
The Orography of Asia. I. Introductory Remarks

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to the coast sierra. On the north of this the country is arid as far almost as the equator, but south of it commences a moister belt, and from Santiago down to about lat. $41^{\circ} 30'$ you have that very beautiful valley which lies between the main range of the Andes and the Pacific coast sierra, which is one of the most beautiful valleys that I have ever travelled through in South America. At the latitude named, it dips under the ocean, and we then have the remains of the coast sierra extending down to the Straits of Magellan, and numberless inlets and every imaginable deviation of ocean and river, which make the coast of Patagonia such a wonderful field for scenic effect. On the east side of the Andes, we have what Darwin has said is one of the most wonderful Tertiary and shingle formations in the world. Take it from Bahia Blanca and from about 700 miles south along the Atlantic and 200 miles inland, we have a cap 50 feet thick of shingle, all of which represents some eight successive movements of elevation from the sea-bottom upwards, eight terraces with all their margins well defined as having been on the edge of the sea-shore, but now elevated to from 300 to 400 feet above sea-level. They represent the wonderful denudation of the Andes. If you examine the map, you will find that north of Lake Titicaca there is a transverse barrier called Vilcanota; north of which the rivers flow northward and enter the Amazon. That knot is the governing-key point of Andean geography, and south of it is Lake Titicaca, which is now only the shrunken remains of what was once a lake of 106,000 square miles, which poured southward through the longitudinal gorges of the Andes, and reached the Atlantic at and near Bahia Blanca. Therefore, all that region is perhaps one of the most interesting, not only geographically, but geologically, that can be found in the world, and, as Sir Thomas has said, Nature has been working there on a vast scale. It has thrown out from a hundred fiery mouths volumes of lava, which have given Patagonia a hard basaltic cap of from 300 to 400 and 800 feet thick in places. It has been one of the most active places on the globe as regards igneous action, and almost rivals Ecuador. I will not detain you longer, but it remains for me to convey your very sincere thanks, which I know you will cordially vote, to Sir Thomas Holdich.

THE OROGRAPHY OF ASIA.*

By Prince P. KROPOTKIN.

I. INTRODUCTORY REMARKS.

DURING a five years' stay in Siberia I made several journeys which offered me special opportunities for gaining an insight into the leading features of the orography of this wide region. In 1866 our small expedition realized at last what had been the dream of the Siberian Expedition of 1860. We crossed in its full width the mountain region which fills up the space between the Lena and the head-waters of the tributaries of the Amur. From Irkutsk we went first northwards to the gold-mines of the Olekma region. We followed the course of the Lena, excavated in the horizontal layers of Red Sandstones, probably

* Maps, p. 280.

Devonian; * we saw next the great river piercing Silurian limestones, in a picturesque valley, and we entered after that, near the mouth of the Vitim, into a zone of gneisses and crystalline slates, probably Laurentian and Cambrian. There we landed, and at the Tikhono-Zadonsk mine (59° N. lat., 115° E. long.) our expedition was organized for its subsequent journey across the wilderness. We went first southwards, crossing for a distance of 400 miles a wild Alpine region, in which I could distinguish four parallel mountain ranges, running south-west to north-east—the first of them chiefly composed of auriferous clay slates; the second, chiefly of dioritic slates and gneisses; and the two latter, on the left bank of the Vitim, of gneisses, granites, and syenites. Thus we reached the Muya river, which flows eastwards, to join the Vitim, in a broad, deeply sunk valley, which is continued further east by the valley of the Chara, and joins in the west the valley of the Barguzin,—these three valleys having the same orographical character and constituting an important landmark.

Continuing our south-bound journey, we climbed upon a high ridge (over 5000 feet), the soft undulating summits of which already from a distance revealed its granitic structure; and, after a short descent, we were on the surface of a plateau from 3300 to 3500 feet high, which we had to cross for a distance of another 400 miles. It was the plateau which Georgi in the last century, and Lopatin two years before us, had visited as they came from the valley of the Barguzin (Baikal), and to which Georgi gave the name of *Vitim plateau*, which name I, of course, maintain. Following our journey on the surface of this plateau, which is only diversified by a few parallel, relatively low ridges (their bases lying on its high surface), we finally came, at a distance of some 15 miles from Chita, the capital of Transbaikalia, to the north-western foot of a second border-range—the Stanovoi, or the Yablonovoi, which lies on the surface of the plateau. A very gentle and short slope brought us to the flat summit of this range—hardly 600 feet over the surface of the plateau—but then we went down a very rapid and a much longer slope in order to reach the Chita river, which belongs to the basin of the Amur. We had thus obtained a full cross-section of an immense highland, nearly 700 miles wide.

Another journey, which I made two years before, was, geographically speaking, a continuation of the above. Starting from Chita, I went to the Tsurukhaitu Cossack village, in the south-eastern corner of

* Baron von Toll considers them as Cambrian-Silurian, but I must confess that I do not feel quite convinced by his arguments. So long as we have no positive proof. I permit myself to keep to Erman's view, according to which the nearly horizontal layers of Red Sandstones of the Upper Lena lie *upon* the Silurian Limestone of the Middle Lena. This doubt lasts now over forty years. Could not some geologist give a summer to the special exploration of the Lena and the surrounding high plains?

Transbaikalia, now the head of the Trans-Manchurian railway. Thence, disguised as a merchant, with eleven trading Cossacks, I started, to find a direct route, across Manchuria, to the Middle Amur; we followed for about 130 miles the surface of another plateau, which I call now the Lower Terrace of the Great Plateau of East Asia (in the afore-mentioned journey we had reached it at Chita, after having crossed the Stanovoi escarpment). Marching eastwards, we reached, even without noticing it, the crest of the Great Khingan. From the character of the vegetation I knew that we were gradually rising to a higher altitude; but only when we had reached the customary *Obo*—a heap of stones and branches, with small offerings to the gods, usually erected on the water-parting—did we learn that the waters which we saw before us were running towards the Amur. Going now down a very steep slope, we came to the stream Gan, which flows into the Nonni, a sister river of the Sungari. It thus appeared that here, under the 50th degree of N. lat., as well as it was known to be further south (from Timkovskiy's, now seemingly forgotten but important journey), on the route to Peking, the Great Khingan is, like the Yablonovoi, a border-range which fringes the lower terrace of the great plateau of Asia, and faces, as an escarpment, the plains of Manchuria and China. It is accompanied along its eastern slope by an Alpine region, some 70 miles wide, composed of three parallel chains, which we crossed, following the course of the Gan. Then we crossed the nearly 1500 to 2000 feet high plains of Merghen, and passed over the flat, undulating hills of the Ilkhuri-alin, where we found the renowned volcanic region of the Uyun-kholdontsi, and reached the middle Amur at Blagovyeshensk.

To complete this picture further eastwards, I may add that during subsequent journeys I crossed on horseback the plains of the middle Amur. They spread eastwards as far as the Little Khingan, or Dousse-alin ridge, which separates them from the lowlands of the Sungari and the lower Amur. These latter, which occupy the space between the Little Khingan (or Bureya range) and the Sikhota-alin coast ranges, are, as is now known, the greatest obstacle to the building of a railway along the Amur, on account of their low and marshy character, and (to use Peschel's expression) "the youth" of their rivers, which have not yet excavated quite permanent beds. I also crossed them on horseback, and moreover, in 1864, went on board the first steamer which ascended the Sungari, as far as Kirin, and thus saw the southern continuation of the Little Khingan. Further east we have the littoral chains of the Sikhota-alin, between the Usuri and the Pacific ocean, and the partly submerged ranges which build up the Japanese archipelago, the island of Sakhalin, and so on, and seem to be still in their building-up period.

These journeys gave me consequently a complete cross-section of the highlands of Eastern North Asia, and they were completed by several

smaller journeys of less importance, one of which was made in the Sayans.

However, these journeys alone would have been insufficient for giving me a complete idea of the orographical structure of North-Eastern Asia. As a rule, the true direction of a chain of mountains cannot be determined by one single crossing of the chain, because the traveller who crosses a chain of mountains is always inclined to represent it as perpendicular to the main direction of his route, which is by no means always the case (see Fig. 1). Two crossings, at least, are required. As to the directions of mountain ranges in an Alpine region of complicated

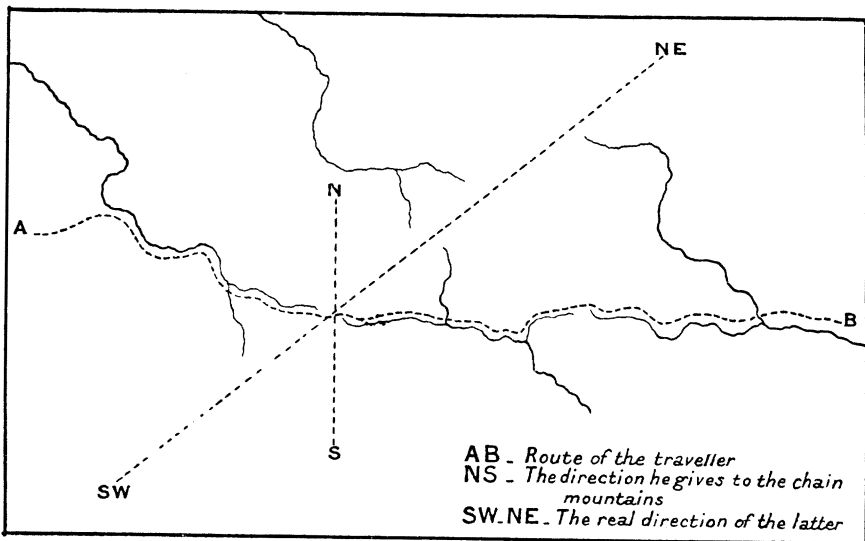


FIG. 1.

structure, they can only be ascertained from a general and detailed study of the region. I had thus to complete my journeys by such a study.*

On the then existing maps of Siberia the whole country was covered with chains of mountains, carefully drawn by the topographers between all the rivers. The darkness of the worms, which were thus represented creeping in all directions, increased in proportion to the importance of the watersheds which they represented. And, finally, a range of very darkly engraved mountains, the Stanovoi Khrebet—"the main

* The few measurements of the dip of the rocks which one can make as he crosses a Siberian highland are (as V. Obrutcheff has quite correctly remarked to Edward Suess) of an extremely small value. Let one imagine taking an occasional measurement of the dip of the shales on the North Cornwall coast, and trying to deduct from this the direction of the foldings of the rocks. On the space of a mile the rocks are found dipping to all points of the compass.

water-parting"—was traced all along the sinuous line which separates the heads of the rivers which flow respectively into the Glacial and the Pacific oceans. This range, as had been already hinted at for some parts of it by Ludwig Schwartz (the head, for many years, of the Siberian Expedition, and the only explorer, with Colonel Akhte, of the Eastern Stanovoi, as also the author of the great map of Eastern Siberia)—this range does not exist in reality. It was born, not even in the imagination of the explorers, but in the map-rooms, where the European topographers, whose education was made in speaking of Alpine chains as of "a prism laid on one of its sides," had traced the highest range of mountains along the main water-parting. In reality, the Stanovoi, as every one may see it now on the railway line near Chita, is only a border-range of the plateau, an escarpment, and the highest mountains of the region are situated elsewhere (Fig. 2, A). In other portions of Siberia the rivers flowing to the two different oceans take their origin in common marshes on the plateau (Fig. 2, B).

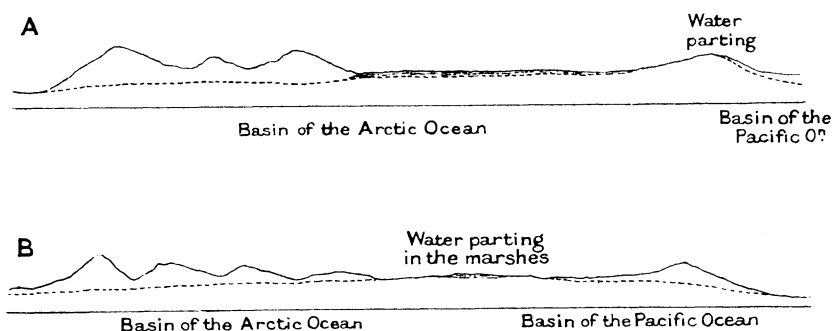


FIG. 2.—WATER-PARTINGS ON THE SIBERIAN PLATEAU.

However, the European topographers, unfamiliar with the plateau type, did not realize such a structure, and when Schwartz intended to represent this type on his large map (27 miles to the inch), they drew, contrary to his indications and sketches, only chains of mountains. Then—he told me that himself—he himself drew the orography as he understood it, on his small map (108 miles to the inch). But the same mistake was now made by the engravers, so that Schwartz told me, "Keep no account of the orography on my maps; find it out yourself."

I had therefore to return to the original itineraries of the travellers. Schwartz gave me all the original meteorological diaries of the members of the Siberian Expedition, as well as his own, very precious, full diary of the Akhte Expedition (1851). Utilizing, in addition to these, all published barometric observations, and those which I had made myself during my journeys, I calculated a catalogue of about 800 altitudes, which was published in vol. iii. of the *Memoirs of the Russian Geographical Society* and in *Petermanns Mittheilungen*. With the aid of these

altitudes I prepared a number of cross-sections of Siberia (part of them is reproduced here, from vol. v. of the same *Memoirs*). Then, taking all the original journeys, I traced on the large map of Schwartz all orographic and geological remarks which these records contained ; and when I saw that a traveller had crossed a range of mountains which had such and such an orographical and geological structure, I endeavoured to discover which of the ranges crossed by other travellers a hundred miles further east or west would best answer to the same structure and character. I proceeded, in short, in a strongly inductive way.

However, as each inductive research is also guided by some deductive hypotheses, I was for a long time working in a wrong direction in consequence of the hypotheses formerly made, especially by Humboldt in his beautiful work 'Central Asia.' The great author of 'Cosmos,' under the influence of the Chinese authors whom he had studied for some time, endeavoured to represent the chains of mountains of Asia as a regular network, in which some ranges were running along the parallels and the others along the meridians ; and, quite unconsciously, I tried for a long time to make the plateaux and mountain ranges of Asia fall in accordance with the system of Humboldt.* It was only after a long succession of failures that I saw that Humboldt's hypothesis, which has rendered great service in stimulating research, does not answer to the reality of facts, and I finally came to the conclusion, first, that the mountains of Siberia do not follow meridians and parallels, but have a general direction from the south-west to the north-east, and second, that the mountain ranges are entirely subordinated to the plateaux. These ideas I embodied in a map which represented schematically the great lines of structure in this part of Asia, and of which a reproduction is now given with this paper, and in a 'General Sketch of the Orography of East Siberia,' which was published in vol. v. of the *Memoirs of the Russian Geographical Society for General Geography* (1875), and will be summarized here.

When this sketch and map were published in Russia, in 1875, Petermann was preparing his map of Asia for the atlas of Stieler. He knew my preliminary work, he had encouraged me in preparing my catalogue of altitudes, and he accepted at once my conclusions. He embodied, in his well-known map of Stieler's Atlas, the system which I now proposed for Eastern Siberia, Mongolia, and Manchuria, and it fell in admirably with the more accurate surveys which had just been made at that time in Turkestan and Central Asia. This representation of the orography of Asia can now be seen reproduced on a great

* It is interesting to note that a trace of the same desire is met with in all descriptions of travels. The very length of the words "north-east," "south-east," and so on, contributes to this.

number of maps, but it is only in the beautiful series of maps of Stieler's Hand-Atlas that the system which Petermann had accepted for his map of Asia, and which has been retained at Gotha since—proving admirably well adapted to embody all subsequent surveys—that one finds it kept in its entirety. In the new editions of 'Asia' and 'Central Asia' of the Stieler's Atlas, as well as in the admirably clear map of the small 'Taschen Atlas' of Gotha, one sees at a glance how the orographic structure of Asia appears when it is conceived in this way.

The distinctive features of this system are the following: The great plateaux of Tibet, Central Asia, and Siberia belong to the same system of massive upheavals. There are two distinct terraces in these plateaux: one upper in the west, and one lower in the east, while several still higher terraces rise in the south, in Tibet. The mountain ranges are entirely subordinated to the plateaux, and run chiefly from the south-west to the north-east; but they are crossed also by a number of ranges running nearly perpendicular to the former, that is, towards the north-west (or rather west-north-west).

As to the Stanovoi, the chain of mountains which was traced west to east to the north of the Amur, it has disappeared. On the contrary, the Great Khingan, which formerly was traced running north and south, but which had never been visited by any geographer north of the 50th degree of latitude, where I have crossed it, runs south-west to north-east, and joins the chain of mountains, Jugjur or Stanovoi, which fringes the sea of Okhotsk. It will be seen further on why I gave it this direction.

This is well seen on all the maps published by the Gotha Institute.* As to other cartographers—without inquiring why the Stanovoi and the Khingan were traced in this or that direction on older maps (hypothetically, of course, as there were no regular surveys, and none have been made since), and why their directions have been changed in the Gotha editions—they combine in an arbitrary way the representation of Petermann with the old representations of mountains (the highest ranges along the main water-partings).†

* An exception must be made for the map of Eastern Siberia, just published by Habenicht. On this map we see again reappearing, under the name of Ilkhuri alin, a high range which runs west and east under the 51st degree of latitude in the west of the Amur. Herr Habenicht has evidently taken it from the Russian maps, upon which this range continues to be drawn, not on the basis of some new surveys, but merely as a reminiscence of the chain of mountains which was traced hypothetically around the head of the basin of the Nonni, on the map of China of the Jesuits (in Du Halde). It must be remarked, however, that *none of the Jesuits have been north of Merghen*, and that till now there have been no surveys in this region, as Herr Habenicht himself implies in giving the Kumara and the upper Nonni in a broken tracing.

† The survey of the western part of the Stanovoi, which was made in 1850, and which I saw at Irkutsk, has perished during the conflagration of this city, without

The work of Prof. Muschketoff in Turkestan permitted us to make a further step forward with the orography of Asia. The Russian geologist has proved that the mountain ranges of this part of Central Asia belong to two different systems: those which run south-west to north-east are the most ancient, and belong to the pre-Silurian, Silurian, and Devonian ages, while those which run north-west to south-east are of a more recent origin, and belong to the Secondary age. These two systems probably must be found in Eastern Siberia as well, and if I could now do afresh the work which I did a quarter of a century ago, I probably should, by looking for upheavals in this second direction, avoid certain difficulties which I found, especially in the basin of the Yenisei. As to the mountains of North Tibet—the Nan Shan, and on the borders of Southern Mongolia—they all confirm this view of the double direction of the main systems of upheaval.

I will also permit myself to ask the following question: Shall we not find, in the systems of mountains of Eurasia, traces of still more modern upheavals, which may be going on now, and whose axis should be directed from north to south? Thus the Urals are composed of several chains of mountains having the direction south-west to north-east, and of escarpments having a north-west to south-east direction (see my article "Urals" in the 'Encyclopædia Britannica,' 9th edit.); but there are also distinct traces of foldings of the Earth's crust which took place along lines directed from north to south, and I ask myself if we have not here a recent system of foldings which carries with it the formerly existing ranges of hills, and produces the accumulation of the greatest heights of a given region in a narrow zone directed north to south?

I will now sum up the ideas on the orography of Eastern Siberia which were brought forward in the above-mentioned publication, and I will consider afterwards how the system of orography of Eastern Siberia accords with the orography of Asia altogether, such as it now appears from the recent explorations in Central Asia.

having been utilized (I utilized only part of it in my map of the Olekma-Vitim region). As to the eastern part of the Stanovoi, we have only one single itinerary, viz. that of Schwartz, who crossed this region in 1851 at the sources of the Konam; but this survey has never been published, and could only be produced from the diary of Schwartz—which, having been given to me by Schwartz in 1870, remained with all my papers at the archives of the State police in Russia, where they were found only in 1895, and delivered to the Russian Geographical Society, which sent them to me, to London. I hastened, of course, to return this precious document to the Geographical Society. However, even when this diary will be utilized, there will be all the region between the Konam and the Olekma (nearly 170 miles), and all the space between the Konam and the Okhotsk coast (nearly 300 miles) still remaining absolutely unknown.

II. THE OROGRAPHY OF EASTERN SIBERIA.*

General Conclusions.—(1) The main mass of the highlands of Asia is represented in Siberia by an immense high plateau which spreads from the south-west to the north-east, that is, from the basin of the Yenisei to the sea of Okhotsk, losing in width and altitude in proportion as it advances north-east.

(2) A second plateau, or rather a second terrace of the above, having the same orientation, but of a slightly smaller altitude, fringes the high plateau along the whole of its length from its south-eastern side.

(3) These two plateaux, taken as a whole, have along their north-western and south-eastern fringes two high border-ridges. The former (that is, the north-western one) is higher than the second. It is there that we find the highest summits of mountains in Eastern Siberia. Both border-ranges also become lower as they progress towards the north-east.

(4) On its north-western slope the high plateau is fringed by a zone of mountains from 130 to 220 miles wide, which has a well-defined Alpine character. It consists of high mountains and peaks, separated by deep valleys, and in the labyrinth of the ramifications of its separate mountain ranges one may distinguish a general orientation from the south-west to the north-east, parallel to the border-range of the plateau. The chains of mountains of this Alpine zone are composed of crystalline and clay slates (often auriferous), as also of granites, syenites, and so on. The height of the mountains in this girdle also decreases towards the north-east.

(5) Beyond the Alpine zone we find, on the same north-western or Arctic slope of the plateau, a wide stretch of high plains, 1500 to 2000 feet high, formed by layers, often horizontal, of more recent sedimentary deposits (Upper Devonian, Secondary, and Tertiary).

(6) The high plains are followed, on the same Arctic slope, by lowlands which rise only a few hundred feet above the level of the sea, and reach both the Arctic ocean and the footings of the Urals. In the southern parts of Western Siberia the lowlands are separated from the high plains by an escarpment; but it is not yet known whether such an escarpment can be traced along the whole line of separation. Isolated chains of mountains rise here and there over the surface of the high plains, as well as of the lowlands, the former also having in preference a direction either south-west to north-east, or from the north-west to the south-east.

(7) Passing over to the Pacific slope,—in those places where we know well the boundary between the high plateau and its lower terrace,

* 'General Sketch of the Orography of Eastern Siberia,' in *Memoirs of the Russian Geographical Society, General Geography*, vol. v., 1875 (Russian).

these two are separated from each other by a border-range which follows the escarpment of the high plateau. However, we do not know yet whether this border-range can be traced beyond the 55th degree of latitude.

(8) On its south-eastern or Pacific slope, the plateau (*i.e.* its lower terrace) is also fringed by a border-range (Great Khingan) which falls with an almost abrupt escarpment towards the high plains of the Pacific slope. The latter are slightly lower than those of the Arctic slope, and on a very large stretch they also are fringed by lowlands. But both the high plains and the lowlands are missing where the sea of Okhotsk reaches with its waters the very foot of the south-eastern border-range of the plateau (from Uda bay to Okhotsk).

(9) Over a great portion of its length the south-eastern border-range of the plateau is also fringed by an Alpine zone, 70 to 160 miles wide, which separates the plateau from the high plains. Two parallel mountain ranges can be distinguished in this Alpine zone.

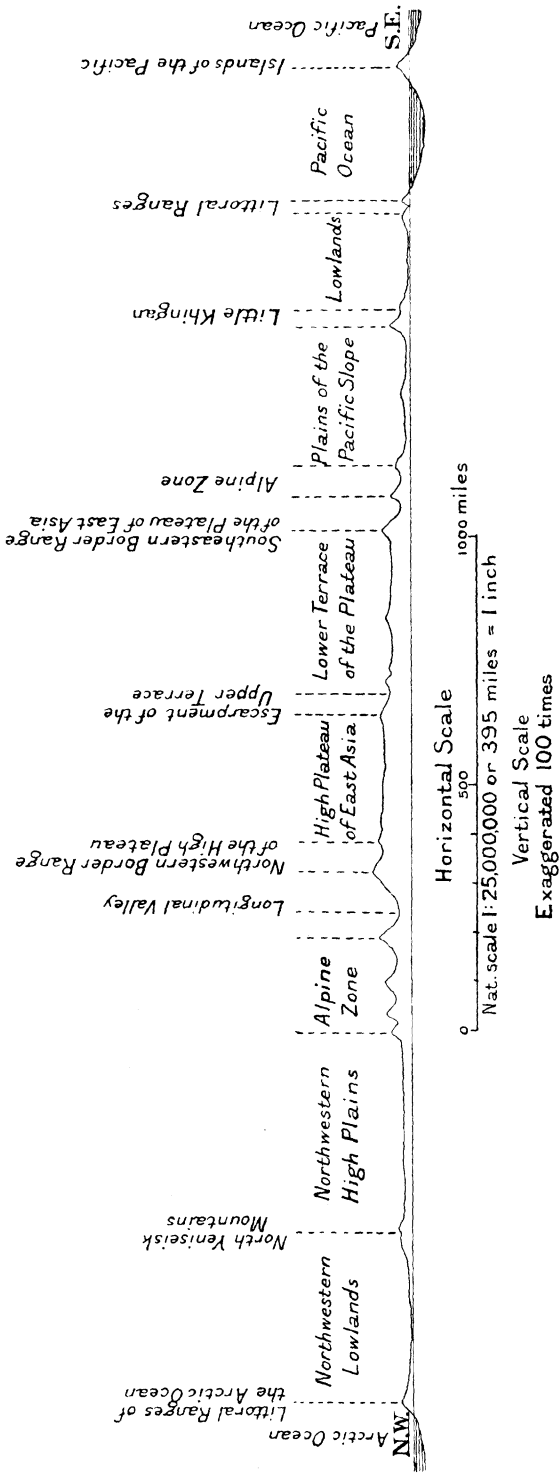
In the midst of the plains and the lowlands of the Pacific slope we also see several distinct chains of mountains, running north-east, as also a series of littoral chains, part of which are in Manchuria, while the others are partially submerged. As a rule, they are also oriented in the same direction as the south-eastern border-range of the plateau. This structure of Northern Asia is represented in the cross-section, Fig. 3.

A.—§ 1. *The High Plateau.*—Its main features are as follows: With the exception of the deep valleys excavated by a number of rivers flowing towards Lake Baikal, which we shall refer to as "trenches," the bottoms of the valleys, even of the great rivers which water it, are situated at considerable altitudes, of from 2800 to 3500 feet. It is only as the rivers reach the peripheral parts of the plateau that their beds are cut in it to a greater depth. As to the water-partings between the rivers, they have as a rule a very flat aspect, and are marshy in the northern parts of Siberia; they hardly rise 1000 feet above the bottoms of the valleys. The river-valleys are wide, open, and marshy in their upper courses, and the traveller who crosses the plateau finds no obstacles excepting in the marshes. Only occasionally a few chains of mountains, parallel to the general direction of the plateau, rise above its average surface by 1000 or 1500 feet. Countless lakes, large and small, cover its surface, our present maps giving only a very imperfect idea of their numbers. In most cases the rivers which water its surface flow parallel to each other. The vegetation which covers the plateau is extremely monotonous, chiefly consisting in the forests of the north of larch and birch. There are reasons to believe that the fauna of the high plateau has a certain distinctive character which, however, has not yet been completely studied.

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FIG. 3.—SCHEMATIC SECTION ACROSS EASTERN SIBERIA, FROM NORTH-WEST TO SOUTH-EAST.



§ 2. We know this plateau over a very wide area; namely, in North-Western Mongolia, on the upper Yenisei, and in the neighbourhood of Lake Kosogol; to the south of Lake Baikal; on the route from Kiakhta to Urga; further on, in Transbaikalia, on the upper Uda (high-road to Chita), on the Chikoi and the Khilok; and then, over immense areas in the basin of the Vitim, the Olekma, and the Tunghir; on the water-parting between the Karenga and the Vitim on the one side, and the Holoï on the other side; at the sources of the Aldan; on the Konam; in the upper parts of the Zeya; and on the two routes from Yakutsk to Udskoi and to Okhotsk. In all these places the character of the high plateau is very typical.

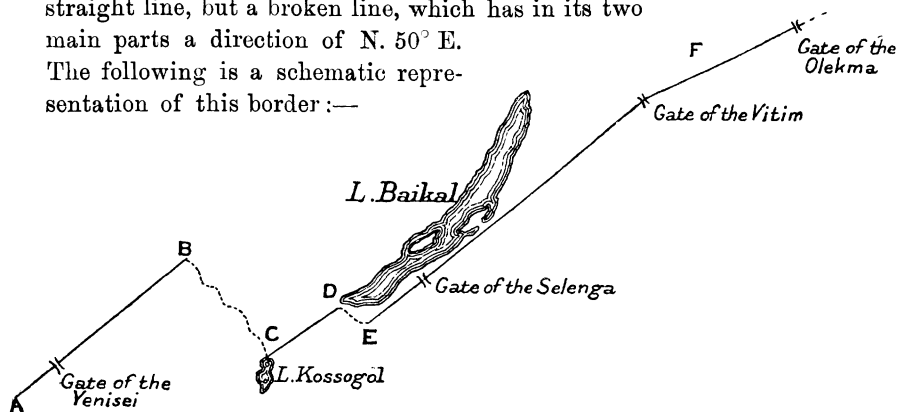
§ 3. The high plateau thus represents an uninterrupted swelling of the Earth's surface, from Mongolia to the far north-east of Asia. It has only been deeply eroded in the vicinity of Lake Baikal by its great affluent, the Selenga and its tributaries (Jida, Orkhon, Tola, Uda, and also the Khilok and the Chikoi). Here the broad and deep valley of the Selenga penetrates southwards, like a deep railway-trench, dug into the plateau, and leads with a small gradient from the lake (1400 feet of altitude) to Urga, situated on the level of the plateau, near its south-eastern border, at an altitude of 3800 feet. A similar trench leads eastwards, up another tributary of the Selenga—the Uda—from the Baikal to Chita, and it is now taken advantage of by the Trans-Siberian railway. Travellers who went along these valleys did not always realize that they were travelling along such trenches excavated in the plateau. As they saw steep, rocky escarpments on both sides of the valley, they only yielded to an irresistible optical illusion when they described these escarpments as chains of mountains. However, as soon as one abandons the valley and goes 10 or 20 miles inland, one finds one's self on the level of the plateau. These "trenches" have rendered an immense service to man. It was along them that the plateau could be climbed, and that the communications between the two slopes of the great plateau of Eastern Asia were established. Elsewhere, far from the great Siberian lake, where the valleys have not been transformed by erosion into such trenches, there is no other means to reach the level of the plateau but to travel up the wild and narrow gorges of the Vitim, the Olekma, or the Aldan, or to climb over the steep slope of its border-range.

It must also be remarked that not one single river cuts through the whole width of the plateau. All of them take their origin in the marshes and lakes scattered over its surface—sometimes near its south-eastern edge; but it is only in their lower courses, on approaching the north-western edge, that their valleys become deeply sunk in the massive upheaval. On approaching Lake Baikal, the bottoms of these valleys take the character of flat steppes and prairies, covered with gravel and dotted with small lakes. In all probability they were

formerly—probably during the Jurassic period—bays or fjords of a large inland sea, which covered also what are now the high plains of Eastern Siberia (Balagansk, Nizhne-Udinsk, Kansk, Minusinsk) and penetrated, in the shape of elongated fjords, in a succession of “longitudinal valleys” (§ 7), which now separate the plateau from the Alpine zone which fringes it.

B.—§ 4. *The North-Western Border-Range of the High Plateau.*—The High Plateau is fringed along its north-western border by a high border-range, which contains in it the highest summits of Eastern Siberia—Munku-sardyk, Khamar-daban, etc. The average altitude of its crest is higher, as a rule, than that of the crest of any other mountain range in Siberia, taking them in the same meridian; namely, from 6000 to 8000 feet in its western parts, and from 3000 to 4000 feet in the far north-east. Its width is from 17 to 25 miles. Its south-eastern foot lies on the surface of the plateau, *i.e.* at an altitude of from 4000 to 3000 feet in the west, and about 2500 feet in the east, while its north-western foot lies in the just-mentioned longitudinal valleys, at altitudes of from 1500 to 2000 feet in the west, and about 1000 feet or less in the east. This mountain range has thus the well-defined type of a border-range of the high plateau. The summits of its peaks have, as a rule, very soft outlines, and the passes through it, instead of following narrow gorges, as is the case in Alpine chains of mountains, in preference go over the very flat summits of the mountains. A typical feature of this border-range is also that we find on both its slopes a great development of volcanic eruptions in the shape of flows of lava, filling certain valleys or spreading over extremely wide superficies on the surface of the plateau.

§ 5. The north-western fringe of the high plateau does not follow a straight line, but a broken line, which has in its two main parts a direction of N. 50° E. The following is a schematic representation of this border:—



Schematic representation of the
Northwestern Border Range of the High Plateau

FIG. 4.

We know this border-range in many places, beginning with the Us, in the basin of the Yenisei (where it was described by Schwartz), then following the Sayan (Polyakoff, and partly Radde), the mountains on the left bank of the Barguzin (Georgi, Lopatin), the South Muya Range (our Vitim Expedition), and on the right bank of the Chara (Usoltseff). We thus know this chain without interruption from the Yenisei to the sources of the Uda, for a distance of about 350 miles (AB in Fig. 4); from Lake Kosogol to Lake Baikal, over 170 miles (CD of Fig. 4); and from Barguzin to the sources of the Chara, nearly 500 miles (EF).

There is some difficulty in explaining the absence of a border-range between the first two just-mentioned portions, but if we imagine Eastern Siberia submerged under a sea 2000 feet higher than at the present time, the continent would be represented by the Sayan and Vitim plateau. In the portions marked in full black lines in Fig. 4, we should have had an uninterrupted shore-line, fringed by a high chain of mountains, similar to the Andes in South America, while in the parts BC and DE there would have been a number of narrow bays penetrating into the depth of the continent. This was, at least, the explanation which I gave in 1875. However, the numerous expeditions which have been made to North-Western Mongolia during the last twenty-five years seem to leave no doubt about the existence of a border-range running in a *north-western* direction in part of the space BC of the above drawing. We should have thus in North-Western Mongolia what we have in Northern Tibet on a larger scale, namely, a succession of higher terraces of the plateau fringed by mountain-ranges running south-west to north-east and north-west to south-east (or rather west-north-west to east-south-east).

The relations are also difficult to ascertain in the neighbourhoods of Lake Baikal (DE of Fig. 4). It would seem as if the lake had penetrated by its southern extremity into the depth of the high plateau, and that at this spot we have the greatest absolute depression by the side of the greatest elevations of the border-range—the bottom of Baikal being in places as low as from 3600 to 4740 feet below the sea-level, and the tops of the mountains along the southern shore of the lake reaching from 8000 to 10,000 feet. It is worthy of note that the presence of deep depressions—in this case much below the level of the ocean—appears in three distinct spots which are all situated along the north-western fringe of the high plateau (Fig. 5), in the Caspian sea, at Lukchun, and in Lake Baikal.

As to the interruptions in the border-range which we see in the valley of the Selenga, they offer no difficulty if we consider this valley—as has been suggested in the previous paragraph, and as it is in reality—as a deep trench, through which the waters that accumulated on the surface of the plateau found, from a very remote geological period,

a passage to the lower level of Lake Baikal. From the Selenga eastwards as far as the headwaters of the Chara ($119^{\circ} 20'$ E. long.), there is no interruption in this tremendous border-range for a distance of more than 500 miles, and everywhere it retains the very same orographic character as appears from the descriptions of Georgi, Lopatin, Schwartz, Orloff, myself, and Usoltseff (from the Barguzin to the Chara).

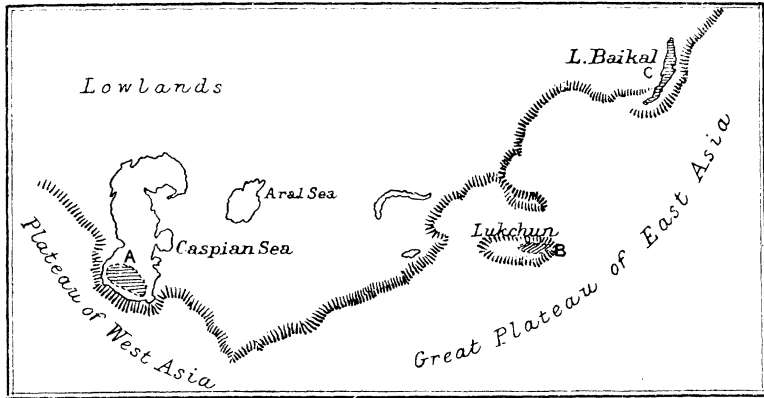


FIG. 5.—DEPRESSIONS, BELOW THE SEA-LEVEL, ALONG THE NORTHERN BORDER OF THE PLATEAU.

As to its further continuation towards the east, we find valuable information in the already mentioned manuscript diary of Ludwig Schwartz, where we have a beautiful description of a quite typical plateau in the valley of the Upper Zeya, and especially along the Konam river. "Wide, elevated, and marshy plains, with rivers slowly flowing over their surface; broad, flat valleys covered with countless small lakes, and having their bottoms at altitudes of 2500 feet." Such is the description which Schwartz gave of this region in his diary, so that I am almost inclined to give to this immense plateau the name of Sayan-Vitim-and-Konam Plateau. It is only on the right bank of the Aldan (a great tributary of the Lena) that Schwartz found a chain of mountains similar in its character to the South Muya border-range which we met in the basin of the Vitim.

We have thus one range of mountains which may be followed almost without interruption from the Yenisei to the sea of Okhotsk, the only really typical mountain-range in Eastern Siberia, to which I propose to give the name of *North-Western Border Range of the High Plateau of East Asia*.

In Western Asia, the Altai and the Tian-shan play the same part of border-ranges, and "It is very probable"—I wrote in 1876—"that these two mountain ranges may represent one, from an orographic and an orogenetic point of view." This suggestion, as will be seen

presently, has been fully confirmed since, by subsequent exploration. It must be remarked, of course, that the altitude of both the plateau and its border-range diminishes in proportion as we advance towards the north-eastern extremity of Asia.

§ 6. There are besides on the surface of the plateau a number of ranges of mountains which, in the classification of Karl Ritter, ought to be described as "superposed chains of mountains" (*angehäufte Gebirge*). They represent elevations of a moderate relative altitude, rising not more than from 1000 or 1800 feet above the average surface of the plateau. Most of them (nearly all in East Siberia) are parallel to the border-ridges. They are marked on my maps by a special sign. None of these ranges of hills can interrupt the uniformity of the plateau, and such chains deserve our attention only because they determine the parallelism of the high valleys. It must be remarked that the same structure which I noticed on the Vitim plateau was found later on in the plateaux of Central Asia and Tibet, where we also find numerous chains of mountains rising some 2000 to 3000 feet above the 12,000-foot level of the plateau, and in North-Western Mongolia.

C.—§ 7. *The Alpine Zone of the North-Western Slope.*—At the foot of the north-western border of the high plateau we find in many places a broad and very typical longitudinal valley which runs parallel to the crest of the border-range. By using the term "longitudinal valley," I do not mean, however, that this valley owes its origin to a longitudinal fold of geological strata. That its origin was primarily determined by some such foldings of the Earth's crust is very probable, but as we see it nowadays it is the result of erosion, both by rivers and by ice-streams, which was going on for ages on a gigantic scale. Perhaps it would have been more correct to describe this feature as a succession of longitudinal valleys, interrupted here and there by transverse upheavals. To take a familiar example, the valley occupied by the Rion and the Kura rivers in the Caucasus—the one flowing towards the Black sea, and the other into the Caspian, and the two being separated by the Mesques mountains—belongs to the same type, and it is also situated at the foot of a high plateau—the plateau of Armenia and Asia Minor, between this plateau and the alpine region of the Caucasus, which fringes it.

In Eastern Siberia, this succession of longitudinal valleys is very striking. The valley is usually limited on the south-east by the escarpment of the border-range of the high plateau, while on its north-western side we see rising, abruptly as a wall, the sharply carved slopes of an extremely regular rocky chain of mountains. The width of this valley is usually from 10 to 25 miles. Its base is flat, and assumes in its lower parts the character of prairies covered with lake and river deposits, having altitudes of from 1500 to 2000 feet in the west, and about 1000 feet in the north-east. It is a very common

feature for two rivers to flow in diametrically opposite directions in this valley, either to meet each other (Muya and Chara) or to run in opposite directions, after having taken origin in a transversal upheaval, like the Rion and the Kura in the Caucasus (Oka and Irkut; Barguzin and Muya). We know such valleys: in the basin of the Yenisei, the valley of the Us; in upper Oka and the Irkut; the Barguzin; the Muya; the Chara; and the Aldan.

§ 8. In all these regions, which represent an extension of nearly 40° of longitude, we find a typical "rocky chain of mountains" bordering these longitudinal valleys from the northern side. The Tunka Alps, the Barguzin Alps, the North Muya Mountains, and their continuation—the rocky chain which runs on the right bank of the Chulban and the left bank of the Chara, belong to the same type of mountains facing the longitudinal valleys; and the likeness between the drawings of Erman and myself of homological chains of mountains on the Irkut, the Aldan, and the Muya, is striking.

The Irkut, in the part where it flows between the rocky Tunka Alps and the Sayan border-range, represents a typical longitudinal valley of this sort; and we find one of exactly the same type to the east of Lake Baikal, in the valley of the Barguzin. As to the space between the two, various conjectures may be made. The Irkut, as has just been mentioned, is accompanied on its northern bank by an extremely typical, rocky chain of mountains, which is known as the Tunka Alps, or The Goltzy (naked peaks), or the White Mountains (Byelki; they are snow-clad); and on the east coast of Lake Baikal we find in the valley of the Barguzin a chain of mountains having absolutely the same typical aspect, and placed in identical relations with regard to the plateau. Further east, we see the same valley and the same rocky chain continued as far as the Aldan—a length of 400 miles. We notice, moreover, that the Barguzin mountains fall exactly on the continuation of the axis of the Tunka Alps, and that where this chain is interrupted by Lake Baikal, there are the only two insular masses of this lake, the island of Olkhon and the peninsula of Svyatoi Nos, in both of which the sedimentary rocks run from the south-west to north-east (Meglitzky and, later on, Chersky). As to the interruption between the Tunka Alps and the island of Olkhon, we have to deal with a region very imperfectly known as to its geological structure. Taking all this into consideration, I permitted myself to suggest that the Barguzin mountains are a continuation of the Alps of Tunka. This last chain of mountains, parallel to the border-range of the high plateau, begins, I should believe, near the sources of the Oka. It continues between the Irkut and the Kitoi under the name of Tunka Alps; then it is cut through by the transverse valley of the Angara, but it reappears further east between the stream of Kuda and its tributary, the Kamenka, on the one side, and the shore

of Lake Baikal on the other side. Next it is cut through by the strait of Lake Baikal, which connects the "great sea" with the "small sea" (*i.e.* the southern and the northern portions of the lake); and further on we find the same chain under the name of Barguzin mountains, while further on still I have named it North Muya mountains, and further still we might name it North Chara mountains, until we lose its traces in regions yet unexplored.

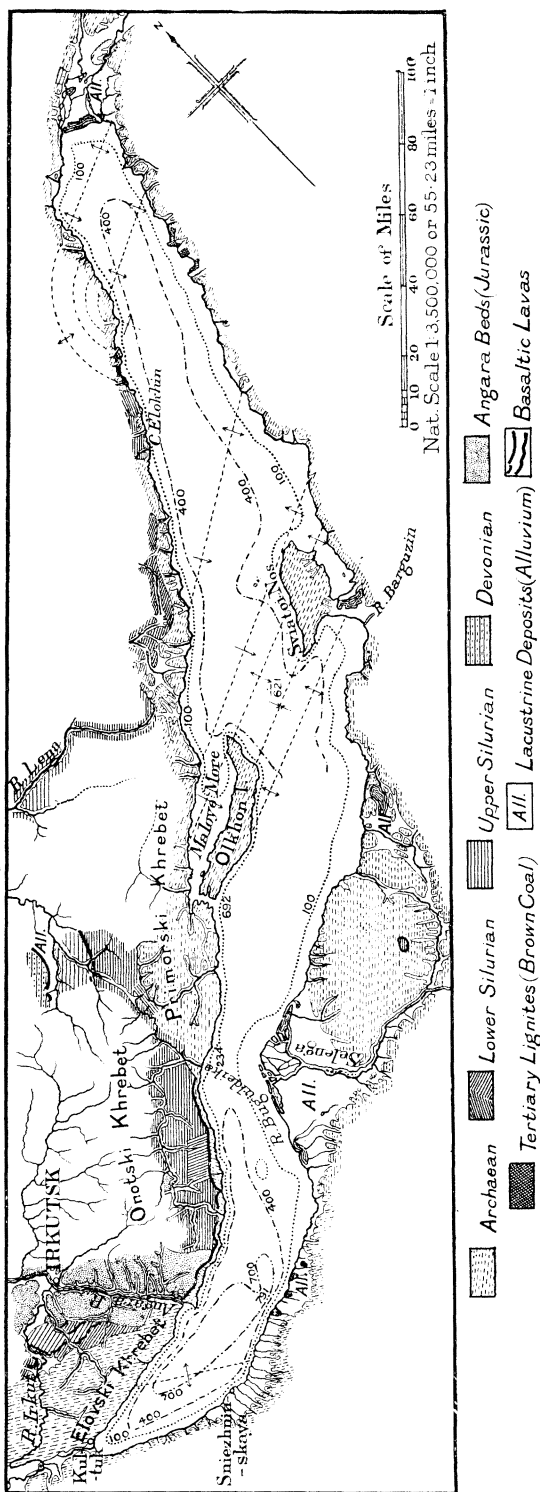
If this hypothesis be true, it would thus appear, I wrote, that Lake Baikal does not represent a longitudinal valley. It is, on the contrary, composed of two longitudinal valleys—the Irkut-Barguzin one, which makes the "great sea"; and a second valley which forms the "smaller sea"—both being connected by the strait between Olkhon island and the Svyatoi Nos peninsula. As to the chain of mountains, Baikalskiy Khrebet, which is represented on our maps in an uninterrupted succession along the western shore of the lake, from the Angara to the lake's northern extremity, I was very much inclined to believe that a more detailed exploration would prove that there are in this region two or even three different chains of mountains—two or three different foldings of the strata—which cross the present Lake Baikal in a diagonal direction.

Such were my conclusions in 1875, when we possessed only the researches of Meglitzky and a preliminary report from Czekanowski. Since that time we have had the works of Chersky and Obrutcheff, of which the former confirms in full detail what Meglitzky had discovered, namely, that the sediments of the western coast of Lake Baikal are continued on its eastern coast; the direction being from south-west to north-east, as is seen on the enclosed reduction of the map of Chersky, upon which I also have given the results of the recent soundings in the lake (Fig. 6). One sees, moreover, that instead of the range of mountains, Baikalskiy Khrebet, which is drawn on the maps, there are at least two parallel chains which reach the coast of the lake at sharp angles and are continued on the other coast. The Baikalskiy Khrebet would thus be only a succession of steep escarpments falling towards the lake. At any rate, we have here a problem which requires further detailed exploration.

As might be expected, the just-mentioned rocky mountain range is pierced in more places than the border-range itself; by the Yenisei, the Irkut (below Ilcha), and the Angara; lake Baikal, the Vitim at the mouth of the Muya, and the Olekma under 58° N. lat. This is also what might have been expected.

The accumulations of water on the surface of the plateau had, of course, to find a way to the ocean, and those of them which took a north-western direction formed a succession of large lakes, all along the north-western foot of the border-range; we still see traces of such lakes in the Kosogol, Shaksha, Bahunt. However, this state of affairs

Geological Map of the Shores of Lake Baikal, after Chersky.
Depths after Drizhenko.



Soundings in fathoms

FIG. 6.

could not last infinitely; the waters had to find a passage from the continent towards the ocean; and they opened such passages in the gates of the Yenisei and the Selenga, the Vitim, and the Olekma. Then they formed very large elongated lakes in the above-mentioned "longitudinal valleys," thus forming a girdle of lakes which ran south-west to north-east, at the foot of the border-range. However, here also the accumulation of water could not last for ever. The lake which once filled the valley of the Us found its way towards the lower-situated plains of Minusinsk. The Baikal began to send part of its waters into the lakes of the Balagansk region; the "great sea" of the Baikal found a passage into the "little sea," by three different gates; the lakes of the Muya found an outlet into the basin of the Oron; and so on. All this was evidently accomplished by slow geological evolution, and where the basin was the largest (the Selenga), the gates that were cut northwards were also the most numerous; thus we find no less than three gates in the rocky chain of mountains facing the gates of the Selenga.

§ 9. Beyond the rocky chain of mountains we have a wide zone of highlands bearing an alpine character. This zone is composed of a number of short chains of mountains which are mostly parallel to the border-range, *i.e.* mostly run in a direction of N. 50° E. The chains are separated from each other and intersected by a labyrinth of narrow and deep valleys. This zone of highlands, in opposition to the plateau, has all the characteristics of alpine regions, presenting variety and differentiation in all directions. High summits rapidly alternate with deep valleys, the former reaching altitudes of from 4000 to 7000 feet, while the bottoms of the valleys are at all levels, beginning with 3000 feet down to 1000 feet, and consequently all the physical characters of the region and its vegetation change with the same rapidity. The wild character of these mountains and the virgin forests which cover them have resulted in the generic name of "*Taiga*" being given to the whole of the region. In nearly all this alpine zone one finds traces, quite evident in my opinion, of previous glaciation on a very large scale. The chains of mountains send—as usual in such highlands—numerous ramifications, and result in a labyrinth of small valleys, but there are in places local plateaux of a secondary order.

Geologically, these highlands are chiefly built up of crystalline slates, upheaved and contorted by veins of granite, syenites, and diorites; clay-slates and quartzites have a very wide extension, but the characteristic feature is the extension of hard clay-slates and chloritic slates (often auriferous). It may be said that in all probability they belong to the Huronian, Cambrian, Silurian, and perhaps the Devonian ages, and the foldings are of a less ancient origin than the plateau itself.

Such systems of mountains appear all along the fringe of the plateau, and are described under different names. In the highlands

of Southern and Middle Yeniseisk, we can distinguish three separate chains of mountains running south-west to north-east, probably intersected by both spurs of the Altai system and by upheavals having a north-western direction. A broad gulf of an ancient sea penetrates into these highlands in a south-eastern direction, forming now the high plains of Nizhne-Udinsk. Next come the highlands of the Biryusa; those of the Oka, in which I crossed three chains of mountains running from the south-west to the north-east; the Alps of the Kitoi; and the Baikal mountains;—all of which still remain but imperfectly known, and thus represent a most promising field for the physical geographer. To the east of Lake Baikal we have the mountains of the Upper Angara and the Mama, almost quite unknown, and about which I advanced a few considerations in my 'Vitim Expedition Report';* the highlands of the Olekma-and-Vitim, which are composed of parallel chains having the same north-eastern direction, with numerous ramifications and subordinate plateaux; and finally the almost quite unknown highlands of the Chara.

Going further east we miss information about the alpine highlands. The plateau appears with its typical features to the south of the Konam river (Schwartz), on the Aim and the Uchur (Middendorff, whose drawings representing the aspect of the country before reaching the watershed of the Stanovoi express very well the character of the plateau), and finally on the highway from Yakutsk to Okhotsk (Ermann). The character of this last region is represented in the corresponding cross-section which I give here. However, the highlands which fringe the plateau on the north-west do not seem to have in the far north the same typical character as they acquire in lower latitudes. It may possibly be that they become lower, like the plateau itself, or maybe they are obliterated by old bays of the Glacial ocean. It must only be remarked that in the extreme north, on the coast of the Glacial ocean, we find, on the prolongation of the East Siberian plateau, highlands which attain as much as 2000 feet of altitude.

D.—§ 10. *The High Plains.*—At the foot of the alpine regions, which have been described in the previous paragraph, we find immense high plains, whose altitude varies from 1500 to 2000 feet in the west, to 800 and 1300 feet in the far north-east. If we take a map of Eastern Siberia on a marine projection, and draw upon it a line, from the sources of the two Yuses (54° N. lat., 99° E. long.) to the mouth of the

* I hazarded in that report the supposition that the auriferous chain in which are located the chief gold-mines of the district of Olekminsk—Obrutcheff has since given it my name—must have a direction from the north-east to the south-west, and from the specimens of rocks which Schwartz had brought in from the Vitim, I determined the place where the Vitim must pierce this chain, as also its probable further continuation in the basin of the Mama. I learn now that rich placers have been discovered since on the Mama; but that is all I know about this interesting region.

Indighirka (72° N. lat., 150° E. long.), we shall have the approximate boundary which separates the alpine highlands of East Asia from the high plains. This line would, of course, be only an ideal limit, because in certain places, and especially between Tomsk and Kirensk, the high plains penetrate into the highlands in the shape of a large gulf directed towards the south-east. We may also determine this boundary-line with more precision, if we say that it runs parallel to the border-range of the high plateau at a distance of about 200 miles to the north-west of it. This boundary-line would consequently have the same broken character as the escarpment of the plateau itself (line DF in Fig. 4).

The high plains are characterized by the total absence of mountains and by an undulating surface which is mostly covered by forests in the north, or assumes a steppe character in the south. The rivers which water them flow in valleys that are sunk for 400 to 800 feet into the mass of the plains. They are entirely built up of marine deposits, the oldest of which belong to the Silurian period, and most of which, beginning with the old red sandstones of the valley of the Lena, are nearly almost horizontal. The region which is crossed by the great Siberian highway (now the railway) between Achinsk and Nizhne-Udinsk, and has altitudes of from 1200 to 2000 feet; the immense spaces between the Yenisei and the lower course of the Lower Angara; between the Angara and the Lena; and this last and the Vitim; the region watered by the Vilui;—all belong to the high plains of this type. Only small local upheavals introduce a certain variety into the structure of these plains; but those parts which were described as hilly owe this aspect of their structure to the deep erosion of the rivers. An exception is only found in the mountain region named Northern Yeniseisk-taiga, where we find an alpine highland, composed of several chains of mountains running in a north-eastern direction; and further north, in the Verkhoyansk range.

E.—§ 11. *The North-Western Lowlands.*—In the north-west of these high plains we find the lowlands of North-Western Siberia, which cover a still wider area; their average altitude is usually less than 500 feet. We cannot say if the high plains are separated from the lowlands by an escarpment, such as we see in the plains of Western Siberia, near Tomsk, but we find in one place that the Northern Yeniseisk highlands rise on the boundary between the high plains and the lowlands. These lowlands, as is known, were under the sea during the post-glacial period, and are covered with post-glacial deposits. Tertiary deposits have also been found in several places.

§ 12. THE PACIFIC SLOPE OF THE PLATEAU. *F. The South-Eastern Escarpment of the Plateau.*—The high plateau is fringed on the south-east, as if by a broad ribbon, along nearly the whole of its length, by another plateau of smaller altitude, which has a slightly different character (see §§ 16, 17), and is especially typically developed in the

Nerchinsk district of Transbaikalia and the Eastern Gobi. In the far north-east the high plateau seems, however, to melt into its lower terrace without being separated from it by a notable escarpment.

§ 13. As a rule, the two terraces of the plateau are sharply separated from each other, the upper falling towards the lower by a steep escarpment, nearly 1000 feet high. The latter is very typically developed, for instance, on the railway from Irkutsk to Chita, in the Stanovoi or Yablonovoi Khrebet. On part of its stretch, but by no means along its whole length, this escarpment represents the line of water-parting between the rivers which flow towards the Glacial ocean and those which flow into the Pacific. The former rise in marshes and lakes which are spread along the fringe of the escarpment, while the streams which flow towards the Pacific take their origin on the rocky and steep slope which falls towards the lower terrace. In other places the headwaters of the rivers flowing towards the two oceans lie in the same marshes, spreading over the surface of the plateau.

The south-eastern escarpment cannot be described as a typical border-range, although in places it has that aspect. Over a very considerable length it is merely an escarpment, which appears as a chain of mountains to the traveller only who looks upon it from the lower terrace, while the traveller who approaches it from the plateau learns that he is crossing the water-parting between the two oceans only when he begins to go down the steep slope that leads to the lower terrace. When the escarpment takes the character of a border-range, its summits do not rise more than from 500 to 800 feet above the average level of the plateau, and not more than 1500 feet above the bottoms of the nearest valleys lying at its foot on the plateau. It attains a considerable altitude only for a short distance, namely, about the Sokhondo (8000 feet).

§ 14. We know that escarpment (*a*) on the route from Kiakhta to Pekin, which reaches the highest point of the plateau immediately in the south of Urga, and then descends steeply towards the lower terrace; (*b*) to the north-east of Urga, where it is known under the name of Kentei (survey of Dorjidaroff); (*c*) at the sources of the Chikoi and the Balja, which both belong to the system of the Pacific (altitudes determined by Fuss); (*d*) on the road from Irkutsk to Chita, which passes the lakes Shaksha, etc., 3000 feet of altitude, and then suddenly goes down for 1200 or 1350 feet to the valley of the Chita; (*e*) on the route which our expedition followed on approaching Chita.

It is worthy of note that in the last two places the escarpment is faced—in homology with what we saw on the north-western slope of the plateau—by a rocky chain of mountains, which separates it from the plains of the lower plateau.

§ 15. In all the above-named spots the south-eastern escarpment

of the high plateau corresponds with the Stanovoi range of the old geographers. In other words, this escarpment is in reality the water-parting between the basins of the Arctic and Pacific oceans. It is extremely difficult, however, to follow it further east. I have made some attempts to do so in my "Orography of Eastern Siberia," and I now learn from the classical work of Suess ('*Das Antlitz der Erde*,' vol. iii.) that my conjectures were correct (see below); but it must be confessed that we still remain in the dark, and that careful surveys, specially intended for mapping this escarpment, ought to be made before any definite conclusion can be come to as to the existence of a sharp division between the upper and the lower plateau in the north of the 52nd degree of latitude. It is very possible that to the east of the 190th degree of longitude the difference of altitude between the two plateaux is considerably reduced. At any rate, we find in the already-mentioned diary of Schwartz no distinct indication concerning the existence of two distinct terraces of the plateau, either on the Aldan or on the Zeya, nor do we find such differences in the itineraries of Middendorff and Ermann, who crossed the plateau further east.

Another supposition could also be advanced. We might suppose that after having followed for a time a north-eastern direction, the escarpment turns eastwards and joins, near the coast of the Sea of Okhotsk, the Jugjur, or Stanovoi. In this case all the rivers which take their origin south of this supposed escarpment would flow towards the Pacific, while those which rise in the north of it would flow to the Arctic ocean. In such case, the Stanovoi mountains, which used to be represented on all maps, would not be a mountain range, but would nevertheless represent an escarpment, perhaps due to erosion, by which the upper plateau falls towards the lower. The numerous sinuosities which this water-parting would represent would be explained by the erosion which was going on at the heads of the rivers flowing towards the Pacific. However, the examination of the materials collected by the Siberian expedition renders this supposition quite improbable. Thus we see, that starting from the valley of the Amazarkan, an affluent of the Amazar, a left-bank tributary of the upper Amur, and travelling up to its source, Usoltseff wrote, that he did not find any traces of the chain of mountains called Stanovoi, which is represented on the maps. The same was noticed by Schwartz, who travelled half a degree further east, namely under the 120th degree of longitude. Going up the Mogocho—a tributary of the Amazar, consequently belonging to the basin of the Amur—Schwartz reached the water-parting between the Amur and the Arctic ocean by following a quite flat region, which presented no traces of mountains. We thus find no traces of the escarpment, when we come to the sources of the Amazar, and still less of the parallel chain of mountains which follows it, as we saw, near Chita; nor do we find any traces of it further

east, on the Zeya, the Konam, and the Ghinim. In short, from a careful and detailed examination of all the available facts, we cannot but come to the conclusion that the Yablonovoi escarpment must continue in a north-eastern direction in the basin of the Olekma, where, in all probability, it must gradually disappear.

This is also the conclusion to which Suess, aided by Obrucheff, comes in his work, after having consulted some recent surveys.

§ 16. We may, therefore, sum up as follows. Over a distance (south-west to north-east) of more than 900 miles (from the 106th to the 120th degree of longitude), a steep escarpment, which gradually decreases in height, separates the upper plateau from the lower plateau. The peak of Sokhondo rises from it, and the escarpment runs in a straight line from south-west to north-east, from Urga (the Kentei) to the Kalakan river. Whether it is continued further, remains unknown. For a distance of nearly 600 miles this escarpment represents the water-parting between the basins of the Arctic and the Pacific; this feature, however, was unfortunately generalized, and has led to the creation, on the maps, of a chain of mountains called the Stanovoi, which was continued far beyond Transbaikalia, from Urga to Kamchatka. Such a chain does *not* exist in reality, and in order to give it a more regular aspect, the geographers (as had been already remarked by Schwartz in 1858) used to place the sources of the Nercha a full degree further south than their actual position. In reality, there is no such chain, whether high or low, whether steep or undulating, that would follow the line of division between the basins of the Pacific and the Arctic oceans. Schwartz had already perfectly well recognized it as regards the region of the Oldoi and the tributaries of the Upper Amur.

G.—§ 17. *The Lower Plateau.*—The lower plateau, which fringes for a great part of its length the upper plateau, also offers an undulating, usually flat surface, without great differences of altitude. The valleys of the rivers which flow over its surface are broad, open, and take the character of prairies or of dry steppes. Numberless lakes are scattered over its surface. Its average altitude is, as a rule, from 2000 to 2500 feet, but, of course, the larger rivers have their valleys sunk to a lower level, and in such cases the bottom of the valley has not more than 1200 or 1500 feet of altitude. From the upper plateau the lower differs mostly by the character of a steppe, or “rolling prairie.” Deserts covered with salt appear only in its south-western parts. In its middle portions it assumes the character of prairie, while in the far north it becomes marshy, like the high plateau. Several parallel ranges of hills rise above its surface; they might be described as “superposed ranges.”

§ 18. We know this plateau to the south-east of Urga, between the Kentei and the Great Khingan, under the name of Gobi, a dry rolling

prairie covered with gravel and intersected by ranges of hills having a north-eastern direction. Its altitudes vary between 2400 and 3000 feet. We find the same lower plateau in Transbaikalia, east of Chita, in the neighbourhood of the Dalai-Nor, and in the fertile prairies of the district of Nerchinsk. Further east we find the same type of elevated prairies (2000 to 2500 feet) on the left bank of the Upper Amur, in the marshy prairies of the Ghilui (Schwartz), and on the routes leading from Yakutsk both to Udscoi Ostrog, and Okhotsk (see the cross-sections). As already mentioned, it is not easy to separate the lower plateau from the higher one beyond the 124th degree of longitude.

§ 19. A number of parallel chains of hills run over the surface of this plateau; such are the mountains running on the right bank of the Ingoda, parallel to the above-mentioned escarpment, and reaching nearly 4600 feet in their highest points; a small chain which is crossed by the Ingoda above its junction with the Onon; the Gazimur mountains, which are made by folds of the Devonian deposits, between the Shilka and the Ingoda; the Nerchinsk mountains; and so on; as also a number of parallel rows of hills which stretch over the Gobi.

H.—§ 20. *The South-Eastern Escarpment of the Lower Plateau.*—The south-eastern escarpment of the lower plateau, and consequently of the whole of the plateau of East Asia, is formed by a border-range, which is known in its southern parts under the name of Great Khingan, and further north-east under the name of the Jugjur, or Stanovoi. This border-range rises very little above the average level of the plateau, but as we have here an escarpment which falls from the 2500 feet average level of the plateau to the plains of the Pacific slope, about 1000 feet high, it has acquired a great notoriety, especially among the Chinese geographers who themselves inhabited the lowlands of China. This border-range is a very typical one. Its north-western slope lies on the plateau itself, that is, at an altitude of from 2300 to 2700 feet; while its south-eastern foot lies in regions having hardly more than 800 to 1000 feet of altitude. The absolute altitude of its crest seldom exceeds 4500 feet, or maybe 5000 feet in the south-west. As we advance further north, it seldom exceeds 4000 feet. The traveller who comes from the side of the plateau reaches the crest of that border-range without noticing it. Such was the case with myself when I crossed the Great Khingan between Tsurukhaitu and Merghen, and the same remark was made by all the travellers who have crossed the Khingan since. Precisely owing to its position between the plateaux and the lowlands, this border-range has a very great importance as a limit for the westward extension of the Manchurian and Chinese flora and fauna, and it represents also an important climatic and ethnographic border.

§ 21. At the present time this border-ridge is perfectly well known from Kalgan (situated on the way from Kiakhta to Peking) to the 50th No. II.—FEBRUARY, 1904.]

P

degree of latitude, where I crossed it. Over all this length it appears as the border-range of the Gobi plateau, and has absolutely the same character. Uncertainty begins only when we try to trace its further continuation beyond the 50th parallel. On most maps the Great Khingan was usually traced beyond that latitude in a meridional direction, as if it were crossed by the Amur just immediately below Ust-Stryelka. It must be said, however, that there are absolutely no surveys upon which such a tracing of the Khingan could be based—nobody having yet (1903) crossed the Khingan north of the 50th degree—and that the escarpment of the plateau surely has not that position. In the absence of definite surveys for this region, we are bound, consequently, in order to find the position of the Khingan, to see where an escarpment, similar to the one we know in the south of the 50th degree of latitude, will be found in the region of the left-hand affluents of the Amur. When we know where the plateau ends, and where the much lower terrace of the plains begins in the basin of the Zeya, we shall have found the position of the escarpment.

We have just seen that in the west of the Great Khingan we have a typical plateau, the altitude of which is from 2000 to 2500 feet, while the plains in the east of the Khingan, after one has crossed a narrow zone of mountains parallel to the escarpment, have already an altitude of no more than from 800 to 1500 feet. Higher altitudes will only be found in separate mountain ranges, such as the Bureya mountains and the Sikhota-alin. Leaving aside all conclusions from the position of the mountains on the Argun, let us consequently consider the altitudes in the basin of the left-bank tributaries of the Amur.

Eight miles below Ust-Stryelka, that is at the mouth of the Mongalei river, we do not find the Great Khingan. Usoltseff crossed this locality, marching towards the right Oldoi, without finding any mountains; he only saw flat marshes, and a hilly region was met with only at the sources of the Oldoi. It must be remarked that Usoltseff travelled here in a north-eastern direction, at a distance of no more than 25 miles from the Amur; that he crossed flat, marshy tracts having an altitude of only 2000 feet, and that we consequently find here no escarpment and no continuation of the Great Khingan. We must, therefore, conclude that the Amur between the Ust-Stryelka and the Oldoi does not pierce the Great Khingan.

However, Friedrich Schmidt, after having remarked how difficult it is to find the spot where the Amur pierces the Great Khingan, remarks that when he climbed, at the mouth of the Urichi river, one of the surrounding hills (Maslyanaya), he saw a succession of parallel ranges of mountains running north to south at a certain distance from the river Urichi. Schmidt considers that the Amur pierces here the Great Khingan. It seems to me, however, that there must be some

misunderstanding; either Schmidt saw the mountain ranges which are pierced by the Shilka above Ust-Stryelka—and in this case they are not the Khingan, but continuations of the Gazimur ranges—or he saw something which has the aspect of a hilly tract, but is not mountain ranges, because—as we have just seen—there are none between the Mongalei and the Uritchi. In all probability he saw the continuations of the Gazimur mountains. In fact, the level of the Amur between Ust-Stryelka and Urichi lies below 1000 feet, while the surrounding country on its left bank reaches the altitudes of 2000 to 2400 feet, or, perhaps, even a little more. It is evident that in such conditions erosion must have given a hilly aspect to the banks of the Amur for a certain, but small, distance from the banks, and that the eroded plateau may have here the aspect of a hilly tract. It is certain, however, that as a line traced from the mouth of the Mongalei to the Modolan does not cross the Khingan, and as the Oldoi lies on the general level of the plateau, the Amur cannot pierce the Khingan between the Ust-Stryelka and the Oldoi. This piercing must be looked for further east.

Owing to the difficulty in going down the Amur to say where this river leaves the plateau, I have tried to discover whether we shall not find the limits of the plateau in the basin of the Zeya. For this region we have the detailed diaries of Schwartz and Usoltseff. From an analysis of these two diaries, which I have made in the Russian text of my work, it appears that the plateau which was seen by Usoltseff and Orloff on the Oldoi is continued further east, without interruption, to the sources of the Ghilui, but that just below the junction of this river with the Zeya we find a sudden fall of the country from the level of the marshy plateaux (about 2000 feet) to the level of the plains, which have an average altitude of 800 feet only. We have thus an important landmark which shows us the position of the escarpment of the plateau on the Zeya, and if we connect this spot by a—roughly speaking—straight line with the Great Khingan under the 50th degree of latitude, we find the correct position of the escarpment. I came, therefore, to the conclusion that the Great Khingan is pierced by the Amur near the mouth of the Kumara, and that from this point the Khingan is continued in a north-eastern direction to the mountain range which runs along the western coast of the Sea of Okhotsk under the name of Jugjur. This conclusion is confirmed, moreover, by the geological structure of the mountains on the banks of the Amur (Maack), which I analyze in detail in the Russian text (see also its French translation), as well as by the sudden change in the character of the vegetation, which begins to be remarked on the Amur below Albazin.

§ 22. Two or three chains of mountains, reaching from 3500 to 4000 feet of altitude in their highest summits, and composed of crystalline slates and limestones, run parallel to the south-eastern escarpment of

the plateau, making an alpine zone of from 65 to 80 miles wide. I found such a zone of mountains on my journey to Merghen, and the same was found by all travellers who have crossed the Great Khingan, either near Kalgan or on the way to Tsitsihar. We find also such secondary chains on the Amur above Anosova; and on the Zeya above its junction with the Deup. Traces of homological chains are found further east as well.

§ 23. Taking all the aforesaid into consideration, we may say that the lower plateau falls towards the south-east—that is, to the plains and to the lowlands of the Pacific slope—by a steep escarpment, which has, broadly speaking, a direction from the south-west to the north-east; over most of its length this escarpment takes the character of a border-range, which is accompanied on its eastern side by a couple of parallel chains of mountains. The position of this escarpment, so far as may be ascertained at the present time, is as follows: From Kalgan, through the heads of the right-bank tributaries of the Nonni and the headwaters of the Kumara to the Amur, which pierces it under the 125th degree of east longitude; then, across the Zeya, near its junction with the Ghilui; between the left-bank tributaries of the Zeya and the right-bank tributaries of the Selinja; through the sources of the Ud, the Udyugun, and Nimni; and further on, under the name of Stanovoi, it passes through the headwaters of the Uyan, the left-bank tributaries of the Maya (system of the Lena), and finally the headwaters of the Okhota. Whether it can be traced further towards the north-east, we do not know. The distinctive feature of this escarpment is, that it is not a high mountain range, but a—so to speak—one-sided range, that is, the escarpment of a plateau which has on its fringe a border-range of but a moderate elevation; consequently, this line will in certain places make sinuosities in accordance with erosion at the sources of the rivers flowing towards the Pacific, or the slope may be lengthened, and the steep escarpment will be more or less obliterated. Over all this length the escarpment of the plateau, which is known in the south-west under the name of Great Khingan, and in the Okhotsk region under the name of Stanovoi (Jugjur), represents an extremely important orographic feature and a limit for the westward spreading of the Manchurian vegetation, and partly also an ethnographic boundary.

I.—§ 24. *The South-Eastern Plains and Lowlands.*—Immense plains spread at the foot of the plateau, to join further east the lowlands which border the Pacific ocean. The low plains of the south-eastern slope are lower than those of the north-western slope. They hardly rise above 1000 to 1500 feet in the nearest neighbourhood of the plateau, and from 800 to 1000 feet further east. In many places they assume the character of beautiful prairies, very fertile, and thickly populated in the Chinese Empire. On immense areas, with the exception of the banks of the rivers, they are covered with a small, half-shrub-like oak; rows of broad,

flat, and low hills intersect them, mostly following the same direction as the escarpment of the plateau.

We know such fertile prairies to the south of the Kalgan escarpment of the plateau, that is, in the neighbourhood of Pekin; all along the route that was followed by Archbishop Paladius from Pekin, through Tsitsihar and Merghen to Aigun, that is, between the Nonni river and the Amur; on the middle course of the Sungari; on the lower course of the Bureya; and in the prairies of the Selinja, now peopled by wealthy settlements of Dukhobors. The Manchurian railway, from its station, Khingan, to the Lao-Tung peninsula, crosses these prairies.

§ 25. The main upheaval which we know amidst these prairies is the flat and broad succession of hills known as the Ilkhuri-alin, which, during the last Boxer uprising, was very often incorrectly described as the Small Khingan. Where I have crossed it, between Merghen and Aigun (50th degree of latitude), it attains nearly 3000 feet of altitude, and I found its surface covered with small volcanic craters and masses of basaltic lava. The Amur pierces it between the villages of Kazakevich and Bibikova; but its further continuation remains unknown, and it seems only probable that the Zeya pierces it above its junction with the Selinja, under 52° and $52\frac{1}{2}^{\circ}$ of N. lat. Mounts Tabiarkhan and Jarakhan seem also to represent its further continuation. In such case it may appear that the Tylskoi range on the coast of the Sea of Okhotsk is also a continuation of these mountains.

§ 26. Another independent mountain range is the Bureya mountains, otherwise the Little Khingan, or the Dousse-alin. It attains altitudes of from 4000 to 6000 feet, and has a width of over 50 miles. The Amur pierces it below the Cossack village of Ekaterino-Nikolsk. Its slopes are very steep, and its foot lies upon heights of nearly 1000 feet in the north-west, and 500 feet or less in the south-east. It does not, however, represent one single chain of mountains, but consists of several parallel ranges, very steep and reaching a considerable height, and is formed of granites and crystalline slates. It is well known in the place where it crosses the Amur, between Ekaterino-Nikolsk and Pashkova; at the sources of the Tyrmi, an affluent of the Bureya, and at the sources of the Bureya. Friedrich Schmidt has explored and partly mapped it. Its position on the left bank of the Amur is thus fairly well determined. As to its continuation on the right, or Manchurian bank of the Amur, I ventured in 1875 to express the opinion that this mountain range is crossed twice by the Sungari, in its lower course and above its junction with the Nonni river. This supposition has been confirmed since by the explorations made in Manchuria by the Anert expedition (see below).

§ 27. This mountain range seems to represent a boundary between the plains of the south-eastern slope (over 1000 feet high) and the lowlands of the same slope (below 500 feet), which reach the Pacific

ocean. At any rate, we find no high plains of the above-mentioned character in the east of this range of mountains: we see only marshy lowlands, covered with numberless lakes, in which the Amur and the Sungari and the Ussuri are still excavating their beds.

A few rows of hills, one of which is the Hokhtsy, rise over the flat surface of these lowlands. The exact position of this range is, however, not yet settled. It is possible that it is pierced by the Sungari, and that its continuations separate the left-bank tributaries of the Tumen-ula (affluent of the Pacific ocean) on the one side, and the Hurkha and the Upper Sungari on the other side. As to the continuation of the Hokhtsy beyond the Amur, it remains quite unsettled yet.

§ 28. Still less is known about the structure and actual position of the next mountain range, the Sikhota-alin. There is no doubt that these highlands may be traced without interruption in a direction from north-east to south-west, from the $49\frac{1}{2}^{\circ}$ N. lat. to the Gulf of Peter the Great. Here it is probably interrupted by this gulf, but it seems to reappear further to the south-west, in the mountain range which separates the Ya-lu-kiang from the Pacific ocean; but whether all the highlands between the Ussuri and the Amur on the one side, and the Pacific ocean on the other side, are occupied by one single mountain range, or whether they contain several parallel chains of mountains, are questions which remain unsettled up to the present time. On the map accompanying this paper, I give them the positions which seem to result from modern Russian exploration. See the map reproduced in Suess' 'Antlitz der Erde,' vol. iii., in French translation.

§ 29. Finally, we see several outer ranges of mountains, partially submerged and partially raising above the sea-level, in the islands of the Pacific ocean. The positions and directions of these mountains remain unexplored. It may be that the southern portion of Sakhalin island is composed of one mountain range which has a meridional direction, as it is represented on our maps; but it is also possible, and even more probable, that the mountains of Sakhalin are not so simple as they seem to be at first sight, and that we shall find in this island the continuation of the mountains of East Siberia. It is very improbable indeed that the narrow width of the Tartar strait (between the continent and the Island of Sakhalin) should be quite accidental, and it is more probable, on the contrary, that on Sakhalin we should find continuations of the south-west to north-east upheavals of Sikhota-alin.

As regards the north-eastern extremity of Asia and the Kamchatka peninsula: On the road from Yakutsk to Okhotsk, the plateau of East Asia is reduced in width to less than 200 miles; but on its continuation we find massive upheavals or plateaux, of which the north-eastern extremity of Asia is built up. I mean the upheavals which give origin to the Kolyma, the Anyui, the Chaun, and the Anadyr. Their orographic character

remains unknown, but it must be remarked that the rivers flowing towards the Sea of Okhotsk from these heights are all extremely short, while the only great tributary of the Bering sea, that is the Anadyr, flows west to east, that is, almost for certain, in a longitudinal valley at the foot of this upheaval. As to the rivers flowing to the Arctic ocean—the Indighirka, the Kolyma, and even the Chaun—they attain a very considerable length, more than 700 miles for the first two. Such a hydrographic net seems to prove that we have a steep slope towards the south-east, and a very gentle one towards the north-west. In other words, it is very probable that we have here a continuation of the plateau, which we know in more congenial latitudes, and which at this extremity of Asia is considerably narrowed and has become much lower. Finally, in Kamchatka, we find, on a continuation of the Sikhota-alin, a mountain range which has the same direction from south-west to north-east, parallel to the Kamchatka river; and then we see, parallel to the shore-line of the Bering sea, a continuation of that mountain range. Another mountain range stretches between the south-eastern coast of Kamchatka and the rivers Bystraya and Kamchatka, and it contains all the now active volcanoes of the peninsula. This chain of mountains also has a south-west to north-east direction, and represents a continuation of the row of volcanoes of the Kurile islands.

The above-mentioned generalizations are confirmed by a number of cross-sections, and are illustrated by the subjoined map.

(*To be continued.*)

THE SWEDISH ANTARCTIC EXPEDITION.

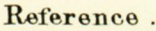
I. SUMMARY OF EVENTS.

WE print below a summary of the scientific results of the Swedish Antarctic Expedition of 1902–3, kindly communicated to us by Dr. Nordenskiöld. It is necessary, however, to preface this by an outline of the course of the expedition from the time when the *Antarctic* steamed north, on February 21, 1902, after leaving the leader and his five companions in the inhospitable neighbourhood of Snow hill, on the eastern side of the northward-pointing land-mass known as Louis Philippe Land. The first business which engaged the attention of the explorers was the erection of houses and observatories, after which an attempt was made to explore the neighbourhood by means of a boat excursion. It was soon found that the season was too far advanced for work of the kind, the movements of the pack placing the boat in frequent

By

Scale of Miles

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„ Higher Terrace 3000-5000 „

Alpine Zone

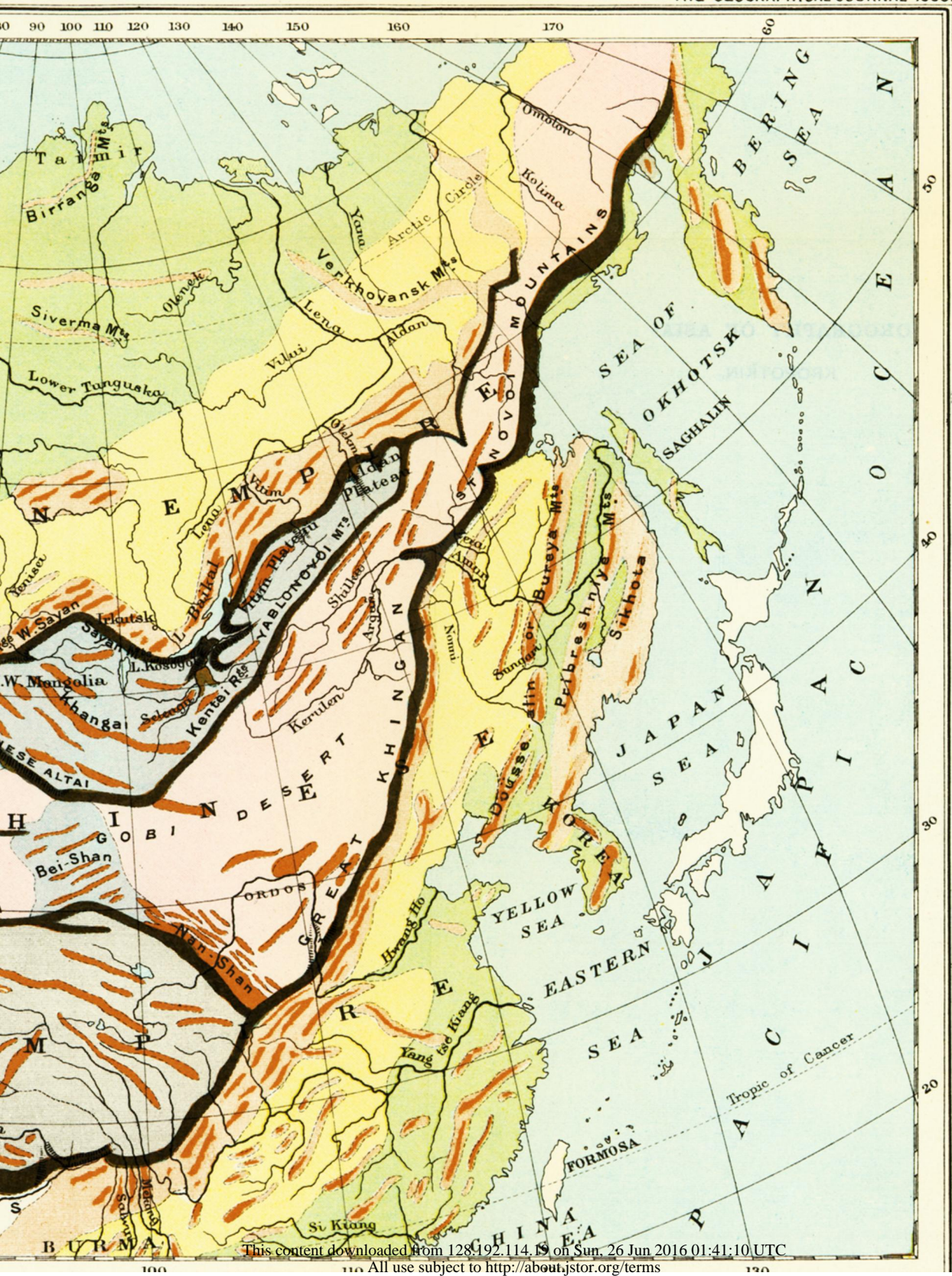
Lowlands, below 500 m.

Border-ranges of the p

"Trenches" leading to the level of

By
KROPOTKIN.

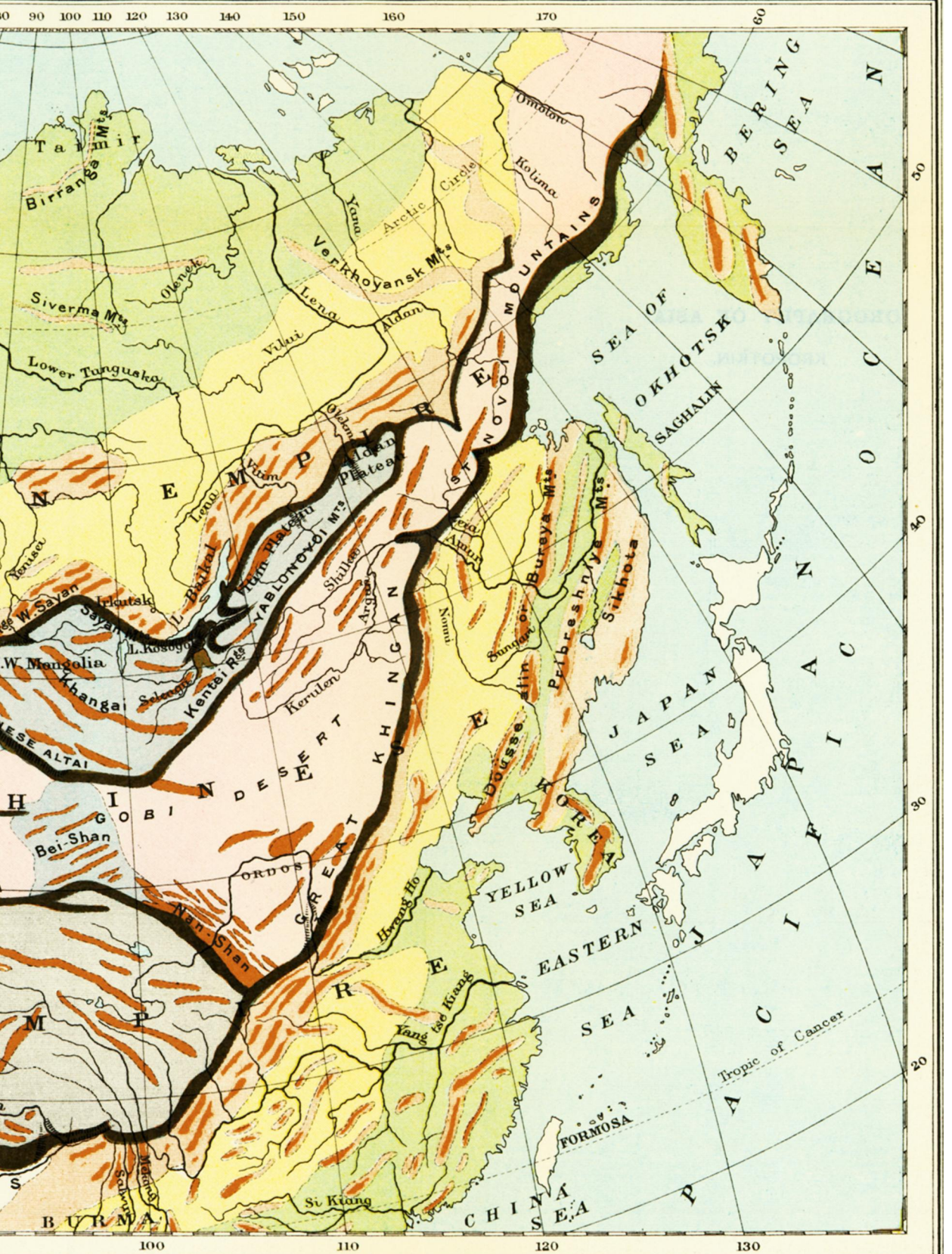
THE GEOGRAPHICAL JOURNAL 1903.



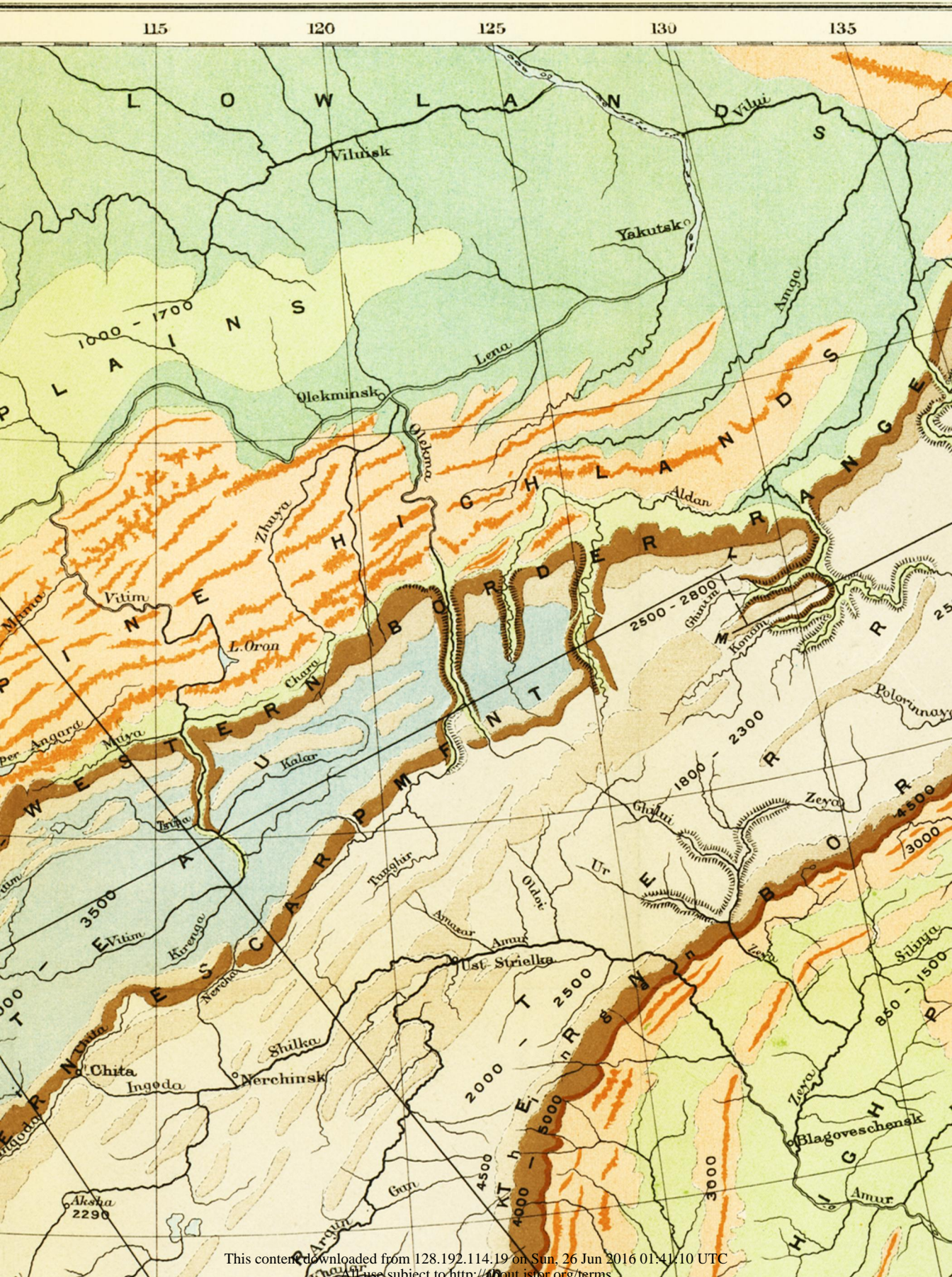


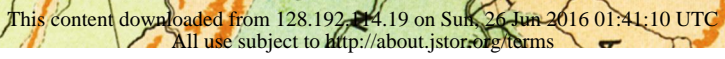
Modified Conical Equal Area (Bonnes) projection

Published by the Royal Geographical Society











OROGRAPHICAL MAP
OF
EASTERN SIBERIA
AND PARTS OF
MONGOLIA AND MANCHURIA.
By
P. KROPOTKIN.

Scale of Miles.
100 50 0 100 200

Nat. Scale 1 : 7,500,000 or 118.35 miles - 1 inch.

Reference.

- High Plateau
- Its Lower Terrace
- High Plains
- Lowlands

Alpine Highlands; the darker markings represent the direction of the mountain ranges.

- Border Ranges of the Plateaus
- Ranges of Mountains having their foot on the surface of the plateau.
- "Trenches" leading with a gentle gradient from the plains to the surface of the plateau.
- The lines A.B.C.D. etc. represent the directions along which cross sections are given.

6000 — 7000 — Altitudes in English feet

95

100

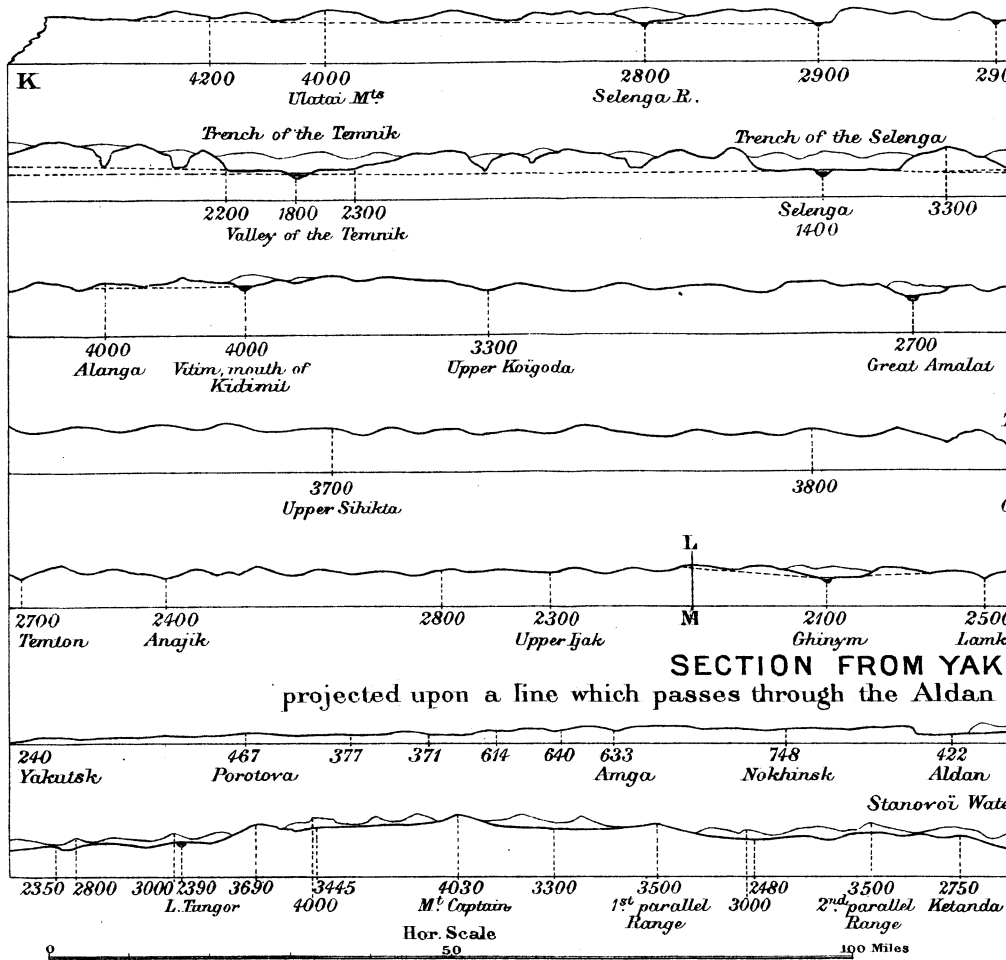
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Modified Conical Equal Area (Bonnes) projection.

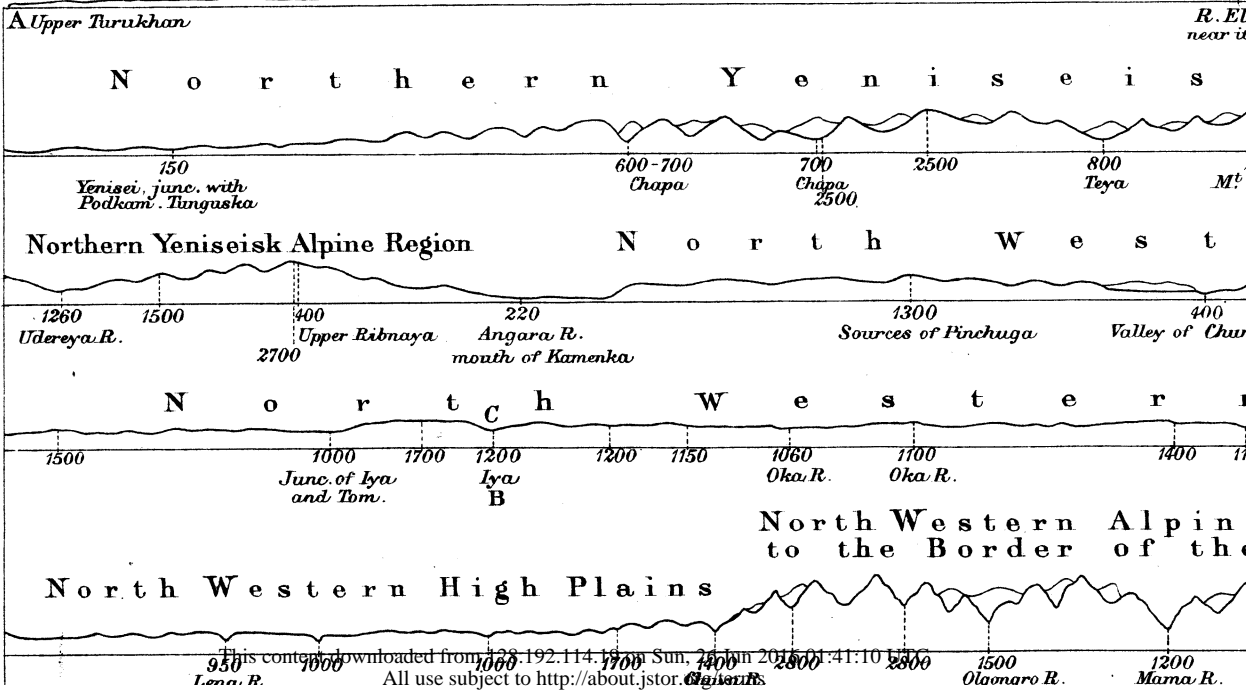


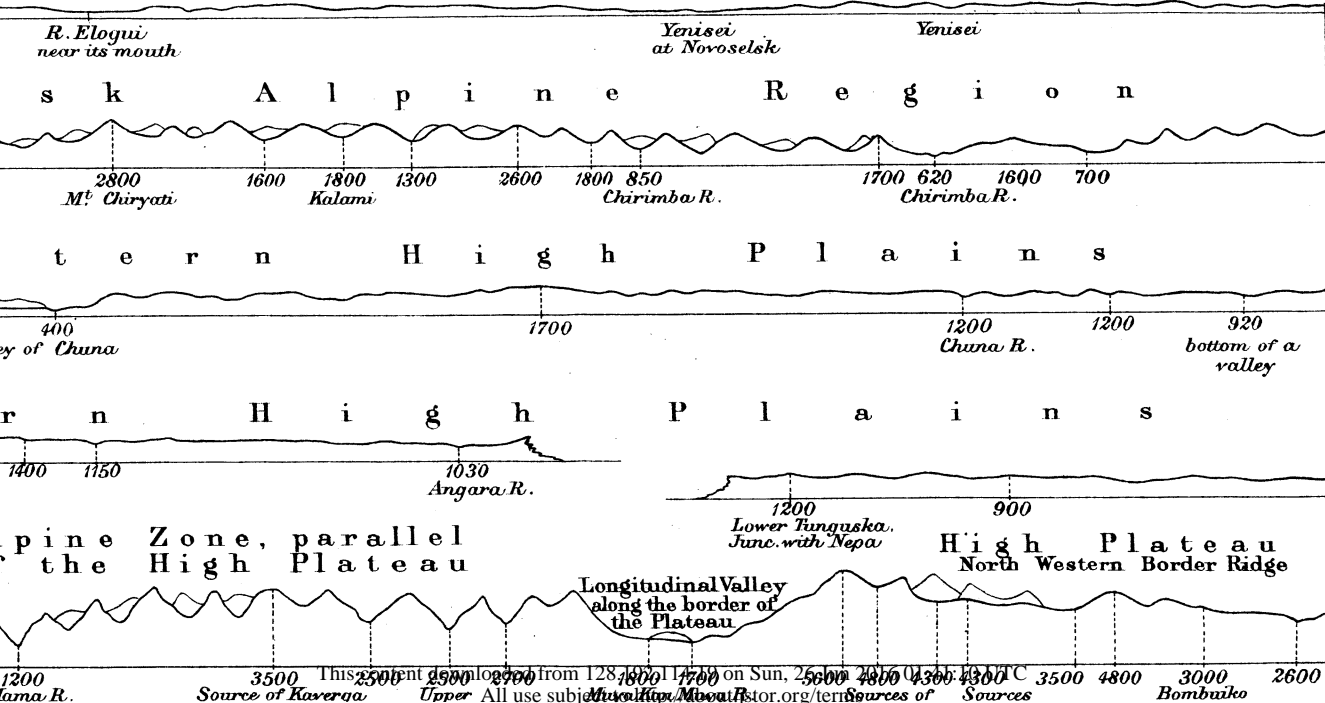


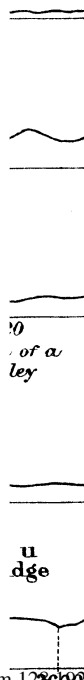
LONGITUDINAL SECTION C from the Sources of the Selenga to the Maya, tribut

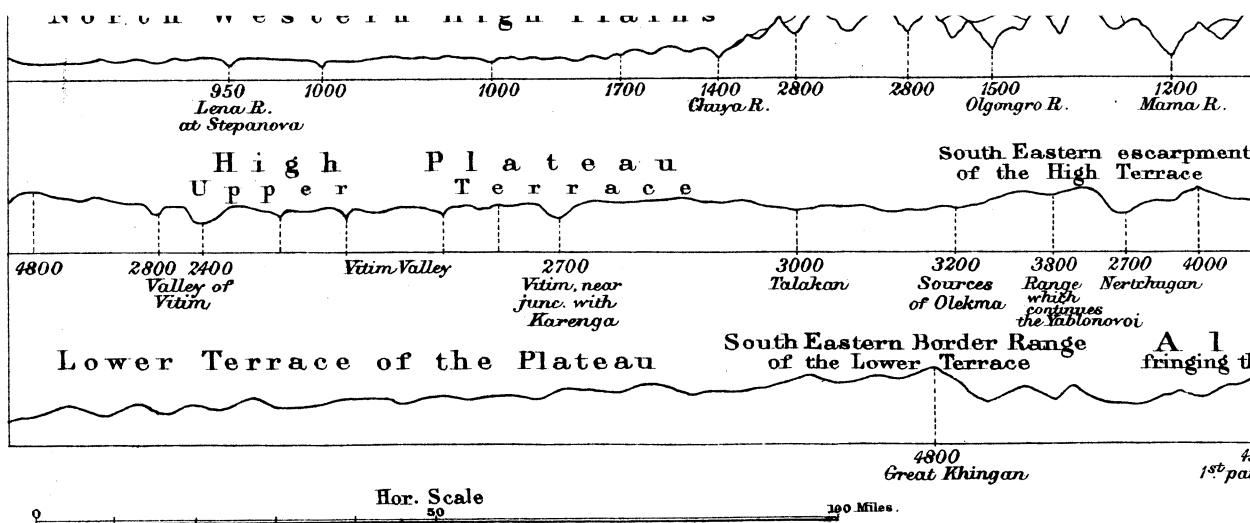


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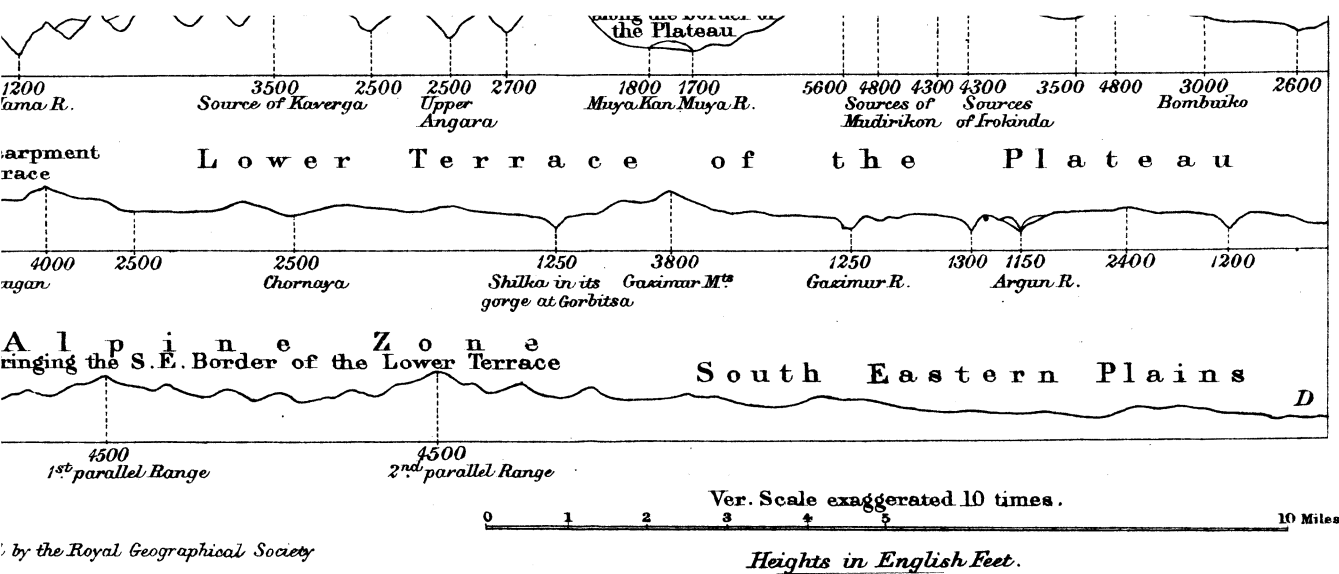




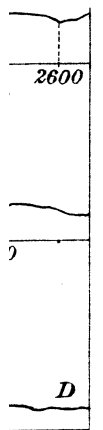




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10 Miles