
The Desert of Atacama (Bolivia)

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Source: *The Journal of the Royal Geographical Society of London*, Vol. 47 (1877), pp. 250-253

Published by: Wiley on behalf of The Royal Geographical Society (with the Institute of British Geographers)

Stable URL: <http://www.jstor.org/stable/1798746>

Accessed: 24-06-2016 18:02 UTC

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Kraals now become very scattered and thinly populated; mealie gardens are very scarce, but cattle abound, and find good pasturage in the valleys and on sides of the mountains. The present proposed terminus is about 8 miles from Lotiti (Ditin), the late king's kraal, and about the same distance, "as the crow flies," in the south-west from Inkegaan, the kraal of the present Amaswasi king, Umbandeen, but to reach either a detour of some 20 miles must be made.

"To the proposed terminus a good road from the watershed between the Little Usutu and Umkomatie rivers, above the source of the Umbelosi, can be constructed at an inconsiderable cost, and when once the watershed is attained from the railway a good natural road exists to the interior.

"The further extension of the railway, which must sooner or later be made to render it available for opening up the coal-fields in the neighbourhood of Klipstapel, can be readily carried out at an expense not greater than the mountain portion of the present railway, and that for a length of about 10 miles, when the watershed would be reached, and the railway cheaply and rapidly extended to any part of the Transvaal."

XI.—*The Desert of Atacama (Bolivia)*. By
JOSIAH HARDING, A.L.C.T.

THE part of the desert of Atacama in which I was engaged was principally the southern part of the coast province of Bolivia, between the range of mountains containing the silver-mines of Caracoles and the coast.

I was chiefly occupied as engineer in the construction of a railway from the port of Antofagasta to Las Salinas, for the "Antofagasta Saltpetre and Railway Company." The object of the railway was to convey "caliche" (nitrate of soda in its crude state) from the deposits in Las Salinas to the coast for the purpose of purifying it for shipment. I occasionally took journeys into unexplored parts of the desert in search of new deposits of saltpetre, when I invariably took my instruments with me for the purpose of connecting, by trigonometrical and astronomical observations, the position of any important point with my railway and other surveys. I was thus enabled to construct a complete map of the greater part of the country from the coast for 100 miles inland.

General Description.—In this part of the desert there are two distinct and principal ranges of hills lying between the coast and the Andes. The first, called the coast range, rises almost



directly from the sea (in many places so abruptly as not to allow of a passage along the shore, but generally from a quarter to half a mile distant), to a height of 1820 feet as a minimum and about 6000 feet as a maximum. The former was the point selected for the passage of the Antofagasta railway.

After passing the coast range, the country rises with a tolerably uniform gradient, along the main valleys, to the range of Caracoles.

Between Caracoles and the coast there are many isolated groups of hills, the most important being Cerro Negro, which rises to a height of about 11,000 feet above the sea.

The Caracoles range rises first in a series of terraces, one behind the other, to a height of 8900 feet (where the town of Placilla is situated), and then more abruptly in peaks and ridges to a height of 10,000 feet.

Behind Caracoles are a few isolated groups of hills and small ranges, and then the great dry lake of Atacama at the foot of the Andes. This part of the country is very little known, and by me entirely unexplored.

Among the hills lying between the Caracoles and coast ranges there are many dry watercourses and lakes, which appear to have been formed by violent and sudden showers, and not by continuous rivers.

All the valleys have, at some remote period, had an exit to the sea, but many have become blocked up in the following manner. The mountains being nearly all bare rocks, the rapid variations of temperature cause them to splinter and crack, and fall away into heaps of angular stones. Violent storms of rain then sweep the gravel down into the valley, but have not sufficient force to carry it away to the sea, and, the valley being choked, the water from inland has no outlet, and so forms a lake. The immense amount of débris filling up the valleys in this way may be imagined by considering the state of things at the Salar del Carmen, where is situated a small establishment for the purifying of saltpetre. A well in the dry lake is 290 feet deep, and the bottom is still in alluvial deposit, whilst the outlet by which the railway passes, and under which is evidently the old bed of the valley, is 120 feet higher than the bed of the lake, or 410 feet higher than the bottom of the well.

The Geological Formation is almost entirely igneous: the greater part of the rocks being granite, and porphyry and granite, with, in the coast range, some metamorphic rocks. In Caracoles, where the silver-mines are, the formation is jurassic, with porphyry; the principal veins of ore having porphyry on one side, and limestone on the other. The existence of a large

number of ammonites gave the name to the range—caracol meaning a spiral. I know of no other stratified rocks in this part of the desert.

Climate.—On the coast the temperature is very equable, varying in Antofagasta from a maximum in summer of 82° Fahr. in the shade, to a minimum of 52° in the winter. There are also usually two or three slight showers of rain fall during the winter, but seldom enough to wet the surface of the ground. The wind is almost invariably a gentle sea-breeze by day and a land-breeze at night.

Passing the coast-range, the climate changes wonderfully. In the Salar del Carmen, although only $6\frac{1}{2}$ miles in a straight line from the sea, and 1700 feet high, the cold in winter is very severe, and the wind blows almost a gale every day. The heat in summer is not very great here, but it increases rapidly as you go inland. In Las Salinas, where are the principal deposits of nitrate of soda, the temperature is very variable, especially between night and day. This is, I suppose, in a great measure owing to the very dry atmosphere and to the ground being covered with salts, which cause a very rapid radiation of the heat at night.

I had commenced a more detailed registry of the temperatures in Las Salinas, when my thermometers were destroyed by a whirlwind; but I have registered a minimum shade temperature, at 7 A.M. in the winter, of 7° Fahr., and at 11 o'clock the same day 98° in the shade, being a rise of 91° in 4 hours. In summer the shade-temperature ranges between about 40° at night and 130° in the day. I have frequently noted the temperature of the ground at 1 P.M. at 145° Fahr. The air is so dry that a piece of thick note-paper if folded and pressed with a paper-knife will break in two when opened out.

Dry as the climate now is, and has evidently been for geological periods, there is abundant evidence on the face of the country to show that violent rain-storms have taken place there, which, having nothing to absorb them, have rushed off in terrific torrents down the steep slopes of the mountains, rolling boulders of many tons' weight in their course. It is impossible to say how often these storms have occurred, but probably the intervals have been hundreds of years, and then they have been very local. One such storm happened near Pan de Azucar, in Chile, about 30 years ago, when the torrent was so great as to sweep away some heaps of copper ore, a blacksmith's forge, some carts, and one woman. Although the storm only lasted a few hours, and the place was some seven miles from the sea, there was never a trace of these things found.

The hills in this district contain a few copper-mines, but they

are not of much importance. The only export worth mentioning, besides the silver of Caracoles, is the nitrate of soda, which exists in several places, the principal being Las Salinas, where the "caliche" is of excellent quality, ranging from 30 per cent. to 80 per cent of nitrate, and is in some places 12 feet in thickness.

It is found in a bed extending over the ground and following all its undulations, generally covered with a crust containing a large proportion of sulphate of zinc and common salt, which varies in thickness from 1 to 6 feet. Guano, birds' feathers in excellent preservation, and even some skeletons of birds are found in the caliche, sometimes at a depth of 10 or 12 feet from the surface of the ground. These things, and many others too numerous to mention, lead me to support the theory advanced by the best chemists on the coast, that the nitrate of soda has been formed from a mixture of guano with seaweed when this part of the country was at the sea-level. As the deposits of Las Salinas are 4000 to 5000 feet above the sea, this must have been many thousands of years ago.

There is no *fresh* water south of the river Loa, so that all the water required both for men and animals has to be distilled from the sea or from water obtained in wells. Even that used in the locomotive engines of the Railway Company is distilled from the sea in Antofagasta, and carried all the way (80 miles) to Las Salinas for the double journey.

This part of the desert, excepting the town of Cobija, has been populated within the last nine years.

The figures on the map give the heights in feet above sea-level. Dry lake-beds are coloured brown.

XII.—*The Kingani River, East Africa.* By FREDERICK HOLMWOOD, Assistant-Political Agent, Zanzibar.*

THE Rufu, or Kingani, had long been classed among those hopeful-looking East African rivers which it was trusted might become highways to the interior, but like the Rovuma, the Wami, and others of these streams that have been explored, it has been found—though not absolutely unnavigable—not to

* Mr. Holmwood's observations on the Kingani, from another Report written by him, appeared in the 'Proceedings of the Royal Geographical Society,' vol. xxi., p. 499, in a paper read by Mr. Edward Hutchinson.