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Observations on the Geography of Southern Peru, Including Survey of the Province of Tarapaca, and Route to Chile by the Coast of the Desert of Atacama

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5 leagues. At this point there is a ridge of high mountains, which would require a tunnel of  $\frac{1}{3}$  of a league, and a very deep excavation of more than  $\frac{2}{3}$  of a league, and for the remainder a small excavation. Thus, while it appears that there is hardly any difference in the extent of both canals, the plan here proposed by me possesses two advantages, viz.:—1st. *That one league is already navigable naturally*; 2nd. *That no tunnel will be necessary*.

*Last Observation.*

It should be borne in mind that all the levels in a perpendicular, as well as a horizontal direction (with the exception of the level of the sloping ground), have been taken approximately, so that on this account no very exact calculation can be made of the expense that would be incurred in making a canal. I think, however, that this survey is sufficient to prove that a canal can be made here with more ease and with less expense than in any other place as yet explored. The object of this statement can be no other than to encourage the supreme Government to have the ground examined by parties who may possess sufficient knowledge for making a minute investigation and an exact calculation, and thus give an impulse towards realizing an idea which, more than any other, is calculated to promote the welfare and grandeur of this country. The great value which the realization of it would have for the commerce of the whole world is so clear, that the carrying into effect such an undertaking has been for many years a great desideratum of all nations. These are the slight observations which I have been enabled to make in the short time during which I remained in the department of Guanacaste. The narrative which I give of them is perhaps not so exact as it should be, owing to the difficulty I feel in expressing my ideas in a foreign tongue. Nevertheless, if the President should consider them worthy of his attention and of some utility to the country, it will be a reward sufficient for me and I shall be satisfied; requesting only that the defects which my account contains may be excused.

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X.—*Observations on the Geography of Southern Peru, including Survey of the Province of Tarapaca, and Route to Chile by the coast of the Desert of Atacama.* By W. BOLLAERT, F.R.G.S

[Read April 28, 1851.]

A RESIDENCE of some years in Lower Peru, in the province of Tarapaca, department of Arequipa, commencing in 1826, during which I was engaged in mining operations at the celebrated silver-

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mines of Guantajaya, afforded me the opportunity of studying the physical geography, &c, of this but little frequented portion of Southern Peru.

In the month of December (the summer of that region) I left Valparaiso with the usual S.S.E. wind, which, during the night veering towards the land, forms the "terral," or cool breeze from the Andes; thus depressing the temperature of the air, dew is formed, and, as but little of it falls on the land, will account in some measure for the arid and desert character of the coast of Peru.

In winter, viz. from May to July, the winds are from the N., the air is charged with much vapour (*garua*), covering the summits of the mountains of the coast, where an occasional cactus and a few bulbous plants appear. This period of the year is known as the *Tiempo de Flores*, when also a few guanacoës may be seen roaming about these elevated flower-spots of the desert.

As Arica is approached barren undulating land is seen, and in its rear ranges of rocky sterile mountains, and farther eastward in the background the peaks of the Andes towering majestically above all.

*Arica*.—All around is a desert, save where a streamlet may run, giving rise to a vegetation, which is artificially increased by irrigation and manuring the land with guano.

The rock of the country is principally porphyritic, reposing on slate; the surface in the hollows and plains is covered with alluvial and saliferous matters.

*Tacna* is 30 miles inland by a desert route. It is supplied with water by a fair stream originating in the Andes, and is a thriving place. I returned to Arica by another track: the country travelled over was one scene of hopeless aridity, masses of rock covered with sand and salt.

As it seldom or ever rains in these latitudes, and there being no vegetation, the surface of the country has remained, and may still do so for ages, in the same state, unless disturbed by earthquakes or other volcanic agency.

*Islay*.—This port is about 100 miles N.W. from Arica, and, although in a desert, has since 1827 superseded Quilca, being free from "terciana" or ague, probably in consequence of there being no water in the vicinity but that which is conveyed to it by means of an aqueduct (*cañaria*). It is a mere landing-place amongst the rocks, although now the principal port of Arequipa.

The road from Islay to Arequipa passes up a ravine which cuts through the mountains of the coast before the great Pampa above is attained—an elevated desert plain, 3000 feet above the sea, its surface covered with sand and volcanic dust, and extend-

ing some 50 miles across ; bounded on the W. by the mountains of the coast, and to the E. by the Andes, with the volcano of Arequipa as a landmark, generally emitting smoke.

In these desert plains may be seen the "Medanos," or moving semicircular sand-hills, the concavity generally towards the N., on account of the winds being from the S. In case of a heavy gale these "Medanos" shift and are blown about, and travellers have been overwhelmed and lost in them. They are of all sizes, from that of an anthill to hundreds of feet.

Having passed the Pampa, another distance of 30 miles of barren hills is to be gone over, composed of volcanic rocks, sandstone, and here and there a little dark granite and their débris, when the vineyards of *Tiabaya* appear, and a few miles farther is

*The city of Arequipa*, at the base of the volcano of the same name, which fire-emitting mountain was anciently called Mistie.

Arequipa is a picturesque, Spanish-looking city ; it has a considerable population and much transit trade with the interior of Peru. The first Spaniards visited the country as early as 1533, and the city was founded by Francisco Pizarro in 1539.

According to Haenke, who reached the summit of the volcano in 1794, the circumference of the principal crater was then about 1380 English feet ; a second crater was 440 feet in its largest part, and 120 feet in its least. The circumference of the volcano at its base he calculated to be 45 miles, and its elevation above the sea 17,454 feet.

Mr. Pentland, to whom we owe so much of our knowledge of the mountainous parts of Peru and Bolivia, makes the elevation of the volcano 18,300 feet, and the city of Arequipa 7788 feet above the sea.

Nearly the whole of the year the summit of the volcano is covered with snow. All around is composed of lava and ashes, which have been ejected from its crater.

Arequipa has often been visited by severe earthquakes ; those of 1582, 1604, 1660, 1667, 1715, 1725, 1784, may be particularised from their ruinous effects. The fearful earthquakes (terremotos) that shook nearly the whole of Peru took place in 1687 and 1746.

In 1667 there was a violent eruption of the volcano of Arequipa, after which its summit was first visited by Europeans, who found a large crater formed by ancient eruptions, and in the centre of it a cone, from the apex of which issued smoke.

In February 1600 there was a great eruption of the volcano of Omate (probably the Uvinas of Pentland), situated to the S.E. of Arequipa, accompanied by severe earthquakes, which destroyed several villages with their inhabitants, and is worth

noticing from the fact of ashes having been carried more than 100 miles distant from the volcano.

The mountains of the coast from Arica to Islay, as well as those to the N., have not the elevation of those to the S. of Arica, neither are they so well defined. They are composed of hard sandstones and porphyries, and sufficiently elevated to receive moisture from the thick mist (*garua*) in the winter months, which gives life to a few cacti, a little pasture, and some flowers on the *lomas* or summits.

*Province of Tarapaca.*—The first account we have of Southern Peru is in 1450, when the Inca Tupanki established for a time his court in Atacama, intrusting the command of an expedition to Sinchi Roca against the Copiapinos: this chief went as far as the fruitful plains of Maipu.

Almagro, when he parted from Pizarro to undertake the conquest of Chile, took the mountain route from Cuzco over the Andes, in which the sufferings of the expedition from cold, hunger, and fatigue were very great. He appears to have descended to San Pedro de Atacama, and thence to Copiapo and Coquimbo: whilst at the latter place (1537) it was that Rada, one of his officers, brought him from Peru information which decided him to return thither; but having experienced so many privations by the mountain track, he took that by the eastern margin of the Desert of Atacama. On this march the desert tracks of Atacama and Southern Peru were first discovered by the Spaniards, and some of his followers determined to remain behind in the less arid localities of Pica, Tarapaca, Camiña, &c., which contained Indian populations under their respective Caciques, Sanga, Opo, Ayvire, Taucari, and Chuquichamba.

Tarapaca was the most distant and extensive province of the empire of Peru, and so uninhabited and without the means of cultivation that it was almost disregarded by the discoverers, who, when they were questioned concerning it, replied by saying “that its tracks were over rocky mountains, sandy, uninhabited, and rainless deserts, covered with salt and without water, excessive heat during the day, and cold at night.”

The physical features of this province, which will apply generally to all the southern part of Peru, may be described as follows:—

I. The arid mountains of the coast, which are of a porphyritic formation, running N. and S., rising oftentimes abruptly from the sea, from 3000 to 6000 feet above it, and some 30 miles in width, having large hollows and undulations in them; destitute of vegetation, and the greater portion of their surface covered with sand, salt, and other saline substances. When the sand and salt are found mixed it is called *caliche*, and may be regarded as a



superficial covering. The origin of the salt is not clearly made out; it has been called a saliferous alluvium, by some supposed to have been washed out of the mountains, by others to have been left there by the ocean.

In this range the silver-mines of Guantajaya and Santa Rosa are situated.

II. The Pampa, or Great Plain of Tamarugal, is from 3000 to 3500 feet above the sea, running N. into the province of Arica, and S. into the desert of Atacama, about 30 miles wide; much of it is covered with sand, salt, nitrate of soda, and other saline bodies. Water, derived from the mountains to the E., is found at various depths. A few tamarugos or acacia-trees are met with in the Pampa.

III. Thence rises a desert range of mountains, chiefly of sandstone, some 7000 feet above the sea, and 20 miles in width.

IV. An elevated district follows, much broken, and here for the first time are seen coarse pastures, brushwood, and large cacti. The pastures improve as they get higher up, until by the severity of the climate they diminish, and finally disappear at an elevation of from 10,300 to 16,000 feet.

V. We are now at the base of the Andes, or Cordillera Real, sometimes called the Western Cordillera of the Andes, in which are very high mountain ridges, including the Lirima, or Chuncura,  $19^{\circ} 47' S.$ ,  $69^{\circ} 12' W.$ , supposed by my friend Mr. G. Smith, from a visit to its vicinity in 1850, to be 24,000 to 25,000 feet above the sea. Ille in Imará means snow: hence Illi-rima, and in Spanish the name Lirima. Crossing the high passes, and descending a little,—

VI. Is an elevated undulating region, known as the Puna, Paramo, or Sierra; this occupies a great extent of country N., S., and E., and is sometimes denominated the mountain knot of Potosi; in it appear high ranges of mountains, including the “snow-capped heights of Lipes,” and farther to the N. and E. Illmani and Sorata.

There are considerable depressions in this elevated region, where there are lakes containing fish, pasture is found, and a small quantity of quinoa (millet) is raised.

This great mountain knot, or rather the Peruvian Andes, may be looked upon as one of volcanic elevation, and contains several active as well as quiescent volcanos.

In the province of Tarapaca the two Cordilleras are not so defined as farther to the N., where they may truly be called the Peruvian and Bolivian ranges.

We know, however, but little of the geography of this great mountain knot in the district under consideration, doubtless the

seat of much volcanic action; indeed the Indians believe that the greater number of the mountain peaks have been formed by volcanos.

A survey of the province was made by Mr. Geo. Smith and myself in 1828, at the request of the Peruvian Government; the results of which have been introduced by Arrowsmith into his later maps drawn for the works of Captain FitzRoy and Sir Woodbine Parish.

The province of Tarapaca lies between  $19^{\circ}$  and  $21^{\circ} 30'$  S. and  $68^{\circ} 15'$  and  $70^{\circ} 22'$  W. It is bounded on the N. by Arica, on the E. by Bolivia, on the S. by the desert of Atacama, and on the W. by the Pacific Ocean. In 1628 it formed part of the province of Arica.

It is divided into four curatos or curacies, viz. Tarapaca, Pica, Sibaya, and Camiña, with a mixed population of about 11,000 souls, consisting of the descendants of Spaniards, Spaniards and Indians, and a few negroes, the greater proportion being Indians whose language is the Aymará.

Those Indians who hold land pay an annual tribute or tax equal to about 1*l.* sterling; other Indians without land, 16*s.*; the white population 12*s.*—the latter also pay a property-tax; the whole annual income of the province is under 3000*l.*

*Curato of Tarapaca.*—The town of Tarapaca ( $19^{\circ} 56'$  S.,  $69^{\circ} 35'$  W.) is the seat of government of the province, the chief of which is a sub-prefect. The ravine, at the mouth of which it is situated, rises in the Cordillera of Lirima. In general there is barely sufficient water to irrigate the land (which is carefully manured with guano), capable of cultivation in this quebrada, as well as in many others; but when thunderstorms with their heavy rains occur in the Andes, great torrents or avenidas rush down the ravines, bringing with them masses of rock, trees, huts, cattle, indeed all that may be in their way—leaving, after one of these sudden and destructive floods, nothing but a bed of stones. The houses are built of adobe or sun-dried brick, and seldom of more than a ground-floor, as a precaution against the frequently occurring earthquakes. The produce of the land is maize, wheat, alfalfa, lucern (*medicago sativa*), fruit, and a few vegetables. Up the ravine are the Indian settlements of Pachica, Laonsana, and Puchurca; in the vicinity of the latter there are some old gold, silver, and lead mines, formerly worked by the Spaniards.

On the road from Tarapaca to Guantajaya, and 6 miles W. of the Pozo de Ramirez, is the Cerrito de Huara, a “bramador,” or rumbling mountain, which is an object of curiosity to the traveller, but to the Indian one rather of fear. The sounds are generally heard about sunrise. This hill is situated in a desert plain; during the day the country around is exposed to great heat;

at night there is a considerable diminution of temperature, in consequence of the hot S. wind having gone to the eastward, where it gets cooled by the Andes, forming during the night the land-breeze; as the sun rises, the air becomes heated, expansion takes place, rapid currents and even gusts of wind are formed, which, striking upon the sides of the mountains, and setting the sand in motion, cause probably the roaring or rumbling sounds in question.

*Mamiña*,  $20^{\circ} 4' 48''$  S., is a large Indian town E. of Tarapaca. The potato is here met with in great perfection, and this locality is supplied with water from clear boiling sulphur-springs. Hereabout is much gypsum, alum, and carbonate of soda. *Hamitca* is in the vicinity, where there is a gold-vein, and in the *Cerro Colorado* are indications of gold, silver, and copper.

To the E. of *Mamiña* is the high range of *Yabricoya*, abounding in metals, principally silver, at the points known as *Picuntisa* and *Paihuanta*; the climate of these elevated mining districts is very severe, there being much rain, snow, and cold.

In the vicinity of *Quipisca*, W. of *Mamiña*, are many desert sandy ravines, and those unaccustomed to travel in such countries would be alarmed at the overhanging precipices, large masses from which have been thrown down by earthquakes. The road from *Mamiña* to *Pica* passes through several deep dells without water. *Pozo de Ramirez* is a well 60 feet deep, sunk in the pampa for the use of travellers. In this province, as well as in many other parts of Peru, no one starts on a journey without a pair of bullock's horns (chifles) full of water slung in front of his saddle, provisions in the saddle-bags, and a thick poncho or two to serve as blankets, as at times he may be for days without falling in with water or a hut.

*Iquique*,  $20^{\circ} 12' 47''$  S.,  $70^{\circ} 14'$  W., is the principal port of the province, sheltered by an island (which was formerly thickly covered with guano, since removed), and situated at the N.W. extremity of a low tract of ground, surrounded by high and barren mountains. *Iquique* stands on a stratum of broken shells (principally cytherea) in all stages of degradation, in some places several feet thick, intermixed with others similar to those now inhabiting the neighbouring seas, and have in all probability been elevated above the level of the ocean at no very distant date: the general opinion is that there is a gradual upheaving of the whole line of coast, extending some distance inland; on this point Mr. Blake\* observes that fragments of recent shells have been found in the pampa of *Tamarugal*, which is 3000 to 3500 feet above the sea, and distant from it 30 to 40 miles. *Iquique* owes its present importance as being the shipping port of the salitre, or nitrate of soda, found on

\* Geological and Miscellaneous Notice of Tarapaca, by J. H. Blake: American Journal of Science, April, 1843.

the western margin of the Pampa de Tamarugal, and of silver, mainly from the mines of Guantajaya and Santa Rosa.

There is neither wood, water, nor vegetation here; most of the water is brought from Pisagua, 45 miles to the N., and is often very brackish; provisions come from the interior and Chile.

The population is employed in shipping nitrate of soda and in fishing, particularly for the congrio (of the conger eel family); there are a few other sorts of fish, which, with mussels, limpets, sea-eggs, and a few small crabs, is the only food to be met with.

The place is healthy and there is no ague.

During three years' residence at Iquique I only once saw a slight shower of rain, barely sufficient to lay the dust. Mean winter heat  $63^{\circ}$  at 8 A.M.,  $67^{\circ}$  at noon,  $62^{\circ}$  at 8 P.M.; summer heat,  $72^{\circ}$  at 8 A.M.,  $78^{\circ}$  at noon,  $74^{\circ}$  at 8 P.M.

Of sea-birds there are immense flocks, including the cormorant, pelican, booby, gull, shag, &c. To these birds is owing the existence of so much guano found on the coast of Peru. From the period of the first shipment of guano to Europe in 1838 to April, 1851, about 1,000,000 tons has been imported into Great Britain, Peru alone having supplied 435,000 tons. From 1850 to the first three months in 1851, there was imported from Peru alone 97,000 tons.

Of land-birds, condors, vultures, hawks, and turkey-buzzards are numerous. There are a few bats, many rats, mice, fleas, and mosquitos in abundance engendered by wet sea-weed; a vinchuca is occasionally seen.

Iquique is the only village on the coast of the province; the other places named in the charts are merely headlands, beaches, islands, &c., visited by the fishermen from Iquique in search of congrio, seals, and sea otters, in their ingeniously-constructed balsas, or floats made of seal-skins, inflated with air. During their stay at such places they live in caves or wretched cabins built of whales' ribs covered with seal-skins, and subsist on water, maize, and fish which they take with them. An old fisherman, on being asked how he amused himself when not at his labours, replied, "Why, I smoke; and as I have consumed 40 paper cigars a day for the last 50 years, which cost me one rial each, will you have the goodness to tell me how many I have smoked, and how much I have expended in tobacco?" The answer was 730,000 paper cigars, value 470*l.*! And this was a poor fisherman.

With the present steam navigation along the Pacific, facilitating the transport of merchandise and provisions, I am led to believe that this, perhaps the most barren coast in the world, will sooner or later be carefully "*cateado*," or examined for mines, and it would not surprise me to hear of important discoveries of the precious and other metals, as also of valuable saline deposits; then, although large cities may not rise up, places of commercial importance will

line the coast. I will mention a few places on this line of the coast of the province worthy of further examination, viz. :—

1. *Alcaparosa* ( $19^{\circ} 29''$  S.), N. of Pisagua. Here is much sulphate of iron, resulting from a decomposition of the sulphuret : the latter is looked upon as a criadero or breeder of gold. N. and S. of the quebrada of *Pisagua* silver veins are met with. *Chanabaya*,  $20^{\circ} 40''$  S., is another important spot ; and if water and provisions could be placed there at a reasonable rate, it is the general opinion that another silver-mine like Guantajaya would rise out of the desert ; here both gold and silver are found. *Chuchulai*, in  $21^{\circ} 8'$ , contains silver veins ; and at *Paiquina* and *Chipana* (in  $21^{\circ} 25'$ ), N. of Loa, some gold has been found. To the S. of Loa there was formerly a great deposit of guano. At *Paquique*, in  $21^{\circ} 56'$  S., and 10 miles S. of it, are the recently-discovered rich copper-mines of *Duendes* and *Tocopillo* : the first cargo from the former left for England early this year (1851). Water is brought to these new mines at the rate of 30s. per tun. In concluding the subject of Iquique I may mention that in 1815 a Chinese junk anchored in its port, and a party of Chinese visited the mines of Santa Rosa.

*Guantajaya*.—These celebrated silver-mines are 7 miles from Iquique, and in  $20^{\circ} 14'$  S.,  $70^{\circ} 7'$  W. They are reached from the port by proceeding over a plain, through which runs an immense ridge of sand. The track is then a winding one along the slope of the mountains to the “Caracol” or steep zig-zag road. At the summit the ground is loose and sandy, thickly covered with large angular pieces of rock, some in an advanced state of degradation, to which ages of solar heat has given a calcined appearance, some having crumbled into powder. Here is much salt, of a variety called clinkers, looking as if they had oozed out of the earth and crystallized by the sun’s heat. They have at a distance the appearance of a collection of bones, and the scene is one of absolute sterility. The mountains of Guantajaya, Santa Rosa, and others, are seen towering above the surrounding country. Everything is of a dull brown colour, except the bluish ranges of the Cordillera, in the distance, covered with snow.

These mines have rendered the province of Tarapaca so celebrated in Peru that it has sometimes been called the Potosi of the south.

They were discovered about 1556, it is said, by Spaniards from Arica, who worked at a spot called the Chiflones, but who after a time abandoned them. The mines were re-discovered by an Indian named Cucumate, during one of his journeys to the coast for guano, who made them known to Juan de Loyaza, who commenced working them, but died without reaping much benefit. In 1718 Loyaza’s son, Don Bartolomeo, found rich ore in the

vein of San Simon, and in 1727 the Paniso\* or unconsolidated rock (composed of argillaceous limestone containing fossil shells) at the foot of the mountain was discovered, in which were found the papas or insulated masses of silver; one found in 1729 weighed 800 lbs., another in 1794 of 400 lbs. In 1746, the Paniso having been bored through, the principal vein was met with, which led to the discovery of many others. The ores are native chloride and sulphuret of silver, and their combinations with copper, lead, &c.; the gangue or matrix is of carbonate of lime.

It was computed in 1826 that the mean annual amount of silver extracted up to that time since 1726 was 750,000 dollars, which would give a total of about 15,000,000*l.* sterling. Since 1826 the produce of the mines has been very irregular, not averaging more than 30,000 dollars a-year.

There are about 50 mines, and in one only has water been met with, but so impregnated with salts of copper as to be unfit for drinking. Had good water been obtained, its value would have been greater than the richest mine.

In such a desert spot labour is expensive, and the mining operations are generally carried on in the veins only, not working by shafts and adits; the system there being to extract little or no loose rock, and, as new works are opened, to throw the loose stuff into older ones: this has caused the mines to be called *enterado*, or buried. Periods elapse when but little silver is extracted; then a *boya*, or rich discovery, is made: one amongst these was a mass of nearly pure silver 15 yards long and in places a yard thick.

The mines being so irregularly worked, some time will pass ere boyas present themselves; and some writers on Peru, hearing that these mines were *enterado*, have erroneously concluded that they were worked out.

Were it not encroaching on the subject of this communication, I might indicate positions where rich veins could be cut at other levels and other veins discovered. This, however, belongs to the mineralogy of the province, and is only locally interesting.

In flourishing times as many as 4000 persons have been employed at these mines, and I have seen as few as 150. The principal habitations are built of wood brought from Chile, the rest of caliche (sand combined with salt).

The water for drinking is brought from the wells of Almonte (s. g. 1.00165, temperature 70° Fah.), distant 21 miles, in llama-skins containing 14 gallons, selling for 4*s.*; when scarce for much more. For a live sheep 10*l.* has been paid, and 20*l.* for a live ox brought from Atacama—an enormous price in South America.

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\* See vol. ii. No. 54, Proceedings of Geological Society. 'Description of Insulated Masses of Silver found in the Mines of Guantajaya,' by W. Bollaert.

At times it is distressing to see the miners returning from a sultry mine, the temperature of which is often  $100^{\circ}$  Fah. (highest exterior temperature  $78^{\circ}$  in the shade), and obliged to go on foot to the wells of Almonte for water. Mean winter heat, 8 A.M.  $53^{\circ}$ ; noon  $64^{\circ}$ , 8 P.M.  $56^{\circ}$ ; summer heat, 8 A.M.  $73^{\circ}$ , noon  $76^{\circ}$ , 8 P.M.  $64^{\circ}$ .

The mines of *Santa Rosa* and those of *El Carmen*, discovered in 1778, are distant from the preceding 5 miles. Independently of yielding the class of ores similar to those of *Guantajaya*, there is much sulphuret of silver and copper (cochiso). From 1815 to 1825 one mine gave 600,000*l.*; and a boya in the *Arcos* mine, 3 yards long and 20 in height, gave 100,000*l.*

S. of *Santa Rosa*, on the track from *Iquique* to the nitrate of soda works of *La Nueva Noria*, is a curious spot called *Las Rayas*, from some rude Indian works of art, said to have been made by them before the conquest. My friend Mr. Seymour, who examined this spot, gives me the following account of it:—"The side of one of the barren hills, in particular, is laid out as if for a garden, with a large double circle in the centre, and paths branching off, dividing the ground into compartments. The loose stones having been carefully picked off the paths, which are rendered hard apparently by the feet of people, it is supposed that religious ceremonies were performed here. In the vicinity is the representation of a llama, produced by taking away the loose dark stones from the side of the mountain, inside the outline." These representations of animals are called *Pintados de los Indios*, or Indian pictures: of this sort there are many specimens in the *Quebrada de los Pintados*, the pictured ravine at *Mani*, as well as in other parts of the province, and may be seen from a long distance. These *pintados* must not be confounded with the engravings and sculpture on rocks found in *Central* and other parts of *America*; those which I saw in the *Quebrada de los Pintados* appeared to be of recent formation, viz. since the conquest.

The *Satinas de Ceremeño* are 15 miles S. from *Iquique*. Common salt is found on a small plain 15 to 20 feet above the sea and 1500 yards from the rocky shore, which has been evidently uplifted from it. The salt is friable and crystalline, sometimes taking a curved appearance. It is met with in mounds, and a little below the surface, from 1-8th of an inch to 2 feet thick, and free from earthy matter. It is in layers between irregular strata of rock, in which are perpendicular splits also filled with salt, one layer communicating with another. When the layers are thick they are made up of five or six smaller ones; they have an inclination towards the sea of  $2^{\circ}$  or  $3^{\circ}$ . Ship-loads are occasionally taken to *Chile*.

In a plain near the *Ansuelo* rock at *Iquique*, and some 1000

yards from the shore, sea-water is found near to the surface. At the margin of the beach there is a sandy ridge or elevation, behind which the land is depressed. It is in this depressed part where the sea-water is found near to the surface, where it readily evaporates, leaving layers of salt. Spring-tides will add to these depositions; and now let the land be upheaved, and we have the origin of so much salt as at Ceremeño, and doubtless what has and is still taking place on other parts of the coast.

The existence and origin of salt and other saline bodies near to the ocean, and in a tropical climate, and where it seldom or ever rains, is not difficult to understand; but when it is met with on the mountain range of the coast, in the Pampa of Tamarugal (here in company with nitrate, sulphate, muriate, carbonate of soda, borate of lime, &c.), as well as high up in the Andes, 15,000 to 16,000 feet, and perhaps higher, with, as I presume, none of the rocks considered as saliferous, it is a curious matter of speculation, and would tempt one to surmise that so much salt, in such elevated positions, may derive its origin from other sources than the ocean, viz. volcanic, and the slow but gradual decomposition of rocks containing the bases of saline materials in their composition.

Mr. Smith writes to me in 1850, "The large salares or calichales (collections of salt) appear to be drawn from the earth by a powerful sun acting on a surface moistened by heavy dew (garua). I think we nearly bared the mountains about Santa Rosa when I sold a quantity of salt to Captain Bowers in 1827; *there is now a very fair new crop upon them.* I lived in a house at Iquique, some years since, which had bricked floors; the principal apartment was matted, and over it carpeting; before these were laid down the floor was well washed with sea-water; some months afterwards we observed the floor to be getting very uneven and lumpy: the carpet and mats were raised, when we found a beautiful white salt, in very small crystals, in some parts an inch thick, and as dry as a bone."

*Curato of Pica.*—The town of Pica (originally Tica, meaning flour), 20° 30' 8" S., 69° 24' W. (the church), is on the eastern margin of the Pampa, on a very sandy soil, at the base of an arid range of mountains, above which is an elevated tract, where the humidity of the air and occasional rain produce coarse pastures, such as ichu (*Stipa eriostachya*), iru, and sajana, upon which feed the domestic llamas, alpacas, and sheep, and in the more retired parts the wild vicuña and guanaco. Some large cacti and a little brushwood are seen, and, ascending in an easterly direction, the sierras or frozen regions of the Andes are entered.

The land at Pica capable of cultivation is very limited, the chief supply of water being from inconsiderable thermal and other springs,



their temperatures varying from 55° to 98°; the water is collected in “*cochas*” or reservoirs, and carefully distributed to the vineyards and farms, some of which are supplied with water by means of “*socabones*” or adits driven on a slight incline into the neighbouring rising ground; some of these adits are more than 2000 yards long, and may have been commenced by the Indians, before the arrival of the Spaniards. The farms of Pica consist of small vineyards, orchards, vegetable gardens, and plots of alfalfa. Among the fruits are the grape, from which wine and brandy are made, figs, guavas, melons, chirimoyas, pears, peaches, quince, small but very sour lemons, pomegranates, tuna (the fruit of the opuntia), date, pacay (*Prosopis dulcis*), the largest tree of the country, and the favourite aji or capsicum, which the Peruvians use in almost every dish. The district of Arica is said to yield *aji* annually to the amount of 120,000*L*. Olives are also cultivated, canes for thatching, a little cotton, camotes or sweet potatoes, the castor-oil plant, chañar, capulies (*Prunus capulin*), and a few other plants.

The principal houses are built of sun-dried bricks, but only of one floor in consequence of earthquakes; the majority of the dwellings are merely bamboo huts, plastered with mud, and have flat roofs, having the appearance of so many square boxes. The streets are covered with much loose sand, which in the day-time during summer becomes very hot and most disagreeable to walk on: so much so that the inhabitants keep a horse or mule saddled at the door to ride from house to house. This spot suffers from ague; a bad sort of which is known as tabardilla, chucchuic, and even peste (plague). The remedies used are, doses of sal San Sebastian (sulphate of soda, found hereabouts in large quantities), Peruvian bark mixed with wine, and lemonades. This local visitation is more fatal to the Indians than to the mixed breeds; consequently localities subject to this autumnal fever are avoided by the former.

Owing to the loose nature of the soil in this vicinity the effects of earthquakes are very severe. Locusts at times do great damage, and the binchuca, or black bug of the pampas, is common. The Cerro de Chuchulai is famed for its “*buenos panizos*,” or as affording favourable indications of gold and silver and other metallic veins.

*Matilla*, 20° 31' 22", is S.W. of Pica; its farms are supplied with water from the little valley of Quisma, as well as from adits. This vicinity was comparatively populous before the conquest, in proof of which there are many ancient huacas, or Indian tombs, to be met with.

The *Pampa de Tamarugal* takes its name from the tamarugo, or tamarisk-tree, likewise called carob, espino, and algarobo

(mimosa). This tree, the only fuel of the country, grows wherever water reaches the pampa from the ravines to the E. Formerly there was much more of this wood, but its constant use for fuel (the growth not keeping up with the consumption) has greatly decreased it. In the same localities there are buried underneath the soil large collections of dead wood, also used as fuel. This has sometimes been called fossil wood, and appears to be a different tree from the present algarobo. Mr. Smith, in a letter to me in 1850, says, "You know that forests of fossil wood have been dug up in the pampa; and, singular to relate, the whole trees were found lying in the same direction, as if swept down at the same instant, either by a hurricane or a torrent of water from the mountain ravines." The pampa extends throughout the whole length of the province, appearing to be elevated towards the N.; its height above the sea is 3000 to 3500 feet. It may be considered as a continuation of the desert of Atacama. Its surface is strewn here and there with pebbles, patches of sand, salt, nitrate of soda, and other saline bodies; marly strata follow, reposing on beds of rounded stones, and, lastly, rock is met with.

By sinking wells water is obtained at various depths; near to the eastern margin it is not far from the surface, but towards the western it is deeper. A curious point about this water is, that although there is so much saline material covering the plain, little or none of it is contained in the water.

On the E. a few ravines descend into the plain from the Andes, bringing down a small portion of water, while there are other ravines quite dry. Only three of these *quebradas* reach the sea—viz. Loa, Pisagua, and Camarones—their waters being brackish, having traversed so saliferous a country.

The view of the Andes from the western border of this plain is very fine. The sky is cloudless in summer, and the heat of the day intense; but the nights are cool even in summer, thanks to the land-breeze. Shooting stars and meteors are seen to perfection at night, darting into and across the plain; but the deceptive *mirage* sadly tantalises the traveller in want of water. The Indians call the *mirage* "flying lakes;" and on the road from Almonte to La Tirana large numbers of these may be seen in the distance, with even the shadows of the algarobo trees reflected in them.

Although a level plain, still, when rains have been abundant in the Andes and have escaped by the ravines into the pampa, water-courses have been formed, producing some irregularities. About noon in summer it sometimes blows strongly from the S.W., when the sand and dry loose earth (*caranso*) is carried before it in large quantities, and is very annoying to travellers. Whirlwinds of this sand, and even landspouts, are seen over the plain. In

1830 there was a terrible sand-storm, the gale blowing from the S. : the sand was lifted up more than 100 yards into the air ; the sun was obscured ; the people in the little villages were greatly terrified, and hurried to the chapels to embrace the statues of the saints and pray to them for protection.

*La Tirana*, 20° 21' 27" S., 69° 43' 30" W. From Pica to this place the track goes zigzag through patches of espino-trees, passing the noria, or well, of Ramirez. As there is some land here free from saline matters, but containing no humus, mould, or decayed vegetable material, experiments were made in 1820 to render the barren lands fit for cultivation : by sinking wells, extracting the water by means of pumps (norias), and irrigating the pure marl and sandy soil, some wheat, lucern, maize, and vegetables were grown. Mr. Smith writes, in September, 1850, that Mariano Morales had been for some time making a farm, which he calls "*Chacra sin riego*," or a farm not requiring irrigation. He had cleared off two feet of earth from the surface, thus approaching the water below the pampa to within three feet, and obtained sufficient moisture to grow wheat, maize, barley, rice, vegetables, &c. Should success attend this most novel mode of culture, it will be of great benefit to the province, and cause many to turn their attention to it. The *Aguadas* of Santana, Chancas, and Hidalgo are other *Chacras sin riego* in the vicinity.

At *La Tirana* water is met with a few feet from the surface (s. g. 1.00255), and, when heavy rains occur in the Cordillera, small streams reach as far as this. The greater part of the silver ores of Guantajaya and Santa Rosa are amalgamated at this spot.

At the *Wells of Almonte* water is found at a depth of 30 yards (s. g. 1.00165, temp. 70°). The mines are supplied from these wells. Here is also an amalgamating establishment.

*Nitrate of Soda*.—The existence of this valuable substance in the province of Tarapaca has been known in Europe about a century. In 1820 some of it was sent to England, but, the duty then being so high, it was thrown overboard. In 1827 efforts were unsuccessfully made by an English house to export it. In 1830 a cargo was sent to the United States ; it was found unsaleable there, and a part of it taken to Liverpool, but was returned as unsaleable in England. A cargo was then sent to France, and in 1831 another to England, when it became better known, and sold as high as 30s. to 40s. the cwt. Its price has varied very much ; present quotations (1851), about 15s. Since 1830 to 1850 the exports of nitrate from Iquique have been 5,293,478 quintals, equal to 239,860 tons ; some of it being used as a fertilizer of land, some in the manufacture of nitric acid.

The principal deposits of nitrate of soda yet known are found

on the western side of the Pampa de Tamarugal, commencing immediately where the level plain ceases, and on the sides of some of the ravines running from the Pampa towards the coast, and in some of the hollows of the mountains. The nitrate has not been found nearer to the coast than 18 miles, and looks as if it gradually transferred itself into salt as it approached the coast. The oficinas, or refining works, are divided into northern and southern salitres; the old salitres being about the centre of the former, and La Nueva Noria that of the latter; there are in all about 100 oficinas.

The nitrate deposits commence about Tiliviche, and extend S. near to Quilliagua, with interruptions of deposits of common salt. The nitrate caliche grounds vary in breadth; the average may be 500 yards, and in places 7 to 8 feet thick, and sometimes quite pure. In the ravines and hollows before mentioned the nitrate is found on their shelving sides; the hollows look like dried-up lakes, and are covered with salt 2 to 3 feet thick, and on the margins there is nitrate of soda, oftentimes going down to some depth; in others there is a hard crust upon it, occasionally 4 feet thick. The nitrate caliche found under this crust is in thin layers, and so solid and pure as to be sought for, although the expense of blasting is very great.

There are several varieties of the nitrate of soda caliche, the following being the principal:—

1. White compact, containing 64 per cent.
2. Yellow, occasioned by salts of iodine, 70 per cent.
3. Grey compact, containing a little iron and a trace of iodine, 46 per cent.
4. Grey crystalline, the most abundant variety, contains from 20 to 85 per cent., affording traces of iodine, with 1 to 8 per cent. of earthy matter.
5. White crystalline: this resembles the refined nitrate. All these contain common salt, sulphate and carbonate of soda, muriate of lime, and occasionally some borate of lime is found under the nitrate beds; one variety of the latter, composed of boracic acid 49·5, soda 8·8, water 26·0, lime 15·7=100, may probably become of use in this country in glass-making, &c.

Fragments of shells have been noticed with and under the nitrate beds; this may account in some measure for the lime in the borate and muriate. Mr. Blake mentions that 200 feet above the Pampa (which is 3500 above the sea), near to Los Salitres del Norte, "limestone containing shells rises from a bed consisting of pebbles and shells cemented together by salt and nitrate of soda. Part of the shells are decomposed, whilst others are perfect in form, and like those now still found living on the rocks in the inlets of the sea."

The rough nitrate of soda is broken into small pieces, put into boilers, water introduced, and the whole boiled; the nitrate is held in solution, whilst the earthy matter, salt, sulphates, &c., are separated, and fall to the bottom of the vessel: the saturated solution of nitrate is let into a reservoir, where it deposits any remaining earthy matter; the clear liquor is run into shallow troughs, exposed to the sun; crystallization takes place, containing only 2 to 3 per cent. of impurities, and is ready to be conveyed to the coast for exportation.

The Pampa de Tamarugal contains sufficient nitrate for the consumption of Europe for ages; the desert of Atacama yields it; it has also been met with in the Andes and in the eastern plains.

Passing *El Pugio*, a small farm on the road from Pica to Guatacondo, and the Rio Salado, the route leads by Cuevas, Tambo, Ramada, and Chipani, halting-places without water. Having passed the Cuesta de Chelis, and descended into the deep ravine of Guatacondo, a few trees and shrubs are seen amongst masses of granite and other rocks. In ascending the ravine it becomes very narrow, and at one place it is taken up by a *chajagua*, or waterfall. In order to pass this *angostura*, or narrow, a path has been cut out of the overhanging rocks, a few miles from which is the Indian village of

*Guatacondo*, 20° 57' 51" S. Here granite, clay-slate, sandstone, porphyries, and their débris are seen in perfection. High up the ravine towards the Cordillera are the gold and copper mines of Ugina. The produce of the valley is maize, fruit, vegetables, and a few sheep are reared. Impejza, Tigua, and Yareta are the names of silver-mines in the vicinity.

From the heights of Guatacondo there is an extensive view into the desert of Atacama. The mountains of Conche, famed for their gold and copper mines, may be also seen. It is from that part of the country where the green sand, or atacamite (muriate of copper), used for sanding letters instead of blotting-paper, chiefly comes.

*Quebrada de los Pintados*, or the pictured ravine. Here are representations of Indians, llamas, dogs, and other forms, on the sides of the dells, as well as in the *Quebrada Onda*, similar to those described at Las Rayas; the figures are 20 to 30 feet high, cut in the sandy marl, the lines being from 12 to 18 inches broad, and 6 to 8 deep.

*Mani*, 21° 10', is the most southern inhabited spot of the province. Near to this are some old gold-works, as well as at Catigna in the *Quebrada Onda*. Proceeding towards the coast,

*Quilliagua* is in the valley of Loa, where a few Indians reside. This stream, which is regarded as the southern boundary of Peru,

is generally 5 feet wide and 5 feet in depth, and is brackish, but during the rainy season in the Andes its volume of water is augmented. It is in contemplation to open a canal above Quillagua, in order to irrigate the neighbouring plain for the purposes of cultivation.

*Loa*, on the coast, in  $21^{\circ} 30''$ , is the abode of a few fishermen. To the N. are the deserted gold-mines of Chipani and Marejo.

*Pavellon de Pica* is a hillock on the coast, from whence large quantities of guano have been and are still taken. A pilot named Reyes was the first to collect guano here; the deposit was then 1 mile long and 300 yards wide.

*Mines of Chanabaya*.—These are of gold and silver. It takes three days to transport water and provisions to them from the interior. There are a dozen small mines. From what I have been able to learn of this place, I am inclined to think, now that there are such facilities afforded by steam navigation, that this spot deserves further notice, and might be got at with comparative facility from the coast.

*Curato of Sibaya*.—*Sibaya*,  $19^{\circ} 47' 33''$ , is an Indian town to the E. of Tarapaca. Much maize is grown, and sheep and llamas are bred. There is a route from this place to Potosi, across the Andes, which takes the Indians 12 to 15 days. From Sibaya to Mocha there are two tracks, one by the mountains, used when the valley is impassable by reason of the sudden rushes of water through the angostura or narrow, which is 2 miles long, 800 feet deep, 2 or 3 yards in width, and in some places almost excluding the light of day. These angosturas appear to have been formed by earthquakes; they are sometimes called *rajas*, splits, or fissures. This pass, although originally a fissure, has been worn down by torrents some 20 to 30 feet more, the latter distance being remarkably smooth; the rock is a dark blue slate.

*Mocha* produces wheat and maize, and here resides a family named Quispe-Sugso, descended from the Incas, which is exempt from the payment of tribute on that plea.

*Usmagama*, *Chusmisa*, and *Guasquiña* are Indian hamlets where llamas are reared; wheat, maize, and potatoes grown. Gigantic cacti are hereabouts seen, 20 feet or more high, a foot thick, and when split serves for doors and even rafters. *Usmagama* is at the bottom of a very deep ravine prettily surrounded with trees, and has a picturesque appearance from the mountain road to Zipisa: the track is steep and dangerous, along a precipice in a zigzag course, some of the steps being cut out of the solid rock, and at great distances from each other, so that a mule in descending is obliged to drop both the fore feet at once, which is not pleasant to the rider.

At Guasquiña there is much gypsum, and on the heights abun-

dant depositions of débris from the higher country, containing sulphuret of iron, supposed to be a favourable indication of lavadero gold. On leaving Guasquiña for Zipisa, the track leads up the N. side of the ravine; it is cut out of the mountain, and looks nearly perpendicular: the road is firm, but so narrow that there is much danger when travellers or troops of animals meet. From the summit of this road the track is most mountainous, until a dry deep quebrada is attained, which is entered by an escalera, ladder path, or flight of steps, at an angle of  $45^{\circ}$ , cut out of the rock, a sort of road the Indians of old knew so well how to construct. Here travellers are obliged to dismount and lead their animals.

*Zipisa*,  $19^{\circ} 38' 6''$ , is in a very rugged country, supplied with water from springs, conveyed by a long acequia, or aqueduct, which is made to wind round the mountains, a system well known and used by the Indians long before the conquest. Here is a sanctuary, the resort of the pious and others in the month of June. It is a pretty spot, where a few paraquets, wood-pigeons, and small birds are seen.

*Sotoca*,  $19^{\circ} 36' 18''$  S., is reached by a mountainous up and down track, and half way between it and Zipisa both villages are seen beneath the traveller apparently at only a stone's throw. In the mountains of Yaracagua is a silver-mine; and as there is much sulphuret of iron in the débris that cover these mountains, it has been supposed that such will some day or other lead to the discovery of *lavaderos* or gold-washings.

*Curato of Camiña*.—At the bottom of the ravine of Camiña is the *Port of Pisagua*. It is from here that Iquique is supplied with water, but the stream seldom comes down to the beach. It is reported that the mountains in this vicinity afford indications of gold, silver, antimony, and copper, but sulphuret of iron is in such abundance as to give rise to large formations of sulphate of iron or alcaparosa, a solution of which natural salt, added to the resinous pods of the tara (a species of mimosa containing tannin), forms the ink used in the country.

*Huayna Pisagua*.—Nitrate of soda from the northern salitres is shipped from this port, as well as from Mejellones.

*Tana*.—Some alfalfa grown here, and there are large deposits of salt in the vicinity. This quebrada of Camiña, like the other two of Loa and Camarones, cut straight through the Pampa, is wide in parts, narrow in others: their structures are alluvial, and imbedded in them are rounded and other masses of rock resulting from the mountains to the E.

*Quimpasa*, Yalamanta, Moquella, Quistagama, Cuisama, and Chapiquilta are hamlets before reaching the large Indian town of

*Camiña* (anciently Carvisa, one of the names of the llama), where maize, alfalfa, grapes, and olives are grown. Much of the culti-

vated land is far above the level of the stream, formed into terraces and watered from above by means of an aqueduct brought some distance from up the ravine. Here may be seen the domestic llama and alpaca, and a little higher up in the mountains the wild guanaco and vicuña. In the N. part of Chile the llama is called moro-moro; the guanaco luan, and when tamed the chiriqueque. At Camiña is an ancient Indian cemetery, "huaca," or sacred place; the bodies are buried in a sitting position with the arms across the breast, and wrapped generally in cotton cloths. Sometimes articles of value, such as images of gold and silver, are found in the huacas, as well as pottery with designs in alto-relief.

The track from Camiña to Isluga leads up the ravine through trees and shrubs. Leaving the quebrada to the N., by a long ascent, you arrive at the

*Cuesta de Parasuya*, without any road being distinguishable from the numerous tracks formed by the herds of llamas and sheep that graze in the mountains. These tracks continue nearly to the pile of stones known as the Pass or Pascana of Pacheta. The Indian who passes here will bring a stone, even from a distance, in order to add another to the pile. These piles are not uncommon in the Andes.

*Maymaga* is near a marsh, the waters of which issue from springs. Now and then a chinchilla and biscacha may be seen, also condors, eagles, and wild geese. At sunrise in November the temperature was 26° Fah. These solitary and dreary spots, of which there are several in the Cordillera, are called *estancias*, and are the residence of a few Indian families, occupied in breeding llamas, and jerking or drying meat. From Maymaga N.E. to the marsh the level land becomes contracted by the vicinity of the mountains; a *cuesta* is ascended, when, after passing the

*Estancia of Mauque*, the track becomes very bad over rising barren ground without a vestige of vegetation, until a high pass in the Andes is reached, known as the

*Abra de Pichuta*, with its pile of stones, which I have estimated to be at least 15,000 feet high. Much inconvenience was experienced in crossing this pass in consequence of the violence of the piercing wind from S.E. From this spot the volcano of Isluga was seen (giving out considerable volumes of vapour), as well as many snow-capped peaks and ridges. Descending from the pass through a ravine, the caves and stream of *Pasirugo* are met with, being the temporary resting-place of the Indians whilst tending their llamas.

*Anquaje* is on the lake of the same name, and is a llama farm. From here five small craters of the volcano of Isluga are seen;



two of the craters are near the summit, three some distance down the S. side.

*The Volcano of Isluga* is not very conical, but occupies some extent. It was winter when I was there, and then it was thickly covered with snow, even to its base. During the summer sulphur is collected about the craters. Loud rumbling noises are heard in its vicinity, and earthquakes are often experienced. I give as the approximate elevation of this volcano 17,000 to 18,000 feet above the sea. I believe Mr. Smith and myself were the first to make known in Europe the existence of this volcano.

Commencing in the S. there is—1, the volcano of Copiapo ; 2, Atacama ; 3, Olea ; 4, Laguna ; 5, Volcancitos of Puchultisa ; 6, Isluga ; 7, Carangas ; 8, Uvnas (quiescent) ; 9, Arequipa ; besides others : indeed, from the character of the rocks of the country and their débris, I should say that the whole of the Cordillera in these latitudes and far N. and S. is one mass of volcanic rocks.

Passing *Enquelca* (estancia), which is on the border of a lake, the Andean town of

*Isluga* is reached. This is the largest village in this part of the Cordillera, on a good-sized stream, which comes from the mountain of Carabaya, running into the lake of Isluga. S. of the village the waters from the lake run eastward into the plain of Sitani. In these inland waters there is an ugly-looking fish called *suchis*, 8 to 10 inches long. I am inclined to give 13,000 to 14,000 feet of elevation above the sea to this place. In the hollows a few potatoes and quinoa (millet) are with difficulty grown, and there are some scanty pastures fed by occasional rains. The severity of the climate freezes the potato, and in this state it is called *chuño*, the starchy matter of the potato being changed into saccharine by the freezing. From the quinoa a fermented liquor is made. During the summer months pasture is found as high as 14,000 to 15,000 feet.

Near to Isluga, water-fowl, a few ostriches, plovers, and *bisacchas*, are found ; the puma is also seen, its prey being the young llamas : the condor is also dreaded. Of fuel, there is a little turf, the *tola*, a small resinous shrub, and the resinous *yareta*, a plant of a globular appearance, the resin exuding in winter.

*Pampa de Sal*.—To the E. of Isluga commences an extensive salt plain, said to extend to Challaputo and the insulated Cordillera del Frayle, 40 leagues distant, and near to Potosi, varying in breadth from 3 to 8 leagues, the salt being from 5 to 10 inches thick. From near *Enquelca* this salt plain is seen as far as the eye can reach, forming a regular white horizon, and in striking contrast with the dark lower parts of the Cordilleras. The elevation of this plain is at least 14,000 feet.

*Cariquima* is an estancia at the western base of the high mountain of Mama-Huanapa. There are other estancias, such as Xiquima, Turini, Chivullani, &c.

*Mauque*, W. S. W. of Isluga, is a small village, with a chapel larger than the whole place put together, and dedicated to our Lady of Guadalupe, who, it is said, appeared to an Indian woman on a hill a few hundred yards N. of the village, at which spot a large cross is erected.

*The Lake of Paríñas* is to the N. of Mauque, where there is much wild fowl and flamingos with red breasts.

*Puchultisa*.—From Mauque to this place a pass leads, which is lower than that of Pichuta. Here are a few huts for the accommodation of the Indian shepherds. A small stream runs by it, which is augmented by others from the boiling springs, water volcanos, or

*Volcancitos de Agua de Puchultisa*.—These lie in a hollow of the mountain, the surface of which is composed of a thick white crust. There are a dozen or more of these volcancitos, or geysers, from 3 to 5 feet in diameter, with water boiling at various levels, some throwing the water to 2 feet in height. The water as it cools leaves a sediment which increases the size of the cones. There are more than 500 smaller ones dispersed over the hollow, emitting a sulphureous odour, whilst a rumbling subterranean noise is continually heard like distant firing. May not the surface of this hollow be the covering of a comparatively quiescent crater, which, as the water runs into it from the mountains, gets heated, expands, and forms these Andean geysers?

*Quebrada de Biscachas* is a deep and rocky ravine, descending which towards evening I saw great numbers of biscachas. These are sometimes called the hare and rabbit of Peru, but are classed with the chinchilla family. The chinchilla burrows rather higher up on the Andes than the biscacha.

A mountainous route by Ulmaga, round the base of Tata Jachura, leads to the large Indian town of *Chiapa*,  $19^{\circ} 32' 19''$  S.,  $69^{\circ} 13'$  W. Here wheat, maize, potatoes, and vegetables are cultivated. In the month of June it freezes at night. The water used in the irrigation of the land is conveyed by aqueducts of some extent. One day's journey E. is the mountain of Quetani, where there are some old silver-mines worked in the time of the Incas. About Chiapa grow the cactus, tola, culen (cytisus arboreus), jarillo (a spartium?), aracache, or wild celery (conium moschatum), valerian, and a few wild flowers.

*Soga* is between Chiapa and Camiña, by so mountainous and broken a track as to be called the Devil's road.

*Quebrada de Camarones*.—The boundary is a few miles N. of the ravine which rises in the Cordillera of Arica. The water in

this valley is brackish, and ague prevails in that part near the coast. Much black oxide of arsenic is found in this ravine.

*Chisa* is a small vineyard in the valley of the same name, in which is also *Miñimiñi*, an Indian town producing wheat and fruit.

*Ascent of the Mountain of Tata Jachura.*—I ascended this conical and beautiful mountain in the month of June, in company with my friend Mr. George Smith, with whom I had travelled over much of the province of Tarapaca. We left Chiapa at noon by ridges, stony cuestas, and in a mountain hollow at sundown camped for the night under the lee of some huge rocks. The following morning at sunrise it blew strongly from the E., and very cold. We travelled onwards as long as the rugged track would permit our animals to do so, when our Indian guides begged to be left behind in charge of them. To this we agreed, and continued the ascent. We were fast leaving the cardon below us, and the only plants seen were a little ichu pasture, stunted tola bushes, and the yareta.

Our ascent was over steep, sterile, broken, argillaceous rock, until we came upon thick ice. We bled a little at the nose, had an unpleasant singing in the ears, headache, dimness of the eyes, and the body benumbed with cold, caused by the puna, soroche, or cold and attenuated state of the atmosphere. However, at 1 p.m., after a painful and laborious struggle, we reached the summit, the last part of our ascent being over broken rock and ice, there being glaciers in a dell below us.

From observations subsequently made I give the elevation of this peak as 17,000 feet at least above the sea. It blew a piercing gale of wind from the E., and so cold was it that the water in a gourd was frozen, and a piece of roasted meat we had with us became as hard as a brick. Our fingers were so stiff with cold that we were scarcely able to use our instruments; there was not sufficient power in them to strike fire wherewith to light a cigar, and we could scarcely hear each other speak.

From the summit there was a glorious view of the Andes, many peaks of which appeared to be from 3000 to 7000 feet higher than Tata Jachura. The cloudless sky was of a dark indigo colour, and the icy peaks and ridges showed a bold and well-defined outline.

During our ascent we saw guanacos, vicuñas, biscachas, chin-chillas, and now and then a condor soaring majestically about its mountain home.

Our descent did not occupy much time; we soon regained our guides, and, entering Chiapa at sunset, we were received by the population, the bells of the church were set ringing, and a good supper awaited us, including the callapurca (this is a dish of

honour—a savoury stew kept hot by large heated pebbles put into it), and old oily chicha de maize, in honour of our having been the first, in all probability, who had ever gained the summit of Tata Jachura.

The eastern side of the province is in the Cordillera, and is very thinly inhabited, there being only here and there farms for breeding llamas.

*Indians of the Province of Tarapaca.*—The Indians are those called Aymarras, as speaking that language. The Quechua is spoken more to the N.E.

The Peruvian Indians may be said to be Christianized (with the exception of those, however, on the eastern slopes of Bolivia, who still preserve some of their ancient customs, among which is that of worshipping high mountains, and the rising sun).

They were ruled by their conquerors with the iron rod of power, political as well as ecclesiastical, and invariably failed whenever they tried to emancipate themselves from the Spaniards. The rebellion of 1780, under Tupac-amaro, however, put an end to the cruel *repartimientos*, or parcelling them out like so many beasts of burden, but in every other respect their miserable state was not ameliorated. Many Spaniards were killed in Tarapaca at that period, the Indians destroying particularly the churches and the curas. Since the separation of the South American colonies from Spain the position of the Indian has been better.

The Indians are of a brown colour, straight black hair, sparsely made, and may be called a small race of people. They have been so subdued that they now pass for an inoffensive and quiet race. They marry young, and polygamy is not known amongst them. The Indian is slow in his movements, but most patient and persevering, performing long journeys with troops of mules and asses laden with the produce of his land for sale, whilst the women remain at home, assisting in the cultivation of the soil, and in tending the herds of llamas, alpacas, and sheep.

At their homes they fare pretty well, living on llama meat, poultry, &c.; some have flour and vegetables, but their principal grain is maize, from which they make bread, and their favourite chicha, the merits of which they celebrate in song; but with a little toasted Indian corn and some coca they will travel for many days over the most desert countries. The coca is masticated with llucta or llipta, composed of an alkaline ash, generally mixed with boiled potato.

Their habitations are built of rough stone, with seldom more than one apartment, without windows; the fire in the centre of it, the smoke going out of the top. At the end of the apartment is an elevated part, on which they sleep on llama and sheep skins. Their cooking utensils consist of a few earthen pots and dishes,

and they manufacture the material for their clothing from the llama, alpaca, sheep wool, and cotton.

The dress of the men consists of a coarse cotton shirt, woollen breeches and jacket, stockings without feet to them, a large hat made of guanaco or vicuña wool, hide sandals. A long strip of cotton hangs loosely round the neck, and sometimes round the head and face, to protect those parts from the cold or the intense heat of the sun's rays. A faja, or waistband, of various colours, in which is the pouch containing the coca, and a coarse blue and red poncho, complete his attire.

The women wear a long cotton garment, over which is a woollen dress; then a long poncho, fastened on each side by a topos, viz. silver spoons, with the handles pointed, serving as pins; a long faja round the waist; then the lliclia, or female poncho, in which they carry their children behind them. They wear sandals, but seldom any covering on their heads; their necks are adorned by a gargantilla (necklace) of coloured beads, little crosses, and many diminutive silver spoons strung on.

Occasionally a few "Chirihuanos," who are Indians from the Yungas, visit Tarapaca. They are denominated the travelling doctors of Peru, in consequence of their ambulatory pharmacy, which is composed of remedies for every disease, viz. herbs, gums, resins, roots, charms of various sorts, including the loadstone; but perhaps the only useful one is the quinquina, or Peruvian bark.

*Description of Section I.*—At Pisagua much black granite is seen, traversed by veins of quartz. The beach is extensive, with a heavy surf beating on it, and its beds of shingle have the appearance of having been recently upheaved or raised. The deep ravines of Tiliviche and Camiña which traverse the Pampa de Tamarugal are composed of sand, silicious pebbles, rounded and angular masses of granite, sandstone, volcanic rocks, and much gypsum. From Yalamanta the section goes through the arid range to Cahuisa, leading to a broken undulating region where there is pasture. To the right is the high mountain of Mama Huta, and just below the pass of Pichuta even the vegetation of the resinous yareta ceases. The volcano of Isluga succeeds; then Carabaya, Tata Sabaya, then along the W. edge of the great Salt Plain to the volcano of Carangas. In this section are seen the primary and secondary rocks, stratified porphyries, and ultimately recent lavas.

*Description of Section II.*—This section commences at Punta Piedra, near Iquique, where granite in a state of decomposition is seen traversed by veins of quartz. Clay slate also occurs in this vicinity. Above these is hard sandstone, which, I presume, gives rise to much of the great accumulation of sand. We are much indebted to Darwin (*see* his 'Geology of South America') for

our knowledge of the class of rocks constituting the mountains of the coast, which are principally porphyritic.

At the mines of Guantajaya (the Chiflones), and near the summit of the mountain, I examined a superficial layer called Manto, which is composed entirely of a fossil shelly deposit of broken valves of a *Gryphæa*.

Immediately beneath the Manto argillaceous limestone is met with; and, at the base of the mountain of Guantajaya, the panizo, a peculiar unconsolidated rock, is found, which contains the papas or insulated masses of silver, as well as fossil shells. Darwin has figured three, viz. *Terebratula inca*, *T. ænigma*, and *Lucina americana*.

My friend Mr. John Morris, on examining the fossil shells I obtained from the panizo, has named them as follows:—*Lucina excentrica*, a *Venus*, *Trigonia* (a cast), and a new *Lucina*, which he has called *L. Bollaerti*: shell somewhat orbicular, compressed, umbones not very prominent, marked with concentric laminar edges, with rather broad striated interspaces, a more orbicular shell than *L. excentrica*, with somewhat concentric markings, but wanting the fold of that species. The worn fragments of ammonites, probably *A. plicatiles*. Professor Forbes writes me that these fossils appear to belong to the oolitic period, and are probably from strata equivalent to that portion of the series including the Oxford and Kimmeridge clays. One fragment of an ammonite is undistinguishable from the *A. biplex*; other specimens of ammonites are either *biplex* or a nearly allied species: the remaining fossils are a cast of a *Trigonia*, very near *T. costata* of the Oxford clay; an *Astarte*, very near a British Kimmeridge clay species; and a *Venus*.

The word panizo comes from panezillo, one of the many terms in the Spanish language for a hill or mountain. Thus a mountain is said to have “buenos panizos:” that is, such colours seen about it from the exposure of edges of veins, which the eye of the miner or cateador easily detects, and leads him to believe there may be mineral matter there. The desert localities of Peru are favourable for such observations, as there is no vegetation to obstruct the view.

Having passed through the panizo, a very hard rock is met with of a basaltic formation, and associated with this is one of a silicious character, having an arborescent appearance. The whole of this district has been much disturbed by earthquakes and volcanic agency, dislocating rocks, causing fissures in them; and at Guantajaya there are two species of chorros or cross-courses—one similar to the panizo, as if formed by the action of water; the other of hard rock, and as if it had been injected into the fissures in a melting state.

Having traversed the coast-range, we reach the Pampa of Tamarugal, with its large deposits of nitrate of soda and other saline matters. There rise out of it some isolated silicious mountains; the principal ones are Challacollo and Challacolito. In the former I visited some silver-mines. Mr. Blake mentions that, in sinking a well on the W. border of the plain, after passing through marly soil, trachytic rock was met with, and then water at 30 feet; and, near the well of Almonte, the ground was pierced to a great depth without coming to water, when the following section presented itself: Saline matters on surface; marl and clay, 50 feet; coarse sand, 2; clay, 80; fine gravel, which terminated in a bed of coarse gravel and pebbles, mixed with large water-worn stones. In the arid range of mountains on the eastern border of the pampa there is much sand and sandstone, and thick beds of detritus; underneath these, in all probability, the rocks are of a similar composition as those of the coast-range. Next in succession is an elevated tract of country, broken by ravines, with much débris from the Andes, composed of volcanic breccias and conglomerates, including angular masses of feldspar and volcanic rocks. This tract is interesting as being the first from the coast on which pasture is met with, some brushwood, and large cactus. On the eastern part of this pasture-land high mountains are situated. This meridian may be designated as the commencement of the Andes or mountain-knot of Potosi.

Having ascended the Quebrada de Biscachas, we come to the water volcanos of Puchultisa, and crossing the pass of Manque there is a descent into the plain of Isluga, out of which rises the volcano of the same name; this elevated region presenting the appearance everywhere of volcanic formation.

A few miles now to the E. commences the great Andean salt plain, extending far towards the E.

In a line N. of Isluga is the high peak of Carabaya; then follow the more elevated ones to the E. of Tata Sabaya, Coypasa, and Cancosa, these peaks being on the boundary line of Tarapaca, on the other side of which the same Andean region extends far into Bolivia (Upper Peru); the whole forming an immense mountain-knot, and generally denominated the Cordillera Real de los Andes. The Indians speak of a "primera Cordillera" (a part of which is Sililica), but such must not be confounded with what is known as the Peruvian Andes of the coast, or the Bolivian Andes of the interior, but are rather isolated ridges.

*Description of Section III.*—I am informed that the coast-range here is similar to that of Iquique. After crossing the Pampa and the mountains E. of it, and arrived at the valley of Guatacondo, granite, clay-slate, porphyries, sandstones, and their débris are met with.

I have no personal knowledge respecting the mineral treasures of Uguina, the volcanos of Laguna and Olea, or the lakes and salinas of Coppa and Napo.

*Earthquakes.*—The inhabitants of Tarapaca expect a severe one every six or seven years, but few days pass without a shock being felt. In 1795 as many as forty shocks were experienced in one day. In 1818 a series of heavy shocks continued for fifteen days. “When the miners of Guantajaya left the town the ground opened, and clouds of dust were raised in the streets by the violence of the concussions.” On one occasion I was at the bottom of a deep mine in Guantajaya, when I heard a faint rumbling, which rapidly increased, sounding like distant thunder, and then appeared to pass onwards; next followed a motion of an undulating sort in a horizontal direction, which shook down part of the slanting road leading to the mine.

*Route from Cobija to Coquimbo by the coast of the Desert of Atacama, with Observations on the Meteoric Iron of Atacama.*

On this trip I had two objects in view: the one to examine the coast of the desert of Atacama; the other to ascertain, if possible, the exact locality of the meteoric iron. I made the passage in an open boat from Cobija to Paposo, a tedious one of 12 days, having wind and current unfavourable; we were generally at anchor during the day, and rowing at night, assisted a little by the land-breeze.

*Cobija* is the only port of Bolivia, or Upper Peru, supplied with water from springs (s. g. 1·00205). To the N. are the improving copper-mines of Rosario and Mamiña.

*Guasimur.*—Silver veins are reported to have been met with here. Having crossed the great bay of Mejillones, I had an opportunity of witnessing the vast numbers of seals that inhabit the coast, a profitable trade being carried on in their skins. The appearance of the coast, to use the expression of my native companions, was “horrorosa;”—steep, naked, jagged, granitic, clay-slate and porphyritic rocks, 2000 to 3000 feet above the sea, with a heavy surf beating on them; the shrieks of seals and the noise of myriads of sea-birds, under a blistering sun, formed no cheering scene.

*La Chimba* is in the centre of the peninsula formed by Morro Mejillones and Morro Moreno, a few miles inland and in a desert. From what I have been able to learn of this spot, and the strong indications of gold ore found there, I am induced to think that this place merits a more careful examination. There is not even water there, but, with the constant traffic of steamers on the coast, water and provisions might without much difficulty be transported thither.



*Morro Jorje* is a favourite locality in the estimation of the cateadores, or mine-hunters. It is from 3000 to 4000 feet high, and in consequence of this elevation it collects and retains some dew, which collects in springs.

*Agua Buena* and *Agua Salada* are springs, and occasional fishing stations. At *El Cobre*, as its name implies, there is copper as well as *liga* (an ore of iron). Along the mountainous shore a tract may be seen in this region of "cuestas, barrancos, y mal pasos," expressions comprehending everything dreadful in the shape of terrible roads.

*Remiendas*, *Tragajente*, and *Botija* are caletas, or fishing coves, where during the season much congrio and tollo are taken, dried, and sent into the interior.

*Punta Plata*.—Here are some springs up in the mountain, where a little vegetation is seen. On the 12th day I arrived at the little settlement of

*Paposo*—situated at the base of the mountains, supplied with water from springs. A little rough pasture grows on the heights, and there are a few pear-trees. This is the principal rendezvous of the changos or fishermen of the coast, who barter dried congrio for clothing, flour, cacao, tobacco, &c. Here I was informed that if I lost no time I might come up in a day or two with a party going into Atacama, who were likely to give me some information relative to the meteoric iron about which I was interested. Passing the fishing coves of *Punta Grande*, *Cachinal*, and *Agua Dulce*, traversing the *Mal Paso*, a very dangerous and rocky spot, I came to *Hueso Parado*, which is the old acknowledged boundary between Peru and Chile; but since guano has been exported from the coast, the Chilenos appear to think that the boundary of their country is farther N. than Paposo. The frontier line is in  $25^{\circ} 23' S.$ , which about  $1\frac{1}{2}$  miles from the shore is marked by a whale's jaw placed upright in the sand, and it is the general opinion that it had been placed there by the old Spanish boundary commissioners. Herrera places the boundary in  $26^{\circ} S.$

At *Hueso Parado* I fell in with the party I had come after, but they were not going into Atacama. I continued my journey with them across the valley of *Briadal*, over the Pampa de *Cardones* to *Tapaderas*, where there is a little pasture, but no water. At *Cachinal* we found a spring; the rocks of the country are granitic, containing much felspar; salt is also in abundance.

In travelling from Copiapo to Atacama I left the road in order to proceed by Peine to Toconao, to examine the site of the meteoric iron which is found in the vicinity of the latter place, and the origin of which has been from time to time the subject of discussion; but I was so unfortunate as to lose my way in the attempt, and obliged in consequence to give it up.

I had, so far back as 1826, obtained a specimen of this iron, which I had no doubt was of meteoric origin; and whilst travelling as far S. as Mani, in the province of Tarapaca, in 1827, I learnt that there were two "iron-mines," one called *Peine*, the other *Huanaquero*, in the desert of Atacama, and that they were called "Reventasones," or burstings. This word fortified me in the belief that they were deposits of meteoric iron, the more particularly as I subsequently learnt that a person named Alejandro Chaves had heard a great noise in the vicinity of *Peine* in 1821, and that shortly afterwards large masses of iron were found scattered about the plain; also that an Indian, named Matico, and who lived near Huanaquero, knew the exact spot of the reventason there. The following route was given me to one of the iron-mines, and I was informed that iron was found in abundance in a mountain. This I suppose to be at *Toconao*. San Pedro de Atacama by Carabaya and Ylo to the iron-mine at Toconao is 22 leagues. It was this information that prompted me to essay crossing the desert when at Cachinal, in search of Huanaquero and Peine, in which I did not succeed. At Copiapo I got only little information on the matter; but at Coquimbo Monsieur C. Lambert corroborated much of what I had been informed in Peru, and mentioned to me that, in 1822, when he was on his journey from Atacama to Copiapo, and wished to be taken to the reventasones, the people of that part of the country would not show him the spots, supposing them to be silver. He afterwards procured some specimens from one or other of the reventasones, which proved to be meteoric iron: one of these he sent to England, and it is now in the British Museum, with a larger one presented by Sir Woodbine Parish. I have entered rather fully into this matter, as the positions have not as yet been visited by any scientific explorer, and the more so as it has been the subject of correspondence between Sir W. Parish and Humboldt: the former having been informed that the Toconao deposit had been found existing *as a vein*.\* Toconao is 10 leagues E. of San Pedro de Atacama, and at the foot of the Cordillera. I have given Peine as 30 miles S.W. of Toconao, and Huanaquero 50 miles S.S.W. of Peine. Supposing the Atacama meteorite to have come obliquely into our system, and to have burst after it had got into our atmosphere, the circuit of dispersion of its fragments would be elliptical rather than circular, and thus account, in some measure, for the masses having been thrown rather more N. and S. than E. and W. There is no account of the direction the meteorite came in, only that it was in the daytime, and with a noise. For the guidance of future travellers who may go in that

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\* See Buenos Ayres and La Plata, by Sir Woodbine Parish, K.C.H.

direction, I subjoin the following route from Copiapo to San Pedro de Atacama :—

Copiapo to Llampos . . .	12 leagues
„ Pujios . . .	3 „
„ Chañaral . . .	10 „
„ Agua Dulce . . .	9 „
„ Doña Inez . . .	8 „
„ Encantada . . .	5 „
„ Juncal bajo . . .	4½ „
„ Chaco bajo . . .	4½ „
„ Baquillas . . .	2½ „
„ Aguas blancas . . .	5½ „
„ Zorras . . .	7 „
„ Pujios . . .	9 „
„ Posos . . .	9 „
„ Peine . . .	3 „
„ Carabajal . . .	8 „
„ San Pedro de Atacama	12 „

A “white metal,” called by the Indians *pampua*, is said to be found at Chala, or Chaupiyunga, N. of Santa Barbara; it is sometimes called *platina*, for on putting it into the fire it gets brighter. I strongly suspect this to be meteoric iron. There are two or three other spots to the N. of Chala, which, when examined, meteoric iron may be found there.

*Chala* (\*) is in 21° 54', 68° 50'; (\*) 21° 42', 68° 48'; (\*) 21° 35', 68° 45'; (\*) 21° 22', 68° 43', are other spots deserving of examination for meteoric iron.

Since the foregoing was read at the Royal Geographical Society, a communication has appeared in Chambers's 'Edinburgh Journal,' 375, March 8th, 1851, relative to this meteorite, or rather a collection of masses of such, by Dr. Reid, from which the following is extracted: “Four days and a half from Cobija is Calama; two days more is Chuicchuic, not far from which are the so famous meteorolites (stones supposed to have fallen from the air). It is my opinion that they are not meteorolites, but of volcanic origin. They were first discovered fifty years ago. At first they were thought to be silver, and the Indians made spurs of them.

“Those which have not been already collected are covered over by the drifting sand, and one must dig in order to get at them. With little trouble we may convince ourselves that a volcanic eruption once took place here, for the direction of a distinct vein can easily be followed. I have my compass with me, and find that these stones contain a large quantity of iron. The stones

\* See Map.

appear in  $23^{\circ} 30'$  S., and between 45 and 50 Spanish leagues from the coast." I put myself in communication with Mr. Bonar, of Ratisbon, a friend of Dr. Reid's, who kindly sent me a small specimen of the meteoric iron collected by Dr. Reid, which appears similar to that from Toconao, and who tells me that "the Indians have found pieces of 50 and 100 lbs. weight, which they use to make spear-heads, knives, &c. Humboldt speaks of these meteorolites: they lie on the ground in heaps, and bushelsful are scattered about. Dr. Reid imagined them to be volcanic, as an extinct volcano is found some distance off." Humboldt is not of this opinion; and M. de Rivero, Consul-General of Peru, informs him that in 1829 he analyzed the meteorite of Atacama, and the results were as follows:—

Iron . . . . .	90.40
Nickel . . . . .	8.60
Residue . . . . .	0.30
	99.30

This does not quite agree with Dr. Turner's analysis (*viz.*, iron 93.4, nickel 6.681, cobalt 0.535), which was from the specimen presented by Sir Woodbine Parish to the British Museum. On reference to Arrowsmith's Map of La Plata, &c., the following are nearly the positions of the deposits of meteoric iron:—

	o	/	o	/
Toconao . . . . .	23	20	S.	68 10 W.
Dr. Reid's . . . . .	23	30		68 50
Peine . . . . .	25	35		68 45
Huanaquero . . . . .	24	30		68 50

NOTE.—Captain Thomas Steele, a Fellow of this Society, at present travelling through South America, has promised to investigate this interesting question.—ED.

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## XI.—*Progress of the African Mission, consisting of Messrs. Richardson, Barth, and Overweg, to Central Africa.*

[Read January 13, March 24, and November 10, 1851.]

### I.

Communicated by Mr. A. Petermann.

THIS expedition is under the direction of Mr. James Richardson (well known from his travels in the northern portion of the Great Sahrá in 1845 and 1846), who is directed by the English Government to proceed to Tripoli, and thence across the Sahrá