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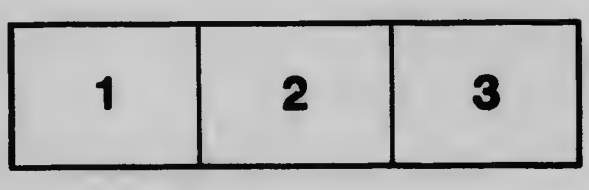

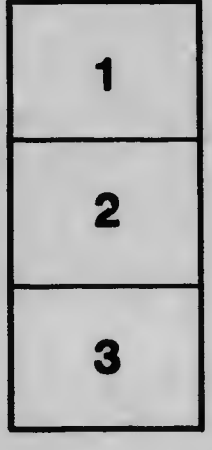

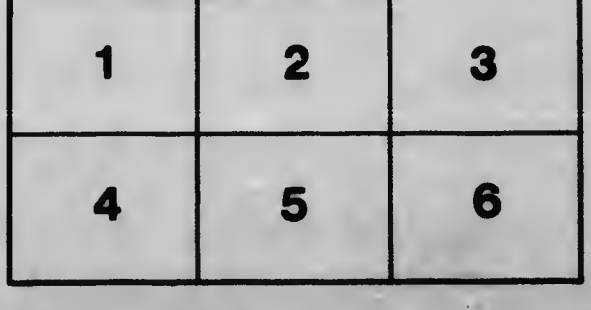

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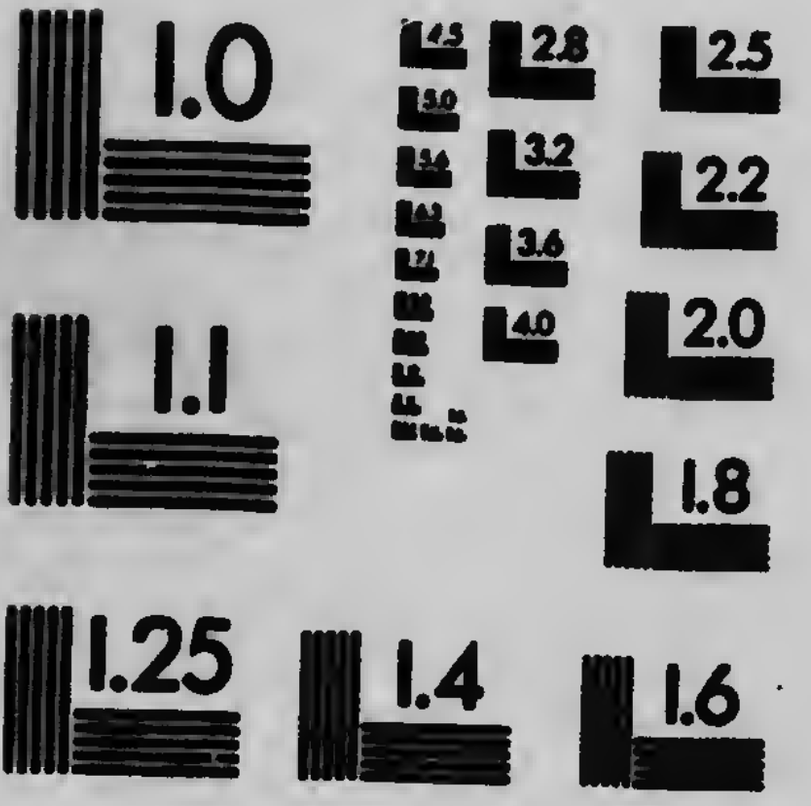

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REPORT OF DR. A. SANDBERG, ON THE COPPER BEARING TRAPS OF TH. COPPERMINE RIVER,

PRESENTED BY

JAMES DOUGLAS, LL. D., NEW YORK.

THE COPPER BEARING TRAPS OF THE COPPERMINE RIVER.

By JAMES DOUGLAS, NEW YORK.

(*Annual Meeting, Ottawa, 1913.*)

The copper-bearing traps of the Coppermine River, within the Arctic Circle, have received more attention at the hands of the historian and traveller than of the petrologist, miner or metallurgist. Mr. Tyrrell's collection of references, published in last year's Transactions of the Institute, is practically exhaustive of the literature of the subject to date. I desire, however, to supplement this information by quoting one or two extracts that he has omitted or that seem worthy of repetition *in extenso*.

After the abortive expedition from England in 1719 to look for the Coppermine River, a Committee of the House of Commons took evidence on the subject. The next important reference was made by Joseph Robson in his "Account of a Six Years' Residence in Hudson's Bay between the years 1733 and 1746." In it he blames the Company for its lethargy in the rôle of a discoverer. He says:

"There are the strongest appearances of rich mines in various parts of the country. I have seen pieces of shining ore which were brought from Knight's Hill, about thirty miles east by south from Churchill River. And it appeared from the evidence before the Committee that ore had been brought to the southern factories, of which buckles were made; that there is a valuable lead mine upon the east main, the ore of which was produced, and that native cinnabar was found upon the coast between Churchill and Nelson Rivers, from which quicksilver was extracted and a specimen of it sent to the Company. There are also the strongest probabilities of there being a rich copper mine northwest of Churchill River. I have seen several pieces of this ore; the Indians of those parts wear them by way of ornament about their necks and wrists; and a man who was present upon making the settlement at Churchill River informed me that the Indians had ice chisels and other implements made of this copper; and the people at the factory called them Copper Indians

by way of distinction, as by their own account they came from that part of the country where the mine is situated. But notwithstanding the agency of such a variety of proofs, the Company have set it at defiance, and made not the least sincere and effectual effort to push the discovery of these mines. Nay, for the sake of invalidating the evidences for the copper mine, their friends have even ventured to assert that the copper brought down by the Indians was not the produce of a mine, but broken pieces of brass guns belonging to a Danish wreck which they found upon some coast."[1]

Mr. Tyrrell mentions Thomas Simpson's reference to the copper-bearing rocks on the islands of Coronation Gulf and Bathurst Inlet in his "Narrative of Discoveries on the North Coast of America in 1839," but its importance justifies its quotation in full:

"On the 17th (June) the ground was frozen hard, but the wind decreasing in the afternoon, we carried forward our baggage to the Dismal Lakes, where the ice lay as solid as in midwinter and the hills glistened with snow. A branch of the Copper Mts. stretches along the northern sides of these lakes, out of view, except at the lower part near Kendall River, where the natives report having found large masses of metal. Some metalliferous stones were picked up here, but we had no leisure to prosecute our researches farther."[2]

Regarding the discovery of copper on Barry Islands he says:[3] "A breeze springing up from the northeast, we sailed across Arctic Sound, and at 8 P.M. encamped on Woolaston Point. . . . . Very early on the 31st (July, 1837) I observed from the summit of the rocks, the gradual formation of a narrow lane of water stretching across towards Barry Islands. We immediately embarked and effected the traverse in two hours. . . . . On the 2nd of August we extricated ourselves from the ice, the northerly winds continuing, we sailed around the south side of the island, which is about six miles long and two wide. Then, crossing a broad channel leading to the southward, we landed on the next island of the same group, which appeared

1 Robson, Page 60-61.
2 Narrative of discoveries on the North Coast of America, by T. Simpson, Page 252.
3 *Ibid*, Page 279.

of great extent. From the top of the lofty trap cliffs I discovered a narrow part with water on the northern side. It proved a high rocky isthmus a quarter of a mile broad, across which we carried the boats and cargoes. After rowing about half a league we had to break our way through a stream of ice, and a few furlongs further came again to the edge of the main body of ice, where we encamped at 9 P.M., having by our toilsome and circuitous route advanced only eight miles of direct distance. Our detention, the following day, was amply compensated by my fortunate discovery of several pieces of pure copper ore. They were lying amongst the debris at the foot of a crumbling rock, which had evidently fallen from the trap hills above. The cliffs were everywhere stained with verdigris, indicating the presence of the metal, which undoubtedly abounds in these islands. Coloured quartz crystals and vesicules were frequent, and I preserved specimens of the leading rocks, both here and all along the coast."

The information, however, from all these sources is very vague, the only scientific data being those of Dr. Richardson and of Dr. Flett's determinations of the collection of specimens brought back by Hanbury.

I am fortunately able to lay before the Institute some little addition to our knowledge of these rocks, gained by a party of three young men, consisting of Mr. George M. Douglas and his brother, Lieutenant Lionel Douglas, of the Canadian Pacific Steamship service, accompanied by Dr. August Sandberg, a Swedish chemist and geologist, who visited the Coppermine River in the autumn of 1911 and the spring of 1912. Dr. Sandberg could report only upon one section of the copper-bearing traps, those to the west of the Coppermine River, owing to the ice breaking up when they reached it in May, and the water remaining too high to cross the river prior to the date of leaving it on the 17th of June.

I present Dr. Sandberg's report in full, and the result of Mr. Graton's examination of the specimens brought back by Dr. Sandberg:

REPORT ON A RECONNAISSANCE ALONG LOWER COPPERMINE RIVER, CANADA.

ITINERARY.

"On the 25th of May, 1911, George M Douglas, L. D. Douglas and I a party of three, left Athabasca Landing with the object of reaching Coppermine River in northern Canada, and of making investigations over the copper-bearing rocks, known to exist at this river and along the Arctic coast east of Coppermine River. George M. Douglas, acting as chief of the party, had previously made arrangements with the Hudson Bay Company for our transport to Fort Norman, which lies at the confluence of Great Bear and McKenzie rivers. From this point we were dependent on our own resources for reaching our destination.

"On our way down we had bought a York boat to take our equipment up Great Bear River, and across Great Bear Lake to its eastern end where we intended to make our winter quarters. At Fort Norman, where we were landed on the 5th of July, three days were occupied in negotiating for Indians to help us track the boat up Great Bear River, a distance of approximately 90 miles.

"On the afternoon of the 8th of July we were ready to make a start, with a crew of six Indians and ourselves, and after six days' travelling we arrived at the lake and landed at the old site of Fort Franklin. At this place there is a settlement of Great Bear Lake Indians. We discharged the Indians and on the 16th we hoisted sail and started on our journey across Great Bear Lake. After eight days, during which time we were frequently stopped by calm weather and unfavourable winds, we reached Dease River and selected a place for our winter quarters, three miles up the river at the foot of the first rapid. Of the old Fort Confidence, situated opposite the big island in the eastern end of Dease Bay, a few miles west of the mouth of Dease River, only the chimneys remain standing. At the place selected for our winter quarters there was already a house, built and occupied during the previous year by Joe Hodgson, an old Hudson's Bay employee. We named the place Hodgson's Point. We stored our supplies in Hodgson's house and made preparations for our departure for Coppermine River. L. D. Douglas remained at Hodgson's Point to build our winter quarter.

"On the 28th of July, George Douglas and I started up Dease River with a canoe, loaded with our supplies. Dease River is a shallow stream with numerous rapids. We made many portages of all or part of our stuff around shallow boulder-strewn rapids. The first 15 miles are a series of rapids with short stretches of quiet water between. About 15 miles up, the river cuts through a limestone ridge, forming a gorge with perpendicular walls and a strong rapid at the head of the gorge. A couple of miles beyond this gorge comes a stretch of quiet water about 10 miles long, to be succeeded again by a long series of shallow rapids. Approximately 45 miles up, the river breaks through a granite dyke, which for miles traverses the country in a southwest-northeast direction.

"A few miles above this dyke the river meanders sluggishly with many curves and cut banks through a sandflat, which terminates east in a peculiar shaped, flat-topped sand hill. This hill, to which attention was first called by Hanbury and which we named Hanbury's Kopje, lies at the confluence of the two upper branches of the river about 70 miles from the mouth.

"It was our intention to take the same route as Hanbury followed on his way from Coppermine River to Norman. He came from the west end of Dismal Lake down a branch of Dease River, which he called Sandy Creek. This route has the advantage of a short portage over the divide estimated by Hanbury to be 3 miles. His description of lower part of Sandy Creek is very vague and we were in much doubt which of the two branches, joining at Hanbury's Kopje, was the Sandy Creek.

"We spent a few days investigating the two branches and surrounding country before we made up our mind to take the northern branch, which proved to be Sandy Creek. It was the evening of the 2nd of August when we arrived at Hanbury's Kopje, and on the morning of the 9th we started up Sandy Creek. This creek is very shallow; in many places only four inches of water trickle over the sandy bottom. A few miles up we had to make a two-mile portage. The creek spreads out over a sandy bed with insufficient water to float an empty canoe. Above this stretch the same conditions—stretches of shallow water over sand

bars alternating with deeper water—prevailed until well up towards the head of the creek, where the water is deeper, but the creek narrows down to a mere ditch.

"On the 11th, in the afternoon, we reached the source of the creek, a distance of about 12 miles in a straight line from its junction with Dease River. In the afternoon we walked over the divide to Dismal Lake to investigate the portage. We found that we had a six-mile portage to make, but we could take advantage of a number of small lakes or ponds on the road. The divide is low, the ascent scarcely noticeable. We met a lone Eskimo at Dismal Lake, who was rather surprised to see two strange men appear of a sudden. We made the portage across the divide in two days. From the top of the divide to Dismal Lake our road followed a gulch about three miles long, the hills flanking the gulch, rising 300 to 400 feet.

"On the following day we paddled down Dismal Lake and camped in the evening at the 'upper narrows,' a channel about a mile long, that connects the western long lake with the middle one. We found many evidences of Eskimos at this place and during the forenoon of the next day, the 15th, we were on the watch in the neighbourhood in the hope of finding some of them still remaining, but without success. In the evening, we camped at the head of Kendall River, which conducts the water from Dismal Lake to Coppermine River. Dismal Lake (called *Teshi-erping* by the Eskimos) is a long narrow body of water, measuring about thirty-six miles from the northwest to the southeast end. The western part of the lake gives the impression of a great cleft in the rock, widening out at the extreme western end, and sending a pointed bay towards the south. The shores are rocky and high. Further east the high land recedes, the shores are lower, and in some places deep bays cut inland; virtually it is three lakes, connected by short narrow channels. The middle lake about seven miles long, is confined between basalt shores. No trees grow except at the extreme ends of the lake, where there is a scanty growth of spruce.

"On the 16th of August, we ran down Kendall River, which took us seven hours. Kendall River has many rapids, some of

which are bad to run at this time of the year. It empties into Coppermine River through a gorge, cut in limestone, and leads the way into the gorge over a swift and curving rapid.

"The following day was occupied in making repairs on the canoe, which had received some damage during the descent of Kendall river, and in making some investigation in the surrounding country; and on the 18th of August we went 10 miles down the Coppermine River and camped at the foot of Copper Mountain at the Great Bend of the river, after three weeks' journey from Hodgsons' Point. We remained here for one week, making investigations at the base of the Copper Mountains on both sides of the river, before we started homeward.

"According to Franklin and Simpson, the rivers and small lakes in the country through which we travelled, freeze up early in September, and it was necessary that we should return while the water was open.

"Upon our return to Hodgson's Point towards the middle of September, we had a short spell of cold weather, which temporarily ice-bound the quiet stretches of water on Dease River, but the actual 'freeze up' did not take place until the middle of October.

"On our return trip we had intended to make some investigations over the basalt beds north of Dismal Lake, but continual dense fog made it practically impossible to accomplish anything. During the winter we received notice from the Hudson's Bay Company's district manager of the McKenzie District, that the steamer *McKenzie River* would leave Fort Norman about the first of August 1912, on its last trip south. That made it imperative for us to get to the Coppermine River at the earliest date, permitting of field work. We decided to haul our supplies by dog-sleigh in the early spring to Coppermine River. This we accomplished during April and beginning of May. Our route was along Dease River to the headwaters of its main branch, a lake called A-ping, over a low divide to Teshi-er-ping mountain and along the southern edge of the basalt formation to Coppermine River, a journey, with a loaded sleigh, of five days without any undue exertion.

"On the 12th of May we had all our supplies at Coppermine River and a camp established at Stony Creek. It proved an easier task to move the supplies in the spring on the snow with dog-

sleigh than in the summer with canoe. There was still too much snow on the ground to do any work, but just after our arrival we had a few days' warm weather, which practically cleared the Coppermine River valley of snow. We proceeded alc the river to the Arctic Coast, packing what supplies we needed on the dogs and ourselves.

"On our return, the 8th of June, to Burnt Creek, the snow-drift which had occupied the valleys along the cliffs in the mountains were practically gone. The 16th of June we concluded our investigations at the Copper Mountains, and started on our homeward journey the following day.

"During our spring travelling we had the valuable assistance of J. Hornby, an English traveller, who wintered at Great Bear Lake, and of his dog team.

TOPOGRAPHIC FEATURES.

"No high mountains exist in the area here considered, which extends from Dismal Lake eastward to a few miles beyond the 116th Meridian, and trends northward approximately following this meridian from 67th parallel to the mouth of Coppermine River.

"The Copper Mountains, by which term the high land trending east southeast from Dismal Lake to Coppermine River and beyond, is designated, are formed by a series of basalt ridges with the same general trend as the range, and occupy a belt about fifteen miles wide. Towards the south they terminate abruptly in a nearly straight line, for miles, dropping with a perpendicular wall to the broad valley of slight relief adjoining the mountains to the south. The mountains attain only an elevation of 1200 to 1500 feet, presenting the appearance of a plateau, interrupted by a number of mutilated ridges, facing south with perpendicular cliffs of varying height, and sloping gently towards north.

"The Coppermine River, traversing the valley, with a northerly course to the south of the mountain, enters the Copper Mountains about five miles below Kendall River. Striking the hard basaltic rock it curves eastward and assumes a course practically parallel with the trend of the basalt ridges for a distance

of 20 miles, before it cuts its way through the ridges with a curve toward northwest and finally emerges with a northerly course

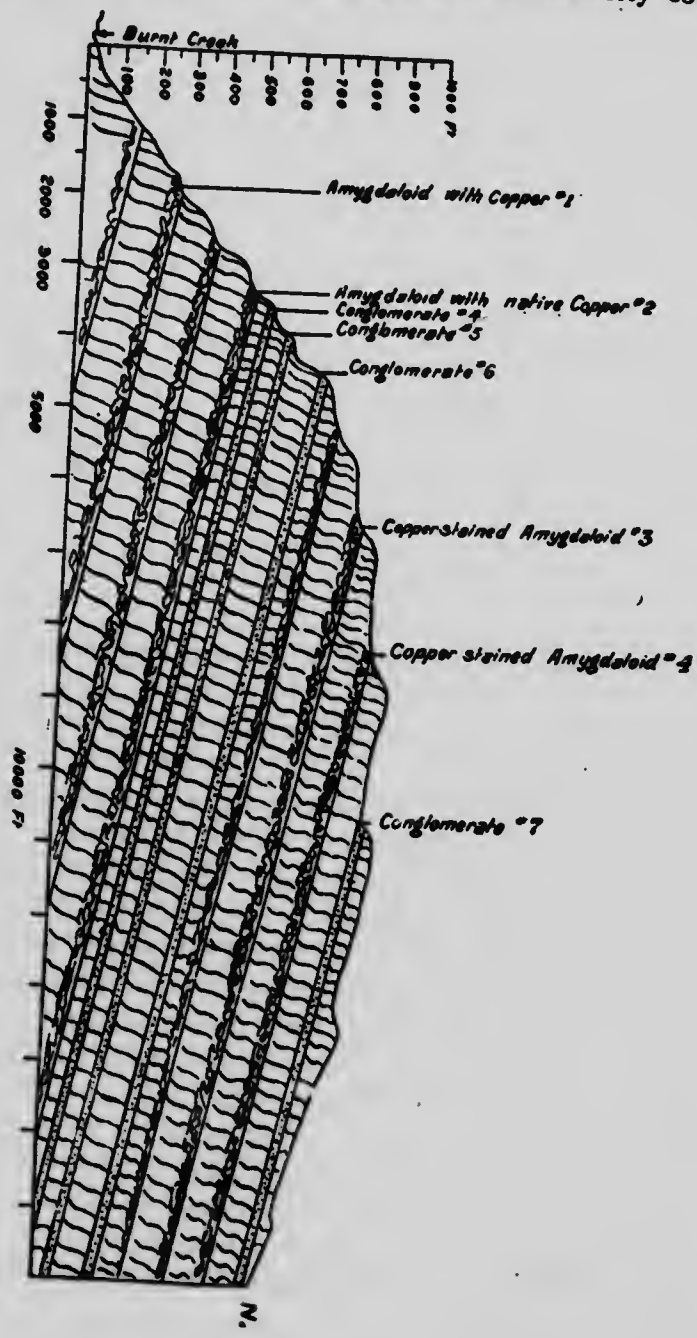
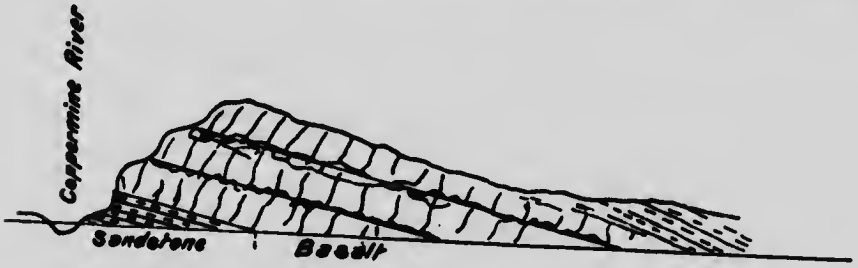


FIG. I SECTION OF HILL NORTH SIDE OF BURNT CREEK

on the plain to which the Copper Mountains slope towards north. In its passage through the double curve the river has cut deep, and in some places has made a narrow valley through the mountain. A number of small creeks flow at right angles into the river and drain the mountains through narrow, constricted gulches in many places dividing the hills in detached blocks. From the valley the mountains rise by steps in the nature of terraces to the summit. The highest altitude is attained by three



SECTION OF BASALT RIDGE NORTH OF SANDSTONE RAPIDS
(Vertical Scale Five Times Horizontal)

adjoining peaks at the point, where the river begins its eastward course. The bottom of the valley in many places is occupied by low ridges and small hills consisting of clay and gravel of glacial origin. On the northwest course of the river, where the valley is quite broad, these clay and gravel deposits extend about a mile from the river on the south shore forming a typical miniature glacial landscape. A good growth of spruce is sustained from this soil, especially along the north shore of the east course and on both sides of the northwest course of the river.

"To the north of Copper mountains the country presents the character of a plain with slight relief, traversed with narrow basalt ridges of the same general trend as the Copper mountains. Only the first and last of these ridges attain an elevation of about 400 feet. Through this plain the river has cut a channel about 100 feet deep with perpendicular sides of sandstone, alternating in some places with shelving clay banks. Where the river cuts through the basalt ridges the channel becomes tortuous and constricted to about 50 yards and less from its average width of about 300 yards.

GEOLOGIC SKETCH

The results of our observations regarding the distributions of the geological formations are represented on the accompanying geological map. In making the map the observations of latitude and longitude made by Franklin have been used. All locations represented on the map have been made with compass and pacing. Magnetic Declination 48° East.

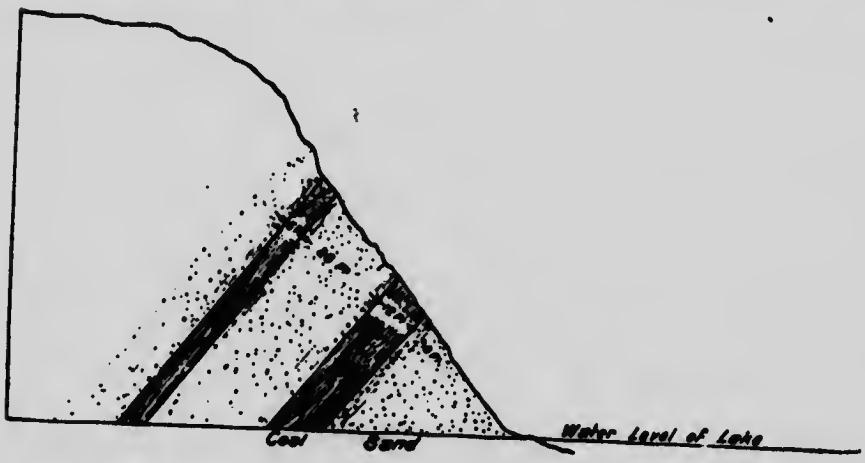
LIMESTONE

"Along the southern edge of the Copper Mountains limestone form part of the cliffs, with which the mountains frequently terminate toward south. On a fresh fracture surface the limestone shows a highly crystalline texture, generally fine to medium grained, of impure white or grey colour, which sometimes has a reddish tinge. Further south between the mountains and Kendall River the in part precipitous west shore of Coppermine River is composed of limestone cliffs about 100 feet high At the exposure in the gorge, through which Kendall River flows into the Coppermine, the limestone beds are interleaved with thin strata of fine-grained red sandstone. The dip of the limestone is flat towards north under the mountains.

COPPERMINE SERIES

"The Copper Mountains are composed of a series of superimposed flows of basaltic lava, which occupy a belt about 16 miles wide in a direction at right angles to their strike. Their lateral extension is large, probably reaching east more than 200 miles across Bathurst inlet, where Hanbury describes the occurrence of salt with native copper. Westward, and about 40 miles north of great Bear Lake, there is said to exist basalt, exhibiting the same general character as the basalt at Coppermine River. Interstratified with the basalt are a number of detrital beds of reddish conglomerate. These occupy various horizons, but as far as our observation goes, they are more numerous in the upper part of the series. The basalt occurs in distinct beds of varying thickness, striking approximately parallel with the range.

Westwards at Dismal Lake the beds strike east 22° south and show a dip of only 8° towards north. At the great bend of Coppermine River the strike is approximately east 12° south and in the upper part of the series at Burnt Creek, the beds strike a few degrees north of East. The most common dip is 12° north. The effect of the bedded basic rock upon the topography is everywhere marked; a steep cliff facing south and a long backward slope towards north forming a shallow drift covered valley between the crest of one and the rising cliff of the succeeding bed. The small streams draining the mountains into Coppermine River divide the hills in detached blocks, rising terrace-shaped from the bottom of the valley.



SECTION OF COAL BEDS AT GREAT BEAR LAKE

"Some thick beds show columnar jointing in their exposed cliffs, but more often the jointing has broken the beds into irregular blocks with the jointing surfaces dipping steeply towards north. Usually the beds present a twofold division, an upper narrower amygdaloidal and a lower compact nonamygdaloidal portion. The lower massive part of the bed is dense, crystalline, medium to fine grained, of dark gray nearly black colour, which in some places change to reddish brown. The compact and amygdaloidal portion of the bed, grade into each other through an intermediary zone with scanty development of amygdules. The amygdaloidal phase of the flow is usually covered by debris

from the crumbling cliffs and drift material. The slope of the bed is always covered with grassgrown soil, through which little mounds of broken amygdaloid frequently stick up. In some of these the pieces show worn edges, while others contain pieces only with sharp edges and corners, indicating their connection with an amygdaloid bed at the place which is otherwise covered. Frequently these broken amygdaloid pieces contain small chips of native copper in the amygdules.

"The matrix of the amygdaloid is dense and shows usually sign of alteration in various stages of progression from comparatively fresh to completely altered to epidotite. In some places the alteration has proceeded to such an extent that only a crumbling mass remains with harder portions of epidotite. Such is the case at Burnt Creek where an amygdaloid of this character was found, containing chips and flakes of native copper in the altered rock, and at Copper Creek where an amygdaloid outcrops, which shows prominently as a reddish mass with intermixed epidote. Some native copper was found in this bed also. The amygdules are filled with calcite, zeolites, epidote, chlorite quartz, a red mineral which probably is secondary orthoclase and native copper, one or more of these minerals filling the cavity. The amygdules show some variation in size and form. They are usually small although amygdules measuring more than 6" were observed, in one place. At north shore of Dismal Lake an amygdaloid with elongated compressed amygdules, suggesting a viscuous flow, occurs.

"In places [illegible] fissures penetrate the beds, forming sometimes a network of s[illegible]ll seams, traversing the shattered rock. They are filled principally with calcite, sometimes containing chalcocite. Fissures of this kind were observed striking nearly north and south and east-west. The conglomerate beds, which occur interstratified with the basalt beds, consist of pebbles of basic rock, pebbles with amygdaloidal development predominating. The matrix is apparently of the same material and is frequently permeated by calcite.

"To the north of Copper Mountain a sandy shale overlies the basalt bed and is succeeded by fine to medium grained sandstone, which continues north to the Bloody Falls, a distance of about 30

miles. Both shale and sandstone are of dark red to brown colour. The sandstone consists of grains of quartz and feldspar, with a highly ferrugineous matrix. The feldspar grains, which are smaller than the quartz grains, predominate. These sandstones are similar to the sandstones in the "Nonesuch" group of Keweenaw series. The deposition of the sandstone was interrupted at four different times by eruption of basalt, which flowed over the floor and became interbedded in the sandstone. (Fig. 2.) None of these flows attained more than a few hundred feet thickness. The rock shows a somewhat coarser crystalline texture than the basalt at Copper Mountains and the amygdaloidal phase of the flow is either scantily developed or non-existent. Between the last two basalt ridges occurs thin strata of a greenish grey slate interbedded with the sandstone. Judging from the appearance the islands in Coronation Gulf beyond the mouth of Coppermine River and the capes on the west shore of the gulf are composed of basalt ridges.

DYKES

"At the foot of Sandstone Rapids a dyke, striking south 17° east, crosses the river. The dyke, which stands perpendicular, measures 100 feet and consists of plagioclase feldspar and a ferromagnesian mineral. It is possibly the source of the magma which formed the flows that are interbedded in the sandstone. The dyke shows cross-columnar jointing. The centre part is coarsely crystalline, gradually becoming finer in grain to glassy at the contact with the sandstone. The dyke-rock shows some copper-stain at the contact with the sandstone. The sandstone has been changed on both sides of the dyke from the baking of the hot magma. The red colour is changed to grey. The comparatively soft sandstone has become hard and fissile at the contact with the dyke. The change is visible, gradually diminishing to 150 feet from the contact. No data regarding the age of the Coppermine series were obtained. Petrographically they show great similarity to the Keweenaw series at Keweenaw Point.

GLACIAL DEPOSIT AND GLACIATION

"In the Copper Mountains evidence of ice action is everywhere present in the form of bed-rock scorings on the crests of the basalt ridges, which have been rounded off and polished. Occasionally a cliff shows scorings, indicating ice movement along the cliff. Glacial drift is to be seen all over the mountains. In the valley the lower benching and bedrock topography is in some places concealed by small terminal moraines and tillsheets, in no place reaching far up on the hillside. Most in evidence are the glacial deposits in the small basin around Tepee and Larrigan Creeks and along the south shore of the Coppermine River on its northwest course through the mountains. The sandstone is covered by a thin sheet of till.

"On the south side of the basalt ridge at Bloody Falls several hills of grayish white stratified clay, lie against the basalt cliffs on both sides of the river. These hills, which are about 300 feet high, have very steep sides, intersected by ravines, and present a very striking appearance.

COPPER OCCURRENCES

"It has long been known that copper in the native state existed in the northern part of Canada. It furnished the source of supply for the weapons and utensils of copper used by the Indians before they were supplied with iron from trading posts.

"As early as 1771, Samuel Hearne on his journey to the Northern Sea established the fact that the Indians got their supply of copper from the Copper Mountains. He describes the 'mine' he visited as situated about 30 miles south-southeast from the mouth of Coppermine River. That would be in the upper part of the series of basalt beds constituting the Copper Mountain, and would correspond to the eastward prolongation of the amygdaloid beds, which outcrop in the hill in the north side of Burnt Creek

"Later, in 1821, the Copper Mountains were visited by Sir John Franklin and Sir John Richardson. Their investigations were made on the north side of the big bend of Coppermine

River around Stony, Glance, and Big Creeks. They found many evidences of native copper, but as Richardson states they 'did not observe the vein in its original repository, nor does it appear that the Indians have found it.' Recently, Hanbury observed the occurrence of native copper in basalt on the Islands in Coronation Gulf at Bathurst Inlet. These islands are probably the eastward continuation of the Copper Mountains. Even to-day the Coronation Gulf Eskimos, or at least some of them, come to the Copper Mountains for their supply of copper. These people do not possess tools for working rock and are restricted to digging in loose rock for pieces of copper, liberated through weathering and decomposition of the rock.

"Judging from specimens in possession of Eskimos we met, the pieces usually found are comparatively small, although they occasionally find pieces large enough to beat out knives about 8" long and about 3" wide. In our search we did not find any large slabs of native copper. But in many places we observed small chips or flakes of native copper in the broken pieces of amygdaloid which forms small heaps in the flat soil-covered valleys on the back slope of the ridges. Usually more or less of a green copper-stain indicates the presence of native copper. In two locations or horizons we found native copper in place in amygdaloid beds, viz:—at the head of Copper Creek and in the hill on the north side of Burnt Creek.

"At Copper Creek on the east side, well upon the hillside, an amygdaloid, showing an exposure of about 30 feet thickness, outcrops. The amygdaloid is much altered, presenting a reddish appearance, which is noticeable at a distance. Kidneys or irregular masses of epidote occur in the bed. The altered rock shows a copper stain on the outside, and although not abundant, small chips of native copper were found in this amygdaloid. It is, however, common that the broken rock shows copper-stained amygdules—(Specimen 145). The dense lower non-amygdaloidal portion contains tiny specks or shots of native copper. A short distance below this bed lies a conglomerate, but no copper was observed in it. The most favourable locality for native copper, so far as our observation went, is at the north side of Burnt Creek.

"A cross-section of the hill is given in Fig. 1. The bed marked No. 1 shows an exposure of about 25 feet thickness with frequent copper-stain in the amygdules—(Specimen 139). Red bands of a much altered rock with copper carbonate stain occur in the bed, which in places show cleavage like stratification. In bed No. 2 the rock, where exposed, has been very much altered in some places to epidote and a crumbling mass of light-coloured rock, in which nearly all the amygdules contain copper carbonate—(Specimen 140). Native copper in the form of chips and flakes is fairly abundant in this altered rock. In some instances a small un-oxidized chip of native copper can be observed enveloped in copper carbonate. Small fractures contain chalcocite. As far as the bed is exposed it shows a depth of about 26 feet. Above this amygdaloid lie three conglomerate beds. Of these the two marked No. 5 and No. 7 show a thickness of 10 to 15 feet and contain some native copper in the amygdaloid pebbles. The bed marked No. 6 shows an exposure indicating a depth of 4 feet. The two amygdaloid beds marked No. 3 and No. 4, lying higher up both show frequent copperstain, but no native copper was observed in them.

"At Glance Creek about a mile from its mouth, occur what appears like a breccia but probably is the filling of a crack. It consists of altered basic rock cemented together with quartz calcite and chalcocite. It outcrops irregularly in the bottom of the creek and on the east bank of the Creek, where in places the adjoining rock looks like sandstone, stained with copper carbonate. No native copper was found here except as tiny shots in the hard basalt a few hundred paces to the east—(Specimen 149). Similarly at the mouth of Stony Creek the hard basalt shows native copper—(Specimen 148). Here the amygdaloid phase of the flow has been eroded away and is covered by drift where it dips under the mountain. Only in places the intermediary part, showing scant development of amygdules remains."

Among the specimens brought back by Dr. Sandberg were some small weathered pieces of native copper picked up on the surface; but as this section of the copper-bearing rocks has been

for centuries explored for native copper, with such implements as the Indians had, the wonder is that any can still be found. The rock specimens, however, show flakes of metal in both the amygdaloid, the conglomerates and the traps, and the rocks themselves are, as shown by Graton, duplicates of those of the Keweenaw Series.

The copper resources of this district are probably large, for from the Islands of Bathurst Inlet to the exposures of these Keweenaw rocks, recognized to the north of the Dismal Lakes, is a distance of about three hundred miles. Stefansson states that the shores of Victoria Land, which is separated from the mouth of the Coppermine River by some thirty-five miles of Coronation Gulf, is the most productive region now frequented by the native copper miners. Copper is still preferred by the Esquimaux and Indians to iron for certain uses. What the actual average copper contents of any large tract may prove to be could only be determined by mining and sampling on a large scale. A preliminary expedition by water, extending over several years, might determine this question, and that of the existence of fuel within economical reach of the ore; for upon favourable conditions in these two respects would depend the possibility of conducting a profitable mining enterprise under the adverse conditions existing within the Arctic Circle. These islands in Bathurst Inlet and the mainland near the mouth of the Coppermine River could be reached by water through Bering Straits, or from the mouth of the Mackenzie River for only a few weeks of the year. On the other hand one has to recollect that for many years the Keweenaw promontory of Michigan was cut off from all communication with the market except during the comparatively few months of open navigation; that supplies of fuel and merchandise were conveyed by water to the mines before navigation closed, and that the copper accumulated on the peninsula until navigation opened the following spring. The open season was of course longer than it would be in the Arctic Ocean, and the climate in the Arctic is more severe than in Michigan, the thermometer dropping occasionally to 40° and 50° below zero. The fall of snow, however, as reported by our explorers on the Dease River, did not exceed at any time two feet; and therefore

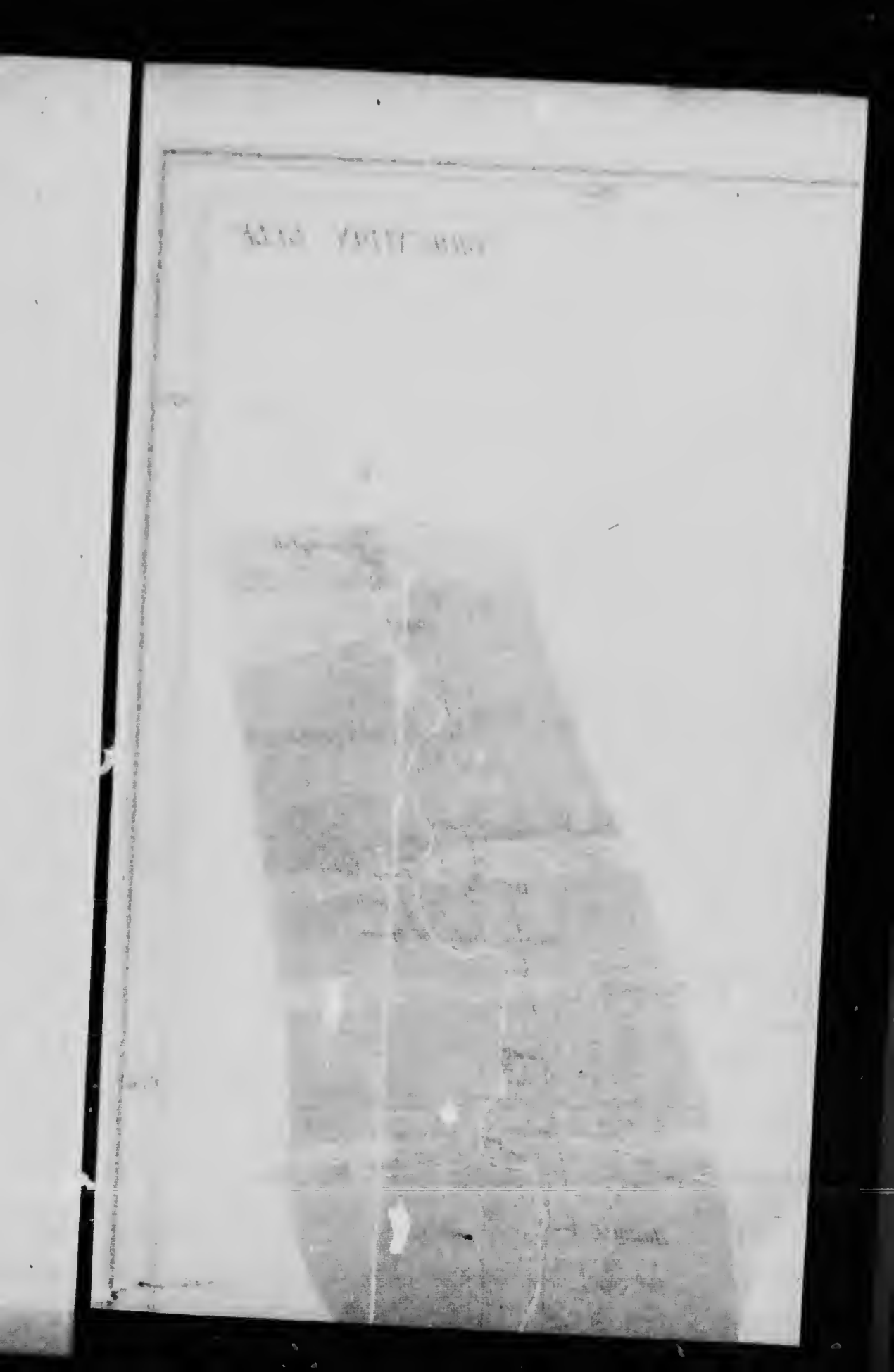
mining, ore concentration and smelting, as well as railway transportation, would not be conducted under conditions much more onerous than in the Province of Quebec or in Michigan.

The government is not likely to go to the very heavy expense of determining practically the possible value of these copper deposits, and assuredly no individuals, acting separately or as a corporation, would undertake the task, unless the [illegible]ernment would grant them concessions to explore the whol[illegible]on; would secure them such areas within that region as the[illegible]ght select; and assure them of title to tracts of sufficient m[illegible]de of these mineral bearing formations to remunerate them for the heavy risks and great outlay they would have to [illegible]ace. Stefansson dreads the advent of the white man with his demoralizing influences on the natives. It would certainly be necessary that any industrial company so remote from supervision should be under rigid regulations, which would protect the aborigines from the malign influence of the white trader.

ASSAYS OF ROCKS FROM COPPERMINE RIVER, CANADA.

Specimen No.		Per Cent Cu.
100	Conglomerate	.09
102	Amygdaloid	.05
3	"	.12
10	Float, Glance Creek	43.39
11	From " "	1.78
13	" " "	.86
106	Glance Creek above 105, 4" thick	.44
107	" " " 106, 3' thick layer	.15
108	" " under 105	.09
139 (C)	Amygdaloid Bed No. 1	1.85
140 (A)	" " 2, Burnt Creek	.08
140 (B)	" " 2, "	.07
140 (C)	" " 2, "	*7.77
144	" " 1	.19
105	From Glance Creek	.008
143	Conglomerate No. 5	.084
130	Sandstone	.002
142	Conglomerate No. 4	.016
149	Basalt (cont. native cu.)	.069

* A sample weighing 179.3 grams contained 1.2432 grams of metallic copper in grains of such size that they would not go through 100-mesh seive.



Geological Map
of
LOWER COPPERMINE RIVE
CANADA
by
A. SANDBERG

Scale, meter
Miles
Kilometers

November 1912.

LEGEND

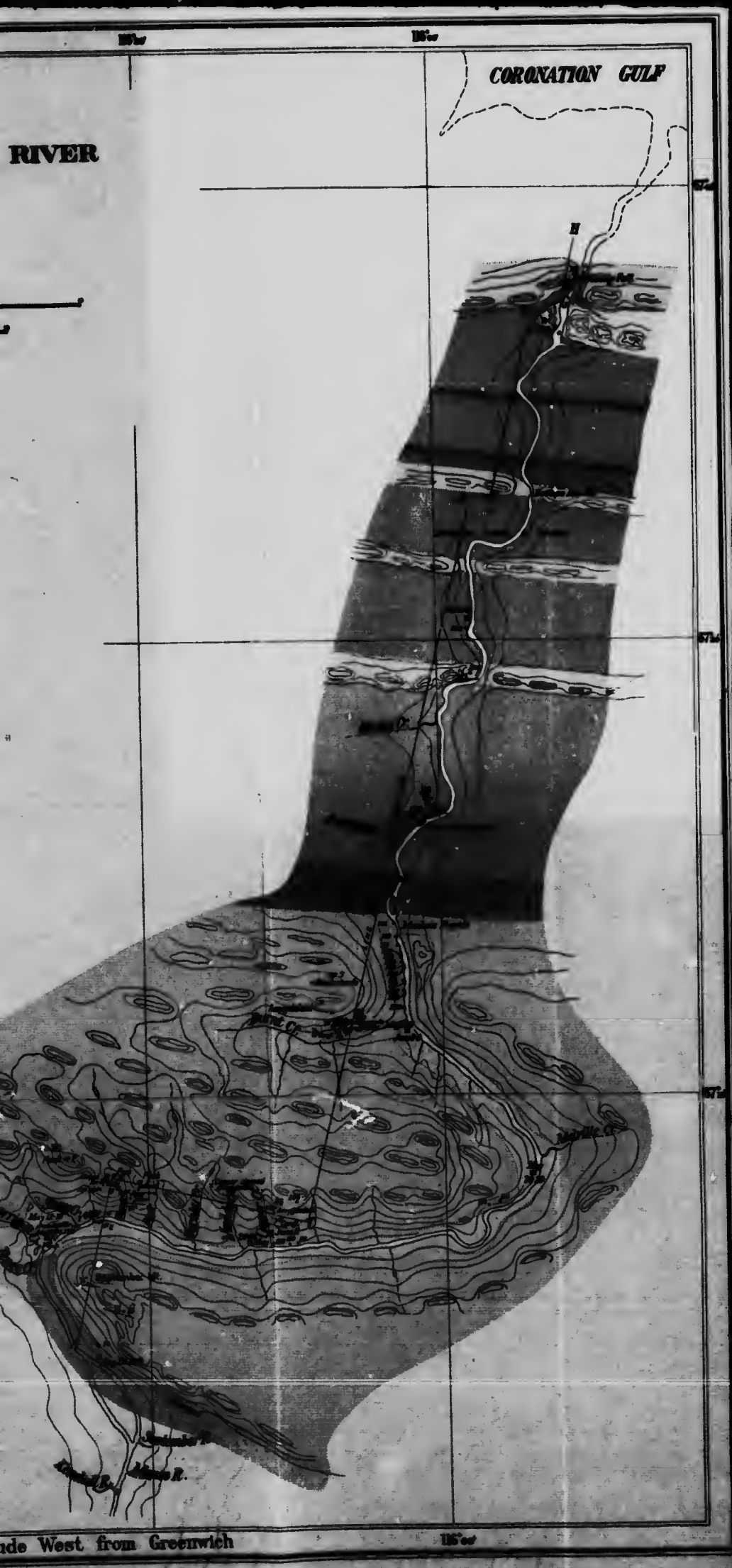
- Glacial deposits
- Gray slate
- Red sandstone
- Red shale
- Basalt beds with conglomerate
- Limestone
- Dip and strike
- Sketch contours
- Reference to specimens
- Camp

STRUCTURE SECTION ALONG LINE A-B
VERTICAL SCALE FIVE TIMES HORIZONTAL

Rocky Creek
Ryke
Sandstone Creek
Burnt Creek
September Mt.

117° 30'

Longitude We


CORONATION GULF
RIVER
ude West from Greenwich