with like, in alternate order.¹ The effect then of contraction due to cooling is probably much greater in producing rock structures than has been generally supposed. Since, however, the chemical composition, and the circumstances of solidification, vary so greatly in igneous rocks, and a very slight difference in the circumstances may produce with these minute structures a very appreciable alteration in the results, we must not be surprised if cases should occur to which we cannot apply the above explanations, at any rate without considerable modification.

IV.—ACROSS EUROPE AND ASIA.—TRAVELLING NOTES.

By Professor JOHN MILNE, F.G.S.;
Imperial College of Engineering, Tokyo, Japan.
(Continued from p. 468.)

Part VI.—*Tomsk to Irkutsk.*

CONTENTS.—Tomsk to Krasnojarsk—Appearance of the Country—Flint Implements at Kansk—Pre-historic Remains in Siberia, probably the 'Spoon' of a race allied to the Eskimo—Geology in the neighbourhood of Irkutsk—Cold of Irkutsk.

THE day on which I arrived at Tomsk, which was the 6th of October, I bought a small tarantass, and next morning I started, with some who had been fellow-passengers on the steamer, *en route* for Irkutsk. There were four conveyances between three parties, one of them being used exclusively for baggage. As each of these always needed three horses, and sometimes four, we often had difficulties at the post-station, where the post-master seemed disinclined to allow such a sudden draft being made upon his stables. Luckily my friends were high officials, and travelling on Government service, and their wants had from necessity to be supplied. My carriage being included with the rest, I went along comfortably and without delay, which would most certainly have occurred had I been alone. Before we were fairly outside Tomsk we ascended what I had, when at a distance, mistaken for hills, but which now appeared to be only a scarp-like face of a plateau, and we were soon upon a dusty road bounded by a low plantation of birch. Now and then we plunged down and over a small water-course, our momentum always carrying us some distance up the other side. Everywhere the country appeared as if it were an alluvial expanse; but in the vicinity I think there must have been some beds of rock, because everywhere along the road stone was being used as a material to repair it. This was yellow, argillaceous, and somewhat slaty in its character, perhaps having come from some of the Coal-measures which I believe exist in the vicinity of Tomsk. The birch-trees were now destitute even of their withered leaves, and the only relics of the falling year were a few white heads of a *Millefolium* and brown tufts of faded grass. During our first day upon the road we met a number of carts carrying a white clay, used in Tomsk for the manufacture of pottery. We travelled day and night, stop-

¹ With this compare the "veined structure" in glacier ice, as explained by Prof. Tyndall, *Glaciers of the Alps*, p. 376.

ping every two or three hours at some post-station to obtain a change of horses. I now noticed that the birch-trees were only growing upon the land which had been cleared on either side of the road; far behind them I could see the dark frontage of woods of fir. The evergreen, on being cut down, had evidently given way, whilst trees, like birch and aspen, had sprung up in its place, giving us an example of that succession in growth which sometimes takes place in the Vegetable Kingdom, and which Lyell and others have represented as having taken place in pre-historic Denmark and in other countries. Every night we now had frosts, and it was necessary to wrap up warmly, whilst every morning the sun streamed in at the open mouth of our tarantass to take off the chill of night, and remind us that it was Eastward Ho that we were travelling.

On the morning of the 27th at last I saw real hills. They were large and smooth in outline. Separating us from them there was a valley filled with mist, between the patches of which small stretches of a shining river could now and then be seen.

As we were entering a village called Bojotol, at about 9.30 A.M., one of our carriages happening to break down, I had an opportunity given to me to walk down to the river I had seen, which I learnt was called the Chulim. In a bend upon the side towards which the water flowed, there were banks 20–30 feet in height. The upper layer of these was of black earth, about $1\frac{1}{2}$ feet in thickness, beneath which came a yellowish clay, which readily crumbled when it was dry. In this latter, which formed the remainder of the bank, about six feet from the top, I found a lower jaw of some small rodent like a Squirrel. This was unfortunately so friable that it broke whilst it was being transported. Two feet below this there was a band of clayey concretions. Two feet still lower I found a number of fragmentary bones, only the articulating heads of which were preserved. They were apparently those of an animal like an Ox. Beneath this bone band there was a bed of bluish clay, from which a talus sloped downwards to the water's edge, hiding all that was beneath. After the difficulties of carriage mending had been overcome, we proceeded on our journey. Some miles farther on the road I saw another section in the banks of the same river, which I have just described. It was, however, twice as thick, and was made up of beds which were very sandy. In the afternoon we passed a square post standing by the side of the road, which marked the division between the governments of East and West Siberia, and the same evening we entered the town of Artchinsk. Before night came on I had time to see that there were a few low hills in the neighbourhood, but these, I think, like those at Tobolsk, were made of alluvial material. Next afternoon, just before we reached Krasnojarsk, which I looked upon as the halfway house upon our tiresome carriage journey, we entered on a hilly country. It was very open, which, with its want of trees, together with its smooth curving contour-lines, gave to it an appearance not unlike our English Downs. For a considerable time whilst we were rolling along the

roads between these gentle slopes, we had before us a view of two very remarkable-looking peaks, which were in shape like Egyptian pyramids. These, however, by the time we had reached Krasnojarsk, which was early in the afternoon, had so changed in their appearance that they were only like towering ragged rocks. Near the entrance to the town I saw upon my right a scarp of reddish rocks.

Instead of doing as I ought to have done, and gone for a scramble among the surrounding hills, I joined my friends in accepting an invitation to sup at the house of the military governor. Here the effects of four days' and four nights' continuous jolting very naturally resulted in my falling asleep in the drawing-room of my host. Before midday next morning we were again upon the move. The River Yenesei, which we crossed just outside the town, is both broad and rapid. On the opposite side of the river there is a range of sharply-pointed hills, amongst the peaks of which I think I recognized my pyramids of the previous day. Between the river and the foot of these hills, there is a narrow line of cultivation. For some distance outside Krasnojarsk there was a continuity of cultivated land, and we had many pretty views of pine-clad hills, which looked down upon villages and fields in the valleys which they bounded.

On the 29th we passed through the little town of Kansk, a short distance beyond which we ferried over the little river Kam. It is so clear that all across you can see its pebbly bottom. These pebbles are mostly siliceous, such stones as Flint, Jasper, and Agate being common. On the opposite shore we were faced by a steep bank, at least thirty feet in height, to the top of which we ascended through a cutting. It was made up of a yellowish sandy soil, with here and there a small patch of bluish clay. Growing on its slope there was a stunted sweet-smelling *Artemisia*, and a small succulent broad-leaved plant like a house-leek, whilst in the water below there were beds of water-weed. Near the top of the embankment the soil assumed a fine sandy character, which gradually merged into a black earth. In one or two places, when these came together, I found fragments of bone and chipped flints. With these there were many pieces of burnt wood. Some few of the flints were in the form of rough arrow-heads without fangs, but the greater number were simply chips. In different parts of Siberia large quantities of the remains of the early inhabitants have been found. In the Museum at Irkutsk I saw many which had been brought to light whilst making excavations in the vicinity of the town. Thus, whilst digging the foundations for a new military hospital on the banks of the River Ooshakofka, a tributary of the Angara, in addition to stone arrows and fragments of coarse pottery, a number of implements and ornaments were also found. These latter were made from ivory, which is apparently that of the Mammoth. One of these resembles a dice box (or the head of a croquet-mallet), but differs slightly in the diameter of its two extremities, and is not hollow. The diameter of one end is $3\frac{1}{4}$ mil., and the other end 29

mil. The length is, I believe, 71 mil. In the centre of this a hole has been bored, which, from its conical shape, looks as if it had been rymed out by means of a flake of flint.¹ Round the diameter of this, circular bands have been deeply scratched. Another curiously-shaped article is spheroidal in form, the two diameters being respectively 45 and 58 mil. Upon it, as upon the cylindrical body which has been just described, there are bands of circles traversing its surface in different directions. The use of these articles does not appear to be known. They were found in clay at about the depth of $2\frac{1}{2}$ mètres, and were accompanied by shells like *Pupa*, *Helix*, and *Succinea*, indicating freshwater and terrestrial conditions. In addition to these I also saw many other relics of bygone times. Amongst these there were many gouge-shaped stone chisels, like those which are dug up in Japan, Newfoundland, and many parts of North America. These, I believe, were used to dress skins with in a manner similar to that in which a Micmac now performs the same operation with a knife. There were also some teeth of *Cervus elaphus*, which had holes bored through them, bones of *Equus caballus* and *Bison priscus*. From the comparison of these beds with others also in the vicinity of the town, where the remains of the Mammoth have been found, Mr. Tschersky, their discoverer and describer, appears to think that they in all probability belong to a Middle Stone period.

Besides those animals which I have just mentioned, others, which are conspicuous amongst the list of European Pleistocene mammalia, have also been found in the vicinity of Irkutsk. Thus we have *Elephas primigenius*, *Rhinoceros tichorhinus*, *Equus caballus*, *Cervus tarandus*, *Cervus elaphus*, *Cervus capreolus*, and very many others.

Prof. Boyd Dawkins shows that the Palæolithic cave-dwellers of Europe have a blood relation with the Eskimos of North America, a view which is chiefly founded on the fact that these two races, which are now removed so far by both space and time, apparently used the same set of implements, a condition which at the present day only exists between blood-related tribes. The Musk-sheep and Reindeer which now give food to the Eskimo, having also furnished food to the early cave-dwellers, strengthens the idea,—and it was as these animals retreated from Europe across Asia towards the north-east, that man retreated also. The bones of these animals, as Mr. Boyd Dawkins tells us, together with those that I mentioned, mark the line of this retreat across Siberia. The flint implements that I found upon the Kan, together with others of like kind from neighbouring localities, tell us that certain implement-forming minerals were everywhere sought out and utilized by primitive Man, who, chipping them into weapons at each convenient resting-place, has thereby left his spoor. If this migration is a fact, and it seems, when all the evidence is considered, to be probable enough, then it may be correlated with those periods of great cold to which I have already several times referred.

¹ The specimens are figured by Mr. Tschersky, who has also described them in the Proceedings of the Geographical Society of Irkutsk, Sept. 18th, 1872.

In the first portion of my journey across Sweden, and along Finland, I described the ice-worn aspect which these countries present, which I, in part, justly attributed to the action of coast-ice on a rising area. I then made reference to the indications that we have, both here and farther south, of the higher lands and valleys being covered with glacier-ice. In some places new ones were freshly formed, whilst in other places pre-existing ones were augmented, so that, as Prof. Ramsay tells us, we had, for example, in the Alps glaciers perhaps 3500 feet in thickness. All this implied an intensification of modern agencies. Farther on, upon the section of my journey across the Siberian steppes, I intimated that indications of an ice-cap, or of conditions so severe as they appear to have been in Europe, are at present wanting, and, therefore, until we have really found them, their existence rests on debatable evidence. Adopting the above views, the tracks of Palæolithic man, and of the animals which were contemporary with him, which are being brought to light in Siberia, may be taken as congruent phenomena, and we may suppose that they retreated from a climate, which in Western Europe was by its severity driving them towards the south, and escaped to one more suited to their conditions. That they retreated directly towards the north as the cold retreated, at present hardly appears to have been the case, because remains of a Palæolithic type do not appear to have been collected from those countries, like Denmark and Scandinavia, where they would naturally be expected to occur.

With this speculation upon the cause of migration, which migration was in itself more or less of a speculation, I will stop, and return to my track upon the road to Irkutsk from which I have so far wandered. The country beyond the River Kan is undulating, and is thickly covered with both pine and birch. As the road sometimes led us along the tops of ridges, we occasionally obtained extensive views. In the afternoon we crossed a morass upon a road which was kept in its place by a row of piles driven in about three feet apart upon either side. Every morning we stopped at the first station we reached after daybreak to warm ourselves and drink tea. At these places we had excellent opportunities for observing a red species of cock-roach with which the walls of the station-house were thickly covered. On the following night, 1st of November, it snowed heavily, and by the morning the ground was so thickly covered that the rapidity of our progress was greatly impeded. The surrounding hills were now higher. Owing to a thaw during the day and a frost at night, the sides of many of the hills which we had to cross became so slippery that it was often doubtful whether we should reach their summits, and much of the night was spent walking alongside our struggling horses. One horse we had to leave for dead. On the 4th it rained and blew heavily, and, in spite of all our endeavours, the rain forced an entrance to our tarantass. On the evening of the same day, about 5 p.m., we reached the shores of the rapidly flowing Angara, on the opposite side of which we could see the glimmering lights of the houses in Irkutsk. In less

than an hour we had crossed the flying bridge, and were safely at the end of this section of my journey: the distance from Tomsk being about 1559 versts, or 1036 English miles. Irkutsk is a large town, of about 30,000 inhabitants, containing many fairly handsome buildings. It is situated on the N.E. side of the Angara, opposite to its junction with the River Irkut. Like St. Petersburg, it may be said to have been built upon a marsh. In 1652 there were only two houses upon the present site, but soon after, in 1686, by order of the Government, the town as it now appears began to rise. Although the town itself is flat, the surrounding country is undulating. All along the sides of the rivers, and running for some distance up the slopes of the hills, there are beds of alluvium. On the hills themselves there is a covering of yellowish earth from two to three feet in thickness, which, from the fragmentary stones it contains, can be seen to have been derived from the disintegration of the subjacent rocks. These are in the main a grey and yellowish sandstone, slightly micaceous, and somewhat gritty. This is quarried and used as a building stone in the few places where stone is required about the town. In some places it is conglomeratic. Whilst examining this rock upon the north-east side of the town, I found several thin vein-like seams of coal. These veins, which had a brownish lignitic character, were from two to four inches in thickness. In the surrounding districts many outcrops of this material have been found, which unfortunately appears to lack more in quality than it does in quantity. From fossils which have been found in this formation, its age, as I have before stated, when speaking of the coal-fields of the Urals, is probably Jurassic. About 40 miles to the north-west this overlies a limestone, which is probably of Devonian age, but even about this there is some doubt. Besides the strata on these two horizons, the only other rocks in the district appear to be either highly metamorphic or else volcanic in their origin. The former of these rocks are well developed along the valley of the River Tunka. The rugged mountains which bound this valley, called the Tunkusian Alps, can be seen from Irkutsk. Mr. Tchersky, who has explained this district, has described a remarkable series of graduations as occurring there. The series commences with limestone, passes through pyroxenic rocks, and ends with rocks that are granitic.

Up this same valley perched boulders of a local origin have been found. Their discoverer, Mr. Tchersky, attributes their origin to glacial action, but on this point local geologists are not agreed. The only other phenomena which can be assigned to the action of ice are the scratched stones in the alluvium of the river-banks, but these are only such as are produced every year. So, as I have before said, we have not yet any undoubted evidence of polar ice-caps or large glaciers.

Besides coal, which I have spoken of, Iron ore, Gypsum, and Kaolin are found in the neighbourhood. A small quantity of gold is also worked, and once there was a lead-mine. The best returns appear to be derived from the salt springs, as at Tailma, which was a station I passed through before reaching Irkutsk.

Two days after my arrival in Irkutsk snow again fell, and this time it covered the ground so deeply that all my outdoor work came to an end.

In Irkutsk there are two museums. One of these is attached to a Technological School, and is used for teaching purposes, and the other is at the rooms of the local Geographical Society, which acts as a branch of the larger Society in St. Petersburg. In this latter there are many objects of great interest. Amongst the minerals, fine crystals of Uilnite and Onvarovite are the most noticeable. In the osteological collection the bones of Deer and of the Mammoth seem to preponderate. Some of the latter had integument still remaining on them. In the Technological Museum there are some remains of the same animal, which, in addition to the integument, have also a good coating of long red hair, eight inches in length. I also saw several skulls of Tigers from the Amoor district, and Seals from Lake Baikal, together with a long series of Crustacea, which also appear to be peculiar to this lake. Of especial interest to the Zoologist and Palæontologist are a number of mummified remains of various animals, which have been obtained from a cave near Nijni Udinsk. As the temperature of this cave appears never to rise above -4°C. , the creatures that have died in it have had a great portion of their integument preserved. The results obtained from exploring such caves, and a number of them appear to have been discovered in these localities, will probably be of great interest, as it will give us a surer insight into the softer parts of many animals with which we have only hitherto been acquainted from their bones. In the museum there is also a small collection of birds and quadrupeds, some insects and fossils, and an antiquarian assemblage of dresses and implements. During my stay in Irkutsk, which was for about a month, the weather gradually grew colder. One night the thermometer sank to -28°R. (-31°F.). Notwithstanding the deadening influence of this cold at night-time, the stars looked brighter and more cheerful than I had ever before seen them, and when the moon was up it was so light, that I could read without difficulty small handbills posted on the walls. The cold was, however, too great to be enjoyed. During the day the appearances were reversed, and the town, especially during the dull weather, was both melancholy and depressing. The smoke from the chimneys, instead of rising to be dispersed in airy clouds, rolled heavily from the chimney tops in a long black horizontal line, and then fell down towards the ground. Its quantity seemed to be increased, which was perhaps due to condensation of the aqueous vapour. When you opened a door, the cold air rushing in condensed all with which it mingled like so much smoke, which rolled across the floor in fuming clouds. If the sun shone brightly, you could often see spicules of ice glittering in its beams.

Although I felt great cold whilst staying in Irkutsk, I did not experience anything like the extreme cold which this district annually experiences. The greatest cold registered during the preceding winter was -39.5°R. , and the greatest warmth during sum-

mer was $+ 21.75$ R., which gives a range of 61.25 R., or of 137.8 F. The average temperature in winter at Irkutsk is $- 14^{\circ}.8$ R., and the average for summer $+ 13.1$ R. For the whole year the average is $- .4$ R., indicating that as a whole the gay society of Irkutsk live in a freezing temperature. Farther to the north at Yakutsk the average temperature is $- 8.6^{\circ}$ R., whilst still farther upon the borders of the Arctic Ocean at Ust Yansk it is $- 13.0^{\circ}$ R.

(To be continued in our next Number.)

NOTICES OF MEMOIRS.

PROFESSOR TOULA ON THE GEOLOGY OF ST. NICOLAS-BALKAN: Section OSMANICH-AK-PALANKA. (Proceedings of the Imperial Academy of Vienna, April 25th, 1877.)

[Communicated by Count MARSHALL, F.C.G.S., etc.]

THE central massif is composed of crystalline unstratified rocks, of granite (St.-Nicolas Defile: altitude 1390 mètres), and very extensive dioritic rocks. Azoic rocks, such as clay-slates and gneissic rocks, with intercalations of chloritic and quartzitic schists, appear both on the south, and especially the north slope. In this direction they extend as far as the River Arcer, where they are partly overlain by "Sarmatic" deposits. The Carboniferous sandstones south of Belgradeik, on the northern slope, include organic remains characteristic of the Old Red ("Walchian") sandstones, as *Calamites*, *Annularia*, *Odontopteris obtusa*, Naum., *Cyatheites arborescens*, Brongn.; *Alethopteris gigas*, Gutb., *Tæniopteris abnormis*, Gutb., and *Walchia pyriformis*, Schlth. These sandstones are unconformably overlain by a thick deposit of red sandstones, probably the Bunter or Lower Triassic Sandstones. The Muschelkalk is met with in the same locality. The fossils are: Teeth of *Saurichthys*, *Lima striata*, Schlth., *Pecten discites*, Schlth., *Pecten Alberti*, Goldf., *Ostrea decemcostata*, Mstr., *Retzia trigonella*, Schlth., *Spiriferina fragilis*, Schlth., *Waldheimia vulgaris*, Schlth., and *Entrochites* in abundance. The overlying strata are white sandstones of unascertained age, and white Upper Jurassic limestones with hornstone and *Belemnites*. These limestones occur likewise beneath the Nerinea-limestones of the isolated hill of Rabis. The Jurassics are conspicuously represented south of Belgradez by hard sandstones ("Middle Dogger"), with *Pecten demissus*, Phil., *Monotis elegans*, Goldf., and *Belemnites* (near *canaliculatus*, Schlth.), conformably overlain by fossiliferous, distinctly stratified limestones, containing *Sphenodus macer*, Quenst., *Lepidotus maximus*, A. Wagn., *Aspidoceras orthoceras*, d'Orb., *Perisphinctes polylocus*, Rein., *Simoceras Douliéri*, d'Orb., *Oppelia Holbeini*, Opp., *Oppelia compsa*, Opp., *Phylloceras tortisulcatum*, d'Orb., *Aptychus latus*, Park., *Apt. Bulgaricus*, sp. nova, *Rhynchonella Agassizi*, Zschn., and *Rhynch.* sp. (near *sparsicosta*, Quenst.).

Cretaceous marls with small *Belemnites* and *Inocerami* are found to a limited extent between Vrbova and Quprén. Middle and Lower