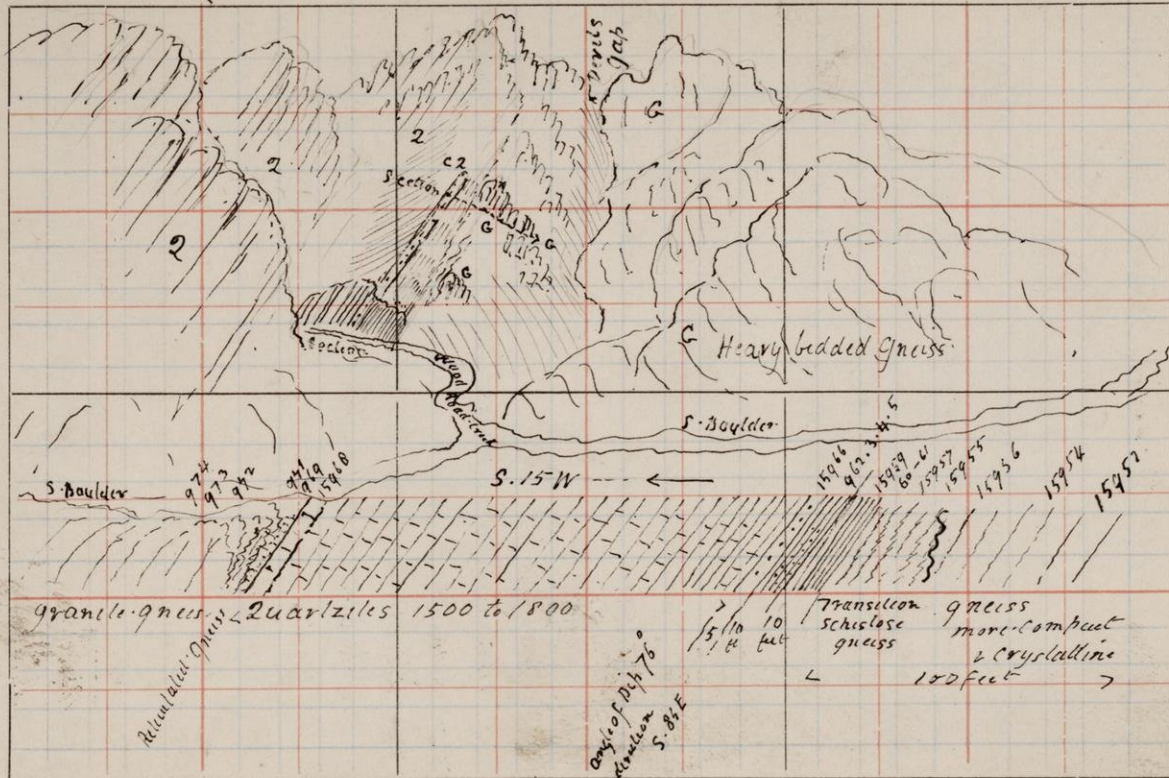
G = granite gneiss L = P.C. Quartzite



- 15949 quartz & mica veins interlaminated (crossing)
between the quartzites on Road cut No 2
exposure S. Boulder
-
- ✓ 15950 Red granite rock intervening between
exposure 1 of Pre Cambrian Quartzites
and the Trias $\frac{1}{4}$ mile from entrance of
Canon S. Boulder, taken about 100 feet above
the Quartzites and apparently conformable
with them ^{gneiss}
- 15951 Dam granite reticulated with quartz veins
at same locality.
-
- Wood Road Canon Tributary to
South Boulder coming into it from the SW
about $2\frac{1}{2}$ to 3 miles up S. Boulder
- ✓ 15952 Granite gneiss 100 feet below P.C. Schists
- 15953 near the same
- ✓ 15954 a little higher in the gneiss series
- 15955 Pegmatite lens in the transition Schistose
gneiss, a few feet below junction with P.C.
schists. Lens conformable to bedding
- ✓ 15956 Red Transition gneiss a few feet below
P.C. schist
- ✓ 15957 Transition schistose gneiss nearer to P.C.
- 15958 Coarse Transition schist next below P.C. schist
- ✓ 15959 P. Camb. schist
- ✓ 15960 do with garnets

View & Section up Wood Road Cañon S. Boulder

Fig 7



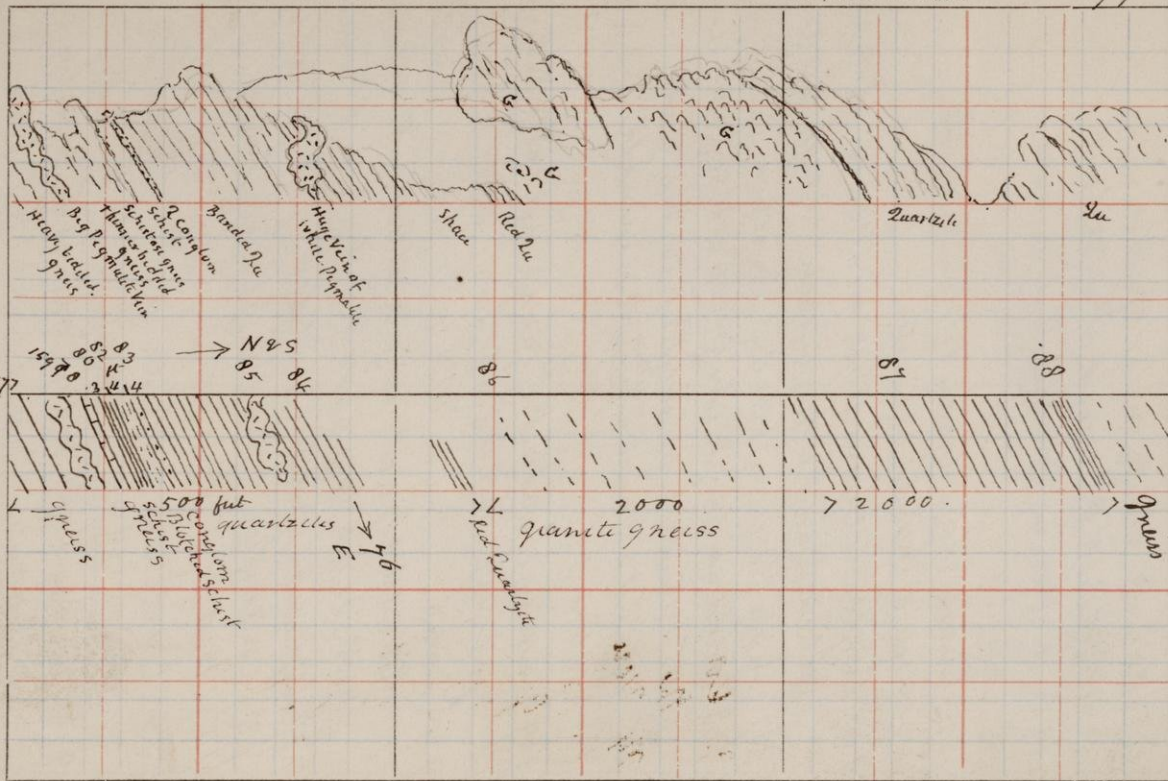
F.

R.
Fig 8

- 15961 do with black mica specks
 15962 Bloched P.C. schist above the last
 15963 do showing mammillate structure
 15964 do
 ✓ 15965 Quartz veins among Bloched schists
 near to Quartzite Conglom.
 ✓ 15966 Conglomeratic quartzite next above Bloched
 schists and passing upward into quartzite
 15967 Same showing banded structure
 ✓ 15968 Hard quartzite about 1000 or 1500 feet above
 P.C. schists in immediate contact with
 granitoid rocks ^{which} ~~very~~ conformably
 above it
 ✓ 15969 Immediate contact of granitoid relictated
 rocks with P.C. Quartzites
 15970 Same
 ✓ 15971 Relictated granite or granitic rock relictated
 with Quartz veins about 50 feet above P.C. Quartzites
 ✓ 15972 granitic bedded rock 100 feet above &
 ✓ 73 conformable to the P.C. Quartzites
 74 do
 15975 Breccia of quartzite included in Quartz
 vein
 ✓ 15976 Massive heavy bedded gneiss in S. Boulder Canon
 about 4 miles up and about 1 mile below
 Precambrian series often showing distinct
 hornblende crystals & Red Feldspar

View & section in Coal Creek Canyon 6 miles from Entrance

Fig 9



T.

Fig 10

R.

Coal Creek Cañon

- ✓15977 Heavy bedded gneiss near head of the Cañon
about $\frac{1}{2}$ mile below the Pre Cambrian
about 6 miles from entrance of Cañon
- ✓15978 Compact gneiss about 50 feet below P.C. schists
- 15979 Same
- ✓15980 a little closer to P. Camb. schists
- ✓15981 Transition schist just below P.C. Schists
- ✓15982 Bloched schist 3 or 4 feet above the last
next below
- ✓15983 Conglomeratic Quartzite within 10 feet of
the Transition gneiss
- ✓15984 Very Quartzose cap of the Quartzites
probably in direct contact with the intrusive
granite splitting the series and also probably
near to a covered large pegmatite vein
- 15985 Enormous pegmatite vein just at junction
of the intrusive? granite and the back
of the quartzites
- ✓15986 Granite gneiss 100 feet above the
quartzites
- ✓15987 Quartzite of Upper Camb.
- 15988 Correlated garnet schist either forming
top of Quartzites or else belong to Archæozoan

T.

R.

(Letters not on file as they were just entries & then cut up for sketches) 8

Report of trip to Ralston Creek canon
as contained in a letter of date June 9, 1890.

Last Friday (June 6th) I took a trip to
Ralston Creek for a whole day, and as
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generally the practical dividing line
between the two sets of formations,
thus (See sketch on opposite page.)

at about 4 miles or more the stream
turns more to the northwest, cutting
across the dip of the gneissic series, by
a canon which I followed for within
2 and 3 miles going towards the core
of the range, and then had to return
before actually encountering the
amorphous granite core if such exists.



Rough section of Canon and its relations of schist gneiss & veins to Trias

(Letters not on file as they were copied entire & then cut up for sketches) 8

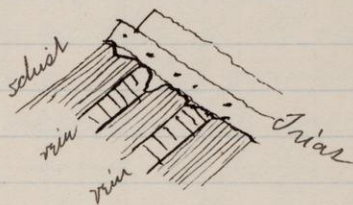
Report of trip to Ralston Creek canon
as contained in a letter of date June 9, 1890.

Last Friday (June 6th) I took a trip to Ralston Creek for a whole day, and as results I don't think there is any representative there of the pre-Cambrian, at least not represented in the distinct manner it is at S. Boulder. I rode about 4 miles up the Canon, which happens to follow the strike of the Trias beds just at their juncture with the gneissic and schistose series, the stream for some 4 miles forming generally the practical dividing line between the two sets of formations, thus (See sketch on opposite page.)

at about 4 miles or more the stream turns more to the northwest, cutting across the dip of the gneissic series, by a canon which I followed for within 2 and 3 miles going towards the core of the range, and then had to return before actually encountering the amorphous granite core if such exists.

I had admirably clear sections for study and frequently came to the direct contact between the Fias and the schistose or gneissic element; which latter I found everywhere thoroughly unconformable to the Fias in dip and often in strike, but the only rock at the juncture was a fine white mica schist, highly crystalline, and nowhere could I see signs of a quartzite or of any appearance of a clastic rock. Moreover, these schists were traversed quite often by large coarse red granitic (pegmatitic?) (20 to 50 feet thick) veins of coarse red feldspar, containing some quartz and some mica, all of them coarse. Tourmaline also quite common in them. These schists stand from verticality to 45° , their average strike being approximately E and W, and dip south; whilst that of the Fias is, strike about N & S, dip east. The great pegmatitic veins commonly follow the dip conformably with the bedding of the schists. At times however they cut across it diagonally. Both veins and schist come up together with their tops

eroded off right under and uncomfortable to the Trias.



This is absolutely all there is in the canon for 500 feet or more from the Trias. After (i.e. below) these schists the canon as it crosses the dip and enters the Archean area shows for at least two miles in thickness nothing but a very uniform series of dark hornblende gneisses, somewhat thin bedded at first in upper portion, but becoming more and more massive and compact.

As the Archean(?) is further penetrated their dip is the same as the schists. They are traversed also by great pegmatitic veins as the schists, which veins rather increased in size and number the deeper we go into the Archean.

I am inclined to think that the pre-Cambrian is not represented in this

canon of Ralston, at least in such way as at South Boulder, but that it is only ordinary Archean.

With the exception of the schists I could find nothing of that quartzite(?) which Marvin describes. It may be that it lies on some tributary side canon further north in the direction of Coal Creek.

(Descriptions and locations accompanying each specimen.)

- ✓ 15901 Muscovite schist. Characteristic of lower and middle portions of Ralston Creek canon, immediately underlying Trias and unconformable to it.
- 15902 Muscovite schist ^{characteristic of lower section.} (Same as 15901)
- ✓ 15903 Thin bedded banded hornblende gneiss about a half mile into the Archean; i.e. about 1 mile west of the Trias at entrance of that part of the upper portion of Ralston Creek where the stream

leaves the strike and cuts NW. across the dip into the Archean(?)

15904 Same as 15903 Thin bedded Hornblende gneiss about half mile into the Archean(?) at entrance of the upper portion of Ralston Canon; i. e., where the canon begins to turn abruptly N.W. across the dip into the Archean.

15905 Blotched gneiss lying between Thin bedded banded Hornblende gneiss at entrance to that upper portion of canon where Ralston creek leaving its course along the strike cuts Northwest into the Archean about one mile west of the Tias.

15906 Lens of pegmatite in thin bedded Hornblende gneiss or schist? Upper portion of Ralston canon. Shows the Hornblende gneiss on either side of specimen.

15907 Banded gneiss. Hornblende

about middle of upper portion
of section of upper part of Rallston
creek canon.

✓
15908 Blotched gneiss near Reynolds
ranch about $1\frac{1}{2}$ miles into
the Archean going N. west
West Rallston creek, upper
portion.

15909 Pegmatitic? Coarse granitic
veins with Tourmaline?
Characteristic of these large veins
traversing the Hornblende gneiss
Taken near upper portion of
canon (Rallston) about one mile
into the Archean? going west.

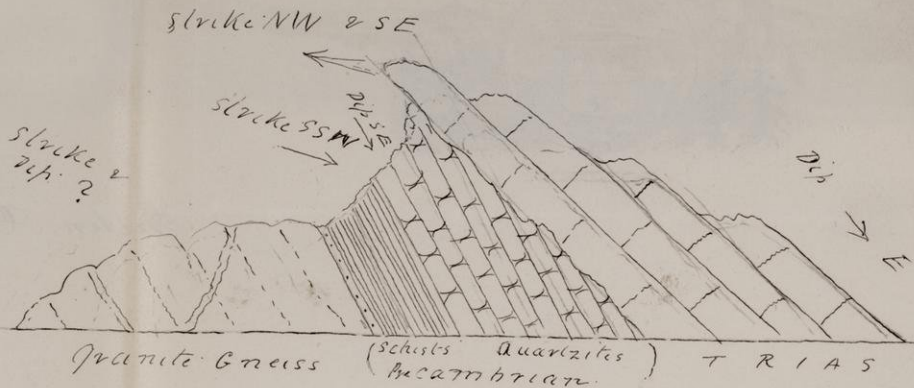
✓
15910 Conglomeratic gneiss, solitary
large boulder, found in upper
portion of Rallston canon near
i.e. above Reynolds House.
It is well into what I call the
Archean series and would ap-
pear to have come down the canon
from still deeper into Archean
but might possibly have come

in front side canon from
the Cambrian? strata lying to
the north east? in direction of
Coal Creek?



189

Golden, Colo.



Ideal section showing what I think is the
general relation of the formations

Report of trip to South Boulder
Canyon as contained in letter
dated June 12th, 1890.

The positive results of my trip
are:

1st That there is a decidedly elastic
series of Quartzites and schists
upwards of 1000 feet thick in-
tervening between the ordinary
Red Trias conglomerates and
sandstones, and the heavy bedded
gneisses of the Archean. Thoroughly
well defined and distinguished
from them, both in color and
composition and lithological
properties, but not so far as
I could ascertain unconformable
with the Archean; but appar-
ently grading into it, though
somewhat suddenly?

2nd That this well defined belt
of quartzites and schists appears
to be unconformable in strike
and steep in dip to the overlying
Trias which appears to rest on
it, and as in Colorado the



A. Lakes 1890

Pre Cambrian
Exposure No 2

View of Trias Intrusive Granite Pre Cambrian rocks and Gneiss & heavy bed Gneiss.
LOOKING SOUTH Taken from North Bank of S Boulder from Exposure No 2. 3/4 mile up Cañon

Trilobites and other fossiliferous rocks are generally conformable to the underlying paleozoic series (when these latter appear at all which they are not known to do in this region from near Colorado Springs south to beyond the Union Pacific railroad north in Wyoming.)

I believe this series not to represent a highly metamorphosed zone of Paleozoics, but a true pre-Cambrian series.

Moreover being fairly familiar with the Cambrian and Paleozoic series in Colorado in South Park and elsewhere, the lithological characters of this present series were quite unlike that of any metamorphosed paleozoic series I am familiar with in Colorado and also I may add quite unlike the ordinary Archean schists and gneisses.

Whilst the quartzites were a little like the hard Saccharine quartzites of the Cambrian, the



Micaceous gneissic
schist
& Pegmatite Veins
300 ft

L. gneiss
schist
gneiss
100 feet

Brown schist 5 ft.
Purple 15

PRECAMBRIAN pinkish white schist (mica)
finely laminated 100 ft

Blue Grey thin bedded Quartzite
Seamed with purple red iron
and traversed by quartz & mica seams & veins
parallel to cleavage

Looking North

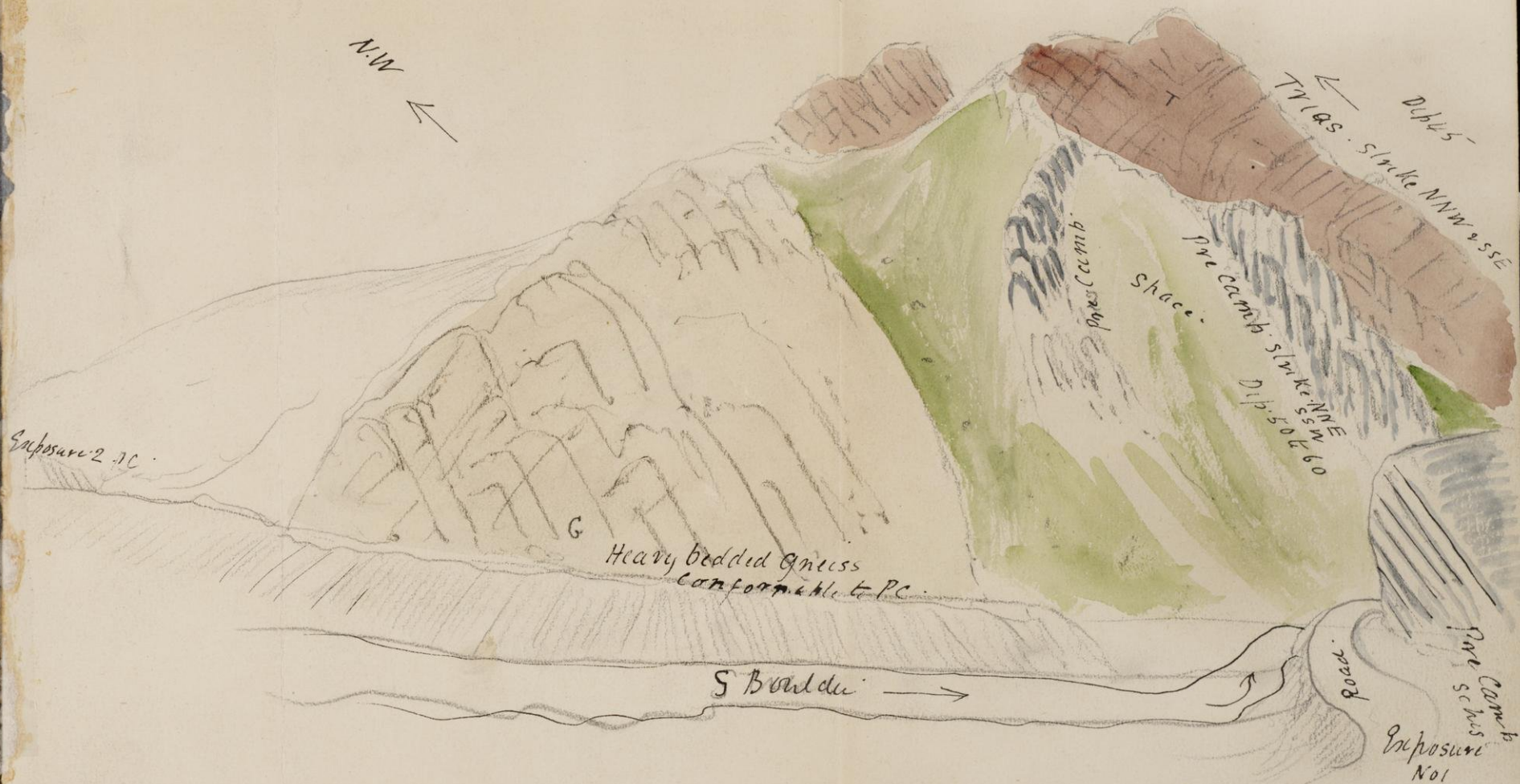
View of 2nd Exposure of Precambrian Rocks
on North bank of river 3/4 mile from entrance
of South Boulder Canon.
Height of hill about 100 feet

A. Lakes
1890

schists were quite unlike, and if the series could be construed into representing the Paleozoics in a highly metamorphosed shape I ought certainly to have found some evidence of limestone of the carboniferous or Silurian represented by their equivalents of marble or highly silicious limestone, but though some portions of the section were inaccessible or covered by detritus I saw no trace of the calcareous element in the 500 ft. or more accessible to me. Nor any trace of pebble or detritus of a calcareous character in the drift proceeding from these rocks. Everything was either of a quartzitic or schistose character or else of genuine gneissic or granite character. The only possible hypothesis for its being of paleozoic origin would be that it is an enormous local development of the Cambrian quartzites and slates or meta-



Relation of Trias to Granite & Quartz to P. Cambrian lower series
 1/4 mile up S. Boulder



Relation of Trias to PreCambrian Quartzites
 & then to granite. S. Boulder
 1/4 mile up Creek
 on North bank of stream



View of Precambrian - rocks from head of Coal creek
Looking SE & E.
Coal Creek

morphic shales as elsewhere in Colorado; but as in Colorado these are rarely if ever more than 300 or 500 feet thick. This seems quite improbable.

Moreover as I said, the highly micaceous schists, the gneiss or semi-gneissic character of some of the rocks, the prevalence of abundance of garnets, renders these strata at sight quite of a different character to the average Cambrian pure quartzite slates, and metamorphic shales of Colorado.

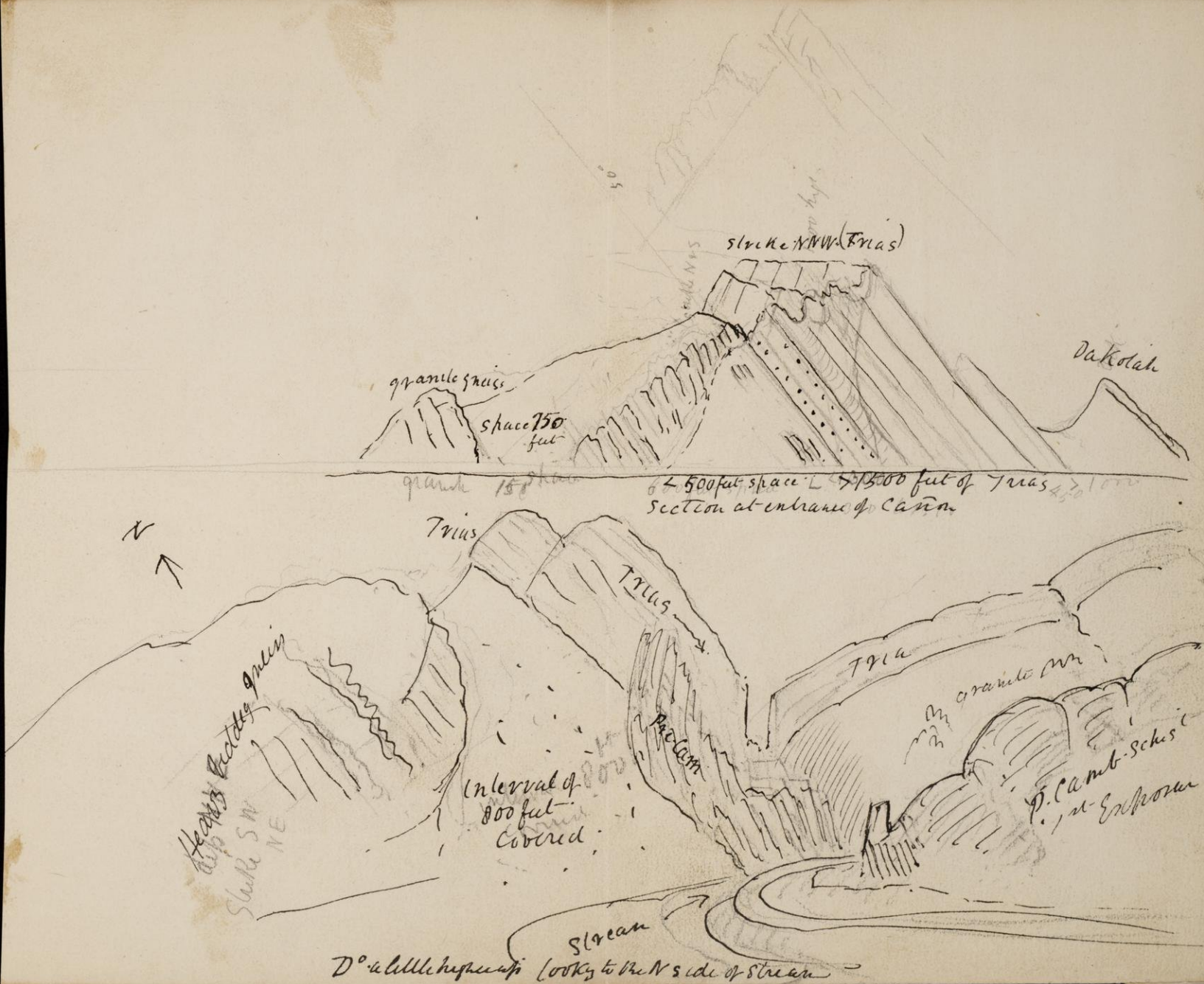
I think there is an apparent and almost certain unconformity in strike and perhaps in dip or at least in direction of dip from the Trias as well as by its lithological character this series is not a local representation of highly metamorphosed paleozoic strata. I may also observe that I saw no true slates in the

ordinary acceptance of that word, & nothing but highly metamorphic bedded micaceous and garnetiferous schists generally of white mica (or muscovite) and blue quartzites.

As distinct again from the average Archean of Colorado, I may mention 1st - the exceedingly distinctly bedded and laminated character of the series.

2nd - the large preponderance of thin bedded, hard white saccharine or bluish quartzites.

3rd - The intercalation of bluish quartzites or of a gneissic habit certainly actual pebbles of quartz in the matrix or else showing a white spotted appearance that the pebbles had only slightly merged into the general metamorphism and that the rocks were of decidedly of clastic origin in the case of varieties and I



am confident that your microscopic examination will prove the same in the finer quartzites and schists.

In such a clastic character nor such even bedding nor even the presence of well defined belts of true quartzites, have I ever observed in Colorado or the Archean proper.

What quartz we have is not of clastic or quartzitic origin, but occurs as quartz veins in the granitic or gneissic rocks. On lithological grounds then alone, I am convinced that this series does not belong to what we commonly consider Archean. Even to a person not a geologist the difference in color the markedly bedded and laminated character of this series is sufficiently strong to lead him to suppose it as something as distinct almost from the great brownish red massive gneisses and granite as the sandstones

and limestones of the foothills one.

The general pale grayish white schistose and bedded aspect of the group is very striking as is distinct from the heavily bedded more amorphous and red hue of the massive gneiss or granites. An effect heightened locally by the fact that for a mile or more the river flows right between the two formations parallel to their strike and after the great Trias ridge comes a parallel ridge of these grey series with an intervening valley and again at one locality besides the river an intervening valley between the crest of the grey series and the red granites so nature has almost exactly separated the different groups into distinct ridges or "hogbacks".

As to their being any unconformity between the grey (pre-Cambrian series) and the massive gneiss

I am not so certain, but from general observations I think not. Certainly at one place there was none and the group of pre-Cambrian seemed to merge into the other rather suddenly but without ~~but without~~ & without apparent change of dip or strike.

As to whether the gneisses are of eruptive origin or not, I can not say, but judging from their bedding I should suppose not. Unfortunately I had not time to go further up the cañon. Beyond the massive rather indistinctly bedded gneisses to see if there was any true amorphous granite still beyond but from observations of an intelligent man I met, I judge that there probably is or at least that the granitic element becomes more and more massive as we go west into the mountains. Time only allowed me to penetrate about 3 miles

into the core of the mountains. In conclusion before I describe more in detail my trip, I would say, - that whilst satisfied with many points and especially with the existence of a pre-Cambrian intermediate series whose lateral extent I don't know, but whose thickness is upwards of 1000 feet; there are many points which would make it desirable for me to revisit the locality and spend at least two days more there at some future date.

General description of Boulder Canon.

At the entrance of the canon we find the Trias red conglomerates about 1500 feet thick and rising to a height of 1000 ft above the stream bed.

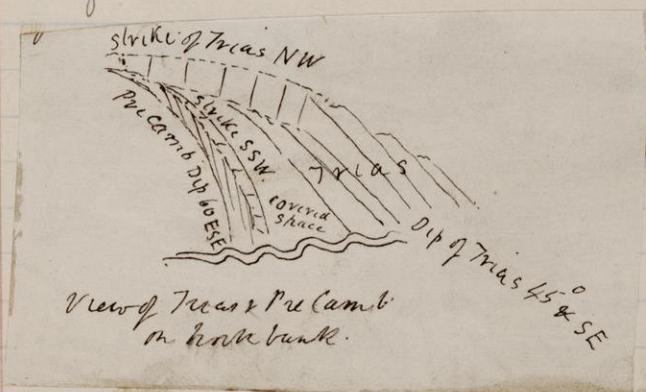
This series forms a grand portal to the canon through which the stream passes in a general east and west direction.

The approximate trend or strike of the Trias is N.W. and S.E. its dip beginning at 30 or 35 steepens gradually as we enter to 45° the direction of dip being about E or a little S.E.

Inside the portal and after passing the Trias series we see the pre-Cambrian schists and quartzites directly underlying the Trias but apparently at a different strike and steeper angle of dip.

The first appearance of this series is that of a ridge.

descending directly and diagonally from the strike or barret edges of the Trias on the North Bank (something like a dyke) down to the river which cuts through it and exposes it again on the opposite south bank whenever it trends off to the SSW on a distinct ridge somewhat diagonally with the trend or strike of the southward extension of the Trias. It is something in this way. I.E. ON North bank.



The exposure along an abandoned Railway cutting on the south bank was at the time accessible and of this we give section

description and specimens. This first exposure occurs near where the stream makes a bend more to the west and flows for some distance along the strike of the pre-Cambrian. Cutting, however, about $\frac{1}{4}$ to $\frac{1}{2}$ a mile further ^{on} some of the lower beds and exposures them on the north or right bank of the stream (going up stream) this is exposure No. 2. and at this point its near relation to the granitic gneiss is more apparent than at the lower or first exposure when just at the point where the two formations should come together, the stream intervenes and separates them for perhaps 100 feet.

The exposure along the strike of the pre-Cambrian or the south or left bank of the stream was not studied by us at the time owing to

the difficulty in crossing the
torrent. This, however, could
be done following the strike
in the direction of Coal Creek
south through a cañon
which shows the pre-Cam-
brian on one side and the
granitic gneiss on the other.
Also the pre-Cambrian could
be followed south on its
dip in a ravine separating
it nearly as a hogback from
the overlying trias.

The general appearance of the
pre-Cambrian is that of grey
ish white schists and quartz-
ites rather thinly bedded and
uplifted at an high angle
and very distinct in color and
appearance from the heavy
bedded granitic gneisses, which
prevail to the north west.

T.

R.

SE ←

Trias

200 feet or more
probably
Quartzites

strike SSW
Dip 60° ESE

Quartzitic zone

200 to 300 thick

specimens 15911 to 15917

Schist zone

150 to 200

specimens 15918 to 15922

South bank

River flows about E & W

North bank

granite

15923

15924

Massive
bedding uncertain
dip uncertain

1000 ft.
chaps
ing
clust
inter-
re-
fect
posed
nk
The
have

28

Details of South Boulder Canon

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The following section of which specimens were taken

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Thickness between 500 and 1000 ft. The extreme upper beds perhaps 200 ft. or less thick underlying the Trias were at the time almost inaccessible owing to the intervening torrent but where the remaining lower 350 or 400 feet cross the river and are exposed on its left or southern bank about half a mile from the outlet of the canon we have the following section of which specimens were taken

Description of Section.

The quartzitic zone of which specimens 15911 to 15917 inclusive were taken is composed mainly of rather thin bedded but distinctly bedded quartzites, hard and often mixed with mica, iron, and some garnets. Veinlets of quartz also run in and out in a net work among the quartzite. A thin streak of malachite or copper carbonate or the chrysotile silicate of copper occurs near the lower part of the white quartzitic group.

I found also a stratum, whose continuity I could not follow, of a rusty conglomeratic or brecciated character.

Specimen 15911 near the upper portion of the quartzitic zone. I don't think it was more than 2 or 3 feet thick and appeared to be a localized brecciation of a quartzitic bed.

the lower portion of the quartzitic section is of a blue more banded quartzite somewhat gneissic in appearance.

These quartzites pass into a laminated schist zone 150 to 200 ft thick consisting of thin bedded quartzitic and schistose strata with lenses or lenticular seams of quartz parallel with the bedding. The seams or lenses not more than an inch or two thick.

Garnets become very common in this schistose series and a red iron ? material is constantly interlaminated with the mica schists.

Thin beds of hard quartzites are also interstratified with the schists. In the upper portion of the schistose zone occurred a mottled gneissic looking quartzite, 1 foot thick, from which I was only able to break off a thin flake.

specimen 15918. The garnetiferous and red iron matter are most conspicuous in the lower 25 feet of the schistose zone. The bed becomes in the lower portion more compact and hard, and lenses of quartz and red iron more abundant.

Its direct relative or connection with the massive granitic gneiss on the opposite side of the stream is interrupted by the presence of the stream which follows for nearly a mile along part of the strike of the pre-Cambrian schists separating them from their underlying granite gneiss.

So we cross the creek by a bridge to examine the granite gneiss 15923, it is massive of a red color, cleaved, shows indistinct bedding. I think more or less conformable to the dip of the pre-Cambrian gneiss.

but of this I am not certain. It is traversed by broad veins a foot or 3 feet in width of exceedingly coarse Red Tabular feldspar some lenticular masses of quartz and some layers of mica crystals.

I am not sure whether these veins follow the cleavage or the bedding planes. They might be called coarse granitic veins in granite gneiss or pegmatitic veins, from their close adhesion to the country rock I should say they were of segregative origin.

On this side, right hand, i.e. north side, of the creek, the continuity downwards from the Trias to the apparently unconformable pre-Cambrian series upon which the former rests to the granitic gneiss upon which the latter either rests or into which it passes might in part be followed by dint of some steep climbing

and some of the upper beds of the pre-Cambrian at this direct contact with the overlying Trias might be studied and also the exactness of the unconformity in dip and strike between them but the exact junction between the pre-Cambrian and the granite gneiss appears again here to be obscured by some 800 feet interval of debris. With more time at my leisure I think I could get some good time points however. Keeping still on the north side of the stream since we are by the stream again precluded generally from following along the strike of the pre-Cambrian and examining further into some of its beds. We continued our course up stream along the road cutting and about $\frac{1}{4}$ of a mile more or less from our last examination of the first available exposure

of the pre-Cambrian, we come
 to a point where the curvature
 of the stream has left us
 again a portion apparently
 of the same set of lower
 beds of the pre-Cambrian
 we have already studied.
 They consist of about 200 to
 300 feet of beds of a quartzitic
 character with many red
 bands of chert and iron
 material interlaminated or
 in veins in the strata together
 with several veins of quartz
 and mica combined and a
 lower zone of exceedingly
 distinctly and finely laminated
 white mica schists ^{15-25' and - 20'} sometimes
 locally contorted passing down
 into a pinker color (perhaps
 less oxidized) the thickness
 approximately of these schist-
 ose beds 100 feet.

These schists approach much
 nearer to the granite gneiss
 than the last probably within
 20 feet which is obscured by

debris. To try and find the exact junction, I climbed perhaps 100 feet or so up the hill and found a bed of perhaps 3 or 4 feet thick of conglomeratic quartzite, within 6 feet of the granite gneiss.

(I was much hurried at this point to get back, having 16 miles to ride to catch train) But I chipped off a piece of granite gneiss which seems of the ordinary kind. I cannot say but think what bedding there was to the granite was conformable to that of the schists. There are points I want to study again more closely.

This is the last exposure of the pre-Cambrian. On the north side of the creek the granite gneiss series of doubtful bedding appears to prevail and the stream and road bend off to the N.W. into it. The end of my course being at Barber's Saw Mills worked

by Mr. Neil about 3 miles up
the Canon.

On the opposite side of the
stream in looking south
the pre-Cambrian can be
seen as a ridge passing
off to the south in the direction
of Coal Creek forming by its
ridge along the strike & a ravine
with massive granite gneiss
on the other side.

The two formations separated
by the ravine. As there is no
stream to amount to any-
thing up this side ravine,
I think it could be followed
to advantage in the direction
of Coal Creek and the lines
of junction and relation to
the granite more certainly
defined. Much more
time than I took is wanted
for this examination.

The canon walls throughout
are very steep and some toler-
ably hard climbing on the heat
ought to be done to determine

certain points. I should like to give this place at least another day principally to determine the following questions
 1st - More accurately and certainly the relative indisp and strike of the pre-Cambrian to the overlying Treas.

2nd - To examine some of the uppermost beds of pre-Camb.

3rd - To determine the exact relations of the pre-Cambrian to the granitic gneiss.

4th - To ride some miles up the cañon and get positively into the amorphous granite core.

5th - To climb to some high point and endeavor to follow with the eye, the lateral extent of the formation. Then follow Bowlder to work my way along the series south to Coal creek and thence trace it more south into the Ballston district.

- 15911 Rusty conglomeratic quartzite upper but not topmost portion of pre-Cambrian series, nearly $\frac{1}{2}$ mile from entrance of S. Boulder Cañon, Northwest bank of river along side of railroad track cutting: E side nearest the stream.
- 15912 Micaceous quartzite adjacent to 15911, S. Boulder Cañon.
- 15913 Quartzite, adjacent to 15911 S. Boulder Cañon $\frac{1}{2}$ mile from entrance
- 15914 Quartzite adjacent to 15913 S. Boulder Cañon $\frac{1}{2}$ mile from entrance
- 15915 Quartzite and mica, same series and few yards 15914.
- 15916 Quartzitic garnetiferous schist a few yards below 15914 $\frac{1}{2}$ mile from entrance S. Boulder Cañon.
- 15917 Quartzitic garnetiferous mica-cious rock, near (below) 15916

$\frac{1}{2}$ mile from entrance.

15918 Small slices of a stratum of conglomerated gneissic rock near lower portion of the pre-Cambrian, same locality as 15917, S. Boulder.

15919. Lower portion of the series not far from junction with granite

15920. Lower portion of series not far from junction with granite same locality as 15919, about $\frac{1}{2}$ mile from entrance to Canon.

15921 Near lower portion of the series not far from junction with granite $\frac{1}{2}$ mile up Canon S.W. side of river.

15922 Lens of quartz in lower series S. Boulder Canon.

15922 A. Quartz in lower series of pre-Cambrian.

15923 Granite gneiss, massive but bedded. Across the north side of river. Direct contact between this and the schists obscured by debris and by river bed. But this is the adjacent granite to the S. Boulder.

15924 Coarse granitic veins in the granite mass of No. 1923.

15925 } Weathered? whitened
15926 } schist, lower portion of series not far from junction with granite. At 2nd exposure of the pre-Cambrian on N. side of stream and road at $3/4$ of mile from entrance of S. Boulder Canon.

15927 } Unweathered purple mica
15928 } schist at base of series within
15929 } 15 feet of the massive granite gneiss and probably graduating into it. actual contact obscured by drift. 2nd exposure $3/4$ mile up Canon S. Boulder.

15930. Iron veins intercalaminated with the lower schistose series in 2nd exposure, $\frac{3}{4}$ mile up creek from entrance S. B.

15931. Belonging in the lower schistose series, 2nd exposure $\frac{3}{4}$ mile up creek, S. Boulder.

15932 } Conglomeratic gneiss, shalun
15933 } 2 or 3 feet thick within six feet of contact with massive granitic gneiss at 2nd exposure, $\frac{3}{4}$ mile up creek S. B. This shalun is a little closer to contact than 15927, schist and I found it by climbing the hill above the schist exposure but cannot tell its exact relation to the schist above it. It is the nearest contact I could find to the granitic series.

15934. Massive gneiss in direct contact with the lowest of the pre-Cambrian schistose

soils at 2nd exposure $3\frac{1}{4}$ mile up creek. Had no time to get better specimen, this is about 6 feet from 15932 interval obscured by debris.

15935 Coarse granitic veins in the massive gneissic granitic series just above saw mill (Barbours and Reils saw mill) about $2\frac{1}{2}$ miles up South Boulder Canon.

15936 Gneiss of the granitic gneissic series about $2\frac{1}{2}$ miles up Canon.

15937 } Exposure No. 2 of pre-Cambrian
15938 } 1 mile up creek (S. Boulder)
15939 } gneiss 100 feet below pre-Cambrian schist.

15940 Compact gneiss near i.e. adjacent to pegmatite vein 50 feet below pre-Cambrian schists. 2nd exposure 1 mile up S. Boulder, north side of creek.

15941. Transitive gneissoid schist
30 to 50 feet below pre-Cambrian
schist proper.
- 15942 A little nearer the pre-Cam-
brian schists. Transitive
schistoid gneiss.
- 15943 Transitive brown schist
between the pre-Cambrian
schists and the gneiss
Smith Boulders. Exposure 2.
15944. Brown transitive schist
between pre-Cambrian schists
and gneiss. S. Boulders.
- 15945 Transitive schist between
pre-Cambrian schists and
gneiss, S. Boulders. 2nd exposure.
- 15946 Conglomeratic quartzite
above pre-Cambrian schists
and below quartzites, passing
up into quartzites, 15 feet above
gneiss. 2nd exposure, 1 mile
up S. Boulders Canyon.

15947. Purple quartzite, 2 feet thick, midway among pre-Cambrian schists. 2nd exposure, 1 mile up S. Boulder.
15948. Contact or junction of pre-Cambrian schists with quartzite, 2nd exposure, S. Boulder 1 mile up Canon.
15949. Quartz and mica veins, intersecting or interlaminated with Quartzites, 2nd exposure S. Boulder Canon.
15950. Granite intervening between pre-Cambrian Quartzites and Trias $\frac{1}{4}$ mile from entrance of S. Boulder Canon, taken 50 to 100 feet above Quartzites.
15951. Granite reticulated with Quartz veins, 50 to 100 feet above pre-Cambrian Quartzites and intervening between them and the Trias. S. Boulder $\frac{1}{4}$ mile up Canon, same as 15950.

- 15952 } Gneiss 100 to 150 feet below
 15953 } pre-Cambrian schists.
 3rd exposure of pre-Cambrian
 up "Wood road Cañon."
 Tributary of S. Boulder and
 2 miles up stream from en-
 trance.
15954. A little higher than 15952
 Transitional gneiss. Wood road
 S. Boulder Cañon.
15955. Lenticular veins, transitional
 laminated gneiss. Wood
 road creek, S. Boulder.
15956. Transitional laminated gneiss
 50 to 75 below pre-Cambrian
 grey gneiss, showing develop-
 ment of feldspar crystals.
 Wood road Cañon S. Boulder.
15957. Transitional laminated gneiss
 30 to 40 feet below pre-Cambrian
 grey schist.
15958. Transitional laminated gneiss

increases to pre-Cambrian
grey schist than 15957
Woodward Canyon, S. Boulder
3rd exposure.

15959. Pre-Cambrian schist next
below true grey schist and
next above transitional lam-
inated gneiss.

Woodward canyon, S. Boulder.

15960 } Grey pre-Cambrian schist
15961 } showing garnets above transi-
tional series.

Woodward Canyon, S. Boulder.

15962 } Red blotched schist next
15963 } above P. C. grey garnetiferous
15964 } schist.

Woodward Canyon, S. Boulder
3rd exposure.

15965. Transitional from blotched
schist to conglomeratic
quartzite.

Woodward Canyon, S. Boulder.
3rd exposure.

15966. Conglomeratic quartzite.
Gravel road cañon, S. Boulder.
- 15967 Conglomeratic Quartzitic
showing gneissoid structure
same as 15966.
15968. Quartzite hard about 200
feet up at top of series over-
lain by reticulated granite.
2 miles up wood road cañon
S. Boulder.
- 15969 } Intermediate close contact
15970 } of reticulated granite lying
above the P. C. Quartzites
2 miles up Wood Cañon
S. Boulder.
15971. Reticulated granite about
50 feet above contact with
P. C. Quartzites. 2 miles up
Wood road cañon, S. Boulder.
- 15972 Granite about 100 feet
above contact with P. C.
Quartzites. 2 miles up Wood

Mad canion. S. Boulder.

15973 } A few feet from 15972.
15974 }

15976. Massive gneiss (bedded
heavy) 3 to 4 miles up S.
Boulders Canion and a
mile or more below the
pre-Cambrian series.

From Goldulig Clear Creek to Rallston Creek

From Clear Creek South to Rallston Creek north the crystalline series consist of the "granite complex" compound of bedded gneisses and schist with numerous pegmatite veins. Compound of coarse red chlorite some quartz & some mica. These veins run in two systems one NW by SE the other NE by SW consequently cross one another. They are most numerous and large in Rallston Cañon. The average dip is to the South or SW and they present their broken eroded upturned ends to receive the superimposed Mesozoic strata lying unconformably upon them at an angle of 30 to 45°. The Trias being the lowest of these strata.

At Rallston Creek a belt of schists and granitic gneisses so lie under the Trias thin dip often vertical or else dipping South 45° steeply E & W. There are however many large pegmatite veins some of them conformable with the bedding. On the eroded tops of these veins which often stand up as dykes the Trias often rests; after going up about 4 miles up the creek which runs at the junction line of the Trias and granite complex the creek bends more to the North west across the dip of the granite series which for two or three miles maintain an even bedded dip & strike. becoming more & more massive. Hornblende & Tourmaline are the leading features of this part of the Cañon the gneisses big dark hornblende gneisses and the tourmaline often appearing as crystals in the pegmatite veins. There is no evidence of a Precambrian or clastic series in this vicinity either in the rocks or in the drift in the Cañon one solitary boulder being found of clastic origin probably coming in from Coal Creek.

Rallston to South Boulder

Returning to the entrance of the cañon we proceed north in the direction of South Boulder. On our way we pass the entrance to Coal Creek and catch a glimpse of the grey cliffs of the Precambrian series lying back up the Cañon. On the South side of the entrance the basaltic dyke of Rallston Creek is seen forming an abrupt ridge terminated by the erosion of the stream. On the North side the Trias is shown in a local hog back overturned its strata dipping west at an angle of about 70 degrees. This local overturning may be caused by the aforesaid dyke having been erupted back of it between and the Precambrian.

A hill of from 500 to 1000 feet thick rises graded over interfaces between the Trias and the Precambrian which may be formed of the terminus of this dyke or of granite or both combined. Beyond this the Precambrian quartzites form lofty cliffs and knobs distinguished by their gray color their average strike here being nearly North and South with a slight inclination west to the East. They are seen stretching away in the direction of the Granite country to the South.

Continuing our course along the plains in full view of the foot hills and along what is called Rocky flat we notice that the surface of this flat from Coal Creek to South Boulder is profusely scattered with large boulders of a Precambrian & clastic origin consisting principally of conglomerate quartzite and dark blue grey quartzite the latter often banded with black streaks giving it a banded gneiss appearance. Both quartzites are frequently streaked with purple iron.

The foot hills west of us consist as before of heavy slabs of Trias uplifted at an angle of 35 to 45 or 50 degrees dipping East and striking

behind them we can see the grey Precambrian quartzites showing their edges diagonally to us more along their strike than the Trias which exposes to us the broad backs of their great slabs. The slight difference in strike and dip is most apparent at Dowdeys Canon midway between Coal Creek and S B Boulder. We also at this point get a glimpse of red granite apparently by way directly back of the Trias and intervening in some places apparently as a rather narrow strip between the Trias and the Precambrian from Dowdeys Canon to S Boulder & probably from Dowdeys to Coal Creek though this latter part is not so apparent. (Dowdeys Canon would be a good point to examine the relations of Trias to this granite and it to the Precambrian the peak also above the Canon would be a good point for mapping the country). The appearance of these foothills and the occurrence of granite etc are shown in my sketch.

As we approach South Boulder and from there northward the Trias assumes lofty and gigantic proportions. Rising in gigantic slabs to a height of 1000 feet above the river bed & surrounding plain and cut into spires & minarets by erosion. It also seems divided into two hog backs. According to Hayden at Boulder Park this is the result of faulting and in their section a tongue or wedge of granite intervenes between the two peaks or hog backs. I could not observe this granite in the section at the entrance of South Boulder probably it occurs either further north or south.

At South Boulder Canon the strike of the Trias appears to turn more to the north west. While that between S Boulder & Coal mine nearly south. Thus making a bend or

South Boulder Creek Cañon

angle just at the entrance of the Cañon

We now ascend the creek and enter the grand narrow portal through the Chasm cut in the heavy bedded red conglomerate whose thickness is about 1500 feet. Emerging from this on the left hand or south we see granitic rocks, apparently in contact with the lower beds of the Trias and occupying a belt of about 500 feet or more West of these. The Precambrian quartzites and schists are seen uplifted in a ridge striking off on a diagonal direction to the SSW and dipping at an angle of 50 to 60° and to the East NE.

It is evident then that on the south side of the river a belt of granitic rocks intervenes between the Trias and the Precambrians.

Turning now to the north bank we see the same quartzite group running up the hill like a dyke in a diagonal direction and coming in close contact with the Trias along its strike. A sharp angle is thus formed between the two formations the interval being covered with debris.

The stream cuts through the Precambrians across their dip and a railway cutting running parallel with the river affords an admirable section of about 400 or 500 feet of the Precambrians.

Exposure
No 1

There (Exposure No 1) we find about to consist of hard thin bedded quartzites showing a good deal of reticulated veining of white quartz. Locally near the top also some patches of breccia included in an iron oxide mass also signs of pyrite and chrysocolite.

The white hard quartzite passes down into a darker more banded and greenish looking quartzite and then into a belt of fine schists much sheathed and interlaminated with purple red iron matter. Garnets also begin to appear and in the upper portion of the schists a stratum

about a foot thick of blotched quartzite suggesting
a conglomerate

The schist have sustained cross fracturing & cleavage
i.e. joint cleavage & possibly faulting as an escape from
them shows a highly polished face several yards
square just at the turn of the road

gneiss

N. Bank

Turning our eyes again to the north bank we see
across the river about 100 feet a mass of rather
neatly bedded compact gneiss traversed by large
pegmatite veins. Against this double of the
schists would not at contact where it is for
the erosion of the stream. The bedding of this granite is conformable.
The stream now makes a bend in a more westerly
direction leading us along the strike of the pre-
Cambrian for nearly a mile. With granite
gneiss on the north bank and Precambrian
on the south.

at a place on the north bank portion of the
Precambrian are left lying against the
granite Exposure N 32

Exposure

2

The road cut passes through this showing an
exposure for two or three hundred feet.

It is in most respects a repetition of No 1 exposure

The upper portion consists of quartzites with a
good deal of red iron matter. Veins of quartz
& mica the latter in good size crystals
ramifying among the bedding.

The quartzites are followed below by finely
laminated white mica quartzite schists
and locally shows signs of contortion.
They pass into a coarser brownish purple
schist and there graduate into

Exposure 2 - North Bank S-Boulder

laminated & compact gneiss not heavily bedded
the lamination becoming generally more and more
obscure with compactness and showing degrees
of development of the crystalline structure especially
that of red feldspars.

between these more compact beds of gneiss
are also beds of schist but of a gneissic
aspect rather than Pre Cambrian

Ascending about 100 feet up this hill
of exposure and over the exposure

we find it near the top capping or over coming
close to the granitic gneiss. here however we
find a well defined bed of Quartzitic con-
glomerate only 15 feet from the gneiss

The interval though somewhat obscured by debris
shows that the Pre Cambrian schist especially
the blotched with red occupy this intervening
space and merge into the gneiss in the
same manner as described below

above the Conglomerate merges into Quartzite
That this Conglomerate should be so near
the gneiss at this point and so little an
interval of schist may be owing to a move-
ment of the strata & faulting by which the
upper part of the hill of Pre Camb has
been pushed forward over the lower near
the road and crushed up against
the gneiss at the exposure of the schist

Wood Road Canon

The quartzites are intensely cross fractured show slickensides etc and signs of entation are seen locally in the schists at the Road bed. It would appear that that there is at this point no unconformity between the Pre Camb and the Greenies but that they grade into one another conformably.

Continuing up the stream we find the North bank occupied by a granitic gneiss country which soon becomes very heavily bedded to the North West.

About 2 miles from the entrance the stream bends round more to the North West at Neils Saw mill & passes into the granitic country.

Just at the bend however a little stream comes in from a deep canon running in a more southerly direction. This is Wood Road Canon for a few hundred yards it runs along the strike of the Precambrian dividing them naturally from the heavily bedded Greenies on the North bank.

Then turns to the South and crosses the Precambrian with many little turns and windings showing a section of them for some 1500 feet. Then turning more to the South West the road and creek follow along the strike of the Precambrian quartzites along their back i.e. their dip East. This brings us again to a granitic country lying on the back of the upturned quartzites and apparently

Wood Road

8

Wood Road Cann. Section

Transition of Cambrian to Gneiss

- 7 50 Covered space
- 8 50 Same as 6
- 9 200 Beds of Muckla gneissite beds of conglom and
seams of red
banded grey quartzite
and so on for upwards of 1000 feet

The entire Muckla of the Pre Cambrian as shown
in this Cann. I estimate at 1800 to 2000 feet

2nd Section later 400 feet up the hill above the
road.

The section here is similar as regards the Conglomerate
Quartzite and the schists

First you have the Conglomerate merging upward
into the quartzites

Then below it the blotched schists these blotches
consist of iron like a semi concretionary or
bolivoid form and by erosion leave the schist
covered with large round purple warts or "boils"
The iron is also diffused in specks & stains

As this character becomes less and less till the
schist is no longer blotched or stained but
the iron matter as we are nearing the gneiss seems
to have collected itself together in the definite
form of iron garnets often $\frac{1}{4}$ inch in diameter.

I fancy that the blotched is the upper schist
were the embryonic form of Garnets which
is completed in full shape in the lower schists

The schists gradually become darker brown in
color and coarser & more crystalline in
texture. Then more compact and the feldspar the
element takes form giving the rock a redder
aspect. Then distinct crystals somewhat

Wood Road Canon

porphyritic are seen and the rock at a hundred feet below the schists becomes a compact but not heavy bedded gneiss. Here the section ended by reason of a gulch so that I was not able to see the continued relation of these thin bedded gneisses to the heavy bedded gneisses 500 feet or more across the gulch to the north west.

At Devil's gap however upwards of 1000 feet above the creek all three series might be observed coming together. but I did not climb up there.

Gneiss

Continuing again up this same wood road canon to the spot where the granite country comes in contact with the Quartzites along their backs: I found a spot of a square yard or so exposed where the granite & the Quartzites were in close contact. The quartzite is hard white. The granite rock lying upon it at the junction seemed somewhat altered & greenish. There was no striking transitional slope from one to the other as in the lower contact just across the creek ^{about} 50 feet above the contact I found a hillock composed of granite rock intensely reticulated by quartz veins. The granite also seemed greenish from epidote or chlorite.

This I thought might be local: but as nearly the same phenomenon occurs near the entrance of S Boulder Canon in the relation of the granite to the quartzite.

Up the South Boulder to Coal Creek.
It may have a significance. Above this, and on the
same S. side of the creek the granite gneisses are
exposed in moderately thick beds. The character
of the granite will be shown in the specimens.
All these granites seemed conformable to the Precambrian.

Returning to South Boulder we followed the creek
for a couple of miles from the Sawmill or one way
over the mts to Coal Creek. The river makes an
exceedingly sharp bend almost doubly upon itself.
As we descend into the granite area the gneiss becomes
very heavily bedded rather fine grained and
shows distinct porphyritic crystals of Red Feldspar
at about 2 miles we left the river and turned.

South up over the mts towards the head of Coal Creek
on the top of the mts probably 2 miles into the granite
area and that much or more distant from the
Precambrian. Large dome like irregular
masses of Amorphous gray granite appear
composed of very coarse large crystals of white
feldspar, mica, and quartz. The relation
of the bedded gneiss to this inner and lower
amorphous series we did not see.

From the top of the mts we have a good view of
the continuation of the country lying north of S.
Boulder Creek. The Trias hogback stretches away to
North Boulder & terminates at that stream. It appears as if
the Precambrian slopes a little north of S. Boulder and granite
comes up in close contact with the Trias west of that all appears
to be granite.

From the hilly country at the headwaters of Coal Creek we see
the Precambrian stretching south as a lofty independent
ridge obscuring by its height its relation to the Trias E of it.
West is all granite gneiss.

Coal-creek

We stopped at Cochran's ranch near the head of the Coal Creek Cañon 6 or 7 miles from its entrance on the plains. From the hill East opposite the house, I sketched the scene East & South. The region to the North East intervening between S Boulder & Coal Creek being obscured by mts. It appears that the Precambrian series are divided into two ridges separated by between 1000 & 2000 feet of granite running parallel and longit. all with them. Some of this granite seemed rather massive or heavy bedded. We could follow the South course of the Precamb. for 6 or 8 miles it appears to take here a more nearly N & S strike. Descending the creek the gneisses are very heavy bedded and traversed by large pegmatite veins. The beddies elsewhere appear to conform in strike & dip to the P.C. about a mile below Cochran's we encounter the lower series of the P.C. cut in section by the side of the stream and road and showing ~~two~~ that it is divided from the upper Quartzite series by an interval of red granite rock. The section was similar in ^{Section} most respects to that in South Boulder only that the schists were restricted to a thick knep of not more than 10 feet and the granitic schists pass rapidly into a compact gneiss which in a few yards beyond becomes heavy bedded and traversed by large pegmatite vein. all so conformable. See section. Near the upper part of this group of Quartzites & schists is a small about 400 feet thick an enormous vein of coarse white feldspar large blocks of white quartz as large as a man's head and mica occur and appears to pass off into the granite near the junction of the two rocks. It bulges out in great irregular masses as if it had been squeezed up through the rocks.

Down Coal Creek

on the corresponding S.W. side of the road the last stratum of Quartzite is nearly pure quartz as if alteration or metamorphism had been great abt its contact with the gneiss or granite a probably the pegmatite vein as its course through observed on this side by debris would pass about at contact: Direct contact of Granite and Qu I could not find but about 100 feet above it found bedded gneiss conformable:

Continuing downwards we pass along side of the intense granite upon which the next great quartzite series rests but time and sleepness prevented me from examining the contact under them to the south of the road the Quartzites assume lofty cliffs 1000 or more feet high of a sombre grey tint the rock intensely crossfractured about $1\frac{1}{2}$ miles below the first exposure the creek turns north a little way along the strike of the Quartzites then East again ^{cross} the dip. The thickness of this upper Quartzite section shows to me very thick at this Creek it forms mountain masses and precipitous rugged cliffs. I think it is not less than 2000 feet & probably greater. There is a good deal of homogeneity about its character blue grey quartzites. sometimes banded with black sometimes traversed by pegmatite & quartz veins sometimes by bands of conglomerate. Sometimes it is very thin bedded almost schistose

Down Coal Creek to Entrance

It is often veined and stained with red matter
its dip is generally very steep rarely under
40° locally at one place it was as low as 25° it
is often vertical it shows some signs of flexure
and local contortion.

Still going down the creek about $1\frac{1}{2}$ miles from its
entrance or outlet we pass over a bed of some
thickness of highly crystalline grey contorted
schists with garnets not looking like the Pre-
Cambrian or of a Clastic origin. As they must
occur towards the top of the Series and a

Granite country immediately underlies
them to the south I am not sure whether they
belong to the Granite Complex or the P-C

I could not trace the connection of the Quartzite
group here with the granite area I doubtless
with more time I might have

at the entrance of the Canon we find the Trias
locally reversed in dip dipping 75° to the west
The Cause of this appears to be the Rallston
Basaltic dyke which appears about 200 yds
on the South bank and whose strike would probably
bring it up back of the Trias or between them and
the granite or Precambrian. As this is the
terminus of this dyke which extends to Rallston

South for 8 or 10 miles it is probably that there was
a strong eruption here. Between the Trias and
the Pre Cambrian west of it is a belt of about 1000
feet thickness which is granodiorite but which may
hide the locus of eruption or be occupied by either
granite or basalt or both.

The rest I have previously described

Respectfully Submitted by

Arthur Lakes

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State School of Min.

Golden, Colorado

to Prof. R. C. Van Dine (Maden),
Wis.

Golden, July 7th 1890.

