A pass (the Obere Bächlilücke) still remains to be crossed between the Bächlistock and the Gross Diamantstock (3,151 m.), which would connect the head of the Bächli Glacier with the head of the Hühnerthäli Glacier, but there is one place on the Bächli Glacier side where it seemed to me that difficulty would be encountered (see 'Climbers' Guide to the Bernese Oberland,' vol. ii. p. 155). Such a pass would make a very direct although not very easy connection between the Grimsel Hospice and the Gaulihütte. Although, with the exception of the Hühnerstock, the ascents referred to in this paper might not be appreciated by the climber of the modern gymnastic school they are well adapted for men like myself, who seek 'mountaineering for the middle-aged' rather than the 'tours de force' of one's younger days, and the expeditions, while not being too lengthy, contain many pieces of interesting work and a certain amount of novelty as well as difficulty.

The Cordillera de Potosi.*

By HENRY HOEK, D.Ph.

S.E. Bolivia is an extensive mountain-land, correctly speaking a high-level plateau, that sinks gradually towards the E., intersected by several deeply cut valleys, above which rise groups and chains of fairly important mountains.

Most of these peaks are uninteresting to the Alpine sportsman. Their ascent is tedious and boring, and they belong absolutely to the class known amongst climbers as 'cow mountains.'

Still I look back with pleasure on the ascents I made there, for the clear, dry desert air ensures an almost unlimited view, which although not beautiful in the ordinary sense of the word is yet curious and impressive. Its chief characteristics are the extent of the landscape, the soft outlines and grey-blue colouring of the whole picture, and the absolute lack of all mist in the distance—that tender haze which in our own Alpine views so readily stirs the romantic and sentimental chords of human nature. It was from the highest point of one of these E. Bolivian mountain groups, the summit of the Cerro Ligui (5,100 metres), that I, for the first time, set eyes on the 'Cordillera de Potosi.' To the N.W., separated from

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* November 1903.

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my standing-point by a level débris waste, at least 100 kilometres broad, broken only by a few low hills, rose a far-stretching wall of mountains with striking, because individually formed, peaks. I was ignorant as to the name of these mountains—as to whether they even had a name at all: we baptized them later on the 'Cordillera de Potosi.' I did not know if our route would lead past them; I only knew that our goal, 'Potosi,' the Silver Kingdom, lay somewhere to the N.W., and yet I could not help speculating on the possibility of gaining a glimpse from one of those summits into an unknown and, on the majority of maps, unmarked mountain world.

During the night following our ascent of the Cerro Ligui, Steinmann and I reached our third companion, with the baggage caravan, and for two days we continued our way towards Potosi, always in a N.W. direction. We crossed the great plain, the Pampa of Otavi, upon which I had looked down from the Cerro Ligui, and from every hill that we passed the mountains ahead of us appeared more imposing and varied in character.

Even in our familiar European Alps it is interesting, as you gradually near them, to identify the various details by means of maps, panorama, or literature, until you are quite at home amongst their—at first sight—indeterminate mass. In a strange land this is a most fascinating occupation, often monopolising the traveller's whole attention. I cannot relate more of the long ride on the second day than that the road was bad and stony, the distance apparently endless, the sun hot, and water very scarce. From the Cerro Ligui I had been able, despite of distance, to specially note several peaks, which I named on my route sketch map according to their shapes, 'Zuckerhut,' 'Klotzberg,' &c. But, as the first day's journey took us westwards through a low-lying country with no view ahead, it became a difficult problem on the second day to recognise the various peaks and to decide as to 'which was which.' One feature struck us about these mountains that was opposed to anything we had so far seen amongst other mountains of S.E. Bolivia: that was a massive bastion-like heap encircling the whole base of the group as far as we could see, an enormous mass of débris out of which rose naked, steep, and isolated rock-peaks. As we neared the mountains in the evening the day's speculations proved a certainty; before us lay the traces of ancient glaciers. The débris masses were moraines, which had been discharged out of every valley or formed into a half-circle in

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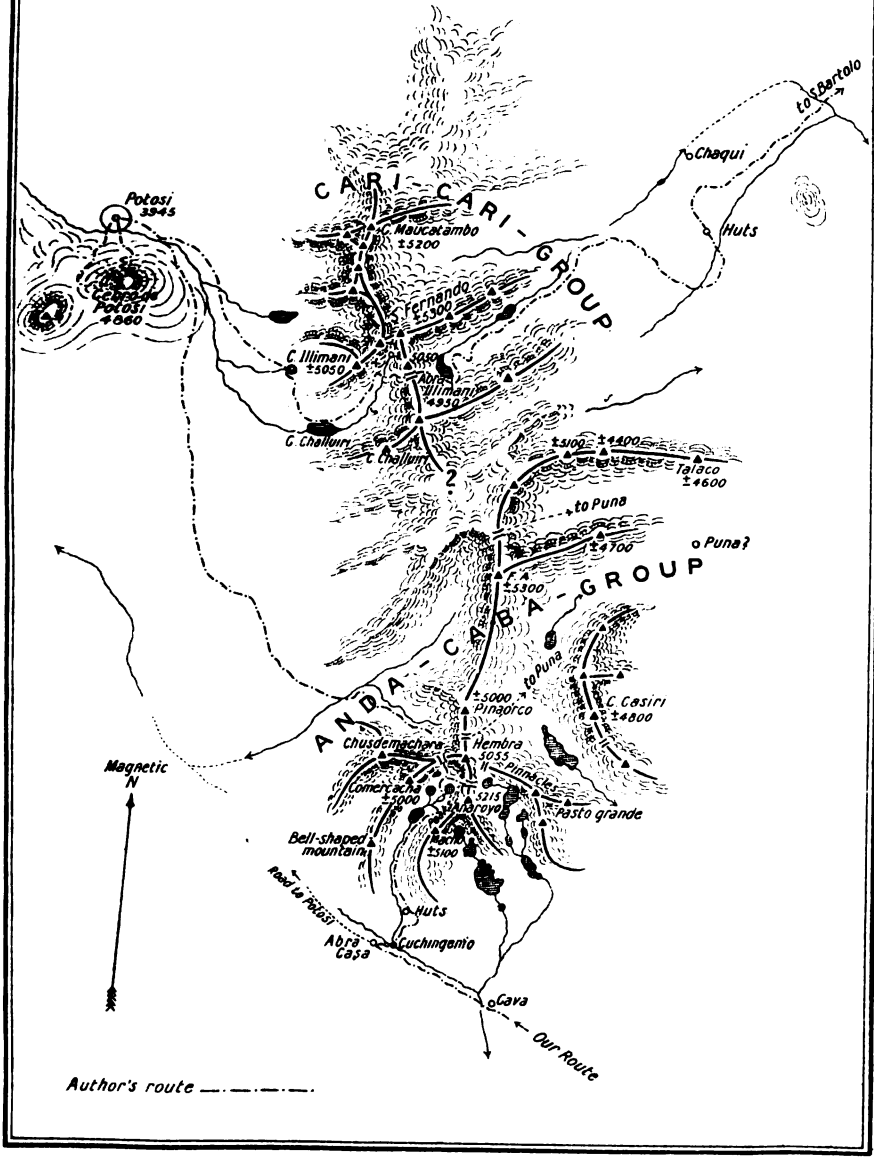
SKETCH MAP OF THE

CORDILLERA DE POTOSI

Reduced from Dr Hoek's Sketch Map on a scale of 1:185·170.



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front of it. This fact decided our plans. Come what might we must force a way into these mountains in order to gain a closer insight into the remains of this S. American ice period. Fortune favoured us. Late in the evening of November 13, 1903, we struck a larger road at the S. end of the group, leading for some 32 miles round the mountains to Potosi. We learned that this road had been made for the purpose of transporting ore from a silver mine to the city, and further, that the mine itself lay only about 14 kilometres distant up in the mountains and was attainable by a good path.

This information was sufficient. We at once put up the tent and passed the night at the cross-roads. Early next morning we sent on the 'tropa' with two of our servants to Potosi, while we three, with only one pack mule, rode up towards the mine, whence we intended to strike straight across the mountains and so reach Potosi later on.

In order to understand our route, I must ask the reader to look at the sketch map of the Cordillera de Potosi. By giving himself this slight trouble he will save me a great one and many words of description, which could never convey so clear an impression as the pictorial one, be the latter ever so imperfect. At the time we started to explore the mountains we had not the advantage of this map; in fact, it is the result of our journey. Since we had splendid weather, both in the S. half of the group, the Andacaba valley, as also later in the N., the Cari-cari valley, I can safely affirm that the relative positions of the peaks and general trend of the valleys through which our route led are correctly marked. The rest is, of course, merely sketchy. The names are given on the authority of a native Indian, and are probably local ones due to the various Indian settlers.

Only the names 'Hembra de Andacaba,' 'Macho de Andacaba,' and, in the N. part, 'Cerro S. Fernando' have been assigned to the striking peaks in the vicinity of the mines Andacaba and Illimani by the Bolivian engineers there employed. In conclusion I will only remark that on Engineer Germann's map E. of Potosi is marked a high group of mountains with everlasting snow and glaciers in the place of our 'Cordillera de Potosi.' Like so much of the Germann map this is pure imagination. On the highest summits of the group small patches of snow do remain, but a regular snow-covering is out of the question.

The group as a whole has a lengthened, elliptical form, the greater length being from N. to S. The central axis bears the highest summits. From it branch out side-ridges with

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secondary elevations. At the S. end the main range divides into two nearly equally important branches. Between these lies a large valley, in the background of which is situated the Andacaba mine.

At the foot of the mountains, near the entrance to this valley, at a height of 700 metres, we passed a cold, uncomfortable night. The wind whistled through the valley, blowing dust and dry refuse into every crevice of our tent, and by morning our sleeping-sacks were covered with a grey powder, and the fine sand-dust grated between the teeth. Washing was, as usual, next to an impossibility.

It is a curious experience, this nomad tent-life on long travels in a wild country. For the first week the free life appears ideal and splendid. It is the idealisation of the joys of living in an Alpine hut, of the pleasures of emancipation from the constraints of civilisation. But hardly has that first week run out ere one begins to discover that cork mattresses and sleeping-sacks for continual use form a hard bed. The lack of water for toilette purposes makes itself disagreeably felt; the mutton roasted on the jack seems daily to become tougher, the preserved butter more rancid; the poetry of the free life daily dwindles in importance as an object worthy of attainment. In a word—one would not object for a change to return once more to the despised luxury of European culture. This phase of mind is, I believe, experienced by every traveller, and it varies in intensity according to the length of the journey that lies before him. The duration of this 'traveller's spleen' is naturally an individual matter. One man may not recover from the attack during the whole journey. Such an one had better never have started. Another may throw it off in a few days, and for him then begin all the pleasures of the untrammelled life that he has chosen of his own free-will. He is absolutely indifferent to all minor privations, is content if he have sufficient food and a dry sleeping-place. He, so to say, no longer knows any other life. With the greatest self-independence, in itself the truest happiness, he gives up yearning for those things he cannot have. Then it is real enjoyment to wander free and unfettered through a far country.

Especially beautiful are the quiet, still nights in the desert. When the stars shine like precious stones in the indescribably clear, dry upper air, when the glowing heat of day gives way to the refreshing cool of night, it is a glorious sensation to lie there in the absolute silence of the broad pampa. But there are also other nights, nights when the storm wind tears at

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the tent pegs and wildly shakes the canvas, when every fresh squall smothers one in dust and sand, and the cold air penetrates into the sleeping-sack. Then is doubly welcome the short-lived dawn that again brings the all-conquering sun with light, warmth, and movement.

Thus we congratulated ourselves when that cold night was ended. As mentioned above, the 'tropa,' with two servants and a letter from us, was sent by the direct road to the care of the German consul in Potosi. We turned off into the valley opening to the S. The path up to the mine had not been over-praised; for Bolivian ideas it was really first-rate. It was possible to remain the whole time in the saddle, without the least discomfort. I shall not here refer to the traces of glacial action that met us throughout the ride in the form of moraine and débris heaps, rather will I try to give a short description of the scenery.

The Andacaba mine itself, i.e. the miners' and overseers' dwellings, consisting of low stone huts, lies at the foot of the silver-bearing mountain, the 'Hembra de Andacaba,' right at the back of the valley, above a small circular, blue-black hued lake, which is embedded in the mountain cirque, and the view extends far down the valley. It is essentially an Alpine view; on every side are sharp rock-peaks and jagged ridges, but even in the finest weather it lacks the friendly, homely character of the European Alps. Dull colours prevail, no sparkling snowfields greet one from the heights, no murmuring brooks leap down the mountain-side, no flowers are visible to the searching eye, not even a blade of grass. It is an extinct world, dead and cold, interesting and curious, but almost repulsive. To the E. the contours of the valley are not bad. Three rock peaks rise here in a finely rounded sweep; the Hembra de Andacaba, the Cerro Anarogo, and the Macho de Andacaba.

We reached the mine towards 9 A.M. It is all but deserted; only two half-breed 'ingenieros' with sixteen workmen live there. These two gentlemen did all that lay in their power for us. The 'office' was cleared out and we spread out our sleeping-sacks on the floor; then we strolled out to have a look round.

A few small snow patches cling here and there to the steep rocky mountain-sides. Great shale heaps reach down to the quiet lake. Not a breath of air is moving; the sky above is cloudless; at the same time it is very cold, 0° C.

As we are at a height of 4,700 metres and the highest summit is not more than 500 metres above us, Steinmann

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and I immediately plan to ascend the Hembra de Andacaba, which must afford a very good view into the whole group. Neither of the two 'ingenieros' can tell us whether this is actually the highest of the surrounding peaks. They only know that it has been ascended by Indians, who even built a cairn on the top. They cannot say if any of the other peaks have been climbed, but think it doubtful.

In spite of the somewhat late hour we did not hesitate to make a start, for, apart from the slight difference in height, the Hembra de Andacaba bears towards the mine much the same relation as the Sulzfluh does to the Tilisunna hut. And a sudden change in the weather, which at such a height might prove dangerous, was in all human reckoning not to be feared at this dry season of the year.

Together with our third companion, Baron von Bistram, we turned first eastwards towards the level pass between Anarogo and Hembra. Bistram was soon obliged to return, being more affected by the high air than we were. After an hour's going over steep, shale-covered slopes we stood on the pass. Our way lay plain before us, a simple easy ridge-climb. In another two hours we had conquered this bit. It offers little attraction, requiring only sure-footedness and a fairly good head. Only at the last came some twenty minutes of genuine, if easy, climbing, which at a height of over 5,000 metres is naturally more exhausting than ordinary straight going.

It was a glorious day when we stood on the summit of Hembra. Not a cloud obscured the sun's rays, and it was so absolutely wind-still that the low temperature in no way affected us, and we were able to carry out our observations without any hindrance. Our first aim was to sketch in on the map the nearest features of the group and to determine the position of the various peaks and many little lakes by means of bearings.

Curious enough are the surroundings of the Hembra. Broad, typical glacial valleys with steep sides lie between the mountains. In their beds lie numbers of small lakes, often queerly formed, silent witnesses to the conditions of the diluvial period. Bare, naked rock peaks rise above these stony, desert valleys. Their shape is often fine, their outlines imposing, yet, in this dismal brown setting, they have nothing in common with the fascinating picture of overwhelming power that impresses one amongst the rock peaks of the Alps.

To the S. and E. of the Andacaba group lies the 'pampa,'

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the high-level plateau. In the hill-like, only slightly steep mountains, that rise like waves out of a petrified sea, the feeble erosive power of a dry climate has cut but slight furrows. All traces of weathering lie on the slopes. The result is a series of broad, V-formed, almost exactly parallel valleys, always with similar angles of escarpment. This system of almost parallel outlines and similar angles is surprising, and at once attracts the attention as a thoroughly typical feature. Far away to the S. and E. are visible groups of high mountains. One such group is the Cordillera de Ligui, another is the Chorolque group. Forgotten islands in an endless ocean, they awaken the explorer's curiosity, but there is nothing homely about them.

We could not have chosen a better point of view than the Hembra de Andacaba, for the mountain lies right in the heart of the S. half of the Cordillera de Potosi. It is unmistakably surpassed in height by three peaks—first by a steep isolated peak to the N., marked on my map as 'F. A.,' secondly by the 'Macho de Andacaba,' and thirdly by the 'Cerro Anarogo,' which is the highest peak in the vicinity of the mine.

As it was only 3 P.M. when we stood again on the pass between Hembra and Anarogo, the ascent of the latter proved too enticing for me to resist. While Steinmann went down to the mine I climbed leisurely up the W. side of the mountain, crossing it completely, and reached a ridge between Anarogo and the S.-lying Macho. This ridge, composed of great sack-shaped granite boulders, afforded fine climbing on good, firm rock. At 5 P.M. I reached the summit of Anarogo (5,150 metres). In the main the view was similar to that from Hembra, only less extensive to the N. and E. I looked down more steeply into the wide glacier valley between 'Pasto Grande' and Anarogo, as also into the fine 'cirque' between Anarogo and Macho, which was also ornamented by an almost circular lakelet.

After I had exhausted the actual scientific interest of the view (to use a rather inadequate expression) I was overcome by a feeling of absolute loneliness, such as I have never before experienced on any peak, not even in mid-winter, when all Nature is frozen into silence. Day was fast closing in. Everything in the clear distance became gradually merged into an undecided bluish-brown, an extraordinary mauve colour. In this lonely hour, when the very silence seemed audible, I lay there and listened to the far-away murmuring of the hurrying waters of the great European life-stream

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echoing in my mind. Many an image of home rose up from the sea of the past; but viewed from an altered stand-point the prospect also alters. I have come to think differently of many things out here, and to think consciously. In the silence, in the far-off solitude, it often seems as if a quiet observer were concealed deep in your innermost being, noting your every thought, and you are conscious of this; and this observer forces his being into the most secret corners of your heart, and so on in an endless succession. Strange melancholy impressions are awakened by the bare dead landscape in whose centre you are absolutely alone with your thoughts.

I reached the mine after dark, to find supper awaiting me—soup with 'aji,' mutton with 'aji,' potatoes with 'aji.' With tea and brandy one manages to wash down the biting stuff. Very soon each sought his couch. That for Bistram was the reverse of a 'thing of joy,' since the recumbent position brought on a well-nigh insupportable attack of mountain sickness.

Before sunrise our servant brought us the hot mathe. The bad maize bread, if flat lumps of half-raw maize flour merit the title, was speedily disposed of, and we saddled up our half-frozen mules. A slight hoar frost covered the hard-frozen ground. We rode down to the little lake, in which was mirrored the Macho de Andacaba, then ascended to the saddle between the Hembra de Andacaba and Cerro Anarogo. A bad track leads over the pass; it brought us into a wide, level valley, sinking gradually to the W., with the striking form of the mountain 'F. A.' in the background to the N.E. Through moraine débris and boulders and scanty bushes of spiky pampas grass we pushed on westwards, as it seemed unendingly, until at last, shortly before midday, the west foot of the mountains was reached. Here too they rose out of vast glacial débris masses. In our valley lay large amphitheatre-shaped terminal moraines; we could count as many as nine concentric walls.

Almost due N., climbing over one moraine mound after the other, our path led to Potosi. The landmark was a broad, flat depression between the outliers of the mountains to the right and the cone-shaped, isolated Cerro de Potosi to the left.

The city of Potosi itself was first visible after we had crossed the pass. Half an hour later we were picking our way through the ruins of the outer city to the centre, the Plaza, forcing our mules up the steep alleys over break-neck cobbles, and obliged, to our annoyance, to make constant halts,

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owing to the flocks of llamas that lay about on all sides. The llamas are one of the characteristic features of the famous old silver city; the second is its mountain, the Cerro. As a third it might well add a drunken Indian to its coat of arms. All three can be seen in every street, the Indian on the ground, the llama with inquisitive uplifted head, the Cerro's regular shape rising high above in the air.

The Cerro de Potosi is in many ways an interesting mountain, celebrated for the enormous masses of silver it contained, with which the old Spanish silver fleets were laden; to-day one can count some four thousand mining shafts in its bare sides. With its fabulous riches, 'una riqueza fabulosa,' it dominated the thoughts of the inhabitants in the former mighty city, which at its zenith had a population of two hundred thousand. To-day the silver is almost exhausted, the prosperity of the city a thing of the past; but still do the thoughts of the natives turn to the mountain and its treasure, and it is hardly a wonder that, almost without exception, nearly every map marks the orographically unimportant 'Cerro' and omits all mention of the mighty 'Cordillera,' at whose foot the city lies.

And yet it is as though one were to cite the Faulhorn near Grindelwald as a mountain and omit the snow-peaks to the E.

This is not the place to describe our stay in the for a third part ruined town, our reception by our hospitable compatriots, the good hotel, or the landlord's skill in the art of brewing cocktail. *En passant*, on our way to pay necessary ceremonial visits we saw the principal monuments of the city's Spanish period, the church, the mint, and the Plaza, with its arched ornamentation. Hardly was our business finished than the all-dominating Cerro began to work its spell on us: we felt bound to ascend the peak that shone with every metallic hue, the famed Cerro de Potosi. And this is no question of skill. One must beware of the innumerable shafts and holes and steep débris slopes, where the mule can find no footing. For almost to the very summit can the 'climber' remain in the saddle. Only during the final half-hour, above the last, highest shaft, is it necessary for him to exert his own limbs, a necessity that told hardly on me, for I suffered more from mountain sickness on this ascent at a height only of 4,865 metres than I did either before or afterwards at 5,000 and even 6,000 metres. The ascent can easily be made in 4 hrs., and well repays the trouble. For, owing to the isolated position of the mountain on the W. side of the Cordillera de Potosi, it affords the climber a splendid view

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over that group, as well as an insight into the confused topography of the sandstone district W. of Potosi. More than an idea of the numerous features there visible he cannot obtain in a single visit, so great is the distance and the variety. All the clearer is the view of the Cordillera de Potosi; the orographical division between the S. group, Andacaba, and the N. group, Cari-cari, is distinctly marked. The latter name is very appropriate. Literally translated it means 'Man-man'; that is as much as 'die Manneln,' a name so often to be found in the Alps; and as a fact the rocky peaks of the N. group, viewed from here, somewhat resemble a row of sentinel-like rock-giants rising sheer above the moraines and débris, which send their last boulders right down into the eastern streets of Potosi.

We undertook yet another, longer expedition to the W., to the rose-embowered 'baths' of Miraflores. One can easily understand the affection that the few European residents in Potosi feel towards this place if one compares the friendly green of its valley to the stony wastes of the city. A picturesque sandstone ravine leads westwards into a second valley. Light red sandstone mountains throw up the green still further in relief, and the white pillar-like terraces of the hot springs, where are visible the ruins of an 'Inka' bath, give the place a peculiarity of its own.

All too soon were we obliged to return to the thin higher air of Potosi, for our journey was to carry us further to Sucre, the constitutional capital of Bolivia. The first day's march is generally as far as S. Bartolo, N.W. of the Cordillera de Potosi, and a good bridle-path encircles the N. end of the group. Along this path we despatched our entire baggage, tents, &c., to Bartolo, with orders to await our arrival.

Our wishes were centred on gaining a closer insight into the N. half of the mountains and on traversing the Cari-cari group. Unfortunately not a soul in Potosi had ever travelled this way, but we were assured that the distance could not exceed 7 'leguas' (about 38 kilometres), and we confidently started, somewhat late, at about 8 A.M., thinking we had an easy day before us, all the more confident because we knew a small mine, Illimani, lay in the centre of the Cari-cari group, where we intended to make our midday halt.

The first half of the day came quite up to the programme. First came débris and moraine. Behind this part, at the outlet of a valley of the glacial sea, we entered the mountains, and 4 hrs. saw us at the Illimani mine. It was drizzling a little, but not enough to hinder observation. The Cari-cari

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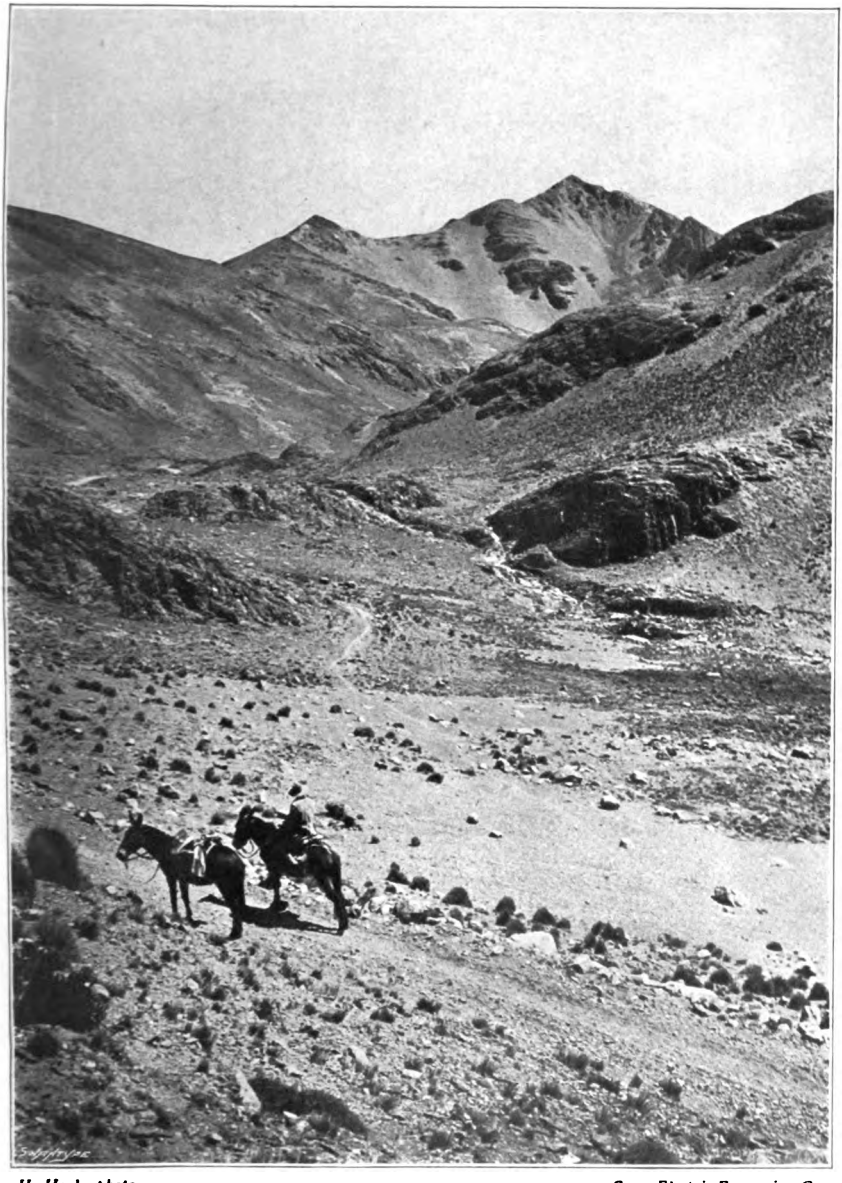

H Hock, photo. *Swan Electric Engraving Co.,*

IN THE CARI-CARI GROUP.

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group shows all the characteristics of the Andacaba mountains. Only here the rock peaks stand closer together. Especially fine is the Cerro S. Fernando, a regular cone-shaped rock-mass, seemingly the highest point of the group. From it branch off several ridges, over one of which, the connecting link to the S.E. with the Andacaba group, we must pass to gain the E. side of the mountains.

We could plainly see the depression in the ridge over which we must go, but doubts assailed us as to the possibility of getting the mules up to this point. However we were told at the mine that the route had sometimes been followed by mounted men. So I left my companions without misgivings to their meal, and began the ascent of a round-shaped elevation immediately N. of the pass. I reached the summit in 2 hrs. over easy terraced rocks, and stood at a height of 5,050 metres. Luck was with me; the weather improved and permitted me to make a fairly complete sketch of the Cari-cari group. Towards 2 o'clock our party reunited on the top of the 'Abra Illimani.' Two of the mules showed symptoms of severe mountain sickness, and were only dragged up with great difficulty, increased by the fact that Herr von Bistram was also unwell. We at once began the descent on the eastern side. Our way led through a long, ancient glacier valley, as typical in formation as any I have seen in Norway. Small hollowed-out lakes with characteristic sills, steep twists in the valley, broad round holes (mills), scratched and polished rocks—every proof of undeniable ice-work was visible to prevent any doubts in our minds as to the geological history of the district in the remote past.

Immediately below the first larger lake a second valley debouched from the N.W. into ours, in the background of which rose the magnificent rock-mass, the Cerro Maucatambo. The left side of the valley shows sharp peaks, with towers and pinnacles; the right side a tamer class of mountain; within the half-circle deep kar-holes are dug out.

At first all this was very interesting; but hour after hour took us down through similar scenery: no vegetation worthy of mention enlivened the picture, and, except for a pair of shy wild geese, not a living thing was to be seen. And the rocky track was of such a degree of badness that riding was impossible; by degrees everything worked together to thoroughly tire us, and we longed for the end of the valley, the Pampa de S. Bartolo, for the day was rapidly drawing to a close. We had long left more than 7 'leguas' behind us, and we hoped to see S. Bartolo somewhere near the end of the valley.

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We toiled up the right side-moraine. Soon reaching its top, we could overlook all the ground far to the S. and N. of the mountain-foot. A vast softly inclined plain with thousand upon thousand of great boulders sank away to the E., where it was merged in a level of alternate yellow sand and salt-white patches. Before the various valleys large moraines extended out relatively some distance. Such a moraine lay in front of our valley. The two side-moraines closed up together to form an almost novel dam, enclosing a small round lake hidden carefully away behind the walls. Further S., at the junction between débris and plain, lay a small regular cone-shaped mountain, that threw a comical shadow on to the plain in the last rays of sunshine.

A jagged mountain chain, rising dark and threatening against the red evening glow in the E., completed the rather bizarre picture in the background.

Had we dreamed that only at the foot of those distant peaks lay S. Bartolo we should most certainly have decided on a bivouac. As it was we were heartily thankful to find an Indian's hut. With difficulty we made the owner understand where we wanted to go, and then for hours and hours we dragged along our weary mules by the bridles over dreary stone wastes, through the beds of dried-up torrents, and over many a hill.

But here begins another chapter. The one concerning the Cordillera de Potosi was for the time being at an end. Other scenes and other neighbourhoods occupied our interests. I first remembered these mountains when drawing out the map at home, and keenly regretted not having devoted a short week to the study of that unknown, peaceful, self-contained world. That would have enabled me to give a geographical review instead of this cursory sketch.

Altitude Measurements by Mountaineers: Practical Experiences with the Watkin Aneroid.

By WILLIAM HUNTER WORKMAN, M.A., M.D., F.R.G.S.

AMONG the various mountain chains of the world the Himalayan, now comparatively little known, is likely to come more and more into favour with mountaineers, not only because it offers a more elevated and hence more attractive field for climbing endeavour than can elsewhere be found, but also because interesting problems connected with great altitudes can thus alone be solved.

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