One of the most striking features in the view of the first Rocky Mts wall of the wall, that we became in sight as they came in sight from Morley, was beside their slightly and broad-folded cliffs of prodigious size, was certenly dem the mighty forest belt of these mountains. The contrast between the threeless prairie, that came with his salsalaceae formation close to the foot of the ~~fr~~ Front-Range, & the appearance of the ~~evident~~ struggle for existence, evident by the single spruces, that rose from the forest, which accompanying the bottom of the side Bow River Valley on one side ~~bottom~~ to the edge of the slopes of the Valley, and the luxuriant forest vegetation, ~~develop~~ developed already in Banff on the other was for me such a surprise, that I intended to pay ~~the~~ very great most attention to the ~~ph~~ phenomenons of the Timberline during my journey over the Condillera and ~~the~~ crossing the coast-lands of Brit. tish-Columbia and Southeastern Alaska.

~~I executed my work bas~~ Based on the maps and charts of the tra. versed country, which we have had in abundant and best choise, thanks Assisted by ce the to the kindest care of our excellent guides, I executed my observa. very great tions by means of one pocket-aneroid (Baucart, ~~#~~ Paris) and the dissimètre double prisme of Colonel Goulier (Balbreck Frs, Paris).

The by crossing of the mountains attained results are very simple, ~~never~~ but nevertheless of the highest interest.

The timberline does not change on the full mountain-profile from the Front-Range between the Kananaskis and Bankhead on the one side and to the Selkirks on the other side [Timberline on the Sulphur-Mt. 2150 m (7000 ~~6600~~'), about in the same hight as on the Sylmore Mt, in the country of the L. Louise 2190 m (7170 ~~7200~~'); Log South Mts in the Purcell Rg. by Golden 2100 m/ (6885' measured ~~6900~~') and in the same range from Six-mile Creek 2250 m (7380' ~~7400~~'); in the Selkirks ~~measured~~ attain the timberline in SSE ~~south~~ exposure on the Mt Cheops 2240 m (7345' ~~6500~~'), and in the west exposure on the slopes of Sir Donald 2120 m (6950' ~~6500~~')] ~~to the great trough French of Columbia Valley descend the t timberline on the East Slopes of the Selkirks and on the Gold range very visible, it lies~~

The timberline is here everywhere very high, 5-600 m higher than in (1500-1800') the ~~more~~ 2° of latitude more south situated Carpathians, and which are situated about in the ~~same~~ as high, as in the 4° ~~south~~ more south situated Centralalps. But not only the high ascent

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of the woods is not the only striking feature of the Cordillera. The second interesting phenomenon is the lack of rising of the timberline against the backbone of the mountain-system, hardly signed by a slight uplift of the timber in the high Selkirks; to these in opposite must be accentuated and also the relatively high ascent of the woods on the East Front of the mountains, as shown by features on the Rundel Cascade or Aylmore Mts. The more striking Stranger is the descent of the timberline on the east slopes of the Selkirks, and on the Goldrange, on both sides of the principal trench of the Columbia. The descent of the timberline (woods) on the mainline of C.P.R. by Revelstoke I noticed only in the important descent of the nevé on Mt. Begbie, but this indirect conclusion is ascertained by direct observation of the timberline on the slopes of the Arrow Lakes, where it stands as well, as in the ranges bordering the Columbia R. by Rossland, it stands in spite of a difference from two degrees of latitude in a height of 2100-2150 m (6900-7000'). The rise of timberline in the Selkirks is in accord with the rise of it in the south part of Rocky Mts. (Steeple Mt.) where it attains 2250 m (7300'), and the insignificant fall on the East Front on the mainline of C.P.R. by Banff corresponds directly to the slight descent of the timberline by Frank (2100-2150 m = 6900-7000') on the Crowsnest-Line.

These facts lead us to another interesting feature, viz. the insignificance of the influence of the latitude, consequently of the temperature. Based upon a very simple calculation, we arrive at the conclusion, that a difference of 2° of latitude corresponding to a difference in temperature of 1°C ought to cause a difference in the height of timberline equal to about 150-200 m (500-650'), a difference, not existing at all. These strange circumstances are developed in a much higher degree on the Pacific-Coast and in connection with them I will attempt a discussion of this phenomenon.

Finally I will made some remarks about this remarkable

descent of the timberline against the ~~E~~ side Columbia-Trench and in the direct neighbourhood with the dry belt of the Interior Plateaus. This descent of timberline can be by no means connected with the features of the dry belt; on the contrary the increasing dryness against the ~~inter~~ Interior Plateaus must cause the rise of all belts of vegetation. The lowness of the Canadian part of the Interior Plateaus only hinders the developement of these features, as characteristic (for) the Interior Plateaus of the U. S.[x] The descent of the woods ~~in~~ on the ~~east~~ west slopes of the

x J. Bowman, Forest Physiography of the U.S. N. York. 1911, p. 206.

Selkirks can be also ~~a fact~~ treated as only an effect of exposition. This But this effect seems to be in the American mountains ~~more~~ still more complex, than in the mountains of Europe, ~~From the same~~ and, from the many facts illustrating the effect of exposition on the glacier developement, ~~dissipated~~ scattered throughout the excellent work of Bowman[xx] I could not find a line, leading to connection between ~~with~~ the climatic and morphologic relation (on one side and the glacier developement on different slopes on the other) ~~of the country~~.

xx Bowman, l.c. p. 161, 267, 353, 368 etc.

All my ~~obs~~ direct observations ~~of~~ on the contrary cover the upper limits of the forest growth guided me to the conviction ~~was for me convincing~~, that the ~~west exposure and~~ W and SW exposure caused a depression ~~was worse~~, ~~than~~ the E ~~or~~ SE and NE exposure. In most of the observed cases I noticed (namely) a very distinct rise of the woods on the ~~east~~ E slopes, that on those exposed to the W, as for example on the Sulphur Mt in the Selkirks by C.P.R. Station Glacier, finally on the Steppe Mt (in the region of Kootenay Lake), where I found the ~~the~~ W slopes ~~more~~ against the ~~E~~ (more favoured) every ~~favoured~~; in one case, on the Turtle Mt by Frank, where the ~~west~~ woods rose ~~a~~ on both E and W slopes to the same height, the condition of the trees ~~over~~ on the W slopes was found ~~to be~~ no more favourable in comparison with that on the E slope, that the above mentioned conclusion can be not ~~changed~~ varied at all.

The neve-line ~~shows~~ in these mountains a strong parallelism to the timberline. The neve-line was in this country determined partly from maps (mean-height between the ~~a~~ culmination of the glaciated area and the level, to which descend the glaciers), but mostly by direct observation of the level, that separates the neve-snow from the glacier-ice. Unfortunately ~~the fresh snow patches from a lately fallen snow reduced me~~ it was not easy

to find this level from a certain distance ~~xxxx~~ on account of the fresh snow-patches; so that I was always inclined to observe and measure ~~xx~~ probably a somewhat higher level, than this, the one corresponding to the real local conditions.

In this way I found the following values for the nevé-line in the Cordillera (51° N) from E to W: Lake Louise-Region 2550 m (8360'), L. Emerauld-Region 2450 m (8030'), in the Selkirks-2675 m (8770') east slope of the Mt Beg., in the S exposure, 2585 m (8475') in the N and W exposure, on the Mt Beg. See in the Gold Range 2400 m (7870'). ~~in the E exposure~~. I have to add, that the [illegible]lmore (Wynnt) on the east front of the Cordillera is very distinct glaciated, we come to the conclusion, that the distribution of the nevé-line here is generally very uniform, disturbed only by a slight elevation in the Selkirk ranges of Selkirks, and a slight depression near the drybelt of the Interior Plateaus. In spite of ~~them~~ the exact fact, that the determination of the nevé-level was not as sure, as that of the timberline, I can, however, by no means ~~accept the conclusions of Penck~~, take part of the assertion of Penck, that the level of nevé rises continually from the Pacific to the east slopes of the Front Range, and that this rise amounts from the Selkirks to the Bow-Range, from 2250 m (7300') to 2750 m (9000') ×

× Penck, Reisebeobachtungen aus Canada Wien. 1898, p. 44.

From other generalisations, based upon the distribution of the woods, I expect to find one confirmed also by the facts of distribution of the nevé; that is, the very insignificance of the latitude. On these features the level of the nevé on the Kootane Mt Syn. situated 2° more south I estimated at 2500 m (8200'), and the glaciers of Bear Peak in the Cabinet Rg, of Lewis Range in the Western Montana refer probably in spite of 4° difference in latitude to one nevé-line, probably still more depressed than in the profile crossed by the main line of C. P. R. ××

×× Bowman, l.c. p. 306, 311.

~~The thesis of Penck, maintaining the continuous descent of~~

~~neve - line against the Pacific is all right not only~~
Beyond the Columbia R. across the mainline of C.P.R. the Interior
Plateaus, that are in the eastern part of the Shushwap and Adams-Lake
Basins low enough to be strongly forested to the top
of the long and flat ridges, while in the western part in the basin of the
Fraser R. are dry enough to remaining far below the here potentially
very high timberline, + will more than the more the neve - line.

From Spencer Bridge, and especially down ~~Lytton~~ the junction of
the Thompson with the Fraser Valley increases the humidity very
rapidly and parallel to them descent the forest cover to the valley
bottom, and a luxuriant vegetation takes the place of the absolute
scarcity, that was for a long time the only dominant feature.
~~For that region, down of Lytton, come at first the thesis of Penck~~
~~in the right sight: the both limits, the of the woods appear as~~
~~the of the neve descend very distinct against W. Though~~
~~very opportunity for observation was in this part of the journey~~
~~Quite limited, two points establish this thesis very clear: the tim.~~
~~berline near slope by the last sharp bend of the Fraser River~~
~~I estimated~~ Though my opportunity for observation was in this
part of the journey quite limited, it is can be no question, that
the thesis of Penck, namely a very distinct descent of both limits,
that of the woods and that of the neve towards the against West, comes
here in full view right. The descent of the neve - line, the ~~gra~~ rapid
growth of the conditions for glacier developement was here espe-
cially apparent. The for long time missed glaciers which have been missing now glanced
here and there already down Lytton and the descent of long,
though narrow glacier - tongues deep in the ~~the~~ dense tangled virgin
forest by Agassiz testified the thesis of Penck better, that all
measures. Some more exact observations I made from Vancouver
on the Lions of the Coastrange and from the Strait of Georgia
on the mountain group of Arrowsmith ± 7825 m (5976'). On the
first point I estimated the ~~no~~ timberline at 1850 m (6050'), the
neve - line at 2050 m (6720'), on the second, pushed towards W not
quite full 2° of longitude descended the timberline ~~at~~ to 1600 m (5200'), the
neve ~~at~~ to about 1725 m (5650').

In a summary we can in the ~~Cordillera~~ Cordillera near the
international boundary distinguish three longitudinal belts:

1) the Interior, between the Columbia and Fraser R. without neve and without upper timberline, 2) the eastern of Rocky Mts with a very high and very uniform snow and trees limits, 3) the Western of the Coast Kges with a low, and toward west the more descending limits.

Beside these differences have both mountain-belts one common quality, a very important in physiographic as in anthropogeographic relation, that is the almost complete lack of a intermediate zone of alpine pasture. This for these mountains very particular peculiar defect is very natural one, when the difference of the level of woods and neve attains in the Coast-Ranges 150-200 m (500-655') only, and not in the eastern mountain belt rises to 350-400 m (1150-1350'), a amount which probably, something exagerated. In both cases are the intermediate zone to narrow for a developement of such characteristic (for other mountains) pasture grounds. It must be namely remembred, that this intermediate zone are deeply sinuous and often broken by the common avalanches, glacier (regenerations) and finally by glacier tongues. But not only this condition but beside these local condition we must put to account another general one, that makes still narrower this insignificant intermediate strip, than for pasture development fully useless. I have in mind the glacier-oscillations, consequently the wandering of the neveline. After my own observations on the Illecillewaet Gl. the retreat of them in the last years very slow, thus in ~~about 11 m (36') in the time 1898-1913, and 15 m (50') in the time 1887-98 yearly this~~ (14½ m = 44' yearly) about 350 m (1145') for the whole period of 1887-1913 in longitudinal sense, corresponding to one vertical rise of the glacier-tongue glacier-end in the same time for 60 m (197'). Beside these short and insignificants oscillations but it gives here likewise very distinct tracks of a ancient much more pronounced glacier advance. I distinguished during my short visit of this glacier-end namely five parallel morainic walls, the fifth close above the junction of the glacier-stream with the Asulkan-Brook, the forth just above the first bridge. Between these two lower walls disappear the old ocular forest, a chronologic sign of the time of the last mighty advance of the Illecillewaet Gl. Apart from the question, if this advance of Illecillewaet Gl. was not

contemporaneous with the much more pronounced glacier invasion in Alaska, recognized by Vancouver, we must be satisfied with the certainty that the Illecillewaet Gl. is subdued to the secular oscillations, attaining about 2 Km in horizontal, and 180 m (600') in vertical direction. This glacial movement corresponds to a descent of neveline of about 100 m (over 300') and consequently to a complete abolition of the intermediate zone. The lack of the alpine pasture grounds in the Cordillera near the international boundary, not only a very striking, but also a very general feature one. The knowledge of this fact means indeed no explanation. This much more complex question is a feature, but perhaps in some relation with another one peculiar feature of the upper forest belt, not only of the traversed part of Cordillera common, but also in the same degree remarkable for all the Pacific-Coast Islands, which we crossed between Vancouver and White Pass on the Yukon-Route on one side, and Yakutat-Bay on the other. This is the lack of one bush-zone in the upper regions of the forest formation. There it is especially in the Pacific-coast-Islands, where the timberlines are low, a very strange apparition: lofty high-grown trees, that project their bare branches by storm and weather beaten against the sky or directly against the neighboring Snowfields. A real upper bush-zone I found on the White Pass only; it was there very distinct and well developped on the south slopes of the mountains above the timberline from 730 m to about 900 m (2400-3000'). But also this single case of bush zone had some qualities that were able to provide him with a note of interrogation. It appeared to me, that this bush zone is composed from the same species of crippled trees (a kind of Picea spruce and Tsuga), that grow not only below 730 m as high grown trees on the south slopes, but also above 900 m (3000') in the north drained interior of the Yukon-Basin. If on the other hand true, that a similar climatic degeneration of the tree growth is also accomplished also elsewhere, for example the Pinus Banksiana on the Sulphur Mt., but there it nowhere reaches a close growth of these crippled trees in a separate zone, they are only in the higher regions, scattered between the high-grown specimens, that those reaching in a more or less unchanged condition the timberline itself. From this point of view the upper belt of bush on the south slopes of the White Pass is a special case, that can, on the other hand in no way by no means weaken the

for the whole favored country characteristic ~~as~~ rule: lack of the alpine
bush zone. ~~For prevention of possible mistakes~~ Some misunderstandings ~~I will~~
could be found in the aspects of the mountains bordering the slopes of
Ya Glacier Bay, Yakutat Bay and many other ~~regions~~, ~~a~~ more re-
stricted places, not long ago covered by snow or ice. Especially some
hills of the Yakutat-Bay region, thickly covered with alder- and willow-
bush from the sealevel to a ~~hight~~ height of about 500 m (1640') could
~~a~~ very easy awake ~~one~~ opinion, that this region (situated) ~~lies~~ outside of the
region of the trees and belong already to the polar bush-region.
Then it is ~~a~~ not so. The alder and willow bush present for this total area,
as ~~good~~ well in the ~~Cordillerean~~ distinct, as in the Pacific-region part an early
stage of vegetation, that covers at first all bare rocks and slopes, rock-
slides, tracks of avalanches, finally it follows ~~does~~ in the steps of a
retreating glacier. ~~So~~ Thus and no ~~one~~ otherwise ought ~~be treated~~ the
strong and wide distribution of the bush formation in Glacier and
Yakutat Bay especially.× to be treated

The vertical distribution of the timber- and nevé-line along the North-Pacific-
Coast is more complex ~~as~~ than across the Cordillera, suggests also many more
problems. ~~Our~~ In our route on the Pacific coast ~~a~~ one can easily distinguish two in
physiographic relations different parts; the one kept in from Vancouver to
Skagway the well closed interior channels, the second one in those from Juneau to Yaku-
tat Bay conducted us trough the wide Icy Strait to the open oceanic
coast. The first was rather a continental route ~~one~~, only once interrupted
~~so~~ oceanic blast ~~by~~ in the Dixon Entrance interrupted, while in the part Ska-
gway-White Pass-Yukon was given a special opportunity for acquaintance
with the pure continental relations ~~with~~ to the timber and nevé line.
~~The~~ On the route Juneau-Glacier and Yakutat-Bay was ~~given~~ found a controll for
the oceanic influences, whereas ~~the~~ visit of the interior fjords of the
two above named ~~fjords~~ Bays allowed ~~a glimpse~~ some glimpses ~~in~~ only in the modifications
of the oceanic influences with the removal from the open oceanic
shores.

~~We~~ We will take first in consideration the ~~most~~ features observed on
the route Vancouver-Skagway and White Pass, where
After these remarks ~~I~~ I shall ~~probably~~ give my observation in a short

× It is possible, that the defect of the alpine bush zone is in some degree connected with another fact, that is with a certain selection of tree species for several hypsometric belts. To this opinion I was ~~guided~~ led by reading the studies of Stewardson Brown, Alpine Flora of the Canadian Rocky Mt. N. York 1907, and ~~yet~~ still more the study of Ayres, Washington Forest Reserve in the 19th Ann. Rept. U. S. Geol. S. 1897/98. This question ~~proved~~ belongs purely to the floristic problems and ~~can be also no~~ cannot be taken by me in discussion.

222:3= 74 уки

333:4= 83

13

review.

~~The route Vancouver - Yukon.~~

	1 Mt Arrowsmith	2 L. Nimpkish	3 Granville Ch.	4 Gr. Rouperé	5 Grenby Bay	6 Gracina L.	7 Cleveland Pass.	8 Skidegate J.	9 Millbanke J.	10 S. contr. I. Stephens Sd. Admir. I.	11 Land West shore	East shore
Latitude	49°	50½°	53½°	54⅓°	55½°	55⅓°	55½°	56°	56½°	57⅓°		57⅓°
Timberline	1600	1400	650	800	550	550	550	550	500	—		—
Neve-Line	1725	1500	—	—	~~850~~	—	—	650	—	550		750
Descent of timberline pro 1°		-133 m		-250		-50		-50				
Descent of Neveline pro 1°		-150 (-133)			-154							

	12 Entrance to Tarku Inlet	13 Douglas	14 Entrance to Lynn Canal W shore	15 E shore	16 Lynn C.	17 Skaguay	18 White Pass	19 Log Cabin	20 East Entrance to North shore	21 Taylor South shore
Latitude	58¼	58¼	58⅓	58⅓	59°	59½°	59⅔°	59¾°	58°	58¼°
Timberline	—	700	~~720~~	800	620	650	730	1000	750	800
Neve-Line	850	—	~~900~~	—	—	850	—	—	—	900
Descent of timberline pro 1°		+ 164 m			- 128 xx			+ 1400 m.		
Descent of neve pro 1°			+ 60							

	22 Coast Mts of the Demont Glacier	23 Coast Mts b. Mt. Foster a. Chamberl.	24 Entrance to Discovery Bay	~~25~~ Entrance to Russell Fj.
	58¾°	59¼°	59⅚°	60°
	700	—	—	
	> 1000	850	700	

1100 : 75 = 14
350
500 : 325 = 15
1750
1250

This short ~~overview~~ review of my observations gives in detail a very complex picture of the here treated problem. At first it is very difficult to find in the succession of these ~~heights~~ levels some natural order, and one feel a inclination and it ought to be wondered if [illegible] could be not a wonder that one ~~xxx~~ inclined to ~~accept~~ the exactness of my observations were suspected. I must confess, that (even) in me grew (some doubts), ~~as the strange character of my observations~~ when after puting my observations on a map the strange character of them and their conclusions came in right light. For that reason I was very satisfied to find in the Guide-Book for the excursions of the Intern. Congress some exact remarks, supporting the principal conclusions of my observations - the very low timberline on the Pacific Coast Islands × on one side, and the proportionally very high rise of them towards the interior of Yukonland ×× on the other. Whereas I confess my doubts and ~~xxx~~

× Viz. the paper of F. E. Wright in Guide Book N°. 10, p. 42.

×× Viz the paper of D. D. Cairnes in Guide Book N°. 10 p. 61.

~~At~~ At the same time also my satisfaction ~~of~~ at the control, found in the Guidebook, ~~xxx~~

written by the first authorities and after the most recent researches,

× Compare the views over that question in such a excellent For the novelty of these views of Wright and Cairness compare the views on over that question in such a excellent book as Bowman, Bly & Forestphysiography, p. 148.

I must likewise accent ~~in the same time~~, that a great part of my observations is executed very careful and that I give them have full confidence in them.

Now some conclusions.

The timberline descends ~~with the it~~ on the Pacific coast very rapidly with the increasing latitude. This descent amounts on ~~the~~ Vancouver Island 133 m (435') per 1°, ~~to the~~ from Vancouver to ~~the~~ Grenville Ch. 250 m (820'), from there to Granby Bay 100 m (330'), and in the section from Granby B. to Mitkow Isl. 50 m (164') only. The low position of the nevé-line in Stephens Passage ~~that~~ authorize the supposition, that the timberline is there also very low. But in the Taku Inlet on the ~~Bay~~ Douglas Island, on both sides of the entrance to Lynn Canal and in the (Before Colorado) north pushed Mansfield Pen. are the timberline is proportionally high; the rise ~~of~~ them in the parts of the fjords situated between 56½° and 58⅓° amounts to 137 m (450') per 1° of latitude. ~~From the entrance to the interior of the Lynn Canal~~ This rise, ~~does~~ ~~interrupted~~ ~~is towards~~ slow interrupted the interior of this fjord, until this head ~~finds~~ at Skagway, ~~find his continuation towards the Yukonland. this rise,~~ ~~exactly formed and measured till Log Cabin, already on the northern sloping interior situated, amounts~~ But from Skagway, where the ~~position~~ Level of timberline was very exact determined at ~~to~~ 650 m (2130') it rises again ~~to~~ on the south slopes of the White Pass at the rate of 280 m (925') per 1°, and from that point to the first northern exposed slopes of Yukonland at Log Cabin it jumps about 300 m (1000') for a very short distance of ca 15 Km. This very high timberline remains ~~they~~ not only at the same level for many degrees of latitude towards north, it rises on the border of the Yukon still more, and I remember my impression, that gave ~~caused~~ over me one photo of a hill country in the Porcupine-basin, situated between 67-68° N with a high grown spruce forest at a height of 2-3000'. The photo was taken by one of the members of Dr. Cairness Alaska Expedition of U. S. Geol. Surv.

Summarizing the results of this discussion we ~~can distinguish~~ ~~can~~ set up some rules about the distribution of the timberline on the „inland passage" of the American westcoast. In this ~~west~~ whole district ~~are~~ the timberline is extremly low, but we can generally distinguish two short marginal parts and ~~one~~ a long, central part.

The south margin ~~xxxxxxxxxx~~ embraces the part of the passage, protected towards the west by the Island Vancouver. The timberline, though here also low, is proportionally to the neighbouring part of the passage high, but the transition between these two parts seems to be so rapidly accomplished, that already on the north points of the Vancouver Isl. the timberline is certainly scarcely about 1000 m (3280') lower than on the west slopes of the Rocky Mts in the same latitude. The north margin embraces the transition between the headlands of the Lynn canal and the Yukonland; A powerfull rise of the woods is the characteristic of this part. The timberline on 60° N is here 1000 m higher than on the coasts of the Atlantic, that are even at 8° of latitude further south completely treeless. In the principal part of the, inland passages the timberline is extremly low, but not uniform. There are from the latitude completly independent, but however not uniform. There are namely two places, at Prince Rupert and the second, where the timberline rises quite unusual.

The high timberline connected with about the passages, the Icy Strait does not change on the oceanic outlet of this Strait. Even on the open oceanic shores was the timberline determined at a height of at least 700 m, and above these it was observed a very well and regular developed Shrubbery-belt, that reached to the nevé line, which was in some places elevated to above 1000 m. Towards NW. of this point shrinks the timberbelt very rapidly; its place is more and more by a bush-vegetation that entirely obtains the mastery. In the interior of the strongly glaciated fjords to exclusive domination comes. As above stated, this bush-zone can only be treated truly as a first stage of vegetation on the barren grounds, or as a representative form of the forest. We have also in the Yakutat Bay and in the Glacier Bay too a migrating form of the forest. We can consequently suppose, that not only either the bush form, but also the forest form had attained here also climatic upper limit and for that reason we must not either the bush or timberlines consider as a right physiographic control for this regions.

In these extremly-glaciated fjords of Glacier and Yakutat Bay we are sur-

prised by a extraordinary peculiar feature ~~never nowhere else~~ in meet for the first time
our journey. It is a very pronounced rise of nevélines toward the centres
of glaciation of the Fairweather and St. Elias Mts. This rise of the
nevelines is the more strange, that it cannot be connected with the
known elsewhere f. ex. in the Alps inclination of all climatic
and physiographic horizons towards the centre of mountain and
this for several reasons: first, this rise is brought about at very short
distance and in direct touch with the ocean and its influence,
secondly, this rise attains a quantity much higher than the same
than one can expect for the neve-lines of the central area of gla.
ciation. A little set of facts ought to serve as an illustration and
also as supports of the above named conclusions.

The nevé line ~~in each~~ of the central area of glaciation in the Glacier Bay
can by ~~it~~ determined with sufficient exactness by means of the levels,
at which the lateral moraines in sight. These levels as well
as the superficial moraines are with special care given on the Chart
№ 8300 of U. S. Geod. a. Hydr. Survey. This ~~mean~~ level is on the basement,
Muir, Carroll, ~~Grand~~ Gd. Pacific and J. Hopkins Glaciers is elevated
~~in mean~~ at a height of 2610' (795 m), than some 100 m (300')
or more depressed in comparison with the nevé-lines in the ~~a~~ east
part of Icy Strait and in the neighbourly passages. ~~The nevéline~~
~~is~~ But on the mountains bordering the now from glacier abandoned
~~part of Glacier Bay~~ it (the nevé-line) is much more elevated. It is sufficient to take
Bay, that all the lateral valleys, which drained mountain
masses, rising 3200-3800' (975-1160 m) ~~are here~~ indicate no sign
of local glaciation; The rise of nevéline in a narrow belt between
the oceanic shores on one side, and the central piemont glaciers
on the other, attaining a amount of about 200 m (650') seems to
be proved for the Glacier Bay region.

~~#~~ Analogic relations of the nevé-line I found in the Yakutat Bay
and its inner fjords. Though the lack of ~~a~~ detailed maps for this region
don't allow to appreciate the height of the nevé-line on the central
area of ~~this~~ glaciation ~~region~~ the rise of nevéline toward the huge icefields of
the Hubbard, Nunatak and Hiddenglaciers is ~~not~~ easy to be recognized
by other means. It is enough to go along the Disenchantment
Bay to the Hubbard-ice cliffs for appreciate a distinct eleva-
tion of the discussed physiographic horizons. The hills sloping
to the toward the ocean towered St. Lafueho ~~also~~ surpass
hardly 3000' (900 m), but ~~are thickly~~ their fine textured valley
system ~~are~~ full of ~~little~~ and also greater glaciers. In opposite
short glaciers (~~the~~ two miles long)

~~x x~~ as a good example I can indicate the mountains on the shore of Icy Strait, opposite to Brown Island

to them the hills sloping to the rocks of Osier I. and facing the Lib. hard ice tongue, although attaining the same height as the preceding, are covered with alderbush in the lower part, and with a bright green colored grassy carpet to the top. The difference is the more remarkable when taken in account the insignificant distance of 13 Km (8 miles) between the extreme points. From the Osier Island there branches at right angles to the Disenchantment Bay the Russelfjord a long and narrow through-shaped submerged valley striking in a direction parallel to the oceanic shores. The peculiar feature observed in the Disenchantment Bay can be confirmed by map analysis for the whole region of the Russelfjord and the neighbourly oceanic slope. I could namely determine for this region after a map, in eleven cases the height of the culmination of the glacier-end and of the culmination of the locally glaciated area, the middle of these two points very closely agreed with the névé-line. In such a manner I found, that the névé-line of the oceanic slope lies at the height of 670 m (2200'), while it rises over the slopes of the Russelfjord to the height of 870 m (2850'). It is very striking to find in both cases, as well in the Glacier Bay as in the Yakutat Bay a completely identic rise of the levels of glaciation in face of the immense icefields of the piedmont-glaciers.

From these various observations, as well as from general impressions, I wished to draw the following tentative explanations of the very complex problem of the distribution of the timber and névé lines in the different physiographic regions of the Cordillera and the Pacific coast-lands.

I will distinguish also at first the most characteristic physiographic types 1). Rocky Mts-Belt east from the Lower Columbia trench (Selkirks-Valley) distinguished by extreme height of the timberline and about normal level, according to the latitude, of the névés. 2). Interior of the Yukon region distinguished by the rise of the woods as high as at 1), but also with parallel extreme high elevation of the névés. 3) Coast Ranges, in its approximately meridianal part limited by the extension of the isle of Vancouver towards the north; this region is characteristic for the about normal height of the timber, and joint with a very slow descent of everlasting snows. 4) The same type as the region 3) is peculiar to some parts of the Coastranges, open to the direct oceanic influence, as the region of Prince Rupert in front of Dixon Entrance or the islands and

and coastlands near the Icy Strait. To the same type belongs the fore-lands and the direct to the Ocean open slopes of the Fairweather and St. Elias Mts, which are everywhere here the correspond here the ascent of the woods to the normal height, according to latitude everywhere correspond; here everywhere is here also the snowline (as also everywhere) proportionally low. 4) It is possible, and according to the theory, also very probable, that the same properties are common to the outer islands of S.E. Alaska too. 5). The „inland passages" consti-tute with the above indicated interruptions a uniform country with an extreme depression of the woods and the nevés; this depression is ~~here so~~ so violent, that the influence of the latitude seems to be here completly suppressed. 6) ~~A narrow mountainbelt, facing the hugh icemasses of Yakutat Bay and Glacierbay, some similar~~ ~~indication I found also on the hills, close to the Taku Snowfields, constitute a peculiar enclave~~ The region of the Alaskan Piemont-Glaciers and Icefields ~~with~~ show everywhere a depression of the nevés, very different in different cases. 7) A narrow mountainbelt, facing the hugh ~~glaciers and~~ icefields of ~~S.E Alaska~~ Yakutat Bay and Glacier Bay, some similar indication, which I found also on the hills close to the Taku snowfields, constitute a peculiar enclave between the regions described at 4) and at 6), and distinguished by an important rise of the nevés, potentially also of the woods to.

Making an attempt at a genetic interpretation of the above-stated physiographic regions ~~as fixed~~ at first a close resemblence of the ~~genetic~~ conditions accompanying the development of the two first regions, the Rocky Mts and Yukonland. While examining ~~looking over a probable cause of these chara-cteristic features I can no find another, then~~ climatic control, common to the both regions and for that reason also probable cause of those physiogra-phic types, I could not find another, any other cause, than a relative scarcity of pre-cipitation and a great deal of insolation. The dryness of the climate of ~~the~~ the Rocky is indeed very much surpassed be the climate of the Yukon, but this defect of the last country seems to be greatly at large recompensed by the long and sunny days of this subarctic dusky landscape. ~~In consideration of this~~ I have had unfortunately very little opportunity for observing in the detailed (physiographic) peculiarities of the Yukonland, but ~~except~~ I was however surprised by one phenomenon. I have in mind the rock-~~wet~~ weathering. This process was found on the whole route along the „inland passages" in a splendid develop-ment; a fine testimony of this is given by the thickly by vegetation ~~covered slopes~~ (here covered thickly with vegetation) mountain slopes, in spite of their steep extreme steepness and immense snow accumulation, both excellent

conditions for development of avalanches. Notwithstanding ~~the~~ ~~finest~~ barren slopes ~~or bluffs~~ on the way of „Inland passages" ~~was~~ almost impossible, and ~~also~~ the common tracks of avalanches was not easy here ~~to~~; the place of them here often a narrow strips ~~cutting the slopes~~ of rock foliation cutting the slopes in the lines of its greatest fall; these narrow strips of rock foliation are evident representatives of avalanches, checked in their way by exceptionally thick vegetation; their growth can be no only explained by ~~irrigation~~ atmospheric precipitation, we must suppose a cooperation of a deep ~~soil~~ layer. But all these peculiarities, seen by me on the route of the „inland passages" ~~was~~ by far surpassed by the surface features of the land near ~~Skagway~~ the head of Lynn canal on the route Skagway - Log cabin (White Pass). One excursion on the left slopes of the Skagway valley over a longitudinal ridge, 2-300 m (650-1000') high, ~~by glacial~~ subglacial drainage in a little bosses ~~carved~~, by glacial action evidently polished gave me an ~~instance~~ example ~~over~~ such a deep weathering, ~~and~~ such a rapid ~~soil~~ production, that I was reminded ~~over~~ the tropical conditions of rock weathering. It was here quite impossible to find a fresh glacial polisture, all the pronounced rocky knobs, on ~~those~~ we ~~was~~ ~~in~~ during all our journey to find the finest signs of glacial sculpture was here ~~thoroughly~~ broken, broken ~~in~~ to shivers, ~~from~~ from a distant I only appeared as typical bosses, ~~roches~~ rocks „moutonnées." A glacial polishment I found here in one case only, and this under special conditions; it is in an artificial cut, that opened the fresh rock surface, covered at first and primarily by a ~~3 f~~ 3' 1 m (3') deep gravelled, overlaid by a mighty soilcover, ~~which had crept~~ creeped down from the slope. ~~This~~ These features of ~~an~~ extraordinary rock weathering I noticed on all the route over the White Pass, and it is tentative for me to explain this extreme elevation of the woods in the Yukonland by excellent soil conditions, that give here a good recompense for the scarcity of rain, even in the higher levels (3-4000') of the timberline.

That dryness of the Yukon Climate, ~~that~~ by good ~~soil~~ conditions, a warm summer and ~~exce bright~~ a high grade of insolation does not prevent the growth of forest to a maximum ~~of~~ height, will be slackened with the rising elevation in the Rocky Mts belt. The same effect over the woods, ~~that~~ as in Yukon, produces in the Rockys in spite of the lower temperature and insolation, ~~the~~ the increasing with elevation precipitation. This rise of precipitation must be but in the Rockies quite considerable,

when the maximum elevation of the timberline is there coincident with
~~the~~ relative ~~it is~~ to a normal height
a low descent of the nevés. Finally there must be also presumed
Rockies also one more peculiar feature, a relatife feebleness of the do-
minant winds, especially of the descending winds (Föhn, Chinook).
To this supporition I was led by following consideration. All
the experiences ~~my~~, made hitherto experienced proved to me, that the strong winds are
the
almost destructive element of the forest on the timberline, a high ascent
of ~~the~~ it in the Rockies can be only imagined by excluding of strong winds. Another
of forests
experience shows that the strongest devastation is effectuated by the falling
winds, and when the ~~american~~ depressions traverse the American plains
from W to E (Rocky mts. alt) then the falling winds in the eastern part of the Cordillera
must ~~have a~~ come from a western direction. In the descriptive part of
this paper it was stated, that the timberline rises on the ridges of the Rocky Mts
higher on its ~~wester~~ eastern, than on its western slopes; it proves that the
direct oceanic winds here have a greater strength, than the as „ chinook"
down deflected falling winds. As the Chinook
consideration of the well known fact of wide distribution of the Chi-
nook. This wind, that blow over the belt of the plains, and reaches
in the eastern direction generally to Medicine Hat and after some
notices on higher latitudes much further off, till Sale à la Bosse or till Great
Bear Lake, in every cases 300 - 600 Km (200 - 378 miles) (distance from the mountains)
means compared directly with the alpine Föhn, a local atmosferic
avalanche, that on account of its territorial limitation increases to
a formidable strength. My own impression of the Chinook, that I received
on the 26th and 27th. IX. 1913 at Frank and that caused as far as Calgary a stiffling
heat was in a good accord with the above given theoretic de-
duction. This wind blew over a great area, it was at the same time per-
ceived at the mainline of C.P.R. and on the Crowsnest-Line and was
(arranged) in very regular waves, quite different from the irregular
and rise rythm interrupting and rising waves of a typical alpine or carpatian
Föhn. Far away from a tendency of deciding upon my single impression,
or even from the consequences of the geographical distribution of
this kind of wind, I will especially accent the fact of a slow depression
of the woods over the western slopes of all the crests of the Rockies
on their in general, and over the western border of this mountain-
belt especially particularly. From this feature as well as from
the first mentioned high ~~act~~ absent of the woods in the Rockies,
I will derive the thesis, that besides several climatic opportunity
it is, the winds do not attain there a notable strength, and

XX W.L. Griffith, Dominion of Canada (Secr. to the office of the High Commissioner of Canada), Dominion of Canada. Toronto 1911 p. 103. In the same work besides very interesting informations some erroneous ideas over „Chinook" p. 102.

that the same are weaker on the eastern, than on the western slopes.

Towards East from the Rockies are the mountains are too low or too dry, and for that reason they remain below the timberline. But in the as the 3. and 4. classed region of the Coast-Ranges are the for vegetative processes necessary abundant humidity in abundance, the oceanic climats are certainly very, or even to strong, but the relative high and uniform temperature causes a luxuriant growth of virgin forests, joint to the above named climatic qualities the timberline as effect of some a mixed result crossing effect of both useful and noxious influences rises here to a normal height, the nevé line descends on the contrary far below. When the snow do not descend in this belt far lower than to an extreme minimum of extreme minimum is to easy by the high and uniform temperature, that are not favourable to patronize the precipitation in snow-form. The extreme favorable conditions for snow accumulation seem to be met in the region 5. of the "inland passages". The partially relative exclusion of the oceanic influences must at first lower the average and especially the winter temperature, to them is but associated the parallel to them increases the snow rate, attaining a amount nowhere more in the northern Hemisphere surpassed. Another feature comes here into account, for favouring the development of a roughness of this country. It belongs in atmospheric relation to the Pacific centre of depression, and the morphologic contrast of the uplifted highlands to the narrow and partially obstructed deep fjord-channels as a consequence of the westwards outflow of the air, stagnant on the uplands must be often transformed in a, but the morphologic contrast between the uplifted highlands and the narrow and partially obstructed fjord-channels creat a disturbing ance of over the atmospheric equilibrium, which that not always can be there restored by normal atmospheric circulation, but mostly by violent falling winds. These winds, the north-eastern gales of this region, the rough (here also) cold „chinook," must have a quite different character, comparable only to the „bora" or mistral" of the Mediterranean country. The excellent optimum of conditions for snowfall joint to the development of the winds of a bora-type are sufficient to effectuate the two peculiarities for of this region, viz: a Maximum of descent of the Tsuga nevé's and also of the woods. Where instead of narrow channels there are wide straits, connecting the mainland with the ocean, as in the axes of the Dixon Entrance or Icy Strait,

× After local information, taken in Juneau.

probably much gentler
there is caused the restoration of a atmospheric disturbance much more
on the other side from
gentle, which excludes the installation of falling winds, and the side
which
thus facilitate the penetration of oceanic influences, that lowers
the snow-contingent. The high higher ascent of the woods and nevés on
the island of Vancouver, though separated from the mainland also
by very narrow strait only, can be probably explained, first by the
uniform mass of this island, that by itself hinders the westward
course of atmospheric movement, secondly, by its southern situ-
ation, so that it is brought more nearer to the pacific centre of barometric
high pressure, and depending from them the antieyclonal air-move-
ment of the air which depends on it.

For the region of the Alaskan Ice icefields I have had above stated
at a depression of the nevélines. This depression has exactly proved
for this for glacier-Bay only, but | Now we come to the most inte-
resting and complicated relations? found in the regin of the Alaskan
connections? icefields, and their borderland. The most strange complication
in these relations depends upon them, that the nevelines ascending
in normal ways towards the centre of glaciation attain really
have in the centre the lowest value and in the next to the centre,
(borderbelt)
a relative very high value. That descent, exactly evaluated for
central
the tidal-glaciers of the Glacier bay, approxima with an approxima-
tion stated for the tidal-glaciers of Russel Fjord, attains probably
very different values amounts. After But after my own impressions, to which I get
during my weekly stay at Glacier-Bay, and after studies over both of
excellent works of from Tarr and Martin, as good as well from Gilbert I
the two not fixed
came to the conviction, that the nevélines in these areas are stipulated
not by the climatic causes only. The most important foundation to for
this opinion lies in is shown in the very complex system of
glacier oscilations in South Alaska, to them of which certainly the
most impressive and analytic picture is certainly given by Gilbert.
How or where one can look over a climatic way of explanation
for short time glaciers oscilation, that attained till
changes of
100 Km (60 miles) change in longitudinal profile and in
a time of Maximum doubled the snow covered (by ice and snowfields) area in the Gla-
cier bay-district? After a very simple consideration we must
arrive at come to the conviction, that the middle elevation of the glacier
of Glacier Bay was
area at the time of Vancouver (1794), several hundred
(4-600 m = 1300-2000') meters greater, than now, and this
smaller

×

×× Gilbert, Glaciers and Glaciation. Harriman Alaska Exp. Vol. III. N. York. 1904.

××× Gilbert, l.c. 102-6.

means that the (as proved by Kurowski)
elevation of a glacier area is even equal to its level of the neves.[x]
The retreat of the Muir glacier since Vancouver's time means consequently a rise of the neve line in this region for several hundred meters, corresponding to a climatic change nowhere (which such a change has been) more in the short period and at a similar rate perceived. But these mighty oscillations, certainly without parallels in the records of glacial changes are, as a physiographic anomaly, still surpassed by another peculiarity, common to this territory. I mean a complete lack of harmony in these glacier-oscillations, which must exist after a systematic geographic arrangement, if the climatic theory of the glacial changes can be maintained. But the geographical arrangement of the known changes demonstrates such opposite extremes, that, although full of admiration for the ingenious suggestions made by Gilbert[xx] in reference to the climatic explanation of the Alaskan phenomena, I can not follow them.
It is not only the amount of changes, that are on the next situated glaciers without accord, but, what are from standpoint of climatic theories excluded, the extreme retreats from on the (simultaneous) east slopes of the Fairweather Rg, are accompanied by extreme advances on its opposite slopes. Analogous phenomena have been demonstrated already by the older and recent studies of Dall, Wright, Russel, Reid, Gilbert, Tarr and Martin[xxx] in abundance, but of the life of Alaskan glaciers during the last few centuries, shown by the study of G. David-(ad)ition son[+] give so chaotic a picture, that I think, after this revelation a climatic explanation of these phenomena can be no more supported.
In the violent earthquake of September 1899 which shaked southern Alaska, and its consequences suggested already Gilbert was found a new factor, to which one could ascribe a new type of glacier changes with a most interesting peculiarity, a lack of simultaneousness. Gilbert[++] already pronounced a similar idea, Tarr has it developed to a complete theory, Tarr himself and L. Martin[+++] have been worked at the verification of this problem. Really in the by me pursued question is the problem of the by earthquakes caused. In my opinion seems to be the problem of the by earthquakes in Alaska caused glacier changes (Glacier changes caused by) the problem seems to be the more complicated, the more comparative materials for comparison are brought together.

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[x] Kurowsky
[xx] Gilbert l.c. p. 109-12.
[xxx] For the detailled literature see Guide Book № 10, p. 169-76
[+] G. Davidson, The glaciers of Alaska. S. Francisco, Cal. 1909.
[++] Gilbert l.c. p. 213 ff. [+++] Tarr and Butler, The Yakutat Bay Region, Alaska. U.S.G.S. Prof. Paper № 64. 1909.

[7] Tarr and Martin, The Earthquakes at Yakutat Bay, Alaska, Sept. 1909. U. S. G. S. Prof. Pap. № 69. 1912.

At all events the fact of the ~~pretended~~ movement supposed to have been caused by the earthquake of Sept 1899 caused ~~can~~ ~~movements~~ of Taku, Childs, Miles or Valder-Glaciers ×
is are not to be connected with the uninterrupted retreat of the most (part of the) tidal glaciers ~~of the Glacier Bay~~ in the Glacier Bay. The lack of an influence of the earthquake of 1899 on the ice fields of Glacierbay is are an important proof against a too far reaching use of the earthquake-theory of glacier oscillations.
Whether Will be this relation found after following studies will be solved in one or in another direction, is the problem of this kind of glacier oscillation from the my point of view, pushed by me, from no importance. Earthquakes can cause avalanching in the nevés, or in the tidal-cliffs, and by this to disturbed disturbance of the balance in the glacial life is followed by glacial floods, but all these spasmodic movements that can be either be of important influence over the periodic changes produced by normal climatic causes, or the more observed great secular movements of glacier can be not made responsible for the little short periodic floods accompanying the earthquakes.

Taking in to consideration all these strange features, peculiar to the Alaskan glaciation, ~~can~~ crowded in me one on rushing into my mind idea certainly of vague character explicable for that I will ask for authorization, as a as no explanation whatever has been found up to now. ~~of till now was found no way for explanation of the~~ present features of Alaskan glaciation. My idea rest on the supposition that the great glaciers of Alaska are only remnants of the Maximum, ~~that~~ probably of the Pleistocene glaciation. The force of ~~the~~ such a glacier, or rather the stregth, to which is due the conservation of these glaciers must be at first looked for in the principle of inertion. Such ice fields especially the southernmost pushed glaciers of Alaska are evidently in relation to the climatic conditions of their environment, ~~they are evidently~~ to a certain degree a anachronistic feature; they are huge a kind of dead glaciers, that although the they exist in some correspondence to the meteorologic changes and oscillations, is to be diminished and slowly go out. yet however their general tendency This ~~is~~ kind of dying glaciers, that are remnants of past climatic condition, I imagin imagine, they can effectuate cause oscillations that are in discord with the compara. tively small present meteorologic climatic changes. From the fact of an immense re. treat of the Muir Gl of 38 Km. in a short time of 86 year, but probably maximal period in a time very much shorter, as more afterwards regarding the principe of the inertion, we can, with some probability, suppose, that the fore.

× Guide-Book No 10, p. 157.

4. As ~~great~~ well as the glaciers on arctic or antarctic ~~regions~~ lands

ceding advance of this glacier was of the same, but probably of a more violent, character. During my stay in Glacier Bay I observed on the Cushing Gl., that the general retreat overwhelmed there also even the (which very) high, situated nevéfields. This nevé has two flats, separated by a very steep slope over which a short time before extended part of (sell incessable to the Carroll Gl. has now completely) disappeared, and from the after information of L. Martin it has gone since the last visit in Glacier Bay in 1911. Such a change can be not without consequences, which can be even of very great importance. One consequence is quite certain, viz. the increasing rate of retreat of the Carroll glacier, thanks to the cut off from its source of nourishment. Geneic cut off. But I suppose, another results are also possible. This flattened high-plateau, or another on in analogic situation, belongs morphologically to the level of the „high peneplain" of Gilbert.× As this level is in want of a distinct sloping slope sloping direction, I ask it put a question, is it not possible, that a greater or lesser part of these snowmasses cut off from one glacier-organism can will be discharged in a normal way, or even by a slide, or another spasmodic movement, to a second glacier on the opposite slope of the highlands? I think, it is quite needless to look over other possibilities, that could explain the anomalies of the Alaskan glaciers oscillations. In view of these suppositions receive but the spasmodic movements, connected with the earthquakes another interpretation. I will only give by a single example given by the Cushing Glacier. Such a glacier, when tidal surprised by a earthquake can never, by being cut off from its upper snowfields, make an advancing movement, but but the same glacier, when tidal affected by shocks, will rapidly retreat.

Finally awaked in me the above developed idea. (It's a fact of the highest importance) I consider at first the exceptional changes of the Muirglacier and its fellows, for which the climatic all climatic theories seem to be by far insufficient. In spite of very complex system of recorded glacier changes for the last century one common feature can be yet discovered. ~~If I am right, I ascribe to this peculiarity a very important~~ The numerous glaciers, namely of the Glacier Bay, of the Yakutat Bay, of Port Wells, finally the Grewingk Glacier, in a sum the most important Alaskan glaciers are now more or less, but without exception, preceded by a greater state, by a Maximum, which may occured fifty,

[A lines!

[A lines!

are what?

× Gilbert, l.c. p. 123-30.

a

hundred or more years ago. ~~This~~ great number of glaciers ~~is~~ offers no ~~opposition~~ to the idea ~~possible to~~ ~~don't oppose to one idea~~ that the whole glaciation of Alaska is in a state of ~~a slow and~~ irregulary but general retreat. One glacier, namely the Columbia seems to ~~to~~ not have ~~be~~ in the last century ~~not~~ touched by the general reduction ~~movement~~, within ~~in~~ the last hundred years and one group of ~~the~~ glaciers, ~~i.e.~~ the Brady and its fellows, shows ~~x~~ traces of ~~an~~ important advance, the same was also ~~recorded~~ perceived on a part of the Malaspina. We see thus that excluding the criterion of time, ~~which~~ the most important control for ~~climatic~~ feature ~~oscillations~~ caused the by climate caused oscillations, we do not find in the ~~glo~~ peculiarities of glacial changes in Alaska ~~xxxx~~ ~~not~~ so much disagreement. That which exists But the remaining will be still more reduced, if we look for a systematic geographical arrangement of these two types of oscillation. Such arrangement ~~could~~ be from a climatic ~~standpoint~~ point of view ~~could be~~, as is well known, not found. From the ~~standpoint~~ point of view of my idea we must look for a morphologic arrangement, and it seems to me, ~~it~~ that such one exists. ~~x~~ All the more or less receating glacier-systems have ~~lost~~ many ~~tidal~~ tidal tongues, and have a wide waterfront, all glaciers of another smaller group on the contrary have no tidal tongues at all, and touch the waterfront in very short lines.*

To this arrangement, ~~as strictly corresponds~~ that influenced considerable also so considerably least all my thoughts in the question of the Alaskan glaciers, I was suggested by Gilbert's excellent deduction about over the wasting power, that top ~~perform~~ ~~xxx~~ the sea water has on the tidal glaciers.× The connection seems to be clear. All the Alaskan glaciers, belonging to the type first ~~of more or less pronounced dying glaciers executing a series of sporadic movements~~, ~~don't~~ are not powerful enough ~~for~~ to ~~oppose against~~ offer any opposition to the wasting strength of the salt and moving sea water. ~~in~~ In ~~x~~ case of ~~a~~ violent ~~chr~~ internal changes, producing a ~~eminent~~ striking advance of the glacier, ~~xxx to~~ the rapid progress ~~of such a glacier~~ is follows ~~as~~ as rapid ~~a~~ retreat ~~too~~. The relation takes another formation in the case, when the ~~a~~ glacier (of the second type) ends on a rockbed or on its own wasteplains. Everybody, that has had the opportunity to observe dead glacier trunks ~~xx~~ cut off from the living iceboby, was surprised by their resistence ~~against~~ to the atmospheric wasting has been agences, and must agree with the opinion of Gilbert, that it are ~~by~~ in "ten times exceeded" from by the melting by the sea. Under those circumstances it can be understood, that a glacier ending in a waste plain, ~~further~~ covered under a ablation moraine, can conserve its ~~by~~ to it protected by pre advances

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× Gilbert l.c. 163 + 168. See also Reid, Studies of Muir Glacier, Alaska. Nat. Geogr. Mag. 1892, p. 49.

spasmodic episodes caused advances by far longer.

3. The last fact, that can be called as a support for the discussed idea is the vegetation upon the glaciated territory. After the opinion of Reid the question of vegetation is not so simple. The well known fact of a secular forest, that grew some two hundreds years ago before Vancouver's time in the place of the subsequent powerful advance of the Muir glacier and its last retreat, was by Reid interpreted as a climatic consequence. Reid says expressly, that the period before Vancouver was milder than the present day climate. I have also not missed allusions, that he ascribes the present day climate at least partially responsible for barren aspect of this country. It is certainly clear, that looking over all these huge glaciers changes from a climatic theory only for explanation of the buried forests from the time preceding Vancouvers observations. The supposed movements during the short period, attaining according to Reid's observations about 100', although seven taken in account by explanation of the change, to find the oscillation of the Muir glacier, could not be compared with the climatic influences. This was also the point of views of Gilbert.× This author had also given many very convincing observations, showing that the bareness of the fresh from glaciers abandoned country is due not to the present conditions of the climate, but is caused by the lack of soil. I can add to the observations of Gilbert some other important ones. The distribution not only of the forests, but also of the shrubbery, and even of single trees or bushes in the inner part of the bay follows everywhere the same plane; they namely have always besides their upper limits always a lower limit, and this is without any exception, inclined toward the outlet of the bay. It can be no doubt, that the lower limit of the forests or of the shrubbery represents the upper limit of ice of the glacier tongue from the Vancouvers time. The distribution of the present forests shows however another interesting relation to the ancient, now buried forest of the time preceding the extension of glaciers observed by Vancouver. Until now only the stumps of the buried forest in a low position have been seen but during my stay at Glacierbay with L. Martha last summer we have observed the stumps, scattered in different heights on the mountains S and N, in an elevation, attaining at least 600-800' (2-200m). It is also evident, that in the forest period of the Glacier bay the

× Reid, Glacier bay and its glaciers. U.S. Geol. Surv. XVII Rep. 1896, p. 439.

× Gilbert, l.c. p. 109.

climatic condition ~~was~~ were for the growth of the forest as favourable, ~~that~~ as ~~they~~ ~~were~~ then not only to low positions limited, but could rise to a relatively significant height. Supported ~~on~~ by the analogy of ~~the~~ present distribution of the forest ~~on it~~ upon the moraimic ridges of glaciers ending in ~~the~~ waste plains, ~~we~~ we are tempted to ~~the~~ supposition, that the old forest of the Beardslee Islands or of the ~~Double~~ Bartletts Cove, ~~that~~ ~~is nothing more, as~~ that it is on the trasting products of the Muir glacier from Vancouver time, are contemporaneous of the forest, which is in the meantime buried by the last glacier extension in the Glacier bay territory. But as well as the forest of the Beardslee Islands ~~are~~ there can be fellows of the same age with the "buried forest," can be also the same high-grown trees, ~~that~~ covering the culmination on the mainland close to ~~the~~ Willoughby Isl, but separated below from a ~~fresh polished~~ barren zone, ~~polished by the~~ deprived of its soil ~~cover~~ by the last extension of glacier. We arrive on this way to one conception, that over all the area ~~of~~ of the Glacier bay grew forests have grown uninterruptedly from the ~~the~~ time, when in what ~~was living~~ the "buried forests" to the present day. The thick stumps, found on the heights of the nunatoks ~~on~~ the as well as the high-grown forests upon the culmination of the north Berg Inlet are probably witnesses of the mild and for long centuries climatic which remained for ~~many centuries~~ unchanged climate in this country.

Of one part of this deductive developed theory, concerning the mildness and stability of the climate ~~of Glacierbay~~ of the Alaskan glacier territory was found during my stay with L. Martin at Glacier bay one exact proof. ~~Ph~~ On the Lebree Island we have namely cut one spruce (probably Picea Sitchensis) for to get receive a glimpse on the conditions of vegetation on this rocky knob, situated on the outer border of the Muir Inlet, which in all case belonging to the inner part of the Glacier Bay. This 44 tree 8½" (21cm) thick was found to be 24 years old, proving the perfect conditions of its growth. ~~A simple analysis is indicate, that the growth of this tree began probably in times, when the Muiriglacier overhelmed or at least touched the shores of this island.~~

E ~~that~~ accepting a proportionality in ~~of~~ retreat glacier retreat between Vancouver and Reid times ~~was~~ still in 1874 by ice overwhelmed. No doubts, that present climatic conditions for forest growth are even in the inner part of the Glacier bay very favourable, and it is very probable, that they were the same during centuries, and that the ~~invasion of glacier~~ ice flood in the Vancouver's time was due not to the climatic oscillations. ~~following~~ ~~that~~ ~~no~~ to have no

I regret, being far away, ~~for not having~~ more opportunity, for further pursecution of the above developed kind of thoughts about the Alaskan glaciation. My only encouragement is, that the numerous friends, learned

by me, especialy during my Alaskan journey, will find perhaps some interest in this idea, and give me once notice over your further investigations over this question.

Whatever will be the theoretical views of the problems of Alas. kan glaciation, it must always take in account the relative low nevé-line in the centres of glaciation (region 6th) and a relative high ascent of it in the bordering hill-ranges (region 7th). A rise of the nevé-liner for 2-300 m (650-1000') for such a small distance is certainly a strange feature, that necessitates some explanation. I see only one way, namely, that Reid found namely, that the atmospheric gradient demonstrated by the movements of clouds, in which the clouds move, in the Glacier bay blew always a north wind, descending from the wide snow and ice-fields. This observation of Reid found completly confirmed by my own observations during my short stay at Glacier bay. From 33 observations of wind direction, I made there, I found 80% blowing from the N-half, and only 20% from the S-half of the horizon, simultaneously observing many times, that the clouds on the slopes of Mt Wright were moving towards N. It is not difficult to understand such an arrangement of the air currents, but the influence of them can probably also not be mistaken. A descending air current embracing a mass, at least 1000 m (3300') thick, directed toward the mountains, the icefields bordering, must cause a constant rise of temperature, and a reduction of humidity of the air over them, and consequently must cause a abnormous rise of the nevé-lines.

The conditions of glaciation upon the 6th and 7th regions, stated by me, suggest some interesting relations, proper to the Ice Age. The first, concerning the relation of vegetation on the front of the continental icesheet, has been already discussed, and conducted to the conviction, that there could be both very hard, and also very good conditions for tree growth, following, that a forest vegetation could accompany the tundravegetation on the south border of continental glaciation.

Still more interesting features seems to follow from the above considered influence of the piemont glacier existing over its borderland. It is this relation not comparable with the relation between the continental ice sheet and the glaciation of the Rocky Mts in America or the middle and alpine glaciers in Europe?

Especially in Europe ~~was~~ the expansion of local glaciers in the Polish and Germain mountains was for a long time considered as a feature strictly connected with the Maximum of the continental glaciation, and taken for a contemporaneous accident; ~~first~~ only recently in the last days ~~have~~ been distinguished some indications, witnessing for a probably independent development of both centres of glaciation, the great boreal, and numerous smaller local centres of European mountains.

In America ~~was~~ the conditions for study were more favourable, the direct contact of the deposits of continental ice-sheets with the glacial system of the Rocky Mts made it possible to get much light on the recognition of these relations. Although in this question there are still many open problems, one fact is already clear: the glaciers of the Rocky Mts attained their Maximum and retreated to a stage of cirque glaciers before the Labradorean invaded the foothills of the Rocky Mts.[×]

× Calhoun, The Montana Lobe of the Keewatin Ice Sheet. Prof. Pap. U. S. Geol. Surv. № 50. 1906. See also Dawnau, l.c. p. 412 and G. G. A. Young, Esquisse géologique et ressources minérales du Canada. Publ. de la Comm. géologique № 1098. Ottawa. 1906. p. 158.

It is in all cases difficult to deny that the relations between Labradorean and Keewatin moraines and the Rocky Mts glacial deposits are very similar to the low nevé line in the Alaskan Piemont glaciers and high nevé line on its foreland. This remains only the question: are the analogic features also the effect of analogic dynamic processes? I am tempted to answer this question in affirmative sense.

II.

With the discussion over the physiographic features of the regions I ventured closely to the problems connected with the very complex and yet more disputed question of glacial erosion. In the first part of my report, where I tried to ~~after~~ mostly from my own impressions and observations to deduce a physiographic classification of the crossed countries, I confess not being able some more to add anything to the suggestions which I received during my journey; when they found, in some degree at last, valuable, can be only developed by the Canadian geologists and geographers. In the problems concerning glacial erosion I will in this paper also limitate myself only to the general impressions and observations, but at the same time I made reference to some to the same question back after my own work over more detailed studies made in Glacier bay, and after analytic cartographic researches for which I have not yet collected the necessary material.

in spite of a theoretical disagreement dividing mostly our opinions

Before beginning ~~the~~ the discussion, I must add, that almost all on the way ~~observed details, th~~ which seemed to me to be ~~from~~ of importance for the interpretation physiographic of the landscape I reported always to other members of the longress, and I am happy to affirm, ~~in spite of a theoretical disagreement, dividing of our opinion~~, that in the description of each ~~detail~~, element of the landscape we were probably without exception, of the same opinion. This great possibility of a discussion over the details, which was afterwards used as the foundation stone of a theory, or at least as an argument against a theory was a peculiar benefit of this wandering ~~noble and excellent~~ assemble. ~~I then I was so happy to find~~ To ~~acknowledgment~~ I am especially indebted to a limited number of members ~~kind~~, and by giving their names especially: I will do my duty; those are ~~especially~~: E. de Margerie, R. W. Brock, R. Daly, Goldswaith, Mac Connel, L. Martin and Woodsworth. ~~These~~ men of a profound science will be not angry with me, when I lay a stress upon a mostly strong theoretical difference, that divided ~~us me to~~ my standpoint from Yours, notwithstanding I learned much by discussion in this ~~excellent~~ society.

I had no chance of observing hanging valleys during my whole journey. ~~Not denying to the some very limited number of hanging valleys, for instance~~ With the exception of some good specimens, for instance the Yoho Valley, or the Cascading Glacier in the Nunatak Fjord the greater number of not well agraded valley junctions made on me the impression, that the ~~so called~~ phenomena of the so called „overdeepening" process are in the Canadian Cordillera and on the North Pacific Coastlands ~~by far~~ widely distant from the analogic features shown by the Alps. On the other side the number of concordant valley junctions or agraded outlets of valleys into the „inland passages" was so common to be seen, that the general aspect of the country, if not glacial polished and rounded mountain slopes, or the everywhere scattered but perfect always forms of rocks „moutonnées", gave me the impression of being ~~build by convinced to be a~~ a landscape of a normal erosion. so different is the aspect of the islands of „inland passages" from the landscape, that we are ~~it is true, mostly on deductive ways~~ accustomed to ascribe to a once glaciated area. Though I propose in another later study to give some more details from my own observations, I think it will be also here not without interest to name 5 4 1 2 3 In general the places, where well agraded valley systems ~~are rarely~~ were observed by me. ~~The agraded lower parts of valleys was seen in a greater number, giving to the whole region a uniform character in following~~

Those are Queen Charlotte Sound,
~~places~~: Granville Chanel, Etolin Island, Mitkoff Island, Lynn Canal,
the peninsula separating Glacier Bay from Lynn C. and Yakutat Bay.
I do not reckon
To prevent all possible mistakes, I ought to confess, that the true am-
phitheatric cirques ~~I exclud~~ do not count the typical „hanging
valleys", stricto sensu features, which are commonly treated
as produced by overdeepening of the mainvalley-glaciers.
In the question of cirques I agree completly with the glacialists.
As well as in the Alps and Carpathians I found also in the Cordille-
ras and in the „inland passages" many splendid examples (e.g. Elsnor of Mt Abbot, Elsnor of Eldorado, Glacier B, Yakutat B, Lynn Canal etc.) of cirques proving
that they are entirely due to the glacial erosion, although
in almost all cases preceded by preadumbrated niches formed
normally at the head-points of a torrential system. For
the explanation of cirques have been proposed many theories but all agree
in spite of different conditions which has been suggested
in accessory conditions of cirque-developement all agree, that the cirques
are a peculiarity of the region, elevated above the neve line. Well,
if the cirques are a feature of a region a high level of the neve, all
cirques must rise far above the bottom of the mainvalley, and this
difference between the level of cirque and valley bottom must also rise
downwards of the main valleys. Besides this rise of the differences
of both levels, be a absolute there must also rise the level of cirque-bottoms up the
main valleys. This feature depends as well on the antecedent rise of
the levels of the torrent heads (towards the centers of maintaining) thus forms, preceding
from the rise of the neve-lines in the same direction. Finally it ought
to be stated, that the initial form of the cirques, the torrent-heads,
all finds the best conditions for development even where the grea-
test difference of slope-gradient comes in close contact. From all these pecu-
liar features, that accompany the development of the cirques is not difficult
to deduce (for instance) the harmonic arrangement of their levels, or the shallowness of the
cascading parts of such glacier-tongues and many others ascribed
commonly to the powerful erosion of the main-glaciers, can be in fact connec-
ted with the conditions very easy deduced. But the hanging cirques
are the dominant mark of distinction of the whole
country we traversed, and except especially of the inland passages". (on the contrary) The inde-
pendent valleys joint the sea at the sealevel, and
most of the secondary valleys, that I have had occasion to observe, were
also mostly agraded. The hanging valleys" well developed hanging
valleys were not only an exceptional phenomenon, but were
also always accompanied by some peculiar condi-
tions. I cannot remember having seen a stricte hanging valley.

A linea!

that
~~which~~ I have seen
by such a kind of hanging valley

all ~~that~~ were transverse valleys, consequently the question of rock control
* brought to my
was ever ~~before~~ mind. In the ~~case~~ example of the Takakkaw Falls in the
arise
Yoho-Valley not only does the question of ~~its~~ rock control, but also another
question, supported by the fact that many other affluents of the Yoho
are almost agraded, and what is of more importance, the supposed overdeep-
ning of the mainvalley (below the Takakkaw Falls) ~~without a ping~~
~~physical reason~~ does not go ~~apart~~, the mainvalley ~~is there~~ remained
a
There at a very high level, cut at first in postglacial time by a
canyongorge, caused by water erosion. This special case, evidently
very complex, can be by no means given as a clear instance, demonstra-
ting the overdeepening theory.

The ~~peculiar~~ strange features of the Yoho Valley remind me, that I
have missed in the work of Canadian geologists the criterion of
epigenetic valleys, even there, where the marks of such a erosional
details of hydr. changes
process seemed to be very striking evident. I will give some, obser-
ved by me ~~details~~, to which I was tempted to explain by
(of hydrographic changes, to)
apply the theory of ~~supers~~ epigenesis ~~to cause~~ by glacial deposits.
cut in
~~It~~ buried ancient chenals. among this kind of features I reckon
the
Bow River valley below Banff supporting this view by existence
(measured by distance)
of a normal descent of 3-5 ‰ between the terraces on Tunnel-Mt and
the bosses, buried in glacial drift ~~bosses~~ about the Lake Minnewanka. The
About
Observation made ~~after~~ the stream-diversion Kicking horse R.- Beaverfoot
(the lake theory was much discussed;
R. near the sharp bend between Wapta and Leanchoil ~~was on place~~
(This standpoint, seeing there
~~discussed the lake theory~~ I agree with ~~Dawson~~ an epigenetic pro-
caused by moraine obstruction, both in
cess ~~as well, as for~~ the origin of Natural Bridge ~~by~~ west of Field,
and in ~~as for~~ the canyon of Quark Creek joining the Columbia R. at
I cannot understand)
Beavermouth; the supposed special rapida (glacial?) erosion, "X
called ~~cold~~ in explanation of this last hydrographic change ~~I cannot under-~~
~~stand~~, I think on the contrary, that here was a special rapida
glacial deposition was in action. "The farther West, the more depends-

X Guide Book No 8, p. 205.

(The present hydrography on ~~the~~ Pleistocene) mighty and very irregu-
lar silt and till deposition. ~~The~~ Most classical epigenetic proces-
ses
(Thompson and)
I suppose, are developed in the system of Fraser ~~and~~ River. The
channel of these rivers, incised here in rock, there in silt layer
evidently
much thicker, ~~deeper~~ than the canyon itself, the high situated alluvial
deposits and terraces, ~~the broad river gaps, connected with~~
the height of which ~~heights~~ corresponds sometimes with broad river gaps,
(which are
connected with ~~well develop~~ as wide valleys, often drowned
(hanging valleys!), many valley crossings and bifurcations

in ~~xx~~ higher levels below ~~these~~ which ~~are~~ the traces of ancient silt obstruction are never lacking, below ~~canon of~~ Chingabar also many rocky islands in a side riverbed, evidently dissected and washed from ~~a deep silt obstruction.~~ a deep and broad ~~s~~ floored glacial sediments. ~~all these peculiar features~~ are the peculiar features of this now rejuvenated but old stream channels.

The dominant theory, treating ~~the~~ the origin of Fraser, Columbia and other transverse valleys of the ~~the~~ last Cascades ~~xx~~ is ~~are~~ supported by the criterion of stream antecedency. ~~the format obvious important~~

~~F [features bearing to this view, ought be regarded the fact of the great age of delta deposit, yielded by some of these rivers, as for instance the old delta of Fraser, beginning with the Eocene.]~~

× ~~Chapin~~ G. Gibbs, Phys. Geography of the NW Boundary of U.S. Journ. Amer. Geol. 1870/71, ~~p. 149~~ p. 144 ff. Smith a. Willis, the Physiography of the Cascades in Central Washington. Inf. Pap. U.S. Geol. S. 1900. No. 19. ~~See also the Guide Book No 8~~

To explain the last accident in the history of these rivers ~~I ~~ ~~explanations~~ is called in the glacial erosion ~~are called the glacial erosion~~, complicated by crustal deformations, in spite of ~~it~~ which the rivers maintained their course ~~over~~ over the ancient dissected peneplain. ××

×× Guide Book No 8, p. 237 ff, 260, 264.

Agreeing on the whole with the proposed theory of stream antecedency in this country, I must confess that neither for the whole history, nor especially for the last stage of hydrographic development I can imagine the processes of antecedency without epigenetic complications. The importance of such a complication even in the smallest degree is demonstrated illustrated by many examples. ~~in the history~~ As far as what concerns theory ~~in the theoretical direction~~ I will remember the important study of Lugeon ×××

××× in consequence of ~~those~~ which first were opened the eyes of ~~the~~ geologists ~~of~~ to the epi-genetic phenomena in the Alps, and for the problems of American physiography I will appeal to the suggestion of Gilbert, ~~xx~~ by ~~who~~ whom it was stated that a supposition of the partial epigenesis of the Columbia valley decided (his) ~~in his views~~ ~~partisans~~ of pre-Pleistocene base-level +

+ Gilbert, l.c. 137 ff

and over the theoretical influence of J.W. Spencer's ++ views, proposed in the discussion concerning the Finger Lakes, ~~xx~~ ~~whom~~ proved in details, it ~~is~~ however not necessary to spent many words.

++ Spencer, Hanging Valleys and their pre-glacial equivalents in New York. Bull. Geol. Soc. Amer. 1912. Vol. 23, p. 477 - 8. Search for

I am quite convinced, that the ~~application~~ of an epigenetic process should very much limit ~~as to~~ the ~~in all our restricted~~ number of hanging valley phenomena, ~~xx which are now the only support of the last~~ which is in any case restricted;

F

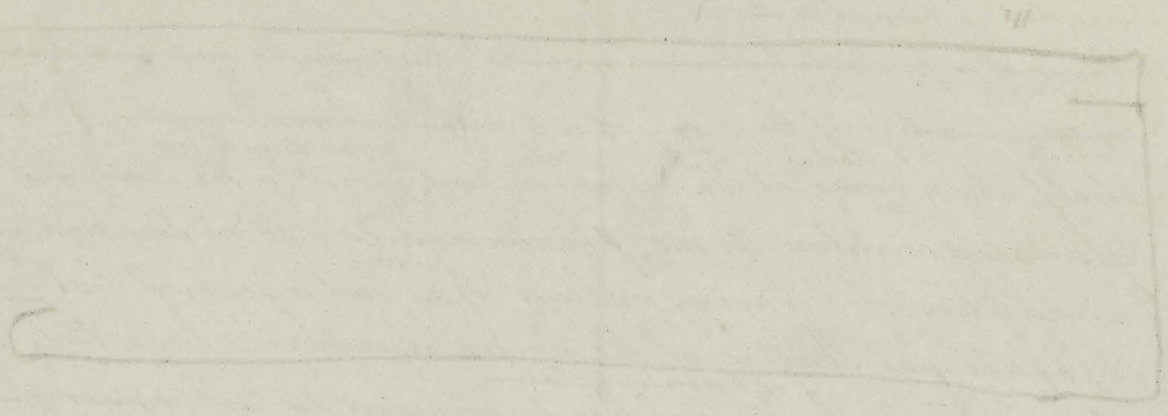
The fact of the great age of delta deposits built by some of these rivers, as for instance the old delta of the Fraser, beginning with the Eocene ought to be regarded as the most important feature, leading to this view.

do Fr 30.

(at the same time) for which one could (instead of a powerful glacial erosion) (seek) another process of normal erosion.

~~Theory of a powerful glacial erosion. that can be now understood only by application of the theory of a powerful glacial erosion. The theory~~ itself, when losing the support given by the universal for glaciated countries dirque-phenomena can be no founded by the apparition of hanging valleys, that are not a general, but rather a exceptional feature of the areas of ancient glaciation. This excep. tional character of having relations, more or less pronounced in all mountain regions is especially for the Pacific "inland passages" a striking most striking feature, which could not be omitted from the discussions of the Congress party. There we have heard often the assertion, that hanging valleys are there submerged, not by crustal movement, but by tremendous glacial erosion, which overdeepened the main valleys far below the sealevel, and transformed them to fjords or to fjordlike lakes, as characteristic of the Interior Plateaux. (L. Martin) (Alaskan guide) even our well known writer on the scientific researches of the Alaskan gla. ciers, and my special guide to Glacier bay, L. Martin often replied regularly to my remarks concerning the lack of remarkable hanging valleys. It was almost impossible to discuss with this argument both on the spot considering all impressions with as now after, and I must assert, that the problem of the fjords as overdeepened valleys awakened in me a desire to work on it on the corresponding charts; I hope to come in a short time with some contributions to this important question.

From my journey I remember only one detail, striking as a case almost excluding the overdeepening of the main glacier, occupying the present Upper Arrow L. Lake. With only one exception of a slightly disturbed valley junction, all the numerous affluents of this lake are perfectly agraded and (consonantly) building a large delta into the lake; I give e.g. the valley of Leon, Nakusp and of several creeks, descending from the Silver Mts. As the U. Arrow L. is over 200 m (700') deep, as recorded by soundings, more than 200m (consequently should be taken here applied) the argument of a submerged hanging valley. But this argument seems to me, are here throughout untenable. The wide Leon delta opened a glimpse not only over the valley of Leon, but also over its tributaries. All this valley system was covered by an almost continuous moraine wall, that evidently came down the lower level of the more it approached the valley bottom till it reached the delta itself to the level of the L. and the lake itself. These hypsometric relations led us to only one possible conclusion: the depth of present delta deposits of Leon are equal to the thickness of the former glacier, which has left



Add 31 H.

The theory of glacial erosion supported by the universal appearance of cirque-like forms in the glaciated valley heads, and especially in the torrentheads, carved on the slopes of mainvalleys, loses its real basis, because the cirque-forms are a morphological feature, peculiar to the nevè-level, where glacial erosion is almost excluded and the form itself can be explained by the excessive rock weathering on the periphery and above the nevè-fields. The only unquestionable basis for the theory of a powerful glacial erosion could be found in the phenomena of hanging valleys, and it is not without importance, that the first mention of this theory by J. Hector in 1863, as well as all posterior developments of it by Fr. Lincoln (1892), Tarr, Garnet, Gilbert, Davis and Penck was even based upon the phenomena of hanging valleys.

× Journ. R. Geogr. Soc. vol. XXXIV (1864), pp. 96-111.

×× Amer. Journ. Sci. 1892, 290-301.

The deduction of the glacialerosion, so clearly deduced from the existence of hanging valleys, is only right on the condition, that the hanging valley is a common feature of territories, which were once glaciated. This condition is generally nowhere found and the hanging relations came only locally and almost exceptionally in sight.

the existing moraimic walls; when we assume for this glacier, which was about over 10 miles (20 km) long assume a thickness of several hundred feet there remains as the depth of the Arrow L. at that point is 5-700' no possibility of a morphologic discordance between the lateral valley of Leon and the main valley of U. Arrow Lake; and as the valley junction was already in preglacial time concordant the origin of Arrow Lake must be ascribed not to glacial erosion, but to tectonical movement of submergence. This example, which was discussed by me on the spot in the presence of a congress party, of which the ground is situated even below sea-level also, that not all lake basins, which are compara, can, without reservation, be taken in support of the over-deepening-theory.

But the term „hanging valley" has become so common in the litterature, concerning the glaciers in the last couple of years, especially after the most attractive, and in their logical architecture very convincing studies of W. M. Davis,× that I am afraid with my negation about the hanging valleys not only of the present standing alone, but also of being suspected of a tendency in my observation, which was caused by a synthesis made a priori. I am very grateful to this all the leaders of the congress party, I will name especially R. W. Brock and A. H. Brooks, for their special care and kindness, in supplying me with the litterature, concerning the problems of American glaciation in genral, and of Alaska in particular. With the help of this litterature it was not difficult to find, that I am in my point of view not mistaken, and that even the most decisive glacialists allow a good deal in support of my conceptions.

I begin my review with the views of R. A. Daly of Harward university, the never forgotten guide of the Congress-Party in the Cordilleran Belt with whom I spent a good time in discussing the problem of glacial erosion without arriving at complete agreement. R. A. Daly developed his views in the standard work: Geology of the N. American Cordillera at the Forty-Ninth Parallel,* published as Memoir No 38 of the Canada Dpt. of Mines G. S. Ottawa. 1912. In Chapter XI of this work (p. 377-98) is treated The glaciation of the Cordillera.

Although full of esteem for and acknowledgement of Daly, as guide and leader of the congress-party in the geological problems of the Canadian Cordilleras I can not agree with him in the morphological questions-

× Glacial Erosion in France, Switzerland and Norway (Proc. Nat. Hist. Soc. Boston. 1901, vol 29, pp. 273-322.

of glacial erosion after the study of his work, ~~as well~~ just as I could not agree with his views, which were developed before the congress-party in the terrain. In his detailled description of the glacial phenomena of the Cordille- ras I can ~~not~~ find any ~~law~~ law, any regularity in the distribution of ~~glacial~~ erosive work executed by glaciers; I see on the contra- ry such a complexity of peculiar forms and morphological changes, now ascribed commonly ~~by Daly~~ to the glacial action, that even Daly himself, representing this point of view seems to find it very difficult to apply a common criterion of explanation of the different features, which are different not only in quantity, but also in quality, (by the same agency of erosion). The study of the paper of Daly's awakes an impression only, that the g.c. phenomena of overdeepening glacial appear in the Cordilleras both in a higher degree of development under the circumstances of a very low degree of glacier-develop- ment, and also in other places the glacial forms of the landscape comes very little to light, though the phenomena of glaciation attained there the highest degree of development. I give one instance only: the Minimum of glacial erosion in the country of the Similkameen River with the Maximum of the thick- ness of the ice; an important erosion 30 miles west from the Similkameen (which was there three times thinner on the Okanagan Rge) with an ice sheet, and a Maximum of supposed glacial erosion in that country by L. Chelan, where the extension of pleistonic ice glaciers was near their end. x

x Daly l.c. pp. 582, 591, 592. Viz. also C. Camsell, Prel. Rep. on a part of the Similka- meen D. District B.C. Geol. S. of Canada N°. 986. 1907, p. 21.

Such relations, taken as a foundation stones of the theory, developed in a de- ductive way, must lead to controversies, which are able to shake the whole theory. [For me, ~~that a man, as Daly~~, who had the opportunity of admiring Daly in the discussion over static me- tamorphism in Shushwap terraine and on many others similar occasions; during our trip across the Cordilleras, it was not easy to believe, that Daly used all these contradictory relations as a theory, and in this way could not avoid a controversy.] And it is a remarkable controversy, if one attempts to explain the feebleness of abrasion, executed by the Labrador ice-cap, showing its ability of free movement in all directions, and in another place he illustrates the power of an erosion made by a valley-glacier by comparing it with the erosive effects of the Labrador ice-sheet. x But this is merely a kind of

x Daly l.c. pp. 582, 92.

(However this is) ~~a~~ "sit venia verbo" oratorial mistake. They ~~this is not~~ not the last one. (mistake)

In the deduction of Daly is of the greatest importance the „concentration of ice-movement" as the decisive agency in the theory of glacial erosion. The rate of this concentration of flow is also in relation and correspondence to the amount of glacial erosion. EE glacial erosion

It is a deduction, to which were led all the adherents of the theory of a powerful EE and with which it is very easy to be in accord without any restrictions. Because all these valleys, for which one admits a strong concentration of flow, must also, according to this deduction, have the coeval development of hanging valleys, and the heights of the hanging steps in a degree traced by the amount of scouring of the mainvalley-bottom by the concentrated iceflow. Daly's deduction asks in its consequences (than other deductions) for a regular development of hanging valleys, perhaps more than in which was the amount of glacial erosion correlated simply with the thickness of moving ice-masses. When Daly's deduction lead him to the supposition of scouring „for thousands of feet in the living rock" by glacial action the only consequence, proving this deduction ought to be, the constancy „ of steps at the same height, with which joining the secondary valleys to the mainvalley. Meanwhile had apparently Daly or I a chance for observing hanging valleys, if he (Daly) noticed for the whole profile of Cordilleras studied by him only two cases of hanging valleys, one of them is only 200' high (Oil-Creek by Waterton Lake), and the other of Phillips Creek, though 500' high, yet probably, structurally determined". Since the second (structural) explanation, concludes Daly, cannot be entirely excluded, Phillips Creek is not to be surely placed in the class of valleys which hang "because of differential glacial erosion."[x]

Dotyd. [

[x] Daly l.c. pp. 579, 85. That I can I am satisfied ascertaining, that Daly, though emphasizing the powerful glacial erosion, does not give one instance in proof of it. I repeat that only a regularity in arrangement of hanging valleys (I can claim for an argument in favour of glacial action), the criterion of rockbasins, even in the Cordilleras with its heavy moraine obstruction and thick timber, can be alone (was) given in support of the theory of a powerful glacial erosion. How one must be cautious in applying the s.c. rockbasins in support of the demonstration of the glacial erosion I was taught by many examples. I will give the instance of the L. Louise, the basin of which was by J. A. Allan, our excellent leader in this country, called

rockbasin. Doing so, (was Allan) completely in accord with the best connoisseur and explorer of the glacial morphology of this country. I am sorry, but as in the discussion with J. A. Allan ~~in emplace~~ on the spot, (also now) I can not accept the reasons of Scherzer, given for the rockbasin-nature of L. Louise. The only reason, given by Scherzer, is, that „the basin of the lake is seen to be a U-shaped ~~valley~~ trough, with a maximum depth of 230 feet just beyond the centre. This shows that the valley was excavated by ice and that, in all probability, the bottom of the lake is a glacially excavated rock-basin“.... „Bedrock is found upon all sides of the lake, except about the foot (~~lower end~~), where there is the ground-moraine dam, filling the valley to an unknown depth.“ x

x Scherzer: Glaciers of the Canadian Rockies and Selkirks. Smiths. Institt. Publ. No. 1692. Washington 1907, pp. 60.

Now I will go farther to the examination of the views and materials, concerning hanging valleys, and collected ~~by another impulse~~ in these westerly countries by C. H. Clapp. Clapp had been working from 1908 on the southern part of Vancouver Isl. and reported from this time regularly not only on economical geologic matter, but also on morphological questions. x In his first report does not ascribe Clapp much work executed by the action of the glaciers, on the contrary he sees only the polishing and grooving of rock, but at the same time he sees here no evidence of cirques or hanging valleys, and the coast forms and fiords he explains by submergence of the country. In his farther reports, a new Clapp not only continually the more work,

x Summary Rep. of the G. S. Branch 1909, pp. 53, 54. Ottawa.

due to glacial action, especially the cirque-formations in the mountains of the country of Mt. Arrowsmith, xx but also he changed slowly his views

xx S. Report of the G. S. Branch. Ottawa 1910, pp. 86.

in favour of the theory of a powerful glacial erosion. Especially in his report of this field-work, executed in 1910, xxx writes Clapp, xxx „the topography was greatly modified during the Glacial period; the monadnock like hills were rounded, the valleys deepened and widened, thus changing the drowned valleys into typical fiords...“ In the

xxx S. Report of the G. S. Branch. Ottawa 1910, pp. 103.

next and last report, written in 1912 makes Clapp scarcely any mention of pleistocenic glaciation and its work. The more interesting statement on this question, drawn up by Clapp in his last geological monograph: Southern Vancouver Island, In this monograph one can distinguish in the question of glacial erosion three elements,

there are ~~by the~~ ~~that is~~, the ~~observed~~ features, which have been ~~f~~ by Clapp observed on the on side, and two quite different theoretical point of views on the other. We read namely in the work of Clapp: „ Valley heads in the higher mountains were excavated by local glaciers, and the mountains now have characteristic serrated summits. Valley glaciers occupied and scoured out the larger valleys, converting many of the westward flowing valleys into fiords, and deepening many of the interior valleys into large lake basins." ~~Something~~ a little further points Clapp directly to the Saanich and Alberni fiord, as types of transversal valleys, which ~~were~~ were by glacial scour ~~converted~~ deepened and converted in the fiords.[×] Quite another interpretation of forms developed by Clapp[××] in

× C. H. Clapp: Southern Vancouver Island. Memoir N.° 13. Canada Dpt. of Mines. Ottawa 1912. pp. 18, 20.

in his descriptions of coastal lowlands and Shore-lines. I repeat his own words:[××] „ Since the drowned irregular valleys of the east coast of southern Vancouver island very maturely to sub-maturely glaciated, the present inlets and passes between the islands are fiord-like in character. A typical fiord is the maturely glaciated, drowned, transverse valley, now occupied by Saanich inlet, which extends southward into the late-maturely dissected portion of the upland."

„ In spite of the fact that the inlets are fiord-like in character, the glaciation does not seem to have been sufficient to have developed the present shore line. Some of the inlets and passes are intricate and very large, the region in general is of low relief, the character of the topography appears to be the result of normal erosion and merely sub-mature glaciation, and the glaciation was accomplished chiefly by a large piedmont-glacier which occupied Georgia and Juan de Fuca straits and flowed southward at a wide angle to many of the inlets and channels. However, the glacier conformed to a rather striking degree to the irregularities of the surface over which it flowed. It seems best to conclude, therefore, that the present irregular shoreline is due to depression rather than to glaciation."

×× Clapp: S. Vancouver Island p. 26.

I think that all agree with me, that in this statement of Clapp there is a conflict between two different deductive theories, which were based partly upon facts: the impressive marks of ancient powerful glaciation was the one set of leading facts, the appearance of very recent movements of shoreline was the ~~all~~ basis for the other theory. ~~One very short, and not mistakable expression is for me from the grea~~ I will not try to obtain a solution to these controversies. For me it is important to point out that Clapp, after ~~years~~ five years' work on the Vancouver Island could not arrive at a uniform view concerning the glacial ~~erosion~~ erosion, but as in his first report, he states ~~after~~ one well observed and important feature: „ hanging valleys are in „

I endless conservation controversy [illegible] Irritating: give [illegible] Oh [illegible]!

conspicuous" ×

× Clapp: S. Vancouver Isl. † pp. 20.

For the explanation of this lack of distinct traces of glacial erosion one could cite the comparatively small degree of glaciation in this country. This point of view will, of course, not be in accord with the generally accepted opinion, that also at the end of the glaciers they are able to do much erosive work, the marginal lakes of the Alps as glacial eroded „Zungenbecken" at the glacierend (according to the theories of Penck and Brückner, the glacial excavated basin of Lake Chelan on the south border of the Cordillerean ice-cap, as asserted by Willis, ×× or the tremendous erosion of the strikingly insignificant glaciers in the Okanagan Rge, as maintained by Daly ×××) but it will be also not in accord with the collected facts, which prove, that also the southern part of Vancouver Island has been overflowed by a ice-sheet of enormous size.

The lack of decision in the views of Clapp, which he has pronounced in the question of glacial erosion gives much interest to the field-work of J. A. Bancroft, made by him in the region of Johnston Str., and therefore in a region not far distant from the wandering field of Clapp, but eminent as a terrain, which was (by a mighty ice-flow overridden). Bancroft has no doubts about the efficiency of glaciers as an important agent of erosion. (opinions from many) (by Bancroft pronounced) in this matter, I choose only one given in his last conclusions, which proves, that he must be counted to the party of the most extreme glacialists. I repeat his own words: „The evidences of the potency of glacial erosion in this district are so convincing that the author is led to the conclusion that by its processes the valleys were not only widened, but their depth was increased by at least from one to two thousand feet. This increased depth permitted the sea to occupy the valleys upon the recession of the ice"

F. J. A. Bancroft: Geology of the Coast and Islands between the Str. of Georgia and C. Charlotte Sd. Canada Dpt of Mines Memoir № 23. Ottawa. 1912. pp. 50, 51.

The extreme standpoint of J. A. Bancroft, which (ascribes) not only the sculpturforms above the sealevel, but also the whole coast-configuration

× Penck u. Brückner: Alpen im Eiszeitalter I. pp. 662
×× Bailey Willis: Geol. Exp. No 19. U.S. Geol. Surv.
××× Daly Geol. Exp. 1912.

~~as x i b e x~~ to the action of the glacier ~~is made his~~ gives to his observation a (on the one side) double value, the value of an observation, and (on the other) ~~the rest~~ of the certainty ~~also~~, that he has well seen all the features, which were in accord with the theory of a powerful glacial erosion. (in vivo!) ~~The~~ paper of Bancroft (on the other hand) proves well enough, that he is ~~not~~ familiar with ~~occurent in~~ the wide literature of this problem and also with the important works of W. M. Davis; ~~are him well familiar~~. It is not possible, that he not have known the opinion of ~~Da~~ W. M. Davis, given in the ~~cit~~ paper, cited by Bancroft, "The Sculpture of Mountains by Glaciers". "The junctions of the various glacial ~~th~~ troughs, says W. M. Davis, are essentially discordant." The peculiar feature of the morphological changes, caused in the landscape by glaciers, the hanging valleys, are, (according to) ~~after~~ the views of W. M. Davis, not an exceptional feature, they ought to be a rule. The universality of hanging valleys in (alpes, with which were) once glaciated ~~areas~~ are ~~for~~ with (yet) more deductive and inductive apparatus developed by W. M. Davis in his last work, published ~~as~~ in consequence of his (lectures), given at the University of Berlin. "It is clear, ~~says there~~ W. M. Davis (says in them) that the difference between the level of the bottom of the main- and of the secondary valley, or as (could) ~~can~~ tell, the altitude, at ~~the~~ which (hangs) the secondary trough above the mainvalley-trough – is ~~xx~~ nearly proportional to the difference between the area of their glaciers." ~~Contra~~ ~~Against~~ For this thesis, which (was even) before Davis stated very exactly

× W. M. Davis: Die erklärende Beschreibung der Landformen. Berlin. 1912. pp. 417; viz. especialy Chapt. IX. "Der glaziale Zyklus". pp. 400-62.

~~stated~~ by Penck and Brückner ×× ~~I opposed after my studies in the~~ I could not find confirmation (of this) in my studies, made in the alpine parts of the ~~Rohr~~ Rhône-basin. I found there on the contrary, that 62% of the features, peculiar to the valley junctions ~~were~~ in the ~~Rohr~~ Rhône basin ~~exposed throughout~~ absolutely opposed ×× in 62% of cases the thesis of Penck & Brückner and Davis, and in 38% of ~~cases only~~ valley-junctions he was (indeed only) found ~~indeed~~ a hanging relation, but this (relation) ~~was~~ was far ~~away to~~ from confirming the law of proportionality between the ~~the~~ difference of the glacier-area and (the) altitude of ~~the~~ steps-hanging.

×× Penck ~~and~~ & Brückner: Die Alpen im Eiszeitalter. 1901-1908. pp. 302, 509.

××× Romer, Mouvements épeirogéniques dans le haut bassin du Rhône. Bull. Soc. Vaudoise. Lausanne. 1911. pp. 65-192; viz. esp. p. 126.

× "The trough of the large side glacier hangs high above the floor of the main glacier. The troughs of the smaller transl glacier hangs over the trough of the large side glacier."

[34 note!

Though the hanging relations in the alpine landscape are after my opinion far distant to prove the overdeepening theory of Penck, Brückner and Davis, the occurrence of hanging valleys are however in the Alps a much more common feature, than in the Cordilleras; - they are there, as pointed above after my impressions, an exceptional feature. Now I come back to the witness of Bancroft. As accentuated before Bancroft is throughout familiar with the theoretical literature both English and foreign, but not only that, he knows also well the theoretical importance of the phenomenon of hanging valleys, he says but expressly[x]: „More than any other single physiographic feature, hanging valleys have convinced many students of the potency and vigour of glacial erosion during Pleistocene time."

[x] Bancroft l.c. p. 45.

For these two reasons I ascribe to the witness of Bancroft more than to any other importance. Bancroft writes about the hanging valleys in three places. First he describes them in the topographical characteristic of the country, secondly in its relations to the drainage, finally he treats about them especially in the chapter on the Origin of the Fjords. In the last chapter Bancroft is convinced of the general appearance of hanging valleys in this country, he speaks of „several good examples", shows the difference in the altitudes of the different hanging steps, and seems to see a „mathematical accuracy in the proportion which exists between the height of the step and the prevailing thickness of the ice in the mainvalley in comparison with the tributary. At the same time Bancroft knows in expressing this opinion about the hanging valleys, very well, that his wide working-field does not give enough examples demonstrating the theory, developed with so striking accordance with the views of H. Garnet, W. M. Davis, Penck, Brückner and many others. The lack of hanging valleys as a normal feature of this country seems to Bancroft to be of no importance. His reasons supporting the theory of „glacial overdeepening" in spite of the fact, that the hanging valleys are not a general feature of his working field, are as follows: 1. „ 1. The mathematical accuracy of this implied proportion is modified, however, by the widening of the mainvalley, through which process not only the spurs were truncated, but the lower courses of some of the tributaries were shorn off. 2. Moreover, some of the lateral valleys must have been occupied by ice for a considerable time after the ice has

disappeared from the fiords. As the soundings on the charts show, a widespread and uniform elevation of this district would convert many of the lateral bays and smaller fiords into hanging valleys."[x]

x Bancroft, l.c. pp. 46.

The second reason, given for the explanation of the in this statement is quite able to explain the lack of hanging valleys in the some glacial landscapes, where the hanging valleys are submerged, must necessarily be this feature superficially inconspicuous. But the process, called for in explanation of the submergence of hanging valleys, namely the prolonged development of glaciers in the tributaries in comparison with the main valley is not easy to maintain. The suggestion, opposition, that the glaciers of the main valley disappear long before they are melted in the tributaries has been already made by Kilian[x] and it is curious that he came on this ground has been reached quite an opposite deduction to that, which was reached by Bancroft. The latter based on this supposition, the diminishing of the discordance between the levels of the confluent valleys, Kilian again, who accepted the flowing water as the dominant agency of erosion, deduced from this same supposition the fact of the increasing value of the overdeepening. But after examining the facts, by which Kilian was led Kilian to his supposition, could the Penck, with right to the following conclusion: "It is not right to suppose, says Penck,[xx] that the overdeepened sections of valleys were later left from ice, the ice is arriven later upon the and that it has left them earlier, than the hanging valleys. It is on the contrary the opposite relation, which is rather probable; the overdeepened sections of valleys are connected with the territories of the most prolonged and strongest developed glaciation". More than ungarbare

x Kilian: Note sur le surcreusement des vallées alpines. Bul. S. Géol. France. 1900. Vol. 28 pp. 1003-5; vid. also Note pour servir à la géomorph. des Alpes dauphinoises. La Géographie 1902. Vol. #6 pp. 17ff.

xx. Penck, Brückner: Alpen im Eiszeitalter pp 729-32.

All my experiences made hitherto taught me that Penck the opinion of Penck, Abbot and many others in this matter is right. I exit appeal only to my morphometric studies made on the glaciers of the Rhône basin, by which it were was proved that the area of each secondary basin is an important factor in the glac development of glaciers, a factor which can in some degree modify the influence of the mean altitude of the basin. The thesis, proved in this study,

xxx Romer: mouvements épeirogéniques dans le haut bassin du Rhône pp. 109-118.

x W. M. Abbot: Glaciation of the Kaiser and Elevator Mts. Yale University. 1903 Sept. Sep. No. 61. U.S. Geol. Survey.

in the excellent study of Abbot.[x] His maps and his descriptive given much exact material covering that the tributary glaciers Penck have retreated before the ice in the main valley left their moraines.

~~the develop area of a basin itself is a function of~~ means, that with (descends the) increasing area of the basin ~~descends the nevé-line~~ (lower) and following ~~with~~ and following with the importance of the valley ~~not only the nevé-line, but also the~~ (descends) ~~descends~~ the nevé-line with all its consequencies of a (more) prolonged and stronger glaciation. ~~While~~ (also) by no means Bancroft can explain the modification, ~~by~~ of the theory found in (the) powerful glacial erosion found in the terrain, the ~~second reason~~ first reason given by (him) Bancroft ~~demands only, that, then the theory of a glacial differential erosion are right, the hanging valleys ought to be then the widening of main troughs are a result of the glacial truncation of the spurs~~ (viz.: that,) with the glacial truncation of the spurs ~~are also~~ the lower courses of the tributaries are also cut off, is a reason, very (well) ~~good~~ reconcilable with the theory of glacial erosion, till now not mentioned at all, but, if this ~~reason a~~ deduction ~~are~~ is right, the generality of the phenomenon of hanging valleys ought to be the more pronounced. ~~This proves~~ This deduction, very (well) ~~good~~ reconcilable with the theory of a powerful glacial erosion, ~~though till now not mentioned at all,~~ states, that the ~~gla~~ phenomenon of hanging valleys can be (not only) produced by differential glacial deepening of the valley bottom, but also by the differencial widening of ~~the~~ glacial trough. ~~The discussion~~

The discussion of the deductive part of the study of Bancroft led (thus) only (to the conviction) that ~~the~~ hanging valleys must be a very common feature in areas, which were once glaciated. ~~But the~~ (But the) existing forms of (the) landscape of the working-field of Bancroft are ~~but~~ in strongest (contrast) ~~opposition~~ to the thesis, deduced by him. In the descriptive part of the topographic features of his own working field ~~tells~~ (says) Bancroft expressly (x about) ~~only~~ "a few side valleys", debouching into the fiords "at varying heights above sea-level" and gives three "most imposing examples" of these hanging valleys, which ~~are but for me~~ awake ~~but~~ in me ~~the~~ only (the) idea, that the ~~existing~~ hanging valleys existing in this district, are only short (channels) ~~canals~~ of hanging cirques, or even wild chimneys of ~~the~~ avalanche-~~tracks~~. In all cases it is ~~hardly~~ quite impossible to find the outlines of the hanging valleys named by Bancroft, (on his map) and if the ~~to~~ specimens, ~~named by~~ given (by him) ~~to me~~ (the)

x Bancroft, lc, p. 23.

("most imposing examples") are the last, found in this country, on must say, that throughout it is deprived of the peculiarity topographical, which is given as a description part legitimation of glacial erosion. The description of the drainage relating of the country, of this country, there are given also the classification of the valleys is also given, establishes in me the certainty that the hanging valleys of Bancroft are in the working field not only an exceptional feature, limited to the smallest branches of the drainage, but what is more, that the aspect of the main and secondary affluents of the fiords are in general reached of a mature character. To this conclusion I suppose, that I am authorized to come to this conclusion by following statement given by the author after his description of some valleys, which were by him explored. „ The preceding description shows that the main streams, says Bancroft, have approximated to a stage of a maturity. The extension of the valley-tracts so far into the mountains and the restriction of lakes and rapids to the upper reaches are, at least, indicative of a well-developed drainage." „ The other rivers, says Bancroft in another place, which debouche into the fiords head of the are smaller, but present similar gradients, the relative inland-extension of the valley tract being dependent upon the size of the stream."

× Bancroft l.c. p. 29, 30.

It is the right moment to call to mind one definition of glacial-sculptured valleys, given by G. K. Gilbert. This definition, like all the thoughts of G. K. Gilbert is deduced with an extraordinary consequence and clearness and ought to be here repeated: „ It is true that the glacial U-trough is sometimes simulated by products of stream erosion, and that a hollow closely resembling the glacial cirque is occasionally produced by aqueous process; but imitative forms belong to the middle life of a stream, when down-cutting has so slackened as to permit valleys to broaden, and they imply a harmonious grading of stream beds, inconsistent with discordance of level at the junction of tributary and trunk. But the combination of discordance of level with U-shaped cross-profiles constitutes a physiographic type peculiar to the work of glaciers."

×× G. K. Gilbert: Glaciers and Glaciation of Harriman Alaska Exp. Vol. III p. 116 N. York 1904.

for the results of this literature, in discussing which I take the more pleasure because I see how well I am in accordance with the facts reported by American geologists though in our conclusion we are so far distant from each other, I am indebted to the extreme kindness of both the leeders of G.S. of Canada and of U.S.A. who supplied me with the American literature on the glacial problem

The review of the literature, concerning the hanging valleys in the „inland passages", their exceptional character, or limitation to ple., „namena" which are inconsistent with the definition of a valley, could have become enlarged to an undesirable amount. On the other hand I am due to the extreme kindness of both the leaders of G. S. of Canada and of U. S. A., which supplied me with the literature American literature of the glacial problem, and take the results of this literature in discussion, what I made with the more pleasure, seeing how well I am in accord with the facts, reported by american geologists, though we are in our last conclusions so far distant one from another.

Paying attention to both reasons given above I shall in a further review of the literature restrict myself to some short remarks.

[A linea!] ? (references) Lansell represents in his report about the topographic relations of the Similkameen valley the view, that the development of hanging valleys here is strictly related with the proportional to the amount of recent uplift. In the part of Lansell's work, concerning historical geology, based partially on the literature and constructed mostly in a deductive way, on the contrary the same author expresses the opinion, that hanging valleys are produced by glacial erosion.

xL. Lansell: Geology of Hadley Mining District B.C. Canada Dep. of M. Memoir No 2. Ottawa 1910 p. 35, 36, 126.

A. M. Bateman xx treats all hanging valleys, known by him in the region of Fraser River as caused by recent uplift.

xx summary Rep. G. S. of the Dep. of Mines 1911, p. 126.

D. D. Cairnes xxx reports on hanging relations of „small streams", but the illustrations given by him, can be hardly counted as valley forms - they are torrential gulches.

xxx D. D. Cairnes: Wheaton District Yukon Territory. Memoir 31. Ottawa. 1912. p. 19 (Plate VII)

S. Paige and A. Knopf+ describe the Matanuska valley and its tributaries as typical forms of a river-erosion, they point out also that the modification made by glacial-erosion does not obscure the terrace character of valley-forms. Some cirques, of a morphological discordance, existing between the wide stretches with oxbows and sharply incised canyons the authors explains by recent uplift.

+ S. Paige and A. Knopf: Geol. Recconoissance in the Matanuska and Talkeetna Basins Alaska. U. S. Geol. S. Prof. Pap. No 327. 1907. p. 37, 39.

Among the Alaskan explorers 47

F. H. Moffit and S. Capps on the other hand the point of view supporting the theory of a very severe glacial erosion. This point of view is developed almost in a deductive way, and the indication of hanging valleys with a discordance of level from 10-1500' as I could not verify on the maps, joint to the report. The examination of the maps (1: 62.500) and especially of the geologic map leads to the view only that the main valleys have suffered in the postglacial time a very heavy modification by water erosion, that swept from them almost all glacial material, cutting in the present valleys the morainic deposition trough to the bedrock in some places to the bearock, filling them again in others with alluvial deposits. In opposition to these processes in the main valleys the secondary valleys hardly underwent any change in the postglacial time. They are almost mostly choked by heavy obstructions of chaotic morainic deposits in which they have cut sometimes only deep but only very narrow gorges. These gorges, e.g. of Chittin or Dan Creek show at least 7-900' thickness of this material, in consequence are thick enough to produce a discordance in the levels of main valleys and their confluents. This discordance, but as produced in postglacial time, has nothing to do with the glacial forms of hanging valleys and rather inspires the supposition of postglacial crustal movements.

× F. H. Moffit and S. R. Capps: Geology of the Nizina District, Alaska. U.S. Geol. S. Prof. Pap. № 448. 1911. pp 43 ff.

This review I close with p At the end of this review I will pay attention to the large and detailed studies made especially by T. Coulter and A. H. Brooks on the general geology of Seward Peninsula, Alaska. When I was many th times led by the facts, collected by American geologists to some views discordating with the common opinion, these I found both with the greatest satisfaction the expression of the same gave me. I found in the studies of Coulter and Brooks the great satisfaction, of which one feels always, by finding when one finds a support of an approximate opinion after a long time of complete isolation. The views of these explorers, which awakened in me special interest can be given in the form of two theses: 1) the cross sections of the glaciated valleys do not differ materially in character from those of some that are nonglaciated.

the
In writers opinion ~~of~~ processes of erosion now operating in Alaska are competent to produce valleys of this type."[x] 2. The morphologi-
x Collier, Hess, Smith, and Brooks: The gold placers of parts of Seward Peninsula, Alaska. U.S. Geol. S. ~~Prof.~~ Bull. N° 328. 1908, p. 96.
cal development of present ~~phys~~ landscape of this country can
~~be after~~ according to the opinion of Collier and Brooks, only be explained ~~only~~ by
the supposition of differential crustal movements, attaining at least an
amount of 1000', and to the same opinion of very recent uplift and
depression. ~~were~~ ~~I~~ the authors were led by ~~exp~~ the facts of the distribution of erratic boulders.[xx]
xx Collier, Hess, Smith and Brooks l.c. pp. 44-48, 98, 300-306.
A.H. Brooks has ~~logical ideas~~ already pronounced and developed analogical views
in his standard-work over Alaska. ~~Although~~ Brooks indeed does not deny
the glacial erosion, but the features ascribed by him to this
element of erosion he either mostly ~~after~~ on the opinions given by other
explorers, or he imputes only to this element the minor features, clara-
teristic to the landscape.[x] The general aspect of present forms A. H. Brooks
on the contrary in relation with crustal movements, ascribing to
them as well the great land forms, as the fiord character of
the coast on one hand, and many minor features as stream
diversion, ~~for~~ or a part of lakes and another basinforms, so
common for the interior-plateaux on the other. In acknowledgement of the
authority of G. K. Gilbert, Brooks always refers giving his
own view to the views of this important pioneer of exploration
and of theoretical ~~synthesis~~ synthesis.[xxx] But doing so, Brooks has
chosen the finest kind of opposition only.
I will ~~finish~~ close this part of my review in pointing out that the best connoisseur
of physical geography of Alaska has only used ~~in his standard work the~~
term "hanging valleys" ~~only one time~~ once in his standard work.[+]

x A. H. Brooks: The geography and geology of Alaska. U.S. Geol. S. Prof. Pap. N° 45. 1906. pp. 50, 52, 246, 247, 296.
xx Brooks l.c. pp. 290-96.
xxx Brooks l.c. pp. 284, 296.
+ Brooks l.c. p. 52.

After this review I see, that in my mischance ~~for~~ in observing hanging valleys I am not at all isolated, that many others, even throughout convinced of the existence of a powerful glacial erosion have missed the view of typical hanging valleys in the inland passages, and that the facts collected by many glacialists are very likely ~~complicated~~ to awake doubts about the hypothesis, ~~of this fiord country area~~ which makes the glacial erosion responsible for the development of the notable physiographic features of this fiord country.

X

In the last couple of years after leaving the number of adherents of the theory of glacial overdeepening, was the work of G. K. Gilbert* the first among the innumerable literature concerning the glacial erosion the first which I read not only with the highest satisfaction, but also because, I could not find in Gilberts nothwithstanding his apparent sympathy for the theory of the glacial erosion, I could not find in his long deductive way one point, with which I could awake the slightest disagreement. In my opinion G. K. Gilbert ought not be counted among the representatives of the school of glacialists because his deductions are never unilateral and in his statements also open doors are always left for an other interpretation of the glacial morphology than by the processes of glacial erosion. For that reason, Gilbert, who is quite right counted among the founders of the school of glacial overdeepening, which was based upon a part of the morphological posibilities deduced in Gilberts work, is often called also to witness against the theory of a powerful glacial erosion.**

* G. K. Gilbert: Glaciers and Glaciation. Harriman-Alaska Expedition. Vol. III N. York. 1904.

** J. W. Gregory: Nature and origin of fjords. London. 1913. p. 319.

From a methodical point of view is most interesting the scale, given by Gilbert for appreciation of the value of glacial erosion.* We see here all possibilites in regarding the importance of glacial erosion; from the most decisive element in development of the glacial landscape to the at least important but worth to be named one. But what are besides it important in this classification made by Gilbert? It is, that the presuppposition for both high and low grade of glacial erosion are in the views of Gilbert the hanging valleys. The back of hanging valleys according to this deduction are identical with an absence of glacial erosion. Gilbert

* Gilbert l.c. pp. 114-19, esp. 117.

Gilbert points out on the other hand, that the conversion of young and narrow gorges into the typical U-trough the widening of old river valleys, the cut of projecting spurs and s.o. demonstrate a large amount of work, done by the Pleistocene glaciers. But accepting this thesis Gilbert pretends exactly, that the ice streams by which was done the work of widening of the valleys could not have failed to wear down their floors.** Overwidening and overdeepening are two consequences, which are bound together inseparable in the theory of a powerful glacial erosion. The falling of one of them must awake serious doubts

** Gilbert l.c. pp. 117, 159.

X

X In the last couple of years after leaving the ranks of the adherents to the theory of glacial overdeepening, during which I was acquainted with the vast amount of literature dealing with glacial erosion, the work of G. K. Gilbert was the first ~~which I read etc.~~

50

~~at 46p.~~

to do 4th (1).

Kochany Gienku!

Otrzymałem z radością pozwolenie. Terminu egzaminów ustępuję jemu nie zrazu (prawdopodobnie 30. czerwca), spisać jednak ofertę muszę wprzód (my spisie potrzebne nabożeństwo, świadectwo szczepienia ospy, a później świadectwo).

Serdeczne uściśnienie

Twój Konstanty

W Lwowie 20. V. 1904.

as to
~~in~~ the reality of this theory. The phenomena of glacial overdeepening ~~are~~
after an examination of morphological features common to the inland passages
ges" ~~xxx~~ must be treated with serious ~~doubtfulness~~ hesitation, so ~~gr~~ that
of glacial erosion is ~~given in doubt~~. a powerful

It must be on the other hand stated, that ~~of course~~ although the most
prominent ~~facts~~ signs of overdeepening, the hanging valleys, are missing in
the „inland passages," the U-trough forms of valleys, straits and
fiords of this district are ~~as well~~ an universal feature, as ~~it is~~ they are
~~universal in all~~ other districts, which were ~~at~~ once glaciated.
The origin of the trough-forms of the valleys, which are so strictly ~~strongly~~ connected with the area of recent
glaciation can be hardly imagined without looking at in the causes and
forces, which are common to the glaciers only. ~~Supposing~~ This ~~supposition~~
~~led many observers to~~ coïncidence of U-valley forms with the glaciation
has led many observers to the opinion, that between these ~~two~~ features there exists
a direct relation, namely that the U forms are an effect of glacial
erosion. In announcing this thesis one forgets) that ~~the overwide~~ glacial
overwidening of ~~the valley~~ mainvalleys must be followed by an over-
deepening of them, 2) that the overwidening of mainvalleys ~~alone~~,
as perceived by Bancroft is able to cause the hang of confluent-
valleys. From this consideration one comes very ~~near~~ close to another
supposition, that the U-trough of glacial-valleys are not in direct
relation to the ~~glacier~~-work of the glacier, and following only a
feature ~~accompanying the glaciation~~, which is due its developement
to forces changed by the coeval developement of glaciers.
× This was the standpoint, announced the first time but in eminent
manner also by Jean Brunhes. × ~~The ideas of Brunhes have been~~

× J. Brunhes: Le problème de l'érosion et du surcreusement glaciaires. Revue Général de sciences. 1908. N°3 Actes de la Soc. Helvetique. Fribourg 1907. Revue I, pp. 155-75. de Géogr. 1906/7. Vol. I pp. 281-308. Viz. also C. R. des Travaux du IX Congr. intern. de Géogr. Geneve. Vol I. pp. 338-42.

~~developped me~~ By the ideas of Brunhes I was ~~throughout~~ completely convinced,
~~but~~ by the ~~and my~~ × succeeding observations and field-works executed in the Carpa-
thians and in the Alps ~~led me to~~ I was led to many other ideas,
confined partially to the views deduced by ~~Penney and~~ Garwood ××,
which were
and so slowly I ~~am~~ came to the thesis, that ~~a~~ the glacial landscape
~~are~~ due mostly ~~its~~ peculiar features ~~to the~~ owes two forces: 1) ~~a~~ to the erosion
of running water, deviated and perturbed by glacier developement
2) to ~~the~~ warping ×. The erosional effect of the glacier seemed to
according to ~~after~~ this synthesis
be limitated to superficial work only, ~~it~~ attaining a greater
amount of work ~~a~~ first in the regions ~~it~~ elevated above the snow-
line, where the running water ~~disappears~~ as an active element
completely disappears. ~~In these high regions as seems to be but~~

× E. Romer: Einiges über die glaziale Landschafts und Seen Entstehung (polish with a german summary) Kosmos, Lwów. 1909. pp. 239-62. Mouvements épirogénique dans le haute bassin du Rhône et évolution du paysage glaciaire. Bull. de la Soc. Vaudoise. lausanne (vol. 47. 1911), pp. 65-192.

× Jean B. was the first to take this standpoint, which he did in an attractive way.

×× Garwood: On the origin of some features in the origin-alluvial terraces. Quarterly Journ. of the Geol. Soc. 1902. November.

But also in these high levels ~~are~~ the snow and firn masses are active more indirectly than directly. In my opinion ~~are~~ the forms ~~as~~ characteristic to the glaciated valley heads, the cirques and their steep walls, certainly ~~strongly~~ (and exclusive) ~~as~~ effect of ~~the~~ glaciation, but in a much greater part due to ~~the~~ excessive ~~coral~~ rock weathering above the névés and (to the) faciliated transport of the produced waste on the névé - slope and with (the) help of ~~never~~ the moving névé, than to the direct scouring power ~~of~~ executed by the pressure and movement of the snow masses. ~~My~~ By the ~~Tatra~~ glacial studies made in the last three years in the Tatra, ~~which are~~ shortly will be ready for publication I learned (have learned) perfect examples of ~~head wall~~ recession of the cirque head-walls, but the process of recession is (there visible) only in the levels elevated above the local pleistocene névé-line, below ~~of~~ it ~~are~~ (on the contrary conservated) the old pre-pleistocenic valley-benches are preserved

I ~~nowhere saw~~ But ~~from~~ in the glaciated mountains ~~I visit~~ with which I ~~was~~ have been till now acquainted ~~no one gives~~ ~~shows~~ at ~~so~~ perfect ~~p~~ physiographical peculiarities, which are able can to support my point of view, ~~than as~~ than the ~~ex~~ drowned mountains of the inland passages". In giving the reasons for the above statement I will ~~confine~~ myself ~~by~~ by giving the observations only from ~~the~~ fiord-embayements, with which I was during my journey better acquainted, it is from Yakutat and Glacier Bay.

These both fiord systems ~~shows~~ (show with a very striking regularity) some physiographical ~~peculiarities~~ properties, ~~which~~ ~~were~~ already mentioned by Brunhes ~~in his theories~~ were by him used in the theories, showing that the glacial landscape can be very well understood, ~~without~~ (it is) then accepted, (that these were) granted only the agencies of a normal erosion active, and that these agencies were by the glaciation ~~only~~ very seriously perturbed.

The first most remarkable feature, ~~by~~ which must be any one surprised, ~~then are can only away from the mighty impressions, made by the magnificent panorama~~ ~~nature~~, is certainly the very unexpected ~~as~~ in the lofty regions but proportionally also perfect aggradation of the whole landscape. All confluents, I point ~~exactly~~ (repeat particularly) that all confluent-valleys, which enter ~~the~~ Disenchantment Bay, ~~the~~ Russell fjord / our ~~little~~ congress-party ~~does~~ did not goes beyond the mouth of Hendrickson Gl. ~~and~~ ~~but~~ and Hidden Gl.), the Nunatak Fjord are as well in ~~it~~ their lower part aggraded to the sealevel, that ~~can~~ it can not be imagined better. The valley of Agua dolce, Catalonha, the little valley, parallel to Russell fj. and ~~of~~ Orange Valley the ~~a~~ valley, which drains the Hendrickson glacier or ~~both~~ two (right hand) confluents of Nunatak Fiord, ~~also~~ are the ~~best~~ examples of (perfect) aggraded valleys in this district. ~~Here~~ When we exclude from discussion the valleys, ~~by which~~ (the rock bottom of which is) are obstructed by heavy sheets

of tidal glaciers, ~~or~~ covered under ~~similar also~~ very heavy morainic and outwash products. I ask where ~~are~~ ~~is~~ are the valleys, ~~which in this~~ district, which can be named hanging valleys? There It is is only one valley left from consideration, that it is the little one ~~valley~~ entering the ~~confluent of~~ Disenchantment Bay, ~~onto~~ ~~to~~ N. from Cataloniha at a small distance from it ~~which are on the named~~ This valley is named on the map of Yakutat Bay[x] ~~just to the Congress Guidebook~~ a hanging valley. I regret very much not to be able to tell ~~some~~ more about ~~this~~ it valley, because of the great impression, which made on me the first glimpse in the perfect agradation of Cataloniha Valley; I can assure only, that the hanging relation ~~are not~~ in this valley from seashore is not evident and when existing, they are developed ~~at first~~ in the upper part of the valley, in all cases above the turn ~~made~~ of the river valley, made near the letter "h", given on the map as a sign ~~of for hanging val~~ of interrupted fall. But Besides these valleys, which are now abandoned from glaciers, also all now glaciated valleys have an appearance, which ~~is~~ suggests a good agradation of their rock-bottoms, and below in all cases ~~a~~ very slight tracks, only from which could be supposed ~~some bit ever~~ some hanging relations, ~~even in a very low degree~~. and when so, in a very low degree only. These agraded types of glacier slope reach to big glaciers, as to Hubbard very far above the tidal cliff, but the same property is common also to by far secondary glaciers ~~as~~ as to the Turner Glacier, Haenke Glaciers, and his unnamed neighbor, which descends ~~para~~ in the corner between the Haenke, and Hubbard, to the Variegated Glacier, Orange Glacier and Hendrickson Glacier. Only the smallest glaciers, ~~occupying~~ the cliff and cirque glaciers or avalanching ice tongues, representatives of gullies and ravines ~~of~~ in a ~~landscape of~~ mountain-relief of a normal drainage shows hanging relations. ~~But on these hanging forms, for which are given~~ The most pro eminent form of this type is given by the cascading Glacier, confluent ~~of~~ to the left arm of the Nunatak Valley. But ~~this only one~~ example can be counted to ~~given as a~~ the types of hanging valleys? In my opinion it is very hard to do so. The whole length of this form attains scarcely three km (1 3/4 of a mile), and from this length can be treated the greater upper part as ~~a cirque~~, an oblong cirque, changed by headwall-recession, while the lower ~~part~~ part, which forms the splendid glacier cascades seems to be controlled by structural agences. But this Cascading Glacier is ~~the only one~~ one, which partly questioned, however the best example of hanging relation in the part of Yakutat Bay, with which I made acquaintance acquainted by me during the journey of the Congress-party. By such kind of hanging forms, naturally ~~of~~ among

(and this, the only one, I partly question)

[x] R. S. Tarr and L. Martin: The earthquakes at Yakutat Bay, Alaska. U. S. Geol. S. Prof. Pap. No. 69. 1912. Plate XXII; vir also Congress Guidebook No. 10.

developed naturally in a incomparable feebler manner, than the Casca-
ding Glacier, but for which (about) gives the above named map of Yakutat Bay
full of information, (in my opinion) (can be) the theory of a glacial
developement of present relief (not well supported).

In this opinion I am in accord with G. K. Gilbert, which in
treating the theory of a powerful glacial erosion, with evident sympa-
thy indeed, but as one of the morphological possibilities only, applied
to this theory a very exact criteria and asked in interpretation of the
relief forms very close and distinct consequences. This was the principle,
which led G. K. Gilbert × to the supposition, that the greater inclination
in the lower part of Turnerglacier and the almost horizontal level
of its cliff part are a sign of floating of the ice cliff
on the one side and of an important hanging relation between the
valleys of Turnerglacier and Disenchantment Bay on the other. From
this supposition, strictly based on the theory of glacial overdeepening
Gilbert easy to deduce, that the depth of the Bay on the Turner
cliff must attain at least 1600' and that „the central depth
should be considerably greater. The theory, claims Gilbert at
the end, could therefore be tested by sounding."

× Gilbert: Glaciers pp. 66-69.

By the soundings, made by L. Martin at 1910, ×× was found, that the
central depth in the of the Disenchantment Bay in the profile indicated
by Gilbert attains not full 300' but from this (computation) was
without any influence on the theory. The theory of glacial
overdeepening remained intact, only the search for the results
of the overdeepening processes was transfered from „talweg" to
where after the simplest principles of physique must be (supposed to be)
the glacial erosion the strongest, to the upper levels of the glacier cirques or
even to the upper levels and borders of the glacier, where it is
difficult to name a reasonable cause
reason for a developement of a more important glacial erosion.

×× L. Martin: The National Geographic Society Researches in Alaska. Nat. Geogr.
Magazine. (Vol. 22 1911), pp. 537-41. Vis also Congres- Guidebook № 10.

As for what belongs the features, ascribed to the phenomena of
the glacial overdeepening on the district of Yakutat Bay I am
almost in accord with adherents of this theory; we describe them
as hanging cirques, or gullies. But in the genetical interpretation
of these features we goes asunder. I gave just now and also many
times above the reasons, for which I cannot count the forms
of hanging cirques being due to the process of the glacial overdeepe-
ning. I will repeate no more, but on the contrary
I will pay attention to some peculiar features, accompanying
the cirque formation, which they have common with the

glaciated mainvalleys, and which are ~~aff~~able, after my opinion, to demonstrate the way of formation of the ~~re gla~~ relief of glacial districts. I ought to point also, that I ~~h~~ nowhere ~~been~~ have seen these features ~~as~~ so distinctly developed, as in these two fiordsystems of Yakutat and Glacier Bay.

The principal sign of this featwre rests on the apparently abnormal form of two lines of drainage in one valley. But this ~~ab~~normality for a relief produced by a normal erosion of undisturbed running water ~~are~~ is a rule ~~in as~~ for a glaciated relief. On the left slope of Russelfiord, which is exposed toward NE hangx some 6-7 cirques. Some of these cirques are dry, but ~~t~~ the bottom of the greater part of them are covered with ca less or more ~~extens~~ large patch of névé-snow. Both kinds of these cirques, the dry and the glaciated ones are drained by ~~double~~ two chanels, which are ~~incised~~ cut in the ~~outter~~ outer rim of the cirque on its right and left borders. The chenals are always very distinctly carved though ~~nearly~~ in general very shallow only. The dry cirques ~~only~~ are seems to be somtimes from the glaciated distinguished by the fact, that one of the chenals are much deeper incised from another and that the deeper chenal are accompanied by an ~~a~~ waste-cone. It is easy ~~x~~ and with much certainty to deduce, that the double drainage ~~ist~~ is a peculiarity of a ~~xxx~~ glaciated torrentbead, which after melting of the ~~snows~~ transforms ~~himse~~ itself in a single chanel. By the observation of ~~this~~ pe these features in Russelfiord one could be also convinced about the stronger ~~e~~ erosion of the intermittend torrents, having ~~it~~ outlet in dry cirques, than of the chanels, flowing off the snowfields; the waste-cones underlying the dry cirques suggests ~~this~~ the above given ~~idea~~ supposition.

The duble drainage ~~of the glacial~~ is but not limitated to the cirque or glaciated torent chenals, it is on the contrary the most general peculiarity of all ~~glaciated~~ valleys, ~~x~~ which are fed by living glaciers. ~~x~~ By a very superficial review of maps concerning the Alaskan and SE-Alaskan glaciation ~~x~~ I was learning also ~~these~~ by this ~~first~~ stage of cartography ~~xxx~~ was this feature ~~was~~ still many times ~~seen~~ very distinctly noticed ~~x~~ recorded ~~x~~

~~x~~ In the following note I brought together the names of the glaciers, which have after the cartographical documents ~~xx~~ double marginal outlet; ~~xx~~ The number given in brackets means the Nr. of U.S. Geol. Survey Bulletins. These glaciers are: Two Delta Gl. (501); Ruth, Tokichitna, Kahiltna (534); Talkeetna, Great Glacier (347); Tasnuna R. Gl, Sheridan (443); Bear, Valdez (526); Berners, Noris, Twin (287); Kennicot, Tana (374); Matanuska, Tarlina, Eagle (502). This number of duble-drained glaciers could be much enlarged. I add only the Hidden (Viz also Gilbert l.c. p. 54), and Klicillewaet, with which I was acquainted, and ~~after Schorer~~ the neibouring neighbourlies glaciers of Yendekemna, Yapta and Asulkan (Viz. Schrrer: Glaciers of the Canadian Rockies and Selkirks. Smithsonian Institution. Publ. Nr. 1692)

led.

The ~~first~~ idea, by which one could by very easy at first taken, ~~are~~ is the supposition, that this double drainage is a simple consequence of stream deviation and bifurcation on the convex-fanforms of the fluvio-glacial deposits. But this supposition can be no supported by all ~~for mine such~~ other features accompanying. First we ~~see that~~ saw already, that the double & and marginal drainage is ~~as well~~ common to the ~~as~~ outwash-forms on the front of the glacier as to the cirque outlets, where ~~in most case~~ the alluvial deposits are almost absent and even ~~a~~ moraine frontal obstruction comes seldom to development. ~~Secondly~~ Secondly The observation of minor features are convincing ~~about~~ that, that the developement of double and marginal drainage are slackened with the increasing distance from the glacier-front and ~~&~~ disappearing shortly after the glacier have been melted in ~~some~~ the valley. More than these both reasons speaks the ~~third~~ one ~~as well~~ in favour of the thesis that the double drainage are not a property of valleys, fed by glaciers, than ~~of~~ a property of the glaciers itself. ~~When the double~~ This significance I will ascribe to the fact, ~~that most of the glaciers which are not lobed have to stream-outlet not~~ that most of glacierstreams does not flow ~~off~~ ~~it~~ on the (central part of the) front of the glacier, only on its ~~the~~ borders, sometimes from one only, but most often ~~from both~~ on both glacier-margins. The double drainage is a feature, characteristic to subglacial drainage, and when ~~does~~ in streamvalleys developed, it ~~is only~~ ought to be regarded as an inherited feature only.

The existence of this marginal subglacial drainage ~~left~~ leaves everywhere very distinct tracts of its work. Especially in the little ~~glaci~~ valleys of East Carpathians (Czarna Hora Suido-wiec) where (existed) during ~~were~~ Pleistocene time many short glaciers ~~are~~ (castle) the tracts of ~~the~~ a marginal erosion are very clear marked. To the feeble developement ~~of~~ a moraine and still more feeble occurence of fluvioglacial deposits, finally ~~the partially~~ to a complete lack of morphological changes in postglacial times must be there ascribed the prominent conservation of ~~forms~~ (subglacial) valley-forms, which ~~can be~~ only by admission of a marginal erosion can be well understood. The peculiarity of these forms rests on the special type of the cross profiles of the valley bottoms. ~~This~~ They are namely not only of a trough-form, but the bottom of the trough is very distinctly convex ~~with two~~ and ~~on be~~ accompanied ~~ing in both margin of the the trough developed channels~~ by two channels, cut between the central broad convexity and the ~~non~~ valley-slopes. That this form can be not at all treated as a result of a glacial erosion, seems to be sure; this form ~~is a pr~~ gives one proof more ~~for the~~ in demonstration ~~the changes~~ of the changes made by glaciation on the processes of ~~a~~ normal erosion.

+ The theories reason speaks more strongly than the other two

Opposite to these works very distinct indeed but very feeble also are of the marginal subglacial erosion in the Carpathians are shown by the morphology of the inland passages and the Alaskan fiords various but all very mighty effects of the same processes, effectuated by greater forces and longer time. and in a longer amount of time.

These works of a heavy marginal erosion we see in abundance on the left bosses of Russelfiord. To this kind of forms I will count all these rocky bosses, which are partly cut from the valley slopes and by it linear arrangement and elevation suggest the idea, that they were cut by subglacial marginal streams in a time, when the Russelfiord was wholly filled with moving icemasses and subsequently a time of subglacial outflow of running water. These marginal bosses (half-cut spurs) are throughout independent from the rock structure, though they are between the Osier Island and Cape Enchantment almost limited to the rocks, withdrawn on the map as the paleozoic group, south of C. Enchantment they occur in the same degree of development on the rocks, belonging to the mesozoic Yakutat group.

The same processes, but in a incomparable higher degree are shown on the forms of the fiordwalls and fiordslopes in the Glacier Bay. The bosses, cut from the fiord slopes, often and cut often very deeply are in the embayments of embranchements of Glacier Bay a very common and regular feature, which belongs to the most characteristic peculiarities of the morphological of this district. Some of this bosses, particularly the smaller one can be given as the best evidence against an attempt toward the explanation these forms by glacial erosion. Such a eminent example can be given by the form of the sc. Nunatak in Rendu Inlet. This boss (situated between the two soundings 80 and 83 fath, noticed on the U.S. Chart No 8306), more about 3-400' high, has not only very bold forms, as is precipitaous not only on it fiord walls, the waterside but about in the same degree in its steclivities, also turns to the slopes of the mainvalley; the cut form shows not only by its freshness, its wilderness, but simply by the well expressed V-cross section, that here were the glacier icemasses never active. Without Best one is tempted to put the question from another and general point of view. The same kind of bosses are found abundant in Grand Pacific Fiord (named by L. Martin Tarr Inlet during our work in Glacier Bay September 1913) on both, its right and left slopes; on the right slopes I remarked 6 bosses, on the left three. They are of several kind Several bosses I noticed on the left slope of Reid Inlet from the point opposite to Russel Island to the Tidal Inlet, some very interesting

Very mighty effects of the same processes which we have, in a slight degree, observed in the E. Carpathians are shown by the morphology of the inland passages and the Alaskan fiords, where they were caused by greater forces and in a longer time.

58

little bosses I found on the opening of the Muir Inlet near Sebree Island (very observation made and from greater distance I was convinced, that the bosses which are a feature common to all glaciated regions are here attain here an exceptionally the highest degree of development found here.

The There are several kind of bosses, which can be classified into the three general types. The first type, though the less remarkable, is very important for explicative treatment of this morphological feature. This type is marked by short oblongs notches, incised parallel (on the fiord slope) to the general strike of the valleys. For the explanation of this form can be called only the erosion of running water, and in regard to the elevation of this short channel form can be taken in account only a subglacial stream, directed by the obstructive element of the glacier. Particularly These forms are particularly striking, when they occur on the same profile in several elevations, as for instance west from on the mainland slopes, west from Russel Island (East from the point 2470' on the chart 8306). These three parallel (clearly) on the same slope one over another notched, are a prominent feature in the view from Tarr Inlet (Gd. Pacific Fiord) looking south, and they can be treated as an demonstrative object for explanation of the genetics of a glacial landscape. Second type of bosses is represented by only slight oblongated (of a very small area) conical spurs, similar to them, (but thick) known as the de. Nunatak in Rendu Inlet. Many Some very belonging to this type I saw also in the Tarr Inlet. The truncation of such a form is very difficult to imagin. Subglacial waters can be so called for the explanation of this are not able to suggeste an explanation for this type of forms. The forms are (to) namely short in long for one could admitt the development of a subglacial and marginal stream. But also from the standpoint of a theory of glacial-overdeepening one is through out helpless in that made if still be made an explicative attempt of explication of this form. But it is but clear, that such a preglacial spur, then even by a wide and flat windgap slightly separated from the mainslope (during glaciation must because) from the standpoint of the glacial overdeepening according to the coeval contraction of the cross profile simultaneously (cause) an important rise of the rate of glacial movement in the central channel. The supposed glacial scouring must attain here a high degree of development. The scouring must be concentated on the line of the always concentrated on the line of talweg" can be here effective also on the outside slopes of the spur. All this consequences are clear. But I see no possibility for explanation a deep notch in the line, where the spur join the main slope. Supposing even, that the preglacial spur was by a wide and flat windgap slightly separated from the mainslope. In all cases when also the glacier had begun to (at the time of beginning of the glacier) swell, it overrod first the

E indeed, we can suppose with Gulbrandsen

x

xx more pronounced and young forms we can for preglacial spurs not suppose

golden

the top of the spur, which formed for one moment
windgap, and only after that it covered the a temporary nunatak.
~~But which bear~~ But to suppose ~~a glacier~~ (remarkable) ~~strength~~ erosive effect,
~~executed by~~ ~~a or shall~~ a thin glacier arm, covering the windgap, seems to be
quite in disaccord with all rules of the theory of overdeepening. But the
thickness of the ice over the windgap ~~can~~ could ~~be~~ during the time
of maximum of glaciation ~~be also very~~ attain a very great dimen-
sions. ~~Supposing this~~ But (not helped) by this supposition will be the theory of a
origin of the deep (outside) nunatak cut between the nunatak and the main
slope; ~~This~~ simply for that reason that the differences in the level
between the top of the old spurforms and their windgaps are
so insignificant, that the proportional increase of the correspon-
ding ice thickness can have not an influence on the ~~increase~~
rate of ice movement, it can be on the contrary by the increased
friction because of direct contact of ice with the slopes of the main
valley. (Throughout balanced)

~~The only one way of~~ explanation of these forms seems to me given
by the ~~first~~ influence, of which have all at valley narrows or barriers
have on the ~~amount of~~ glacier oscillations. The valley glacier, obstructed
by a projecting spur expresses the climatic oscillation more by the
changes in cross profile, than by the changes in of its length. Such a
projecting spurs are (for this reason) the places, ~~there the glaciers~~ behind their are
placed very common the glacier end, ~~fluctuate~~ which ~~is~~ can be flat
or swollen according to ~~climatic~~ glacier oscillations. ~~In these conditions~~ It follows from these conditions, that the ~~pre~~glacial wind-
gap are often used as the chanel for the outflow of the glacierstreams
which ~~accompany~~ commonly the glacier margin. From this
consideration follows that the first beginning of this kind of
losses is given by the fluvioglacial stream-erosion, and according
to this provenience of the loss the separating notch is deeper cut
in its down part, than in its part directed ~~upward~~ up the valley.

The third kind of losses, (the most numerous) is represented by great, often high,
very oblong ridges running parallel to the seashore, but always
bearing distinctly out from the mainland as oblong and broad caps or
peninsulas. Most of them are more than one mile long, but analogical
forms extende in the coastforms of Glacierbay (yet west to) at a length of 5-7 miles
(8-11 km). All this losses are inherited ~~from~~ forms of a subsequent
~~old~~ landscape of ~~an~~ a normal erosion. The inheritance from old
forms is stated by the lack of accord between the structural lines
~~and at~~ on the one side, and the subsequent ~~notches~~ ridges and
notches ~~from~~ on the other. ~~This partially epigenetical character of~~
~~the forms suggest, that they belong here a component~~ belonged
~~to one polycyclical landscape of a normal erosion, and that~~
~~they was by the glaciation changed in not visible manner.~~
The independence of these ridges from the structural lines witnesses (and notches)

against the participation ~~of~~ in developement of these forms by the glacial erosion, which must be imagined at first as a selective erosion. The marginal situation of the ~~eroded~~ strongly eroded lines, separating the bosses from the mainland speaks more than any one other reason against the participation of the glacier erosion. This longitudinal notches, ~~sometimes very deep incised, sometimes when deeply incised~~ which are more or less deeply incised, ~~but never hanging, more or less agr~~ and although short always more or less agraded, and never hanging, for this reason they must be treated as forms, which suffered great changes by the processes of a marginal sub-glacial erosion.

These bosses of the third kind were already ~~often~~ perceived not only as by Brunhes and Bugeon by the adversaries of the theory of a powerful glacial erosion, but also in the same degree also by it adherents. One of the ~~last~~ first representants of the theory of glacial erosion, Prof. E. Brückner of Vienna paid to this problem much attention, and arrived in this matter to following conclusions. In his opinion there does not exist ~~any~~ in principle any difference between the cross-bars, ~~which~~ by which are the ~~of~~ basins of glacial-eroded valleys, and the longitudinal bars or bosses. The cross-bars are ~~easily~~ in his statement shown as ~~of~~ forms, ~~which~~ are due partly to the selective erosion of the glacier, partly to the ~~the~~ water erosion of a chaotic system of subglacial streams, ~~but~~ but finally to the accumulative process of the glacier, which filled by its ~~ground~~ all irregularities of the cross-bar during the time of the advance of the glacier. ~~The primary form was~~ But the cross-bar is, ~~after~~ according to this idea, the primary form of the glacial landscape. This form follows, after the opinion of Brückner, throughout to the rules of the processes of glacial overdeepening. It arises either ~~or~~ at places at the mouth of a confluent valley in the mainvalley, or ~~in similar~~ under similar conditions, given where by many confluents ~~giving~~ origin to the mainvalley, or at the place, where the glacier was long time stationary, finally at points where the geological conditions promoted the development of a selective glacial erosion. It is ~~very interesting~~ to notice, ~~point~~ that Brückner himself points out, that many bars ~~lays~~ lie on places, which ~~can be by no means counted to the above named~~ correspond by no means to one of the above named given conditions. ~~Has I~~ These bars are either

To account for these bars, says Brückner, one must call for differences in the erosive power of the glacier, which appeared in the longitudinal direction as a consequence of corresponding changes ~~of~~ in the inclination of the valley bottom or in the square of its cross-section." But this relation between the morfology of the valley and

× Penck a. Brückner: Alpen im Eiszeitalter p. 621 ff.

The developement of cross bars was by nobody shown exactly, and 62 by the examination which I made[x] between the forms of overdeepening in the Pô- Rhône-basin and the for the valley-system of the Rhône was found on the contrary no relation between the amount of valley-overdeepening and the degree of the fall of it. was found

x

The question is finally after in the opinion of Prof. Brückner of no greater importance because the relative height of the bars is in comparison to the thickness of the moving ice, which in the pleistocenic ice quite insignificant; he appreciates this relation to be normally 1/14 and in only one case 1/7 of the ice-thickness.[xx] If it is so the bars although they are very prominent in the landscape are no more as irregularities of the by glacier-erosion formed valley bottom scoured by the glacier, for which exists a direct analogy to, compared with the small irregularities of a river bottom in comparison to the depth of the running water.

xx Penck-Brückner bd. 622.

The longitudinal bosses, which are such a striking feature of the bottom of glacier glacier-valleys, are after this opinion of Brückner, according to Penck, a subsequent forms of the cross bars. They are two causes, by which the bars are changed in bosses: 1) the denudation of the carrying of the morainic mantle by means of subaeril denudation and opening of the ancient buried channels, which were cut by glacier-streams in the rock-bars; 2) the erosive power of the double drainage, which is as common for the glacier zung. To this last processes are by Brückner counted the best known, thanks to their bosses, which are best known in the alpine valleys, thanks to their prominence in the landscape.

Still more often by Brückner are by Penck described to this double drainage of glacial valleys the development of longitudinal bosses.[x] But as well as Brückner points also Penck the morphological insignificance of these forms in the glacial landscape. In all cases is Penck opposed against the supposition, that the irregularities in the bottom of glacial-valleys, as they are given by the marginal bosses can be supported treated as a proof against the theory of a powerful glacial erosion. These forms are, says Penck, not remnants of an preglacial "morphology, but they were developed during glaciation because of a weaker erosion upon the bosses than anywhere elsewhere. These forms are well comparable with cliffs flats, which come regularly below the eddies depth, accompanying the eddies; As well concludes Penck, as the river bars or flats does not just

x (Riegelberge, Inselberge)

x Penck a. Brückner, Alpen im Eiszeitalter p. 304.

deny the water erosion, the basses of the glacial valley does not deny the erosive power of the glacier."
There are many things to be offered to these views against these views it many to oppose.

1. The normal type of the basses, which occur in the bottom of the glacial valley, are longitudinal and not transversal. Especially in the landscape of the inland passages and in the Alaskan fiords it is hardly to find basses which can be arranged in transversal lines, while many of them can be followed for long distances in longitudinal lines, suggesting the the destructed remnants of ancient surface of an ancient slope of the main valley, destructed by the cut off by the subglacial marginal streams. In all cases the marginal basses seem to be independent a kind of forms, which are independent from the more unusual forms of the rocky cross-bars.

2. Accepting even the transversal descendence of the marginal basses from the transversal bars, which is not can be made not without difficulties and risk seems to be not quite easy for in most cases not probable, to find not easy to compare the forms of the bottom of glacial-valley not with the forms of a river the valley-bed of a river. The river flats, which appear regularly below the depths are namely built by accumulation of the material carried off by eddying water from the upper depths, while in the morphogenetic arrangement of the forms in glacial valleys is quite opposite: the supposed × to crossbars, which come below the the supposed deep basins are forms of erosion, and the basins are filled by accumulation.

× I point the hypothetical nature of many of the glacial bars and basins rock-basins, fallen as I was by my observation led to the same opinion in this matter, which was is represented splendidly before long ago by Albert Heim. See viz. also his paper: Beweist der Einbruch im Lötschbergtunnel glaciale Übertiefung des Gasterentals? Vierteljahresschrift d. Naturf. Ges. Zürich. 1908. No. 20. Bd. 53. No. 20.

3. The fact, pointed by Penck, that the basses are not remnants were developed during glaciation is doubtless. But this fact explains only can be only stated, that the morphology will be proved only that the accident of glaciation (a complete cessation of the life processes) do not mean for the geographical cycle, and I think, that the extreme adversaries of the powerful glacier-erosion never maintained this opinion. The landscape × are is alive also during glaciation, it is no question. The question is: ×) if the degree of this life is slower or faster during glaciation than during the conditions of a normal erosion, and further, which is the principal element of erosion during glaciation, the ice or the subglacial running water. And if we remain by the just discussed matter, I ask for a reason, by which could be explained the weaker erosion upon the basses than elsewhere. All they all the functions of erosion glacial erosion rise the rate of movement of the glacier, its mass thickness and pressure, rise also are diminishing strikingly towards the borders of the glacier the cut off of the marginal basses can be never explained by the glacial erosion. When it is so, it

only remains for the explanation of ~~this~~ these common and important forms of the glacial landscape only ~~the~~ water erosion.

4. The development of these forms (Riegelberge, Inselberge) in the glacial landscape is ~~as~~ no evident = ~~that for a~~ product of water erosion, ~~that this proces~~ it was confessed even by the first representatives in the science, which not at all inclined to ascribe to the water erosion anything important in the development of a glacial landscape. But at the same time as was granted the processes of a normal erosion by on the formation of bosses, was ~~also~~ from the part of adherents of the theory of a powerful glacial erosion pointed also the morphological insignificance of these bosses, which were characteristically named „small bosses". When this point of view opinion is very hard to support for the forms found in the Alps, it is throughout inadmissible for the relations characteristic for the Alaskan landscape. It is sufficient to ~~show~~ look at the relations found in the Glacier Bay. There are, besides numerous small basses, six large longitudinal and marginal islands elevated 500-1600' ~~above the seabord~~ in mean 1100' above the sea level, which in regard to the ~~depth of the~~ surrounding sea ~~rise~~ in mean to an average of 1800' above the bottom of ancient glaciers, ~~which covering the long pleistocene time buried and overhelmed~~. ~~But it~~ Still higher than the island-bosses are the peninsular bosses, which are in complete morphological analogy with the one exception, that their inner ~~coastal~~ cut is not submerged. The relative height of the four most pronounced peninsular bosses of Glacier Bay is ~~2600'+1780-2400'+600'~~ the depth of the surrounding ~~sea~~ 3200' (i.e. it is 2600' above, and 600' below the sea level) on the inner side and over 2000' on the outer, the mainland side, (which amount in vertical scale 1/2 - 2/3 of the pleistoc. ice thickness).

It is difficult to say, that these forms, are small bosses, or even, that they correspond to the quantitatively to the irregularities of the river-bottom to the depth of the river during flood stages, during which these irregularities are formed.

In view of the conditions above described I find it very hard, when not altogether possible to ascribe the forms of the marginal bosses to the glacial erosion, I find on the contrary, that these forms are very easy to join genetically to the processes of water erosion, which was deviated and deformed by the accident of glaciation.

In the theory, which was developed in such a manner, still I see one question, which ought to be still cleared. We saw, that the insular bosses are in all cases lower then the perinsular bosses. This fact, which is unquestionable, could be treated from the point of view of a powerful glacial erosion as supporting this view. One could namely explain the lower height of the first bosses by the fact, that they were buried under a thicker ice-mass than the second bosses, which were also for shorter

time ~~occured~~ than the former. But in spite of the apparent connexion, which exist between these features and the glacial theory, it seems to me impossible to support this point of view not only because of the deduction ~~which~~ I made above. ~~I ought to~~ One ought to have regard for it, that the ancient river valley was incomparably narrower than it was after the glaciation, ~~and following that the ancient normal valley was situated~~ and that their widening was a function of the continuous widening of the icemass-stream. But from the point of view of the glacial erosion ~~the~~ glacial erosion could be effective only and in all cases principally on the lines of ancient normal valleys, ~~Only then the icemasses~~ because only there came during the accident of glaciation ~~it to~~ a more important concentration of the ice flow. Outside ~~of~~ the ~~a no~~ channels of the normal valleys ~~was~~ the thickness ~~to small~~ was generally too small to overcome the friction of the bottom, which opposed to the icemovement. In no stage of ~~ice~~ the ~~development~~ life of the glacier was ~~given for the glacier~~ the opportunity to develop a strong ~~erosion~~ erosive sculpture on the slopes of the ancient normal valley. We can imagine a widening of glaciated valleys by slow and ~~consequent~~ continuous scouring and polishing of the valley borders, but we must expect, that the ~~only~~ principal work of the glacier is ~~to~~ indicated by the lines of the ~~greatest~~ greatest concentration of iceflow ~~and~~ and following the effect of this work must be at first seen in ~~the~~ overdeepening of the main valleys. ~~It is of co~~ It would be, of course, a special glacial sculpture, but this special kind of sculpture is not at all to unite with the characteristical sculpture, ~~demonstrated~~ shown by the ~~ice bow~~ marginal bowlders. ~~When~~ Of this sculpture, executed on the borders, or on the terraces and highlands bordering the ancient normal valleys, ~~it~~ is to be treated as inappropriated to the glacial processes, ~~it must be~~ one must at the same time confess, that it can be and is also ~~very~~ probably very common to the processes of water erosion, ~~deformat~~ which is deformated by the accident of glaciation. This supposition is supported by the fact, that the thawing of ice is not only common on the ice front, but also far above it, and there especially on ~~the bo~~ both bor glacier-borders, where the ice comes in contact with the dark, warm rock. On these iceborders, where the ice-erosion is ~~nit~~ null ~~is the for~~ attains the torrential erosion of the subglacial water its Maximum. ~~Here~~ But these lines of a Maximum ~~of the~~ torrential erosion wander with the development of glaciation in parallel lines towards the lateral waterchannels and ~~prepare by it the~~ by this process will be prepared the widening of the glacial valleys with its bowlers arranged in ~~one~~ one or more parallel systems. ~~By this~~

By this deduction can be explained not only the ~~kind~~ existence and the special kind of this forms, but finally even ~~but also~~ the striking fact also that the height of the bowlers rises towards the borders of the glacial valley,

fact, that ~~high~~ huge and high ~~ter~~ bosses are especially common to the valleys, which were during pleistocene most intense glaciated.

The ~~relations of~~ morphological relations of Glacier Bay described above ~~explained~~ ~~desk~~ one more consequence, which must be pointed: the ~~gla~~ mainland was during maximum of glaciation at least 500'-1000' higher elevated as it is now, otherwise could be the fluviatile origin of the straits, ~~sep~~ which separate from mainland the islands not explained; but this supposition is in no collision with the experiences made till now by the explorers of this country.

The problem of the changes in ~~level~~ sealevel or movements of the earth crust led us to a discussion over another morphological feature which is very common to the landscape of the inland passages and which must be regarded as of ~~the~~ first importance for the answer in to the question of glacial erosion. I mean the existence of several base-levels in the morphology of the inland passages and in Alaska.

~~I first during my journey in the inland passages very surprised by the learned during my~~ glacial studies, which I made in the carpathians and in the Alps ~~to high degree~~ I was learned to pay great attention to the terraces and ~~more pronounced~~ other base-levels and for this reason I gave to this feature ~~in the~~ during my journey in the inland passages the highest interest, ~~after~~ I noticed and sketched ~~them~~ the base levels all over the country, where the forms were ~~only~~ clear enough, developed and ~~gave~~ could be given where some guaranty, that a mistake ~~is not~~ would can be at least partially excluded. For diminishing the risk of ~~making~~ a mistake I appreciated ~~always~~ in most cases the distance of the observed levels on the charts and appreciated ~~I in most cases the~~ their height ~~of the observed levels~~ by means of the clisimetre observation.

As a result of ~~the~~ these observations I came to the conclusion that ~~in~~ the whole part of the traversed country between ~~N.~~ Cape Renfrew and North of U. St. 50°58° of latitude (Gastineau Channel) one can very clearly and ~~surely~~ discern besides the contemporaneous base-level of the sea three other ancient base-levels, which are elevated to the following approximative heights: 50'-100', 700-1000', and ~~2000'~~ 2700-4000'. All these levels are so well marked, that even the occurence of higher residual ~~hei~~ forms on each of these levels does not obscure their ensemble. I have sketches based upon observation from the following points: Vancouver Isl (50½°N) with ~~I-III~~ level I-III, Calvert Island (51½°) two observations with I-III, islands in Fitzhugh Sd (51½°) with I and II, Pearse Island in Portland Inlet (55°N) with I-III, Kinkolith in Observatory Inlet (55°N) I-III, ~~4~~ north part of Observatory Inlet (55½°N) with I-III Gravina Island (55½°N) with I and II, Prince of Wales Island (55 3/4°N) with I-III, Douglas Island (58½°N) with levels I-III.

Below the lowest I level are cut the ~~de~~ deep valleys, which

being submerged represent the very intricate net of fiord-channels and -inlets. The question, which ought to be cleared at first concerns 1) the age of the ancient levels of denudation, especially the age of the lowest level and 2) the derivation of the in fiords changed valleys, which are cut into it. In my opinion both questions are closely connected and by the same kind of related facts and processes also both together explained. I see in explanation of them only two eventualities, which both must count with the quite sure supposition, that the lowest level is of prepleistocenic age. The first eventuality based upon this supposition is that during pleistocene land was the earthcrust here throughout stable, and in this case the fiords are exclusively due to the glacier erosion, which was independent from the sealevel and the second, that the earthcrust during pleistocene (an upwards movement of the earthcrust) to which was due the building of the lowland to level came during the pleistocene elevated and the fiords are in this case must be regarded as rejuvenated valleys, which were eroded by subglacial streams, and afterwards again submerged. From this deduction I see two possibilities: the fiords are products of glacial erosion if the land was during pleistocene stable, or they are products of water erosion, if the land stood at that time higher. For the last supposition I could found nothing during my hasty visit, excepting with the one fact, by which I was surprised: I missed namely in general the existence of morainic deposits on the whole route of inland passages, and the only one section, which was found abundant on moraines, is the region between the Icy Point (near Brady Glacier) and Yakutat Bay; and it is remarkable, that the whole coast lacking moraines is indented by fiords, and the coast rich in moraines is strikingly monotonous. We are accustomed to look over connection between the observed facts and I found it in the supposition, that these different parts of the coast owe their special morphology to differential movements and warpings, which suffered this coast in the last moments of its development. As well as for the last eventuality I found also nothing for the first, which could support the fiord one, excepting the one fact, that the fiord channels show some distinct irregularities in their submarine morphology, which is quite well consistent with the theoretical views concerning the forms caused by glacial erosion. But besides the only one morphological feature, which as well as by processes of glacial erosion can be perhaps (with more probability) explained also by processes of glacial accumulation, I found more features, moments, which

[A line!]

[A line!]

can be called to witness against the supposition of the stability of the sealevel during pleistocene and (which is) closely ~~therewith~~ connected with the supposition of glacial origin of the fiords. Without repeting the reasons given ~~still~~ already before for this opinion I will restrict now my analysis to the motives connected directly with the problem which is now treated, i.e. with the question of the movements in the sealevel. ~~From the point of view~~ Accepting the view, that the sealevel, ~~does not changed during pleistocene, that the~~ during the long stay of which was formed the (I) lowest base-level, did not changed during the whole pleistocene, ~~and post pleistocene time~~ we must at the same time confess, that the fiords owe almost exclusively their origin to the glacial scouring and that all the fiords are submerged hanging valleys. But against this deduction made already by many glacialists I must (oppose) two questions: 1) because all these valleys, which were scoured by the glaciers not strong enough, to be submerged after the recession of the ice, are scoured just to the contemporaneous sealevel; and 2) because the lowest base-level, representing a levelled land surface from the time preceding the glaciation was saved from glacial scouring, when at the same level was in so many places executed a tremendous glacial erosion? Shortly speaking the two facts: the lack of hanging valleys above the sealevel and the existence of lowest base-level are two striking features in the landscape of the inland passages, which seems to be quite inconsistent with the supposition of the glacial origin of this landscape. But it is very easy and inviting to bring the same feature in connection with pleistocenic movements upwards of the land: By doing so, ~~we find clear if that be~~ and supposing that the movement was not sufficient duration to be find clear that 1) the rejuneva, tion had only taken place in the main valleys of the country, and, as they lasted for proportionally short time, the last base-level of denudation (1 level) could be nearly everywhere saved; 2) the minor valleys were not affected by rejunevation and for that reason ~~are~~ after return of the sea to the level which it attained already had in pleistocenic time ~~are~~ these valleys (are) almost agraded.

This was my deduction supported by my own observations, which I made during the journey. ~~I not knew in this~~ I was at in this time not yet acquainted with the special literature of this district and I must ~~confess~~ confess my surprise, which I felt at the information, received on (from Chicago) my return back-way from Alaska, that the existence of the first lowest base-level was already recognized by G. K. Gilbert, by ~~Gilbert, from~~ the famous (G. K. G.) Gilbert geologist, which was at the same time ~~called~~ among the for the first authority, by which was the theory of glacial erosion in the Alaskan fiords principally supported. (between the congress-party called spoken of as)

69 have

The Acquaintance with the work of G. K. Gilbert[x] was my first need. I gave already given my opinion in this matter; I found, that Gilbert has an apparent sympathy with the theory of glacial erosion", which is common to the work of Gilbert and notwithstanding to them, that he can be „ with full right counted among the founders of the school of overdeepening", G. K. Gilbert is in his deductions never unilateral and in his statements are left always open doors also for other interpretation of the glacial morphology as by the processes of glacial erosion." Perhaps in no question we can with more right point 46. this opinion about the work of Gilbert as in the question of out Epeirogenical movements, which suffered this country during Pleist. Scene and in the question of conservation of the first base-level in the Alaskan landscape.

The views of Gilbert in those problem ~~can be represented reproduced in follo-~~ ~~wing last examen.~~ are namely following: The first base-level of denudation in the „inland passages", which is absolutely the same as ~~which was~~ ~~recognized~~ by me, „ in opinion of Gilbert formed during the preglacial time by the position of the sealevel, which „ could not have differed greatly from the present" (p. 131). The same opinion repeates Gilbert by the description of the low peneplain on the Kadiak Island (p. 182). The conservation of this peneplain is for Gilbert a proof in the opinion, that „ the glacial degradation must have been locally quite moderate, or the general plain character would not have survived" (p. 131). On another place, where on which he treates the problem of glacial erosion, he again looks for the reason of the preservation of the low peneplain. In this statement developes Gilbert nearly about the same deduction, as was given by Brückner in explanation of the losses" which were connected not with hard by layers accompanied by no visible element to which could be ascribed (the processus of overdeepening. „ The remnants of low peneplain, says Gilbert (p. 160) were preserved, despite the softness of their rock, because they lay outside the lines of flow of the strong currents." This supposition of such surprising inequalities of glacial erosion, as shown by the existence of low peneplain near the deep fiords, which in the landscape, which is as a whole regarded as if had been sculptured by glaciers seems to be for Gilbert in opinion supported by the exceptional character of the remnants of the low peneplain. On Gilbert points out several times this exceptional character of these morphological remnants, which were found by him only on the island of Annette and near Sitka. But therein lies is the only difference in this matter, which exists between the views of Gilbert on this matter and my own. I saw the low peneplain in at leaest ten places, one of which I found in common with Gilbert (Amalk and Graviua Island)

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x Alaska Harrimann Expedition. Vol. III Glaciers and Glaciation by Grove Karl Gilbert. N. York. 1904. The numbers given in brackets corresponds to the pages of this work.

× a certainty in this respect would not only change my views on the theory of glacial erosion, but also those of others.

Besides these and Gilbert himself as many others saw the same level also well developed in the other Alaskan fiords islands and even on the mainland (Prince Gillims Sound, Seward Peninsula)×. The low peneplain must be regarded as a The general preservation of the low peneplain, which as stated by Gilbert, is a product of degradation of the softest layers in the structure of the borders of inland passages is an important moment in the treatement of the problem of glacial erosion and I will suppose, that by the ascertainment in this regard would be changed the views in the theory of glacial erosion not only in me.×× Gilbert himself was surely the first, who took to take in account all consequences, which could be developed from the fact of preservation, although partially only in his opinion. Speaking of the fiords, which are cut below the level of the sea-level, Gilbert proclaims without any restriction "that those water-filled valleys are clearly products of erosion" (p. 135), the question only is the amount of change, executed on the floor of these river-valleys by glacial erosion and deposition. "Whatever the extent to which the hollows were deepened and enlarged by glaciers, it is probably not only that they were initiated by rivers, but that some of the rivers-trunk then beds considerably below present tidelevel" (p. 135).

With this point we enter in the most decisive moment of the discussion about the glacial erosion. Gilbert supported by studies, which were made by Batt Bailey Willis in Puget Sound accepts, that some

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××× of Alaska. U.S.G.S. Prof. Pap. 45. p. 20 Pl. IV A); the same level saw Gilbert only about Islond and regarding the distance of these points from oceanic shoreline he concluded, that this higher level corresponds with the low peneplain from Sitka and Annette Island. This question can be regarded as an open question but against the interpretation of Gilbert can be urged 1) the fact, that in the far off shore inlet at Portland Ch. both levels, the low and the middle are well represented 2) the supposition of Gilbert, with which I very well agree, that the preglacistocenic sealevel was the same as the contemporaneous.

×× By this occasion I will also look at in another detail for balance in the differences, which exist between my observations and the observations and views of Gilbert. Gilbert sees in the morphology of the inland passages only two, namely the high and the low peneplains, while I see there three baselevels. The level, being in the middle was by me as many times observed, that I not suppose a mistake in this regard. This middle level was by me as shown before many times observed and it gives some indications that we are when not in the interpretation of facts, as at least in the identification of the observed facts in accord with Gilbert. Gilbert saw myself namely as well as I saw in the Gastineau Ch. by near Treadwell and one level in a height of seven hundred feet (perfectly shown in the photo given by Brooks in his Geology and Geography)[2] ××× [1]

× Viz. U.S. Geol. Surv. Bull. № 328 p. 47, 300-305.
U.S. Geol. Surv. Bull. № 443 p. 17.

(p. 135 and 136)

~~of the~~ the existence of crustal movement during pleistocene. ~~What~~ As far as concerns the amount of the difference ~~in sealevel~~ between the present and pleistocenic sealevel Gilbert estimates ~~him~~ it to „at least 500 feet, and probably 1000 feet or more" (p. 136) and the consecutive of processes, which were connected with this movement describes Gilbert as follows: „It is a noteworthy, and probably significant, fact that the oceanic base-level of the region, after resting for a long time at the height indicated by the low peneplain, dropped below ~~them~~ it at the ~~th~~ time of the excavation of the fiords and then returned to approximately the same position." (p. 184).

Besides the fact proved by G. Hillis, that is the filling of preglacial valleys ~~by~~ during glaciation, points Gilbert ~~the~~ and the ~~lac~~ missing absence of moraines deposits on oceanic shorelines as one of the most ~~dem~~ common features, by which the lower ~~bas~~ sealevel during the Maximum of glaciation is demonstrated (p. 165-167, 176).

The differences between my ~~view~~ views and the opinion of Gilbert, ~~in this matter is quite insignificant~~ which will be called the 4 remain remain. The remaining differences are limitated to few moments, which are both more or less hypothetical: ~~if~~ Gilbert is inclined to hold for first consider the ~~the~~ changes, which affect the relation ~~in sealevel~~ between the land and sea during Pleistocene to direct movements of the sealevel (p. 184/5, 185) I am on the contrary an adherent of the view of ~~for~~ differential ~~of~~ epigenetic movement of the land. For both opinions ~~are~~ given there are many indications, ~~they~~ 2 are both 3 also given by Gilbert, But the ~~question~~ solution of this question asks still much later study. The second difference exists in the ~~appreci~~ evaluation of the amount of movements. Gilbert accepts in this matter the limits, given by the studies of Hillis in Puget Sound and it is interesting. That I was ~~conducted~~ brought to the same limits by my more detailled consideration of the morphological features ~~in~~ of Glacier Bay. But convinced by the morphology of the inland passages, which show as many superficial patterns of glacial ~~ero~~ polishing and as little ~~proofs~~ indications for internal modification of the landscape (below the pleistocenic névé-line) I came to the conclusion, that the crustal movements ~~was~~ during Pleistocene ~~to~~ reached ~~such~~ a extent, ~~that~~ ~~all~~ which is indicated by the depth of the submerged valleys.

Quite different is the opinion of Gilbert in this matter: „(p. 136).

When we once agree, that by the climatic changes, ~~that~~ ~~by~~ which cause the descent of the snow line the shearmoraines will ~~be~~ not abolished but only deformed, ~~disappear all difference~~ ~~in the draw~~ or the heavier stone ~~of~~ foundation of the theory of overdeepening ~~is~~ has fallen. Done!

15/XI 14.

One of the most striking features in the view of the first wall of the Rocky Mts as they came insight from Morley was beside their slightly-and broad-folded cliffs of prodigious size, certainly the mighty forestbelt of these mountains. The contrast between the treeless prairie, that came with its salsalaceae formation close to the foot of the Front-Range and the appearence of the struggle for existence, evident by the single spruces that rose from the forest which accompanied the bottom of the wide Bow River Valley to the edge of the slopes of the valley on one side, and the luxuriant forest vegetation, already developed in Banff on the other was such a surprise for me, that I intended to pay very great attention to the phenomena of the timberline during my journey over the Cordillera and crossing the coastlands of British Columbia and Southeastern Aleska.

Assisted by the maps and charts of the traversed country, of which we had an abundance and the best choise, thanks to the very great care of our excellent guides, I executed my observations by means of a pocket-aneroid/Boucart, Paris/ and the "clisimetre double prisme" of Colonel Goulier/Balbreck Frs, Paris/.

The results of my observations attained by the crossing of the mountains are very simple, nevertheless of the highest interest. The timberline does not change on the full mountain-profile from the Front-Range between the Kananaskis and Bankhead on the one side to the Selkirks on the other side.

Timberline on the Sulphur-Mt. 2150m/7000′/, about the same height, as on Mt. Aylmore, in the country of L. Louise 2190 m /7170′/, Dogtooth Mts in the Purcell Rge near Golden 2100 m /6885′/, and, in the same range measured from Six-mile Creek 2250 m/7380′/, in the Selkirks the, timberline attains in SSE exposure on Mt Cheops 2240 m/7345′/, and, in the west-exposure on the slopes of Sir Donald 2120 m/6950′/.

The timberline is here thus everywhere very high, 5-600 m /15-1800′/ higher than in the Carpathians, which are situated 2 of latitude more south, and about as high, as in the Central-Alps, which are situated 4 more south. But the high ascent of the woods is not the only striking feature of the Cordillera.

The second interesting phenomenon is the lack of rising of the timberline against the backbone of the mountain-system,

hardly marked by a slight uplift of the timber in the high Selkirks,and also the relatively high ascent of the woods on the east front of the mountains ought to be accentuated,as shown by features on the Cascade,Rundel and Aylmore Mts.~~Strøn~~ Stranger is the descent of the timberline on the east slopes of the Selkirks,and on the Goldrange,on both sides of the principal trench of the Columbia.I noticed the descent of the woods on the mainline of Canadian-Pacific Railway/CPR/ by Revelstoke only in the important descent of the névé on Mt.Begbee but this indirect conclusion is ascertained by direct observation of the timberline on the slopes of the Arrow-Lakes,where as well as in the ranges bordering the Columbia River by Rossland,it stands – in spite of a difference of two degrees of latitude– at a height of 2100-2150 m/6900-7000′/.The rise of timberline in the Selkirks is in accord with the rise of it in the south part of Kootaney Lake/Stepple Mt/,where it attains 2250m /7300′/,and the insignificant fall on the east front on the mainline of CPR by Banf corresponds directly to the slight descent of timberline by Frank 2100-2150m = 69-7000′/ on the Crowsnest-Line.

These facts lead us to another interesting feature,characteristic of the Corilerean timber-belt,viz:the insignificant influence of latitude,consequently of temperature.Based upon a very simple calculation,we arrive at the conclusion,that a difference of two degrees of latitude corresponding to a difference in temperature of 1 **0** ought to cause a difference in the height of timberline equal to about 150-200 m/500-650′/,a difference not existing at all.

Finally I will made some remarks about this remarkable descent of the timberline to the wide Columbia-Trench and in the direct neighbourhood of the dry-belt of the Interior-Plateaux. This descent of timberline can be by no means connected with the features of the dry-belt,on the contrary the increasing dryness against the Interior-Plateaux must cause the rise of all belts of vegetation.The lowness of the Canadian part of the Interior Plateaux only hinders the development of these features as characteristic of the Interior Plateaux of the USA.The

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its deposits.[x]

x/Calhoun:The Montana Lake of the Keewatin Ice Sheet.Prof. Paper U.S.Geol.Surv.Nr.50.1906.

Bowmann le.p.412.

G.A.Young:Esquisse géologique et resources minérales du Canada.Publ.de la Comm.géol.Nr.1098.Ottawa.1906.p.158.

It is in all cases difficult to deny that the relations between the Labradorean and Keewatin moraines and the Rocky Mts glacial deposits are very similar to the low névé line in the Alaskan Piemont glaciers and the high névé line on it foreland.The question remains:are not the analogical features also the ffect of analogical dynamic processes?and I am tempted to answer this question affirmatively.

II.

With the discussion over the physiographical features of regions 6 and 7 I ventured closely to the problems connected with the complex and still more disputed question of glacial erosion.In the first part of my report,where I tried mostly from my own impressions and observations to deduce a physiographical classification of the countries I crossed,I confess to not being able to add anything to the impressions which I received during my jounney.,if my ideas are found,in some degree at least,valuable,they can only be developed by the Canadian geographers and geologists.In the problems concerning the glacial erosion I will in this paper also limit myself to general impressions and observations,but at the same time I reserve the right to come back to the same question after working on more detailled studies made in Glacier Bay,and after analytical cartographical researches,for which I have not yet collected the necessary material.[xx]

xx/In consequence of numerous occupations which were connected with my long abroad and especially by the arrangement of the new geographical Institute on the University of Lwów was the progress on my report very slow and the work on it was even many times interrupted.In meantime I made not only my se-

I.Bowman:The Forest Physiography of the U.S.New York 1911,p.206

descent of the woods on the west slopes of the Selkirks can be also treated as an effect of exposition only.But this effect seems to be in the American mountains still more complex,than in the mountains of Europe,and,of the many facts illustrating the effect of exposure on the glacier development and scattered throughout the excellent work of Bowman,I could not find a line leading to the connection between the climatic and morphologic relation on one side and the glacier development on different slopes on the other. On the contrary all my direct observa-

I.Bowman,lc.pp.161,267,353,368 etc.

tions over the upper limit of the forest growth guided me to the conviction,that the W and SW exposure caused a depression, the E,SE and NE exposure a rise of the timberbelts.In most of the observed cases I noticed a very distinct rise of the woods on the E slopes,than on those,exposed to the W,as for example on the Sulphur Mt,in the Selkirks by CPR station Glacier,finally on Stepple Mt in the region of Kootenay Lake,where I found the N slopes more favoured than the S.In one case,on Mt Turtle by Frank,where the woods rose on both,E and W slopes to the same height,the condition of the trees on the W slopes was found so miserable in comparison with that on the E slopes, that the above mentioned conclusion can not be varied at all.

The névé line in these mountains shows a strong parallel to the timberline.The névé line in this country was determined partly from maps/mean-height between the culmination of the glaciated area and the level,to which the glaciers descend/, but mostly by direct observation of the level,that separates the névé-snow from the glacier-ice.Unfortunately it was not easy to find this level from a certain distance on account of the fresh snow-patches,so that I was always inclined to observe and measure probably a somewhat higher level,than the one,corresponding to the real local conditions.

In this way I found the following values for the névé-line

in the Cordillera/51 N/from E to W:Lake Louise -Region 2550 m /8360′/,L.Emerauld-Region 2450 m/8030′/,in the Selkirks 2675 m /8770′/in the S exposure,3585 m /8475′/ in the N and W exposure,on the E slopes of the Mt Begbee in the Goldrange 2400 m /7870′/.When we add,that Mt Aylmore on the east front of the Cordillera is very distinctly glaciated,we come to the conclusion,that the distribution of the névé-line is here generally very uniform,only disturbed by a slight elevation in the Selkirk ranges and a slight depression near the drybelt of the Interior Plateaux.In spite of the fact,that the determination of the névé-level was not as sure,as that of the timberline,I can,however,by no means agree with the assertion of Penck,that the level of the névé rises continually from the Pacific to the east slopes of the Front Range,and that this rise amounts from the Selkirks to the Bow-Range,from 2250 m/7300′/ to 2750 m/9000′/.

Penck Albrecht:Reisebeobachtungen aus Canada.Wien.1898,p44.

Among other generalisations,based upon the distribution of the woods,I expect to find one,which is also confirmed by the facts of distribution of the névé:that is,that the very insignificance of the effect of the latitude on these features.The level of the névé on Kokane Mt situated 2 more south I estimated at 2500 m/8200′/,and the ////// glaciers of Bear Peak in the Cabinet Range,or of the Lewis Range in the western Montana in spite of 4 ////// difference in latitude probably refer to one névé-line,probably still more depressed than in the profile crossed by the mainline of CPR.

Bowman lc.pp 306,311.

Beyond the Columbia River across the mainline of CPR the Interior Plateaux,that are in the eastern part of the Shushwap and Adams Lakes Basins are low enough to be strongly forested to the top of the long and flat ridges,while in the western part in the basin of the Fraser River they are dry enough to remain far below the here potentially very high timberline,

and stoll more below the névé-line.

From Spencer Bridge and especially down the junction of the Thompson with the Fraser Valley the humidity increases very rapidly and parallel to them the forest-cover descends to the valtey bottom and a luxuriant vegetation takes the place of the absolute scarcity that was for a long time the only dominant feature.Though my opportunity for observation was in this part of the journey quite limited,ther can be no question,that the thesis of Penck,namely a very distinct descent of both limits,that of the woods and that of the névé towards the west comes here into full power.The descent of the névé-line,the rapid growth of the conditions of glacier developement was here especially apparent.The glaciers which had been missing for long time — now glancing here and there down Lytton and the descent of long,though narrow glacier-tongues deep in the tangled virgin forest by Agassiz — testified to the thesis of Penck better,than any measurements.Some more exact observations I made from Vancouver on the Lions of the Coast Range and from the Strait of Georgia on the mountain group of Arrowsmith 1825 m/5976/.At the first point I estimated the timberline at 1850 m /6050'/,the névé-line at 2050 m/6720'/,at the second,pushed toward W not quite 2 of longitude the timberline descended at 1600 m/5200'/, the névé to about 1725 m/5650'/.

In a summary we can distinguish in the Corillera near the international boundary three longitudinal belts:1.The Interior, between the Columbia and the Fraser R.without névé or upper timberline,2.the Eastern side of Rocky Mts with a very high and uniform limit of the snow and the trees,3.the Western side of the Coast Rges with a low limit.

Besides these differences both mountain-belts have one common quality — a very important one in physiographic and anthropogeographic relation — that is the almost complete lack of an intermediate zone of alpine pasture.This defect,which is to these mountains especially peculiar,is but natural when the difference of the level of the woods and névé attains in the Coast Ranges 150-200 m/500-650'/ only,and in the eastern mountain-belt rises to 250-400 m/1000-1350'/,an amount which is somewhat exagerated probably by a too high estimation of the névé-line.In both cases

the intermediate zone is too narrow for a developement of pas-
ture grounds,which are characteristic of other mountains.It
must namely be remembered,that this intermediate zone is deeply
sinuous and often broken by frequent avalanches,cliff-glacier
regenerations and finally by glacier tongues.But besides these
local conditions we must take into account another general one,
that makes this insignificant intermediate strip still narrower
and for pasture developement for that reason quite useless.I have
in mind the glacier oscillations,and consequently the wandering
of névé-line.After my own observations on the Illecillewaet
Gl.the retreat of this glacier in the last few years is very
slow,that is about 350 m /1145′/ for the period of 1887-1913
/ 14 m = 44′yearly/ in longitudinal sense,corresponding to one
vertical rise of the glacier-end in the same time of 60m/197′/.
Besides these short and insignificant oscillations there are
here likevise very distinct tracks of an ancient and much more
pronounced glacier advance.I distinguished namely during my
short visit to this glacier-end five parallel morainic walls,
the fifth close above the junction of the glacier stream with
the Asulkan Brook,the fourth just above the first bridge.Between
these two lower walls the old secular forest disappear,a chrono-
logic sign of the time of the last mighty advance of the Illeci-
llewaet Glacier.Apart from the question,if this advance of Ille-
cillewaet Gl.was not contemporaneous with the much more pronoun-
ced glacier invasion in Alaska,recognized by Vancouver,we must
be satisfied with the certainty,that the Illecillewaet Gl. is
subdued to the secular oscillations,attaining about 2000m in a
horizontal,and 180 m/600′/ in a vertical direction.This glacier
movement corresponds with a descent of névé-line of about 100 m
/over 300′/and consequently with a complet abolition of the in-
termediate zone.

The lack of the alpine pasture grounds is in the Cordillera
near the interaational boundary ,not only a very striking fea-
ture but also a very general one.The knowledge of this fact in-
deed has no explanation.This much more complex question is a fea-
ture perhaps in some relation with another peculiar one of the
upper forest belt,not only of the part of the Cordillera common,
which we crossed,but also in the same degree of all the Pacific-

Coast Islands.It is the lack of one bush-zone in the upper regions of the forest formation.There is,especially in the Pacific-Coast Islands where the timberlines are low,a very strange apparition: lofty trees,that project their branches storm-and weather- beaten directly against the neighbouring snowfields or against the sky. A real upper bush-zone I found on the White-Pass only,it was there very distinct and well developped on the south slopes of the mountains above the timberline from 730 m to to about 900 m/2400-3000'/.But also this single case of bush-zone had some /!!!/ qualities that were able to prvide it with a note of interrogation.It appeared to me that this bush-zone is composed of the same species of cripppled trees/a kind of spruce and tsuga/that grow not only below 730 m as a high growing tree on the south slopes,but also above 900 m in the north drained interior of the Yukon-Basin.It is on the other hand true,that a similar climatic degeneration of the tree-growth is also found elsewhere,for example the Pinus Banksiana on the Sulphur Mt,but there it nowhere reaches a close growth of these crippled trees in a separate zone,they are only in the higher regions,scattered between the high grown specimens,those reaching in a more or less unchanged condition to the timberline itself.From this point of view the upper belt of bush on the south slopes of the White Pass is a special case,that can,on the other hand,in no way weaken the characteristic rule for the whole traversed country:lack of the alpine bush zone.

Some misunderstandings could be found in the aspects of the mountains bordering the slopes of the Glacier Bay,Yakutat Bay and many other more restricted places,not long ago covered by snow or ice.Especially some hills of the Yakutat-Bay region,thickly covered with alder-and willow-bush from the sealevel to a height of about 500 m/1640'/ could very easy give rise to the opinion,that this region is situated outside of of the region of the trees and belongs already to the polar bush-region.It is not so.The alder and willow bush present for this total area,as well in the Cordilleran,as in the Pacific region an early stage of vegetation,that covers at first all bar rocks and slopes,rockslides,tracks of avalanches,finnally it follows in the track of a retreating glacier.Thus and in no other way ought the strong

and wide distribution of the bush formation in Glacier and Yakutat Bay especially to be treated.X

The vertical distribution of the timber- and névé-line along the North-Pacific-Coast is more complex than across the Cordillera and suggests also many more problems. In our route on the Pacific Coast one can easily distinguish two different parts in physiographic relations, the one kept in the well closed interior channels from Vancouver to Skagway/"inland passages"/, the second in those from Juneau to Yakutat Bay and conductet us through the wide Icy-Strait to the open oceanic coast. The firs was rather a continental route only once interrupted by direct oceanic blast in the Dixon Entrance, while in the part Skagway-White Pass-Yukon a special opportunity was given for acquaintance with the pure continental relations to the timber and névé-line. On the route Juneau-Glacier and Yakutat-Bay was found a control/ for the oceanic influences, whereas the visit of the interior fiords of the two above named Bays allowed some glimpses into the modifications of the oceanic influences with the removal from the open oceanic shores.

X It is possible that the defect of the alpine bush zone is in some degree connedted with another fact, that is with a certain selection of species of trees for several hypsometrie belts. To this opinion I was led by reading the studies of S. Brown, Alpine Flora of the Canadian Rocky Mts. New York 1907, and still more the study of H.B. Ayres, Washington Forest Reserve in the 19th Ann Rep. U.S. Geol S. 1897/98. But this question belongs purely to the floristic problems and cannot be taken by me in discussion.

After these remarks I shall give my observations in a short review

	1. Mt Arrowsmith 49	2. L. Nimpkish 50 1/2	3. Granville Ch. 53 1/2	4. Pr. Rupert 54 1/3
Latitude				
Timber-line	1600 m	1400 m	650 m	800 m
Névé-line	1725	1500	—	—

	5 Granby Bay	6 Gravina I.	7 Cleveland Pen.	8 Etolin I.	9 Mitkow I
Latitude	55 1/2	55 1/3	55 1/2	56	56 1/2
Timber-line	550 m	550 m	550 m	550 m	550 m
Névé-line	850 m	—	—	650	—.

	10 S.entrance to Stephens P. Admiralty Island West Shore	11 East Shore	12 Entrance to Taku Inlet	13 Douglas	14 Entrance to Lynn Canal West	15 East
Latitude	57 1/3	57 1/3	58 1/4	58 1/4		58 1/3
Timber-line	—	—	—	700m	720m	800m
Névé-line	550	750	850	—	—	—

	16 Lynn C.	17 Skagway	18 White P.	19 Log Cabin	20 E.entr.to Iey Str North Shore	21 South
Latitude	59	59 1/2	59 2/3	59 3/4	58	58 1/4
Timberline	620 m	650 m	730 m	1000 m	750 m	800m
Névé-line	—	850	—	—	—	900

	22 Coast Mts n.Piemont Gl.	23 Coast Mts b.Mt Fastiest	24 Entrance to Disenchantment B.
Latitude	58 3/4	59 1/4	59 5/6
Timberline	700 m	—	—
Névé-line	o.1000	850	700

This short review of my observations gives in detail a very complex picture of the problem treated here. At firs it is very difficult to find some natural order in the succession of these levels, and it would not be surprising if the exactness of my observations were suspected. I must confess, that some doubts grew ever in me, when after putting my observations on the map the strange character of them and their conclusions came to be rightly seen. For that reason I was very satisfied to find in the Guide-Book for the excursions of the Intern. Congr. some exact remarks, supporting the principal conclusions of my observations — the very low timberline on the Pacific Coast-Isl.[x] on one side, and the proportionally very high rise of them towards the interior of Yukonland[xx] on the other. Whereas I confess

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x Viz. the paper of F.E. Wright in Guide-Book Nr 10, p.42

xx Viz. the paper of D.D. Cairness in Guide-Book Nr 10, p.61.

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my doubts and at the same time also my satisfaction at the control, found in the Guidebook, written by the first authorities

and after the most recent researches I must likewise accent, that a great part of my observations is executed very carefully and that I have full confidence in them.

For the novelty of these views of Wright and Cairness compare the views on the question in such an excellent book as Bowmann, Forestphysiography, p.148.

Now some conclusions.

The timberline descends on the Pacific Coast very rapidly with the increasing latitude. This descent amounts on Vancouver Island 133 m /435′/ per 1, from Vancouver to Granville Ch, 250 m /820′/, from there to Granby Bay 100 m /330′/, and in the section from Granby Bay to Mitkow Isl. 50 m /164′/ only. The low position of the névé-line in Stephens Passage authorizes the supposition, that the timberline is there also very low. But in the Taku Inlet and on Douglas Isl. and on both sides of the entrance to Lynn Canal and in the Mansfield Penninsula the timberline is proportionally high, its rise in the parts of the fiords, situated between 56 1/2 and 58 1/3 amounts to 137 m /450′/ per 1 of latitude. This rise is slowly interrupted towards the interior of this fiord, until its head at Skagway. But from Skagway, where the level of the timberline was very exactly determined at 650 m /2130′/ it rises again on the south slopes of the White Pass at therate of 280 m /925′/ per 1, and from that point to the first northern exposed slopes of ~~the White Pass~~ Yukonland at Log Cabin it jumps about 300 m/1000′/ for a very short distance of ca 15 km /9 miles/. This very high timberline remains not only at the same level for many degrees of latitude towards north, it rises on the border of the Yukon still more, and I remember the impression, that gave me one photo of a hill country in the Porcupine Basin, situated between 67-68 N with a high grown spruce-forest at a height of 2-3000′. The photo was taken by one of the members of Dr Cairness Alaska Expedition of U.S.Geol.Surv.

Summarizing the results of this discussion we can set up some rules about the distribution of the timberline on the "inland passages" of the American Westcoasts. In this whole district the timberline is extremly low, but we can generally distinguish

two short marginal parts and a long,central part.The south margin embraces the part of the passage protected towards the west by the Vancouver Island.The timberline,though here also low,is,in proportion to the neighbouring part of the passage, high,but the transition between the two parts seems to be to rapidly accomplished,that already on the north points of the Vancouver Island the timberlin is certainly about 1000 m/3280'/ lower than on the east slopes of the Rocky Mts in the same latitude.The north margin embraces the transition between the headlands of Lynn Canal and Yukonland,a powerful rise of the woods is the characteristic of this part.The timberline on 60 N is here 1000 m higherthan on the Atlantic coasts,that are even 8 of latitude further south/ completely treeless.In the principal part of the "inland passages" the timberline is extremly low and completely independent of the latitude, but not uniform.There are namely two places,one at Prince Rupert and the second in the axis of Icy Stait,where the timberline rises quite unusually.

The high timberline about the passages connected with the Icy Strait does not change on the oceanic outlet of this Strait. Even on the open oceanic shores,on the hilly foreland of the Piemont Glacier the timberline was determined at a height of at least 700m,and above it was observed a very well and regularly developed shrubbery-belt,that reached to the névé-line, which was in some places elavated to above 1000 m. Towards north-west of this point the timberbelt shrinks very rapidly,its place is taken more and more by a bush-vegetation that in the interior of the strongly glaciated Russell Fiord entierly obtain the mastery.As above stated this bush-zone can only be treated as a first stage of vegetation on the barren grounds,or as a truly representative form of the forest,We have also in Yakutat Bay and in Glacier Bay too a migrating form of the forest,we can consequently suppose,that not only the bush-form,but also the forest form had here attained its climatic upper limit and for that reason we must not consider either the bush or timberlines as a right physiographic control for this region but the névé-lines.

In these extremly glaciated fiords of Glacier and Yakutat Bay we are surprised by an extraordinary feature which is peculiar to it met the first time in our journey.This is a very pronounced rise of névélines towards the centres of glaciation of Fairweather and St Elias Mts.This rise of névélines is the more strange,in that it cannot be connected with the inclination of all climatic and physiographic horizons towards the centre of mountains known elsewhere f.ex.in the Alps,and this for several reason:first the rise is here brought about at a very short distance and in direct touch with the ocean and its influence,secondly,this rise is much higher than one can expect for the névé-lines of the central area of glaciation. A little set of facts ought to serve as an illustration and also in support of the above named conclusions.

The névé-line of the central area of glaciation in Glacier Bay can be determined with sufficient exactness by the levels, at which the lateral moraines come in sight,These levels as well as the superficial moraines are with special care given on the Chart No 8306 of U.S.Geod.a.Hydr.Survey.This level on the Casement,Muir,Carroll,Gd Pacific and J.Hopkins Glaciers is elevated at a mean height of 2610′/785 m/,then some 100 m/300′/ or more depressed in comparison with the névé-lines in the east part of Icy Strait and in the neighbouring passages.But on the mountains bordering the part of Glacier Bay which is now free from glaciers the névé-line is much more elevated.It is sufficient to say,that all the lateral valleys,which drain the mountain masses,rising 320-3800′/975-1160 m/ indicate no sign of local glaciation.The rise of the névé-line in a narrow belt between the oceanic shores on one side,and the central piemont glaciers on the other,attainig an amount of about 200 m /650′/ seems to be proved for the Glacier Bay region.

Analogical relations of the névé-line I found in the Yakutat Bay and its inner fiords.Though the lack of sufficiently detailed maps for this region do not allow the height of the névé-line on the central area of glaciation to be appreciated,yet the rise of névélines towards the huge icefield of the Hubbard,Nunatak and Hidden glaciers is easy easy to be rekognized

at first and primarily by a 1 m /3'/deep gravelbed and secondly overlaid by a mighty soilcover which had crept down from the slope.These features of an extraordinary rock-weathering I noticed on all the route over the White Pass,and it is tentative for me to explain this extreme elavation of the woods in the interior of Yukonland by excellent soilconditions,that give here a recompense for the scarcity of rain,even in the higher /3-4000/ levels of the timberline.

That dryness of the Yukon-Climate,which by good conditions of soil,a warm summer and a high grade of insolation does not prevent the growth of the forest to a Maximum height,will be lessened with the rising elavation in the Rocky Mts.But the same effect on the woods,which in Yukon produces temperature and insolation produces in the Rockies a precipitation increasing with the elevation.This rise of precipitation must be in the higher levels of the Rockies quite considerable,when the Maximum elevation of the woods is there coincident with a relative low descent to a normal height of the névés.

Finally there must also be persumed for the Rockies one more peculiar feature,a relative feebleness of the dominant winds,especially of the descending winds/Föhn,Chinook/.To this supposition I was led by the following consideration.All the experiences hitherto made proved to me,that the strong winds are the most destructive element of the forest on the timberline,a high ascent of it in the Rockies only can be imagined by excluding strong winds.Another experience shows that the strongest devastation of forest is effected by the falling winds, and when the depressions traverse the American plains from W to // E then the falling winds in the eastern part of the Cordillera/Rocky Mts belt/must come from a westerly direction.In the descriptive part of this paper it was stated that the timberline on the ridges /p/ of the Rocky Mts rises higher on its eastern,than on its western slopes,it proves that the direct oceanic winds have here/ a greater strenght,than the down deflected falling winds as the Chinook.To the same conclusion we come after consideration of the well-known fact of a wide dis-

tribution of the Chinook.This wind that blows over the whole belt of the plains,and reaches in the eastern direction generally to Medicina Hat and according to some notices x/ on higher latitudes much further,to Lake Isle a la Crosse or to Great Bear Lake,in every case 300-600 km/"_370 miles/ distance from the mountains,can be by no means compared directly with the alpine Föhn,a local athmospheric avalanche,that on account of its territorial limitation increases to a formidable strength.

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x/ W.L.Griffith/Secr.to the office of the High Commissioner of Canada/Dominion of Canada.Toronto 1911.Viz p.103.In the same work besides very interestinf information some erroneous ideas over "Chinook"/p.102/.

My own impression of a Chinook that I experienced on the 26th and 27th IX 1913 at Frank and which caused a stiffling heat as far as Calgary is in complete accord with the above theoretical deduction.This wind blew over a great area,it was at the same time perceived at the mainline of C.P.R. and on the Crowsnest Line and was in very regular waves,quite different from the waves of a typical Alpine or Carpatian Föhn,which interrupt and rise in irregular rythm.Far from a tendency of deciding on the question of the Chinook from my single impression,or even from the consequences of the geographical distribution of this kind of wind,I will especially accent the fact of a slow depression of the woods over the western slopes of all the crests of the Rockies in general,and over the western border of this mountain-belt paricularly.On this feature as well as on the first-mentioned high ascent of the woods in the Rockies,I will base the thesis,that besides several climatic opportunities,the winds do not attain there a notable strength, and that the same are weaker on the eastern,than on the western slopes.

West of the Rockies the mountains are too low or too dry, and for that reason they remain below the timberline.But in the regions of the Coast Ranges,classed 3 and 4,the humidity necessary for vegetation processes is in abundance,and the oceanic winds are certainly very or even too strong,but the relative

high and uniform temperature joined to the above named climatic qualities causes a luxuriant growth of virgin forests, the timberline as a mixed result of both useful and noxious influences rises here to a normal height, the névé-line descends on the contrary far below the average in its relation to latitude. When the snow does not descend in this belt lower than to an extreme Minimum it can be explained by the high and uniform temperature, that is not favourable to precipitation in snow-form.

The extreme favourable conditions for snow accumulation on the contrary seem to be met in region 5 of the "inland passages". The partial exclusion of the oceanic influences must at first lower the average and especially the winter temperature, parallel to them the snow-rate increases, attaining an amount nowhere surpassed in the northern Hemisphere. Another feature comes here into account, favouring the development of a roughness of this country. It belongs in athmospheric relation to the Pacific centre of depression, which/ a consequence of the outflow of the air, which is here generally directed westwards, but the morfologic contrast between the uplifted highlands and the narrow and partially-obstructed fiord-channels creat a disturbance of the athmospheric equilibrium, which can not always be restored by normal atmospheric circulation, but mostly by violent falling winds. These winds, the north eastern gales of this country, though also here called "Chinook"[xx/], must have a quite different character, only comparable to the "Bora" or "Mistral" of the Mediterrenean region. The excellent condition for snowfall

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xx/After local information, taken in Juneau. As this paper was already written I found more information iin this matter, especially in the Report of Alaska Railroad Commission, House of Repr. Docum. Nr1346, p30, A.C. Spencer gives for this kind of winds the local name "woolie". Viz U.S. Geol Surv. Bul. Nr. 287, p.7.

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with the development of the winds of a bora-type are sufficient to effect the two peculiarities of this region, viz: a Maximum of descent of the névés and also the woods.

Where instead of narrow channels there are wide straits connecting the mainland with the ocean,as in the axes of the Dixon Entrance or Icy Strait,there is probably caused the restoration of a atmospheric disturbance in a much gentler way, which excludes the installation of falling winds,and on the other hand the wide straits facilitate the penetration of oceanic influences,which lowers the snow-contingent.The higher ascent of the woods and névés on the island of Vancouver,I/ though separated from the mainland also only by very narrow straits,can probably be explained,firs by the uniform mass of this island,that by itself hinders the westward course of atmospheric movement,secondly by its southern situation,so that it is brought nearer to the Pacific centre of barometric high pressure,and the anticyclonal movement of the air,which depends on it.

Now we come to the most interesting relations,found in region 6,the Alaskan icefields,and 7,their borderland.The strangest complication in these relations depends upon the facts, that the névélines ascending normally towards the centres of glaciation,really attain here the lowest value in the centre,and,in the borderbelt nearest the centre,a relative very high value.The central descent,exactly evaluated for the tidal glaciers of Glacier Bay,with an approximation stated for the tidal-glaciers of Russell-Fiord,attains probably very different values.But after my own impressions,which I got during my weeks stay at Glacier Bay,and after studies of the two excellent works of Tarr and Martin,x/ as well as of Gilbert xx/,

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I/Tarr R.S. and L.Martin:The Earthquakes at Yakutat Bay,Alaska,in Sept.1899.U.S.Geol.Surv.Prof.Pap.No.69.1912.

xx/Gilbert:Glaciers and Glaciation.Harrimah Alaska Exp.Vol.III. New York .1904.

I came to the conviction,that the névélines in these areas are not fixed by the climatic causes only.The most important foundation for this opinion is shown in the very complex system of glaciers oscillations in South Alaska,of which the most

impressive and analytic picture is certainly given by Gilbert.x/

x/Gilbert,lc.p.102-6.

How or where one can look for a climatic way of explanation for a short time glacier/s oscillation,that attained changes of 100 km/60 miles/in a longitudinal profile and in a time of Maximum doubled the area in the ~~G~~/~~l~~~~a~~~~c~~~~i~~~~e~~~~r~~/~~B~~~~a~~~~y~~/~ Glacierbay-district now covered by ice and snowfields?After a very simple consideration we must arrive at the conviction,that the middle elevation of the glacier area of Glacier Bay was,at the time of Vancouver/1794/,several hundred meters lower than now/~~a~~~~n~~~~d~~/~~t~~~~h~~~~i~~~~s~~/. ~~n~~~~o~~~~w~~/ For right appreciation of this fact it ought to be ~~s~~~~t~~~~i~~~~l~~~~l~~ remembred,that the mean elevation of a glacier area is after the studies of Kurowski x/ equal to its ~~n~~~~o~~~~w~~/ level of the névé.

x/Kurowski:Die Höhe der Schneegrenze,Geogr.Abhandl.hrg.von A.Penck.Wien.1891.Bd V.

The retreat of the Muirglacier since ~~M~~~~a~~~~n~~~~y~~~~ _~~~~ Vancouvers time means consequently a rise of the névé-line in this region for several hundred meters,corresponding to a climatic change, which in such a short period and at a similar rate have nowhere been more perceived.But these mighty oscillations,certainly without parallel in the recordsof glacial changes are,as a physiographical anomaly,still surpassed by another peculiarity, common to this territory, I mean a complete lack of harmony in these glacier oscillations,~~i~~~~n~~/which must exist after a systematic geographical arrangement,if the climatoe theory of these glacial changes can be maintained.But the geographical arrangement of the known changes demonstrates such ~~a~~ opposite extremes,that,although full of admiration for the ingenious suggestions made by Gilbert XX/ in reference to the climatic explanation of the Alaskan phenomena,I can not them follow.It is not only that the amount of change that is without any agreement on tthe nearest glaciers,but,which is excluded from the standpoint of climatic theories,the extreme retreat on theeastern slopes of the Fairweather region is accompanied by a simultaneous extreme advance on its opposite slopes.Analogous phenomena

have been already demonstrated in this territory by the older and more recent studies of Dall, Wright, Russell, Reid, Gilbert, Tarr and Martin[x] in abundance, but of the

x/For the detailled literature see Guide Book Nr 10

life-conditions of Alaskan glaciers during the last few centuries, shown by the study of G. Davidson[xx] give so chaotic a pic-

xx/G. Davidson: The glaciers of Alaska. San Francisco 1909.

ture, that, I think, after this revelation a climatic explanation of these phenomena can be no more supported.

In the violent earthquake of September 1899, which shook southern Alaska, was found a new mighty factor, to which one could ascribe a new type of glacier changes with a most interesting peculiarity, a lack of simultaneousness.[xxx] Gilbert has already expressed a similar idea, Tarr[X] has developed it to a complete theory, Tarr himself and L. Martin[XX] have been working at the verification of this problem. In my opinion the more the ma-

xxx/Gilbert lc. p. 23 ff.

X/Tarr and Butler: The Yakutat Bay Region, Alaska. US. Geol. Surv. Prof. Pap. Nr. 64. 1909.

XX/Tarr and Martin: The Earthquakes at Yakutat Bay, Alaska. U.S. Geol. Surv. Prof. Pap. Nr. 69. 1912.

terials, that are collected for comparison, the more complicated seems to be the problem of the glacier changes caused by earthquakes. At all events the fact of advance of Taku, Childs, Miles and Valdez Glaciers, supposed to have been caused by the earthquake of Sept. 1899 is not to be connected with the uninterrupted retreat of the most part of the tidal glaciers in Glacier Bay. The lack of influence of the earthquake of 1899 on the icefields of Glacier Bay is an important proof against an excessive use of the earthquake-theory of glacier oscillations.

Whether this relation after pursuing studies will be solved in one or another direction, the problem of this kind of glacier

oscillations is of no importance from my point of view. Earthquake shocks can cause avalanches in the névés or in the tidal cliffs and this disturbance of the balance in the glacial live is followed by glacial "floods", but all these spasmodic movements can either be of important influence over the periodic changes, produced by normal climatic causes, or the greater secular glacier movements observed in Alaska can not be made responsible for the little short periodic floods accompanying the earthquakes.

Taking all these strange features peculiar to the Alaskan glaciation into consideration, one idea rushed into my mind for which authority is wanting, as no explanation whatever of the present features of Alaskan glaciation has up to now been found. My idea rests on the simple supposition that the great glaciers of Alaska are as well as the bigger ones on arctic or antarctic icesheets only remnants of the Maximum probably of the Pleistocene glaciation. The source of such a glacier, or rather the strength, to which the conservation of these glaciers is due must at first be looked for in the low of inertion. Such icefields, especially the southernmost-pushed glaciers of Alaska are evidently to a certain degree an anachronistic feature in relation to climatic conditions of their environment, they are a kind of huge dead glacier, that, although they exist in some correspondance to the meteorologic changes and oscillations, yet their general tendency is to be diminished and slowly disappear. This kind of dying glaciers that are remnants of past climatic conditions I imagine, can submit oscillations, that are in discord with the comparatively small present meteorological changes. From the fact of the immense retreat of the Muir Glacier for 38 km in a period of 86 years at most, but probably in a very much shorter time, and from considering the low of inertion, we can, with some probability, suppose, that the preciding advance of the glacier was of the same, but probably of a more violent character. During my stay in Glacier Bay I observed on the Cushing Glacier, that the general retreat overhelmed there even the névéfields, which were situated higher. This névé has two flats, separated by a very steep slope over which a short

time before part of Cushing Glacier fell in cascade to the Caroll Glacier. This part has now completly disappeard and from the information of L. Martin it has gone since his last visit to Glacier Bay in 1911. Such a change can not be without consequences, which can even be of very great importance. One consequence is quite certain, viz the increasing rate of retreat of the Caroll Gl., thanks one part of its source of nourishment being cut off. But I suppose, another result is also greatly possible. This flattened part of the snowfield, or another one in an analogical situation, belongs morphologically to the level of "high peneplain" Gilbert x/. As this level is in want of a distinct sloping direction, I ask if it is not possible, that a greater or lesser part of these snowmasses cut off from on glacier organism, can be discharged in a normal way, or even by a slide, or another spasmodic movement, to a second glacier, on the opposite slope of the highlands?

I think, it is quite needless to glance at other possibilities of a similar kind, that could explain the anomalies of the Alaskan glacier oscillations. In view of these suppositions the spasmodic movements, connected with the earthquakes receive another interpretation. I will only give by a single example, which is supplied by Cushing Glacier. Such a glacier, when surprised by an earthquake can never, by being cut off from its upper snowfields make an advancing movement, but the same glacier, when tidal, being affected by shocks, will begin a rapid retreat.

Finally a short summary of facts, that awakened the above developed idea in me. 1. I consider the exceptional changes of the Muir Glacier and its fellows as a fact of the highest importance for which all the climatic theories used seem to be very insufficient. 2. In spite of the very complex system of recorded Alaskan glacier changes for the last century one common feature can still be discoverdd. The numerous glaciers namely those of Glacier Bay, of Yakutat Bay, of Port Wells and finally the Grewingh Glacier, in one word, the most important Alaskan glaciers were preceded more or less, but without any exception, by a greater state, a Maximum, which may have occured fifty a

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x/ Gilbert, le p. 123-30.

hundred or more years ago. This great number of glaciers offers no opposition to the idea, that the whole glaciation of Alaska is in a state of irregular but general retreat. One glacier, namely the Columbia seems not to have been touched by the general reduction within the last hundred years and one group of glaciers, the Brady and its fellows, shows traces of an important advance; the same thing was also perceived on a part of the Malaspina. We thus see, that excluding the criterion of time, which is the most important controlling feature for oscillations caused by climate, we do not find so much disagreement in the peculiarities of glacial changes in Alaska. But that which exists will be still more reduced, if we look for a systematic geographical arrangement of these two types of oscillation. Such an arrangement from a climatic point of view could, as is well known, not be found. From the point of view of my idea we must look for a morphological arrangement, and it seems to me, that such exists. All the more or less retreating glacier-systems have many tidal tongues, and a wide waterfront; all glaciers of another smaller group have on the contrary no tidal tongues at all, and touch the waterfront in very short lines.

To this arrangement, that influenced all my thoughts in the question of the Alaskan glaciers so considerable, I was lead by Gilbert's excellent deduction about the wasting power, that seawater has on tidal glaciers. x/ The connection seems to be

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x/Gilbert l.c. p.163-68. See also Reid: Studies of Muir Glacier, Alaska. Nat. Geogr. Magazine. 1892. p.49.

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clear. All the Alaskan glaciers belonging to the first type are not powerful enough to offer any opposition to the wasting strength of the salt and moving seawater; in case of violent internal changes, producing striking advance of such a glacier, its rapid progress is followed by a retreat as rapid. The relation takes another form in the case when a glacier of the second type ends on a rockbed or on its own wasteplains. Everybody, that has had the opportunity of observing dead glacier trunks cut off from the living icebody, has been surprised by their resistence to the athmospheric wasting-agences and must agree with

the opinion of Gilbert,that it is "ten times exceeded" by the melting by the sea.Under those circumstances it can be understood,that a glacier ending in a waste plain,protected by an ablation moraine,can preserve its advances caused by spasmodic episodes far longer.

3.The last fact,that can be called in support of the discussed idea is the condition of the vegetation upon the glaciated territory.According to the opinion of Reid the question of vegetation is not so simple,The well known fact of a secular forest,that grew some two hundred years ago before Vancouver's time in place of the subsequent powerful advance of the Muir Glacier and its last retreat,was interpreted by Reid as a climatic consequence.Reid[x/] says expressly,that the period before Vancouver was milder,than the climate of the present day, and I have also found allusions that show that he makes the present day climate at least partially responsible for the barren aspect of this country.It is certainly clear,that looking over all these huge glacier changes from a climatic theory one must look only in the same direction for explanation of the buried forests from the time,preceding Vancouvers Observations.The supposed elevation during the short period,attaining, according to Reid's observations,about 100',although taken even into account in explanation of the changes ,found in Muir glacier,could not be compared in importance to the climatic influences.This was also thepoint of view of Gilbert.[xx/] This author

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xx/Gilbert,lc.p.109.

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gives many very convincing observations,proving that the bareness of the country,which has been recently abandoned by glaciers is due not to the present conditions of the climate,but is in relation to the lack of soil.I can add to the observations of Gilbert some other important ones.The distribution noy only of the forests,but also of the shrubbery in the outerpart of Glacier Bay,and even of single trees or bushes on the mainland and islands in the innerpart of the Bay everywhere follows the same plan,namely,they always have a lower limit besides their upper limit,and the latter is,without exception,inclined towards

the outlet of the bay.There can be no doubt,that the lower limit of the forests or the shrubbery represents the upper limit of ice of the glacier tongue in Vancouver's time.

The distribution of the present forests shows however another interesting relation to the ancient buried forest observed by Vancouver.Until now one has only seen the stumps of the buried forest in a low position,but during my stay last summer at Glacier Bay with L.Martin we observed stumps,scattered in different heights on the nunatak I and H,at an elevation,attaining at lest 6-800'/2-250m/.It is also evident that in the forest period of Glacier Bay the climatic condition were as favourable for the growth of the forest,as they were then limited not only to low positions,but could rise to a relatively significant height.Supported by the analogy of the present distribution of the forest on the morainic ridges of glaciers ending in waste plains,we are tempted to suppose,that the old forest of Beardslee Islands or of Bartellets Cove,that is on the wasting products of the Muir Glacier from Vancouver's time,are contemporaneous of the forest which is in the meantime buried by the last glacier extension in the Glacier Bay territory.But as well as the forest of the Beardslee Islands there can be forests coeval with the buried forest,there can be the same high grown trees, covering the top of the mainland close to Willoughby Island, but separated below from a barren zone,deprived of its soil by the last extension of glacier.We arrive in this way to one conception,that over all the area of Glacier Bay forests have grown uninterruptedly from the time,when the "buried forest" existed to the present day.The thick stumps,found in the heights of the nunataks as well as the high grown forests on the culmination north of Berg Inlet are probably witnesses of the mild climate which remained for many centuries in this country.

Of one part of thsi deductive developed theory,concerning the mildness and stability of the climate of the Alaskan glacier territory one exact proof was found during my stay with L.Martin at Glacier Bay.On Sebree Island we cut one spruce/Picea Sitchensis/to get a glimpse at the conditions of vegetation on this rocky knob,situated on the outer border of Muir Inlet, which in any case belonged to the inner part of Glacier Bay

temerature and the reduction of the air humidity over them, and consequently must cause a abnormal rise of the nvé-lines.

The conditions of glaciation in the 6th and 7th regions, stated by me, suggest some interesting relations, proper to the Ice-Age. The first, concerning the relation of vegetation on the front of the continental icesheet, has been already discussed above, and leads to the conviction, that there could be both very hard and also very good conditions for tree growth; it follows therefore, that a forestvegetation can accompany the tundra-vegetation on the south border of continental glaciation.

The above suggestions are followed by a still more interesting features, ~~seem to follow fromthe above considered~~ namely the influence of the Piemont-glacier over its borderland. Is this relation not comparable with the relation existing between the continental icesheet and the glaciation of the Rocky Mts in America or in the middle and alpine glaciers in Europe?

Especially in Europe the extension of local glaciers in the Polish and German mountains was for a long time considered as a feature strictly connected with the Maximum of the continental glaciation, and then taken for an contemporaneous accident; only recently some indications have been distinguished which bear witness to a probably independent developement of both centres of glaciation, the great boreal and the numerous smaller local centres of European mountains.

In America the conditions for studying these ~~conditions~~ relations were more favourable, the direct contact of the continental deposits of icesheets with the glacial system of Rocky Mts let in much light on the recognition of these relations. Although there are still in this question many open problems one fact is now clear: the Maximum of developement of different icesheets was in North America not contemporaneous; it is now no doubts more, that the mountain glaciers in the Rockies attained it Maximum at first, that they retreated already to a stage of eirque glaciers, when the icesheet of the Keewatin centre invaded the local drift of the mountain glaciers, and that after the retreat of the Keewatin advanced the Labradorean icesheet and covered the Keewatin drift with

ging valleys,and the coast forms and fiords he explains by submergence of the country.In his further report,Clapp saw not only continually more work,due to glacial action,especially the cirque-formations in the country of Mt.Arrowsmith,but also he

x/Summary Rep of the G.S.Branch Ottawa.1910,pp.86.

slowly changed his views in favour of the theory of a powerful glacial erosion.Especially in his report of this field-work,executed in 1916,Clapp xx/ writes: "The topography was greatly modified during the glacial period,the monadnocklike hills were rounded, the valleys deepened and widened,thus changing the drowned valleys into typical fiords..." In the next and last report,written

xx/Summary Rep.of the G.S.Branch.Ottawa.1911,p.103.

in 1912 Clapp makes scarcely any mention

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Before beginning the discussion, I must add, that almost all details observed on the way which seemed to me to be of importance for the physiographic at interpretation of the landscape, I always reported to other members of the Congress, and in spite of a theoretical disagreement dividing mostly our opinions I am happy to affirm, that in the description of each element of the landscape we were probably without exeption, of the same opinion. This great possibility of a discussion over the details, which was afterwards used as the foundation stone of a theory, or at least as an argument against[a] dominant theory was a peculiar benefit of this wandering assamblee.

I am especially indebted to a limited number of members and I will do my duty by giving their names; those are especially: E. de Margerie, R.W.Brock, R.Daly, Goldwaith, Mac Connel, L.Martin and Woodsworth.

I have had no chance of observing hanging valleys during my whole journey. With the exception of some good specimens, for instance the Yoho Valley, ot the Cascading Glacier in the Numatak Fjord the greatest number of not well agraded valley junctions made on me the impression, that the phenomena of the so called " overdeepening" - process are in the Canadian Cordillera and on the North Pacific Coastlands widely distant from the analogic features shown by the Alps.

On the other side the number of concordant valley junctions or agraded outlets of valleys into the "inland passages" was so common to be(se)en, that the general aspect of the country, if not the ~~mountain slopes~~ glacial polished

and rounded ~~mountain slopes~~, or the always perfect forms of rocks " mouton nées ", gave me the impression of being a landscape of a normal erosion; so different is the aspect of the island of"inland passages" from the landscape.that we are accustumed to ascribe to a once glaciated area. Though I propose in ~~a later~~ the third part of this study to give some more details from my own observations,I think it will be not without interest here also to name in general the places,where well agraded valley systems were observed by me.
Those are:Queen Charlotte Sound,Granville Chanel,Etolin Island,Mitkoff Island,Lynn Cønal, the peniusula separating Glacier Bay from Lynn C. and Yakutat Bay.
To prevent all possible mistakes, I ought to confess, that I do not reckon the true amphitheatric cirques among the typical " hanging valleys" sticto sensu, features, which are commonly treated as produced by overdeepening of the mainvalley-glaciers.

In the question of cirques I agree completly with the glacialists; As well as in the Alps and Carpathians, I found also in the Cordilleras and in the " inland passages " many splendid examples of cirques / eg:E. Slopes of Mt Abbot, E Slopes of Elko Mts, Glacier B, Yakutat B. Lynn Canal etc. proving that they are entirely due to glacial erosion, although in almost all cases preceded by niches formed normally at the headpoints of a torential system. For the explanation of cirques have been many theories proposed but in spite of the different conditions of cirque-developement which has been suggested all agree, that the cirques are a peculiarity of the region, elevated above the neveline. Well, if the cirques are a feature

of a level of the nevè.all cirques must rise far above the bottom of the mainvalley,and this difference between the level of cirque and of the valley bottom must ~~also rise~~ diminish up ~~down~~ of both bottoms. It is the main valleys.Besides this rise in the differences of both ~~of the main valley and that of the cirques~~ levels,there must also be an absolute rise of the level of cirque-bottoms up the main valleys.This feature depends as well on the rise of the levels on the torrent heads towards the centres of mountains,thus forms preceding the glaciation as also from the rise of the nevelines in the same direction. Finally it ought to be stated,that the initial form of the cirques,the torrent head finds the best conditions for develepment even where the greatest difference of slop-gradient comes in close contact.Almost all the phenomena of hanging cirques for instance,the harmonic arrangement of their level or the shallowness of cascading parts of such glacier tongues and many others commonly ascribed to the powerful erosion of the main glaciers can be very well deduced from all these peculiar features,that accompany the development of the cirques. In any case it ought to be noted, that ~~But~~ the hanging cirques are the dominant mark of distinction of the whole country we trawersed and especially of the "inland passages".

The independent valleys on the contrary join the sea at the sealevel and most of the secondary valleys that I have had occasion to observe, were also agraded. The well developed hanging valleys were not only an exceptional phenomenon, but were also always accompanied by some peculiar conditions. I cannot remember having seen a strike hanging valley, all that I have seen were transverse valleys consequently the question of rock control by such a kind of hanging valley was ever brought to my mind. In the

example of the Takakkaw Falls in the Yoho valleys not only does the question of rock control arise, but also another question, supporte by the fact, that many other affluents of the Yoho are almost agraded, and what is of more importance, the supposed overdeepening of the mainvalley does not go below the Takakkaw Falls, the mainvalley remaining there at a very high level, cut at first in a postglacial time by a canyon gorge, caused by water erosion. This special case, evidently very complex, can be by no means given as a clear instance, demonstrating the overdeepening theory.

The strange features of the Yoho Valley remind me that I have missed in the work of Canadian geologists-the criterion of epigenetic valleys, even where the marks of such a erodional process seemed to be very evident. I will give some details of hydr(ographic) changes observed by me, to which I was tempted to apply the theory of epigenesis cut in ancient chenals buried by glancial deposits. Among this kind of features I reckon the Bow River valley below Banff, supporting this view by the existence of a normal descent of 3-5 o/oo (measured by *disimètre*) between the terraces on Tunell -Mt. and the bosses, buried in glacial drift about Lake Mimewanka. About the stream diversion Kicking-horse-Beeverfoot R(iver) near the sharp bend between Wapta and Leancholl (the lake theory was much discussed.) I agree with this standpoint, seeing there an epigenetic process caused by morainic obstruction, both in the origin of Natural Bridge west of Field and in the canyon of Quartz Creek joining the Columbia River at Beavermouth. I cannot understand the supposed special rapid / glacial?/ erosion " [x] called in explanation of this last

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[x] Guide Book No.8, p.205.

hydrographic change.I think on the contrary,that here a special rapid glacial deposition was in action. The farther West, the more the present hydrography depends on deposition of leistocene mighty and very irregular silt and till.Most classical epigenetic processes I suppose,are developed in the system of Thompson and Fraser River.The channel of these rivers,incised here in rock,there in silt layer evidently much thicker, than the canyon itself,the high situated aluvial deposits and terraces,the high of which corresponds sometimes with broad windgaps,connected with as wide valleys, which are often drowned / hanging valleys !/,many valley crossings and bifurcations in higher levels, below which the traces of ancient silt obstruction are never lacking,below Chinabar also many rocky islands in a wide riverbed,evidently dissected and washed from a deep and broad floored glacial sediment are the peculiar features of this now rejunevated but old stream channels.

The dominant theory,treating of the origin of Fraser,Columbia and other transverse valleys of the Cascade Mts is supported by the criterion of stream antecendncy.[x]

The fact of the great age of delta deposits,built by some of these rivers,as for instance the old delta of the Fraser,beginning with the Eocene ought to be

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[x]G.Gibbs,Phys Geography of the N W Boundary of U.S. Journ Amer.Geol.1870/71p.144 ff.Smith a Willis,The Physiography of the Cascades in Central Washington Prof.Pap.U.S Geol.S.1900 No.19.

regarded as the most important feature, leading to this viww.

To explain the last accident in the history of these rivers is called in the glacial erosion, complicated by crustal deformations, in spite of which the rivers maintained their ancient course over the ancient dissected peneplain. xx

Agreeing on the whole with the proposed theory of stream antecedency in this country, I shall confess, that neither for the whole history, nor especially for the last stage of hydrographic development I imagine the process of antecedency without epigenetic complications. The importance of such a complication even in the smallest degree is illustrated by many examples.

As far what concerns theory I will remember the important study of Lugeon xxx in consequence of which the eyes of geologists were at first opened to the epigenetic phenomena in the Alps, and for the problems of American physiography I will appeal to the suggestion of Gilbert by whom it was stated, that a supposition of a partial epigenesis of the Columbia valley decided his views over the question of pre- Pleistocene base- level ⊣ and over the theoretical influence of J.W. Spencer's ⊣⊣ views, proposed in the discussion

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xx. Guide Book No.8, p.237.ff, 260, 264

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⊣ Gilbert, lc p.137 ff.

⊣⊣ Spencer, Hanging Valleys and their pre-glacial equivalents in New York. Bull. Geol. Soc. Amer. 1912. Vol 23 p.477- 86.-

concerning the Finger Lakes,when proved in details, it is however not necessary to spent many words.

I am quite convinced,that the search for an epigenetic process should very much limit the number of hanging valley phenomena,which is in any case restricted for which one could at the same time seek another process of normal erosion instead of a powerful glacial erosion.

The theory of glacial erosion supported long time by the universal appearance of cirquelike forms in the glaciated valley heads, and especially in the torrent heads,carved on the slopes of mainvalleys,loses its real basis,because the cirque-forms are a morphological feature,peculiar to the neve-level,where glacial erosion is almost excluded and the form itself can be explained by the excessive rock weathering on the periphery and above the neve-fields.The only unquestionable basis for the theory of a powerful glacial erosion could be found in the phenomena of hanging valleys, and it is not whithout importance that the first mention of this theory by J.Hector in 1863[x] as well,as all posterior developments of it by Lincoln / 1892/[xx] Tarr, Gannet,Gilbert,Davis and Penck was even based upon the phenomena of hanging valleys.

The deduction of the glacial erosion,so clearly deduced from the existence of hanging valleys,is right

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[x] Journ.R.Geogr.Soc.Vol.XXXIV /1864/.pp.96-111

[xx] Amer.Journ.Sci.1892 ,290-301.

only on the condition, that the hanging valley is a common feature of teritories which were once glaciated. (for the Canadian Rockies) This condition is generally nowhere found and the hanging relations only locally and almost exceptionally came in sight.

This exceptional character of hanging relations more or less pronounced in all mountain regions is especially for the Pacific " inland passages " a most striking feature, which could not be omitted from the discussions of the Congress party. Then we have often heard the assertion, that the hanging valleys are there submerged, not by crustal movements, but by tremendous glacial erosion, which overdeepened the main valleys far below the sealevel, and transformed them to fjords or to fjordlike lakes, as characteristic of the Interior Plateaux.

Even our Alaskan guide, L. Martin, the explorer of the Alaskan glaciers, and also my special guide to Glacier Bay often replied to my remarks concerning the lack of remarkable hanging valleys with this argument. It was almost impossible to discuss with such an argument both on the spot, as now after considering all impressions with and I must assert, that the problem of the fjords as overdeepened valleys awakened in me a desire to work on it on corresponding charts; I hope to come in a short time with some contributions to this important question.

From my journey I only remember one detail as a ca-

se almost excluding the overdeepening of the mainglacier,occupying the present Upper Arraw Lake.With only one exception of a slightly disturbed valley junction, all the numerous affluents are there perfectly agraded and constantly building a large delta into the lake; I give e.g. the valley of Leon Nakusp and of several creeks, descending from the Silver Mts.As the U.Arrow L as recorded by soundings is over 200 m /700'/ deep.the argument of a submerged hanging valley consequently should be also here applied. But this argument seems to me, are here throughout untenable.The wide Leon delta opened a glimpse not only over the valley of Leon,but also over its tributaries. All this valley system was bordered by an almost continuous morainic wall,that evidently the lower the more it approached the valley bottom till it reached the level of the delta and of the lake itself. These hypsometric relations led us only to one possible conclusion: the depth of the present delta deposits of Leon are equal to the thickness of the former glacier, which has left the existing morainic walls; when we assume for this glacier,which was over 10 miles about / 20 km / long a thickness of several hundred feet as the depth of the Arrow L. is 5-700' there remains no possibility of a morphologic discordance between the lateral valley of Leon and the main valley of U. Arrow Lake; and as the valley junction was already in preglacial time concordant the origin of Arrow Lake must be ascribed not to glacial erosion, but to crustal movement of submergence.This example, which was discussed by me on the spot, in the presence of a

a morphologic discordance between the lateral valley of Leon and

congress party proves also, that not all lake basins, of which the ground is situated even below sea-level can without reservation, be taken in support of the overdeepening theory.

But the term " hanging valley " has become in the litterature, concerning the glaciers so common in the last couple of years, especially after the most attractive, and in their logical architecture very convincing studies of W.M. Davis, x that I am afraid not only of standing alone with my negation abouth the hanging valleys but also of being suspected of a tendency in my observation, which was caused by a synthesis, made a priori. I am thus very grateful to all the leaders, of the congress - party I will especially name R.W. Brock and A. H. Brooks, for their special care and kindness in supplying me with the litterature concerning the problems of American glaciation in general, and of Alaska in particular. With the help of this litterature it was no difficult to find, that I am not mistaken in my point of view and that even the most decisive glacialists allow a good deal in support of my conceptions.

I beginn my review with the views of H.A. Daly of Harward University, the never forgotten guide of the Congress-Party in the Cordillerean Belt, with whom I spent a good time in discussing the problem of glacial erosion whitout arriving at a complete agreement.

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x Glacial Erosion in France, Switzerland and Norway Proc. Nat. Hist. Soc. Boston 1901 Vol. 29 pp. 273-322.

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x Glacial Erosion in France, Switzerland and Norway
Proc. Nat. Hist. Soc. Boston 1901 Vol.29 pp.273-322.

R. A. Daly developed his views in the standard work: Geology of the American Cordillera at the Forty-Ninth Parallel published as Memoir No.38 of the Canada Dpt. of Mines G.S. Ottava .1912. The glaciation of the Cordillera is treated in Chapter XXI of this work / p.577-98./

Although full of esteem for and acknowledgement of Daly, as guide and leader of the Congress - Party in the geological problems of the Canadian Cordilleras - I cannot agree with him in the morphological questions of glacial erosion after the study of his work, just as I could not agree with his views, which were developed before the Congress - Party in the terrain.

In his detailed description of the glacial phenomena of the Cordilleras I can not find any law, any regularity in the distribution of erosive work executed by glaciers; I see on the contrary such a complexity of peculiar forms and morphological changes, now ascribed commonly to glacial action, that even Daly himself, representing his point of view seems to find it very difficult to apply a common criterion of explanation by the same agency of erosion the features which are different not only in quantity, but also in quality, / by the same agency of erosion /. The study of the Daly's paper awakes an impression only that the s.c. phenomena of glacial overdeepening appear in the Cordilleras both in a highest degree

of development under the circumstances of a very low degree of glacier development, and also in other places the glacial forms of the landscape comes very little to light, though the phenomena of glaciation attained there the highest degree of development. I give one instance only: the Minimum of glacial erosion in the country of the Similkameen River with the Maximum of the thickness of the ice; an important erosion 30 miles west from the Similkameen R. on the Okanagan Rge with an ice sheet, which was there three times thinner and finally a Maximum of supposed glacial erosion in that country by L.Chelan, where the extension (of) pleistocenic glaciers was near their end. x

Such relations, taken as a foundation stone of the theory, developed in a deductive way, must lead to controversies, which are able to shake the whole theory. /: For me, who had the opportunity of admiring Daly in the discussion over static metamorphism in Shushwap terraine and on many other similar occasions, during our trip across the Cordilleras, it was not easy to believe, that Daly used all these contradictory relations as a theory, and in this way could not avoid a controversy. / And it is a remarkable controversy, if

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x Daly lc. pp. 582,591,592. Viz. also C. Camsell, Prel. Rep. on a part of the Similkameen District B. C. Geol. S. of. Canada No.986. 1907, p.21.

one attempts to explain the feebleness of abrasion, executed by the Labrador ice-cap, showing its ability of free movement in all directions, and in another place ~~he~~ one illustrates the power of an erosion made by a valley-glacier by comparing it with the erosive ~~pppp~~ effects of the Labrador ice-sheet[x]. But this is mere-

x/ Daly lc.pp.582,592.

ly a kind of a "sit venia verbo" oratorical mistake. However this is not the last mistake.

In the discussion of Daly ~~//~~ the concentration of ice-movement is of the greatest importance ~~/as the decisive agency p//~~ in the theory of glacial erosion. The rate of this concentration of flow is also in relation and correspondence to the amount of glacial erosion. It is a deduction, to which all the adherents of the theory of a powerfull glacial erosion were led, with which it is very easy to be in accord without any restrictions. Because all these valleys, for which one admit~~/~~s a strong concentration of flow, must also have, according to this deduction, the coeval developement of hanging valleys, and the heights of hanging steps in a degree traced by the amount of scouring of the mainvalley-bottom by the concentrated iceflow. Daly's deduction asks in its consequences for a regular development of hanging valleys, perhaps more that other deductions, in which the amount of glacial erosion was correlated simply with the thickness of moving ice-masses. When Daly's deduction led him to the supposition of scouring "for tousands of feet in the living rock" by glacial action the only consequence, proving this deduction ought to be the constance of steps at the same height, joining the secondary valleys to the mainvalley. Meanwhile Daly notices only ~~/~~ two cases of hanging valleys for the whole profile of Cordilleras studied by him, one of them is only 200' high/Oil-Creek by Waterton Lake/ and the other of Philipps-Creek, though 500' high, yet probably "structurally determined". "Since the second/structural/explanation, concludes Daly[x], cannot be entirely excluded, Philipp Creek is not to be surely placed in the class of valleys, which hang because of differential glacial erosion".

X/ Daly lc.pp.579,585.

I am ~~s~~ satisfied that I can ascertain, that Daly, though emphasizing the glacial erosion, does not give one instance in proof of it. I repeat that I can claim for an argument in favour of glacial action, onla a regularity in arrangement of hanging valleys, the criterion of rockbasins, even in the Cordilleras with its heavy morainic obstruction and thick timber, can not be given alone in support of the theory of a powerful glacial erosion. How cautious one must be in applying the s.c. rockbasins in support of the demonstration of the glacial erosion I was ~~t~~aught by many examples. I will give the instance of the L.Louise, the basin of which was by J.A.Allan, our excellent leader in this ~~p~~ country, called rockbasin. Doing so ~~p~~ Allan was completely in accord with W.H.Sherzer, the best connoisseur and explorer of ~~th~~ the glacial morphology of this country. I am sorry, but as in the discussion with J.A.Allan on the spot, also now I can not accept the reasons of Sherzer, given for the rockbasin-nature of L.Luise. The only reason given by Sherzer x/ is, that "the basin (of the lake) is seen to be a U-shaped through, with a Maximum depth of 230' just beyond the centre. This shows that the valley was excavated by ice and that, in all probability ~~y~~, the bottom of the lake is a glacially excavated rockbasin."..."Bedrock is found upon all sides of the lake, except about the foot where there is the groundmorainic dam, filling the valley to an unknown depth."

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x/ Sherzer: Glaciers of the Canadian Rockies and Selkirks. Smiths. Institute. Public. No 1692. Washington. 1907. pp. 60.

I will now go further to the examination of the views and materials, concerning hanging valleys, and collected in these westrely countries by ~~B.H.K.~~ C.H.Clapp. Clapp had been workink from 1908 on the southern part of Vancouver Island and reported from this time regularly not only on matter of economical geology, but also on morphological questions. In his first report xx/ Clapp

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xx/ Summary Rep. of the G.S.Branch Ottawa. 1909, pp53, 54.

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does not ascribe much work to the action of the glaciers, on the contrary he sees only the polishing and grooving of rock by them, but at the same time he sees here no evidence of cirques or han-

ging valleys, and the coast forms and fiords he explains by submergence of the country. In his further report, Clapp saw not only continually more work, due to glacial action, especially the cirque-formations in the country of Mt. Arrowsmith, but also he

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x/ Summary Rep of the G.S. Branch Ottawa. 1910, pp. 86.

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slowly changed his views in favour of the theory of a powerful glacial erosion. especially in his report of this field-work, executed in 1910, Clapp xx/ writes: "The topography was greatly modified during the glacial period, the monadnocklike hills were rounded, the valleys deepened and widened, thus changing the drowned valleys into typical fiords..." In the next and last report, written

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xx/ Summary Rep. of the G.S. Branch. Ottawa. 1911, p. 103.

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in 1912 Clapp makes scarcely any mention

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which I read with the highest satisfaction simply for this reason because,notwithstanding his apparent sympathy for the theory of glacial erosion,I could not find in his long deductive way one point,which could awaken the slightest disagreement.In my opinion G.K. Gilbert ought not be counted among the representatives of the school of glacialists because his deductions are never unilateral and in his statements also open doors are always left for an other interpretation of the glacial Morphology thare by the processes of glacial erosion.For that reason,Gilbert,who is quite rightly counted among the founders of the school of glacial overdeepening,which was based upon a part of the morphological possibilities deduced in Gilbert's work,is often called also to witness aguinst the theory of a powerful glacial erosion. / J.W. Gregory :Nature and origin of fjords.London 1913.p.319/.

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Most interesting from a methodical point of view is the scale,given by Gilbert for appreciating the value of glacial erosion./ Gilbert lc.pp. 114 - 19,esp.117. Gilbert points out on the other hand,that the conversion of young and narrow Gorges,into the typical U- trough,the widening of old river valleys,the cut of projecting spurs and s.o. demonstrate a large amount of work,done by the Pleistocene glaciers.But accepting this thesis Gilbert claim exactly, that the ice streams,by which the work of widening of the valleys was done could not have failed to wear down their floors. Gilbert lc. pp. 117,159. Overwidening and overdeepening are two consequences,which are bound together inseparably in the theory of a powerful glacial erosion.The failing of one of them must awaken serions doubts. We see there all possibilities in evaluation of glacial erosion: from the most decisive element in development of the glacial landscape to that unworthy of being mentioned.But what is important besides in this clas ification made by Gilbert. It is that the presupposition for both high and low grades

as to the reality of this theory. The phenomena of glacial overdeepening after an examination of morphological features, common to the „inland passages" must be treated with serions hesitation; so at follows that the theory of a powerful glacial erosion is doubtful.).

of glacial erosion is in the views of Gilbert the hanging valleys.The lack of hanging valleys/////////// according to this deduction is identical with an absence of glacial erosion.

It must be stated on the other hand that although the most prominent signs of overdeepening,the hanging valleys ,are missing in the „inland passages ",the U-trough forms of valleys,straits and fiords ////////////,are universal feature of this district,as of all others,which were once glaciated.The origin of the trough - forms of the valleys,which are so strictly connected with the area of recent glaciation can be hardly imagined without looking at the causes and forces, hich are common to the glaciers only. This coincidence of U-valley forms with the glaciation has led nany observers to the opinion,that between these two features there existes a direct relation,namely that the U- - forms are an effect of glacial erosion.In pronouncing this thesis one forgets 1/ that glacial overwidening of ma - invalleys must be follawed// by an over,ddepening of them ,as proved by Gilbert and many others; 2/. that the over- only widening of mainvalleys as perceived by Bancroft can cause the hang of confluent - valleys.From this consideration one comes very close to another supposition,that the U-trough of glacial valleys is not in direct relation to the work of the glacier,and therefore is only a feature,which owes its developement to forces changed by the coeval developement ////////// of glaciers.

Jaon B was the first to take this standpoint,which he did in/ a attractive way. / J.Brunhes: Le problème de l´éroion et du surcreusement glaciaires.Revue général des sciences.1908.N-o 3.Actes de la Soc. Helvetique.Fribourg 1907,I p.155-75.Revue de Géogr.1906/7 Vol.I pp.281 - 308. Viz. also C.R. des Travaux du IX Congr. intern. de Géogr. Geneve VOl.I pp.338 - 42. /.

B, the ideas of Brunhes I was completely convimed ,but by the succeeding observations and field - works,exe-

cuted in the Carpathians and in the Alps I was led to many other ideas,which were confined partially to the views,deduced by Garwood,/ Garwood: On the origin of some harying Valleys in the Alp and Seimalagas.Quarterty Journ. of the Geol.Soc.1902.November./,and so I came slowly to the thesis,/ E.Romer: Einiges über die glaziale Landschaft und Entstehung / polish with a german summary /, Kosmos,Lwów,1909,pp.239 - 62.Mouvements épeirogéniques dans le haut bassin du Rhone et évolution du paysage glaciaire. de la Soc.Vaudoise.Lausanne,1911,Vol. 47,pp.65 - 192./,that the glacial landscape owes its peculiar features,mostly to two forces: 1/.to the erosion of runing water,deviated and perturbed by glacier developement 2/ to warping.The erosional effect of the glaciers according this synthesis seemed to be limit to superficial work only,attaining a greater amount of work first in the regions elevated above the néveline,where the ruming water as an active element completely disappears.

But also in these high levels the snow and firnmasses are active more indirectly than directly.In my opinion the forms characteristic to the glaciated valley heads,the cirques and their steep walls are a certain and exclusive effect of glaciation,but in a much greater way due to the excessive rock weathering above the neves and to the facilitated transport of the produced waste on the nevé - slope and with the help of the mowing neve,than to the direct scouring power executed by the pressure and movement of the snowmasses.By the glacial studies made in the last three years in the Tatra,which will shortly be ready for publication I have gound perfect examples of recession of the cirquehead - walls,but the process of recession is only visible there in the levels elevated above the local pleinstocene névé - line,below it on the contrary the old propleistocenic valley - benches are preserved.

But in the glaciated mountains with which I have been Till now acquainted I nowhere saw as perfect physiographi-

cal peculiarities,which can support m., point of view,than the 'drowned mountains of the „inland passages ".In giving the reasons for the above statement I will content myself wid giving the observations from only two fiord - embayements,with which I was better acquainted during my journey i e from Yakutat and Glacier Bay.

Poth these fiord systems with a very striking regularity show some physiographical properties,already mentioned by Brunhes which were used by him in the theory,showing, that the developement of glacial landscape can be very well understood,when it is granted that only the agencies of a normal erosion were active,and that only these agencies were very serionsly perturbed by the glaciation. The first most remarkable feature,which must surprise any one in these lofty regions is / certainly the very unexpected but proportionally also perfect agradation of the whole landscape.All confluents I re point particularly all confluent - valleys,which enter Disenchantment Bay,Russelfjord /our congress - party did not go beyond the mouth of StendricksenGl. and Hidden Gl./,the Nunatak Fjord are in their lower parts so agraded to the scalevel,that it can not be better imagined.

The valley of Aquadolce,Catalonha,the little valley, parallel to Russelfj. and Orange Valley.The valley,which drains the Hendricksonglacier or two righthand confluents of Nunatak Fiord,are the examples of perfect agraded valleys in this district.When we exclude from the discussion the valleys the rock bottam of which is obstructed by heavy sheets of tidal glaciers,or covered under very heavy morainic and outwash products,I ask where are the valleys in this district, which can be named hanging valleys? I here is only one valley left under consideration,that is the little one entering Disen chantment Bay N. from Catalonha at a small distance from it . This valley is named on the map of Jakulat Bay / R.S.Tarr and L. Martin: The carthynakes at Yokutor Bay, Alaska,U.S.Geol. S.Prof.Pap . N-o 69 1912,Plate XXII;viz al-

so Congres Gnidelvok N-o 10,/,a hanging valley. I regret very much not to be able to say anythnig more about it,because of the great impression,which teh first glimpse into the perfect agradation of Catalonha Valley made in me; I can only state,that the hanging relation in this valley is not evident from the seashare,and of it existis,it is develoned first in the upper part of the valley,at any rate above the turn of the river,made niar the letter „h",given on the map as a sign of interrupted fall.But besides these valleys,which are now abandoned by glaciers,also all now glaciated valleys have an appearance,which suggests a good agradation of their rock bottoms,and shows in all cases very slight - trace only from which some hanging relations could be supposed and when so,in a very law degree only.These agraded types of glacier slope reach to big glaciers,as Hubbard very far above the tidal cliff,but the same property is common also to by far secondary glaciers as the Turner Glacier,Haenke Glacier, and its unnamed Neighbomr,which descends in th corner between the Haenke,and Hubband,to the Variegated Glacier,Orange Glacier and Hendrickson Glacier. Only the smallest glaciers, the cliff and cirque cddciers or the slort avalanching ice tongues,representatives of gullies and ravines in a mountain- relief of a normal drainage show hanging relations.The most pro minent form of this type is given by the lascading Glacier,confluent to the leftarm of the Nunatak valley.But can this example be counted the types of hanging valleys? in my opinion it is very hard to doso.The whole length of this form scarcely attains three km. / 1 3/4 of a mile/,ana from this length the greater upper part can be treated as an oblonge cirque,changed by headwall - recession,while the lower part, which forms the splendid glacier cascades seems to be controll ed by structural agences.But this Cascading Glacier is ho - wever the best example of hanging relation in the part of Y.- akutat Bay,with which I made acquaintance,during the journey of the Congress - party an a this,the only one,I partly question.By ouch Kind of hanging forms,developed naturally in a

incomparably feebler manner than the Cascading Glacier about which the gives above named map of Yakutat Bay much information, asefuly but the theory of a glacial developement of present reltief can be not well supported.

In this opinion I am in accord with G.K.Gilbert,who treating of the theory of a powerful glacial erosion with evident sympathy indeed,but as one of the morphological possibilities only,applied a very exact criterion and asked very close and distinct consequences in interpretation of the relief forms .This was the principle,which led G.K. Gilbert / Gilbert : Glaciers pp. 66 - 69 /, to the supposition,that the greater inclination in the lower part of Turner Glacier and the almost horizontal level of its cliff part are a sign of the floating of the ice on the one side and of an important hanging relation between the valleys of Turnerglacier and Disenchantment Bay on the other.From this supposition,strictly based on the theory of glacial overdeepening Gilbert could easely deduce, that the depth of the Bay on the Turner cliff must attain at least 1600′ and that „the central depth should be considerably greater.The theory,claims Gilbert at the end,could therefore be tested by sounding."

By the sounainge,made by L.Martin in 1910 / L.Martin:The National Geographic Society.Les carches in Alaska. Nat .Geogr.Magazine,1911,Vol.22,pp.537 - 41.Viz also Congress - Guidebook N-o 10./,it was found,that the central depth of Disenchantment Bay in the profile indicated by Gilbert attains not fully 300′but this constatation was without any influence on the theory.The theory of glacial overdeepening remained intact,only the search for the results of the overdeepening processes was transfered from "talweg " where the glacial erosion must be to be the strongest,to the cirques or even the upper levels and borders of the glacier,where it is difficult to name a reasonable cause for a developement of a more important gla-

cial erosion.As far as the features now ascribed to the phenomena glacial overdeepening in the district of Yakutat Bay are concerned I am almost in accord with the adherents of this theory;we describe then as hanging cirques or gullies.But in the genetical interpretation of these features we hild different opinions.I gave iust now and also many times before the reasons for which I cannot reckon the forms of hanging cirques as being due to the process of glacial overdeepening.I will repeat them no more, but on the contraty,I will pay attention to some peculiar features,accompanying the cirque formation,which they have common with the glaciated mainvalleys,and which are able, in ony opinion,to demonstrate the way of formation of the relief of glacial districts.I ought to point out also,that I have seen these features so distinctly developed,as in these two fiord systems of Yakutat and Glacier Bay.

The principal sign of this feature rests on the apparently abnormal form of two lines of drainage in one valley.But this abnormality for a relief produced by a normal erosion by undisturbed running water can be taken as a rule for a glaciated relief.On the left slope of Russel fiord which is exposed toward NE some 6-7 cirques hang.Some of these cirques are dry,but the bottom of the greater part of them are covered with ca more or less large patch of névé snow.Both Kinds of these cirques,the dry and the glaciated ones are drained by two channels,which are cut in the outer rim of the cirque on it right and left borders. The channals are always carved very distinctly,though in general only superficially.The dry cirques seem to be sometimes distingnished from the glaciated by the fact,that one of the channals is much deeper incised than the other and that the deeper chal is accompanied by waste cone.It is easy to deduce with much certainty,that the double drainage is a peculiarity of a glaciated torrenthead,which after the melting of the snows transforms itself into a single channel.By the observation of these features in

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Russel fiord one could be also he convinced of the stronger erosion of the intermittent torrents - having their outlet in drycirques,than of the chanels flowing off from the snowfields;the waste - cones,underlying the dry cirques suggest the above given supposition.But the double drainage is not limitated to the cirque or glaciated torrent chnals,it is an the contrary the most general peculiarity of all valleys,whicharc fed by living glaciers.By very superficial review of maps,concerning the Alaskan and SE Alaskan glaciation I was tought that also in this stage of cartography this feature was still many times very distinctly recorded / In the following note I ing together the names of the glaciers,which according to cartographical documents have a double marginal outlet /4/; the number given in brackets means,the n-r of Bulletins U.S.Geol. Surve,.These glaciers are:Two Delta Gl./ 501 /,Ruth,Tokichitna,Kahiltna /534 /;Paterson,Great Gl. Stikine /347/, Tasnuna R.Gl.,Sheridan /443/,Bear,Valdez /526/,Berners, Noris,Twin /287/Kennicot,Tana /374/,Matanuska,Tarlina, Knik /327/,Two Susitna,West Fork, Mc Laren /498/ Mendenhall,Herbert,Eagle /502/.This number of double drained glaciers could be much enlarged;I add only the Hidden / Viz.also Gilbert lc.p.54 / and Illicillewaet ,with which I was acquainted,and the neighbourlies glaciers of Wenkchemma,Wapta and Asulkan / Viz.Scherzer:Glaciers of the Canadian Rockies and Selkirks.Smithsonian Institution.Publ. N-o 1692/.

The idea,to which one could by e at first very easily led is the supposition,that this double drainage is a simple consequence of stream deviation and bifurcation on the convex - fanforms of the fluvio - glacial deposits.But this supposition can not be supported by all other accompanying features.First we saw already,that the double marginal drainage is common both to the outwash - forms on the front of the glacier and to the cirque outlets,where the alluvial deposits are almost absent and even a mo-

rainic frontal abstruction seldom comes to developement. Secondly the observation of minor features is convincing that, the debelopement of double and marginal drainage is slackened with the increating distance from the glacier-front.and disappearis shortly after the glacier has been melted in the valley.More than the other two I the third reason in favour of the thesis that double drainage is not a property of valleys fed by glaciers, but a property of the glaciers itself.This significance I will ascribe to the fact, that most glacierstreams do not flow from the central part of the front of the glacier but only from its borders, sometimes from one only, but oftenest from both glaciermongins. The double drainage is a feature characteristic subglacial drainage, and when developed in streamvalleys it ought to be regarded as an inherited feature only.

The existence of this marginal subglacial drainage every where leaves very distinct traces of its work. Especially in the little valleys of the East Carpathians /Czarna Hora, Świdowiec/ where during the Pleistocene age many shord glaciers esurted the tracts of a marginal erosion are very clear marked. To the feeble developement of a morainic and the still more feeble occurrence of fluvioglacial deposits, finally to the complete lack of morphological changes in postglacial times must be ascribed the prominent conservation of valley - forms there which only can be well undershord by the admission of a marginal subglacial erosion. The peculiarity of these forms rests on the special type of the cross profiles of the valley bottoms. They are namely not only of a through - form, but the bottom of the trough is very distinctly convex and accompanied by two channels, cut between the central broad convexity and the valleyslopes. That this form can not be treated at all as a result of a glacial erosion, seems to be certain; this form gives one more proof in demonstration

of the changes made by glaciation on the processes of a normal erosion.

Very mighty effects of the same processes which we have, in a slight degree, observed in the E Carpathians are shown in the morphology of the inland passages and the Alaskan fiords, they were caused by greater forces and in a longer time.

These works of a heavy marginal erosion we see in abundance of the left slopes of Russelfiord.
this Kind of forms I will reckon all these rocky bosses, which are partly cut from the valley slopes and by their linear arrangement and elevation suggesting the idea, that they were cut by subglacial marginal streams at a time, when Russelfiord was wholly filled with moving icemasses and subsequently was a line of subglacial outflow of running water. These marginal bosses / half cut spurs / are throuthout independent of the rock structure and though they are between Osier Island and Cape Enchantment are almost limited to the rocks, marked on the map as the paleozoic group; south of C. Enchantment they occur in the same degree of developement in the rocks, belonging to the Mesozoic Yakutat group.

The same processes, but in a incomparably higher degree are shown on the forms of the fiordwalls and fiordslopes in Glacier Bay. The bossesoften very deeply cut from the fiord slopes are in the embranchments of Glacier Bay a very common and regular feature, which belongs to the most characteristic morphological peculiarities of this district. Some of these bosses, particularly the smaller ones combe given as the best evidence against an attempt at explaniny these forms by glacial erosion. Such an eminent example can be given by the form of the sc. Nunatak in Rendu Inlet. This boss /situated between the two soundings 80 and 83 fath, noticed on the U.S. Chart N-o 8306 /, 3-400 ' high has not only very bold forms, is not only precipitions on the water side but also about in the same degree in its declivities turnd to the slopes of the mainvalley; the cut-

form shows not only by its freshness, its wildness, but simply by the well expressed V-crossections, that here the ice-masses were never active. The same Kind of bosses is found in abundaive in Grand Pacific Fiord / named Tarr Splet by I. Martin during our work in Glacier Bay September 1913/, on both its right and left slopes; on the right slope. I-remarked 6 bosses, on the left three. I naticed Several bosses on the left slope of Reid Inlet from the point opposite Russell Island to the Tidal Inlet, some very interesting little bosses I found on the opening of Muir Inlet near . Sebree Island and Vy observation made from a greater distance I was convinced, that the bosses which are a feature common to all glaciated regions attain here an exceptionally degree of developement.

The several Kind of bosses, found here can be classified into three general types. The first type though less remarkable is very important for explicative treatment of this morphological feature. This type is marked by short oblong notches, incised on the fiordslopes parallel to the general strike of the valleys. In explanation of this forms only the erosion of running water can be cited and in regard to the elevation of these short channel only a subglacial stream, directed by the obstructive element of the glacier can be token in account. These forms are particularly striking, when they occur on the same profile in several elevations, as for instance on the mainland slopes, west from Russell Island / East from the point 2470' on Chart 8306 /. These three parallel notches clavated an the same slope one over another, are a prominent feature in the view from Tarr Inlet. /Gd. Pacific Fiord/ looking south, and they can be treated as an demonstrative object for explanation the genetics of a glacial landscape.

The second type of bosses is represented by only slight oblongated conical spurs of a very small area similar to that which is known as the sc. Nunatak in Rendu Inlet. Some vosits belonging to this type I saw also in

Tarr Inlet.The truncation of such a form is very difficult to imagine.Subglacial waters cannot suggest an explanation for this type of forms.The forms are namely too thort for one to admit the development of a marginal stream .But also from the stanapoint of a theory of glacial overdeepening one is throughout helpless if an attempt made explanation of this form.But it is clear,that such a preglacial spur must from the stanpoint of glacial overdeepening during glaciation cause according to the coeval contraction of the crossprofile an important rise of the rate of glacial movement in the central channel. The supposed glacial scouring must attain here a high dgree of development.The scouring always concentrated on the line of „talweg" can also be here effective on the outside slopes of the spur.All there consequences are clear.But I see no possibility for the explanation of a deep notch in the line,where the spur joins the mainslope. We can with full right suppose that the preglacial spur was separated from the mainslope more pronounced and younger forms can be not suppose for preglacial spurs by a wide and flat windgap slightly and the time of beginning of the

In all cases swell of the glacier it overrade first the windgap,and only after that it covered the top of the spur,which formed for one moment a temporary nunatak.But to suppose remarkable erosive effect,executed by a thin glacier arm covering the windgap,seems to be quite in disaccord with all rules of the theory of overdeepening.But the thickness of the ice over the windgap could attain during the time of maximum of glaciation very great dimensions. But by this out will supposition/the not be helped theory of a glacial origin of the deep between the Nunatak and the mainslope/; simply for this reason that the differences in the levels between the top of the old spurforms and their windgaps ave so insignificant,that the proportional increase of the corresponding ice thickness

can not have an influence on the rate of ice movement, it can be on the contrary throughout balanced by the increased friction because of the direct contact of the ice with the slopes of the mainvalley.

The only explanation of these forms seems to me given by the influence, which all valley narrows or barriers have on the glacier oscillations. The valley glacier, obstructed by a projecting spur expresses the climatic oscillation more by the changes in crossprofile than by the changes in its length. Such projecting spur are for this reason the places, behind which the glacier are commonly placed very ends, which can be flat or swollen according to glacier oscillations. It follows from these conditions, that the preglacial windgaps are often used as the channel for the outflow of the glacierstreams which commonly accompany the glacier margin. From this consideration it follows that the firstbeginning of this Kind of bosses is caused by the fluvioglacial stream - erosion, and according to this origin of the boss the separating notch is cut deeper in its down part, than in that part, directed up the valley.

The third Kind of bosses, which the most numerons is represented by great, often high, oblong ridges, running parallel to the seashore, but always distinctly bearing out from the mainland as oblong and broad capes or peninsulas. Most of them are more than one mile long but analogical forms extend in the coastforms of Glacierbay to a length of 5-7 miles. /8-11 km./. All these bosses are inherited forms of a subsequent old landscape of a normal erosion. The inheritance from old forms is shown by the lack of accord between the structural lines on the one side, and the subsequent ridges and Notches on the other. The independence of these ridges and notches from the structural lines witnesses against the participation in developement of these forms by glacial erosion, which must be imagined at first a selective

erosion.The marginal situation of the strongly eroded lines separating the bosses from the mainland speaks more than any other reason against the participation of glacier erosion.These longitudinal notches,which are more or less deeply incised,although short always more or less agraded and never hanging and for this reason they must be tredted as forms,which have suffered great changes by the processes of a marginal subglacial erosion.

These bosses of the third Kind were already penceived not only by the adversaries of the theory of a powerful glacial erosion as by Brunhes and Lugeon but in the same degree also by its adherents.Que of the first representatives of the theory of glacial erosion Prof-E.Brückner of Vienna paid much attention to this problem and in this matter arrived to fodlowing conclusions.In his opinion /////// there does not exist any difference in principle between the cross bars,by which the basins of glacial eroded valleys are closed and the longitudinal bars or bosses.The cross bars are in his statement shown as forms,which are due partly to the selective erosion of the glacier,partly to the water erosion of a chaotic system of subglacial streams,but finally to the accumulative process of the glacier,which filled by its groundmoraines all irregularities of the cross bar during the time of the advance of the glacier. But the cross bar is according to this idea,the primary form of the glacial landscape.This form follows,according to the opinion of Brückner,throughout the rules of the processes of glacial overdeepening.It arises either in places at the mouth of a confluent valley in the mainvalley,or under similar conditions,where many confluents origin ate the mainvalley,or at the place, where the glacier was for a long time stationary,finally at points/// where the geological conditions promoted the development of a selective glacial erosion.It is very interesting to notice,that Brückner himself points out

that many bars lie on places,which by nomeans correspond to either of the above named conditions.I o account „for these bars,says Brückner,/ Peuck a. Brückner :Alpen im Eiszeitalter p.621 ff./,one must imagine differences in the crosive power of the glacier,which appeared in a longitudinal direction asa consequence of corresponding changes in the inclination of the valley bottom or in the square of its cross section." But this relation between the morphology of the valley and the developement of cross bars was by nobody shown exactly and by the examination which I made /

of the valley - system of the Rhone on the contrary no relation between the amount of valley - overdeepening and the degree of its fall was found.

The question is finally in the opinion of Prof. Brückner of no great importance because the relative height of the bars is quite insignificant in comparison to the thickness of the pleistocenic ice;he appreciates this relation to be normally 1/14 and in only one case 1/7 of the ice thickness. /Peuck - Brückner lc.622 /.If it is so allhough the bars are bery prominent in the landscape they meap no more thas the irregularities in the valley bottom,scoured by the glacier, for which there exists a direct analogy to the small irregularities of a river bottom incomparison to the depth of the running water.

The longitudinal bosses,which are such a striking feature of the bottom of glacier - valleys,are according to this opinion of Brückner subsequent forms of the cross bars.According to hinc re are two causes,by which the Bars are to the changed into bosses: o1/.The carrying off of the morainic mantle by means of subneril denudation and opening of the ancient burvied channels which were cut by Glacier - streams in the rock bars. 2/.The crosive power of the double drainage,which so common at the glacier end.To this last process the bosses are attributed by

Brückner, which are best known in the alpine valleys, thanks to their prominence in the landscape.

To this double drainage of glacial valleys is ascribed by Peck even more than by Brückner the development of longitudinal bosses / Riegelberge, Inselberge/. But Peuck points out as well as Brückner the morphological insignificance of these forms in the glacial landscape. In all cases Peuck is opposed to the supposition, that the irregularities in the bottom of glacial valleys, as they are given by the marginal bosses can be treated as a proof against the theory of a powerful glacial erosion. Even these form says Peuck are /Peuck a. Brückner: „Alpen im Eiszeitalter p.504/. not remnants of a preglacial" morphology, but they were developed during glaciation because of a weaker erosion upon the bosses than elsewhere. These forms are well comparable with flats, which come regularly below the depth, accompanying the eddies; just as he concludes the river bars or flats do not contradict the water erosion, so the bosses of the glacial valley not contradict the erosive power of the glacier".

There are many things to be opposed to these viems.

1/. The normal type of the bosses, which occur in the bottom of the glacial valley, are longitudinal and not transversal. Especially in the landscape of the inland passages and in the Alaskan fiords it is hard to find bosses which can be arranged in transversal lines, while many of them can be followed for long distances in longitudinal lines, suggesting the destructed remnants of an ancien slope surface of the mainvalley, destroyed by the cut off by the subglacial marginal streams. In all cases the marginal bosses seem a kind of form which is independent of the more unusual forms of the rocky cross bars.

2/. Even accepting the descendt of the marginal bosses from the transversal bars, which in most cases not

to be probable,we not find it easy to compare the forms of the bottom of glacial valleys with the forms of the valley -bed of a river.The river flats,which appear regularly below the depths are namely buitt up by accumulation of the material carried off by the eddying water from the upper depths,while the morpho//genetic a/rrangement of the forms in glacial valleys is quite the opposite:the supposed / I accentnate the hypothetical nature of many glacial bars and rock - basins,as I was led by my observation to the same opinion in this matter,which was splendidly represented long ago by Albert Heim.See also his paper: Beweist der Einbruck im Lötschbergtunnel glatiale Übertiefung des Gasterentales ? Vierteljahresschrift S. Naturf. Ges.Zürich,1908 Bd .53 H-o 20./,crossbars,which come below the supposed deep basins are forms of erosion and the basins are filled by accumulation.

2/.The fact,pointed out by Peuck,that the bosses were developed during glaciation is without doubt.BUT BY this fact it will be only proved that the accident of glaciation does not mean a complete cessation of the life processes in the geographical cycle,and I think,that the extreme adversaries of a powerful glacier erosion never maintained this opinion.The landscape is alive also during glaciation of this there is no question.The question is if the degree of this life is slower or faster during glaciation than during the conditions of a normal erosion- ; and farther,ab is the principal element of erosion during glaciation,the ice or the subglacial running water.And if we continue the discussion I ask for a reason,by which the weaker erosion upon the bosses than elsewhere can be explained.When all the functions of glacial erosion, the rate of movement of the glacier,its thickness and pressure,are ////////// strikingly diminishing towards the borders of the glacier the cut off of the marginal bosses can never be explained by glacial erosion.If it is so there only remains for the explanation of these

common and important forms of the glacial landscape water erosion.

4. The developement of these forms / Riegelberge, Inselberge/ in the glacial landscape is no evident a product of water erosion, that it was confessed even by the first representives in the science, who were not at all inclined to ascribe anything important in the development of a glacial landscape to water erosion. But at the same time as the processes of a normal erosion on the formation of bosses were granted was out pointed on the part of the adherents to the theory of a powerful glacial erosion/the morphological insignificance of these bosses, which were characteristically named „small bosses"/. It is very hard to support this opinion for the forms found in the Alps, but it is the more inadmissible throughout for the relations characteristic of the Alaskan landscape. It is sufficient to look at the relations, found in Glacier Bay. There are, besides numerons small bosses, six large longitudinal and marginal islands, elevated 500-1600′ on the average 1100′ above the sealevel which mass rises in regard to the depth of the surrounding sed to an average of 1800′ above the bottom of ancient glaciers. Still higher tha the island - bosses are the peninsular bosses which are in complete morphological analogy to the first bosses with the one exception, that their inner annuel out is not submerged. The relative height of the four most pronounced peninsular bosses of glacier Bay. is 3200′ / i. e. 2600′ above and 600′ below the sealevel / on the immerside and over 2000′ on the outer, the mainland side.

It is difficult to say, that these forms, which amount in avertical scale to 1/2 - 2/3 of the pleistocene, are small bosses, or even, that they correspond quantitatively to the irregularities of the niver-bottom at the depth of the river during flood stages, during which these irregularities are formed.

In view of the conditions, above described I find it very hard if throughout possible to ascribe the forms of the marginal bosses to glacial erosion. On the contra-

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ry I find that these forms are very easyto join genetically to the processes of the water erosion,which was devedted and deformed by the accident of glaciation.

In the theory,which was developed in such a manner ,I still see one question which ought to be cleared.. We saw,that the insular bosses are in all cases lower that the peninsular bosses.This fact,which is unquestionable,could be treated from the point of view of a powerful glacial erosion as supporting this view.One could namely explain the lower height of the first bosses by the fact,that they were buried under a thicker ice mass than the second bosses,which were also scoured for a shoster time than the former.But in spite of the apparent connexion,which existe between these features and the glacial theory,it seems to me impossible to support this point of view not only because of the deduction which I have made above.But also oneought to have regard for the fact that the ancient river valley was incomparably narrower than it was after the glaciation,and that its widening was a function of the continuons widening of the icemass stream.But from the point of view of glacial erosion this could only be effectiv and in every case principally effective on the lines of ancient normal valleys,because only there during the accident of glaciation a more important concentration of the ice flow was reached.Outside the channels of the normal valleys the thickness was generally too small to overcome the friction of the bottom which opposed the icemovement.In no stage of the life of the glacier was the oportunity given it to develop a strong erosive sculpture on the slopes of the ancient normal valley. We can imagine,a widening of glaciated valleys by slow and continuons scouring and polishing of the valley borders,but we must expect that the principad work of the glacier is indicated by the lines of the greatest concentration of iceflow and

following the effect of this work must at first be seen in the overdeepening of the mainvalleys. It would be, of course, a special glacial sculpture, but htis special kind of sculpture is not at all to be united with the characteristic sculptures, showad by the marginal bosses. If this sculpture, executed on the borders or on the terrasses and highlands bordering the ancient normal valleys, is to be treated as inappropriate to glacial processes, one must at the same time confess that it can be and is also probably very common to the processes of water erosion, which is deformated by the accident of glaciation. This supposition is supported by the fact, that the thawing of ice is not only common on the ice front but also far above it, and there especially on both glacier borders, where the ice comes in contact with the dark, warm rock. On these iceborders, where the iceerosion is nul, the torrential erosion of the subglacial water attains its Maximum. But these lines of a Maximum torrential erosion wander with the developement of glaciation in parallel lines towards the lateral watersheds by this process prepared the widening of the glacial valleys will be, rich in bosses arranged in one or more parallel systems.

By this deduction not only the existence and the special kind of the forms can be explained, but also the fact that the height of the bosses reels towards the borders of the glacial valley, finally even the striking fact, that huge and high bosses are especially common to the valleys, which were most intense glaciated during Pleistocene.

The morpholocical relations of Glacier Bay described above prerefone more thing, which must be pointed on,: the mainland was during the Maximum of glaciation at least 500'- 1000' higher elevated than it is now, could not be the fluviatile origin of the straits, which separate the island bosses from the mainland explained. but this supposition is in no collision with the experien-

ce,made up to now by the explorers of this country.

The problem of the changes in sealevel or the movements of the earth crust lead us to a discussion over another morphological feature which is very common to the landscape of the inland passages and which must be regarded as great importance to the answer to the question of glacial erosion.I mean the existence of several base - levels in the morphology of the inland passages and in Alaska.

During the glacial studies,which I made in the Carpathians and in the Alpes I was cuight to pay great care to the terraces and other base - levels,and for this reason I gave the highost interest ti this feature during my journey in the inland passages,I noticed and sketched the base - levels all over the country where the forms were developed clear enough only and where some garantee could be given that a mistake could be partially at least excluded.For diminishing the risk of a mistake I appreciated in most cases the distance of the observed on levels the Charts and appreciaded their height by means of the clisimetre.

As a result of these observations I came to the conclusion that in the whole part of the traversed country between the 50° and 58° of latitude / Gastineau Channel/ one can discern very clearly besides the contemporaneons base - level of the sea three other ancient base - levels which are elevated to the following approximative heights : 50′- 100′,700′- 1000′, and 2700′ - 4000′ .All these levels are so well marked,that even the occurrence of higher residual forms on each of these levels does not obscure their ensemble.I have sketches based upon observation from the following points: Vancouver Isl. / 50 1/2°N/, with level I -III,Calvert Island / 51 1/2 °/ two observations with I - III,islands in Fitzhugh Sd / 51 1/2°/ with I and ~~x~~ II,Pears Island in Portland Inlet /55°N/ with I - III,Kinkblith in Observatory Inlet / 55°N/ I-III,

north part of Observatory Inlet / 55 1/2 °N /with I-III, Gravina Island / 55 1/2°N/ with I and II, Prinz of Wales Island / 55 3/4 ° N / with I-III, Douglas Island/ 58 1/2 ° N with levels I-III.

Below the lovest - th I st. - level are cut the deep valleys, which being now submerged represent a very intricate net of fiord - channels and inlets. The question, which aight to be cleared up concerns 1/ the age of the ancient levels of denudation; especially the age of the louest level and 2/ the derivation of the valleys changed into fiords; ,which are cut. In my 6pinion both questions are closely connected and I seeein explanation of them, only two eventualities, which must both be counted with the supposition, that the lowest level is of prepleistocenic age. The first eventuality, based upon this supposition is that during the pleistocene the land was here throughout stable, and in this cases the fiords are exclusively due to the glacier erosion, which was independent of the sealevel and the second eventuality that after the stability of the cartherust to which, came during the pleistocene an upwards movements and the vuilding of the in this case the fiords must be regarded as rejunevated valleys, which vere eroded by subglacial streams and afterwards again submerged.

From this deduction I see two possibilities: the fiords are products of glacial erosion if the land was during the pleistocene stable; or they are products of water erosion, the land stood at that time higher. For the last supposition found notting during my hasty visit, the one fact, at which I was surprised: I missed namely in general the existence of morainic deposits on the whole route of inland passages and the only section, which was found abundant in mordines is the region between Icy Point / near Brady Glacier/ and Yakulat Bay; and it is remarkable, that the whole eouast lacking moraines is indented by fiords, and the coast rich in moraines is strikingly monotonoas. We are accustomed to over look the connection between the facts observed and I found it in the supposition, that these different parts of the co-

ast owe their special morphology to differential movements and warpings,which this coast ruffered in the last moments of its developement.

As well as for the last eventuality I also found nothing which could support the first one,excepting the one fact, that the fiord channels show some distinct irregularities in their submarine morphology,which is quite consistent with the theoretical views concerning the forms caused by glacial erosion.But besides the one morphological feature,which can perhaps be explained with more probability by processes of glacial erosion and also by processes of glacial accumulation,I found more features , which can be called to witness against the supposition of the stability of the scalevel during pleistocene and which is closely with it the supposition of glacial origin of the fiords connected ~~with it~~ .Without repeating the reasons already before given for this opinion I will now restrict my analysis to the motives connected directly with the problem which is now treated of i.e.with the question of the movements in the sealevel.Accepting the view,that the sealevel,during the long stay of which the /I/ lowest base - level was formed,did not change during the whole pleistocene,we must at the same time confess,that the fiords owe almost exclusively their origin to glacial scouring and that all the fiords are subnerged hanging valleys.But against this deduction made already by many glacialists I must/oppose/two questions: 1/ why ~~it~~ is it that all these valleys,which were scoured by glaciers not strong enough to be submerged after the recession of the ice,are scoured just to the contemporaneous sealevel? and 2/ that the lowest base - level,representing a levelled land surface from the time preceding the glaciation was saved from glacial scouring,when at the same level in many places a tremendoous glacial erosion took place? In short we see these two facts: the lack of hanging valleys above the sealevel and the existence of the lowest base - level are two striking features in the landscape of the inland passages,which seem to be quite inconsistent with the supposition of the gla-

cial origin of this landscape.But it is very easy and inviting to hing the same feature into connection with pleistocenic upwards movements of the land.Doing eo,and supposing that the movement was not of sufficient duration, we find it clear that 1/ the rejunevation had only taken place in the main valleys of the country;and as it lasted for proportionallya short time,the lastbase - level of denudation the / I - st level / could be saved nearly everywhere; 2/ the minorvalleys were not affected by rejunevation and for that reason after the return of the sea to the level which it had already attained in pleistocenic time these valleys are almost agraded.

This was my deduction supported by my own observations, which I made during the journey.I was at this time not yet acquainted with the special literature of this district and I must confess the swiprise,which I felt at the information,receiwed on my se from Alaska,that the existence of the first,lowest base -.level was already recognized by G.K. Gilbert the famous geologist,who at the same time amons the congress -porty was shoken of as the first authority,by whon the theory of glacial erosion in the Alaskan fiords was principally supported.

Acquaintance with the work of G.K.Gilbert [1.] was my first need.I have already given my opinion in this matter-;I found namely that in oof „an apparent sympathywith the theory of glacial erosion ",which is common to the work of Gilbert and notwithstanding,that he can be „with full right counted among the founders of the school of overdeepening ", G.K. Gilbert is „in his deductions never unilateral and in his statements doors are always left open also for an other interpretation of the glacial morphology than by the processes of glacial erosion ".Perhaps in no question we can with more right point ont this opinion about the work of Gilbert

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1. Alaska Harriman Expedition.Vol.III.Glaciers and Glaciation by Grove Karl Gilbert.N.York.1904.The numbers giben in brackets corresponds to the pages of this work.

as in the question of epeirogenical movements,which this countr„ suffered during Pleistocene and in the question of conservation of the first base - level in the Alaskan landscape.

The views of Gilbert in those problems are the following: The first base - level of denudation in the „inland passages," which is absolutely the same as recognized by me was in the opinion of Gilbert formed during the prepleistocenic time by the position of the sealevel,which could not have differed greatly from the present " /p.131/ 1. Gilbert repeats the same opinion in the description of the low peneplain on Kadiak Island / p.182/ The preservation of this peneplain is for Gilbert a proof of the opinion,that „the glacial degradation must have been locally quite moderate,or the general plain character would not have survived " /p.131 /.In another place,where he treats of the problem of glacial erosion,he again looks for the reason of the preservation of the low peneplain.In this statement Gilbert developes nearly the same deduction,as was given by Brückner in explanation of the „bosses " which were accompanied by no visible chemnat,to which the processus of overdeepening could be ascribed. „The remnants of low peneplain,says Gilbert / p.160 / were preserved,despite the softness of their rock,because they lay outside the lines of flow of the strong currents ." This supposition of such surprising inequalities of glacial erosion,as shown by the existence of low peneplain in the landscape,which is as a whole regarded as if it had been sculptured by glaciers seems in Gilberts opinion to be supported by the exceptional character of the remnants of the low peneplain.Gilbert ont several times points this exceptional character of these morphological remmants,which were found by him only on the island of Annette and near Sitka.But therein lies the only difference which exists between the views of Gilbert and my own in this matter.I saw the low peneplain in at least ten

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places,one of which I found in common with Gilbert Gravina Island and besides them Gilbert himself and many others saw the same level also well developed in the other Alaskan islands and aven on the mainland / Prince Willim Sound,Seward Peninsula /.[1] The general preservation of the low peneplain,which as stated by Gilbert,is a product of degradation of the softest layers in the structure of the landscape of inland passages is an important moment in the treatment of the problem of glacial erosion and I thinh a certainty in this respect would not only change my views on the theory of glacial erosion,but also those of others. On this occasion I will also look at another detail for balance in the differances,which exist between my observations and views of Gilbert sees in the morphology of the inland passages only two,the high and the low peneplains while I see there boselevels.This middle level was observed by me I have as many times shown before and it gives some indications that we are in accord with Gilbert if not in the interpretation of facts,at least in the identification of the observed facts. Gilbert saw as well as myself in Gastineau Ch. near treadwell one level at a height of severst hundrell fect / perfectly shown in the photogiven by Brooks in his Geography and Geology of Alaska.U.S.G.S. Prof.Pap.45. p.20 Plate IV A./;the same level Gilbert saw only about Wrangels Island and regarding the distance of these points from the oceanic shorelim he concluded,that this higher level corresponds with the low peneplain from Sitka and Annette Island - This question can be regarded as opers but opposed to the interpretation of Gilbert can be urged 1/ the fact,that in the far aff shore inlet ad Portland Ch. both levels,the low and the middle are well represented 2/ the supposition of Gilbert,with which I very well agree, that the prepleistocenic sealevel was the same as the contemporaneons.

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1. Viz. U.S.Geol.Surv. Bull. N-o 328 p. 47,300-305.
U.S.Geol.Surv. Bull.N-o 443 p.17.

/27/.

Gilbert him was surely the first,who towh in to account all the consequences which could be developed from the fact of preservation of the low peneplain,although it was only partially and even exceptionally in his opinion.Speaking of the fiords, which are cut below the first baselevel,Gilbert proclaims without any restrictions that „those water - filled valleys are clearly products of erosion". / p.135/,the only question is the amount of change,executed on the floor of these river - valleys by glacial erosion and deposition.„Whatever the extent to which the hollows were deepened and enlarged by glaciers,it is probable not only that they were initiated by rivers,but that same of the rivers sunk their beds considerably below present tidelevel "./p.135/.

With this point we enter on the most decisive moment of the discussion about glacial erosion.Gilbert,supported by studies,which were made by Bailey willis in Puget Sound acctepts the existence of crustal movement during pleistocene./ p.135 and 136/ as faras concerns the amount of the difference between the present and pleistocenic sealevel Gilbert estimates it be to „at least 500 fect,and probably 1000 fect or more " / p.136/ and the consecution of processes,which were connected with this movement Gilbert describes as follows : „It is a noteworthy, and probably significant,fact that the oceanic base- level of the region,after resting for a long time at the height indicated by the low peneplain,dropped below it at the time of the excavation of the fiords and then returned to approximately the same position "./ p.184/.

Besides the fact proved by Willis,the filling of preglacial valleys during glaciation,Gilbert points ont the absence of morainic deposits on oceanic shorelines as one of the most common features,by which the lower sealevel during the Maximum of glaciation is demonstrated. / p. 165 - 167,176 /.

The differences between my views and the opinion of Gilbert in this matter which will be falled quite insignificant.The remaining differences are limitated to two moments,which are both more or less hypothetical : Gilbert is for first inclined to

conseder the changes,which the relation ~~suffered~~ between the land and sed suffered during Pleistocene to direct movements of the sealevel. / p.184,185 / I am on the contrary an adherent to the view differential epigenetic movement of the land.For both opinions there are many indications,both are ,also given by Gilbert ,but the solution of this question asks still deeper stady. The scoond difference exists in the evaluation of the amount of mevements. Gilbert accepts in this matter the limits,given by the studies of Willis in Puget Sound / and it is interesting, that I was brought to the same limits by my more detailled consideration of the morphological features of Glacier Bay.But convinced by the morphology of the inland passages, which show as many superficial patterns of Glacial polishing and as little indications of internal modification of the landscape / below the pleistocenic névé - line /. I came to the conclusion,that the crustal movements reached this extent during Pleistocene which is indicated by the depth of the submerged valleys. Quite different is the opinion of Gilbert in this matter: „/ p.136 /.

„When we once agreee,that by the climatic changes,which cause the descent of the snow line the shreamerosian will not be abolished,but only deformed,heaviest foundation stone of the theory of overdeepening has fallen.

15/V. 1914.