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PRELIMINARY REPORT

—ON THE—

FIRST SEASON'S WORK

OF THE

Geological Survey

OF YESSO,

BY

BENJAMIN SMITH LYMAN.

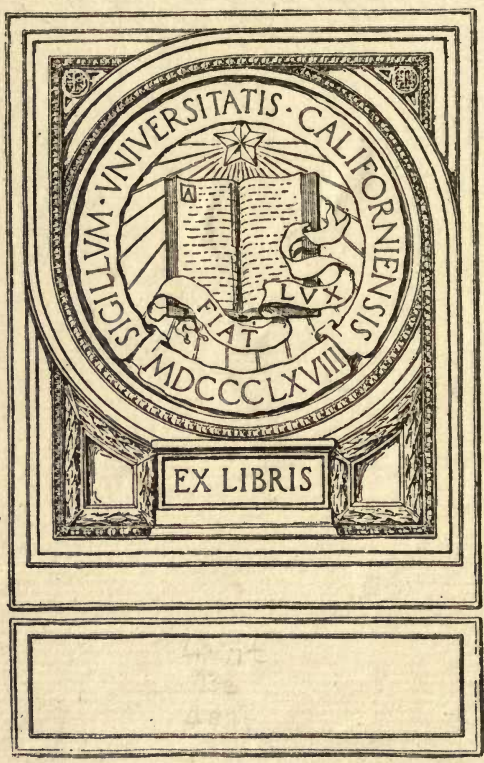
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BENJAMIN SMITH LYMAN.

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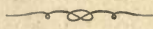
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THE
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Preliminary Report on the First Season's Work of the Geological Survey of Yesso.



	PAGE.
Nature of Survey	3
Limits of Survey	3
General Plan	4
Fossils	4
Topographical Method	5
Advantages for studying the Geology	5
" " setting forth "	6
Surveying required of the Geologist himself	6
Assistants	6
Their good behavior	7
General nature of their work	8
Benefit of the work to them	8
Instruments	9
Office work	9
Choice of points to Survey	10
Economy of Geological Surveys	10
History of Operations	11
End of April to 1st July	11
1st July to beginning of October	12
Beginning of October to middle of November	13
Geology of the Region surveyed	15
Alluvium	15
New	15
Old	16
Volcanic-pebble Rocks	16
Volcanic Rocks	17
Toshibets Karafto System	18
Coal Bearing Rocks	18
Horumui Karafto System	19
Toshibets Kuril System	20
Economic Geology	20
Coal	20
Kayanoma	20
Situation and Geology	20
Coal Beds	21
Shipping	21
Tramway	21
Harbor	22
Horumui	23
Situation and extent	23
Geology	23

Coal Beds	24
Shipping	24
Kudow	25
Iron Sand	25
Yurap to Otoshibe	26
Kobui village	27
Southwesterly of Kobui	27
Shirikishinai	28
Komangadake	28
Whole amount	29
Sulphur	29
Esan	29
Tarumai	31
Iwaonobori	32
Nuburibets	32
Oi Lake	33
Kobui	33
Whole Amount	34
Limestone	34
Garonosawa	34
Ishizaki	35
Kamiyunosawa	35
Washinoki	36
Traces elsewhere	36
Gold	36
Toshibets	36
Kudow	37
Esashi	38
Jimikishi	38
Other Rivers	38
Whole Amount	38
Rock Tar	38
Washinoki	39
Yamukushinai	40
Idzumisawa	41
Mineral Springs	41
Table	42
Summary	46

SHIBA, YEDO ; 25TH DECEMBER, 1873.

To the Honorable K. KURODA,
Jikuwan of the Kaitakushi.

SIR,

My orders on leaving Sapporo were to report to you fully at Yedo in regard to the past season's geological work in Yesso. As it will take some time yet to work up the details and set them forth in maps and full reports, I hasten now after arriving at Yedo to give you a sketch of what has been done, its nature and its probable results.

The work according to your instructions has been confined to the four south-westernmost provinces, Oshima, Shiribets, Iburi and Ishcari, about one-third of the island. Indeed only the lower part of the province of Ishcari was visited, by the direction of Governor MATSMOTO ; since nothing of mineral value was reported from the upper waters, and it would have taken three months or more to visit them, and there was little

prospect of seeing much of geological interest without making, in addition, long and difficult excursions away from the almost unvarying alluvial plains that border the river itself.

Within the region examined the aim has been to learn something definite in regard to a few important points at least, rather than even to go over much more ground and obtain only vague and wholly imperfect information ; since it is certain that the one method gives results ten times more valuable than the other. All places, however, where useful minerals were reported to exist have been visited, with scarcely a single exception, even though they often proved to be worthless either in quantity or quality ; and in passing from one point to another, an effort has been made to learn as far as possible the general geology of the region aside from its useful minerals merely.

For this purpose also a number of fossils have been collected at several places ; and they will probably be useful not only in recognising rocks of the same age at other points in Yesso, but in determining their age as compared with the rocks of the rest of the world, and so possibly enabling conjectures to be formed sometimes of the quantity and quality of certain minerals they are likely to contain. A more minute study of the fossils is of great interest to paleontologists and of great value for the progress of learning, and I would urgently recommend placing the collection in the hands of somebody specially skilled in such matters, to be studied, described and published. As our libraries here in Japan are too defective in this branch of learning, to say nothing of the lack of a man well fitted for the study, it would probably be best to send the fossils abroad. There are yet too few fossils and too little prospect of large additions to the number hardly to justify the employment

here for the present at least of a foreign paleontologist for Yesso alone. For the education of the youth of Japan, in general, it would however no doubt be desirable to have such a foreigner come here, and if one should come, these fossils might be turned over to him.

In the survey, the American, Pennsylvanian topographical method has been used ; for the creation and improvement of which, not only in its working details on the small scale, but in the discovery of its general laws on a large scale, geology owes so much to Professor J. PETER LESLEY, of Philadelphia ; as I had the honour of showing about two years ago in a paper read to the American Institute of Mining Engineers. That method is indeed, as compared with others in geology, what quantitative analysis in chemistry is to mere qualitative analysis, and is no less important for theoretical purposes than it is useful for practical ones. It strives to determine the extent and position of mineral deposits both underground and at their outcrop, by means of laying down on paper the shape of the surface of the ground (by contour lines), as well as all the dips and strikes of the rocks that can be observed ; so that the contour of any rock bed or vein may be drawn as it is even underground, and its contents above or below any given level or within any given limits may be calculated. In short, the surface and the deposit are geometrically constructed on paper. Of course, just as a chemical quantitative analysis may be more or less exact according to the difficulties of the case, so these geological surveys are only roughly exact when poor instruments are used or when the case is specially difficult ; but in almost any case are far better than merely qualitative observations alone. They are, in fact, as far as they go, definite and precise ; while ordinary geological surveying, so called,

gives vague and conjectural results, just as the qualitative analysis of a mineral enables the quantitative composition only to be guessed at.

The topographical method moreover gives by its maps very much the best means of compactly and clearly setting forth to others, observed geological facts and the conclusions arrived at. From such a representation of the facts, inferences can readily be drawn by others independently of the observer's opinions, confirming or opposing his judgment. The results of the season's work then will be not merely personal opinions, but facts so gathered and arranged that in future any other geologist can form his own conclusions from them with no need of revisiting the ground, unless a more detailed survey should be desired.

A quantitative measurement naturally requires much more time and work than a mere qualitative one; and that has hindered the more general adoption of LESLEY'S method in countries where time and work are dear, in spite of its abundantly countervailing advantages; and has even caused professed geologists to remain in ignorance of it and of its merits. There is perhaps no country in the world whose surface has already been topographically mapped minutely enough to answer in a detailed measurement of the rock deposits; and only a few countries which have been mapped well enough for somewhat more general geological purposes. It is therefore necessary for the geologist to undertake the mapping of the surface as well as of the underground features; and he can do it better for his purpose than a mere topographer, because his work is guided by the geological structure.

The assistants you kindly furnished me have added very much to the amount of work that could have been done by any one man; even though they were young

and inexperienced, and for the most part wholly ignorant at the outset, not only of geology but of surveying, drawing and even almost of common arithmetic. They have been very useful, partly because they have eagerly and rapidly learned what they could in a very short time; and partly because such surveys require much work of a comparatively very simple character.

Mr. HENRY S. MUNROE, the American assistant, was, by his former studies, much better fitted than the Japanese assistants for undertaking such work, although it was in great part practically new to him. He entered upon it with interest and intelligence, and has worked industriously and faithfully. He was especially useful at first in teaching the others drawing, and in the field has had charge of the details of the work of one-half of them and the whole management of the gold surveys, under very general instructions. Of the Japanese assistants Mr. T. YAMAUCHI by his greater age and therefore more advanced education and matured judgment has easily stood at the head. Mr. H. SATOW, besides, his remarkable success as interpreter and his good service as an assistant in surveying, has with admirable zeal made for us an excellent botanical collection. My quartermaster since August, Mr. Y. AKIYAMA, from mere love of learning, frequently made himself very useful also in surveying though it was quite outside of his required duties to do so. He has therefore more than replaced the single assistant whom it was found necessary to dismiss. Mr. MUNROE's quartermaster, Mr. S. ICHICHI, has kindly improved the opportunity of his abundant leisure on the Toshibets by making an interesting collection of insects. All the assistants, (including besides those already named, Messrs. INAGAKI, KUWADA, MISAWA, TAKAHASHI, KADA, SAKA and SAITO), with a laudable desire to do even more than their mere duty, and to help

forward the interests of the survey—and with eagerness for their own improvement—have done more than could be reasonably exacted from them; or, at any rate, in addition to bearing many hardships cheerfully, have worked harder both bodily and mentally than even laboring men in Japan are commonly expected to work with their bodies alone.

I have tried to turn the assistants' services to the best account by giving them the simpler but more time-taking work to do, while I myself (after they had had a few weeks' practice) visited a larger number of places more rapidly, and attended especially to purely geological observations, where either little other work was required, or where it was done by the rest.

Besides the aid they have given, notice should be taken of the benefit to them and to the empire of the knowledge these Japanese have gained by their season's labor. They are not only the first Japanese but the first Asiatics to undertake the study and practice of geology; and although the training of native geologists in India has been begun nearly at the same time, (or is soon to begin), I trust that ours will continue to take the lead, and that Japan will become in a few years independent of foreign countries in their profession. The young assistants have not only learned something of surveying and geology, but have in the field work, had under them each two or more laborers for rod-men and choppers, and have therefore gained a little experience in the management of men—a matter of very great consequence, if they are ever to be put in charge of important mining works. It is, however, a matter too apt to be wholly neglected in the training of the young men in all but the military schools of foreign countries, although quite as needful in civil or mining engineering or in agricultural affairs as in military.

On account of the shortness of the time for preparation and practice before going into the field, the Japanese assistants neither learned the use of the larger and more exact kinds of surveying instruments, nor were such instruments received in time and in numbers enough to be made much use of; in fact only two came to hand in the course of the summer, and one of them in a poor condition. The surveys therefore were almost wholly made with small and in part badly made instruments, generally without the useful occasional checks of a larger one. Still, the surveys made this season were mostly of a somewhat preliminary nature and required less exactness than would be needed in the actual working of a mine; and they are in that respect probably satisfactory enough for present purposes. The measurements were mostly made with prismatic compasses, hand levels, aneroids and pacing; and owing to the partial balancing of the numerous small errors, sometimes less sometimes more than the exact truth, the errors of the results were far less than inexperienced surveyors would suppose. Between the exactness of such results and merely conjectural mapping, by even the best head most familiar with the ground, there is simply no comparison whatever. For another season it would be very desirable to have at least a few somewhat larger, light, more correctly made instruments, by which with a stadia both compass or transit running and levelling and the measurement of distances could be done almost or quite as rapidly as they could be with this year's instruments and much more exactly. Surveys with such instruments of the better kind would be satisfactory as far as they went for working maps in any possible future mining.

It is a great advantage to have the first rough mapping of such surveys keep pace from day to day with the field work, but owing to the changeableness of the climate,

(which sometimes brought several rainy days together), and owing to the inexperience of the assistants in office work, so that it would have required more time, and for other reasons, it was on the whole thought advisable, this year at least, to leave much of even the rough mapping to be done in the winter after returning to Yedo. This arrangement has enabled somewhat more field-work to be done, and has made the employment of the laborers and some other matters rather more convenient; but besides, the disadvantage with respect to the surveys themselves will lessen the time that the assistants can give to other practice and studies during the winter, and will therefore leave them next spring less well fitted than they otherwise would have been for another season's work.

In determining the importance of the points to be more carefully surveyed, regard was had chiefly to their mining value; for the importance of any one of them in respect to theoretical geology was sure to be great enough; and it was likely that those that should be specially studied would throw such light on the general geology of the island as to make it comparatively easy to fill up the gaps with sufficient exactness by the time the whole of Yesso should have been gone over on the present system. In regard to the general geology of the field of this year's work some important points remain still undetermined, such as the relative age and the superficial extent of certain groups of rocks; but some of them will perhaps be made known by the winter's mapping; while others may be cleared up by the surveys of other parts of the island, or may possibly require special examination at some future time.

Many places were visited where valuable minerals had been supposed to exist, but where they proved to be deficient either in quantity or in quality. Indeed, on

the island of Yesso as almost everywhere else the chief directly practical benefit of a geological survey is far more in saving the expense of foolish outlay in mining worthless deposits than even in guiding productive work, and much money would have already been saved in Yesso if competent men had long ago been employed to examine the deposits properly, and authoritatively discourage the working of mines whose ruins now remain as marks of the hopefulness of human nature. This hopefulness here, as in other countries, leads most men to the ruinous belief that the part of a deposit that is hidden deep within the earth, is better than the part exposed near the surface; so that good deposits are sure to be worked however unskilfully even without the recommendation of a geologist; while bad ones are apt also to be tried until his advice puts an end to further waste of money. It would be very interesting if the millions wasted all over the world in foolish mining that would have been prevented by a good geological examination could be compared on the one hand with the perhaps hardly greater profits of successful mining, and on the other with the relatively trifling cost of such a survey.

On coming to Yesso towards the end of April we went at once to Sapporo according to the instructions given at Yedo, expecting to begin at that time the survey of the country to the north, hitherto geologically unexplored. But owing to the reported high stage of the Ishcari River we were directed to go first southward for forty or fifty days to the coal mines at Kayanoma and its neighborhood. After finishing the coal survey, I sent Messrs. MUNROE, SATOW, INAGAKI, MISAWA, KADA and SAKA still further southward to make a somewhat detailed survey of the Toshibets gold region, against my visit there in September, and then to go on towards Hakodate; as

they afterwards did, making rapid surveys of the small gold regions near Kudow and Esashi, and of the lead mines at Yurap. The other five assistants and myself arrived again in Sapporo at the end of about fifty days having visited the gypsum at Yunai in the Raiden mountain (apparently too poor to work); the zinc blende, galena and copper pyrites vein near Yudomari and Sakkadzuki (quite too thin to work); and the place of the supposed traces of coal at Furubira (merely a lump of coal that had been brought, no doubt, by some boat or by the hand of a man, and dropped on the river shore). On the way, moreover, according to instructions, we went quite around the Shakotan peninsula, without however hearing of any minerals of economical importance; though we had an interesting view of the rocks as we passed along, sometimes by land where there were roads, at other times by sea. After a week of office work and preparation we set out from Sapporo for the coal field on the Horumui, a branch of the Ishcari; from a rapid survey of which we returned to Sapporo in just a month, after many unexpected delays occasioned by the weather and other causes beyond my control.

From Sapporo I sent Mr. YAMAUCHI and the three other assistants then left with me, to Horikap to make a small addition to the Kayanoma survey, against my revisiting that place in company with General CAPRON; and myself visited the blende, galena, pyrites and orpiment place (worthless as it turned out) near the Jôzan hot-springs on the upper waters of the Toyahira; and afterwards according to instructions, accompanied General CAPRON to the mouth of the Ishcari, to Tôbets, and then to Iwanai, Horikap and Kayanoma, on the way visiting the pyrites place near Rubeshibe, which proved however to be quite insignificant. After inspecting the work of the four assistants at Horikap and making a survey of

the Chatsunai and Shibui harbors and a visit of exploration across the mountain to the Furubira River, I took the assistants to the Iwaonobori sulphur place, and made with their help a hasty survey of it. From there I sent them to begin surveys at Yamukushinai and Washinoki; while with Mr. AKIYAMA I went myself across the Shiribets valley to Usu on the east coast, and visited the sulphur place there, which turned out to be wholly unimportant. We went thence still further north-eastward along the coast to the sulphur place at Nuburibets hot-spring, and then to the one on the top of Tarumai volcano. Returning south-westward we visited some newly discovered ores of zinc, lead and copper on the Horobets, and found them too poor to work; and also investigated a reported discovery of coal at the mouth of the Washibets near Mororan; but it proved to be several lumps of coal that had been washed ashore from a wrecked steamer. Then following the sea shore as far as Kunnui, we went to the gold mines on the Toshibets; but as Mr. MUNROE had just gone with his party to the Kudow gold field and by some mistake had left none of his mapping behind and no special information in regard to the surveys he had made, after a day or two of examination of the gold washings we went to Yamukushinai. Here with the help of the rough mapping of Mr. YAMAUCHI's party the oil place and the iron ore sand of the beach were examined and the daily yield of oil was measured.

From Yamukushinai Mr. AKIYAMA and I made a short trip to the old lead mines of Yurap, and left somewhat detailed instructions in regard the survey to be made there by Mr. MUNROE and his party. Thence we went to Washinoki, visiting the Boro and Kusuri hot-springs while passing Otoshibe. At Washinoki, the oil place was visited and the geological observations of Mr. YAMAUCHI

and his party were reviewed, and their other work just then finished was inspected. They were then sent to Idzumisawa to make in like manner a map of the oil place there. Mr. AKIYAMA and I fixed the position of the Washinoki limestone, and visited the Nigorikawa hot-springs and the Torizaki insignificant lignite and oil gas, all near Washinoki. Then going south-eastward along the shore, we visited the Tomi hot-springs near Shikabe; the sulphur place (unimportant as it proved) on the top of Komangadake; the Shikabe hot-springs; the Isoya hot-springs; the Kemushitomari lignite between Isoya and Kumadomari (found to be quite unworkable); the Obune hot-springs; the Kakumi hot-springs; and the Esan sulphur mines of some importance. Then turning south-westward and westward along the shore towards Hakodate, we visited the Kobui gray sulphur mines; the Kobui iron sand; the Setarai worthless pyrites and calc spar; the Ishizaki limestone; the Yunokawa hot-spring; the Yunokawa kaolin; the Kami-Yunosawa limestone and hot spring. Then westward from Hakodate we visited the Idzumisawa (or Kamaya) oil spring, and with Mr. YAMAUCHI and his party reviewed their geological observations and inspected their whole survey at that time about finished. Then we visited the Mohejikawa brick kilns and clay pits; the Tomigawa lignite (quite unworkable, as it proved); and the Ichinowatari long abandoned lead mines (very justly abandoned as it seems). Then, with Messrs. YAMAUCHI and TAKAHASHI, we visited the very abundant lime-stone of Garonosawa; and on our return were joined by Messrs. KUWADA and SAITO, and we all came to Hakodate on the first of November, the field work all done. The next day was very stormy and much snow fell at the Yurap mines where Mr. MUNROE'S party had been working; and they all hastened, in accordance with my instructions, to

Hakodate. They arrived on the seventh; on the ninth much more snow fell even around Hakodate; and on the tenth we all sailed for Yokohama and came directly to Yedo.

The part of Yesso surveyed so far, contains the following groups of rocks:—

Alluvium, new and old.

Volcanic-pebble Rocks.

Volcanic Rocks.

Rocks of the Toshibets Karafto System of Folds.

Coal bearing Rocks, or Rocks of the Horumui Kuril System of Folds.

Rocks of the Horumui Karafto System of Folds.

Rocks of the Toshibets Kuril System of Folds.

Alluvium.—Along the Ishcari River are rich alluvial plains, in all about fifteen miles (six ri) wide and forty miles (sixteen ri) long; and similar smaller plains are found bordering all the large streams, the Shiribets, Toshibets, Yoichi River, Horikap, Yurap, and many others not so large, making admirable farming sites, only with the lack of roads at present. The soil indeed seems to be very good even on the uplands, and supports a rich growth of wild plants. The chief exception is in the neighborhood of Tarumai volcano, where for many miles around even the low plains by the sea-shore have so lately been covered by pumice as very much to lessen their fertility. Yet even here a rich black soil, in some places six feet thick, exists at the depth of only about a foot below the surface of the ground.

On the Horumui, the Toyahira and elsewhere beds of lignite and peat three feet or more thick are exposed in this alluvium, very recent looking lignite with the woody fibres and form plainly seen. This lignite is also found in bits on the Shiribets and on the Furubira. At Kobui there are eight feet or more of peat.

A somewhat older alluvial deposit almost every where along the coast forms gently sloping plains from a few yards wide to several hundred between the mountains and the sea-shore often spread out in fan shape just outside the mouth of narrow valleys; and as it has been eaten into by the sea it forms bluffs in many places. The bluffs are not by any means always made up wholly of the alluvium, but often merely capped by it. The height of the top of the bluffs is often pretty uniform for a good distance, but varies in different places from a score of feet to a couple of hundred. Such gently sloping plains at the top of bluffs have been called marine terraces in Yesso, and their materials a terrace deposit; but bluff deposit would perhaps be a better name. True marine (or lake) terraces seem to have been found nowhere on the shore except two or three one above another near Hakodate, especially at Idzumisawa. If they were caused by different stages of sea level it would be strange not to find similar terraces on other parts of the coast. Possibly therefore the sea between Yesso and Nippon (either in part or wholly) was once a closed basin with the water standing successively at different heights. The rocks that chiefly make up the terraces are much older and firmer than the loose alluvial matter with which they are covered, so that they may have lasted since the time when the outline of the land was so very different; and volcanic action may have hastened the changes.

Volcanic-pebble Rocks.—Much of the western part of this portion of the Island is covered with rocks that are chiefly made up of pebbles of volcanic rocks. Such pudding rocks are found especially in great thickness around Iwanai and along the coast northward around the Shakotan peninsula. The pebbles (sometimes very large, even three feet) are of various kinds and are often

different from the finer sand-like materials in which they sometimes lie embedded, and they are often very much rounded as if by water. These beds of rock have been called "tufa conglomerates" but would seem rather to be the result of the wearing away of volcanic rocks by water. They have much the same dips as the coal bearing rocks, or even steeper and rest perhaps conformably on them.

Volcanic Rocks.—The volcanoes that still have active sulphur vapors seem to be mostly along the shores of Volcano Bay and the adjoining coast. Beginning at the north there are Tarumai, Nuburibets, Usu, Komangadake, Esan; and besides there is Iwaonobori near Iwanai on the west coast. Of these, Tarumai had a small eruption about the first of March (20th of 1st month) 1867, and a large one seventy years before, both of pumice; and Komangadake one on the 23rd September (26th of 8th month) 1856, also of pumice; the only pumice volcanoes met with, and the only ones that have been active within historic times. They are about 55 miles apart. Besides these partially active volcanoes, are many more that seem to have long been quite extinct. The highest, most symmetrical and beautiful of them all, is Shiribets Mountain, perhaps 6,000 feet high above the sea, and almost a regular cone. It stands fifteen miles (six ri) south-east of Iwanai, half-way between the two coasts; either one of which has here for some distance a nearly circular outline, with that mountain for the centre. Possibly old eruptions of the volcano may have had an influence on the position and outline of these parts of the coasts though it is not obvious upon a cursory examination of the rocks and topographical details. A large part of the rocks of the southern end of the Island, say from Sapporo southward, are volcanic, oftenest porphyritic in structure and several old ruined

craters apparently are still to be seen, as for example on Hakodate Mountain.

Toshibets Karafto System.—At the Toshibets gold field and further southward, are rocks with dips from 50° to 25° , or even less with axes bearing north five degrees east (magnetic) or thereabouts. These rocks contain on the Toshibets, and at Yurap mines, Idzumisawa and elsewhere great numbers of the fossil tubes of the tube-worm; and in other places there are very modern looking shells that seem to belong to the same group of rocks, which are moreover mostly soft and very new looking. Also, in rocks of that group at Tomigawa, across the harbor from Hakodate, are two or three thin beds of earthy brown compact lignite much newer looking than the Kayanoma and Horumui coals, though much older than the lignite found in various places in the alluvium. This folding may conveniently be called the Toshibets Karafto System; for the sections of the Toshibets survey will probably show the rocks folded by this system more fully than any other. Mr. MUNROE thinks that they have there a thickness of three thousand feet, with reddish brown soft sand rock at the bottom, but above almost wholly greenish gray soft clayey sand rocks or sandy clays with some balls of limestone near the bottom, and here and there in other places bands of pebble rock. This description, except the red rocks at bottom, answers closely also for the rocks of Idzumisawa.

Coal Bearing Rocks.—The productive brown coal measures both at Kayanoma and on the Horumui have axes running about north fifty degrees east (magnetic) with dips of thirty degrees to sixty degrees, steep on the north-west side at Kayanoma, and on the south-east side on the Horumui; and seems to be of comparatively recent age, perhaps tertiary, from the appearance of fossil leaves in the shales. A number of fossil shells

found in the Horumui field will perhaps determine the age more exactly. The coal very much resembles the coal of the Rocky Mountains, of about the end of the cretaceous and beginning of the tertiary. At Kayanoma, the coal-bearing rocks seem at the edges of the field to be overlain by the volcanic-pebble rocks; the underlying rocks have not been seen. In the Horumui field, the coal measures seem to be underlain by rocks of the Horumui Karafto System of folding. The coal rocks of the Kayanoma field are mostly light gray shales, with but one exposure of limestone, a three foot bed. In the Horumui field the rocks are mostly blue gray shales having in certain parts balls of limestone with fossil shells; but no bed of limestone was found here. The close parallelism of the axes of the coal rocks to the trend of the Kuril Islands seems to justify the convenient name of Horumui Kuril System for the folds.

Horumui Karafto System.—The rocks just mentioned as seeming to underly the Horumui coal have a nearly vertical dip and a strike of north three degrees or five degrees east (magnetic). They are at least six hundred feet thick, and are bluish grey shales and pebble rocks, coarse and fine, all much older-looking than the coal rocks, as if somewhat metamorphosed. The pebbles of the pudding rocks are of granitic, syenitic, or other ancient crystalline rocks, such as are not seen at all in the overlying beds. No fossils have yet been found in these older nearly vertical beds. The close parallelism of their strike to the general trend of the Island of Sagalin (Karafto) and of the northern part of Nippon is very noticeable, and seems to justify giving to such rock folds the name of the Horumui Karafto System.

Near the Tomigawa lignite of the Toshibets Karafto System is the Garonosawa limestone, a much older looking rock, much broken up by cleavage planes and

apparently much metamorphosed. It would seem, therefore, to be of nearly like age with the vertical rocks of the Horumui; while the more recent looking rocks near it of similar strike would seem to be newer than the brown coal measures, and to have been folded by a later action than that of the Horumui Karafto System, though nearly or quite in the same direction.

Toshibets Kuril System.—On the Toshibets Mr. MUNROE found in places ancient looking syenite, generally quite soft, which had a strike nearly north-east and south-west with nearly vertical dips. Pebbles of similar granitic rocks are found on the headwaters of Kunnui River and perhaps elsewhere. If these be really (as they seem) older than the rocks of the Horumui Karafto System, to which they probably furnished the crystalline pebbles, the folding of the rocks of the island would seem to have been twice alternately about north-east and about northerly in direction, and the folding of these crystalline rocks may be said to belong to the Toshibets Kuril System.

Of course the same system of folds might affect rocks of very different age; but no more precise determination of the relative age of the rocks has yet been made. Still, the thickness of the rocks belonging to each system is not very great, and each group has throughout an appearance so uniform that there is probably no very great difference in the age of their different parts.

The useful minerals of chief importance in the field gone over this year are:—Coal, iron-sand, sulphur, limestone, gold, rock tar and mineral springs; and traces of silver, lead, zinc, manganese and copper.

Coal.—The *Kayanoma Coal Field* is about seven miles (three ri) north of Iwanai, and one mile and a half (half a ri) from the sea-shore, and covers half a square mile or so (say 400,000 tsubo). The beds of rock lie in

the form of a saddle running nearly north fifty degrees east (magnetic), the axis passing through the Shibui valley. The coal at the present mines dip steeply (fifty degrees), but in other parts of the field the coal beds dips only thirty degrees or even ten degrees. The coal rocks seem to be limited on all sides by overlying beds of volcanic-pebble rock made up of volcanic materials; the underlying rocks seem not to be exposed.

There are six workable coal beds from three feet to eight feet in thickness. The coal is what is strictly called brown coal, probably of tertiary age, though closely resembling bituminous coal in its appearance and in many of its qualities. The coal of one of the old mines, abandoned on account of its greater distance from the sea shore, cokes in the fire; none that has been tried at other points cokes. The quality of some of the beds is very fair, although assays made last winter show from $6\frac{2}{3}$ per cent. to 9 per cent. of ashes, and consumers complain of it in this respect. The mining has, however, been so poorly managed that much slate is no doubt needlessly mixed with the coal. The whole field contains perhaps a million and a half of tons of coal above its lowest natural drainage level, and as much more for every hundred feet in depth below that.

The present mines are about two miles (28 cho) from the sea shore at the present shipping place at Kayanoma. Vessels there are very much exposed to the weather on a dangerous rocky shore; and special attention was given to the question of shipping the coal elsewhere. Our maps will probably show the possibility of building a tramway, with ease and without tunnelling from the neighborhood of the present mines to the Shibui harbor close to Chatsunai—less than two miles distant in a straight line. Such a road would start from the lowest natural drainage level of the bed now mined,

much lower than the present mines and near the foot of the second inclined plane, and doing away with the third also would, with a very gentle down grade, pass along the hill side and over the lowest gap in it, and then descend more rapidly to the shipping place. If the last descent should prove so steep as to require a plane, it could perhaps be so arranged that the loaded cars should draw the empty ones to a little greater height than the bottom of the gap, so that they could run all the way down hill to the mines again. Coal has also been opened at several points in the Chatsunai valley itself, about two miles from the harbor, and one of the beds has about 8 feet of coal and dips but thirty degrees. A tramway could easily be built, with a gentle down grade, from this coal all the way to the harbor.

The harbor at Chatsunai is, however, very small though well protected, and the deep water of Shibui harbor close adjoining is still smaller in extent. But a break-water 375 feet long in water at most 25 feet deep, built from the northern head of Shibui harbor to the north end of an outlying ledge of rocks ; and some 250 feet more to connect this ledge with other smaller ones in line with it, would make a land-locked harbor of about six acres of water twenty-five feet or more deep, and give protection to about ten acres of like depth from all quarters except about thirty degrees (west to south-west by west), and to much more from the north-westerly storms of winter. It seems an unusually good place for making an artificial harbor. The breakwater would be not only in shallow water but very short in comparison with the surface protected. The stone for building would be in the cliffs at the very starting point of the break-water ; the entrance to the harbor would be wide, deep and easy ; and the only streams emptying into the harbor are two small brooks which could not silt it up. On

the other hand, the Iwanai poorly sheltered harbor is the next best resource, and it is five miles distant from the coal and separated from it by the Horikap River and the hill next to it. To the foot of this hill, however, the country is flat, and a tunnel of perhaps only a thousand feet would reach a thick bed in the Chatsunai valley from the Horikap side.

The *Horumui Coal Field*, near the head waters of the Horumui and about twenty seven miles (eleven ri) east-northeast of Sapporo, is part of what would seem to be a very large field. Our survey this year went over a portion of it only, about three miles ($1\frac{1}{2}$ ri) long by half a mile (seven cho) wide: because that seemed enough to show what part of the field was nearest to the navigable water of the Ishcari, and whether it would be best to open mines there soon. The surveyed coal lies about a dozen miles (five ri) in a straight line from the Ishcari river, and is separated from it chiefly by a level plain. We did not see the north-eastern end of the field. Indeed information was given, some months after our departure, that coal was known to exist on the Sorachi river, some twenty five miles (ten ri) to the north-east, almost certainly a continuation of the same field, since the general strike of the coal is about north fifty degrees east (magnetic). Coal is also said to be found on the south side of the mountains between the Horumni and the East Coast, and quite likely it belongs also to the same field. In that case there would seem to be an extent of some thirty miles (twelve ri) in length by perhaps as much in breadth.

In the portion we traversed, we found the beds to lie in the form of a saddle running (as at Kayanoma) about north fifty degrees east (magnetic); with a steep dip of some sixty degrees on the south-east side, and a gentler one of say forty five degrees on the north-west side. No

rocks are exposed above the coal-bearing rocks within the limits of this year's surveying; but the underlying rocks apparently are exposed in many of the neighboring streams and are chiefly grey shales, 600 feet thick at least it would seem, and some brown pebble rocks with pebbles of old crystalline metamorphic or possibly eruptive rocks. The dip of these underlying beds is very steep, eighty five degrees, and the strike is north three degrees or five degrees east, (magnetic), closely parallel to the general course of Sagalin (Karafto) and of the greater part of Nippon.

The whole number of workable coal beds seems to be six, with different thicknesses, from three feet to five feet. The coal is (like that of Kayanoma) a brightly shining brown coal, probably of tertiary age, very closely like good bituminous coal in appearance. A sample assayed by Mr. MUNROE last winter, said to come from here, contained

Moisture	3.8	
Volatile matter	39.5	
Fixed carbon.....	52.4	} Coke (friable and dull) 56, 7
Ash (fawn color).....	4.3	

100.0

We have now taken a number of samples from each one of the six beds, and they will be assayed this winter. The coal is much firmer than that of Kayanoma, and will therefore bear rough handling and distant transportation better than that does. In the portion of the coal that we went over there would seem to be perhaps ten millions of tons of coal above the natural drainage level. The hills are high (some five hundred feet) and the larger valleys are wide enough for mines to be opened near the points where the outcrops of the several beds cross the streams.

It is a dozen miles (five ri) to the nearest water navigable for large boats (the Ishcari river), and

the country between seems to be wholly a flat plain, mostly covered with heavy (but rather open) timber, with here and there treeless prairies, and sometimes swamps. From the nearest point of the Ishcari the distance by river to the sea is about 30 miles (12 ri) and the water is said to have been found, by Lieut. Day's survey this season, to be deep enough for vessels drawing fourteen feet, except on the bar at the mouth, where for a short space there are but twelve feet at low tide. In another direction a railroad might be built, over almost wholly level ground, to the excellent harbor of Mororan, about eighty miles (thirty two ri) distant. Unquestionably the amount of coal in the field would enable the shipment of coal enough to repay amply the cost of such a road.

The traces of coal at *Kudow*, though of no economic value, (three beds from two to fourteen tenths of a foot thick) were yet found by Mr. MUNROE to be interesting, from the fact that the rocks there had a strike of about north fifty degrees east, like the coal rocks of *Kayanoma* and the *Horumui*.

Iron Sand.—The only ore of iron that has yet been found in any quantity in Yesso is magnetic iron sand. It is most abundant on the south shore of Volcano Bay, especially near *Yamukushinai*. It is also found in some quantity near *Kobui*, on the eastern end of the peninsula, east of *Hakodate*. Though these two are the only workable places yet found the magnetic iron ore is also found in some quantity on many a beach, and in the sands of many a river bed. Indeed, traces of it, at least, are found in almost every deposit of sand, even though not noticeable to the naked eye before separation by a magnet. It is sprinkled through many of the wide spread volcanic rocks of the island, and, from the wearing away of these rocks, their reduction to sand and concentration of the

heavier ore by the washing of the tides and waves or rivers that the sand ore deposits are due.

The iron sand deposit on the shore from *Yurap* to *Otoshibe*, and perhaps a little beyond at either end, is, say, ten miles (four ri) or 17,600 yards (8,800 ken) long, by twenty yards (ten ken) wide on the average, and perhaps half a foot thick on the average; making in all, 58,667 cubic yards (7,333 cubic ken). The ore looks very rich in many parts, but is generally mixed with a notable amount of other sand. If it would average eighty per cent of pure ore there would be about 120,000 tons of it, which would contain 87,000 tons of iron. The ore seems to contain a certain amount of titanium; for, at the old forge near *Okotsunai*, the ore was found hard to work alone, and was mixed with half its quantity of *Kobui* ore to make it more fusible. The old iron works of *Okotsunai*, half a mile from the sea shore, and a mile and a half (half a ri) from *Yamukushinai*, were first built some ten years ago, worked a couple of years, were idle a year and a half, worked again four or five years, and were finally abandoned three years ago, and are now in ruins. There were two bloomary forges, with large bellows worked by a water-wheel. The furnaces were worked only in the summer half of the year. Eight workmen were employed daily in two shifts, four in each; and 5,800 lbs. (700 kuanme), it is said, were made in three days, that is 1,933 lbs. in one day (perhaps in some exceptional case only). The amount of charcoal burned was three and a half times the weight of iron produced, they say, and costs now one quarter of a cent a pound (twelve and a half sen for six kuwamme); formerly it was a little cheaper. For the mere washing of the ore there is plenty of water in the small streams that cross the iron sand and empty into the sea at every little distance. The same streams would float down wood for charcoal to be used in smelt-

ing; and the supply from the Yurap valley would be very large. Besides the iron sand reckoned in the estimate just given, there is a very large amount of poorer sand, either in underlying layers or in neighboring places, and with cheap labor it is quite possible that more ore could be washed.

At *Kobui village*, on the sea shore, twenty seven miles (eleven ri) easterly from Hakodate, is a deposit of easily smelted iron sand. At the thickest point it is about two feet thick, but thins out to a knife edge in all directions from that. The whole length of the deposit is about six hundred yards, almost all (say five sixths) of it either very thin (one tenth of a foot) or comparatively poor. There are perhaps in all 250 cubic yards (thirty one cubic ken) of sand, containing perhaps two hundred cubic yards, or say four hundred tons, of pure ore, which would hold 290 tons of iron.

About a mile (half a ri) *south westerly from Kobui village* is some more rich sand, at the mouth of the Otsuki river. Ore was taken here and at the village, for the blast furnacce whose ruins now stand half a mile (ten cho) inland on the Musagawa; but smelting the ore was abandoned within the first year, fifteen years ago. About ten years ago a single boat load, it is said, of ten koku (perhaps one ton and two thirds) of sand, was sent from the mouth of the Otsuki river to the iron works near Yamakushinai, to be mixed with the ore there as already mentioned. No other working of the sand has been done. The rich part of the deposit is about thirty yards (fifteen ken) in diameter, with a thickness of two feet and eight tenths at the centre; and contains, perhaps, 700 cubic yards of sand of which, perhaps, 500 yards, or 1,000 tons would be pure ore, containing 725 tons of iron. From this place for four hundred yards or so towards Kobui is poorer sand, formerly thought too poor to work,

some twenty yards wide and perhaps a foot thick on the average, making in all 3,667 cubic yards; containing perhaps 2,000 cubic yards, or 4,000 tons, of pure ore, holding 2,900 tons of iron. That would make in all, at Otsuki, 5,000 tons of ore, containing 3,650 tons of iron. But these estimates of the richness of the sand at all places are mere guesses from looking at it, as no assays have yet been made of the samples taken. No more solid bed of such ore is known in this region.

At *Shirikishinai* on the sea shore, near Kobui, and twenty five miles (ten ri) from Hakodate, is a small bed of iron sand, say a hundred yards long by twenty five yards wide, and said to be one foot and three tenths thick at the thickest place, and containing therefore some 100 cubic yards. The sand does not look very rich, and holds perhaps in all 140 tons of iron. The sand was worked seventeen years ago, and during three years after that for a furnace on the Menokonai river near by, at two miles (thirty cho) from the mouth. The furnace is said to have been oblong square in form, seven feet long by four wide and five feet high, and built of clay; and to have been of the kind used in Nambu, the neighboring province of Nippon. The iron, they say, was soft and pretty good, though not the best; and the working was abandoned from the smallness of the quantity of ore.

No vein of solid ore has yet been found anywhere, and most likely there is none. In one case, however, in a gully on the side of the volcano *Komangadake* a layer of magnetic iron sand a foot thick was found, regularly bedded with the other volcanic rocks, and about seven feet and a half from the surface of the hill. It is 1150 feet above the sea, and two miles a half (one ri) distant from it. It seems to be exposed nowhere else, and its extent and persistence in thickness is quite unknown. Above it is only loose pumice, which would need to be stripped off in case

the ore were worked. Perhaps it may at some future time be thought worth working and can then be explored by digging, but at present it does not seem worth while.

The whole amount, then, of pure ore in the principal workable deposits is perhaps 125,500 tons, containing 91,000 tons of iron. Only 5,500 tons of the ore (containing 4,000 tons of iron) are of the easily smelted kind.

Sulphur.—The Sulphur occurs mostly within the craters of now inactive volcanoes. Hot sulphur fumes rise through small crevices and deposit yellow sulphur on the cold surface of the ground, forming a crust more or less impure, with a mixture of partially decomposed rocks. The shape of such deposits is extremely irregular and often rather inaccessible in many parts; so that the precise extent can hardly be measured except very roughly. At the place at Esan (the only mines worked at present) some four tenths of the surface over which the deposit is scattered seemed to be covered with sulphur earth. The thickness of the sulphur layer there is about half a foot, but the lower part is so very impure that only one twentieth to one fifth of a foot, perhaps one tenth on the average, is at present thought worth gathering. This gathered impure mixture yields, it is said, four tenths of its weight in sulphur. If this be taken as a guide in estimating the quantity at the different places there would be at Esan (guessing roughly) 400 koku, or about sixty three tons of sulphur, to be won, but the workmen there estimate the amount at less than one fourth of that, owing perhaps in part to its having been worked out in places, since the working has been going on for a dozen years on a small scale. There may perhaps be thirty tons (or nearly 200 koku) left.

The *Esan* sulphur is on the northern side of the crater of a volcano long inactive, and on the close adjoining slope of the mountain just outside the crater. The elevation

above the sea is from 1,250 to 1,550 feet; and by road the distance is about a mile and a half (a long half ri). In the middle of the plain, half a mile in diameter, that now fills the old crater, stand the small sulphur works, where for a dozen years in the summer months the sulphur earth has been purified by melting. It is melted three times over, in three large pots two feet in diameter and three in depth. The stones and dirt mostly sink to the bottom of the pots and are separated so; but the sulphur after the last melting is strained through thick canvas. Five men do the whole work of gathering the sulphur, bringing it to the furnaces, tending the melting, and packing the sulphur in the bags to be carried to the sea-shore at Netanai. One hundred koku or about sixteen tons of sulphur are made in three months, at the following cost, according to the workmen:—

	<i>En.</i>	<i>En.</i>
Wages of five men, at \$10,		50.00
Food for five men, for three months :		
Rice,	16.87 $\frac{1}{2}$	
Miso,	9.00	
Soy,	5.62 $\frac{1}{2}$	
Salt,	0.56 $\frac{1}{4}$	
Pickles,	4.50	
	<hr/>	36.56 $\frac{1}{4}$
Iron pots,		189.00
Wood fuel, 75 cords of 125 ft. @ 1.06 $\frac{1}{4}$,		76.93 $\frac{3}{4}$
Cotton bags,		53.12 $\frac{1}{2}$
Picks, hoes, hammers, skimmers and other tools,		33.87 $\frac{1}{2}$
Kegs for moulds,		18.75
Mats and ropes for carrying sulphur earth, ...		10.87 $\frac{1}{2}$
" " " " to Netanai,		28.75
Horse hire for carrying sulphur,		15.37 $\frac{1}{2}$
		<hr/>
		513.25
Carriage of sulphur to Hakodate,		25.00
		<hr/>
		538.25
		<hr/> <hr/>

As the price of sulphur at Hakodate is said to be from three hundred to three hundred and fifty dollars (en)

for 100 koku, it is possible that there is some mistake in the statement just given; but it is also possible that the sulphur is manufactured at a decided loss. Since the wood costs at Netanai only eighty-seven and a half cents (sen) for one cord, the saving in respect to it, if the furnaces were on the shore, would just about equal the additional expense of bringing down there the impurities of the sulphur earth, and there would besides be many advantages in having the furnaces there. Horses could go all the way from the sea to the mines. The great expense for kettles would be reduced one-half by working at night also, instead of merely keeping the sulphur liquid in the kettles as at present. Although sulphur is so valuable and rare a mineral, no royalty is taken for it; in order, it is said, to encourage its manufacture.

The sulphur on the top of *Tarumai volcano*, about nine miles ($3\frac{3}{4}$ ri) from Tarumai village on the sea shore, is wholly within the inner crater, of about 400 yards in diameter and 250 feet below the edge of the outer crater lip, which is about 3,000 feet above the sea. The sulphur appears to be in two deposits only — one of them in crescent shape about four hundred yards long by twenty yards wide, the other about thirty yards long by twenty yards wide; making in all, then, a surface of 8,600 square yards. Reckoning the same average thickness of workable sulphur earth as at Esan, there would be about thirty-five tons (or over 200 koku) of sulphur to be won here. The very abundant fumes here, as at Esan, must be constantly adding to the deposit, but how rapidly there is at present no means of judging. The present deposits, however, have probably accumulated since the last eruption, a small one about seven years ago. The sulphur was formerly worked for three years, but abandoned thirteen years ago. The ruins of the furnaces with places

for at least five pots are still to be seen about two miles (twenty-seven cho) below the mines. Horses could go all the way to the mines from the sea.

The sulphur on the top of *Iwaonobori* is about fourteen miles ($5\frac{1}{2}$ ri) from the sea at Iwanai, and about 3,500 to 3,800 feet above the sea. The sulphur deposits cover perhaps twenty thousand square yards, and would contain, by the same reckoning as at Esan, perhaps seventy-five tons (or 150 koku) of sulphur to be won. The ruins of the old sulphur works, abandoned five years ago after many years of work, are just below the mines and seem to have been larger than those at Tarumai. The road to them from Iwanai is passable for horses and even beyond that as far as the mines; but the last two or three ri are at present very bad, though a good road for horses could be built without any great difficulty. If the Shiribets valley, as it deserves, should be opened up by a wagon road from Isoya, the distance to the road from the sulphur mines would be perhaps only a couple of miles (or a ri). The sulphur fumes are less abundant here than at Esan and Tarumai.

The *Nuburibets* sulphur is found in a small valley close by the Nuburibets hot-springs, about nine hundred feet above the sea, and at about four miles from the sea shore at a point seventeen miles (seven ri) from Mororan by the new road. The sulphur place hardly seems to be an old crater, though possibly it may be so. Abundant sulphur fumes however rise from the rocks, and other appearances are the same as in volcano craters. The extent of the deposits is, at a rough guess, fifty thousand square yards, containing by the same way of reckoning as at Esan some one hundred tons (600 koku) of sulphur. The working of sulphur here was abandoned some sixteen years ago; there seem to have been but three melting pots.

The *Oi Lake* sulphur is on the banks of that lake of hot and boiling water, about a quarter of a mile (4 cho) from the Nuburibets sulphur. The lake is apparently within an old crater. The sulphur covers perhaps 8,600 square yards, and would in that case be capable of yielding, according to the Esan reckoning, thirty-five tons (or over two hundred koku). A horse path or wagon road could probably be easily made from the lake all the way down the valley of its outlet to the Nuburibets hot-spring, and so to the sea shore.

The *Kobui* sulphur is partly at the old sulphur works on the Musu River, at four or five miles (a ri and a half, or two ri) from Kobui village near the mouth of that river on the sea shore, and partly at a place discovered this year on a branch of the same stream about a mile to the north-west. The sulphur is a bedded deposit from sulphur water and seems to be very pure, but is of a gray color quite unlike the yellow sulphur of all the other places. The deposit at both places is extremely irregular. The old mine is a drift called 240 yards (two cho) long, which is said to have followed a vein one foot thick which contained yellow sulphur (without any gray) in small nests and single crystals, but gradually grew poorer to the end. Outside near the mouth of the mine is a bed of gray sulphur about two feet thick, dipping 35° north 80° east, and is exposed for a length of about four yards. Also, at the mouth of the mine is a thickness of four feet of gray sulphur, which the former worker of the mine however insists does not extend to the interior. Still it was not much sought after, as, on melting some of it a dozen years ago and sending it to Hakodate, it could not be sold, it is said, on account of its color. Nevertheless, the bed having been deposited probably in a stream or pool of sulphur water is not likely to be very uniform in thickness nor very wide spread. The same may be said

of the newly discovered gray sulphur a mile to the north-west, which however is exposed for a space of a hundred feet in length, in the bank of a small ravine, and some four yards in height, partly very pure, partly mixed with earthy impurities. Perhaps one-third of the whole is pure sulphur. It might perhaps be well enough to count upon two hundred tons of sulphur here in all, and twenty-five tons at the old mines; but the quantity may prove to be far greater.

The whole quantity of sulphur to be got from the places visited this year would seem, then, to be possibly five hundred tons (three thousand koku). The completion of our maps may bring about very important changes in these estimates.

Limestone.—The principal exposure of limestone is on the small stream Garonosawa, about five miles from Arikawa and Sekirichi, which are seven miles (three ri) across the bay from Hakodate. The limestone is exposed in cliffs on the hills either side of the brook to a height of perhaps six hundred feet, for a distance of some four miles. The amount, then, within one yard of the surface would be (very roughly) some eight million cubic yards, or twenty million tons. As the whole depth is probably many yards, perhaps hundreds of yards, that quantity is very little compared with what may be expected to exist within the hills, and may be safely considered as inexhaustible for a thousand years. Of that amount perhaps twelve thousand cubic yards, or thirty thousand tons, are already in loose blocks in the bed of the brook. The quality seems to be very good indeed, say one-half dark blue limestone, the other half light gray. It all seems very much metamorphosed, in some small parts even like marble; and no fossils could be found. The cleavage planes are very strongly marked and often obscure the dip; but at least one saddle in the rocks (anticlinal) is

to be clearly seen, with a course of north five degrees east (magnetic) sinking five degrees in the opposite direction, south five degrees west, the bearing of the Horumui Karafto System of axes. A wagon road or a railroad could easily be built with down grade all the way about four miles to the sea shore. Wood at the limestone costs two dollars a Japanese cord (125 feet).

On the sea shore at the western end of the village of *Ishizaki*, ten miles (four ri) east of Hakodate, begins an exposure of gray and white pure looking lime rock about 250 yards long in cliffs on the side of a bluff eighty-five feet high. The whole amount "in sight" may perhaps be 2,000 cubic yards or 5,000 tons. No doubt a far larger amount exists behind what is in sight; namely 15,000 cubic yards or 40,000 tons for every six feet (one ken) back from the face of the bluff, or in 100 yards, 750,000 cubic yards, or 2,250,000 tons.

The *Kamiyunosawa* limestone about five miles (two ri) north-east of Hakodate, is exposed on both sides of a very small valley here and there for a space of a quarter of a mile. Some 800 cubic yards or 2,000 tons (very roughly speaking) seem to be exposed. The quality is good; and a kiln is in use here since last year for burning the stone to make lime. The kiln is thirteen feet high by six feet in diameter, cylindrical; and, it is said, burns 1,750 lbs. (210 kamme) of lime at a time during three days, and burns twice and a half in the month or 4,325 lbs. (525 kamme) about two tons in all. Nine Japanese cords (of 125 feet) of wood, at \$1.45 a cord are burned each time — that is \$18.60 for a ton of lime. The carriage of one horse load of 218½ lbs. of lime to Hakodate is \$0.115, or \$1.20 a ton. Laborers' wages are \$0.25 a day. The lime at Hakodate brings \$7.10 a ton (or 37½ sen for one hio of four to or 13,100 me). A wagon road to Hakodate could be made with very

great ease, as it would be almost wholly over nearly level ground free from rocks and trees.

About a mile (twelve cho) north-westward from *Washinoki* on the sea shore some gray limestone is exposed that looks rather impure with clay, but on burning may make strong lime. The exposure is at the axis of a basin (synclinal) with a dip of sixty degrees on one side, and one of eighty-five degrees east on the other; and belongs therefore probably to the *Toshibets Karafto* System of rock folding. The thickness of the limestone is about four yards in all, besides some accompanying gray clay shales, perhaps limy also. Supposing it extends only a quarter of a mile ($3\frac{2}{3}$ cho) inland, and to have an average height of thirty feet from the sea level up to the surface of the ground, the whole amount would be 17,500 cubic yards or 4,300 tons; enough to supply such a kiln as that of *Kamiyunosawa* at the present rate for about a thousand years. Single blocks or large balls of limestone are also found on the *Washinoki* river about a mile above the main oil spring, and may come from the same beds as those just mentioned as exposed on the sea shore. It is also not unlikely that these beds may be found in place farther up stream as their bearing from the sea shore would seem to bring them there.

In like manner, balls of limestone are found in some numbers near the *Horumui* coal beds; but none are in place except small ones imbedded in the thick beds of shales that accompany the coal. It is probable, therefore, that the balls come wholly from such a source, and that there is no bed of lime rock.

Gold.—The chief gold field surveyed this season is that of the *Toshibets*. The gold occurs in the form of small grains and scales in the alluvial gravel that borders the river. The bed rocks are of the *Toshibets Kurile* System, chiefly soft sand and clay rocks. No gold-bearing quartz

vein has yet been discovered, but the grains of gold seem to be somewhat larger in the upper part of the field. The gold-bearing alluvium of Mr. MUNROE'S survey he found to extend half a dozen miles along the river (four miles and a half in a straight line), and to cover in all a space of some three square miles and six-tenths, with a thickness of some six to twelve feet; in some places 25 to 30 feet covered by five or ten feet of barren yellow sand. The richness seems to him to be perhaps four, possibly five, cents to the cubic yard; but he has not yet had a chance to weigh the gold he washed from measured quantities of gravel. That would give for the whole amount of gold within the field surveyed, say a million and a half of dollars worth. But one-half or more of the field seems to have been worked over in old times, and is consequently still poorer; and that would bring down the amount of gold to a million dollars or even less. Of course the cost of washing the gold should be subtracted from that in estimating its value. The streams seem to furnish ample amounts of water at sufficient height for washing the whole by the hydraulic method, without very long flumes. It is hardly probable, however, that so poor and small a field would pay for working on a large scale. Washing by hand, as hitherto practised, yields about twenty cents a day to each laborer, rather scanty wages for Yesso. The survey was not pushed to the very uppermost (northernmost) limit of the field, and it is possible that a small extent of somewhat richer ground may be found there, since the grains are slightly larger in that direction. But that part of the valley is narrow and must be quite short. The working of this field has been abandoned for about eleven years.

Near *Kudow* Mr. MUNROE found about a third of a square mile of gold-bearing earth four to eight feet thick,

poorer than that of the Toshibets and resting on marlite, volcanic and metamorphic rocks. The whole value of the gold within the field would be then only some eighty thousand dollars, and probably quite too much scattered to work at all.

Near *Esashi* he found on the Jimikishi river about one fifth of a square mile of gold-bearing earth three to eight feet thick; with perhaps four to five cents worth of gold to the cubic yard. The bed-rock was of mica schist and other metamorphic rocks. There were some quartz veins which perhaps furnish the gold, though no gold was found in them. The whole amount of gold on this river would seem then to be some sixty thousand dollars worth; so much scattered, however, as scarcely to pay for working.

On other rivers near Esashi, the Meniu, Todo, Gokatte, Asabu, Otobe and other small streams, he found some four to five square miles of the gold bearing earth, three to twelve feet thick, poorer than that of the Jimikishi, except the headwaters of the Asabu and Otobe, which may prove equal to Jimikishi but no better. The whole amount of gold then would seem to be perhaps a million and a quarter of dollars. All the streams for fifteen miles (six ri) and more, along the coast here, yield more or less gold.

The amount of gold then in all the fields surveyed would seem to be less than two millions and a half of dollars; and in none of them to be abundant enough to give much encouragement to working.

Rock Tar.—The so-called oil of Washinoki, Yamukushinai and Idzumisawa is all black, and so very thick as to deserve better the name of tar. At Idzumisawa it comes clearly from the soft bluish gray somewhat shaly sand rock, that in its dip belongs to the Toshibets Karafuto System, and has the some fossils as the Toshibets and

Yurap rocks. Some at least of the Washinoki tar comes from rocks with a similar system of dips; the rest comes from alluvial gravel in which it has perhaps accumulated after oozing out of such rocks below. At Yamukushinai it comes only from alluvial gravel, but has perhaps entered it from rocks below of like age with those of Idzumi-sawa. All the oil would seem then to be possibly of the same age and it very likely is so; and that age seems to be comparatively recent, perhaps tertiary.

The *Washinoki* oil springs all occur within two thousand feet up and down the Washinoki river and within a mile or so (one half ri) from the sea. The main well is a somewhat triangular hole dug last year, about ten feet long by five wide and half a foot deep. Within the past year about four gallons accumulated here. The next day after gathering that amount about two gallons more were taken; it was of the specific gravity marked by fifteen degrees of Beaumé's scale. Another well dug last year and reopened this year is about a quarter of a mile below the main well and is a shallow hole about two feet and a half in diameter. About eleven quarts (seven sho) were taken here as the past year's accumulation; and within the next following day a pint and a half accumulated, which marked twelve degrees and a half of Beaumé. There are two or three still smaller springs near by. The oil seems to come wholly from deposits of small extent; and though in some cases seeming to come from the alluvial gravel, it probably at the outset came from the soft greenish gray sandrock from which it seems to come at the two wells just mentioned. That rock dips from thirty-five to seventy degrees at different places, so that its outcrop crosses the country far and wide. Yet the oil springs are confined within a narrow space, and would seem therefore to belong to but a small portion of the oil-bearing beds of rock. It is not likely then that

a large yield of oil can ever be got here ; and as with so steep a dip the depth and consequent cost of wells would very rapidly increase according to the distance from the outcrop at which they are bored, the encouragement to such undertakings, in view of the small yield of the present wells, is not very great.

The oil at *Yamukushinai* is found wholly within the village in the alluvial gravel of a plain 150 yards (75 ken) wide, that borders the sea shore. The main well, dug last year, is a hole some ten feet square and eight feet deep loosely walled at the sides with wood. About twenty four gallons were taken here as the accumulation of the past year ; and in the next day a little over three pints (about one sho) collected there, which was so thick as to have the specific gravity of eleven degrees of Beaume's scale. Another well, somewhat smaller, dug by a merchant at about seventy yards (thirty five ken) southward of the main well, yields only a few drops of oil in the day. One or two other very small holes one foot or so in diameter have exposed the same black thick oil in the gravel. But all these exposures are within a diameter of about a hundred yards (fifty ken) except a slight trace at a distance of four hundred yards (200 ken) south of the main well. The deposit then appears to be of very limited extent ; for, although the underlying rocks from which the oil probably comes, have a dip of twenty five degrees or so, and an outcrop running doubtless a long distance through the country, there is nowhere else a trace of oil coming from it. There is nothing then to encourage very expensive exploration by boring. Perhaps it may be worth while to gather what oil can be got by digging small inexpensive wells near the main one, and if they turn out profitable, it may some time be good to sink a small borehole to a short depth near the main well. The thickness of the oil goes to show that it is a very superficial

deposit. Besides the oil here, there are perhaps forty cubic feet of asphalt (dried oil), which would weigh say a ton and a half.

The oil at *Idzumisawa* is in a narrow ravine, about a mile from the village, and about half a mile from the sea shore. It is only found at the main well and in mere traces at some other holes within ten yards of that. The main well dug last year is a hole about four yards long by a yard and a half wide, and two yards and a half deep with about four feet of water in it. About eighty-two gallons (two *koku* and one *to*) were taken here as the accumulation of the past year; and in three days afterwards an average of two quarts and two gills and three-quarters (one *sho* and a half) were taken; which marked eleven degrees *Beaumé*, it was so remarkably thick. The oil comes almost wholly from one corner, from greenish gray somewhat shaly broken sandrock with a dip of some twenty degrees. Although much digging has been done close about here, only traces of oil have been found, and not even so much as that has been noticed at any other part of the necessarily extended outcrops of so steep a bed. It seems therefore highly unwise to undertake the boring of wells along the outcrop, especially very deep ones.

Mineral Springs.—Mineral springs are quite numerous and of varied character in the southern part of Yesso. They have all been visited in passing, with but two or three too distant exceptions; and the main facts in regard to them have been gathered so far as possible without a chemical analysis, and are given in the following table:—

(The heat is given in degrees centigrade; a star means a close approximation; a question mark, a rougher one.)

NAME.	No.	HEAT.	CHARACTER.	ROCK.	PLACE.	REMARKS.
Oi Lake	1	99°	Sulphur with gas.	Black mud	$\frac{1}{4}$ mile N. W. of Nuburi- bets Hot Springs.	$\frac{1}{4}$ mile wide. 900 ft. above the sea.
Nuburi- bets	1-6 7 8 9 10	99° 83° 81° 78 $\frac{1}{2}$ ° 48°	Sulphur with gas.	Alluv- ial earth.	At the Nuburi- bets sul- phur place and close by.	6 or more boiling springs in the sulphur deposit, 900 ft. above the sea, also other cooler ones.
Jôzan	1 2 3 4 5 6	89° 89° 87° 83° 83° 80 $\frac{1}{2}$ °	A little sulphuret- ted hydro- gen.	grani- tic (vol- canic?)	At Jôzan on the Toyahira 17 miles above Sapporo ; all within 100 yds.	Nos. 1, 2, 3, 54. 6 large springs. Some 2 or 3 other springs besides.
Obune	1 2 3 4	78 $\frac{1}{2}$ ° 74 73 68	Sulphu- retted hy- drogen.	Alluvi- al gravel.	1 ri in- land, from Kumado- mari and Usudzui,	All small, but oth- ers still smaller. All with- in 12 yds.
Isoya	1 2 3 4 5	72° 69 67 67 48	Sulphur- retted hydrogen, with gas.	Gray soft clay.	$\frac{1}{2}$ ri in- land from Isoya, between Shikabe and Kuma- domari.	All with- in about 20 yds. and not large.

NAME.	NO.	HEAT.	CHARACTER.	ROCK.	PLACE.	REMARKS.
Nigori-kawa	1	57°	Sulphuretted hydrogen, with gas bubbles, except No. 4.	Alluvium.	1½ ri from sea shore, near Ishikura, 2 ri N. W. of Washinoki.	All small, all within 50 yds.; ½ m. & 1 m. towards sea, many small cold sulphur springs.
	2	55				
	3	51				
	4	49				
Esan	1	53*	Very acid and astringent, sulphuretted hydrogen.	Alluvium.	On Esan Mtn, "½ ri" from Netanai.	All small and within 20 yds.
	2	50*				
	3	45 ?				
Kakumi	1	50*	A very little sulphuretted hydrogen, gas bubbles, but none from No. 1.	No. 2 from surface gravel; others, greenish, gray volcanic porphyry.	½ ri inland from Kakumi, all within 100 yds.	All small.
	2	47				
	3	40 ?				
Yunai	1	49½°	Sulphuretted hydrogen with gas bubbles.	volcanic, mottled white and bluish gray.	In Raiden M't'n 3 ri N.W. from Iwanai.	All within 30 yds. another 30 cho distant cooler.
	2	47				
	3	46				

NAME.	No.	HEAT.	CHARACTER.	ROCK.	PLACE.	REMARKS.
Kusuri Lower	1	45½°	Sulphur and iron with gas.	Allu- vium.	200 yds. towards Otoshibe from Kusuri upper springs.	Within a space of 25 yds.
	2	cold.				
	3	cold.				
Yudo- mari	1	33°	Sulphur? and copperas with gas.	Pale green gray volca- nic por- phyry.	At Yudo- mari "copper vein" near Sak- kadzuki.	Water used as an eye wash
	2	32½				
	3	29				
	4	27½				
Kusuri upper	1	35°	Sulphuret- ted hydro- gen with gas bubbles.	River gravel.	3 ri from Otoshibe on Esashi road.	Small.
Notap	1	cold.	Sulphuret- ted hydro- gen.	River gravel.	2 ri from Otoshibe towards Esashi.	Small.
Shikabe	1	91°	A little iron, gas bubbles.	Beach gravel of sea shore.	In Shika- be village No. 1 at 200 yds. from the others and below high tide.	No. 1 largest, all small, No. 1 probably boiling at little depth.
	2	70½				
	3	70				
	4	44				
	5	42				
Yumoto	1	43*	Iron.	Gran- ite (or syen- ite?)	On Kennichi River 1½ ri from W. coast.	Deposit of traver- tine (H.S.M.)
	2	43*				
	3	43*				

NAME.	No.	HEAT.	CHARACTER.	ROCK.	PLACE.	REMARKS.
Yuno-sawa	1	43°	Iron.	Light greenish argillite? metamorphic.	1 ri from sea on Moshibets near Kudow.	Near so-called copper mines (H.S.M.)
	2	32°				
Yurap	1	39'	Iron, (no gas?)	Alluvium.	Close to the furnace building.	No. 1 rather large No. 2 small.
	2	35°				
Yuno-kawa	1	35°	Iron (carbonate?) with gas.	Alluvium.	At Yuno-kawa village 6 miles N. E. of Hakodate	Small.
Boro	1	33°	Iron (carbonate?) with gas.	Alluvium.	1 ri from Otoshibe towards Esashi.	Small.
	2	27				
Yuno-saki	1	cold	Strongly copperas? without gas	Alluvium.	4 cho W. of Washinoki near sea.	Small. On beach close by, cold springs.
Tomi	1	50%	Nearly pure water.	Alluvium.	1½ ri from Ikusakusa, 2 ri from Shikabe.	Small.
Kamiyunosawa	1	30°	Nearly pure water.	Alluvial gravel.	At Yunosawa lime 2 ri N. E. of Hakodate	Pretty large.

Of these twenty one springs, then, there are thirteen sulphur springs with temperature from coldness up to boiling; six iron springs from 27° to 91°; one cold spring with copperas; and two nearly pure springs 30° and 50° hot.

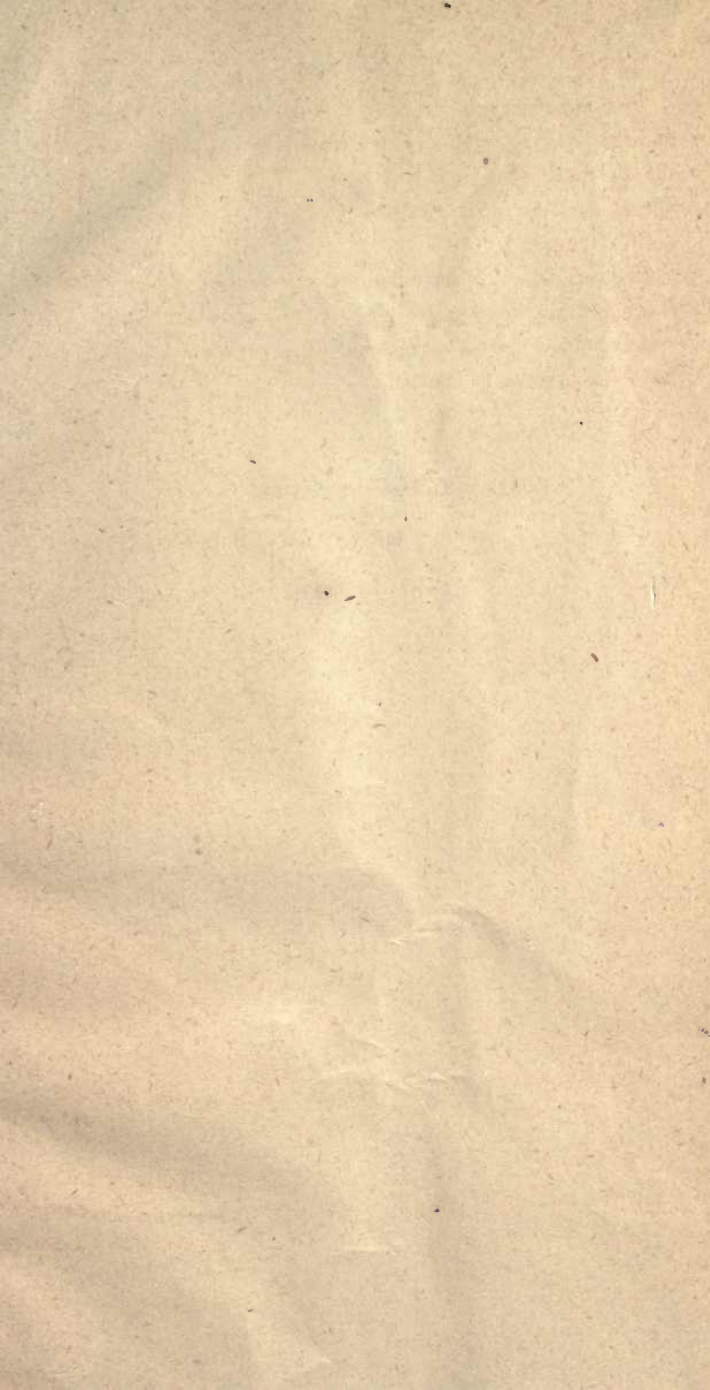
Hoping that this statement of the probable results of the season's survey may be of some use while you are waiting until they can be worked out more exactly; I have the honour to remain,

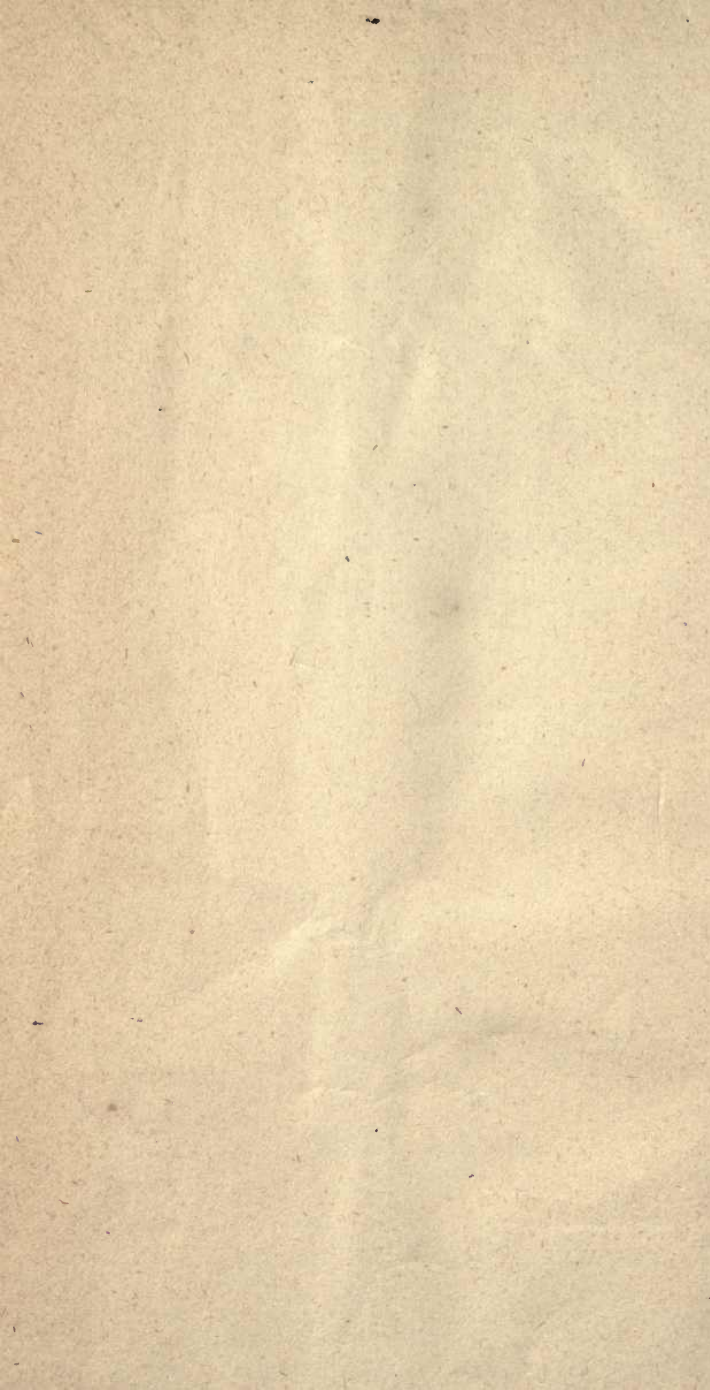
Sir,

Your most obedient servant,

BENJ. SMITH LYMAN,

Chief Geologist and Mining Engineer.







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