The evidence relates to roads, not to conditions of human habitability, and the conclusion rests upon a belief that the roads then, as now, were selected with a measure of reason. The hard conditions of travel in an inhospitable mountain country make unnecessary circuitousness within short distances a practical absurdity. The llama trails upon the stony beaches, no longer followed because of the incomparably better road below, and the roundabout route on the south side of the basin, long since abandoned for a better one, appear to offer proofs of a convincing order.

Putting the evidences from the three sources in review, one notes, as concluding features, their wide geographical distribution, their interpretative dependence upon absolutely different criteria, the apparently incontrovertible nature of *some* of the evidence in *each* group, and finally the fact that it is just that evidence that in the first two cases is gathered first hand by the recorder himself that is most convincing. So that, with the hearsay evidence entirely omitted, the conclusions we have drawn upon direct evidence of profound climatic change within the human period seem not only tenable but obligatory.*

EXPLORATION IN THE TIAN-SHAN MOUNTAINS.

By Dr. GOTTFRIED MERZBACHER.

My expedition is ended, and, now on my way home, I hasten to forward provisionally a few particulars respecting its course. Only in their broad features and in a cursory manner can I sketch the routes pursued by the expedition. Of the abundance of observations collected, a few passing indications are all that can here be offered. So soon as circumstances permit, it will be my endeavour to fill in the lacunæ by a somewhat more detailed "Provisional Report."

As shown in my communication dated February 15, 1908 (see *Journal*, vol. 31, pp. 395–400), the first year of the expedition was devoted to a more exact exploration of the systems of the chief rivers of the eastern central Tian-Shan, the Agias and Kok-su to an *in*tensive study, so to say. Following up its programme, the expedition's second year was, on the other hand, occupied more with *ex*tensive labours. The disadvantages necessarily involved in this procedure were, however, richly counterbalanced by the fact that a general view was thereby obtained over an immense region and over the homogeneous geological and morphological phenomena constantly recurring therein. Through the comparison thus rendered possible, the genetic connection of the phenomena and their further relation to other facts previously observed elsewhere, such as had hitherto seemed enigmatical or doubtful, was cleared up, and one could gradually arrive at an estimate of the forces

* The climatic change itself, and the physical evidence for it in the form of low-altitude moraines, U-shaped valleys, cirques, glaciated rock surfaces, and abandoned shore-lines in other Andine basins will be described in a later paper.

that in the main determined the present configuration of the Tian-Shan, and in particular of the way in which those forces acted.

To gain the most correct idea possible of the geological structure of the eastern Tian-Shan, the plan was adopted of several times crossing the whole of the chains constituting it, and, as far as possible, in a direction transverse to their strike. This plan was in part successfully carried out, and several nearly complete geological cross-sections could thus be obtained.

As mentioned at the close of my communication above referred to, the final break up from winter quarters at Kulja was fixed for the beginning of March, dependent though it was on the timely arrival of my new geological coadjutor, Dr. P. Groeber. Owing, however, to unforeseen circumstances, his arrival was so long delayed that I was unable to start from Kulja till April 27. To make up for the loss of the guide, Franz Kostner, who had returned home, the expedition secured the services of Franz Wenter from Tiers, near Bozen, in the same capacity. Otherwise its *personnel* was similar to that of the previous year. Besides the three Europeans, it consisted of two Cossacks and another Russian of Central Asia, four Sarts, and two Kirghizes, with a complement of twenty-six to thirty horses.

The first objective was the great longitudinal valley of the Kungess (about 160 miles long), drained by the headwaters of the Ili. The Ili first takes this name after having, as the Kungess, united its waters with those of the Kash, which runs parallel to it, and is hardly inferior to it in size, and debouched into the wide Kulja basin. This valley, leading into the heart of the eastern Tian-Shan, and keeping in its lower course the character of a wide high steppe framed by but moderately high mountain chains, was followed up to near its head. Having reached the upper course of the Kungess, where the landscape has already assumed the character of a high mountainous region, the expedition turned southwards, crossing by the higher passes of Tai-assu and Dagüt, the watershed towards the Yuldus and the intervening longitudinal valley of Zanma. By this course the expedition reached the largest valley system in the eastern Tian-Shan, that of the Chaidik-gol, which flows through the Yuldus valleys, already highly remarkable for their conformation. The study of these valleys and of the causes of their peculiar course formed one of the chief problems of the expedition. In the Yuldus valleys even the Tian-Shan traveller, long habituated to imposing scenery, is astonished at the dimensions of the mountain chains comprehended in one outlook, though extending apparently into the immensity of space, at the grand monotony of the ranges which constitute the landscape, and lastly by the hundreds of *névé* basins which strike his eye, whose waters go to swell the mighty Chaidik-gol.

Pursuing its way eastwards up the so-called "Little Yuldus" valley, some 95 miles wide, up to the region of its headwaters, the expedition

came to the Kotil pass. In the geological structure of its bounding walls, as also in its grand morphological aspects, the valley of this river presents a series of important problems, the full solution of which, however, owing to its inhospitable character, presents insurmountable difficulties. It was impossible to overtake all the work that was then calling to be done, though the material there collected is of the greatest interest. Among other things it may be worth noting that my former assumption respecting the enormous development of the glaciation in the past of the southern slope of the Tian-Shan range was fully confirmed. On May 20 we reached the town of Karashar, which enjoys the great advantage of being situated on the imposing river Chaidik-gol, here fully one-third of a mile broad. Thence we proceeded to the north bank of the great lake, Bagrach-Kul. The expedition next followed its outlet, the Konge-daria, which, in a narrow defile (incorrectly represented in existing maps), breaks through the southern border ranges of the Tian-Shan. And so we arrived at the town of Kurla. Following the foot of the southern declivity of the Tian-Shan for a distance of over 200 miles, we next travelled by way of Bugur to Kucha, one of the most considerable, and in many respects the most charming, of all the towns in the Tarim basin. In consequence of the belated start from Kulja, we arrived at the now overheated southern sides at least four weeks too late, and the members of the expedition suffered much on the march from the enormous heat and the sand-storms.

At Kucha, where I was about 60 miles, on a bee-line, from the extreme eastern point of my route in the last expedition (1903), it devolved on me to make comprehensive preparations for the most difficult and doubtful part of the whole enterprise. Here, where the eastern Tian-Shan attains its greatest breadth, little short of the extreme breadth of the central part of the range, to the average vertical elevation of which it closely approximates, we had to face the task of crossing transversely, in as direct a line as possible, the entire complex, in order to obtain a complete geological profile. For such an undertaking the available bases were inadequate, the intelligence scanty and contradictory, the season unfavourable—four weeks too early or too late. Still I determined to carry my design into execution.

On June 6 the task was begun, its first part being executed with comparative ease. But the farther we pressed northwards the more did difficulties accumulate, threatening at last to become insurmountable, so that we seemed almost driven to the fatal necessity of retracing our steps. And matters might, indeed, have come to such a pass had not the season grown too late, but the circumstances did not allow a retreat. Rivers were so much swollen, that we crossed only under the most difficult circumstances, and we could not comply with the risk to recross them on the eventuality of a retreat. Besides, the northern slopes of the passes already crossed were too steep to be climbed in an

eventual retreat. There was no choice left us but at any cost to push our way northwards. Happily, the results obtained were proportionate to the difficulties and dangers overcome.

In this journey, through country hitherto unexplored, almost each day's march brought with it fresh and unexpected discoveries, and exceedingly valuable observations were secured. We pushed our way into the mountains through the great transverse valley of Kiu-Kenik, which bears also the names of Kiju-Kule, Kuji-Kule, Kuju-Kunnuk, Kiu-Kelik, and is besides quite wrongly represented in our maps. In its peculiar course the valley shows a remarkable variety of features. While trending north it cuts through various younger formations of very diverse age, which, by their geological structure, the peculiar effects wrought on them by climate, and their vivid colouring, form landscapes of a rare type and of a charm all their own. The middle section of the valley being impassable, a diversion had to be made westwards into the neighbouring valleys of Kizil-Ketun and Dshon-Jailak, and several passes crossed. Thence, again bending eastwards, we reached the upper course of the main valley, which is carved out of palæozoic formations and the series of eruptive rocks connected with them.

The further march to the north-east brought the expedition through a morphologically interesting region of lakes (either already desiccated or in process of desiccation) to the foot of the high Kok-tepe chain, which, in consequence of the slight extent to which its ridge has been indented, offers but few crossing-places. We crossed the chain at Kiu-Kenik pass, which, structurally, plays an important *rôle* in this part of the mountain system. A second pass surmounted, we descended northwards, and came into the valley of the northern Kiu-Kenik, known also as Zagan-ussun.* This, one of the most important affluents of the Chaidik-gol, breaks through the chains which hem in the "Great Yuldus" valley on the south. And the place at which it cleaves its way through them is exactly the spot where they present the greatest elevation, the boldest and most manifold mountain forms, and the most important development of glaciers—a development far exceeding my expectations. Even in the Tian-Shan there are not many mountain scenes to surpass in grandeur the panorama here disclosed. The marked thermal contrast between the heights of so considerable elevation and the wide-extended steppes of the floor of the valley, exposed as they are to an intense solar radiation, causes the mountain chains to be in the summer season mostly veiled in clouds, and heavy rains are, as a rule, a daily occurrence.

Having entered the "Great Yuldus" valley we turned westwards, where we were confronted with the task of more closely investigating the eastern continuation of the great conglomerate mountains of the upper Kok-su, mentioned in my former letter, so as to arrive at a more

* In this part of the Tian-Shan also the valleys radiating in different directions from a particular point of a mountain crest often bear the same name.

complete understanding of the mode of their formation. Not only were these investigations crowned with success, but it was further possible to make a series of important observations relative to the tectonics of a large part of the Tian-Shan, the development and present conformation of the valleys of the Kok-su and Yuldus, and finally, to a knowledge of the phases of their former glaciation. In the course of these investigations I crossed the southern one of the Karagaitash passes, and once more entered the Karagaitash valleys, visited the year before, and thence reached, for the second time, the uppermost region of the Kok-su. Dr. Groeber, meanwhile, made his way beyond the headwaters of the Kok-su, over the pass of Ulan-bulak. Our roads offered welcome opportunities of supplementing my previous year's observations.

On its way back to the "Little Yuldus" valley the expedition visited the summer residence of the most important chief of the Torguts, who in the summer months, with the greatest part of his nomadic folk, frequents the wide steppe-regions of the valleys of the Yuldus and its tributaries. The splendid "yurts" (felt tents) of the chief's family, and the many others which served as temples to the numerous lamas here assembled, offered much that was interesting. I was most hospitably entertained, and the Torgut officials were lavish of their assistance on behalf of my further undertakings.

In the "Little Yuldus" valley Dr. Groeber was successfully engaged in investigating the transgressive upper strata of the lower carboniferous there considerably developed. I on my part made ready for a further advance northwards, an advance which brought us to the transverse valley of Dunde-Kelde. There, too, we lighted on palæontological finds, the closer examination of which should be of great import for the determination of the age of the so-called "younger formations" of the Tian-Shan and of their mode of origin. We succeeded in making valuable observations on the tectonics of the region, especially at the termination of the valley at the crossing of the Dunde-Kelde pass, which gives passage northward. Arrived at the northern foot of the pass, the expedition found itself in the valley of the Khustai, the uppermost headstream of the great glacier-fed river Manass, the most considerable of all the rivers draining the northern slope of the eastern Tian-Shan. On crossing the pass the great and widely glaciated chain of Iran-Charbut lay before my eyes for the first time. It forms the backbone of the eastern Tian-Shan. Here, too, as everywhere in the eastern part of the range, the extremely slight indentation of the summit ridge is an important characteristic. There are no easy passes accessible to a large caravan. This unfavourable state of things is aggravated by the circumstance that none of the great river-valleys offers a practicable route throughout its whole course, and that the streams which traverse them, fed as they are by the great accumulations of *névé* stored up in the numerous head and lateral valleys, are heavily swollen

and extremely rapid, and consequently fordable at few spots, and at these only with great difficulty, which is heightened by their very winding courses hemmed in between steep rock-walls. Rich as is the growth of alpine grass in these valleys, they still, therefore, continue uninhabited, even the nomadic Kirghiz and Mongols avoiding them. Only in the winter, when the water-level is low, do the nomads frequent them. In these desolate regions the traveller cannot reckon on finding help or supplies. These circumstances will explain the difficulties I encountered in the execution of my task. The only course open was to endeavour—so soon as its canyon-like contractions rendered one valley impassable—to reach the next parallel valley by crossing a pass in the intervening chain. There we could once more prosecute our northward march till again compelled to have recourse to the like toilsome mode of egress.

In this way I followed first the course of the great mountain river, the Manass, into which numerous large glacier streams, emerging from an extremely ramified valley system, pour their muddy water with bewildering uproar. Repeatedly crossing the main river, the expedition was several times in no slight danger, which at first made me doubtful about trying the venture too often. When, however, in shunning this risk we also failed to force a passage across the Askti pass, it seemed as though the expedition were cut off alike from advance and from retreat. Only after great dangers did we at last succeed in gaining the foot of another pass, the Tsintetoe. After successfully effecting this high and difficult passage, we were able to descend into the valley of Charagaitoe. But as this offered no other outlet, there was no help for us but to cross a farther high gap in the mountains, the Tsoe pass. We next descended into one of the most magnificent alpine valleys of the eastern Tian-Shan, that of Chorgoss. As a background to its principal head and lateral valleys, the grandest mountain forms tower up before the traveller, who sees extended before him the most important glaciers of the eastern Tian-Shan. The glaciers I found in a stage of marked retreat.

Less impracticable was the road over the Tainu pass, which commanded a comprehensive view of the glacier regions of the whole of this region. This passage admitted us to the great alpine valley of Ulang-su. Greatly swollen by the waters derived from numerous *névé* fields in its lateral valleys, and terribly wild, the Ulang-su river opposed great obstacles to the further march of the expedition.

Defiles and rapids at length completely barred further passage in the valley of the river; yet, as the provisions were at an end, some outlet had to be found at whatever cost. The beginning of the venture was hazardous. We had to negotiate a series of eight passes in order to cross the deeply furrowed mountain complex to the west of the Ulang-su and reach the passable Koi-ashu valley, which led us out to the gently sloping northern declivity of the range.

A march of several days was now made through the more recent chain of hills which fringed the northern foot of the old mountain system. These hills are of much interest, especially from a morphological point of view. The expedition thus reached Shikhodse on the northern imperial highway, and thence arrived, on July 22, at the town of Manass. Our arrival here at a date so much later than anticipated filled me with forebodings as to how the further extensive programme was to be executed. I therefore abandoned my previous intention of travelling eastwards along the foot of the range, and availed myself of the imperial highway to journey to the large town of Urumchi, the seat of the central government of the province. There we made a longish halt in order to reorganize the expedition for the exploration of the easternmost of the great glaciated chains, the Bogdo-Ola, and replenish our supplies. On July 31 we resumed our march, which took us at first eastward to the town of Fu-kan. My intention was to combine as careful an exploration as possible of the central and highest part of the chain and its extensive glaciation, which had already impressed us from a distance with a complete traverse from north to south, in order to obtain a geological cross-section. If hitherto the weather had on the whole been pretty favourable to our travels, it now entirely changed. Owing to the considerable vertical elevation of this mountain mass (much over 17,000 feet), between the northern Gobi and the deep depression of the wide Turfan basin on the south, the Bogdo-Ola district is a scene of perpetual storms. Nevertheless it was found possible to carry out the programme. The great transverse valley of Bogdo-Ola leads from Fu-kan to the central portion of the range. It offered the means of advancing directly southwards, transversely to the trend of the chains. In its lower course, the valley is wholly carved out of the coal-bearing formations, supposed to be of comparatively recent age, which are here developed to an extraordinary degree, and of which a thorough examination was to be the task of Dr. Groeber. He succeeded in making some important discoveries of fossils, the determination of which seems likely to shift the age of these deposits back to a considerably more remote era than has been hitherto assumed. Even in these secondary chains, close as they approach to the border of the Gobi, the traces of the diluvial ice-age surprise us by the extent of their development, while they are exposed to view in an unmistakable manner. The Bogdo-Ola valley is watered by the principal effluent of the magnificent alpine lake, Bogdo-Ola, to which it guided us. This lake and its environment may, in point of scenery, be taken as the pearl of the eastern Tian-Shan. It is hard to conceive of anything more charming.

This may be the reason why in their simple faith the Chinese of the plain look on the lake as sacred, and make it the theatre of their religious myths. A number of monasteries are seen towering up, romantically planted on the beautifully wooded mountains which encircle

the lake, and are mirrored in its blue waters, grandly overtopped by the icy peaks of the central Bogdo-Ola group.

Owing to the deep ravines which intersect this region, our further advance to the northern foot of these magnificent mountains encountered many obstacles. From a high camp at the northern foot of the icy chain, and again, after crossing the Miskan Pass which cuts through the heart of the group, from a camp at its southern foot, I occupied myself with the study of the geological structure of the chain and of its widely extended glaciers. The ascent of some high glaciated mountains on the north and on the south border materially furthered these labours.

Meanwhile Dr. Groeber successfully prosecuted his investigations, further eastwards, into the structure and composition of the "younger" part of the range, plotting the results in section. On the way down southwards to Lake Sayopu the expedition reunited, and on August 25 again returned to the northern slope on its way to Urumchi. The season being so advanced, it behoved us to press forward with all possible speed to the more western field of work, which had been included in our plan of travel. I therefore again made use of the Imperial highway—mockery of a highway as it is—in order to return to Manass, and thence to make a further journey to Shikho. From this town it was my intention to go southwards once more, and to cross the mountain chain, by a route as nearly transverse as possible, into the uppermost part of the great longitudinal valley of the Kash, and thence to the headwaters of the Kungess. This would have brought us into the way leading southwards from the valley of the Kungess, which we had struck in the spring. By this course it would have been possible to complete a further geological cross-section, but our design was opposed by the above-mentioned peculiarity in the structure of the chains constituting the Iran-Charbut mountain system, namely, the small indentation coupled with the great elevation of the crests. Only a few of the great rivers flowing northwards take their rise in the main crest of the range, but most of them in the secondary chains in front, and there are therefore no great valleys leading to the main watershed, which accordingly shows no important indentations. In a length of about 125 miles, from the meridian of the Manass rivers westwards to nearly the western end, there is not so much as a single pass admitting passage from north to south of this range.

From Shikho I made my way with the caravan to Sigoshur, the seat of another Torgut chief, who showed me much hospitality, and thence southwards to the great and picturesquely constructed Buddhist monastery of Zagan-ussun, situated immediately at the foot of the high mountains. From this place I made the ascent of a high pinnacle, whence I commanded an instructive view of the structure of the mountains and their glaciation. Unfortunately, I had also to admit the fact that the planned advance southwards through the great transverse valley of Jirgaltoe was

not practicable. A continuous covering of *névé* crest and walls, coupled with an absence of great valley glaciers, again characterizes the glaciation of the north side of the mountains, still so wholly unknown. While searching for a passage further west, the expedition pursued its way to the town of Jinkho with the intention of travelling thence to the valley of Dundoe-Iin, south-south-east of this town. This valley, with the second mountain valley of Dundo-Mutun, was said to give access to a pass—Shari-davan—forming a gap in the main crest, and often used, it was alleged, by the Kalmucks. In this way we hoped at last to reach the Kash valley. Turning in an upward direction, in country interesting for the clearly exposed granite intrusions, we came to the residence of another Torgut prince. Thanks to his friendly assistance, we now reached the range forming the water parting on the side of the Kash valley, not, however, by way of the Shari-davan, which caused me at first some vexation, but further west. This time, however, chance had done us a good turn. The way we took over the Ara-Mutun, Dondo-Khustai, Nilkha, Shargutoe, and Kursai passes, through the valleys of Khar-Mutun, Salikh-toe, Khojurno-Ussun, and Nilkha, and finally, down through that of Borogobossun to the Kash, led through a region which, from a tectonic and morphological point of view, is one of the most interesting in the Tian-Shan, so far as known to me. Instructive phenomena succeed one another in rapid sequence. The phases of past glaciation can likewise be studied as from an open book. Of lower carbonic fossils we were able to gather a rich harvest in excellent preservation. The detailed exploration of the great longitudinal valley of the Kash—140 miles long in a bee-line, and over 200 in actual length—had been planned as the concluding task of the present season. For the history of the formation of the Tian-Shan the valley offers problems of the greatest importance. This is apparent in the heterogeneous form and in the varied character of the landscape of the different sections of the valley. The two great longitudinal valleys, Kungess and Kash, running approximately parallel to each other, once formed a common basin, the formation of which is most closely connected with the deep-seated disturbances to which the Tian-Shan owes its present configuration. The line of elevation which separates the middle and lower courses of both valleys can hardly be dignified by the name of mountains, even when viewed from the Kungess valley, the floor of which lies considerably lower than that of the Kash. For the geological location of the series of quartz-porphyry rocks, so widely distributed and so extensively exposed in the Tian-Shan, indications of great value may be here observed. Among the subjects of investigation were included the relation of the granite, here attaining an unusual development, to the limestones; a study of the younger sediments so well developed in the Kash basin, with their rich coal deposits, and here and there also with their well-preserved

fossils; as well as the present and past glacierization of the heights bounding the valley.

In order to throw light on these questions, it was necessary to ascend the Kash valley to its highest sources. In connection with our present object, we proposed to cross the watershed between the Kash and Kungess several times and at different places, as also to advance into the region of the headwaters of the Kungess and the watershed between it and the Yuldus. Unfortunately, the design could only be carried out in part.

We pushed our way up the river, first on its right and then on its left bank, turning the impassable parts by making use of a series of transverse valleys and the passes connecting them. We then passed over to the right bank, whence we pressed northwards through the Mungati valley to the high watershed. On our further march up the valley, we kept steadily to the right bank, and after long wandering reached the hot springs near the end of the valley.* From a camp which we made there, we visited both the Borochoro valley, one of the largest upper valleys of the Kash, and the uppermost basin of the Kash itself. By ascending several important heights, a commanding view was gained of their glaciated portions. The present development of glaciers in Kash valleys and its lateral valleys fell behind my expectations. There was indeed an extensive display of *névé* both on the crest and walls, and a very large number of *névé*-basins and of glaciers was seen in the upper valleys. Of valley glaciers proper, however, there are but few, and these of no very great extent. Their tongues are almost without exception in a stage of marked retreat. The evidences of diluvial glaciation in this enormous valley system are likewise not nearly so numerous as in the other great valley-basins of the Tian-Shan. Special circumstances, which cannot be entered into here, may possibly have effaced the traces of such action. A tributary river on the left bank, comparable to the headstream itself, particularly attracted my attention in consequence of its great volume of water as compared with the shortness of its course. I conjectured that there must be a considerable extent of glaciation in the area behind its valley, which bears the name Borgora. To clear up the matter, I made an advance into the valley, which I found barred by an impassable zone of vegetation, but from a peak which I climbed for the purpose, I was able to verify the presence of masses of *névé* and glacier falling far short of those of the principal valley.

Hitherto the weather, especially in the fall of the year, had been very favourable to the labours of the expedition. On October 21, however, a sudden and drastic change set in, the winter overtaking us

* Such hot springs are also met with in many places in the transverse valleys, especially in those discharging from the northern chain, and are closely connected with tectonic disturbances.

all at once with great violence. Severe cold and long-continuing snowstorms threatened to cut off our retreat. We had to hasten with all speed to lower altitudes. On approaching the lower middle course of the main valley we were all at once vouchsafed a taste of the terrible fury of the Tian-Shan winter. After a visit to the great Buddhist monastery of Bogdan-Kura, the largest in the whole of the Tian-Shan region, we were surprised by a snowstorm of eighteen hours' duration, which in violence was no whit behind the severest blizzard.

A thick and uniform snowy mantle now overspread the mountains down to the bottom of the valley, imperatively ordering all wanderers, however eager for action, to cease from their labours. Great was my regret at this. Only three weeks more of favourable weather, and the important investigations in the Kash-Kungess basin would be happily completed. At the outlet of the Kash valley, towards the Kulja basin, where the tectonic conditions are unusually complex, we made our final geological observations, which agreed in a satisfactory way with the examination of the same ground at the beginning of the season. With the return to Kulja on November 5 the period of exploration was at an end. Thence Dr. Groeber passed, by way of the Musart pass, into the Kashghar basin, to work there for some months longer, while I was occupied for some time with the arrangement and despatch of the collections.

If, then, it had once more proved impossible to accomplish everything which I had set before me, I may yet, I trust, look back with some satisfaction on these two years of labour and toil. In this last year especially wide regions were traversed, which were in part still very imperfectly known, in part wholly unknown, and a comprehensive knowledge was obtained of the structure of the eastern Tian-Shan.

So soon as the material necessary for the purpose has been housed and sifted, I shall apply myself to the task of drawing up a "Provisional Report" giving a general summary of results. This will, if possible, be provided with a general map, in which some account will be taken of the rich material at my disposal in the form of careful route-surveys, determinations of position as well as of altitude, the last both trigonometrical and barometrical.

The year's harvest is satisfactory also as regards the collections obtained. There is an abundance of material awaiting treatment, especially under the heads of geology and palæontology. The zoological and botanical collections offer much that is interesting, and form a welcome supplement to the material brought home the years before. The result of the photographic labours will be exceedingly rich, and I am in hopes of being able to illustrate my researches by a great number of successful panoramas and tele-panoramas. The results of the meteorological observations, which were regularly carried out, will also supply an important basis for a climatology of the Tian-Shan.

contains much olivine. Masafuera has a rather different aspect from Masatierra. It rises steep out of the sea to a height of about 6000 feet. Towards north and east radiate very deeply cut valleys, veritable cañons. The rock is more coarsely crystallinic than on Masatierra."

3. *Mr. T. Halle's Remarks on the Geology of the Coal-mines between Coronel and Lebu.*

"I spent five weeks working in the coal district in the province Arauco. According to a determination published by Prof. Nathorst, Dr. Dusén collected a glossopteris in Lebu, this genus being the typical fossil of the Gondwana series. As I had studied this formation on the Falklands, I was anxious to visit the locality. I found the same fossil fern, and made some observations of interest, which I, however, cannot deal with yet, from reasons not to be mentioned here.

"The coal-mines of Coronel and Lota have been studied before, and are considered to belong to the Tertiary, or perhaps better the Upper Cretaceous. As one could imagine, that under these layers should appear more ancient strata with Glossopteris, I occupied myself during the first part of my stay with a close survey of the oldest layers reached in the mines, but could only find the same Arauco series. No trace of Glossopteris was seen. Large collections were made of marine and plant fossils, amongst which are ferns, Angiospermæ and Gymnospermæ."

RECENT EARTHQUAKES.

By R. D. OLDHAM.

In the February number of this *Journal* I pointed out the resemblances and analogies between the recent earthquake in Calabria and that of 1783, but in one point the resemblance was incomplete. In 1783 the earthquake was particularly violent and destructive in the interior; in the district round Oppido fissures opened in the ground, numerous changes of level occurred, and 215 lakelets, ponds, and marshes were formed by interruption of the drainage of the country. In the recent earthquake, though we heard much of the destruction of the sea-coast towns, nothing appeared in the daily papers regarding the interior of Aspromonte, and it almost seemed as if this might not have repeated the history of 1783, and might have escaped the ruin which fell on Messina and Reggio. Unfortunately, this was not the case; though the daily newspapers have said nothing, the *Hampshire Chronicle* has published a letter from a correspondent containing some very interesting extracts from the *Resto del Carlino*, which give an account of a medical mission, despatched from Bologna three days after the earthquake. Composed of doctors and medical students, to the number of sixteen in all, it seems to have been