



July 21 - Salt Wells - gauge
Nov. 13 - Barnstable

Paid back to me 3 00

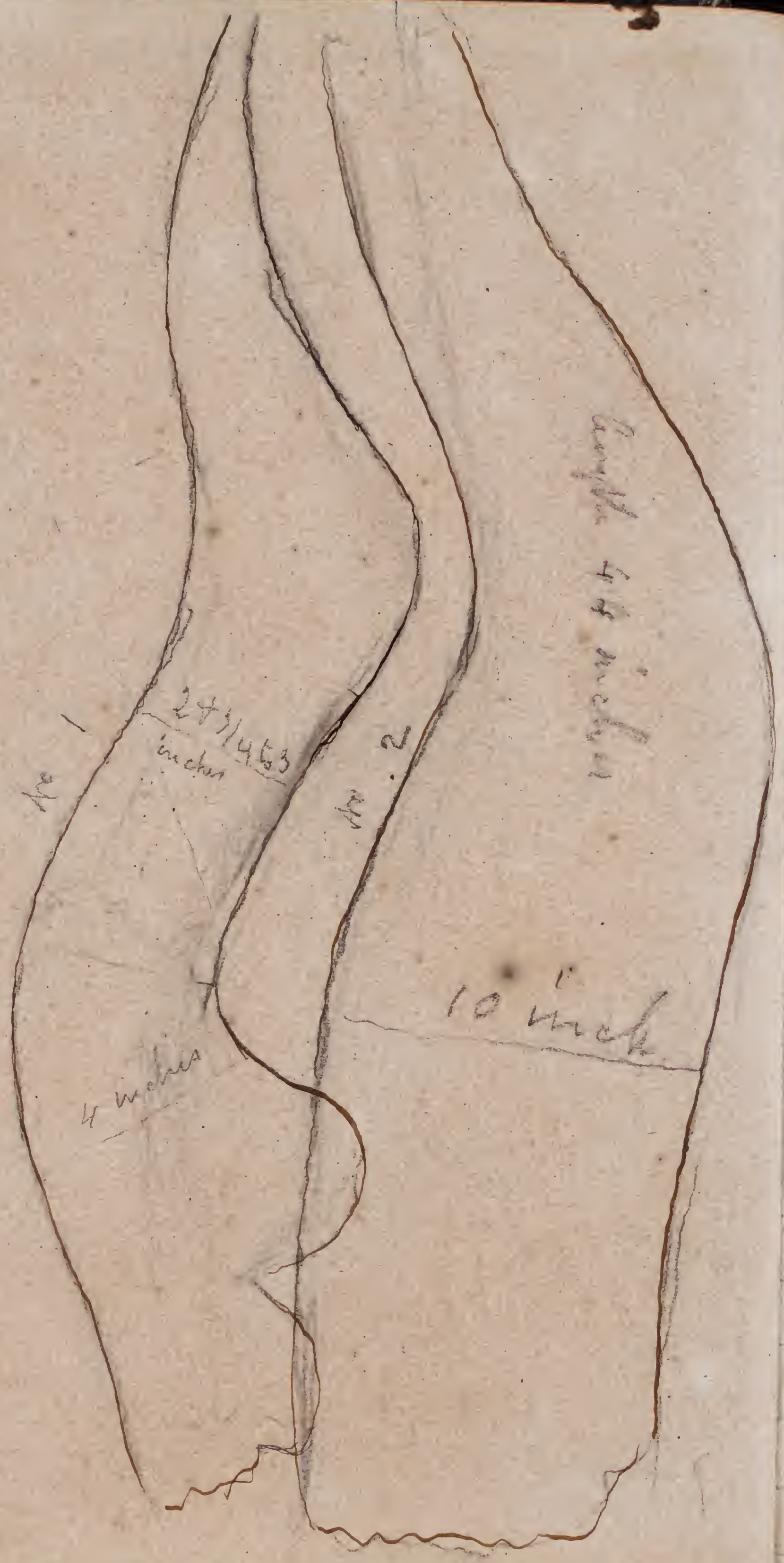
Leaving to be paid 2 40

At Isaac R. Deane's 3
3 00

Paid back at Barnstable from Nov. 50
3 50

Evansville \$ 5 00

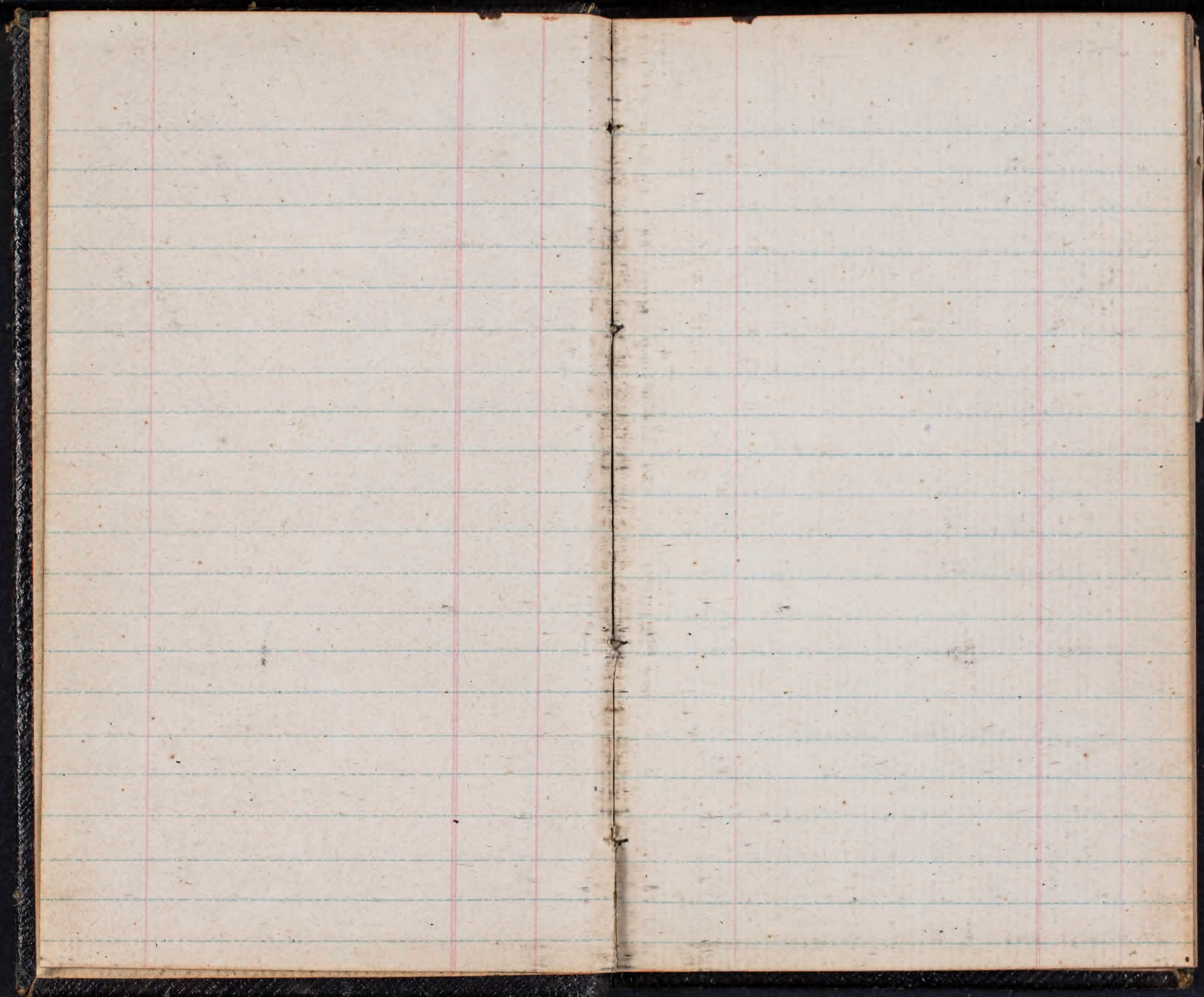
Rough sketches of a large bone



On the opposite page is a rough sketch of a large bone seen in one of the beds at Black Butte station, U. P. R. R. See bed 15 of section on p. 48.

No. 1 is an edge view. It was shattered in the bed and fell into thousands of fragments so that we could only save a part of the head or end with its process. The entire bone was app. 4 ft long or more.

No. 2 is a side view of same. Some large vertebrae and a rib bone were also found in connection with the same.



1872

7

June 25 Started westward at 6 o'clock
P.M. Am.

June 26 Arrived at Columbus Mo

June 27 Reached Chicago and Evening

June 28 Started west at 11 o'clock
westward

June 29 arrived at Council Bluffs
at 11 o'clock P.M. but did not look
over to Omaha until 1 o'clock A.M.

June 30th Remained at Omaha

July 1st Started westward on Pacific
Railroad, at 11 o'clock A.M. from Omaha

July 2 Arrived at Cheyenne at
1 o'clock P.M. Came on down to
Denver. Splendid view of Mount

all the way - to west. Higher parts occupied by Snow-Long Peak in sight all the way - 10,000 feet above plains, and 15,000 ft above sea.

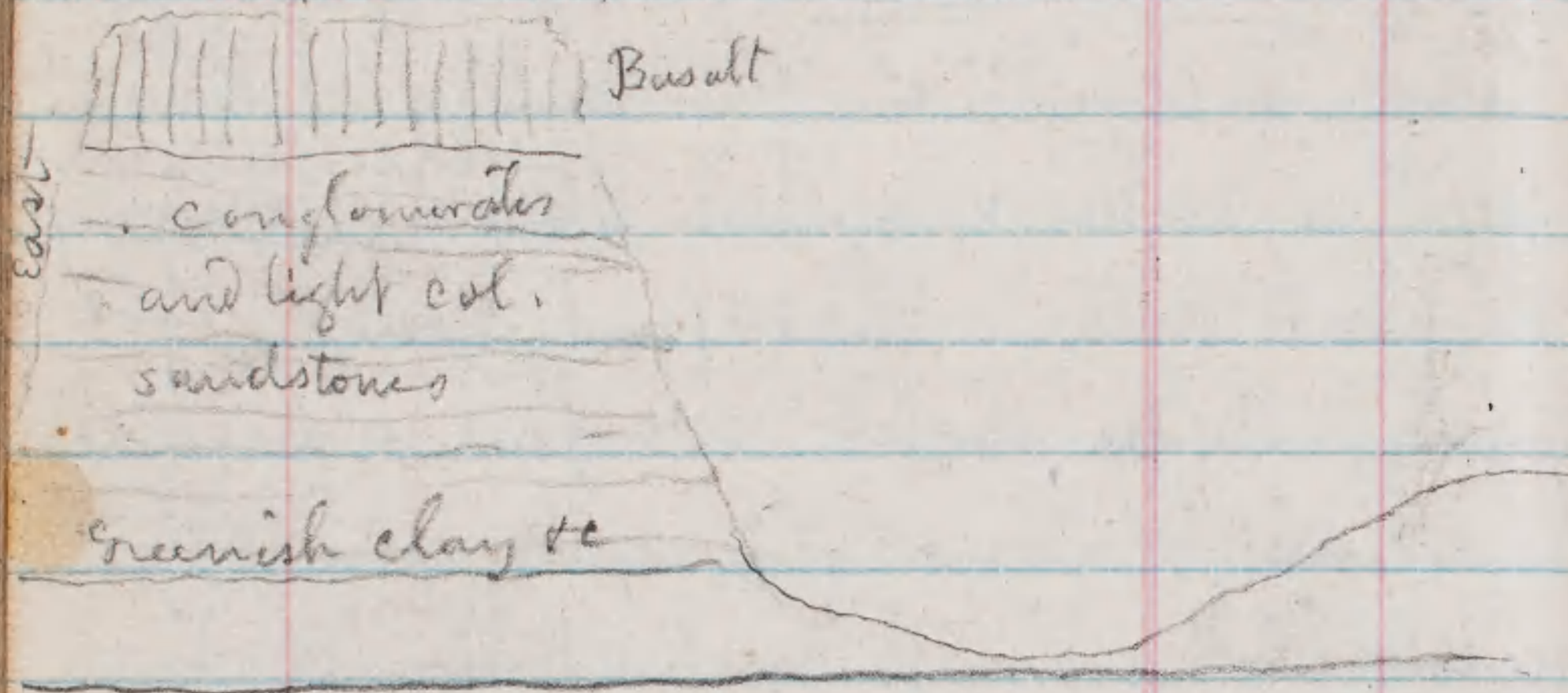
July 3rd Wednesday - Went up the Boulder valley branch of Rail road to Erie, some miles in N.W. direction from Denver. Being 3rd July, we could get not ready private conveyance on to Boulder city, to see the Coal mines there, and returned on same train to Denver, where we took another train to Golden City, 16 m. nearly west of Denver.

Erie. At this place there is a Coal mine - Coal crops out of a little slope on the plains some 6 to 10 miles from the foot hills. Coal overlaid by whitish Sandstone - bed ^{said to be} 7 to 9 feet thick - dips about 8° to S, or S.E.

Seems to be of good quality - taken out in large blocks, but like all of this coal it readily crumbles by exposure to the air. Palms found in ^{both Coal & Sand st.} Sandstone - certainly probably, July 4th Golden City - A pretty little town situated in the valley of Clear creek, a rapid Mountain Stream ^{flowing Eastward,} among the foot hills. These first ranges of foot hills are about 500 feet in height above the plain on the east, and are nearly flat on top just at this place, being capped by columnar Basalt about 100 ft thick, with a gentle slope to the south. The whole below the Basalt is said to be sand stone and Conglomerate, with greenish clay below, all lying nearly horiz. These beds under the Basalt are probably Tertiary of the same age as that of the Plains to the eastward. Clear creek valley cuts directly through the foot hill

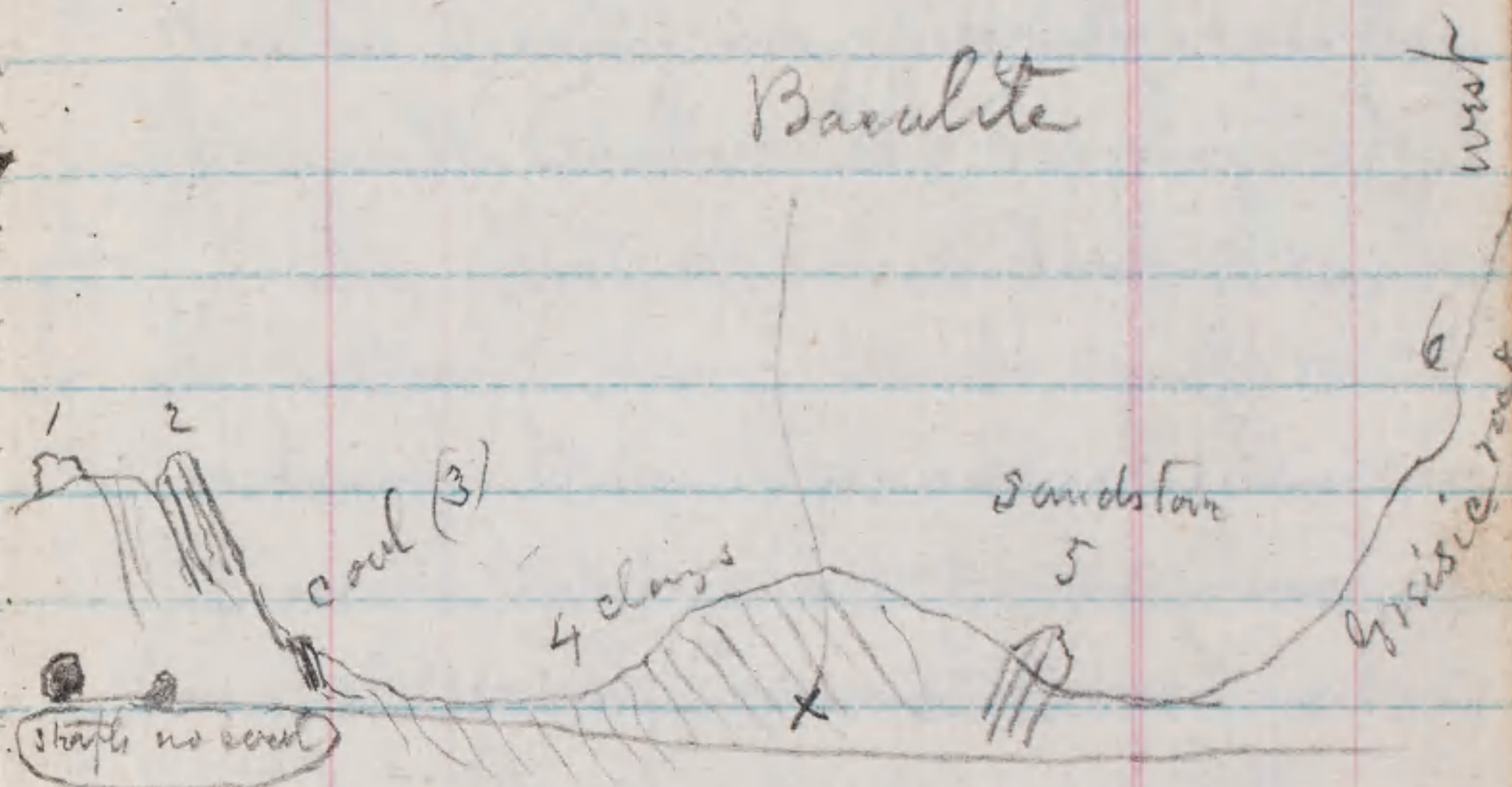
that is capped with Basalt, but just west of this hill (which is called here Flat Mountain), the Golden city village of this coal to the other rock will be a section running E. & W.

500 ft above valley



I did not examine the hill to the east of from the valley, and was informed by composing all of it below the basalt, is not more than ~~the~~ $\frac{1}{4}$ of a mile or less within the town, on the summit of a grey sandstone is seen dipping at an angle and containing many impressions and No 2 ash colored clays. No 2 same as No 1, and contains the

west of this hill (which is called here and coal mines occur. The relations understood by the following diagram



best saw the columnar Basalt capping. Capt. Berthoud, that the sedimentary rocks nearly horizontally. Going west from this, on the south side of Clear Cr. and almost little Hill at No 1, a brownish and light angle of about 75° in a S. S. W. direction of leaves of trees. There is between this is light, or whitish sandstone dips same plants.

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Almost in contact with this sandstone on S.S.W. coal ⁽⁴⁾ has been found, in alternations of light colored clays and light col. sandstone. Continuing in the direction of the dip we find a series of light gray or ash colored clays dipping same as coal and sandstone, and in these clays at the point marked (x) we found a Baculite at the point marked (x) only about 80 yards from the coal and sandstone. These clays are seen dipping in same direction for 30 to 40 yds. farther, where a mass of same sandstone as No 2 is seen tilted at a high angle in the opposite direction; while just west of this the second range of foot hills higher than the first are seen along Clear creek and on their E. slopes to be composed of Gneissic rocks, at some places becoming hornblende

7

with feldspar streaks - and passing at places almost into a granite the whole presenting the appearance of being metamorphic.

On the north side of Clear creek between the 1st and 2d ranges of foot hills, there is a dip-slope, and in this shafts have been sunk all on a range (or strike N. N. W. and S. S. E) with that already mentioned in the section on pages 4, 5 and at (3). Some of these shafts are 120 ft. deep. Coal occurs here associated with the clays and sandstone, as at (3) on the S. side of creek - beds coal said to be 7 to 14 feet in thickness, and dips with clay & sandstone as on South side Cr.

From section on p. 45 the coal and sandstone certainly seem to hold a lower position than the bed. clays containing the Baculite.

It is also worthy of note that this sandstone 1 + 2 contain leaves that seem to me like those found in the Dakota Sandstone on the Missouri. Hence I am inclined to think this Golden City coal occurs in the Cretaceous. There may however have been an overthrow of the beds here. Capt. Beardsley, that a few miles further south there are 5 beds of coal seen with alternating sand stone and clays, all standing nearly vertical, but with a slight easterly inclination, and he added that generally all along the eastern foot hills here, where the coal is found, the beds containing the Baculites and Ammonoites are to the westward of those containing the coal, and as

he thinks beneath its horizon. The impression left on my mind is, that this Golden City coal, and that at Boulder which further north, which I am informed occurs exactly in the same way dip to are level, and that at Erie, east of the foot hills, and much less upheaved in Tertiary

July 4th. Nights and mornings quite cool here at Golden City. Had to put on my over coat, even at dinner, though the sun was quite warm out doors.

Land here and all along the eastern slope of foot hills, and for a day or eight miles out on plains, at places, cultivated by irrigation, the water being conveyed from the Mountain by ditches, one of which is 27 miles in length, at Greeley colony,

Returned to Denver at 3 o'clock, where remained for the night

July 5th Came on to Cheyenne, where we took Pacif. Rail route for west, and arrived at Carbon Station at 9 o'clock P.M. Time view coming over Mt. at Sherman air quite cool. Coarse rapidly decomposing granite compose the Mt. at Sherman and for some distance. Descending to Laramie plains, saw much reddish and whitish rock exposures some places forming knobs and projections naked rock rising out of plains. At Rock creek and for some distance both E. & W. of there gray ash col. and dark clays like cut rocks.

Saturday July 6th

The section of the rocks here, as far as we could determine from

the exposures and shafts would be about as follows:—

		feet
12	Shale	8.00
11	Coal 2 1/2 to	6 in
10	Sandstone and sandy shale	50.00
9	Shale 2 feet to	5.00
8	Coal	9.00
7	Light ^{col} sandy shale, with harder, argill. layers containing many impressions of leaves. bed varying from 8 ft to	18 00
6	Coal varying from 3 to	4 00
5	Light ^{col} sandy shale	9 ft
4	Coal	5 ft
No 3	Light ash and drab or bluish soft sandy shale with some sandstone and probably some coal about	50 00
No 2	Heavy bedded and irreg. thin layers of thin	

divided light grayish and
 drab ^{rather coarse} sandstones, varying
 much in hardness, but
 weathering into large irreg-
 ular cavities; some beds
 to be hard, others soft.
 No 2 - 300 ft. containing at places con-
 fusely mingled ^{impressions of} stems and
 branches of trees - some fragments
 of lignite & thickness of white about
 Alternations of thickly lami-
 nated, rather hard sandstone, and
 No 1 - light ash colored clays and
 shaly soft sandstone, about 30 ft.

This section, it should be under-
 stood was not all seen exposed at any one
 place. No 2 ~~is~~ is well exposed,
 but No 1 & 3 are not well exposed, and their
 thickness is not given as exact. No 1 may

contain one or more ^{other} thin seams of
 coal. The order of succession, and
 thickness of the beds above are not far
 from correct. Those from No 8 to 12,
 were penetrated in a shaft ^{in dip}

The coal here from bed No 8 seems
 to be a good quality, and appears to the
 eye almost exactly like Carboniferous
 bituminous coal, though it of course
 differs chemically from the old coals.
 It burns freely with a bright flame
 and leaves a large amount of light
 gray ash much ordinary wood ash,
 without any clinker. It crumbles a good
 deal in handling, about 1/8 being broken
 or too fine for use in digging it
 in the mine, and it breaks rather
 rapidly into small fragments when
 exposed to the

These coal beds are much in-
 clined to ignite and burn upon

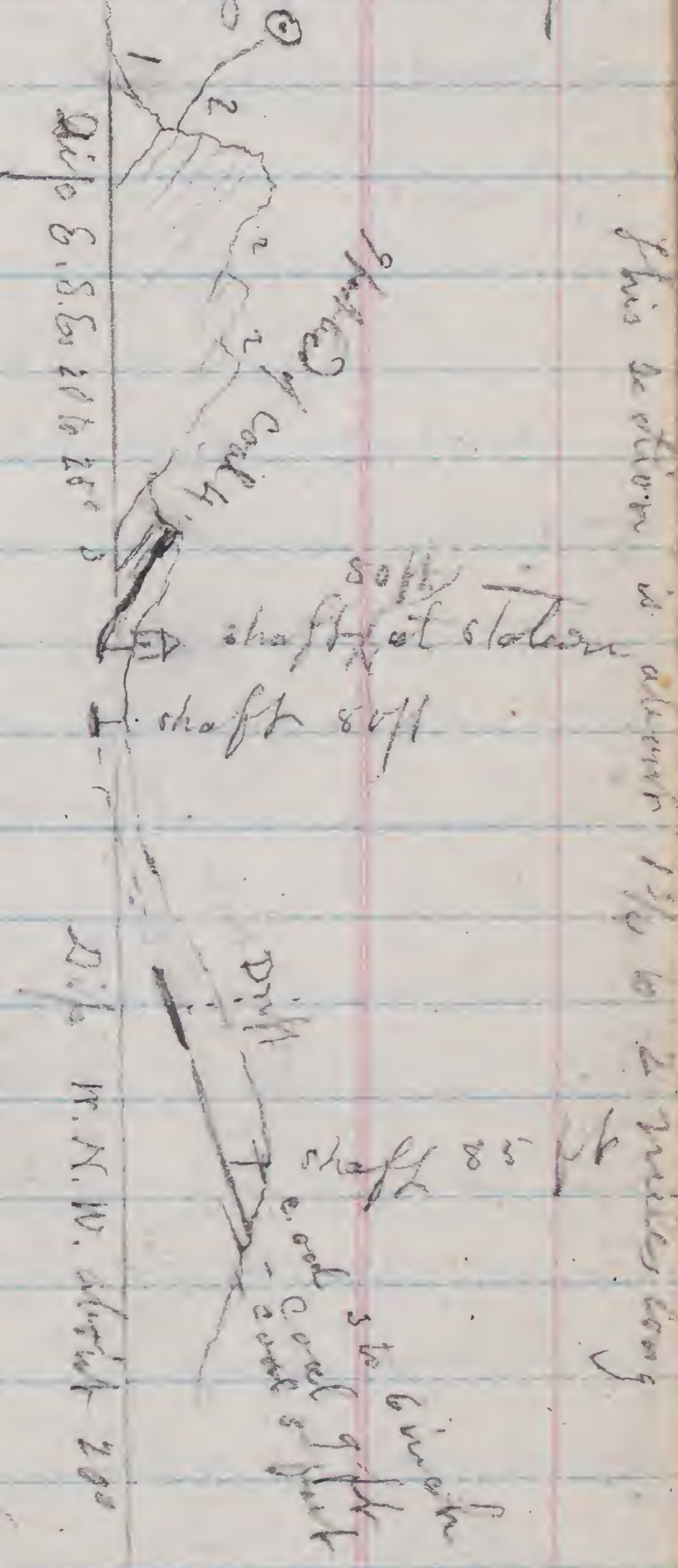
-taneously, at the outcrop and also far inward causing the earth to crack and fall in, over considerable areas. Indeed the mines say, it is burning at places nearly to the middle of the little basin. The beds are also much faulted at places so as to be rather hard to follow. The roof is also poor, and difficult to prop, requiring about 18 inches in thickness of the coal itself, to be left to form a roof to hold up the shale.

It is probable that Cretaceous beds occur here at little distance below the bed No 1, as light ash colored and bluish clays, like Cretaceous beds were seen in the lower ground off in the opposite direction (W. N. W.) to the dip. At about one mile in that direction, across a flat valley all the beds show a dip

to W. N. W.

Here at the mines, the whole series of beds show a decided trough like dip

Thus
 E. S. E. under the above section on the hills bounding N. N. W. side of this valley the sandstones, conglomerate, and shales are seen dipping in the dip
 1/2 to 2 miles across, showing light ash colored and gray clays with some sand beds and layers, probably dipping
 Each of this section there is a flat valley perhaps
 This section is about 1 1/2 to 2 miles long



beds all dip to S. S. E. Those nearest the valley are tilted at an angle of about 35°, but as we go farther from the valley in the direction of the dip, the angle of inclination ^{at first} gradually becomes greater and ^{near the middle, where it is 55°, after this it decreases again} until at the point marked *Plants* on the left of the foregoing section, the dip is only about 16°, while a little farther on in the same direction, the beds seem to spread out still more nearly horizontally. We made no measurements, but as near as we could estimate while walking along the Platte in the direction of the dip, on the south side of the valley, there would seem to be at least 1700 feet of these sandstones and shales here. Mr. Emmons informed me that the entire thickness of this series in this region is over 2000 feet.

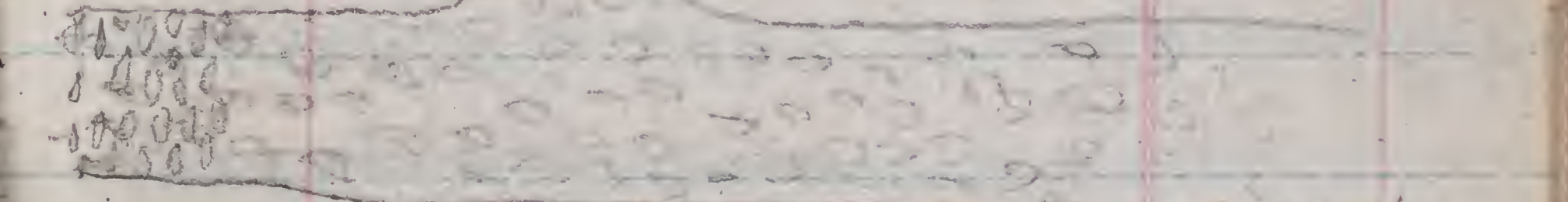
At several places on the S. side of the valley, the shales were seen by us to be thinly laminated, and full of fragments

of plants, with a few very thin seams of ^{to} inch ^{to} two feet of brown coal intercalated; while they sometimes become rather dark or in part nearly black from the carbonaceous matter finely mingled. The dark parts of the beds however are rarely more than a foot or so in thickness.

At one point marked *Oysters* in the section there is a bed ^{3 feet thick} almost entirely composed of oysters, which are the only animal remains seen by us in the series.

Near the middle of the series we saw in one of the sandstone beds, many casts and moulds of a plant having the surface scars similar to those seen on many coniferous trees this.

The largest stems seen were only about one ^{or two} inch diameter, while the smallest were seen

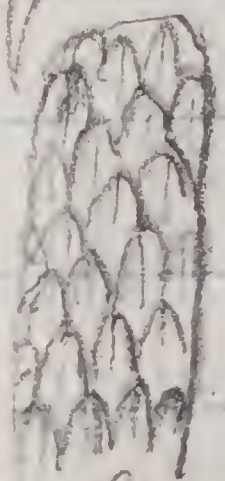


† There seems to be 2 oyster beds; Mr. Emmons saw one near top.

more than $\frac{1}{4}$ inch diameter. The branches often seemed to be given off nearly at right angles to the stems, and nearly to equal the same in diameter. In other instances the branches were given off at more acute angles.

I was interested to see this plant here, because I had also seen the same at Carbon in the beds at the point marked \odot in the section on p. 15 - say 350 feet below the coal.

Near the top of the series here, on the S of Platte valley, at the point marked "plants in shale" of the sec. on p. 19, I also found in one of the shaly beds alternating with sandstones, and at places becoming quite ^{dark} carbonaceous from the abundance of plant remains, flattened stems of a plant apparently much like that seen in the sandstone already mentioned. These are converted into thin films of coal, but leave

the impressions of their leaf scars quite distinctly on the shale like the  reminding one of *Sepidodendron* of the older Carb. Period. Numerous ~~the~~ smaller fragments of other plants also occur in this shale as well as in other beds lower in the series.

I saw no leaves like those found both under and above the coal at Carbon.

I am inclined to think the coal bearing part of the Carbon section holds a little higher horizon than any of the beds seen here, though they and the beds seen under the coal bearing strata at Carbon may correspond to some of the upper part of the section here at Fort Steele.

Mr. King and Mr. Emmons think the whole of this Fort Steele series Cretaceous; but I saw no fossils I could certainly refer to that epoch, or even doubtfully unless the above mentioned *lepidodendron*.

dendron-like plant is the same as one found in No 5 of W. J. per. etc. which it certainly closely resembles.

I did not examine the beds dipping nearly north, but they are mainly the same series, dipping in ^{opposite direction} nearly the

I noticed one peculiarity of the thick beds of sandstone of this series - that is, they are divided vertically by many ^{parallel} regular joints at right angles to the strike, the joint being so distinct as to give some of these beds almost exactly the appearance of strata standing on end, as seen on the broad surfaces of the upper beds.

Came on to Rawlins station, where we arrived at ^{a little after} 12 o'clock A.M. and went to bed quite tired and early.

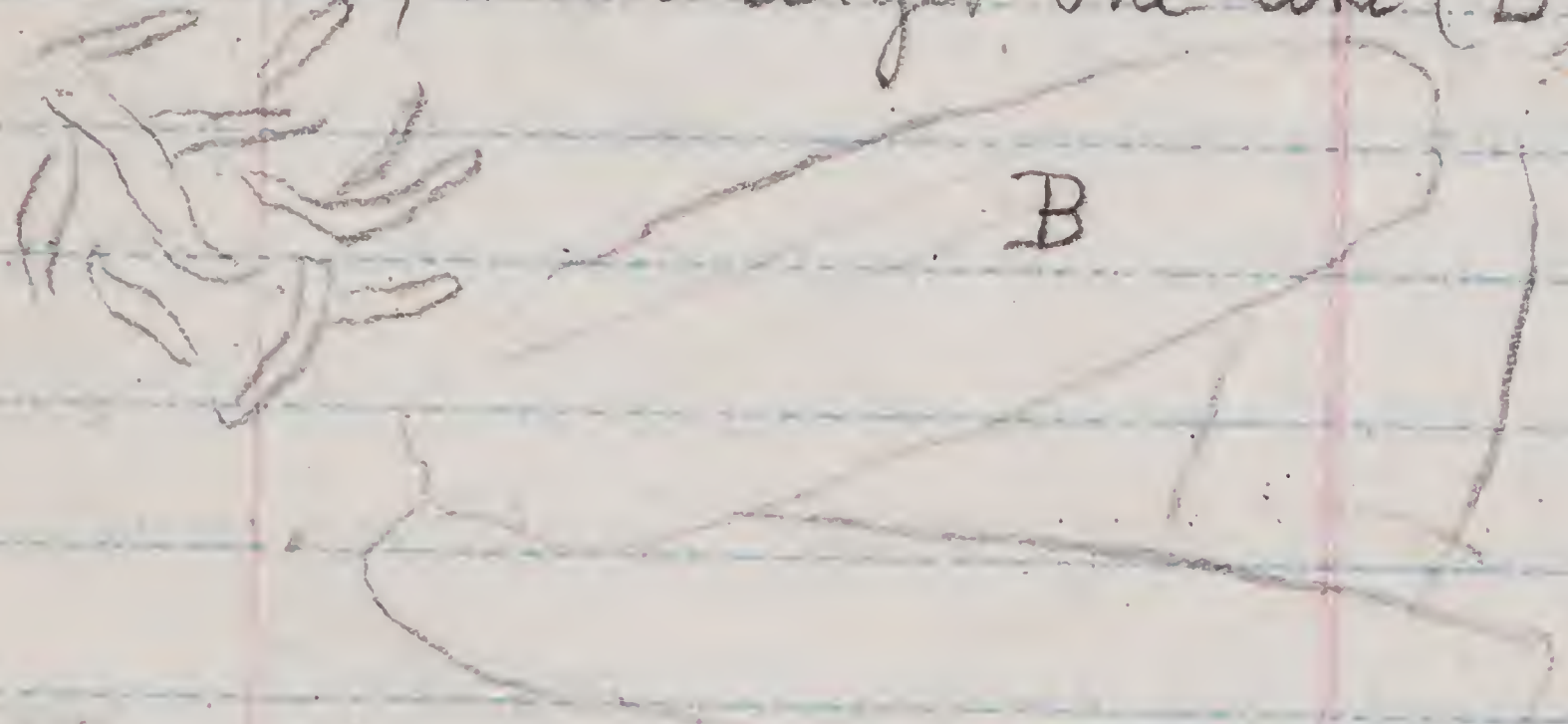
Tuesday & Wednesday July 7th & 10th

Remained at Rawlins station to examine the out crops, which show this we afterwards at other local. See other Sec.

(Rawlins Station)

	feet
Athyris + Whitish and grayish limestone	
Some beds very dark gray with flint layers, & thin vein-like seams of calc. spar cutting in various directions	200 to 300 or more
Ferruginous sandstone with pebbles at places sometimes passing into a rich Iron ore	10 to 20
Grayish and flesh-colored sandstones very distinctly stratified in layers of few inches to 2 or 3 feet - often extremely hard or thicker layers as compact as quartz-rock. Upper beds fine grained, lower becoming coarser with very small quartz pebbles, so as to pass into beds below	350
Very hard gray conglomerate, composed of coarse quartzose sand and small quartz pebbles - passing gradually into above	75
Rather fine textured grayish flesh colored granite rock composed of feldspar and quartz with at places apparently some hornblende - above valley	300 or more feet

species one small something like (A),
A. and a larger one like (B)



The larger, was usually seen on the surface of the layers a little above those containing the smaller.

In regard to the age of this sandstone No 3, and the conglomerate No 2, of course nothing positive can be said, but I suspect it is Lower Silurian of the Potsdam period.

No 4. This is at places only a highly ferruginous, and sometimes probably sandstone, but at other places it passes into a very pure Iron Ore, and some persons are now mining it at a point $2\frac{1}{2}$ miles S of the Rail road Station. The mine is situated at the base of the

hill at the right hand extremity of the section on p 24, the dip of the strata having brought the bed down to this horizon. When opened here, the ore seems to be an irregular mass without lamination or stratification, and probably swells out to a considerable thickness, though did not see how thick it is.

At this point we noticed that the dip of the beds causes them to roll over as it were to the Southward at a steeper angle than the S.E. dip farther up the slope.

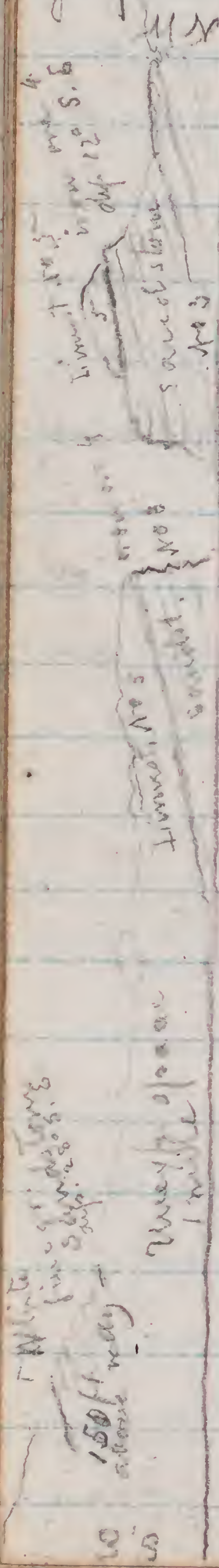
No 5. This is a hard whitish and dark bluish limestone, in part in massive beds containing beds of brown flint. These darker beds are often cracked in various ways, as if they had been shattered, and the cracks afterwards filled with white calcareous matter. It is best exposed at the spring supplying the station four miles nearly due West of the latter, as represented on the left of section on page 24. We did not have a good opportunity to measure it, but it seems

to be here between 200 and 300 feet in thickness or more. The only fossil seen in it, was near the top of the hill at the point marked Athens, where we found a species of that genus like A. subtituta. The rock however is almost certainly Carboniferous.

In looking at the section on p. 24, it will be observed that there is a wide space between the granite (No. 1) and the sandstone (No. 3) seen at the foot of the hill to the left. This space on the right of the granite uplift, it will be seen, is occupied by the extremely hard conglomerate and overlying sandstone, only a little of which latter is seen nearly foot of the hill to the left. Why these very hard beds are not exposed in the valley here immediately on the left of the granite I am at a loss to explain.

Glacial marks. At many places on the ridges the very hard sandstone No. 3 and conglomerate No. 2, are polished apparently by glacial action, which seems to have come directly from the N. judging from the direction of the markings, which can scarcely be called scratches, being simply a polishing of the surface of the extremely hard layers.

The Railroad here within about 200 yds of the station, passes through an abrupt gap in a ridge of the hard sandstone of No. 3. The direction of this ridge (which is near 100 ft. in height at the gap and perhaps 200 ft. a little N. of the gap) trends nearly S.E. & N.W. It is difficult to understand how this gap could have been made through this ridge composed of such extremely hard strata, but we may at least infer, I think that it was not worn by a running stream of water.



Between the limestone on the left of the gap, and the white sandstone seen cropping out of the slope of the hill, about 1/2 mile toward the left (S. E.) there is a long unexpressed space, which would be large enough, allowing for the dip, to afford room for 800 to 900 feet of strata. How much of this is occupied by the limestone, we could not determine, though only 25 to 35 feet of the limestone was exposed near the gap. The space is probably in part occupied by the white sandstone seen to the left. This is a very fine grained slabby sandstone, perhaps made finer further in, but splitting into thin slabs at the outcrop. It conforms to the dip of the limestone and sandstone below. Some are visible in it, and do not know whether it is Carboniferous.

The slope about 1 mile S. E. of this gap rises to a height of 500 or 600 feet, in the form of smoothly rounded hills. On ascent to the summit of these hills, we had a grand view of the surrounding country in all directions, for from 20 to more than 100 miles. The whole country being tundra we could see the outcrops of rocks of various ages, as clearly as in a geological model. On the S. long lines of bluffs composed of sp. Jurassic, Cret. & Tertiary beds, could be seen extending a way N. Eastward for 20 to 30 mi. The two first dipping to the S. ^{or a little W.} the latter app. ^{this now covered mountains.} dip in descent. Far beyond to the North, immense exposures of these and perhaps other rocks could be seen in the form of long ranges of continuous strata perhaps 2000 or more feet in height; while between these and the base of the hill forming the right hand end of the section on p. 24, a long belt of red rock could be seen cropping out in the

the low ground. This is probably of Triassic age. Elk Mt. could be seen with snow on its upper part in the N.E. at a distance of 40 miles to the N.E. At a low elevation some distance this side of Elk Mountain, there is a hill or mountain presenting a peculiar whitish appearance due to the nature of the rock composing it, but I do not know what it is.

Separation Station

Friday July 11th Came on to Separation

Three miles before reaching this place (E.S.E. from the station, the road crosses obliquely, a series of sandstones, whitish and ash colored laminated clays, with several beds of dark carbonaceous shales and some coal. These beds all dip at an angle of 10° to N.W., and the outcrops can be seen for a long distance trending off to the W.S.W. and E.N.E. From the Station we walked across the plane about 3 miles, in an E.S.E. direction

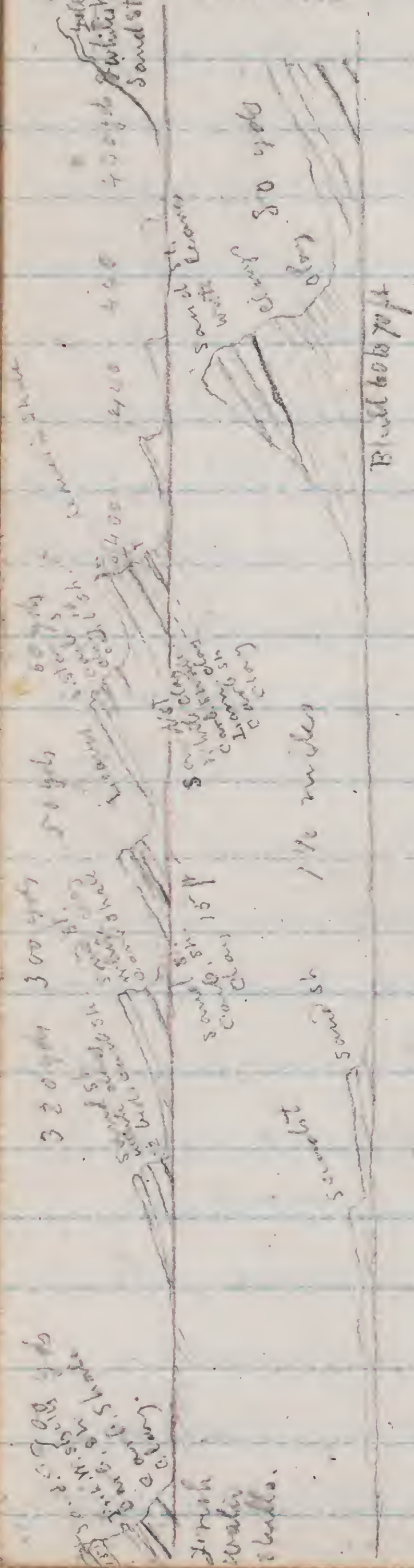
to examine them. We found there is here a series of alternations of sandstones whitish and bluish laminated clays, and dark carbonaceous shales, with some coal.

The shales and clays greatly predominate over the sandstones, however, in making up the whole, excepting at or toward the base of the series where there is a considerable development of white sandstone.

The whole series dips to N.W. at an angle of about 10° . The sandstone being harder than the clays and shales, stands up in the form of parallel ridges, with valleys and flat depressions between, owing to the more ready denudation the clays and shales. ^(excepting some of the heavy white S.S.) None of the ridges however, rise more than 100 to 150 feet above the plains on the N.W. here, while a majority of them are only 10 to 30 feet in height. A section across these outcrops at right

to the

strike would be like this



The length of this section from the white sandstone on the left of the upper division to the hill 60 to 70 feet high in the lower division, is nearly or quite 2 miles in a direction nearly E S E, and opposite the dip of the strata, which is nearly N. W. about 15° below the horizon, which would make about 1700 ft. strata. After leaving the 60 ft. bluff, and coming toward the R.R. station, in a nearly N. W. direction across the plain for about 1/2 miles some low outcrops of sandstone are seen showing a slight dip to N. W. with the same strike as the other beds. These would probably

be 500 to 600 feet of unexposed beds in this low flat space between these outcrops and the highest (60 to 70 ft.) hill, thus making altogether or 2200 to 2300 feet of these beds above the heavy beds of the white sandstone.

It will thus be seen that we have here a great development of alternations of whitish clays, carbonaceous shales, sandstones and some coal. Some of the carbonaceous beds we saw ^{or contain} pass into thin seams of coal, and there are doubtless other coal beds in the shales of the little valleys between the ridges, where they were unexposed, as we were informed at the station that there is one 25 foot bed of coal in the series that has been spiced, and worked to some extent, but abandoned because it is inferior to the coals farther west.

In one of the thin layers of sandstone over a bed of Carb. shale, above the middle of the whole series we found specimens of *Vivipara*, *Limnea*, *Gonobasis*.

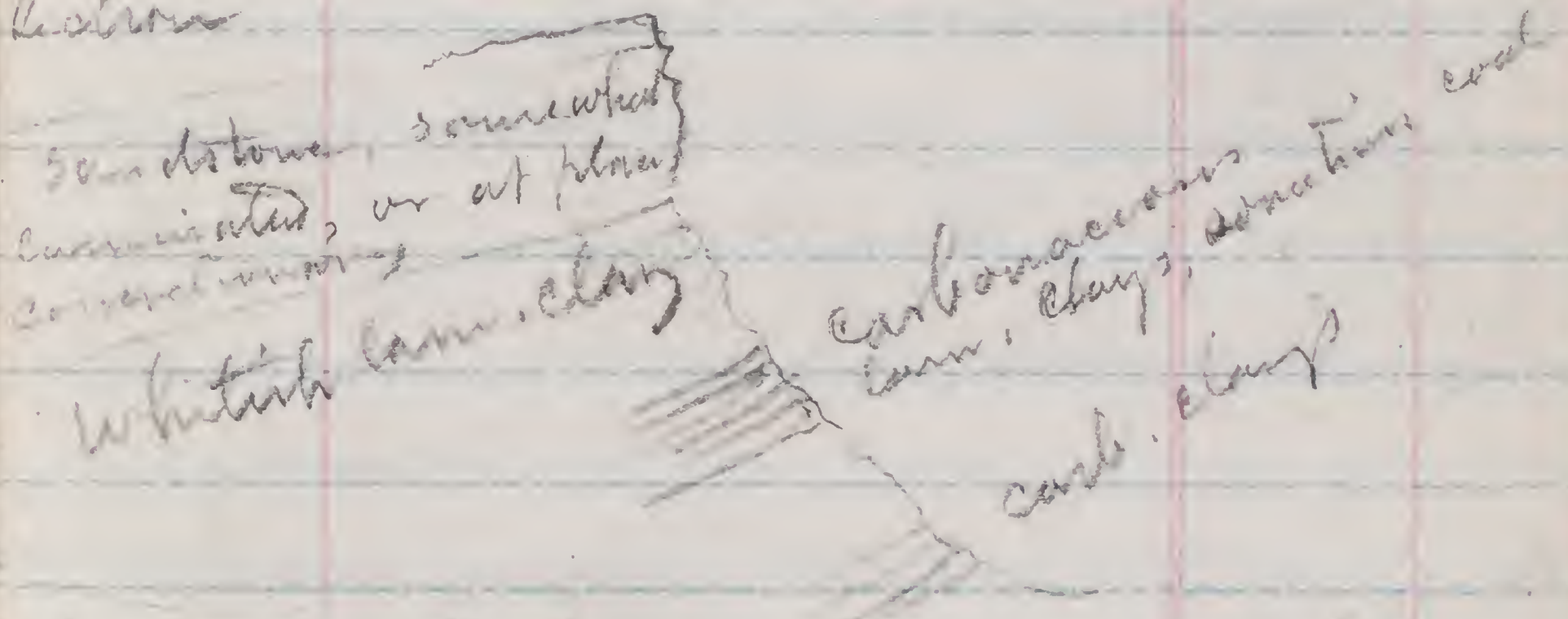
and fragments of Uros, showing the beds to be fresh-water. At several horizons below this, and at one above it, we saw imperfect impressions of large leaves like those of Platanus.

I think this series nearly, or quite all of Tertiary age, and that with possibly the exception of some of the lower part of later date than any of the beds we saw at Fort St. Vede. Its lower part I think corresponds to the beds at Carbon.

Whitish clays and darker shales predominate in this series over the sandstones, which are usually comparatively thin and incline to a laminated structure. The clays and shales are also usually laminated. These white clays together with the massive white sandstone at the base give a whiteish aspect to the whole formation, especially as seen in the distance, and I have little doubt but that the peculiar white

hills seen near Elk Mt. from Ft. St. Vede and Rawlins are composed of this formation.

As seen here at Separation, the outcrops form a succession of parallel ridges, with depressions between, each ridge being formed by the harder sandstone, and each depression by softer clays and shales. These ridges usually present each the following section



Some of the beds of sand st. are ferruginous, or contain concretions of iron ore, and there are of course not always just tops of the beds of dark shale.

This formation evidently spreads out and underlies a considerable area here to the N., N.E., N.W., West & W., S.W., which is

low and comparatively nearly flat. Here at the station, about $2\frac{1}{2}$ to 3 miles N.W. of the nearest high outcrops represented in the section, they are sinking an Artesian boring, to find good water. At this time they have gone down 550 feet, through strata similar to those forming the section on p. 35, and evidently forming the upper part of some series (see sec. of borings in Mr. Bannister's note book).

In looking back toward the granite uplift at Rawlins's station, the rocks seen there form elevations quite distinctly seen from here. A little to the left of the granite carb. ^{to} there is a high hill said to be 1500 ft in height, the upper part of this hill presents the same whitish appearance as the rocks here, and is almost certainly formed of them as the strike is in that direction and from the hills south E. of here the parallel ridges formed by these rocks can

be traced back to this very high hill near Rawlins's station.

Water in the borings here — The water obtained here up to this time, is impregnated with ^{carb.} soda and carb. lime. The proportion of the two salts together, ^{to the water,} is said to be 138 grains per gallon. This forms a crust on the inside of steam boilers; hence they have bored deeper, and are still boring. The water found just now, ^{however,} is much free from alkali, and considered good, though they are continuing the boring with the hope of striking water that will rise to the surface — that now obtained having to be raised by a steam pump for about 38 ft.

This is a very barren desolate region. Wild sage & mesquite are the prevailing, and largest vegetable growth seen. There are however, a number of pretty flowers; I think the variety of these greater than in the rich prairies of the Mississippi valley. Nearly all the plants of this region

(Bitter Creek Section)

grow in bunches, with bare whitish clays & sand between.

Saturday July 12th Came to Bitter cr

Table rock

15 feet hard sandstone - *Uris, Gonobasis.*
6 in. shale and coal

2.0 ft light br. incoh. sand st.
3 1/2 ft shale

12 ft. light brown soft sandst.

20 ft shaly sandst

12 ft. Lt. br. incoh sandst

240 ft shaly sandst with intercalated beds clay & shale

Gonobasis, Virifans

Gonob. uris

12 ft. harder sandst, shells

25 ft whitish shales

10 ft light st. *Gonobasis*

Whitish shaly beds, with some intercalated harder strata - at base 4 ft. carb. sh

136 ft
No fossils seen

Unexposed long slope, probably including 200 feet of sandstones and shaly clays

Alternations of soft high gray and buff rather whitish and gray clays, the gray generally more or less harder brownish sandstone

All dip 4° to 8.5° S.

The top of this section (Table rock) is an isolated part of the formation left by the denudation of the surrounding strata, standing on a lower bench of the same formation. About 6 miles farther back, there is a still higher bench, about 200 feet more of strata; while there are about 180 feet under this isolated hill (Table rock) of some rocks down to base of the first bench. From the latter there is a long slope to an other series of benches ^{coming down to} near the bottom of the lowest country

4 miles *unexposed* N. S. W. 4 E. N. E.

or more

heavy bedded sandstone, and laminated. Some thin layers of

275 ft } No fossils seen

* It is flat, and nearly an acre in extent on top, which is at the same elevation as a part of the immediately adjoining country to the East

This lower outcrop shows about 275 feet of soft sandstones, with some harder layers alternating with whitish shales and clays. Between this and the base of the first bench 4 to 4 miles E.S.E., the rise of the slope is very gentle, but this being ~~very~~ nearly in the direction of the dip there must be nearly 150 to 200 feet of unexposed strata there. This would make here, above the base of the valley, including the most distant bench back on the highest country, about 1200 feet of strata.

This great series contains many alternations of soft, rapidly decomposing, very light gray to buff sandstone in beds from about two to 15 feet, alternating with whitish to ash colored clays and shales often more or less laminated. The thicker beds of sandstone sometimes show oblique lamination and contain little bullet-like ferruginous concretions, with some large irregular masses of hard brownish sandstone. These beds all change their lithol-

characters so suddenly that local sections of the same strata will be seen to differ much in short distances, and thus become less useful, excepting to fix horizons of fossils. It is much like the section at Separation, but contains less carbonaceous shales. I think it belongs to the same group, and in fact even to the same part of the group. It contains ^{fossils and mostly} shells here however, and we saw ^{and esp. dark carb. shales} some leaves of it, which at Separation were observed in several beds.

The beds all rise gradually here to the W. N. W. gently so that lower beds come up in that direction. About 14 to 18 miles in that direction there is a very high isolated hill, evidently composed of these ^{or similar} ~~which~~ beds.

For some distance back (eastward) along the Rail road in the region of "Red Bank" fine exposures of this formation are seen forming a long bluff apparently about 400 feet in

on to this place) height, above the road, which, runs along a kind of plain 4 to 6 miles from this bluff. Off to the west of the road, in sight of Red-desert and Table rock stations, there are seen on this lower country or plain outliers of the same formation, at a distance of 10 to 12 miles from the road, forming singular pyramid-like hills of naked whitish material apparently 400 to 600 ft in height. All the strata here appear almost horizontal to the eye, but have a gentle dip of 3° or 4° to the E. S. E.

An artesian boring has been sunk here to a depth of over 200 feet, commencing at about the horizon of the base of the section on p. 41 (for beds penetrated see Mr. Barnister's note Book). Remained here until Sunday morning.

Sunday July 13th

Came out this morning at 9 o'clock to Black Butte station. The distance

from Bitter creek to Black Butte, is, by the Rail road, about 9 miles, but by a right line, it is only about 5 or 6 m. We are here only about 40, ^{feet} below the actual elevation at Bitter creek; but as the dip of the strata is nearly eastward 6° to 8° degs, we are geologically hardly less than 150 feet lower here, and probably much more.

Rested here during Sunday

Monday & Tuesd. July 14 & 15

Examined the rocks here, and found a great development of sandstones and shale clay etc with several beds and seams of coal. All of these beds are lower than the lowest seen at Bitter. There must be at least 1500 ft of beds between the lowest outcrop seen here and the lowest at Bitter Cr. Station, as the dip is in that direction (E), at the rate of 8° or 10° here, and decreasing to about 3 to 5 there while the distance by a right line is about 6 miles. See following section

Black Butte sec.

47

Great development whitish clay and sand st. off in direction of dip

all
 of
 the
 dip
 of
 the
 strata
 is
 toward
 the
 west
 at
 an
 angle
 of
 6
 to
 8
 degrees
 nearly
 east
 and
 west

32	Above the last, alternations of bluish & ash col. clays with oc. 300)	
31	-casional thin beds lam. Sandst	
30	Sand st. yellowish gr. Palm & other ^{leaves}	2
29	Ash col. bluish lam. clay	6
28	Lam. grayish brown sand st	1
27	Bluish lam clay with 1 foot darker shale above	7
26 X	Red lam. sand st. and shale - a very marked horizon about	20
25	Light yellow shale with 6 to 8 inch thin laminated sand sh above	10
24 -	Coal	1/2
23	Lam. sand st. light col above - and darker below	9
22	Dark shale, with lighter more sandy above	7
21	Light gray lam. sh. with thin sand sh above	8
20 =	Coal	3.
19	Bluish lam. sh. with a dark ^{scum} near middle - lighter below (selinite)	12
18 =	Coal 4 1/2 dark sh. above & below Mine worked	6
17 x	Lt. shale below, darker above with Oyster shells - lam. sandst. above	5 1/2

48

16	Coal & shale	2 to	3
15 +	Dark gray buff sand st. in thin layers shells - large bones!! one x 1/2 to		2 -
14	Shaly clay, with seams sandst.		8
13 -	2 ft coal, with 1 ft. dark shale above, and same below		4
12	Lighter lam. shale or clay		4
11	Lam. dk. gray shale, with Marine shells and a sulphur like powder. Vertical thin seams calcareous matter.		2
10 =	Coal		1 1/2
9	Laminated shale 1/2 foot to		1
8 +	Soft sandy & becoming more or less laminated below		15
7	Massive light gray sandstone becoming more thin layers above		40 50
6 +	Bedd light gray sand st. in parts becoming brownish. Spirifer and shell corals		
5	Areaceous clays, or soft, about lt. gray sandstone		6
4 x	Shale with stems of Spirifer and other plants, some as seen but it st. shale		14
3	Soft light gray sandy material with some lam. sh.		12
2	Light gray and some buff massive sand st.		20
N ^o 1	Large grayish planish clays before upheaval into alternations of same with sand st. splitting in exposure into thin shales		130

The foregoing sec. was taken with much care, though I am aware that local sections in these rocks cannot be relied upon for the identification of the same beds at different localities. They are useful however to show the relative positions of fossils in the series.

I have little or no doubt that beds Nos. 1 to 8 inclusive, are the lowest beds seen by us at Separation Station, and are the same massive sandstones underlying the coal at Carbon Station. At least they agree well in lith. Char., in their positions with relation to the coal beds, and contain the stems of the same *Lepidodendron*-like plant seen in that at Carbon.

It is worthy of note, that this same plant occurs at Fort Steel in the sandstones below the middle of the series seen there.

Bed No 15 contains numerous shells of an elongated *Corbicula*, mingled with some oysters, and a small rounded *Corbicula* - Some *Melania* or *Goniobasis*, a *Vivipera* I can't distinguish from *V. trochiformis* of the Upper Mo. Lignite, also bones of a very large Saurian? #N.B. in labeling the fossils of this bed the bones are marked "Bone bed" and the shells found at another locality are labeled "Shell bed". We afterwards found out that they came from exactly the same bed No 15.

Bed No 11 contains many shells but in such a condition, that we could not preserve them, the shaly matrix falling & crumbling to pieces so readily. I saw among them, however, an elongated trigonal *Corbicula*-like shell that is more like a species from the Lignites of the Upper Mo. and

and doubtless belongs to near the same horiz. Various other shells, almost certainly marine forms occur here in this bed, but they could only be seen in a crumbling condition.

I am much inclined to think this bed (11) not far from ^{about} the dividing line between the Cret. & Tertiary. It is true Oysters occur in beds 16 & 17; but the shells associated in bed 15 are fresh and brackish water types, that may have been swept into an estuary salt enough for oysters to live in. It is worthy of note however that the Oysters have a more worn appearance (as if drifted) than the other shells, and are less numerous. At any rate, as we find no characteristic Cret. types in any of these rocks; while the Corbiculars are very like those Eocene types from the Signites of the Paris basin, I see no decided evidence

that any of these beds are Cretaceous, but think them Eocene, ^{or Cretaceous} though the beds below No 10 & 11 are probably Cretaceous. I have little doubt but the clays forming No 1 are. These layers seem to be of considerable thickness, as a bluff off some miles to the S.S.W. from the State on here can be seen capped by the other beds up to 7 & 8 inclusive, with a slope apparently 200 feet in height to all appearance composed of No 1 of the section. The country off to W. N.W. is also low with rounded hills that look as if composed clay only. At a distance of 12 to 14 miles beyond these hills or undulations however, a very high isolated ⁸⁰⁰ ^{1 to 1000} hill (Blk Butte) is seen covered partly with cedar trees which gives it the dark appearance that has caused it to be ^{called} Blk. Butte. Whitish out crop, however, with

harder rock on top, can be seen in places. These are evidently lower beds seen here at the Station, ~~and~~ ^{than those} ~~lower ones~~, brought to that elevation by the rise of the strata in that direction (800 to 1000 ft) This is the same hill mentioned on p. 44 as being in sight off Bitter Creek Station.

It will be seen that the strata composing the section seen here in $\frac{3}{4}$ of a mile of Blk. Butte station, given on pages 47 & 48, includes about 340 feet. This is $\frac{3}{4}$ ^{mile} going directly in the direction of the dip, which is almost exactly in the direction of an air line between Blk. Butte & Bitter Creek stations, which are by such a line 5 miles ^{apart}. If the strata dipped all the way at the same rate (6 to 8°) this would make 2250 ^{feet of beds}, crops out between here and these lowest beds seen there. The dips, however, gradually decrease

so that at Bitter creek it is not more than from 3° to 5°. Allowing for this, there would probably not be less than 2000 feet of beds come in between here and the lowest stratum seen there. Add to this the 1200 feet between Bitter Creek station and the highest part of the country back of Table rock ^{we have} 3200 feet of beds in three great series.

Wednesday ^{to} Thursday 17 & 18.

Spent these days studying the rocks that come in between (below) the Black Butte sec. ^{a mile below} and Hallsville (4 miles). Between these two points we make very careful sections measuring every bed, by walking over the hills in the direction of the dip, and climbing up. The dip was about 2 miles, ^{at right angle to dip} and the distance walked was at right angle to dip.

The top beds (42) of this section, connect with No. 1. the Blk. Butte section on pages 47 & 48; but it is worthy of note, that the connecting beds of these sections are not conformable,

55 (Hallville Section)

The dip of the upper beds of the Hallville sec being 18 to 20° to S.E. - while the lower beds of BKK sec. dip E, 5 to 8°

dip 15 to 20 E.
 dip 15 to 20 E.
 dip 15 to 20 E.
 dip 15 to 20 E.
 dip 15 to 20 E.
 dip 15 to 20 E.
 dip 15 to 20 E.

42	Bluish white soft sandst. & clays, with thin harder gray sandst.	90
41	White soft sandst.	60
40	Bluish sandy sh. darker carb. & laminated at top	10
39	Hard brownish sandst.	2
38	Whitish dash col. clays, with thin seams darker do. & some sandst.	26
37	Buff and gray coarse sandst.	26
36	White sandy clay, and dark carb. shale, with thin imp. coal	20
35	Mafine light gray & whitish sandst.	33
34	White sandy sh. clays, with some darker, passing into thin seams coal at places	25
33	Grayish buff sand sh. & sh., with some darker shale	25

32	Gray heavy bed sand st. some beds sandy shale	12
31	Gray and darker carb. shales & brown red and buff at places (Leaves)	20
30	Grayish soft sandy bed with <i>Ostrea glabra?</i>	5
29	Very dark lam. clays. In places brown in at places	5
27	Whitish sandy clay, 8 to 10 feet, passing East and into bluish white sandst.	25 to 30
26	Gray sand sh. weathering brownish	8
25	Sh. drab. sh. and lam. clay	15
24	Ash col. lam. clays	8
23	Hard gray sand st. & some sh. & clay + <i>Ostrea glabra?</i>	30
22	Light grayish sandy clay sh. with some thin seams brown sandst. + <i>Sepidod.</i> plant at top in brown sandst.	350
21	Wahley fossils 30 feet <i>Stroma</i> <i>Musk</i> , 30?	
20	Light colored and dark arenaceous clays, with possibly some coal. sand st.	50
19	Thin layers brownish sand st. with <i>Spiram</i> <i>divid</i> plant	2
18	Drab clay, & sandy shales. Lam. bluish gray and light col. sh. - BKK. lam. carb. sh. below 2 ft.	37

	17	Light gray ripple marked sand st. with above 2 or 3 ft. gray or bluish shaly clay & ore or 2 dark carb sandy shale some thin sand st.	20
	16	Thin layers gray shaly sand st. weathering brown ripple marked	4
	15	Same as no 13 repeated	74
center	14	Gray ripple marked shaly sand st. weathering brownish with some shale	8
3	13	Bluish gray & yellowish lam. clays with some carb. shale	26
B	12	Layers gray sand st. weathering brownish	4
2	11	Ash col. sandy clay & shale	12
1/3	10	Thin layers brownish sand st.	3
5	9	Light col. sandy shale above 2 Blk. carb. sh. or imp. coal. veg. fragments 2	4
8	8	Lead gray lam. carb. sh.	24
8	7	Bluish gray concretionary sand st.	4
5	6	Yellowish sand, or soft decomp. sandy sh.	14
5	5	Gray lam. carb. shale with selinite	8
2	4	Bluish & ash col. sandy lam. sh. & clay	13
A	3	Bluish white sand st. & sandy shale	20
2	2	Gray lam. sandy shale	3
	1	Very rough bluish, white and gray sand st. rather coarse, with some brown is parts. some parts oblique lam stratification obscure. (see p. 63)	125

great bluish gray
series
is parts.

stratification obscure. (see p. 63)
see p. 63

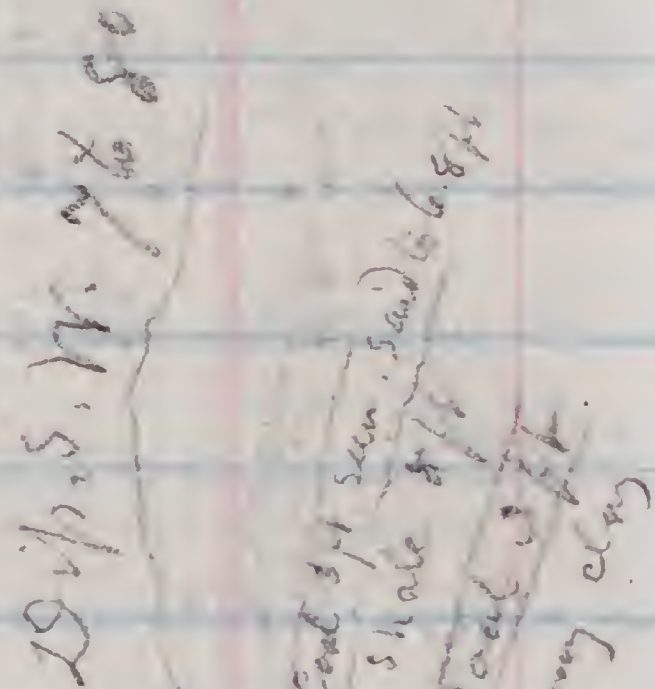
The non conformability of these dips at the junction of these two sections, as well as the direction of the dip throughout the two, would seem to indicate that they belong to different epochs, though apparently the same system, and certainly the same *Lepidodendron* plant, as well as dict. leaves occur in them both.

The disturbance of the beds that caused the non conformability is seen at the Hallville coal mines, and extends thence obliquely across in an eastward direction.

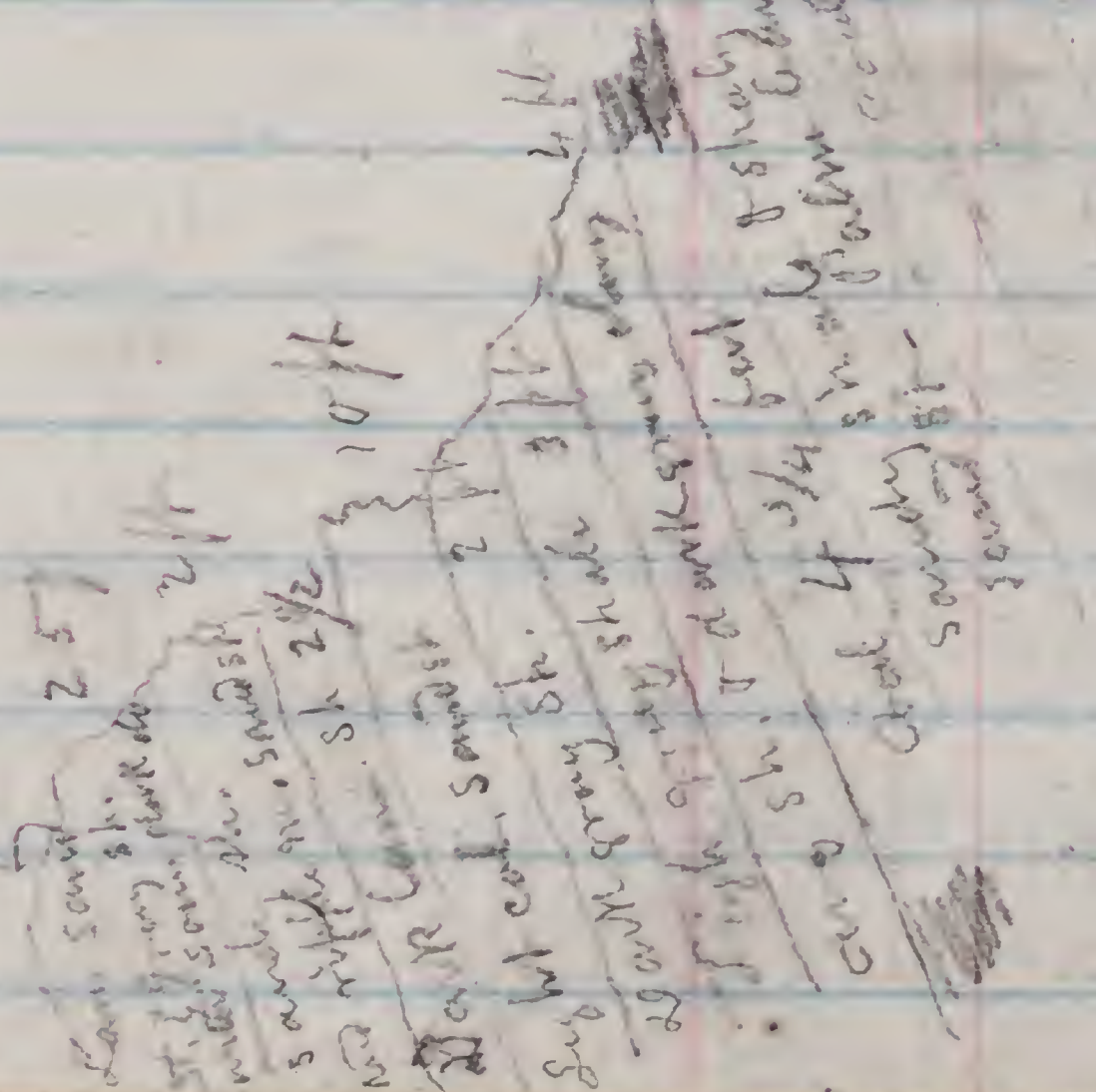
The position of the coal beds at Hallville in the section is between no 8 & 19 of the section, but the coal seems to have mainly passed into carbonaceous shales at the point where the base of the Hallville section commences, one mile to a mile and a half N. N. W. of the mines.

The mines have not been worked for some time, and consequently the drifts have fallen in, so that I could not get a good section at the mines, where the strata

are also somewhat confused. I seem to be as follows though I am not positively as to the number & thickness of the beds (accepting the thickness of the 4 foot 9 inch bed)

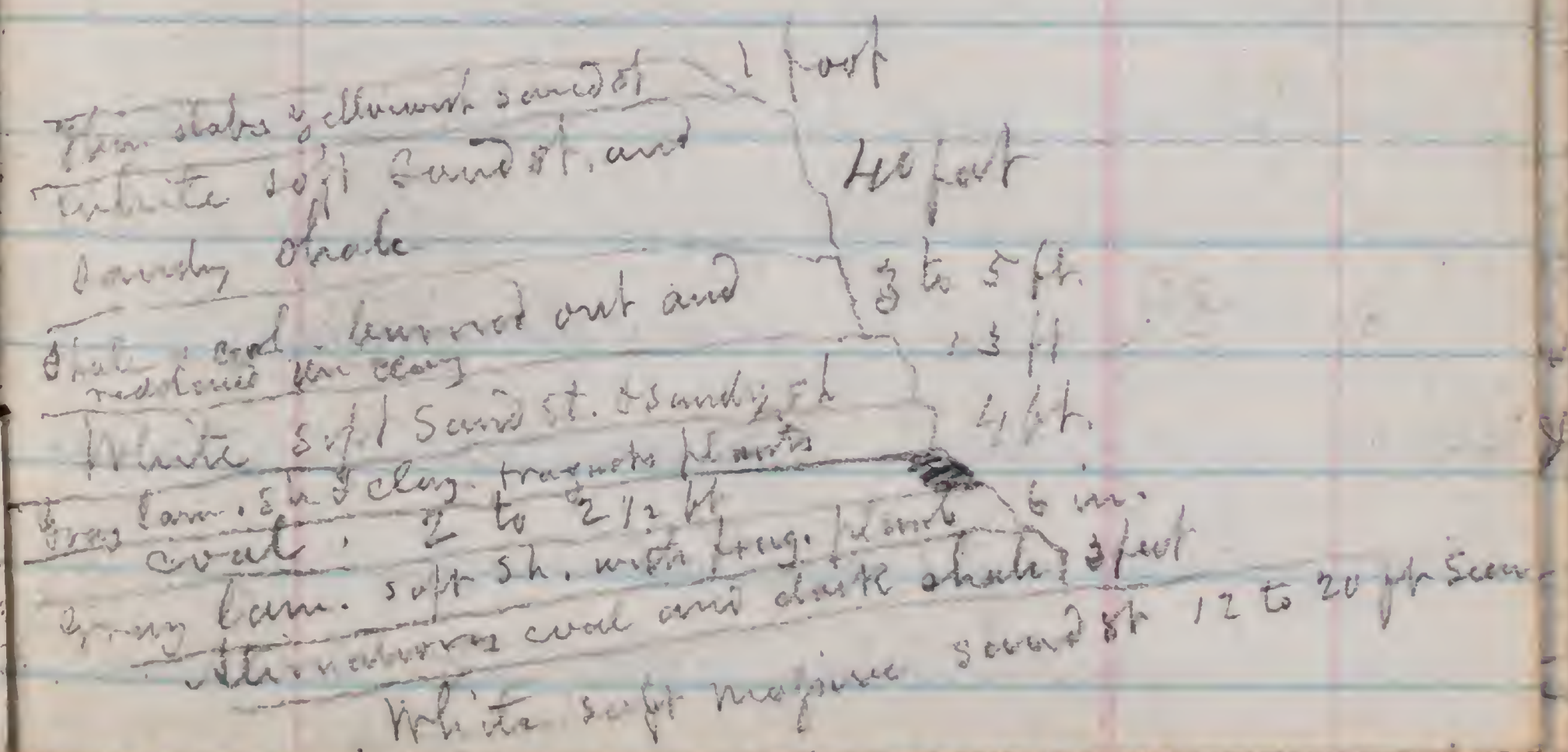


Dip N.E. 10 to 15°



This appearance of a S.W. dip here on the left may be due to a slipping down of the strata. The thickest bed of coal I could see the entire thickness of measured 4 ft 9 in. and seemed to be pretty good coal, as did that of the other beds. None of those I saw open out however, have a good roof over them the shales above being soft and difficult to prop up.

Coming back toward Elk Butte Station, from the Hallville Coal mines, about 1 mile S.S.E. and of course at a higher geological, as well as a somewhat higher actual level we saw the following section.



This little section is nearly 2 miles W. of the point where the corresponding beds in the sec. on ps. 55, 56 & 57 were seen. Its position in that section is from 27 to about 36 inclusive, though in these rocks no two sections of the same beds at a little distance apart correspond in details. Standing on the high hills, however, we could trace this white zone of strata so as to connect the outcrops for miles along the strike of the strata.

It is worthy of note, that in these formations, the coal beds occur as it were in groups of several beds separated by shales. These shales and coals form dark zones that can be seen for a number of miles from high points. It is also a fact worthy of consideration that these are nearly always more or less heavy beds of white sandstones below each coal zone, that can be seen

for long distances. Often the coal has ignited spontaneously, and reddened and sometimes, in places, fused the contact areas clays. These reddened clays form brick-red zones above the white ones.

Came on this evening to Point of Rocks.

Friday July 19th

The bluish-white, and lead gray beds forming No. 1 of the Hallville section, forms a continuous line of bluffs on the right hand side of the road coming westward from Hallville to, and beyond the Point of Rocks. It is a peculiar rock, weathering into very rugged out crops, or nearly perpendicular cliffs. It is generally soft and rapidly decomposing. It includes some of usually local beds and seams of ^{bluish} gray, dark gray and black, generally sandy shale, with occasionally, a little coal. Its beds frequently change from rather massive, to shaly or thin layers in short distances; while

(Sec. at + near Point of Rocks)

Some of the beds change to yellowish gray, and other colors; but everywhere the prevailing tint is a light bluish gray or often bluish white.

This morning after breakfast, we went westward on a hand car with some Chinese laborers and their overseer, six miles, and then worked back eastward to this place taking a continuous section of the rocks, which dips to the W.E., back to this place, which is as follows

	feet
Great lead-gray and bluish white	500
27 ²⁰⁰ of sandstone series (this includes the 125 ft. at base Hallville sec. given on p. 55, 56 + 57)	
26 Dark gray sandy shale	2
25 Soft drab and brownish harder sandst. above, and drab and gray sandy shale below	23
24 Massive drab sandst	27
23 Bluish sandy shale	4
+ Gray sandstone with masses	

22 + small oysters, some corbulae } a Corbula, Goniatites } 1/2	
21 yellow, brownish & gray soft shale + sandst; thin sandst that weather brownish	55
20 Massive yellowish drab + light brownish sandstone	36
19 - light col. shale, with some black and perhaps a little coal	2
18 whitish sandst. with some white and gray shale, dark lam. shale	30
17 and shaly sandst with some thin seams coal.	
15 Grayish soft sandst shaly in places	45
14 with white sandst above	
13 Heavy bed whitish sandst.	14
12 Yellowish or light brownish sandst with some sandy shale	22
11 Yellowish sandy clays + shales with alternations thin + brownish sandst.	155
10 Soft yellowish drab sandst some parts lam.	26

12	Whitish sandy shale	16
11	Yellowish drab sandst.	26
10	Soft light gray decomp. sandst. and sandy shale	10
9	Light grayish shale	8
8	Thin black lam. carb. sh.	2 1/2
7	Yellowish drab sandst.	20
6	Soft shaly sandst, with dark shale, with 12 inch coal and soft sandy shale above	12
5	Yellowish shale, lam. sandst and sandy clays	12
4	Dark lam. carb. sh. & light col. sandy clays	50
3	Coal	2 1/2
2	Dark shale	1
1	Gray sandy sh. lam. with two or three inch coal lighter shale & clay below	18

Saturday July 20th

In the bluffs here, in the horizon of the Hallville coal, above the great Lead gray series, there are 4 or five beds of coal. Could not make out their exact thickness. One of the beds (I think the second one has been worked a little) is 4 feet in thickness. The upper bed is near 150 feet above the Lead gray series, and a little ~~is~~ above it, there is a bed of gray sandy ^(8 in to 2) rock filled with Oyster of different species from the little one found 2 1/2 m West Pt. R. which holds a position about 700 ft lower. This larger one also holds a lower position than those seen in the Hallville section. Hayden & King have both collected the same sps.

A Sulphur Spring at base of bluff here at Point of Rocks
Lable rock in sight from the tops

of hills here in a direction slightly S of E.

Came on to Salt Wells Station at 12 O'clk today, and rode back 5 miles on a hand car, to continue our section ending on p. 65, downward in the series. Had to walk back 2 miles to the point where that section ends. The rocks having a N. E. dip here and back to Blk. Butte Station (and east of there, to and beyond Table ^{big dip nearly east} rock) we are constantly descending in the series here, for a long distance coming westward.

Commencing our section, we have next below No. 1, of Pt. Rock section ending up 65, the following beds, descending, but numbered from below upward:

Sec. Betw. P. Rocks & Salt Wells station

	Grayish drab massive sandst	20
23	Light col. clay & sandy shale	13

22	Drab or yellowish sandst	2
	Light col. sandy clay with some	
21	lamin. Carb. sh. and coal	7
20	Bluish white sandst & shale	4
19	Light grayish shales, clay & sandst	14
18	Grayish drab sandst.	30
17	Bluish white sandst	6
16	Drab or grayish buff sandst	40
15	Soft shaly sandst. & light col. sh.	30
14	Bluish white sandst.	10
13	Carb. Shale (some coal?)	2
12	Bluish white and yellow ^{thin} sandst	25
11	Carb. Shale	3
10	Bluish wh. sandst	10
9	Drab heavy bedded sandst	50
8	Light gray shale & shaly sandst.	18
7	Blk. shale & coal	2
6	Bluish white sandst.	10
5	Grayish drab massive sandst	40
4	Bluish white sandst.	6
3	Heavy ^{red} drab sandst with some shaly ^{alternation}	80

2	Bluish white sandst	10
1	Grayish drab sandst	30

This section is all seen in coming ^{South} Westward about 1 3/4 to 2 miles across the strike of the inclined strata, though none of the hills rise at any one point more 150 to 200 feet above the valley of Bitter creek

The lowest beds of the above section end in descending order, the great series of Gray, drab & bluish white Sandstones Shale &c composing the sections back to Black Butte Station; while in coming westward, we immediately meet with a lower series, of thin layers of grayish drab slabby sandstones, clays ^{in the upper part} and some coal, in which ^{we see} no more bluish white, and heavy beds of grayish drab sandst. This series ^{is named by Hayden to be} presents quite a contrast in appearance with that

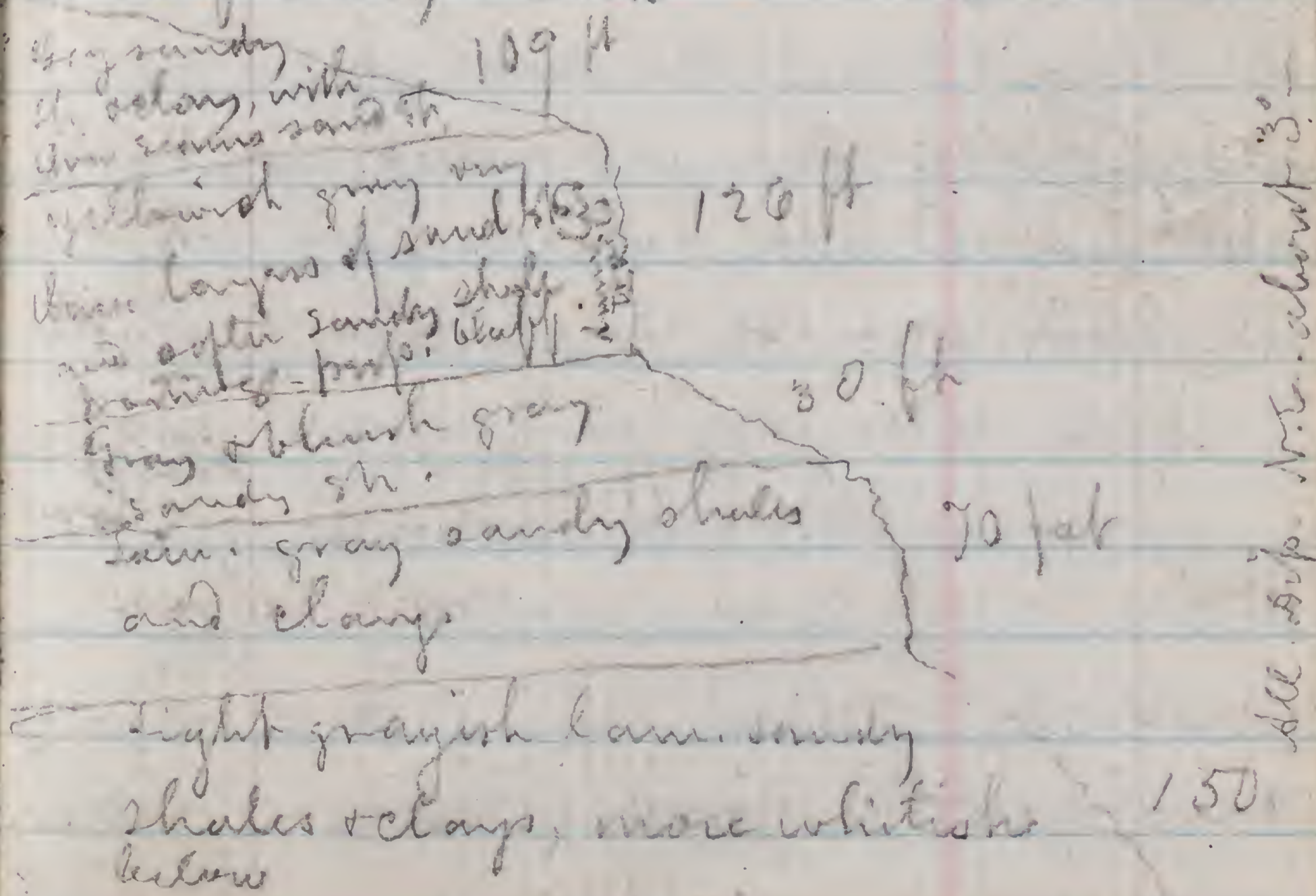
under which it dips to the N.E., having no heavy beds of any kind, and ^(more) ~~usually~~ presenting perpendicular outcrops

Sunday July 21st

Rested at Salt Wells Station

Monday July 22^d

Salt Wells station is situated on the broad valley of Bitter creek. Two miles S of the station there are high bluffs of the lower series mentioned above, shown in the following section



All dip N.E. about 30°

From the top of this section, I could see off to the N.E. at a distance of 4 1/2 to 5 M. the lowest outcrops of the last section ending on page 69, and as near as I could estimate from the gentle dips, and from following by the eye the gradual slope of the best marked horizons of strata in that direction, I should think that about 200 to 250 feet ^{or more} of beds similar to those composing the section on the last page come in between its upper beds and the lower beds of the sec. ending on p. 69. This would make about 700 feet of this ^{lower} series here, between Salt Wells and the point where the lower beds of the section ending on p. 69 were seen.

Salt wells station, however, is situated in an anticlinal valley, there being a reverse of dip some 4 or 5 m. farther westward, and as the station is 2000 miles east of the middle of the anti-

clinal, there are probably some lower beds of this lower series, than those of the base of the section on p. 70, that come to the surface a little W. of here in the valley, so that there can scarcely be less than 1000 feet of this series here above the base of Bitter Creek Valley. I saw no fossils of any kind in this series, but a few markings like fusoids and Annular trails were seen.

From the top of the hill forming the upper bed of sec. on p. 70 Black Boulders were in sight to E.S.E. some 30 to 40 miles. In looking from base hill to the N. & N.S.W. obliquely across the broad valley the same beds could be seen forming hills and dipping gently to S.W. Over and beyond these some 3 or 4 miles farther ^{the another higher range of hills composed} of the Great Blush White Sandstone ^{alternations bluish - white st. clays Coal &c &c} could be seen; and beyond these another range of higher hills, composed of white

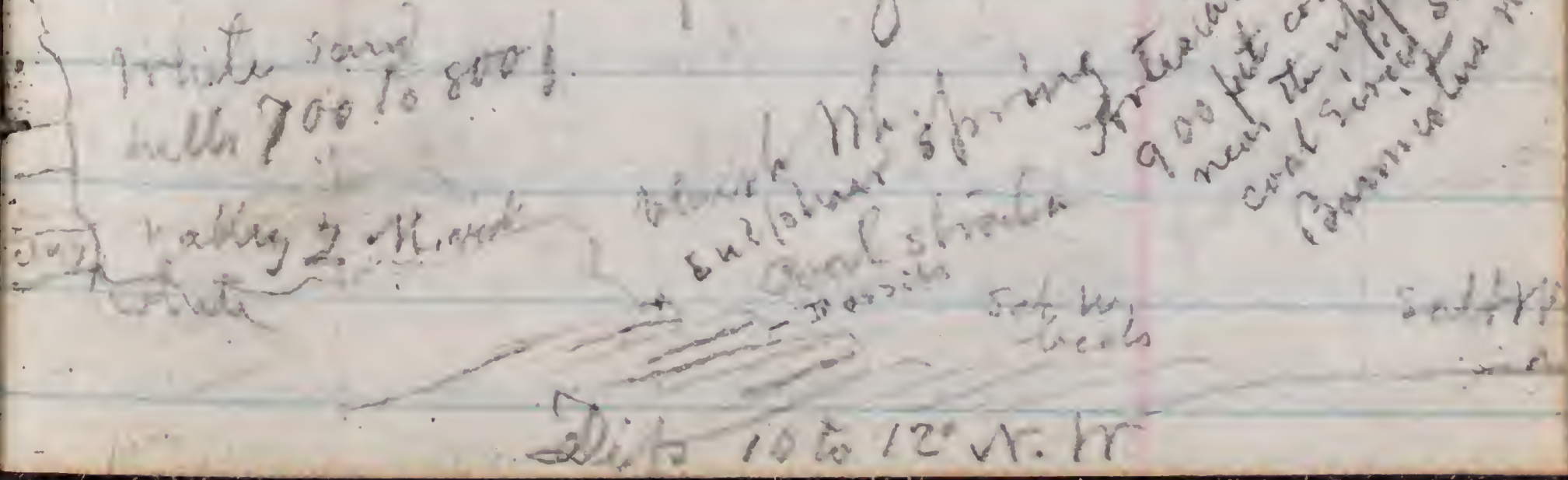
beds. Far beyond the latter, an isolated hill with a flat top, could be seen to the west, probably 40 to 50 miles distant.

On coming onto Rock Spring station we found fine exposures of the series seen on p. 63, 64, 65, 67, 68 & 69.

It seems to be of about the same thickness here, and dips to the N.W. 10 to 12°. Here, however, it contains many valuable beds of coal, from a few inches to 9 feet in thickness. The lowest bed exposed is 4 feet in thickness, of good quality, and has so firm a roof of indurated clay, or gray slate that it requires little or no timber to hold it up. Above the middle of the series, and 8 feet thick is now being extensively mined for the use of the Railroad locomotives. Some 40 to 50 feet below this bed, and not far from the middle of the series, we found a thin seam 3 to 5 inches in thickness containing many specimens

of a strongly ribbed *Corbula*, some *Strophia*, a *Modiola*, and a *Spondylus*? Here, as farther E., this series of rocks has at the top a great bluish white or light grayish sandstone, with some intercalations of shale, & perhaps at places some little coal. This does not seem to be quite so thick as Pt. of rocks, though there are more beds of the same character below it here than there. There are here more numerous, and thicker beds of coal in this series below the great bluish white sandstone. This horizon being here the great repository of coal while farther east (Wallville, Pt. of Rocks) the main coal horizon is above the great bluish white or light gray sandstone.

Rock Springs



The coal series here dips to N.W. 10 to 12°; so that the upper great bluish or gray sandst. passes down nearly to the horizon of the Bitter Cr. valley a little below the R.R. station. Across this valley ^(2 miles wide) to the N.W. there is a long range of high hills perhaps 800 feet in height almost entirely made up of white fine lam. sandy beds with some shale. The coal series and sandstone evidently dip down and pass under this high country. The strata in this white hill seem to lie nearly horizontally, but have a gentle W. or N.W. dip of 2 to 2 1/2° and are of course unconformable to the older series upon which they rest. After sketching the section on last page at Rock Springs, I noticed as we come on in the cars, distinctly, the unconformability of this new group of strata, to the older. This is better illustrated in the following

Rock Springs, July 23^d

Brown sandst.

white lam. sandy layer

valley 3 m

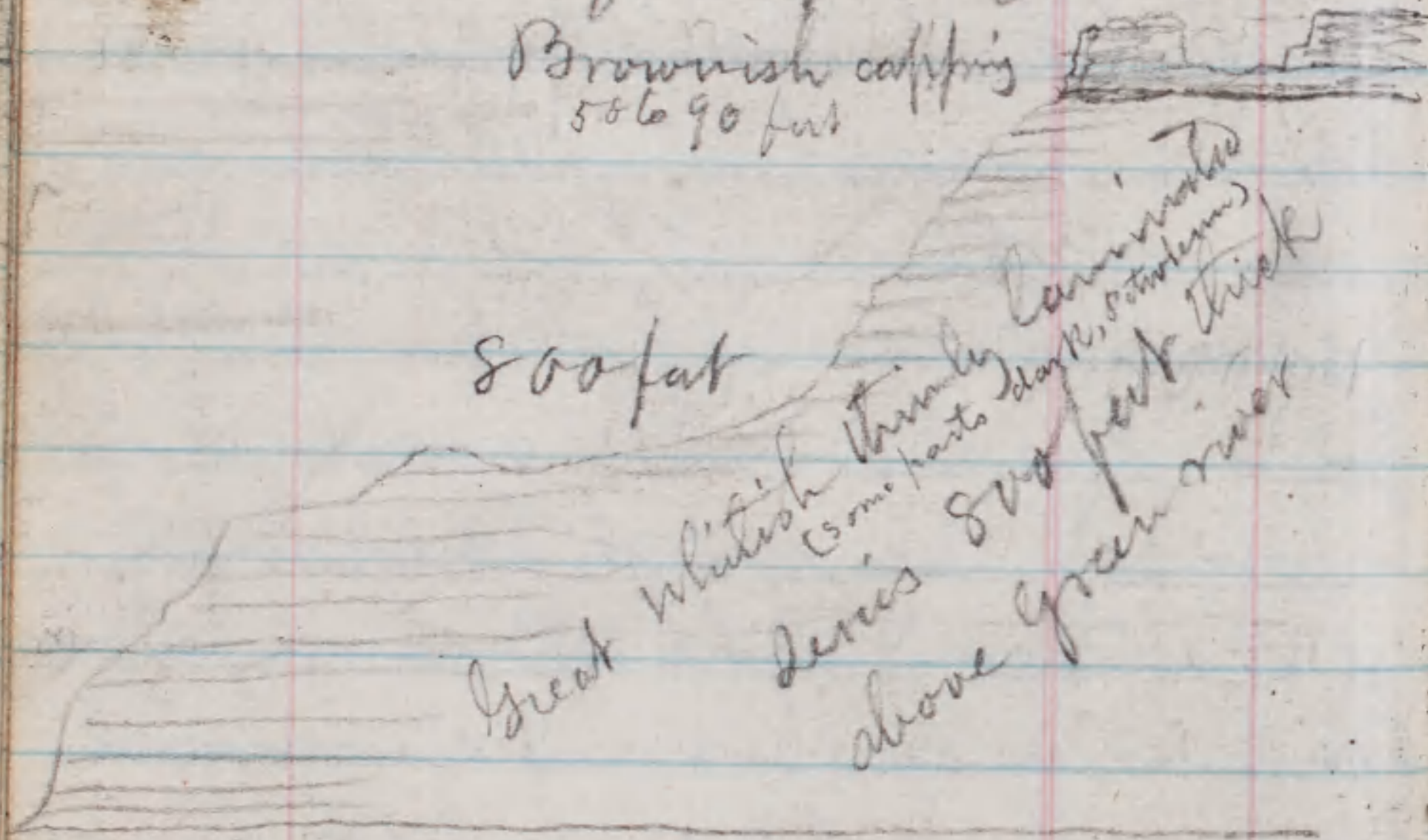
Coal series, dip N.W. 10 to 12°

Coming on to Green river, we immediately leave the Coal series, and overlying Great bluish white sandstone ^{near Rock sp.} and pass between hills composed of the later group. These hills look almost white, being composed of fine whitish arenaceous clayey material lying nearly horizontal, or only with a dip of 2 to 2 1/2° to N.W. or N.W. When freshly laid open in Rail road cuts, this material is more compact with a slight bluish tinge, but on exposure it splits into thin laminae like the leaves of a book, and then crumbles into fine loose, whitish clay sand or arenaceous clay. At some horizons there are grayish and darker bands ^{impregnated with Petroleum} but they weather whitish

78 Green River
Tuesday July 24

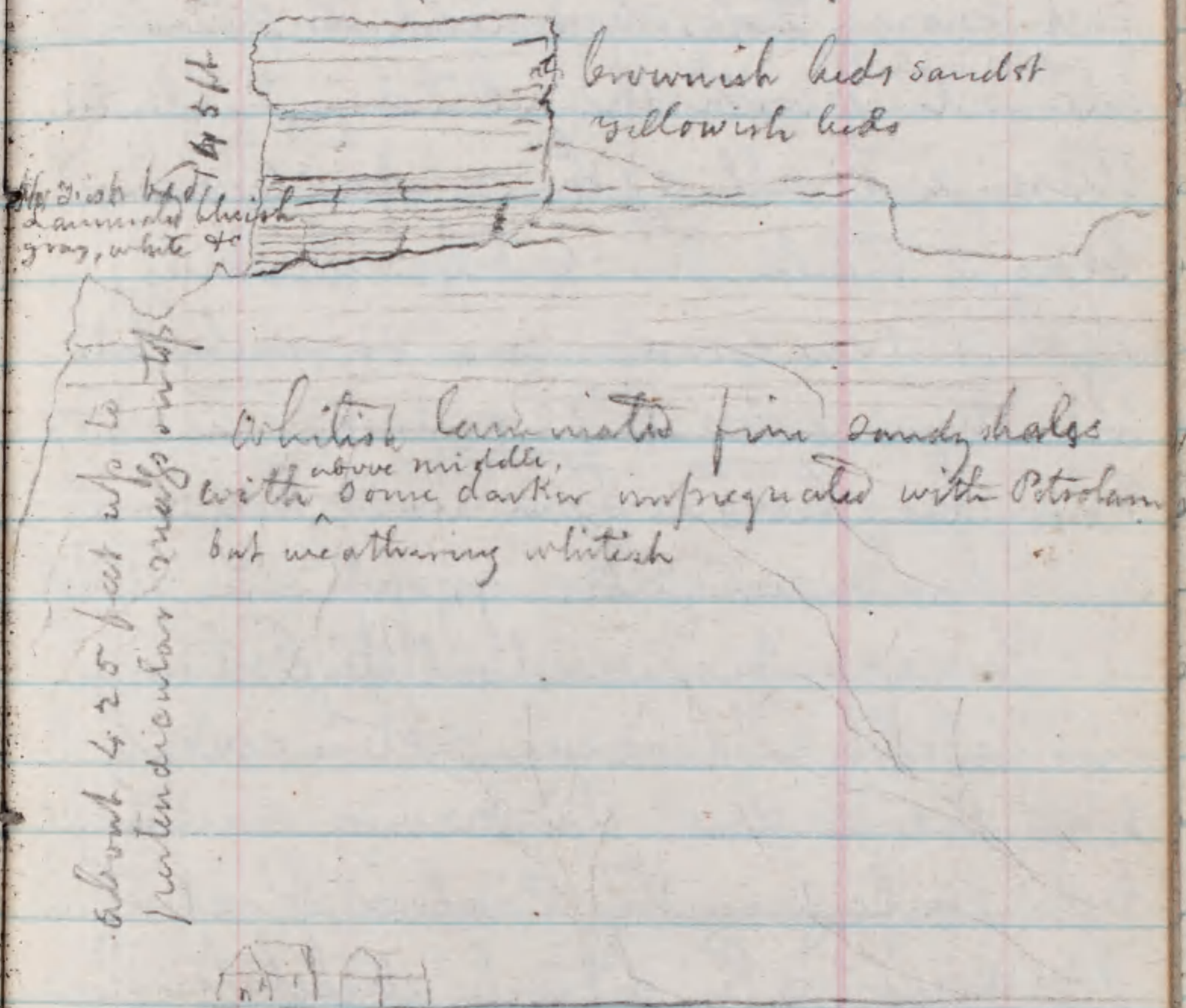
It rarely forms perpendicular outcrops, but very steep naked slopes. On top of them there is here at Green river 90 to 150 feet capping of harder, more massive, brownish, and yellowish sandstone, with at places yellowish and lighter colored bands, and sometimes more or less concretionary structure. This forms perpendicular outcrops crown in many isolated hills here. Just below the Green river village the following sec. occurs

Brownish capping
50 to 90 feet



Green River 79

Just behind the village, there is an isolated mass of the upper brownish beds crowning one of the hills as follows



west of Green river station the dip brings the upper brownish beds lower, and away to the gentle dip the rise of the surface they soon pass out of sight. Back between Green river and Rock Springs

there are some lower beds of this new group than are to be seen here at Green river; perhaps 100 to 250 feet more, that show reddish bands alternating with the whitish. Including these and all of the upper brownish beds, I think the entire thickness of this new group can scarcely be less than 1000 to 1200 feet; and it may be more. It is what Hayden calls the Green river group.

This group is undoubtedly Tertiary, and probably Miocene. It is certainly more recent than the marine or estuarine beds containing the Coal at Rock Sp. It seems to be entirely destitute of Coal, but contains in the upper beds many little fishes, flattened between the laminae, at a locality 3 miles W. of Green river station, in a Rail Road cut.

Three M. W. of Green R. in a Rail road cut through ^{the} lam. beds forming the lower 25 to thirty feet of the perpendicular map crowning the hill at Green R. numerous small fishes are found flattened between the lam. ^{of the} shales.

Wednesday July 25th

Came on to Bryan's Station this morning. A few miles west of the fish locality near Green river, the brownish and yellowish sandstones capping the hills at Green river pass by a gently westward dip, out of sight, to be succeeded by lighter colored beds of shale, and soft sandstones much like those below, in places, but generally grayer. The country here is rather level and but little elevated above Green river. About 4 1/2 miles W.S.W. of Bryan station, ^(in upper part of) there are some isolated Buttes about 150 feet in height above ^{at this place} Green river. The lower beds here are grayish laminated, or thin.

layers sandst. Higher there are bluish
 and whitish ^{more argillaceous} And at the top of the flat
 topped Buttes there are thin rather hard
 gray layers filled with *Uris*, and *Goniatites*
 more or less silicified. In one layer there
 are also millions of *Cypris*.

A little N. of E. from here an
 isolated butte of considerable height, and
 flat on top, is seen at a distance of 20
 to 25 miles.

Winta Mountains are in sight at a
 distance of 70 to 80 m. to S. S. W. whitened
 with snow.

The strata here, and back to Green
 River, appear nearly horizontal, above the
 Brown sandst on tops hills at that place.
 There are apparently about 200 feet of
 the lighter beds above the brown sandst
 and I think these upper beds belong to
 the same group as those at Green
 River, to which they seem to be conformable.

able. Hayden however, proposed the name
 Bridger group for this upper series.

Friday July 25

Coming on westward this upper series
 of the Bridger group continues to form the
 whole country. Its strata lie very nearly
 if not quite horizontally. It is seen at some
 points forming hills perhaps 150 feet in
 height above Green river. It continues on
 or all the way to Carters Station. Just
 west of the latter place, an other series
 of strata, composed of grayish sandstones
 often tinged with green, and alternating
 with reddish and whitish or light colored
 clays, rises from the Bridger group. This
 latter series is not quite conformable
 with the Bridger group, as it shows
 a distinct dip of 5° to 7° nearly eastward
 which, as above stated, lies nearly horizon-
 tally. I do not think the Bridger gr

attains a thickness here of more than 250 to 300 feet

The group rising from beneath the Bridger (which Hayden calls the Wasatch gr.) presents quite a contrast to the Bridger gr., having more massive and more greenish gray sandstones, with decidedly reddish clays. It also imparts a different, and more hilly appearance to the face of the country, and supports a scattering growth of small ^{scrubby} Cedar trees. From Carter's station we came on up the shallow valley of Muddy Creek to Bridger Station, 9 miles in a nearly south direction, ^{travelling} all the way on the Wasatch group. Winta Mts in sight, whitened with snow, all the way.

Saturday July 27

Here at Bridger Station we saw the following section, in the hills a little N. or S. of road from the station

		Alternations of gray rather	
		coarse sandstones, and reddish	165
		and ash colored sandy clays	
	13	Massive gray sandst. stained reddish above	13
	12	Ash col. and reddish sandy clays	22
	11	Gray sandst.	8
	10	Reddish & yellowish gray sandy clay	16
	9	Massive gray sandst. stained reddish above	23
	8	Reddish & ash col. sandy clays	20
	7	Gray sandst.	4
	6	Whitish sandy clay	3
	5	Gray sandst.	2
		Reddish sandy clays, with some soft sandst.	15
	4	Gray massive sandstone	8
		Reddish & yellowish clays	10
	2	Gray sandst.	5
	1	Reddish and ash. col. arenaceous clays, with perhaps some layers sandst.	42

Looking from the top of the hill forming No 14 of the foregoing section, off Eastward, the strata are seen to dip so as to bring this bed down nearly to the horizon of the base of Muddy Cr. Valley in about 1 1/2 miles. Then succeeds bluish and ash col. clays perhaps 150 to 175 feet; and beyond these outcrops of the same kind of beds forming the foregoing section, forming a bluff altogether perhaps 350 to 400 feet more of strata. There would therefore appear to be between 800 and 900 feet of this Wasatch group here above the valley of Muddy Creek.

The direction of the R. R. here is nearly N. & S., and soon after passing Bridger Station to S. there is a reverse of dip so that the road runs nearly N. & S. in an anticlinal valley so that the strata as seen along the east

* See note on p. 89

side look as if they were nearly horizontal although dipping Eastward 3 or 4°.

Before reaching Piedmont, however, the road curves and runs some distance to the E. of S. so that we ascend in the series to higher beds. About 1 1/2 to 2 miles before reaching Piedmont high steep hills are seen on the left, white above, and with alternate red clays and gray sandst. below. The section here is as follows:

14	White limestone	20
13	White clays with perhaps some limst	70
12	White limestone (Small Planorbis)	2
11	White clays	58
10	White limst (Planorbis fish bones &c)	3
9	White clays above - bluish below	36
8	White clays - above greenish white further down - and some red below	30
7	Light grayish sandst and clays somewhat sandst in upper	45
6	Reddish ash col. & bluish sandy clays, and some sandst.	30

5	Reddish clays	5
4	Mafive gray sandst.	15
3	Reddish ash col. & whitish sandy clays with perhaps some sandstone	25
2		
1	Mafive gray sandstone	16

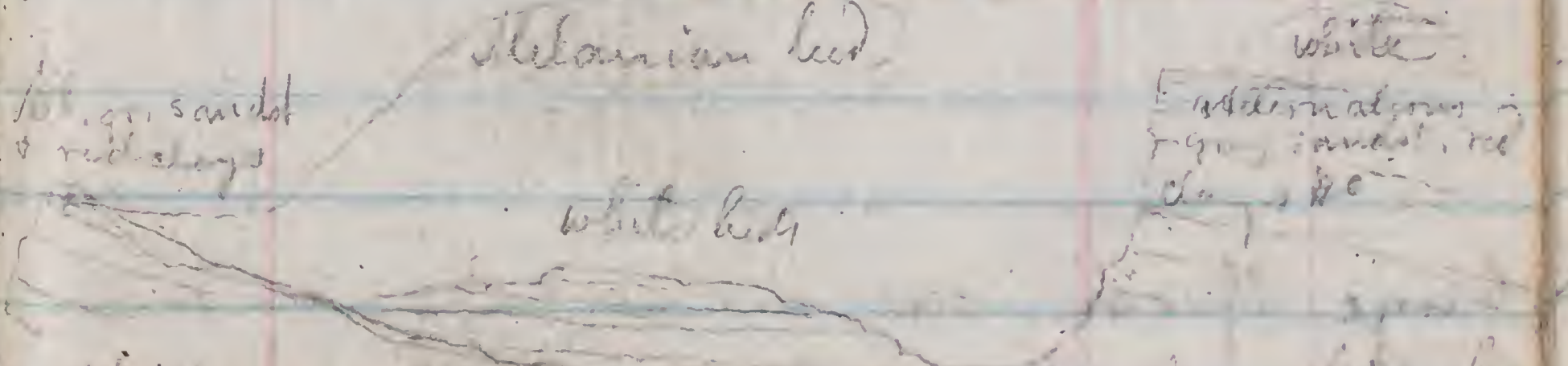
Dip low beds apparently a little N. of E.

All of this section up to 107 inclusive evidently belong to the same series as seen at Bridger station, but higher than those examined there. The white clays and limestones above however, belong to a different group - possibly to the Bridger group but if so, to some part of it not have not seen before. It seems to be the same white limestone from which several collectors have brought in from Utah some large specimens of *Planorbis*. In the lower bed of white limestone Mr. Barnard found a cast very like *Helix Seidyi*.

There is evidently no coal here in the Reddish (Wasacht) group, the Bridger group nor in the white limestone series forming the upper part of the last section. Any of these may, however, contain coal at other localities.

Note referred to on p. 86.

Since seeing the white limestone and white clays forming the upper part of the hills here at Piedmont, I suspect that ^{the} white beds seen from the top of the hill at Bridger station off in the direction of the dip may be a belt of these white beds resting unconformably on the reddish formation there.



If this is the correct relation of the white beds seen here to the Wasacht group of course, the white beds here mentioned at Bridger

Station form no part of the Wasatch group and do not dip under the high hill of reddish and gray beds seen at a distance of 2 or more miles, and represented on the right of the sketch. This would require however, a considerable denudation of the Wasatch group before the deposition of the white beds at that. I regret that I did not examine these white beds more carefully while there.

Sunday July 28th

Came on to Evanston this morning at 2 o'clock A.M. Very cool riding in car at night, even with overcoat on.

Monday July 29

Spent the forenoon in looking at the coal mines here but did not take a section as we had not time and intend give the rocks here a more thorough examination before leaving here.

Went back to Aspen station this morning but too late to make any observations.
Tuesday July 30th

Between Piedmont and Aspen station the valley along the road is rolling and shows reddish gray and whitish beds; the sandstone being generally soft and light gray color, and have a gentle dip of 3 to 4 degrees to N of east. These beds are evidently the same seen at Bridger station, and the lower beds at Piedmont (Wasatch of Hayden).

Off some miles to the left of the road, all along there are long flat topped hills or plateaus some 4 or 500 feet in height the upper part of which is composed of white beds, evidently the same forming the upper 200 to 250 feet of the hills near the station of Piedmont. These show a very gentle inclination of 2 or 3' to the eastward.

Wednesday July 31

Here at Aspen the lower country is

is 6 to 8 miles wide and trends N. N. E. & S. S. W. Wasatch mountains seen at a dist. of 10 miles to southward

Immediately on the west side of the road here at Aspen steep hills rise to a height of two hundred or more feet. These are composed of white very hard fissile slates above, and dark bluish below, with near the base of the hills one or more beds of dark ^{hard} bluish gritty limestone a foot or two in thickness. In this limestone we saw unrecognizable fragments of fossils.

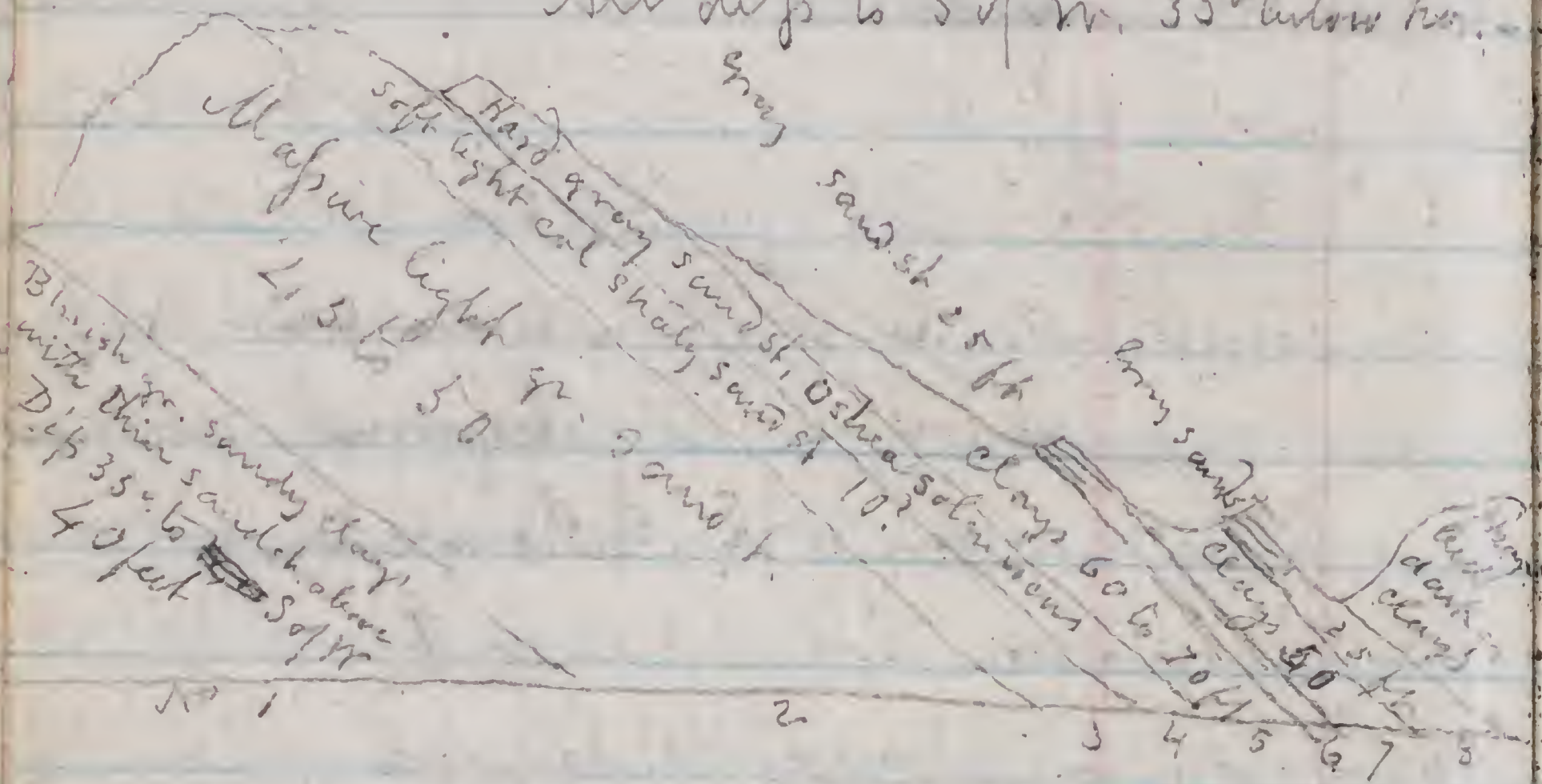
In the white and bluish slates we found many small scales, and other fragments of fishes, and in the white a fragment of an Ammonite. These showing these beds not to be Silurian, but most probably but equivalent to No 2 of the Nebraska section. This series here is not less than about 500 feet in thickness and dip N. or a little south of west, at an angle of

The reddish and whitish clays and gray sandstones, of the lower country to the S. W. of these hills, are clearly unconformable to the white & bluish slates forming these hills, as they lie upon the N. E. basis of the same and show a gentle N. E. dip.

The dips of these brit. slates soon bring them down so that they pass out of sight beneath the level of the valleys, to the west or a little south of W., to be succeeded by a later group of light colored and whitish sandstones and clays, the sandstones being thin and distantly separated by heavy beds of clays, some of which are grayish. This series is apparently conformable to the Carl slates, and can scarcely be less than 1500 feet in thickness. Some of its upper beds show heavy light grayish sandstone that forms a ridge trending N. N. E. & S. S. W. within 2 miles from Aspen at the nearest point, in the direction

of the dip. The rail road cuts through this ridge at a point 3 m. S.W. of Aspen showing the beds very clearly. The section of this ridge exposed here is as follows:

All dip to S of W. 35° below hor.

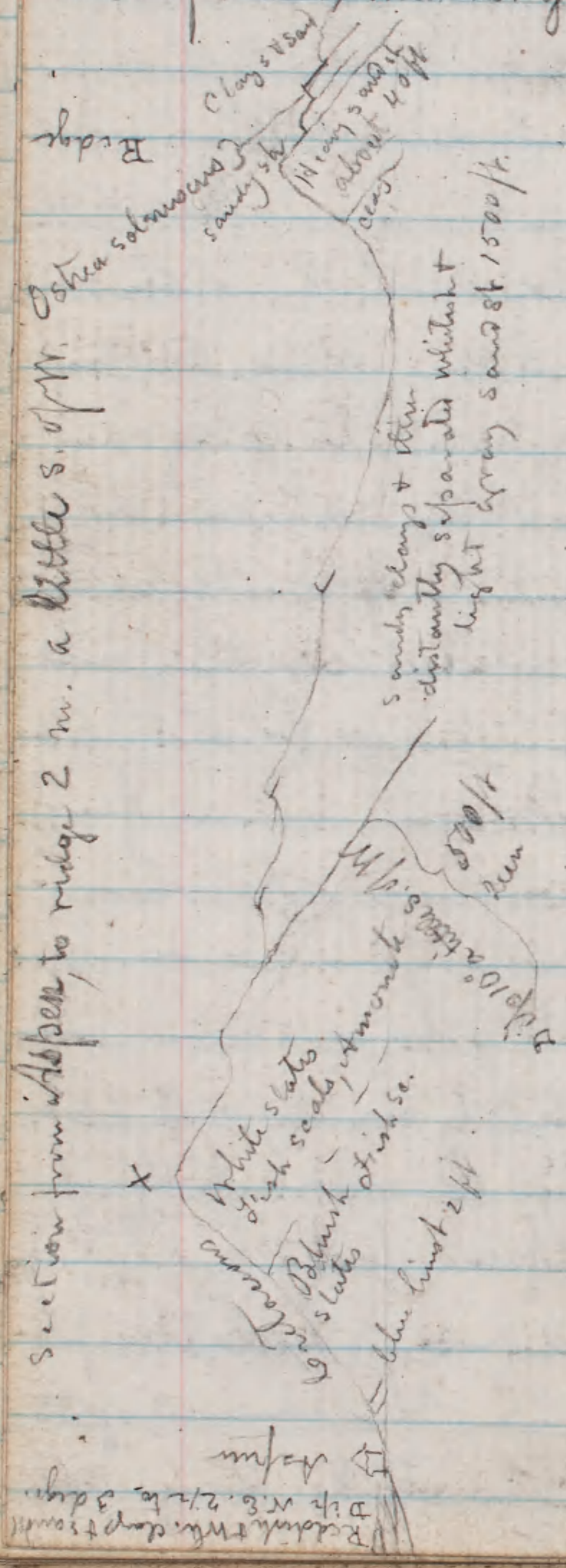


Did not see exact thickness of bed No 3, it being decomposed, and masses of No 4 being slipped down and mingled in it. Near the junction of No 4 & 5 a very fine cool spring of water flows out. The thickness of 5, 7, & 8, was not clearly seen but appeared to be about as noted. Some 25 feet of No 6 were seen. It is gray sand st. in thin layers. No 8 is merely the beginning of heavy beds of dark gray

clays like those of No 4 of the Nebraska section. These continue on to a ridge composed of some of the beds seen at Bear river city that trends so as to be only about 2 miles from the ridge cut by the R.R. at the nearest point off to the N.W. Near the point where the Rail road exposed the foregoing bed. These dark clays, No 8, were seen dipping in the same direction but apparently at some-
times so high an angle, while between them and Bear River station, they looked in the distance as seen off to the right of the road, as if nearly horizontal at places, but this may have been deceptive.

The ridge composed of the beds seen in the foregoing section trends nearly N.W. & S. & S.W. The point where the road cuts through it is 3 m. S.W. of Aspen; but it is not more than 2 miles from the latter place at the nearest point in a direction S of W. A section across the strike from Aspen

to S of M. by this ridge, would be as follows.

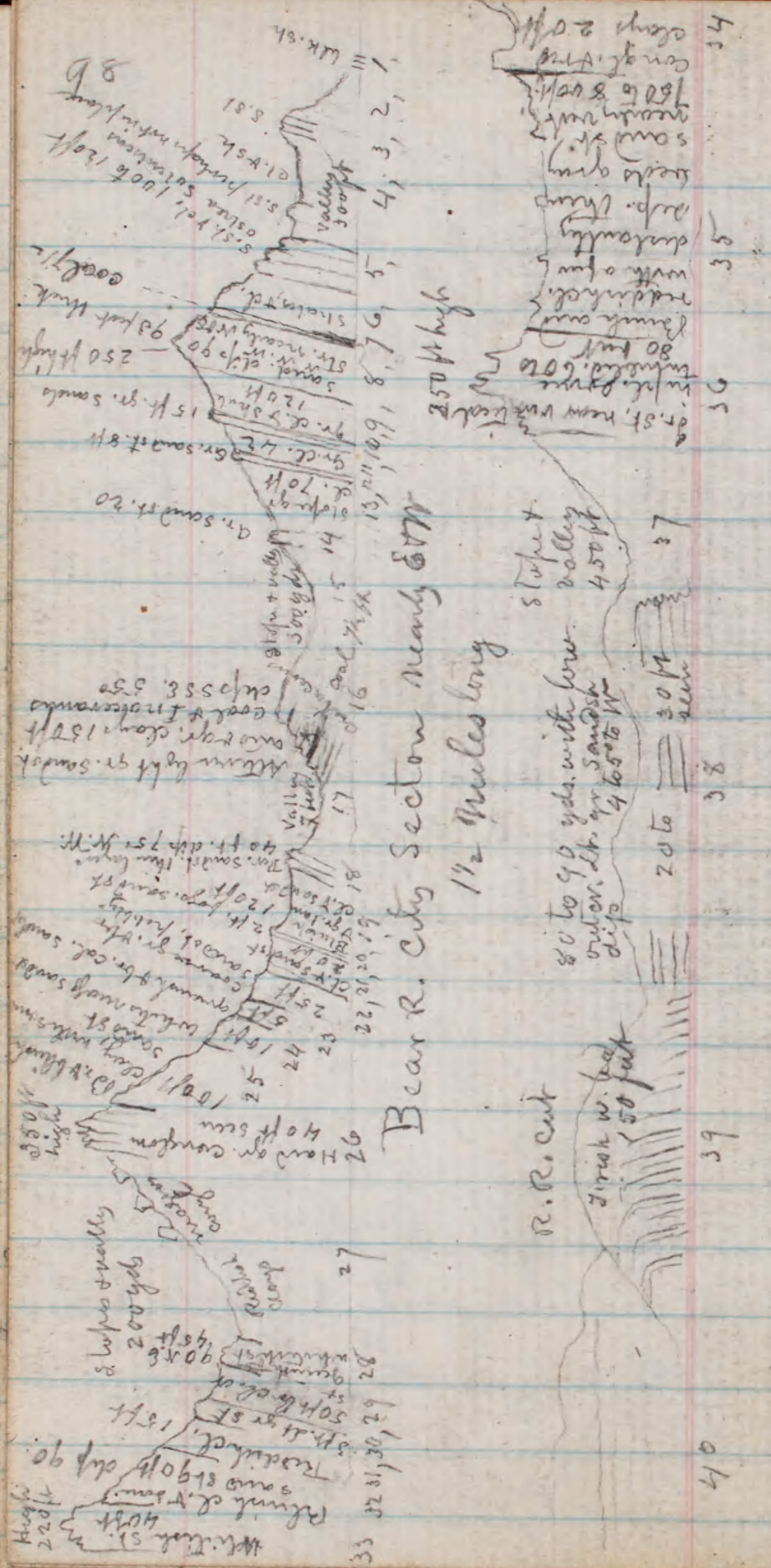


From the top of the Cent. Hill (X) at Aspen, a very extensive view of the surrounding country. Off to E, E. S. E. & S. E., as well as E. N. E. the country is lower and rolling, with outcrops of reddish & whitish clay and light gray sandstone, with a moderate E. or N. of E. dip (see left of above sec) unconformable to the Cr. slates upon which they seem to cap. Six to 8 miles further in same direction

this beds of the lower country are seen to be capped in high flat hills, by the whitish limestones seen at Piedmont. Far beyond these hills to S. & S. E. the Masach Mts are seen at 40 to 60 m. distant, with patches of snow.

About 3 miles from the cut through the ridge (right of foregoing section), in a N. N. W. direction, obliquely across the strike, following the broad valley of Sulphur cr., we come to the Bear river city exposures near the mouth of Sulphur cr. On the right of the road between these two points the dark clays like No 4 of Nebraska section are seen, as already stated, at some points apparently nearly horizontal. From their relations, however, to the beds forming the ridge on the right of the foregoing section, they can scarcely be No 4 of the Neb. sec. if the ridge with O. solomons, is Tertiary.

At Bear river city we have the following sec



The length of this section, including from No. 1 to No. 30, is about 1 1/3 miles in a nearly E-W direction across the strike of nearly vertical strata. I think probable that all from No. 1 to No. 16 are Ostracods, including the coal strike of all the nearby hills.

I have numbered the beds of this sec. from left to right consecutively, for convenience, and not because I suppose this to be the order of their superposition before upheaval. No. 1 is seen in the bed of Sulphur cr. and is black shale, with intercalated layers hard ferruginous argillaceous material six to 8 inches thick. These show the same dip and strike as the beds in the hills - that is their strike being nearly N. & S. while the stand nearly vertical. The slope (No. 2) between this and the sandst. No. 3, seems to be made up of clays ^{two or three} heavy beds of light gray or yellowish sandstone separated by clays. Intercalated in the upper part of the lower? (right hand, as we look at the sec) there is one, or perhaps two layers 18 in to 2 feet thick containing *Ostrea soleniscus* with an elongated *Tapes*-like shell ^{other bivalves} or two. The exposure of these beds No. 5

at the point examined, is a little obscure as to the exact thickness of the beds, so that 100 to 150 feet may not be exactly correct.

No 6 is made up of grayish and bluish sandy clays, with some layers soft sandstone, and some appearance, at places of thin beds dark shale.

The bed of coal No 7 is said to be 7 1/2 feet thick and of good quality. The drift into it was fallen in so that we could not examine it. About five feet of soft light gray sandy shale comes in between it and the heavy sandstone No 8 on the left.

Next after the heavy sandstone No 8 there is an extensive series of grayish clays, with comparatively thin distinctly separated sandstones, standing nearly vertical. Beyond these to the left there is a slope and a little valley, and then we come to a low hill composed of alternations of light grayish yellow sandstones

and gray clays dipping S. S. E. at an angle of 55° towards the hill composed of the beds already described. In this hill, at the point marked - , there is a bed of coal, said by Mr. Thorpe, who owns the land, to be 7 1/2 feet in thickness. In one of the beds of sandstone, perhaps 30 feet above the coal, we found numerous specimens of *Succinea* - *annus problematicus*, with a few of *Cardium* and of a *Univalve*. It is evident from these shells, that unless there has been a complete overturning of all the beds composing No 16, that the bed of coal in it is of Cretaceous age.

The other bed No 7, from the fossils found in No 5, would seem more probably Tertiary but we yet want more information in regard to the proper horizon of *S. solimera*.

Passing to the left, we have a great series of sandstones, clays, and some conglomerate, all standing nearly

In these we saw no fossils, excepting some obscure fragments of shells in the thin band No 20, and these could not be identified. Farther to the left, or north, or west of, about 150 yds, we come to low exposures (No 38), of light grayish, or yellowish white sandst. showing a gentle dip of only 4 or 5° toward the west or north of west.

Following these a little farther westward 150 to 200, we come suddenly to a cut of the R.R. in a N.W. direction through a hill or low ridge, showing No 39, composed of a great number of thin seams and layers of carbonaceous shales, thin sandy beds and some argillaceous, and harder calcareous sandy beds, all filled with vast numbers of *Pyrquilifera humerosa*, *Uris priscus*, *U. belliplicata*, *Corbicula Durkei*, &c. and dipping at a very high angle a little north of E. At the west end of the cut these beds are abruptly bent over westward about

(see Durkei's Sec. in Hayden's report) These beds seem to abut abruptly against the sands St. 38, that dip gently to the opposite direction.

A short distance to the N of west, from the west end of these dark highly fossiliferous fresh, or brackish-water beds, other strata of sandstone and clays were seen dipping gently to the N.W. at first near the fossiliferous beds (upon which they seemed to lie) and further westward, or N.W. they appear to become more nearly horizontal.

It will thus be seen, that all of these beds here are so disturbed and confused that it is difficult to understand clearly their natural order of succession.

Thursday Aug. 1.

Returned to Evanston at 6 P.M.

Friday Aug. 2^d

Spent the day in taking a section of rocks here at the coal mines as follows

Evansston Section
descending

55	Series of alternations ^{gray} sandst and yellowish sandy clays & shales - a little reddish at places below	500 or more ft.
54	Grayish sand st. and conglom with some sandy shale	30
53	Yellowish and gray sandy clay or decomp soft sandst.	70
52	Massive yel. gr. sandst	6
51	Yell. sand clays or decomp sandst	8
50	Massive irregularly mixed coarse and fine gr. and yellowish gr. sand st. (Nests with curious subst.)	25
49	Ash col. reddish-brown and yellowish sandy clay or soft st.	100
48	Yellowish gr. sandst above, and conglomerate below	15
47	Yellowish, ash col. purple and reddish sandy clays, some sandst	100
46	Light gray sandst	10
45	Yellowish sandy clays	15

44	Coarse gr. sand st. with some pebbles	15
43	Yellowish sandy clays above Decomp sandst. middle Reddish clays below	40
42	Conglom. with seams sandst on top	2
41	Yellowish sandy clays, or soft decomp sandst.	50
40	Sandst and conglomerate	25
39	Gray sandst	5
38	Yellowish gray sandy clays and some soft sandst.	40
37	Pebbly sandst. above, passing into conglomerate below	8 ft.
36	Sandy clays, with perhaps some beds sandst. Some clay slightly reddish	50
35	Gray sandst	4
34	Rather fine conglomerate - pebbles almost all in contact - cement sand.	14
33	Yellowish gr. sandy clays or soft sandst	32
32	Conglomerate like 14 ft. bed above	22

31	Yellowish gr. sandst, with possibly some reddish clay	50
30	Rather fine cong. pebbles nearly in contact with each other	13
29	^{yellowish} mainly sandstone with some sandy clay & a little coal	60
28	Course conglomerate, composed of pebbles from small sizes to 4 or 5 inches in diameter; also includes some irregular lenticular masses sandstone, and at some places pretty heavy beds sandstone near the middle	140
27	Yellowish and whitish sandstones, and some sandy clay	170
26	Dark gr. sandst & gray lills	22-
25	Light col sandy shales or clay	12
24	Gray sandst	9
23	Dark grayish bluish gray sandy shales - some carbonaceous near base	150
22	x Yellowish sandst (shaly)?	12-
21	Sandy shales or clays, rather dark gray, with thin seams sandst	150
20	+ Gray sandst., with large diest. leaves	4
19	Light col. sandy shales with perhaps some sandst	45

total conglomerate 104

18	+ Light gray sandst with diest. leaves	14
17	Dark and light col. sandy sh.	60
16	Gray rather heavy bed sandst. with (Uniones?)	20
15	Dark gray sh. and light col. sandst, with some dark lam. shale, or possibly a little coal below	100
14	Gray sandst and sandy clay	5
13	+ Arg. shales & thin layers with (with leaves)	20
12	Coal	4 1/2
11	Dark clay	4
10	Hard impure coal (Rock coal)	2
9	Coal good	9 1/2
8	Imp. coal (Rock coal)	4 1/2
7	Coal (good) (Drifts here)	10
6	Shaly clay	9 1/2
5	Coal	5 1/2
4	Shaly clay (about)	20
3	Impure Iron ore (Iron sandst)	3
2	Clay	15
1	Coal	1

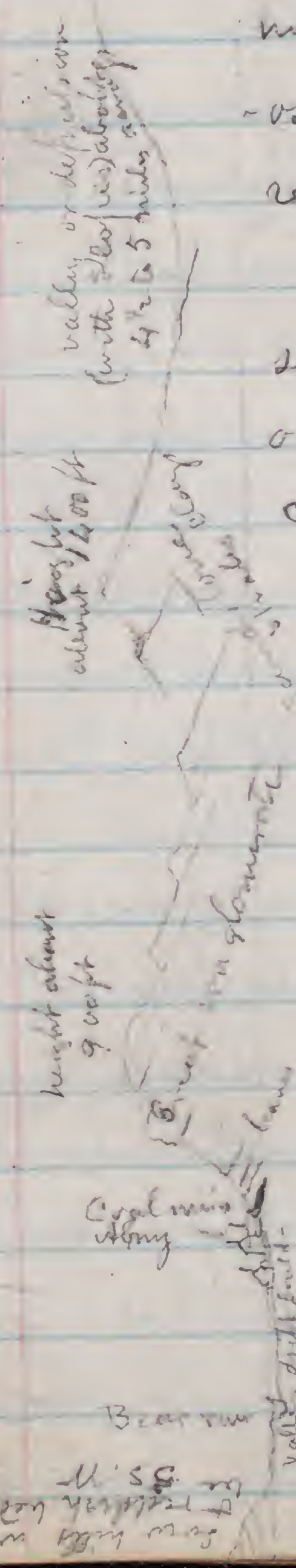
This long section is seen in high hill or ridge, ^{at a point} about 3 miles about WNW from Evansston, which is situated in the broad valley of Bear river. This ridge trends a little N of W and S of E. being at the nearest, ^{point} only about 1 1/2 m. from Evansston, in a direction N.N.E. Its trend would bring it almost on a line with the exposures at Bear river city.

The profile where the Evansston section was taken would be about as follows on the next page.

The great coal deposit is worked here by the Rocky Mt. coal & iron company, and other parties, ^{at about 3 m. from Evansston}. The inclination of the strata brings it to the surface ~~at~~ along the base of the high hill bounding Bear river valley for a mile or more, where it is extensively and systematically mined by ^{some 3 or 4} drifts, the coal being drawn up the inclination of the bed to the entrances, by wire ropes

Medicine Bow
Point, about 9 m
N. of Evansston
1000 ft high

Evansston section
about 1/2 m. N. of
Evansston
Dip 18 to 20 nearly N. & E.



would by steam engines. The roof is formed by hard impure coal left for the purpose, and is so firm as to require no propping.

There are also some seams one to two inches or more of this impure coal, intercalated in the good coals, and these are separated from the coal taken out to be sold to the R.R. This hard coal seems to contain so much argillaceous matter, and other impurities, that it does not diminish in size in burning, though, it loses much weight and become whitish. It burns, however, quite

well and makes heat enough to drive the Steam Engines at the mines, for which it is almost alone used.

The good coal is of excellent quality and would not be distinguished by its general appearance, hardness, color, luster & from the best coal of the Carb. period, which it also resembles in showing char. coal on the surfaces of blocks split parallel to the planes of deposition. It shows scarcely any visible pyrites, and answers very well for use in driving locomotives. The superintendent ^{of the mines at Army} Mr. Duval informed me that their smiths use it and find no difficulty in welding inch bars of iron with it. The loss in slack coal and hard or impure coal that has to be separated is about 20 per cent of the whole taken out. It has been found by experiment, the agent told me, to yield large quantities of gas, but unfor-

tunately, the gas has a very offensive odor the it has been found impossible to remove, so far as yet tried. It is considered by the R.R. men the best of all these far western modern coals, and the supply seems to be practically inexhaustible.

Unfortunately the dips of the beds containing these coals, too deep to be very conveniently worked at other localities than a mile or so along the base of the ^{curve of} hills mentioned. They will doubtless be reached at other points by shafts, however, at no very distant day.

We have as yet, no evidence that these beds are older than Tertiary.

The iron ore (bed 1003 section) is too impure to be of any use, as it only contains according to Prof. Mass of San Francisco, about 30 per cent oxyd, ^{+ carb.} of iron, with 20 per cent silica, and 33.85 per cent carb. lime

Note referred to on p. 104, in connection with bed No 30. Nearly opposite Evanson in the bluff on the N. Side Bear river, a thin bed coal has been opened apparently in the upper part of this division. The section of beds in immediate association with this coal, given in detail is as follows.

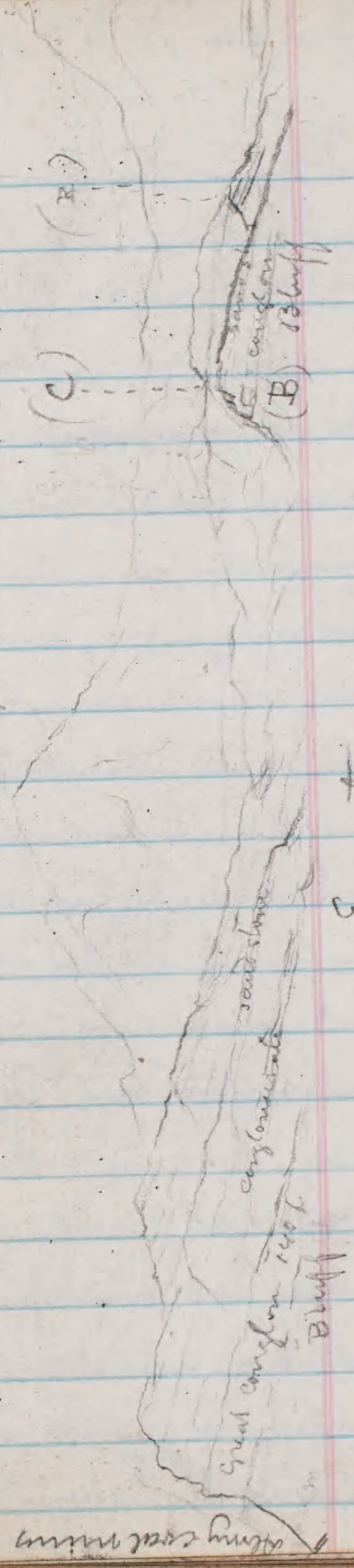
conglomerate with a 1 foot seam of gray sandstone near middle	15'
bluish light gray soft sandstone	15'
sandy rather dark bit shale 3 in to	1/2 foot
Coal	7 in to 1/2 in
grayish & ash col clays	5' seen

Saturday Aug. 3rd

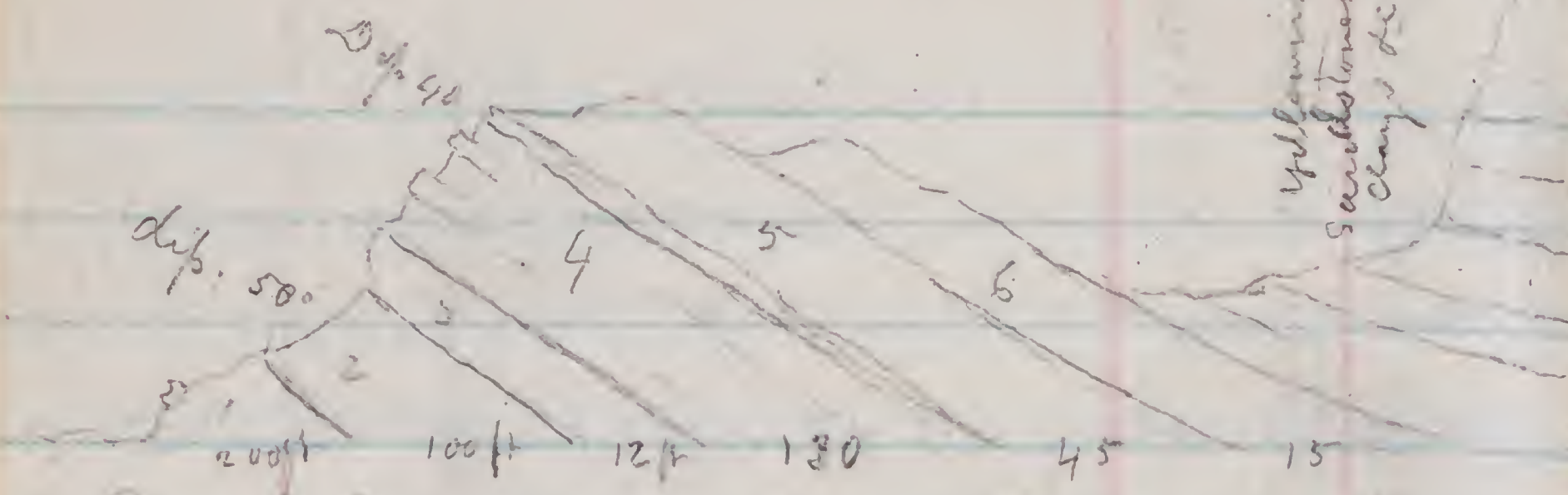
The bluff on the N. Side Bear river at Evanson faces to the SSW, obliquely across the strike of the strata from the coal mines up to a point opposite the town; the strike being nearly N.W. & S.E. In looking across from the town at the face of this long bluff, so as to take in a range of about 1 1/2 miles, it presents much the appearance seen in the sketch

given below. About 3 miles back in N. N.E. direction from the bluff (B) on the other side of the hills as to be out of sight in the sketch an exposure was seen of sandstone & clays conglomerate \approx dipping eastward at high angles, as shown in the section given on p. 112

Medicine Bow Bluff 9 m. back



(Sec. 4 m. N.N.E. of Evanston)



1. Brownish red sandy clays with some conglomeration below 200 feet.
2. Slope yellowish and ash col. sandy clays, some reds, 100 ft.
3. Conglomerate 12 feet
4. Alternations light gray sandst. and sandy clays 130 ft.
5. Yellowish, ash col. sandy clays 45 ft.
6. Yellowish sandst. 15 to 20 feet.

All of these beds dip slightly S of E, the lower at a high angle, but the dip gradually decreases eastward so that, ⁱⁿ the high hills a little farther back it is only about 3 to 4 degrees, & these same higher beds appear to be nearly horizontal on the N. S. of the river between here and Bear river city, where some beds of the same series are seen lapsing upon the ^{ridge composed of the} brackish water beds seen in the cut there.

The ridge composed of the highly inclined beds composing the above section, trends

very nearly N. to S. and on following its strike southward to the river it intersects the Bluff just above Evanston at the point marked (E) in the sketch on p. 111; its not being parallel to the beds forming the bluff from Evanston down to the Coal mines, but intersecting it at a rather acute angle. Yet the beds of the bluff B. dip down and pass under this N. to S. ridge, while the beds composing the latter are also seen to pass under those to the eastward that are less and less inclined.

I am somewhat at a loss to understand this different strike ^{and dip} of the beds composing this N. to S. ridge from those forming the high bluff overlying ^{and extending up to Evanston} the Coal mines, its upturned strata being seen more and more highly inclined northward, and passing in that direction on the right on each side of Medicine how butte. It seems probable that there may be a fault and lateral displacement of the strata.

here; the fault and lateral displacement being much more extensive over toward Medicine Bow Butte than nearer Evanston.

East of this N.T.S. ridge, the strata dip gently Eastward between here and Bear river city, and would seem, unless there is a great fault here, to consist of near 1000 feet of light colored sandstone sandy shales (some of the latter being reddish) newer than the Evanston Section.

It is worthy of note, that not a single marine, or even brackish water fossils has yet been found in any of these here near Evanston, which are I think later any, of later date than Eocene.

Monday Aug. 4th

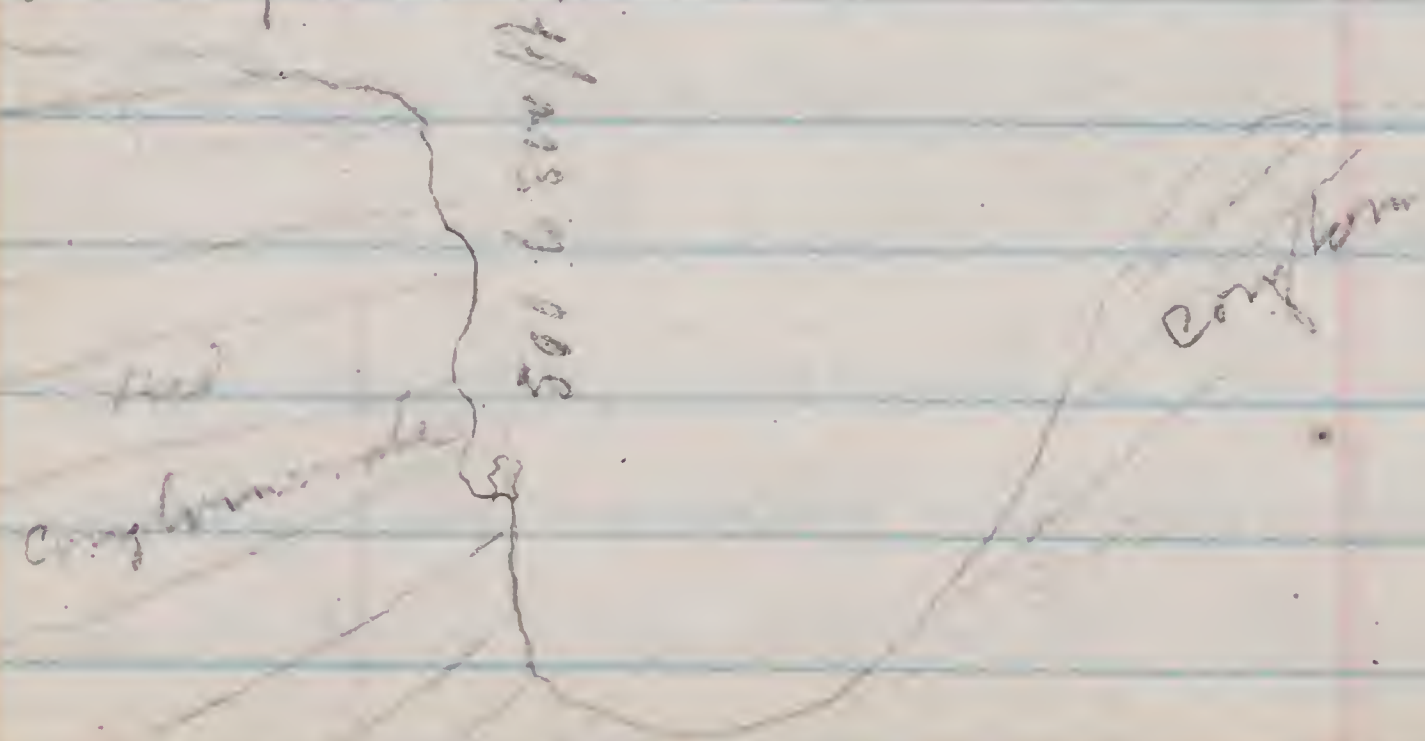
Started westward from Evanston at 9 o'clock & 10 M. A.M. Here the R.R. curves off to the S. and leaves the valley of Bear River. The country is lower than on the N. side of Bear R. and shows occasional

al exposures of yellowish gray sand stones whitish and reddish, as well as yellowish sandy clays, dipping at places, more or less to the west.

All along from near Wasatch station to and beyond Castle rock station many outcrops soft decomposing red and yellowish sandst, with streak or occasional thin layers bright light blue, and occasional thin beds conglomerate. Soon the

Road rather rapidly descends into Echo canon. Here the same red and yellow ^{soft} sandstones and conglomerates form precipitous outcrops, especially on the right hand side, the direction of the Canon being generally nearly N.W. and S.E. As we descend deeper into the Canon red conglomerates are seen to form the ^{lower part} precipitous though the same reddish sand stones and clays are seen above. The farther we go down the Canon the higher the precipitous hills become.

, being bare high exposures of naked red or, brownish coarse conglomerate on the right, and steep hills, with occasional outcrops of sandstone and conglomerate on the left. The precipices of Conglomerate on the right very about 500 to 800 ft high, with a more or less defined dip to N. W. Within one mile of the mouth of the Canon, Conglomerate near the base of bluff dip to N. W. at nearly an angle of 45°, but the dip decreases as we ascend to the higher beds; also as we come down nearer to the mouth of the Canon. Looking up the Canon from near its mouth the appearance is as follows.



These conglomerates are very coarse, being composed of silicious pebbles and boulders from the smallest sizes up to 8 or 10 inches in diameter. They seem to be nearly all composed of grayish quartz rock or metamorphosed sandstone generally very hard and compact. The reddish, or more properly yellowish brown color of the whole is mainly due to the paste of the conglomerate, which is brownish yellow sand and ^{partly} argillaceous matter, the pebbles themselves being light grayish generally crystalline or igneous pebbles of any kind seem to be very rare. There are occasional streaks and layers, with some thin beds of yellowish brown sandstone intercalated in the conglomerates, to which the stratified appearance of the outcrop is mainly due. These show oblique and wavy lamination, and attest the fact that they were deposited

in rapid whirling water. The conglomerates are so very coarse as to present much the appearance of consolidated drift. Some of the included boulders and pebbles are themselves aggragation of pebbles, showing that they are parts of fragmentary conglomerates. At the mouth of the Canyon, and near it along the Weber the conglomerates only show a gentle dip to the N. W.

Hayden thinks this vast accumulation of conglomerate holds a position above the sandstones and conglomerates seen at Evanston, and the red and yellowish sandstones & clays seen along back to Carter station, but the reverse seems to me to be the case, as there certainly are beds corresponding to them in appearance anywhere seen above those outcrops east of here. They seem to me to be the lower part of the series

called by Hayden the Wasatch gr. The great thickness, of these rocks, and the coarseness of the materials, seem to show that we are here much nearer the source of these vast accumulations of silicious material. Then at any point east of here it is possible, however, that some of these great conglomerate series, may belong to the Eocene and it appears to rest, as will be seen further on, conformably upon the Cretaceous.

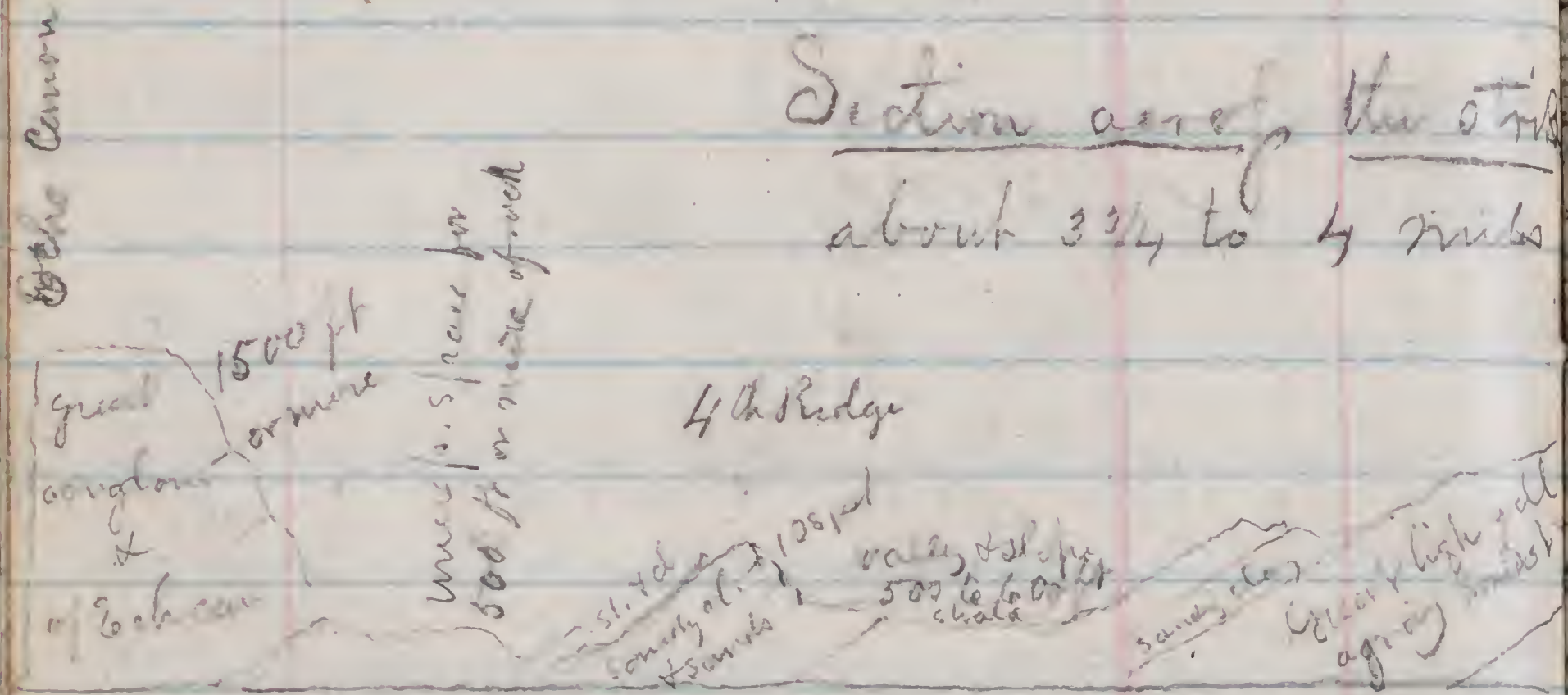
Tuesday Aug. 5 X

Went up Weber river today, five miles to Coalville, which is situated in the valley of Weber in a nearly S. W. direction from Echo. The Cretaceous rocks here are very extensively developed, and upheave at rather high angles so as to afford an excellent opportunity to study them. They form four principal nearly parallel ridges of heavy sandstones, with clays, shales, & softer sandstones between, which have been

X Remains until Aug 12 (Sunday) & Army geology

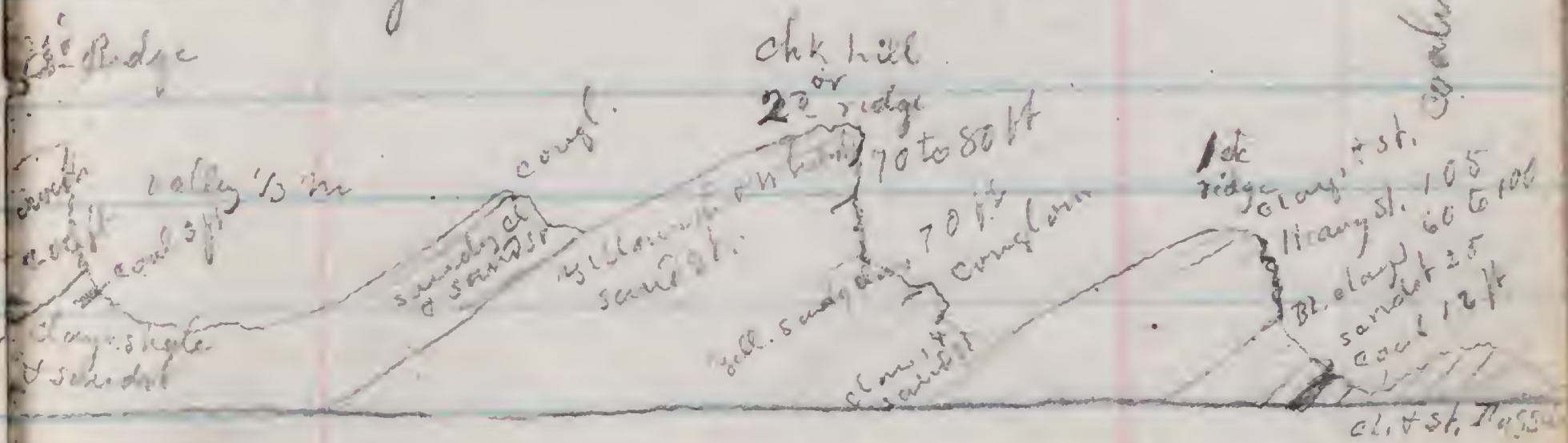
worn away so as to form valleys or depressions between the ridges of harder sandstone

Section across the strike about 3 1/4 to 4 miles



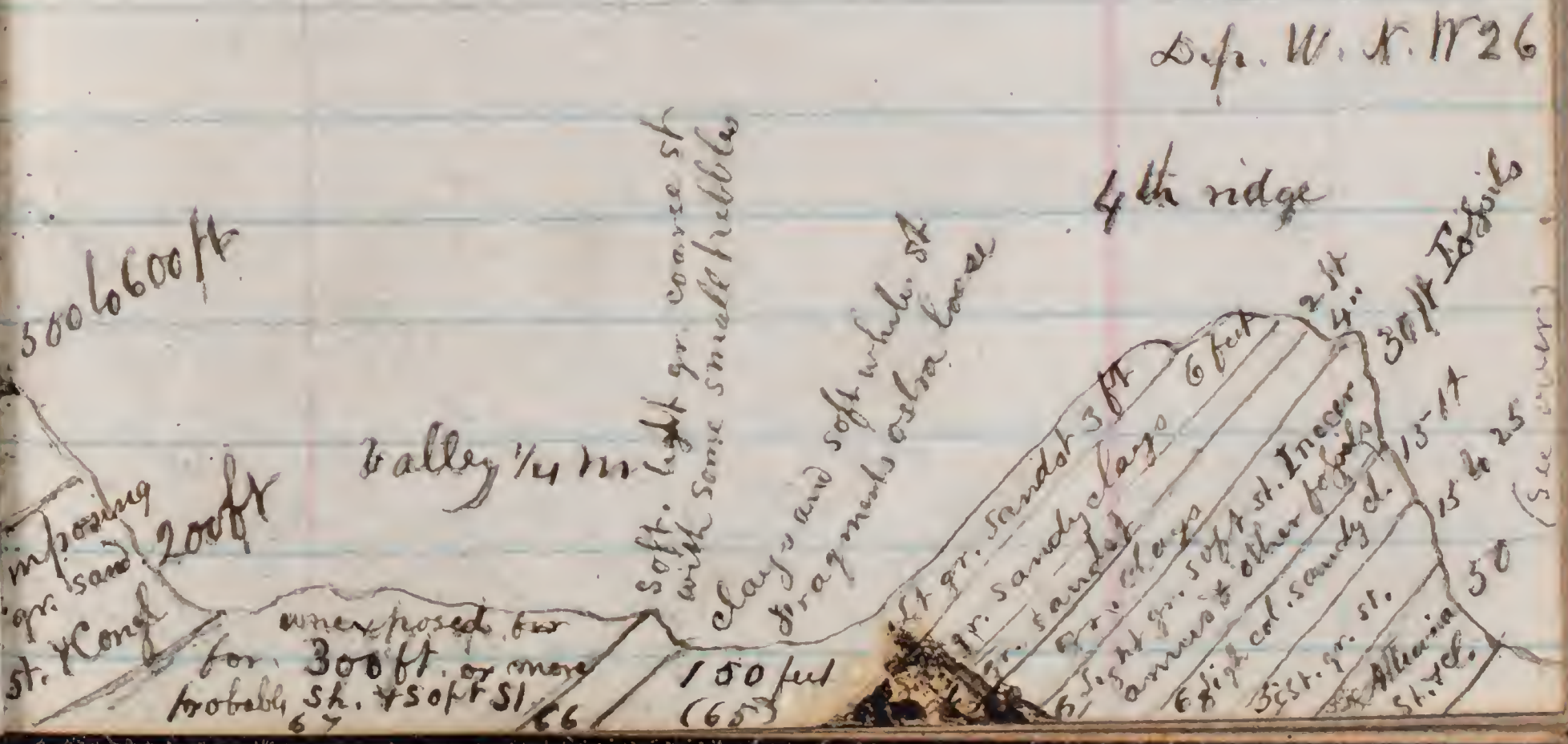
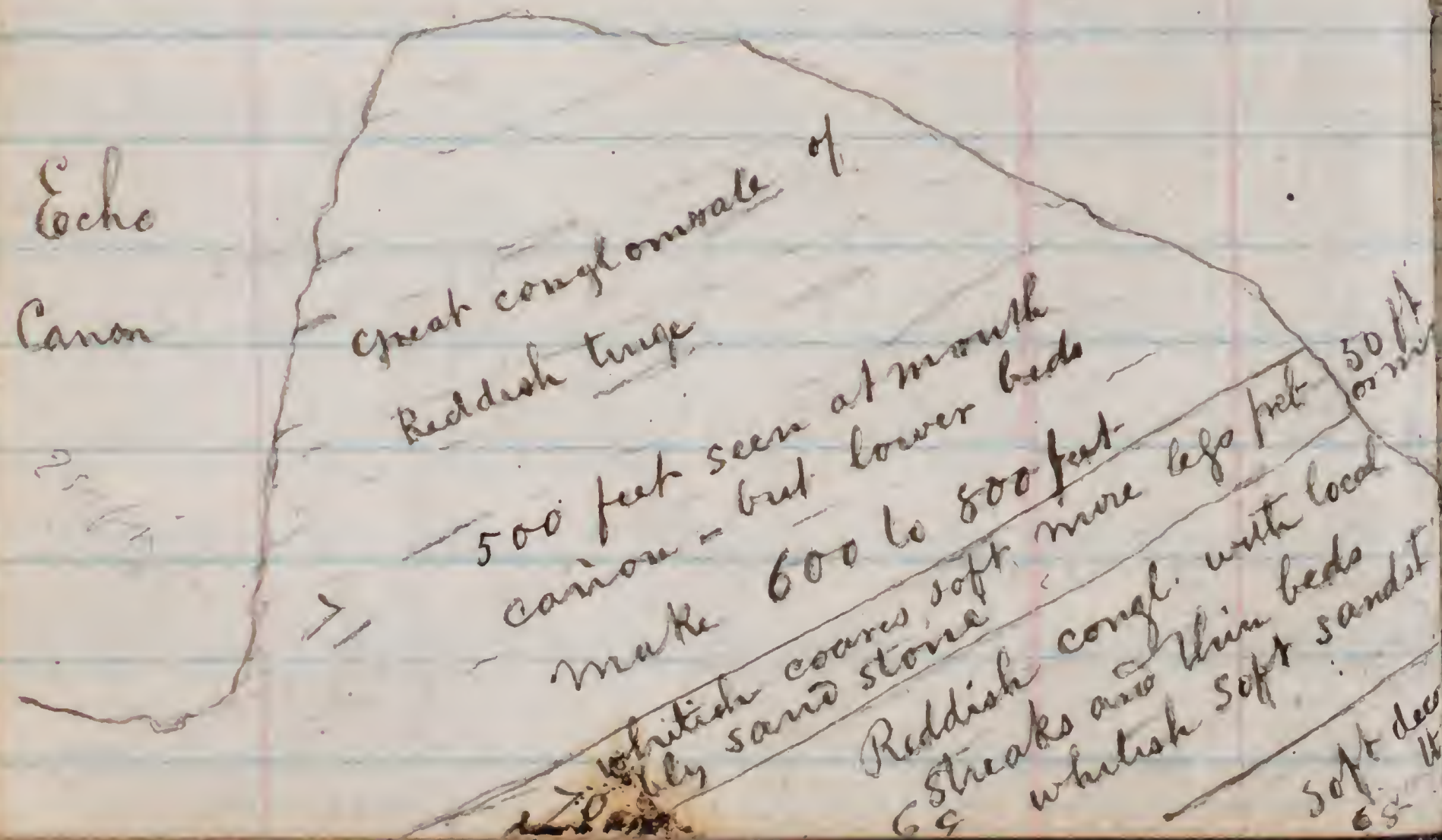
The following sketch will serve to give a general idea of these beds.

Section from Coalville mines to Echo Canon N.W. 1/4 S.S. 8 in length.



The above sketch of course only gives a very clear and exact view from the following more and proceeding to lower and lower beds to the

general idea of these rocks, which will be more detailed section, starting from Echo Canon right to Coalville

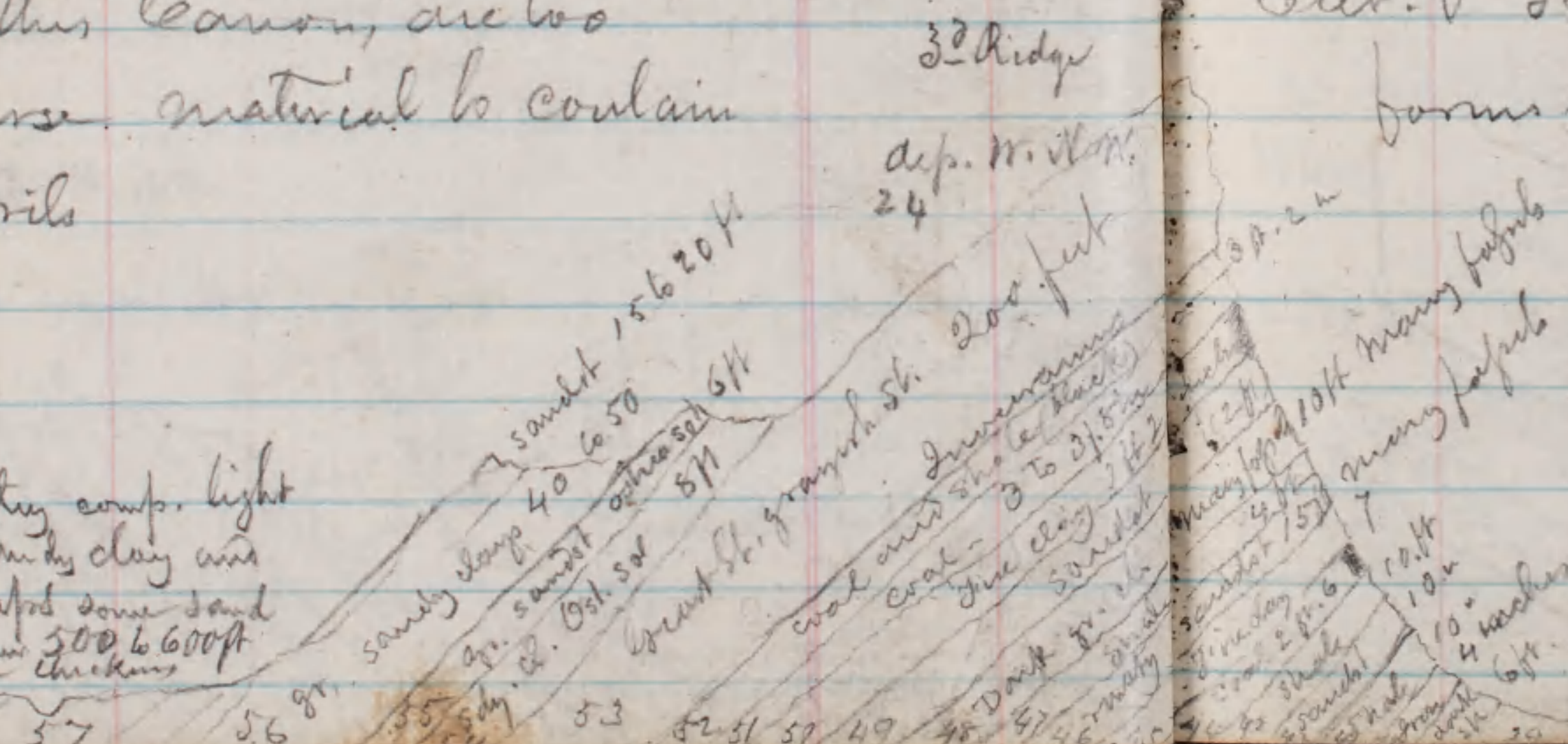


From Echo Canon

It will be observed, that the farthest from to the N.N.E. coming from Coalville toward Echo canon, at which any traces of fossils were found was in Division 61 of the section. These were Ostrea in four fragments. In division 65, many Inoceramus, ^{ostrea} & other bivalves were seen showing that the Cretaceous must be carried at least this high in the series, and that all of the Coalville coal certainly belongs to that epoch.

All of the beds farther toward Echo Canon, including those forming the walls of this Canon, are too coarse material to contain fossils

Worthy comp. light gr. sandy clay with perhaps some sandstone 500 to 600 ft in thickness

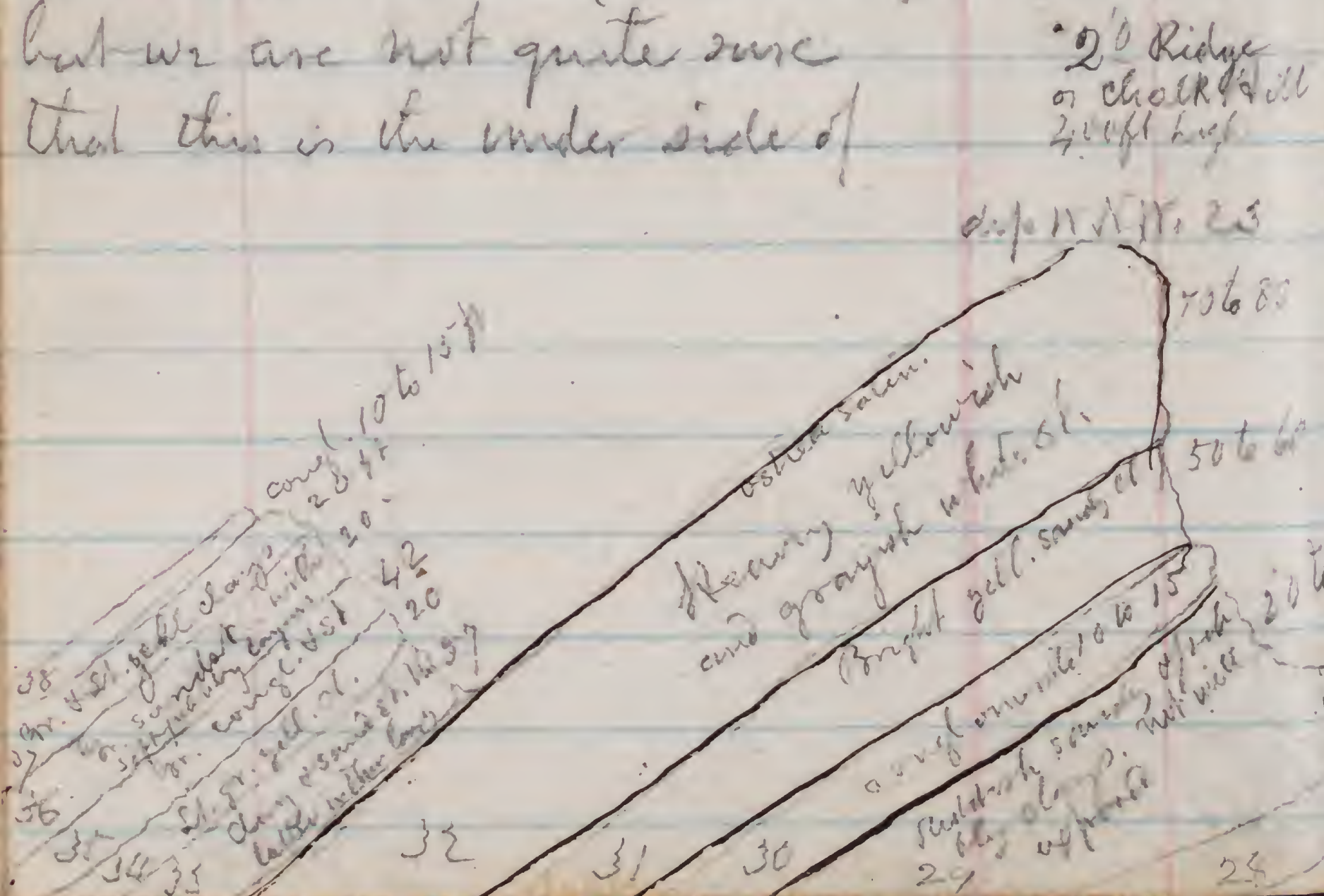


to 1 1/2 m. beyond Coalville

Proceeding farther along the section toward Coalville, to the third ridge, we find in bed 53 (or atleast in a bed at the base of that division or somewhat below it at Mr. Carltons mine on the other side of the river) Inoceramus again. In beds 48 & 46, at Mr. Carltons mine we found many fossils of fresh and marine types mingled together, all, or very nearly all new to science, being an entirely different group of species from any I have seen before. These being clearly below beds containing Inoceramus must be Cretaceous, and thus show that we have here both Cret. & Tertiary fresh & brackish water forms in this region.

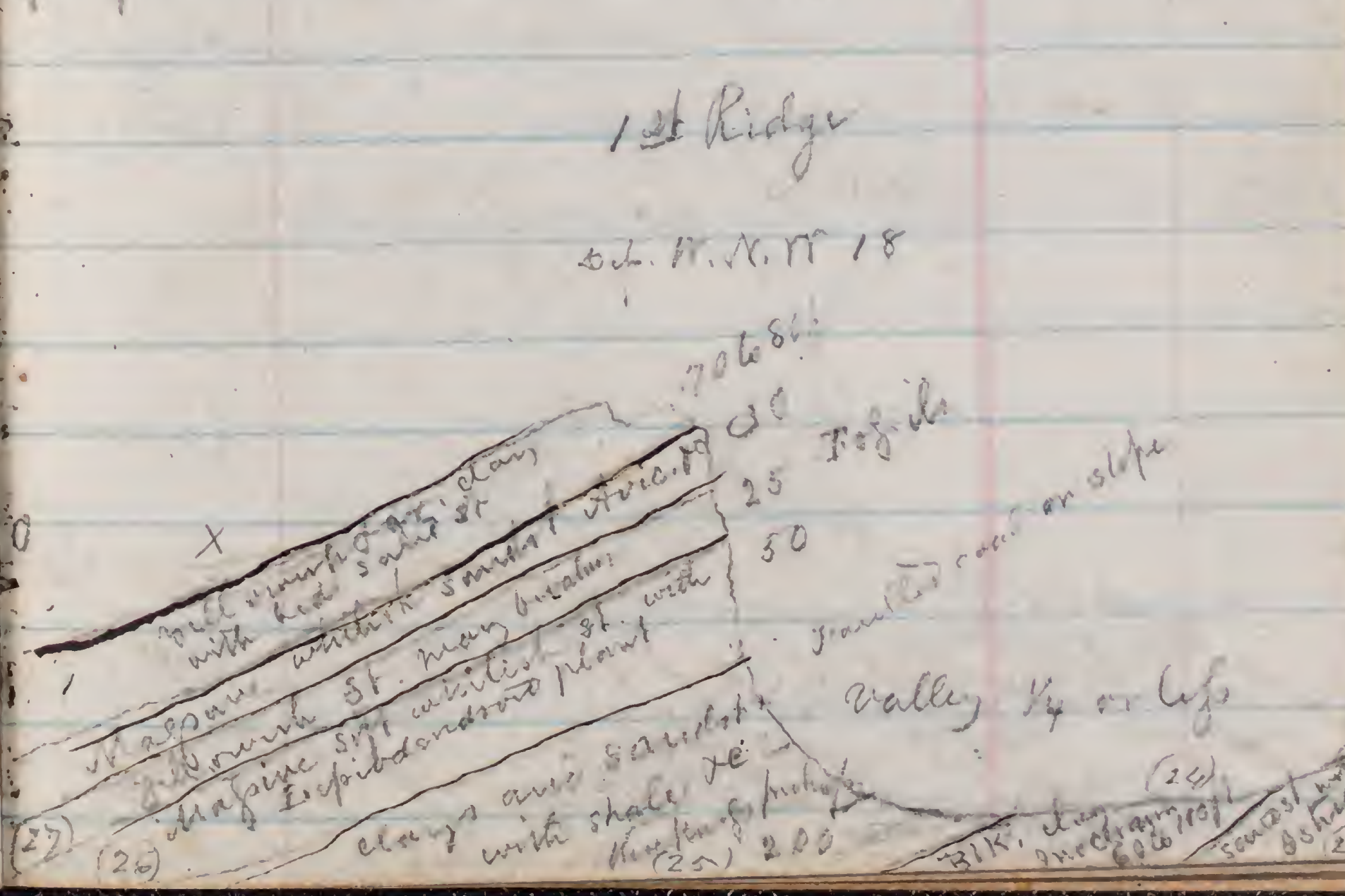
over

It may be proper to remark, that all of the beds from 40 to 32 inclusive of the section, were only seen by us in Mr. Carlton's drift, which passes obliquely through them to his bed of coal. The drift commencing much below the coal in a slope, and passing into the hill horizontally in the direction of the dip, cuts through these beds to the coal. It was in the sandstone ^{or rather of the shale above the coal} roof of the coal that we saw *Proceramus*, but we are not quite sure that this is the under side of



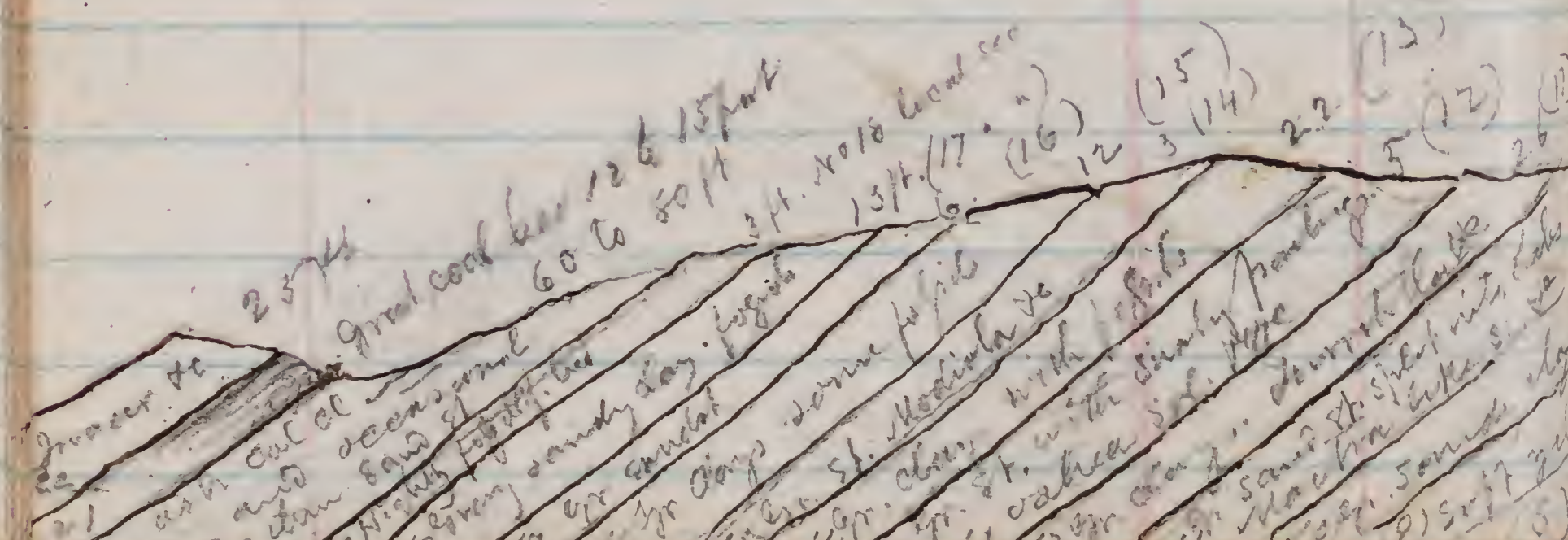
The sandstone No 53, though it seems to be. At any rate heavy beds of 53 crown the hill above, and are believed to extend down to the coal. It is possible, however that there may be an intervening bed of sandy clay or shale, ^{from a few feet to 25 or 30} with a ^{thin} bed of sandstone under it that forms the ^{shale over the} roof of the coal.

Mr. Carlton's coal seems to be of good quality; but I fear he will not find it a ^{very} profitable mine to work, because the shale



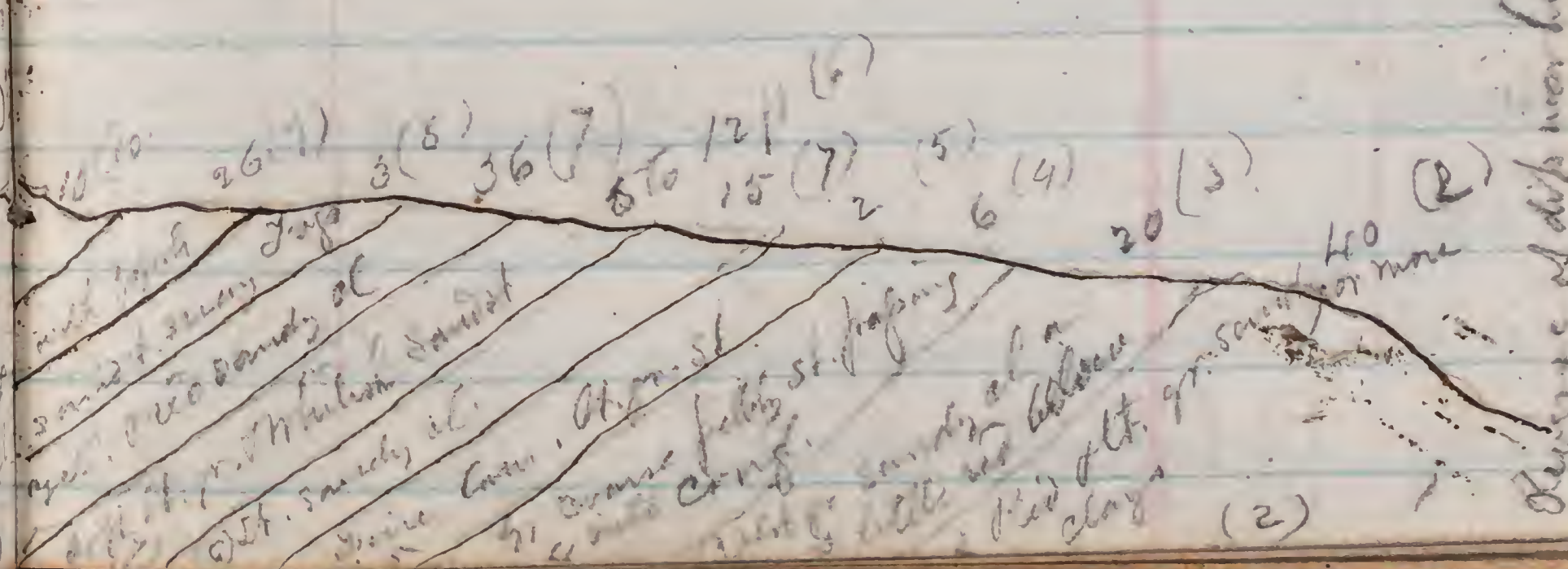
forming the roof of the bed in way
 from and therefore it has to be timbered
 up. The coal being only about 3 feet
 thick, and timber so scarce and ex-
 pensive here, it cannot be otherwise
 than a costly operation to extract the
 coal. Still there must always be a good
 and increasing demand for coal here, for the
 use of the rail-road, and a large area of
 country.

The lower bed of coal here must be
 of great value, being from 11 to 15 feet in thick-
 ness and immediately overlaid by a pretty firm
 sandst. that generally requires no timbering
 up; while it is of good quality.



So far as I could ascertain there would
 seem to be only two workable beds of coal
 yet known here - the lower great bed
 No 21, and the upper No 51. There are two
 openings however between these from which
 some ^{little} coal has been taken; but the beds were
 found to be faulted, and as they occur at the
 point where a lateral fault or displacement
 of the strata to be mentioned further on
 occurs, I am inclined to think they are
 merely fragments of the large bed 21
 thrown out of their natural position.

One and a half miles E.S.E. from the
 opening at Mr. Spriggs' mine directly in Coalville
 at the right hand end of this detailed section



Decrease of dip over bed

on a little beyond, there is a reverse of the dip, and here in the N. N. W. slope of a hill, a little above the valley of Weber river, coal has been found. It is evidently the lower bed No 21, as it has the same sandst. and clay over it, and corresponds in other respects. It was found to be faulted, however, and has not been worked much. Two or three openings have been made here, at different elevations, and some persons have counted these as so many distinct beds of coal from each other and from the great bed No 21 of the Sec.

A little beyond these openings there are high rounded swells, that soon rise into mountains 1500 to 2000 feet in height, composed of reddish conglomerates & sandstones like those at Echo Canon. They are

not near so much exposed here however and laps upon the coal bearing Cretaceous series, so as to hide all but some of the beds near the horizon of the lower coal bed.

It is possible, however, that other workable beds may yet be found here, in some of the shaly clays between the great Sandstone as these softer shaly beds are not always so clearly exposed that every stratum or layer can be clearly seen without digging into them.

Several remarkable faults, or lateral displacements of all of these beds, varying from a few feet to more than 100 feet cut through the whole series, more or less nearly in the direction of our section. These ^{disturbances} seem also to extend to the Conglomerate beds of Echo Canon, which to dip at a much higher angle and to show other (irregularities) about one mile up from

the mouth of the Canon, than at the same. These displacements give origin to some puzzling complications in the association of beds at some places. For instance the beds from about 3 to 19 inclusive, that really belong as represented in the section, below the lower bed of coal, form a ridge that abuts directly against the ^{west end of the} 1st. ridge, and when seen at a little distance seem to form a continuation, of that ridge, when we come to examine this ridge however, we find, that there is an abrupt change from the heavy beds of whitish and yellow sandstones (beds 26, 27 & 28) to the thin beds from 2 or 3 to 18, and we also observe on close examination, that these beds forming the west end of this ridge dip at a higher angle than the heavy sandstones against which

the abut, and have a somewhat different strike. In short, they have been bodily removed laterally one or two hundred feet, and also elevated 100 feet or more above their natural position with relation to the lower coal bed as, as to appear to hold a position above the same, as seen 2 m. to E.S.E. at the most extensively worked mines.

This movement or displacement can be seen in all the ridges, and has also caused the lower bed (21) and the associated beds of rock, to be flexed around, at Briggs directly in coal ville, so that their dip is nearly N. 75. and then dip nearly west. This may give trouble by faulting the coal at Briggs mine. The dips and strike of the beds at Briggs mine are such with relation to the displaced fossiliferous beds abutting against the west end of the first ridge, that

I was at first inclined to think these highly fossiliferous beds must hold a position above the lower thick bed of coal, as well as above the overlying sandstone and dark Inoceramus clay, but on examining farther around the low slope to the E.S.E. of Mr. Briggs' mine, we found these beds clearly, and unmistakably beneath the lower bed of coal (Briggs).

These displacements, and the fact that ^{we did not clearly see in place} the beds filling the space ^{between} 24 & 26 leave doubts as to the thickness and nature of the beds filling this space.

Another point of some little doubt, is whether the whole of the first ridge, proper, that is from 26 to 30, may not, instead of dipping under the second ridge as they seem to do, be really be only the same beds forming the 2^d ridge from 31 to 38 inclusive thrown down by a fault, so as

to appear as a different set of lower strata? At the same time that I suggest the possibility of this I do not think it very probable.

On Crossin Nelson river, ^{to W.} the 1st & 2^d ridges of sandstone are found to plunge beneath the slope so as to be seen no more, while the 3rd and 4th ridges are elevated 500 to 600 feet above the valley, they also curve around so as to make the strike nearly N. 45° and ~~N. 45°~~ and the dip nearly W. about 13 to 15°.

August 13th

Remained at Coalville until this morning studying the rocks of that locality. Having finished our work, we came back to Echo in time to have taken the 1 o'clock P.M. train for Ogden; but as my notes on Coalville were on loose papers, and I wished to write them out more fully, while the whole was fresh on my mind, I concluded to remain until the following day before starting.

Aug. 14

Came on to Ogden, and had a fine view of the grand and rugged scenery of Weber Canyon from the observation car. Rocks greatly contorted and upheaved. Saw to possess considerable variety of formation but we did not stop to examine them. Could see quartz at places, and dark lime stone, with various other kinds of strata.

Reached Ogden at about 4 o'clock P.M. and came on down to Salt Lake city, where we arrived at 6 o'clock.

Remained at Salt Lake city 6 days - Then came up to Ogden again, where I remained six days awaiting draft from East.

Then went direct to San Francisco where remained about 6 days.

Then came east to Dutch flat and Gold Hill. Examined Gold mines and Hydraulic process of mining here.

Wishing to see something of quartz mining, I ran back from Gold Hill to Coalfax, where I saw two small mills one of four stamps and one of 8. These mines are only shallow shafts of 250 to 300 feet. Ore said to yield \$30 to \$40 per ton.

Then came on to Truckee and stopped to see Donner Lake 2 1/2 m.

Steamboat Springs Nevada

from there.

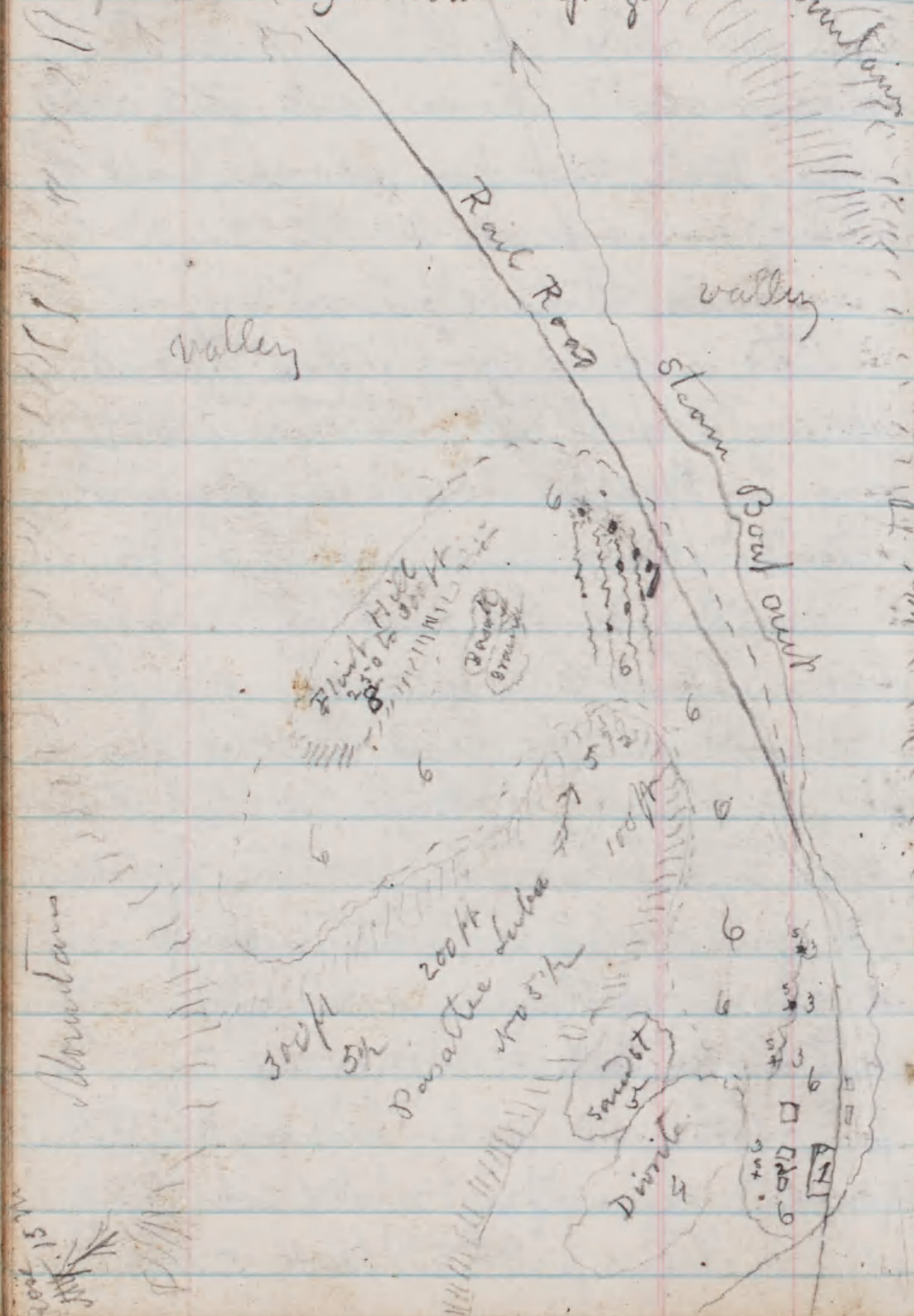
Sept. 6th

Came on to Reno; and at 2 o'clock A.M. took car for Steam Boat Springs (where) arrived at 3 o'clock A.M.

Found these springs very interesting. Situated in valley of Steam Boat Spring Creek, ^{about 400 ft above tide} a small creek that flows in Washoe Lake and runs N.

into Truckee river. This valley is bounded on the east by a range of mountains 600 to 2000 feet high; and also on the west by low mountains. To S.W. about 15 miles, Mount Rose is seen ^{above all other} ~~at~~ ^{intended} by patches of snow and lower mountains continue southward at closer distances; some of the higher containing patches of snow. Far to the northward some high mountains can be seen, perhaps 40 to 50 miles. The valley of Steamboat creek

is from $\frac{1}{8}$ to 3 or four miles in breadth
 as follows. (Very narrow at Springs)



The foregoing diagram will give
 some idea of this locality. No 1 is the Hotel
 on the Rail road. 2 Bath houses just west of
 Lane 3333. Hot springs near the Hotel &
 Bath houses. 4 some outcrops of granite
 Divide along the slope above the springs
 No 5 some metamorphosed sandstone nearly
 a quartzite. No 5 1/2 Basaltic lava
 from one to 300 or 400 feet above valley
 sloping northward. No 6 6 6 6 6 6
 deposit whitish calc. matter 50 to 90 feet
 above valley, left by Springs

At 7 there are some four zigzag, but
 parallel fissures ^{1000 yds long} in the deposit left by the
 Spring, ^{80 to 100 feet above valley} ranging S.E. & N.W. These are
 from $\frac{1}{2}$ an inch, to 7 inches in breadth, with
 occasional openings 18 inch to ^{across} 2 feet. They
 doubtless pass down through the deposit
 and connect with a fissure in the old
 granite or basaltic rocks beneath
 No 8, about 1 mile west of

these figures, is a ridge 200 to 250
feet in height ^{600 to 800} ^{yards long & 70 to 80} ^{wide}
of flint rock, showing at places a tendency
to laminate structure. ^{high to 500 yards long} At some places
near its south end it is seen dipping to
S.E. at angle 40 to 45° while along its
N.W. side and on top there appears to be
a gentle dip to N.W. At several places
along this ridge there are remains of extinct
hot springs, and from one of these I saw a
little steam escaping. It is evident that
this whole ridge consists of a silicious deposit
of hot spring now nearly or quite extinct.
They evidently held much more silicious
matter in solution than those now in
action a mile eastward and along the
base of the hills south eastward to the
boathouses near the hotel, which
deposit a white calc. matter with
some reddish and yellowish material.
This flint rock is much pitted

and broken. On the east side of it
over a considerable area is occupied
by millions of ^{comparatively fresh} broken fragments, apparently
left by the Indians in making arrow
heads. I do not think the dip of this
rock due to sudden upheaval, but more
probably to expansion by the expansion &
contraction of heat. This is indicated by the
slight dip generally seen from the opening
and cracks in the Calc. matter where
the springs are now active. Usually
there are veins up of the matter around
each spring, that is evidently not alto-
gether due to a deposition of calc. mat-
ter, as there is often seen ^{considerable} a cavity
beneath the surface crust. Many
of these openings are now entirely dry
and look as if no water had flowed
from them for a long time. Other
and west at times a little steam
and ⁱⁿ some of these at times, the

1001 15

hot water rises to, or overflows
the margin. Others again have
hot water constantly standing in them
sometimes boiling from the escape of
steam. Still others pour out con-
stantly variable quantities of hot
water, sometimes in a state of ebulli-
tion, and at others quiet. When
boiling more or less steam escapes
there must be 50 to 60 ^{or more} of these springs
in a more or less active condition, and
they send forth altogether enough water to add
perceptibly to the volume of Steamboat Creek
but affect its temperature. ^{but little, the water} Some of them are
almost constantly in a state of ^{vigilant} ebullition
others puff or pulsate, as it were, at inter-
vals of a second or two. They all seem
to be more or less intermittent, and
emit a more or less strong sulphurous
odor. The deposit around some has
a yellowish and greenish tinge, with
a strong acid taste. Around others

it is reddish, while some deposit a little
black matter. The general col. of same is ^{whitish} white or
Sometimes very little steam is seen
escaping from any of them; white at
other times considerable volumes of steam
are seen issuing from most of them. In
some cases it escapes with a puff or
shorting sound, and a splashing up and
flow of water in regular pulsations of
seconds

Although the deposit around some of these
springs has a strong acid taste, I never could
taste anything of the kind in the water.
This deposit is most frequently seen about
small springs, that only seem to flow out
at intervals, and then cease, the deposit
being left by vaporization of the water as it
ran down gentle slopes

The basaltic rock on the hill
west of the springs is often ^{near surface} very vesicular,
though compact within. In some cases

100

the vesicles are drawn out into greatly elongated cavities, ranging north and south - showing I think that the flow of the molten matter came either from the south or north. Most probably from the south as, the hills and mountains rise much higher in that direction; while the surface of the flow slopes northward and ends at in short distance in that direction.

The Diorite near or a little west of the Hotel, contains imbedded masses of finer grained, darker portions apparently containing more hornblende. These look as if they were pebbles and small boulders, or fragments of different material that had been imbedded in a conglomerate or breccia, that had been metamorphosed. I saw the same at Truckee.

The water in the springs here is very hot, I cooked an egg hard in 5 minutes in one of the springs a

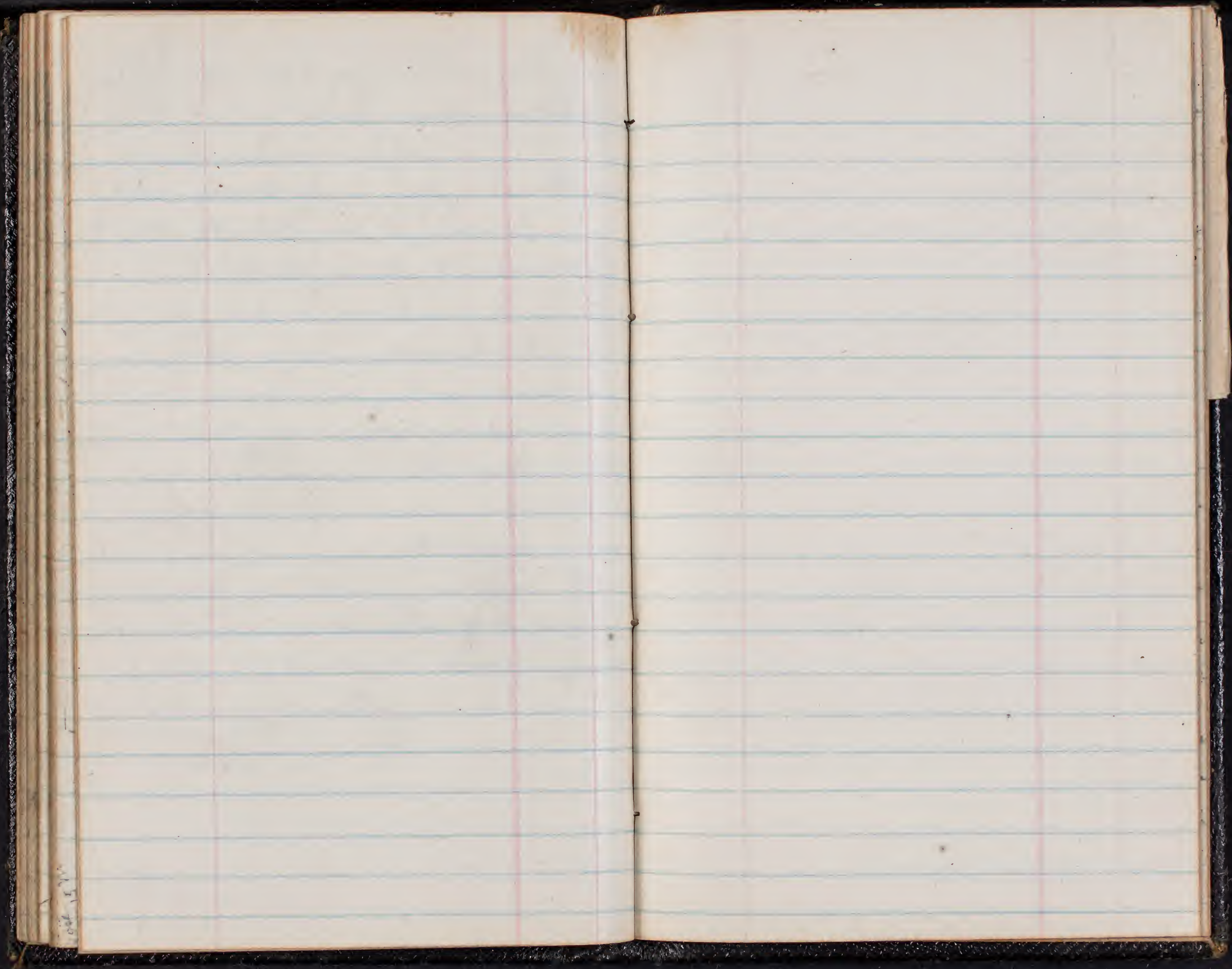
short distance N.W. of the hotel. This spring, however, only gave by thermometer, a temperature of 195° while several of the larger, more active springs $\frac{3}{4}$ to one mile farther north sent the mercury suddenly up to 200° which was as high as the thermometer I had extended to and I immediately withdrew it for fear of breaking it when the mercury reached the top of the tube. I think the temperature of some of these springs can scarcely be less than two hundred. Of course this temperature at this elevation above tide, would, ^{materially be increased by} cause a violent ebullition which is the case with many of the springs though I found some that were quiet, excepting the escape of a few bubbles of vapour (I think they give off but little gas) marking 200 degrees Fah. The vapour from most of them has a rather strong sulphurous odor, but the water itself is generally not strongly impregnated with hydro

sulphuric acid gas. When allowed to cool, even in closely corked bottles, it is almost entirely inodorous.

When drunk freely before breakfast it acts slightly on the bowels.

Immediately on the E. side of the valley opposite the Hotel, and the south part of the spring deposit, there is a hill 300 to 400 feet in height, composed wholly, or in part of a curious kind of dark volcanic rock, with a kind of laminated appearance, but very solid and compact. At places it shows a slightly vesicular appearance. Usually it shows not the slightest disposition to split into laminae, though in some conditions of weathering it does so.

Oct 15th



Virginia City & Gold Hill.

This place has about 7000 inhab. Its principal street 6200 feet above tide. Situated on E slope Mt. Davidson, but still about 2000 feet above Carson valley in sight at a distance of 4 miles to the east and south east. Between the city & this valley to the south there are several spurs of mountains with various valleys or canyons extending down.

Gold Hill is another ^{mountain} town of smaller size situated 2 miles S of Virginia city and at about 300 feet lower elevation ^{partly} in a valley or ravine called Gold ravine and also near the eastern base of a mountain. These mountains are mainly composed of Siennite, traversed nearly north and south by several rich gold and silver bearing quartz veins or lodes. The famous Comstock lode so rich in gold & silver passes directly through Va. city and the

two of Gold Hill, and the ground under these places is riddled by deep shafts, drifts, and other excavations for mining purposes. Vast sums of money have been expended here and large fortunes made in these mining enterprises.

In addition to ~~some~~ smaller mining operations, there are here a ^{Gold Hill} Va. city, the following important mines, their names being given in the order of their importance -

- | | |
|-------------------|------------------|
| Virginia C. | Gold Hill |
| 1. Gould & Curry | 1. Yellow Jacket |
| 2. Savage | 2. Imperial |
| 3. Hale Norcross | 3. Crown Point |
| 4. Chollar Potosi | 4. Overmantle |
| 5. Ophir | 5. Kentucky |
| 6. Sierra Nevada | 6. Belcher |
| 7. Virginia | 7. Caledonia |

In and about these two places 425 miners are employed

Of these mines at Gold Hill, the Belcher is the deepest, going down to 1700 feet. I was told however that they are not working in this lower level, ^{only, nearly barren quartz} little gold being found there & it is said it is not so warm there as in the 1300 foot level in Crown Point. Gould & Curry deepest in Va. city or extending 1685 feet.

These mines are all worked in the famous Comstock lode. This vein or lode is more or less pure quartz with the gold and silver so finely disseminated as to be not readily seen. Lode varies from 1 foot to 125 feet in thickness, being in some places "pinched out" by the closing of the walls of porphyry.

I only went into the Crown Point mine it extends down 1300 feet. I went down 1200. Went 1100 feet by one vertical shaft and then 100 feet by incline. Hottest place I saw 108° Fah. air. In the

1300 foot level. I was told air is
110° and water and rock at places 122
to 125°. Miners accustomed to work
here can only work 20 to 30 minutes at
a time in these warmer places, when
they are compelled to retire to cooler
places to rest. Men unaccustomed to
work at these depths can only work from
5 to 10 minutes. (Miners here all American
& European, I believe; I saw no Chinese in
the mine.) Men entirely naked excepting
a pair of cotton pants & shoes or boots. Per-
-piration pouring from every part of surface
I saw some with only a cloth about their
loins, that had come from the hottest
places, lying resting with sweat streaming
from every pore. Miners looked stout
and hearty - though I am told it is an
unhealthy business. Diseases chiefly
of the lungs - and dysentery.
All quartz lodes here dip at
a high angle Eastward

Gold and Silver very unequally
disseminated through the lodes, some
parts containing but little, others none
while some parts are very rich. Ore that
contains less than \$20 per ton does not
pay to work, by the best means now
known, as it costs \$12 per ton now
to crush and reduce the ore.

There are 4 quartz mills at Gold
Hill, capable of stamping 170 tons of
ore per day; & 3 mills at Carson with a
capacity of 340 tons per day. Whole
number of stamps in all 186.

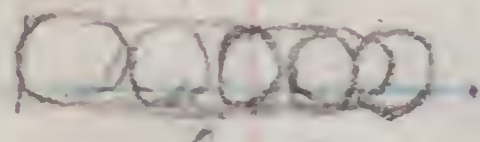
1 Mill belongs to Crown Point
Mining Co. & to Jones & Haywood &
Patten; 1 to Jones, Haywood & Mackay
& Fair.

Men remain in mines 8 hours ^{day} per
working perhaps about half of this time
or four per day.

Most parts of the C. P. mine
I saw were comparatively dry.
Gold & Silver in C. P. mine 18 to 22.

though there is much water in some parts, particularly in the lower level. They use a Steam pump to Steam free the mine from water, with an 8 inch column, 6 foot stroke, and 12 strokes per minute.

A tunnel connects Crown P. and Imperial mines, through which men could escape in case of accident.

Accidents sometimes occur from fire, or the falling in of lode, in places, by which life is destroyed, but scarcely ever from the parting of the hoisting cable, which is made of Iron wire rope, several being united to form a flat cable about 4 or 5 inches broad & 1 to 1 1/2 thick, a section being like this . There is also an ingenious contrivance to prevent the falling of the iron cage on which the men ascend & descend; even in case of the parting of the cable. It would stop suddenly

before descending more than a few inches if the cable would break.

I was told that where there is much lime and Sulphur in the ore, the temperature of the mine is much higher. This however, may be an effect, rather than a cause of the heat.

The temperature of all of these mines has been found to average an increase of about 1° for each foot in depth.

Sulpho tunnel

When this great work is completed, it will drain & ventilate nearly all of the mines here. It starts from Carson Valley 4 miles due east of Va. city and will reach that place at a depth of about 2000 feet. It is believed that when this is done, and the cross or nearly N. & S. branch is done, that the mines can be worked to a depth of 4000 feet, as all

the mines above it can be con-
nected with it by shafts or bore holes
so as completely to drain and ventilate
them; while the water that runs down
will give power enough to drive machinery
that will drain & ventilate all the shafts
and tunnels at lower levels.

The Tunnel Company do not pro-
pose to do mine themselves, but to con-
struct the tunnel at an expense of
\$1,000,000. ^{or} \$5,000,000. They receive a
royalty of \$2 per ton for all the ore
raised, and \$1 per thousand feet for all
the lumber used by each mine receiving
the benefit of the tunnel. They have
also acquired of land at the mouth
of the Tunnel, and along its entire
length, from Congress.

Sept. 9th. Ascended Mt. Davidson
at 5 o'clock P.M. the sun having set
to the Pacific in Va. city, at 4:30. Found
it much higher than it looks

I had not asked its height, but supposed
it ^{was} about 1000 feet above the main st.
of the city. After going up about 1000
feet however, I looked up at the flag
staff on top, and it looked very nearly
as far as from the starting point in
the city. I continued however, to ascend
slowly, stopping frequently to rest, and
at last reached the summit just as
the sun sunk behind the mountains in
the west. The wind was sharp and cool
there (5000 feet above tide), but the
view in every direction was grand
beyond description. At the base the
mountain, almost at an angle of 40°
below me, I looked down upon Va.
city, and a little farther S upon the
town of Gold Hill. Between these places
and Carson valley 4 miles to the east-
ward, and S.E. foot hills 1000 to
1500 feet in height, with several
cannons or valleys between,

running more or less nearly eastward were seen. Carson valley, with its broad level bottom, was seen beyond these ^{perhaps 4000 feet beneath the} hills. The stream (Carson River) itself is very insignificant, in size, but could be seen winding through the valley, fringed by a few small trees, toward the east or N.E. Some places the valley spreads out to 15 to 20 miles in breadth. At one place perhaps at a distance of 15 or more miles a little N. of E. from Va. city, a white plain of considerable extent could be seen like a sheet of white water. This I was told is called alkali desert, being doubtless the saline matter left by the drying up of a lake. Not the slightest trace of vegetable matter could be seen on it.

Beyond Carson valley the eye wanders over a vast area of mountains to the eastward; and

far beyond and above these at a distance of 200 miles Walker river range of mountains could be seen bounding the view. To the south beyond Carson valley, mountains occupy the whole country, the highest being known as Silver Mountain. These ^{cultry} were whitened with snow and are said to contain many rich silver mines, at a distance of 50 to 60 miles from Va. city, probably in some of the same veins of quartz mined at the latter place.

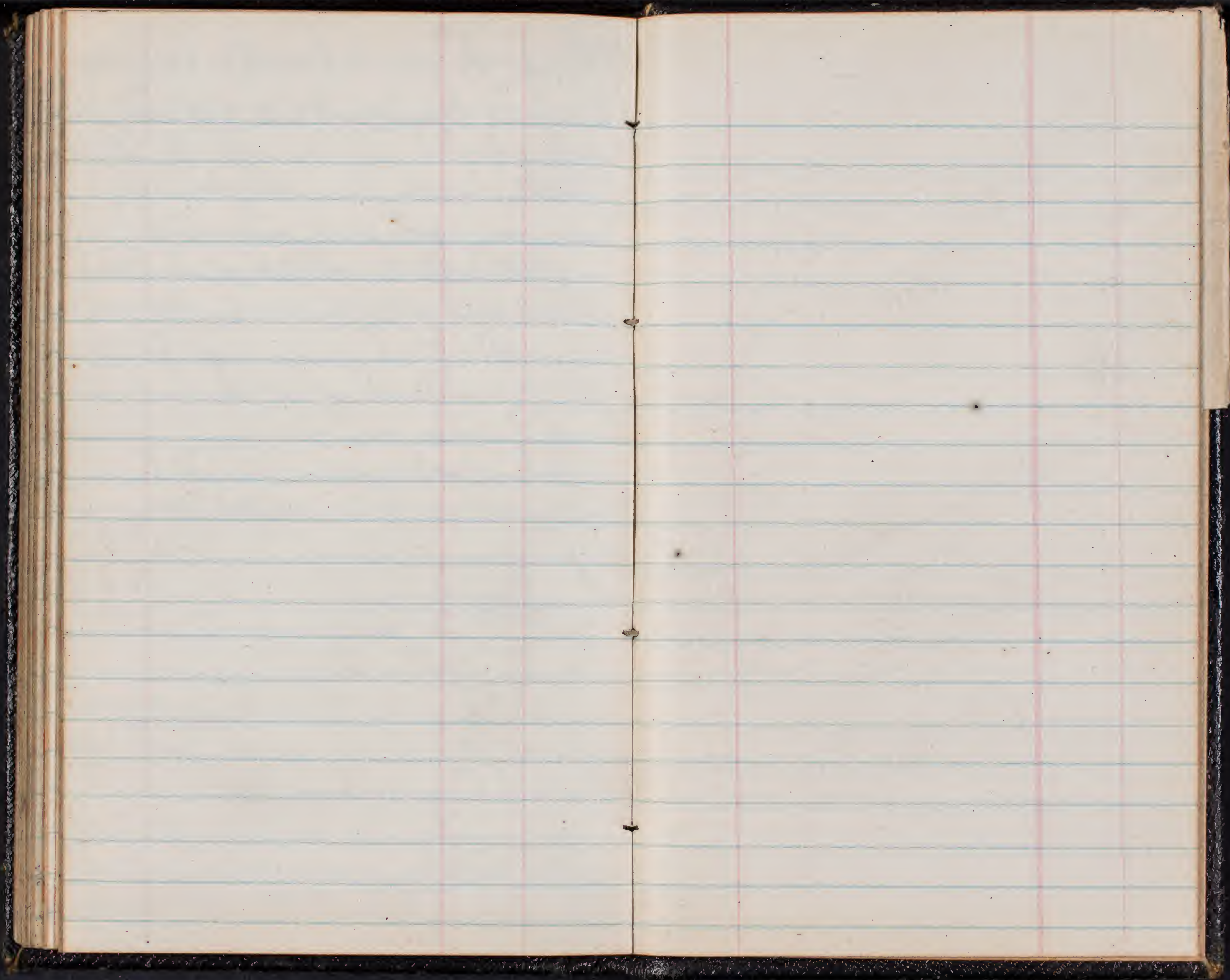
To the westward, or a little S. of W. almost directly beneath me, at the foot of the mountain on which I was standing, was to be seen Lake Washoe, a beautiful clear Mountain Lake. Beyond this to the west, as well as to the S. W. & N. W. mountains everywhere; and at a distance of 40 miles or so some of the higher parts of the Sierra Nevada

-da (Mt. Rose etc) were seen ^{whenever}
by patches of Snow. To the north
also the eye wandered over vast areas
of Mountains. On some of these high
or mountains pine trees grow, but
with the exception of these, and a few
very small trees (Willows & Cottonwood)
along the margin of Carson River, the
whole boundless area of country is, ^{as} truly
desert.

I had but a very few minutes to
enjoy the scene as the wind was very
cold, while the reverse in ascending
had caused a profuse perspiration. Put-
ting up my coat, I ^{only} cast a ^{quick} ^{glance}
glance around before starting down.
Happening to look upward, I saw
an Eagle soaring 1000 to 1500 feet above
my head, and as he circled around
I could see from the glances of
light from his wings that the
Sun was still shining upon him

for an instant,
though it was below the horizon
to me. Hastening back, I arrived
at the Hotel in Va. City at about
7:30 P.M., having been two & a half
hours in ascending and returning.

Although 8000 feet above tide
at the apex of the mountain, I
did not experience much dif-
ficulty in breathing, or shortness of
breath more than the same amount
of physical exertion would have
caused at a lower altitude.



1 1/2 mi E S S from Pres

Sandstone 12 ft
Clay 4.5 ft
Grey sand st 10

Slope
Reddish clay
and decomposed
alterna clay +
grey sand st 7 ft 3 in

Green conglom 1 ft 0 in
Reddish large sh
Slope clay 9 ft 10 in

Sand st 15 ft 2 in

Level

Sandstone sh 4

Gr Sand clay 4

Sand st 2 1/2

tan ash col clay 3 sec

~~tan ash with both points~~
~~clay~~ 2000

Ent. dip of ridge at E. end
N. N. W. to N. W.

Lesq. - Blk. B. Platanus
Haydeni, Sabala, Rhamnus,
Cyperaceae etc. Some same as at
Evanston - Red shale near
Blk. B. Juglans rhamnoides,
Cornus, Cinnamomum granu-
di, all tertiary sp.

Red shale over main coal
Blk. B. Platanus, Licium trilobifolia
Populus, Sabala, Licium Heeri,
Ulmum asperum, all
Eocene types -

120 feet lower, in white
sandst. Halimnites? which
marks the Eocene char. of
the Eoc. sandst. from Raton
Mt. to Rock Spring, Wyoming.

G. K. Gilbert

1235 Maple Ave.



