

CHAPTER XVI.

Coast-road to Coquimbo—Great loads carried by the miners—Coquimbo—Earthquake—Step-formed terraces—Absence of recent deposits—Contemporaneousness of the Tertiary formations—Excursion up the valley—Road to Guasco—Deserts—Valley of Copiapó—Rain and earthquakes—Hydrophobia—The Despoblado—Indian Ruins—Probable change of climate—River-bed arched by an earthquake—Cold gales of wind—Noises from a hill—Iquique—Salt alluvium—Nitrate of soda—Lima—Unhealthy country—Ruins of Callao, overthrown by an earthquake—Recent subsidence—Elevated shells on San Lorenzo, their decomposition—Plain with embedded shells and fragments of pottery—Antiquity of the Indian Race.

NORTHERN CHILE AND PERU.

April 27th.—I SET out on a journey to Coquimbo, and thence through Guasco to Copiapó, where Captain Fitz Roy kindly offered to pick me up in the Beagle. The distance in a straight line along the shore northward is only 420 miles; but my mode of travelling made it a very long journey. I bought four horses and two mules, the latter carrying the luggage on alternate days. The six animals together only cost the value of twenty-five pounds sterling, and at Copiapó I sold them again for twenty-three. We travelled in the same independent manner as before, cooking our own meals, and sleeping in the open air. As we rode towards the Viño del Mar, I took a farewell view of Valparaiso, and admired its picturesque appearance. For geological purposes I made a detour from the high road to the foot of the Bell of Quillota. We passed through an alluvial district rich in gold, to the neighbourhood of Limache, where we slept. Washing for gold supports the inhabitants of numerous hovels, scattered along the sides of each little rivulet; but, like all those whose gains are uncertain, they are unthrifty in their habits, and consequently poor.

28th.—In the afternoon we arrived at a cottage at the foot of the Bell mountain. The inhabitants were freeholders, which is not very usual in Chile. They supported themselves on the produce of a gar-

den and a little field, but were very poor. Capital is here so deficient, that the people are obliged to sell their green corn while standing in the field, in order to buy necessaries for the ensuing year. Wheat in consequence was dearer in the very district of its production than at Valparaiso, where the contractors live. The next day we joined the main road to Coquimbo. At night there was a very light shower of rain: this was the first drop that had fallen since the heavy rain of September 11th and 12th, which detained me a prisoner at the Baths of Cauquenes. The interval was seven and a half months; but the rain this year in Chile was rather later than usual. The distant Andes were now covered by a thick mass of snow; and were a glorious sight.

May 2nd.—The road continued to follow the coast, at no great distance from the sea. The few trees and bushes which are common in central Chile decreased rapidly in numbers, and were replaced by a tall plant, something like a yucca in appearance. The surface of the country, on a small scale, was singularly broken and irregular; abrupt little peaks of rock rising out of small plains or basins. The indented coast and the bottom of the neighbouring sea, studded with breakers, would, if converted into dry land, present similar forms; and such a conversion without doubt has taken place in the part over which we rode.

3rd.—Quilimari to Conchalee. The country became more and more barren. In the valleys there was scarcely sufficient water for any irrigation; and the intermediate land was quite bare, not supporting even goats. In the spring, after the winter showers, a thin pasture rapidly springs up, and cattle are then driven down from the Cordillera to graze for a short time. It is curious to observe how the seeds of the grass and other plants seem to accommodate themselves, as if by an acquired habit, to the quantity of rain which falls on different parts of this coast. One shower far northward at Copiapó produces as great an effect on the vegetation, as two at Guasco, and as three or four in this district. At Valparaiso a winter so dry as greatly to injure the pasture, would at Guasco produce the most unusual abundance. Proceeding northward, the quantity of rain does not appear to decrease in strict proportion to the latitude. At Conchalee, which is only 67 miles north of Valparaiso, rain is not expected till the end of May; whereas, at Valparaiso some generally falls early in April: the annual

quantity is likewise small in proportion to the lateness of the season at which it commences.

4th.—Finding the coast-road devoid of interest of any kind, we turned inland towards the mining district and valley of Illapel. This valley, like every other in Chile, is level, broad, and very fertile: it is bordered on each side, either by cliffs of stratified shingle, or by bare rocky mountains. Above the straight line of the uppermost irrigating ditch, all is brown as on a high road; while all below is of as bright a green as verdigris, from the beds of alfarfa, a kind of clover. We proceeded to Los Hornos, another mining district, where the principal hill was drilled with holes, like a great ants'-nest. The Chilian miners are a peculiar race of men in their habits. Living for weeks together in the most desolate spots, when they descend to the villages on feast-days, there is no excess or extravagance into which they do not run. They sometimes gain a considerable sum, and then, like sailors with prize-money, they try how soon they can contrive to squander it. They drink excessively, buy quantities of clothes, and in a few days return penniless to their miserable abodes, there to work harder than beasts of burden. This thoughtlessness, as with sailors, is evidently the result of a similar manner of life. Their daily food is found them, and they acquire no habits of carefulness; moreover, temptation and the means of yielding to it are placed in their power at the same time. On the other hand, in Cornwall, and some other parts of England, where the system of selling part of the vein is followed, the miners, from being obliged to act and think for themselves, are a singularly intelligent and well-conducted set of men.

The dress of the Chilian miner is peculiar and rather picturesque. He wears a very long shirt of some dark-coloured baize, with a leathern apron; the whole being fastened round his waist by a bright-coloured sash. His trowsers are very broad, and his small cap of scarlet cloth is made to fit the head closely. We met a party of these miners in full costume, carrying the body of one of their companions to be buried. They marched at a very quick trot, four men supporting the corpse. One set having run as hard as they could for about two hundred yards, were relieved by four others, who had previously dashed on ahead on horseback. Thus they proceeded, encouraging each other by wild cries: altogether the scene formed a most strange funeral.

We continued travelling northward, in a zigzag line; sometimes stopping a day to geologise. The country was so thinly inhabited, and the track so obscure, that we often had difficulty in finding our way. On the 12th I stayed at some mines. The ore in this case was not considered particularly good, but from being abundant it was supposed the mine would sell for about thirty or forty thousand dollars (that is, 6000 or 8000 pounds sterling); yet it had been bought by one of the English Associations for an ounce of gold (3l. 8s.). The ore is yellow pyrites, which, as I have already remarked, before the arrival of the English, was not supposed to contain a particle of copper. On a scale of profits nearly as great as in the above instance, piles of cinders, abounding with minute globules of metallic copper, were purchased; yet with these advantages, the mining associations, as is well known, contrived to lose immense sums of money. The folly of the greater number of the commissioners and shareholders amounted to infatuation;—a thousand pounds per annum given in some cases to entertain the Chilian authorities; libraries of well-bound geological books: miners brought out for particular metals, as tin, which are not found in Chile; contracts to supply the miners with milk, in parts where there are no cows; machinery, where it could not possibly be used; and a hundred similar arrangements, bore witness to our absurdity, and to this day afford amusement to the natives. Yet there can be no doubt, that the same capital well employed in these mines would have yielded an immense return: a confidential man of business, a practical miner and assayer, would have been all that was required.

Captain Head has described the wonderful load which the “Apires,” truly beasts of burden, carry up from the deepest mines. I confess I thought the account exaggerated; so that I was glad to take an opportunity of weighing one of the loads, which I picked out by hazard. It required considerable exertion on my part, when standing directly over it, to lift it from the ground. The load was considered under weight when found to be 197 pounds. The apire had carried this up eighty perpendicular yards,—part of the way by a steep passage, but the greater part up notched poles, placed in a zigzag line up the shaft. According to the general regulation, the apire is not allowed to halt for breath, except the mine is six hundred feet deep. The average load is considered as rather more than 200 pounds, and I have been assured that one of 300 pounds (twenty-two stone and a half) by way

of a trial has been brought up from the deepest mine! At this time the apires were bringing up the usual load twelve times in the day; that is, 2400 pounds from eighty yards deep; and they were employed in the intervals in breaking and picking ore.

These men, excepting from accidents, are healthy, and appear cheerful. Their bodies are not very muscular. They rarely eat meat once a week, and never oftener, and then only the hard dry charqui. Although with a knowledge that the labour was voluntary, it was nevertheless quite revolting to see the state in which they reached the mouth of the mine; their bodies bent forward, leaning with their arms on the steps, their legs bowed, their muscles quivering, the perspiration streaming from their faces over their breasts, their nostrils distended, the corners of their mouth forcibly drawn back, and the expulsion of their breath most laborious. Each time they draw their breath, they utter an articulate cry of "ay-ay," which ends in a sound rising from deep in the chest, but shrill like the note of a fife. After staggering to the pile of ore, they emptied the "carpacho;" in two or three seconds recovering their breath, they wiped the sweat from their brows, and apparently quite fresh descended the mine again at a quick pace. This appears to me a wonderful instance of the amount of labour which habit, for it can be nothing else, will enable a man to endure.

In the evening, talking with the *mayor-domo* of these mines, about the number of foreigners now scattered over the whole country, he told me that, though quite a young man, he remembers when he was a boy at school at Coquimbo, a holiday being given to see the captain of an English ship, who was brought to the city to speak to the governor. He believes that nothing would have induced any boy in the school, himself included, to have gone close to the Englishman; so deeply had they been impressed with an idea of the heresy, contamination, and evil to be derived from contact with such a person. To this day they relate the atrocious actions of the bucaniers; and especially of one man, who took away the figure of the Virgin Mary, and returned the year after for that of St. Joseph, saying it was a pity the lady should not have a husband. I heard also of an old lady who, at a dinner in Coquimbo, remarked how wonderfully strange it was that she should have lived to dine in the same room with an Englishman; for she remembered as a girl, that twice, at the mere cry of "Los

Ingleses," every soul, carrying what valuables they could, had taken to the mountains.

14th.—We reached Coquimbo, where we stayed a few days. The town is remarkable for nothing but its extreme quietness. It is said to contain from 6000 to 8000 inhabitants. On the morning of the 17th it rained lightly, the first time this year, for about five hours. The farmers, who plant corn near the sea-coast where the atmosphere is more humid, taking advantage of this shower, would break up the ground; after a second they would put the seed in; and if a third shower should fall, they would reap a good harvest in the spring. It was interesting to watch the effect of this trifling amount of moisture. Twelve hours afterwards the ground appeared as dry as ever; yet after an interval of ten days, all the hills were faintly tinged with green patches; the grass being sparingly scattered in hair-like fibres a full inch in length. Before this shower every part of the surface was bare as on a high road.

In the evening, Captain Fitz Roy and myself were dining with Mr. Edwards, an English resident well known for his hospitality by all who have visited Coquimbo, when a sharp earthquake happened. I heard the forecoming rumble, but from the screams of the ladies, the running of the servants, and the rush of several of the gentlemen to the doorway, I could not distinguish the motion. Some of the women afterwards were crying with terror, and one gentleman said he should not be able to sleep all night, or if he did, it would only be to dream of falling houses. The father of this person had lately lost all his property at Talcahuano, and he himself had only just escaped a falling roof at Valparaiso, in 1822. He mentioned a curious coincidence which then happened: he was playing at cards, when a German, one of the party, got up, and said he would never sit in a room in these countries with the door shut, as, owing to his having done so, he had nearly lost his life at Copiapó. Accordingly he opened the door; and no sooner had he done this, than he cried out, "Here it comes again!" and the famous shock commenced. The whole party escaped. The danger in an earthquake is not from the time lost in opening a door, but from the chance of its becoming jammed by the movement of the walls.

It is impossible to be much surprised at the fear which natives and old residents, though some of them known to be men of great com-

mand of mind, so generally experience during earthquakes. I think, however, this excess of panic may be partly attributed to a want of habit in governing their fear, as it is not a feeling they are ashamed of. Indeed, the natives do not like to see a person indifferent. I heard of two Englishmen who, sleeping in the open air during a smart shock, knowing that there was no danger, did not rise. The natives cried out indignantly, "Look at those heretics, they will not even get out of their beds!"

I spent some days in examining the step-formed terraces of shingle, first noticed by Captain B. Hall, and believed by Mr. Lyell to have been formed by the sea, during the gradual rising of the land. This certainly is the true explanation, for I found numerous shells of existing species on these terraces. Five narrow, gently sloping, fringe-like terraces rise one behind the other, and where best developed are formed of shingle: they front the bay, and sweep up both sides of the valley. At Guasco, north of Coquimbo, the phenomenon is displayed on a much grander scale, so as to strike with surprise even some of the inhabitants. The terraces are there much broader, and may be called plains; in some parts there are six of them, but generally only five; they run up the valley for thirty-seven miles from the coast. These step-formed terraces or fringes closely resemble those in the valley of S. Cruz, and except in being on a smaller scale, those great ones along the whole coast-line of Patagonia. They have undoubtedly been formed by the denuding power of the sea, during long periods of rest in the gradual elevation of the continent.

Shells of many existing species not only lie on the surface of the terraces at Coquimbo (to a height of 250 feet), but are embedded in a friable calcareous rock, which in some places is as much as between twenty and thirty feet in thickness, but is of little extent. These modern beds rest on an ancient tertiary formation containing shells, apparently all extinct. Although I examined so many hundred miles of coast on the Pacific, as well as Atlantic side of the continent, I found no regular strata containing sea-shells of recent species, excepting at this place, and at a few points northward on the road to Guasco. This fact appears to me highly remarkable; for the explanation generally given by geologists, of the absence in any district of stratified fossiliferous deposits of a given period, namely, that the

surface then existed as dry land, is not here applicable; for we know from the shells strewed on the surface and embedded in loose sand or mould, that the land for thousands of miles along both coasts has lately been submerged. The explanation, no doubt, must be sought in the fact, that the whole southern part of the continent has been for a long time slowly rising; and therefore that all matter deposited along shore in shallow water, must have been soon brought up and slowly exposed to the wearing action of the sea-beach; and it is only in comparatively shallow water that the greater number of marine organic beings can flourish, and in such water it is obviously impossible that strata of any great thickness can accumulate. To show the vast power of the wearing action of sea-beaches, we need only appeal to the great cliffs along the present coast of Patagonia, and to the escarpments or ancient sea-cliffs at different levels, one above another, on that same line of coast.

The old underlying tertiary formation at Coquimbo, appears to be of about the same age with several deposits on the coast of Chile (of which that of Navedad is the principal one), and with the great formation of Patagonia. Both at Navedad and in Patagonia there is evidence, that since the shells (a list of which has been seen by Professor E. Forbes) there intombed were living, there has been a subsidence of several hundred feet, as well as an ensuing elevation. It may naturally be asked, how it comes that, although no extensive fossiliferous deposits of the recent period, nor of any period intermediate between it and the ancient tertiary epoch, have been preserved on either side of the continent, yet that at this ancient tertiary epoch, sedimentary matter containing fossil remains, should have been deposited and preserved at different points in north and south lines, over a space of 1100 miles on the shores of the Pacific, and of at least 1350 miles on the shores of the Atlantic, and in an east and west line of 700 miles across the widest part of the continent? I believe the explanation is not difficult, and that it is perhaps applicable to nearly analogous facts observed in other quarters of the world. Considering the enormous power of denudation which the sea possesses, as shown by numberless facts, it is not probable that a sedimentary deposit, when being upraised, could pass through the ordeal of the beach, so as to be preserved in sufficient masses to last to a distant period, without it were originally of wide extent and of considerable thickness: now

it is impossible on a moderately shallow bottom, which alone is favourable to most living creatures, that a thick and widely extended covering of sediment could be spread out, without the bottom sank down to receive the successive layers. This seems to have actually taken place at about the same period in southern Patagonia and Chile, though these places are a thousand miles apart. Hence, if prolonged movements of approximately contemporaneous subsidence are generally widely extensive, as I am strongly inclined to believe from my examination of the Coral Reefs of the great oceans—or if, confining our view to South America, the subsiding movements have been coextensive with those of elevation, by which, within the same period of existing shells, the shores of Peru, Chile, Tierra del Fuego, Patagonia, and La Plata have been upraised—then we can see that at the same time, at far distant points, circumstances would have been favourable to the formation of fossiliferous deposits, of wide extent and of considerable thickness; and such deposits, consequently, would have a good chance of resisting the wear and tear of successive beach-lines, and of lasting to a future epoch.

May 21st.—I set out in company with Don Jose Edwards to the silver-mine of Arqueros, and thence up the valley of Coquimbo. Passing through a mountainous country, we reached by nightfall the mines belonging to Mr. Edwards. I enjoyed my night's rest here from a reason which will not be fully appreciated in England, namely, the absence of fleas! The rooms in Coquimbo swarm with them; but they will not live here at the height of only three or four thousand feet: it can scarcely be the trifling diminution of temperature, but some other cause which destroys these troublesome insects at this place. The mines are now in a bad state, though they formerly yielded about 2000 pounds in weight of silver a year. It has been said that "a person with a copper-mine will gain; with silver, he may gain; but with gold, he is sure to lose." This is not true: all the large Chilean fortunes have been made by mines of the more precious metals. A short time since an English physician returned to England from Copiapó, taking with him the profits of one share in a silver-mine, which amounted to about 24,000 pounds sterling. No doubt a copper-mine with care is a sure game, whereas the other is gambling, or rather taking a ticket in a lottery. The owners lose great quantities of rich ores; for

no precautions can prevent robberies. I heard of a gentleman laying a bet with another, that one of his men should rob him before his face. The ore when brought out of the mine is broken into pieces, and the useless stone thrown on one side. A couple of the miners who were thus employed, pitched, as if by accident, two fragments away at the same moment, and then cried out for a joke, "Let us see which rolls furthest." The owner, who was standing by, bet a cigar with his friend on the race. The miner by this means watched the very point amongst the rubbish where the stone lay. In the evening he picked it up and carried it to his master, showing him a rich mass of silver-ore, and saying, "This was the stone on which you won a cigar by its rolling so far."

May 23rd.—We descended into the fertile valley of Coquimbo, and followed it till we reached an Hacienda belonging to a relation of Don Jose, where we stayed the next day. I then rode one day's journey further, to see what were declared to be some petrified shells and beans, which latter turned out to be small quartz pebbles. We passed through several small villages; and the valley was beautifully cultivated, and the whole scenery very grand. We were here near the main Cordillera, and the surrounding hills were lofty. In all parts of northern Chile, fruit-trees produce much more abundantly at a considerable height near the Andes than in the lower country. The figs and grapes of this district are famous for their excellence, and are cultivated to a great extent. This valley is, perhaps, the most productive one north of Quillota: I believe it contains, including Coquimbo, 25,000 inhabitants. The next day I returned to the Hacienda, and thence, together with Don Jose, to Coquimbo.

June 2nd.—We set out for the valley of Guasco, following the coast-road, which was considered rather less desert than the other. Our first day's ride was to a solitary house, called Yerba Buena, where there was pasture for our horses. The shower mentioned as having fallen a fortnight ago, only reached about halfway to Guasco; we had, therefore, in the first part of our journey a most faint tinge of green, which soon faded quite away. Even where brightest, it was scarcely sufficient to remind one of the fresh turf and budding flowers of the spring of other countries. While travelling through these deserts one feels like a prisoner shut up in a gloomy court, who longs to see something green and to smell a moist atmosphere.

June 3rd.—Yerba Buena to Carizal. During the first part of the day we crossed a mountainous rocky desert, and afterwards a long deep sandy plain, strewn with broken sea-shells. There was very little water, and that little saline: the whole country, from the coast to the Cordillera, is an uninhabited desert. I saw traces only of one living animal in abundance, namely, the shells of a *Bulimus*, which were collected together in extraordinary numbers on the driest spots. In the spring one humble little plant sends out a few leaves, and on these the snails feed. As they are seen only very early in the morning, when the ground is slightly damp with dew, the Guasos believe that they are bred from it. I have observed in other places that extremely dry and sterile districts, where the soil is calcareous, are extraordinarily favourable to land-shells. At Carizal there were a few cottages, some brackish water, and a trace of cultivation: but it was with difficulty that we purchased a little corn and straw for our horses.

4th.—Carizal to Sauce. We continued to ride over desert plains, tenanted by large herds of guanaco. We crossed also the valley of Chañeral; which, although the most fertile one between Guasco and Coquimbo, is very narrow, and produces so little pasture, that we could not purchase any for our horses. At Sauce we found a very civil old gentleman, superintending a copper-smelting furnace. As an especial favour, he allowed me to purchase at a high price an armful of dirty straw, which was all the poor horses had for supper after their long day's journey. Few smelting-furnaces are now at work in any part of Chile; it is found more profitable, on account of the extreme scarcity of firewood, and from the Chilean method of reduction being so unskilful, to ship the ore for Swansea. The next day we crossed some mountains to Freyrina, in the valley of Guasco. During each day's ride further northward, the vegetation became more and more scanty; even the great chandelier-like cactus was here replaced by a different and much smaller species. During the winter months, both in northern Chile and in Peru, a uniform bank of clouds hangs, at no great height, over the Pacific. From the mountains we had a very striking view of this white and brilliant aerial-field, which sent arms up the valleys, leaving islands and promontories in the same manner, as the sea does in the Chonos archipelago and in Tierra del Fuego.

We stayed two days at Freyrina. In the valley of Guasco there are four small towns. At the mouth there is the port, a spot entirely des-

ert, and without any water in the immediate neighbourhood. Five leagues higher up stands Freyrina, a long straggling village, with decent whitewashed houses. Again, ten leagues further up Ballenar is situated; and above this Guasco Alto, a horticultural village, famous for its dried fruit. On a clear day the view up the valley is very fine; the straight opening terminates in the far-distant snowy Cordillera; on each side an infinity of crossing lines are blended together in a beautiful haze. The foreground is singular from the number of parallel and step-formed terraces; and the included strip of green valley, with its willow-bushes, is contrasted on both hands with the naked hills. That the surrounding country was most barren will be readily believed, when it is known that a shower of rain had not fallen during the last thirteen months. The inhabitants heard with the greatest envy of the rain at Coquimbo; from the appearance of the sky they had hopes of equally good fortune, which, a fortnight afterwards, were realized. I was at Copiapó at the time; and there the people, with equal envy, talked of the abundant rain at Guasco. After two or three very dry years, perhaps with not more than one shower during the whole time, a rainy year generally follows; and this does more harm than even the drought. The rivers swell, and cover with gravel and sand the narrow strips of ground, which alone are fit for cultivation. The floods also injure the irrigating ditches. Great devastation had thus been caused three years ago.

June 8th.—We rode on to Ballenar, which takes its name from Ballenagh in Ireland, the birthplace of the family of O'Higgins, who, under the Spanish government, were presidents and generals in Chile. As the rocky mountains on each hand were concealed by clouds, the terrace-like plains gave to the valley an appearance like that of Santa Cruz in Patagonia. After spending one day at Ballenar I set out, on the 10th, for the upper part of the valley of Copiapó. We rode all day over an uninteresting country. I am tired of repeating the epithets barren and sterile. These words, however, as commonly used, are comparative; I have always applied them to the plains of Patagonia, which can boast of spiny bushes and some tufts of grass; and this is absolute fertility, as compared with northern Chile. Here again, there are not many spaces of two hundred yards square, where some little bush, cactus or lichen, may not be discovered by careful examination; and in the soil seeds lie dormant ready to spring up

during the first rainy winter. In Peru real deserts occur over wide tracts of country. In the evening we arrived at a valley, in which the bed of the streamlet was damp: following it up, we came to tolerably good water. During the night, the stream, from not being evaporated and absorbed so quickly, flows a league lower down than during the day. Sticks were plentiful for firewood, so that it was a good place of bivouac for us; but for the poor animals there was not a mouthful to eat.

June 11th.—We rode without stopping for twelve hours, till we reached an old smelting-furnace, where there was water and firewood; but our horses again had nothing to eat, being shut up in an old courtyard. The line of road was hilly, and the distant views interesting from the varied colours of the bare mountains. It was almost a pity to see the sun shining constantly over so useless a country; such splendid weather ought to have brightened fields and pretty gardens. The next day we reached the valley of Copiapó. I was heartily glad of it; for the whole journey was a continued source of anxiety; it was most disagreeable to hear, whilst eating our own suppers, our horses gnawing the posts to which they were tied, and to have no means of relieving their hunger. To all appearance, however, the animals were quite fresh; and no one could have told that they had eaten nothing for the last fifty-five hours.

I had a letter of introduction to Mr. Bingley, who received me very kindly at the Hacienda of Potrero Seco. This estate is between twenty and thirty miles long, but very narrow, being generally only two fields wide, one on each side the river. In some parts the estate is of no width, that is to say, the land cannot be irrigated, and therefore is valueless, like the surrounding rocky desert. The small quantity of cultivated land in the whole line of valley, does not so much depend on inequalities of level, and consequent unfitness for irrigation, as on the small supply of water. The river this year was remarkably full: here, high up the valley, it reached to the horse's belly, and was about fifteen yards wide, and rapid; lower down it becomes smaller and smaller, and is generally quite lost, as happened during one period of thirty years, so that not a drop entered the sea. The inhabitants watch a storm over the Cordillera with great interest; as one good fall of snow provides them with water for the ensuing year. This is of infinitely more consequence than rain in the lower country. Rain,

as often as it falls, which is about once in every two or three years, is a great advantage, because the cattle and mules can for some time afterwards find a little pasture on the mountains. But without snow on the Andes, desolation extends throughout the valley. It is on record that three times nearly all the inhabitants have been obliged to emigrate to the south. This year there was plenty of water, and every man irrigated his ground as much as he chose; but it has frequently been necessary to post soldiers at the sluices, to see that each estate took only its proper allowance during so many hours in the week. The valley is said to contain 12,000 souls, but its produce is sufficient only for three months in the year; the rest of the supply being drawn from Valparaiso and the south. Before the discovery of the famous silver-mines of Chanuncillo, Copiapó was in a rapid state of decay; but now it is in a very thriving condition; and the town, which was completely overthrown by an earthquake, has been rebuilt.

The valley of Copiapó, forming a mere ribbon of green in a desert, runs in a very southerly direction; so that it is of considerable length to its source in the Cordillera. The valleys of Guasco and Copiapó may both be considered as long narrow islands, separated from the rest of Chile by deserts of rock instead of by salt water. Northward of these, there is one other very miserable valley, called Paposo, which contains about two hundred souls; and then there extends the real desert of Atacama—a barrier far worse than the most turbulent ocean. After staying a few days at Potrero Seco, I proceeded up the valley to the house of Don Benito Cruz, to whom I had a letter of introduction. I found him most hospitable; indeed it is impossible to bear too strong testimony to the kindness, with which travellers are received in almost every part of South America. The next day I hired some mules to take me by the ravine of Jolquera into the central Cordillera. On the second night the weather seemed to foretel a storm of snow or rain, and whilst lying in our beds we felt a trifling shock of an earthquake.

The connexion between earthquakes and the weather has been often disputed: it appears to me to be a point of great interest, which is little understood. Humboldt has remarked in one part of the Personal Narrative,* that it would be difficult for any person who had

* Vol. iv. p. 11, and vol. ii. p. 217. For the remarks on Guayaquil see Silliman's Journ. vol. xxiv. p. 384. For those on Tacna by Mr. Hamilton,

long resided in New Andalusia, or in Lower Peru, to deny that there exists some connexion between these phenomena: in another part, however, he seems to think the connexion fanciful. At Guayaquil, it is said that a heavy shower in the dry season is invariably followed by an earthquake. In Northern Chile, from the extreme infrequency of rain, or even of weather foreboding rain, the probability of accidental coincidences becomes very small; yet the inhabitants are here most firmly convinced of some connexion between the state of the atmosphere and of the trembling of the ground: I was much struck by this, when mentioning to some people at Copiapó that there had been a sharp shock at Coquimbo: they immediately cried out, "How fortunate! there will be plenty of pasture there this year." To their minds an earthquake foretold rain, as surely as rain foretold abundant pasture. Certainly it did so happen that on the very day of the earthquake, that shower of rain fell, which I have described as in ten days' time producing a thin sprinkling of grass. At other times, rain has followed earthquakes, at a period of the year when it is a far greater prodigy than the earthquake itself: this happened after the shock of November, 1822, and again in 1829, at Valparaiso; also after that of September, 1833, at Tacna. A person must be somewhat habituated to the climate of these countries, to perceive the extreme improbability of rain falling at such seasons, except as a consequence of some law quite unconnected with the ordinary course of the weather. In the cases of great volcanic eruptions, as that of Coseguina, where torrents of rain fell at a time of the year most unusual for it, and "almost unprecedented in Central America," it is not difficult to understand that the volumes of vapour and clouds of ashes might have disturbed the atmospheric equilibrium. Humboldt extends this view to the case of earthquakes unaccompanied by eruptions; but I can hardly conceive it possible, that the small quantity of aëriform fluids which then escape from the fissured ground, can produce such remarkable effects. There appears much probability in the view first proposed by Mr. P. Scrope, that when the barometer is low, and when rain might naturally be expected to fall, the diminished pressure of

see *Trans. of British Association*, 1840. For those on Coseguina see Mr. Caldcleugh in *Phil. Trans.*, 1835. In the former edition, I collected several references on the coincidences between sudden falls in the barometer and earthquakes; and between earthquakes and meteors.

the atmosphere over a wide extent of country, might well determine the precise day on which the earth, already stretched to the utmost by the subterranean forces, should yield, crack, and consequently tremble. It is, however, doubtful how far this idea will explain the circumstance of torrents of rain falling in the dry season during several days, after an earthquake unaccompanied by an eruption; such cases seem to bespeak some more intimate connexion between the atmospheric and subterranean regions.

Finding little of interest in this part of the ravine, we retraced our steps to the house of Don Benito, where I stayed two days collecting fossil shells and wood. Great prostrate silicified trunks of trees, embedded in a conglomerate, were extraordinarily numerous. I measured one, which was fifteen feet in circumference: how surprising it is that every atom of the woody matter in this great cylinder should have been removed and replaced by silex so perfectly, that each vessel and pore is preserved! These trees flourished at about the period of our lower chalk; they all belonged to the fir-tribe. It was amusing to hear the inhabitants discussing the nature of the fossil shells which I collected, almost in the same terms as were used a century ago in Europe,—namely, whether or not they had been thus “born by nature.” My geological examination of the country generally created a good deal of surprise amongst the Chilenos: it was long before they could be convinced that I was not hunting for mines. This was sometimes troublesome: I found the most ready way of explaining my employment, was to ask them how it was that they themselves were not curious concerning earthquakes and volcanos?—why some springs were hot and others cold?—why there were mountains in Chile, and not a hill in La Plata? These bare questions at once satisfied and silenced the greater number; some, however (like a few in England who are a century behindhand), thought that all such inquiries were useless and impious; and that it was quite sufficient that God had thus made the mountains.

An order had recently been issued that all stray dogs should be killed, and we saw many lying dead on the road. A great number had lately gone mad, and several men had been bitten and had died in consequence. On several occasions hydrophobia has prevailed in this valley. It is remarkable thus to find so strange and dreadful a disease, appearing time after time in the same isolated spot. It has been

remarked that certain villages in England are in like manner much more subject to this visitation than others. Dr. UnanÁ¹e states that hydrophobia was first known in South America in 1803: this statement is corroborated by Azara and Ulloa having never heard of it in their time. Dr. UnanÁ¹e says that it broke out in Central America, and slowly travelled southward. It reached Arequipa in 1807; and it is said that some men there, who had not been bitten, were affected, as were some negroes, who had eaten a bullock which had died of hydrophobia. At Ica forty-two people thus miserably perished. The disease came on between twelve and ninety days after the bite; and in those cases where it did come on, death ensued invariably within five days. After 1808, a long interval ensued without any cases. On inquiry, I did not hear of hydrophobia in Van Diemen's Land, or in Australia; and Burchell says, that during the five years he was at the Cape of Good Hope, he never heard of an instance of it. Webster asserts that at the Azores hydrophobia has never occurred; and the same assertion has been made with respect to Mauritius and St. Helena.* In so strange a disease, some information might possibly be gained by considering the circumstances under which it originates in distant climates; for it is improbable that a dog already bitten, should have been brought to these distant countries.

At night, a stranger arrived at the house of Don Benito, and asked permission to sleep there. He said he had been wandering about the mountains for seventeen days, having lost his way. He started from Guasco, and being accustomed to travelling in the Cordillera, did not expect any difficulty in following the track to Copiapó; but he soon became involved in a labyrinth of mountains, whence he could not escape. Some of his mules had fallen over precipices, and he had been in great distress. His chief difficulty arose from not knowing where to find water in the lower country, so that he was obliged to keep bordering the central ranges.

We returned down the valley, and on the 22nd reached the town of Copiapó. The lower part of the valley is broad, forming a fine plain like that of Quillota. The town covers a considerable space of

* *Observa. sobre el clima de Lima*, p.67.—Azara's Travels, vol. i. p. 381—Ulloa's Voyage, vol. ii. p. 28.—Burchell's Travels, vol. ii. p. 524—Webster's Description of the Azores, p. 124.—Voyage Á l'Isle de France par un Officier du Roi, tome i. p. 248.—Description of St. Helena, p. 123.

ground, each house possessing a garden: but it is an uncomfortable place, and the dwellings are poorly furnished. Every one seems bent on the one object of making money, and then migrating as quickly as possible. All the inhabitants are more or less directly concerned with mines; and mines and ores are the sole subjects of conversation. Necessaries of all sorts are extremely dear; as the distance from the town to the port is eighteen leagues, and the land carriage very expensive. A fowl costs five or six shillings; meat is nearly as dear as in England; firewood, or rather sticks, are brought on donkeys from a distance of two and three days' journey within the Cordillera; and pasturage for animals is a shilling a day: all this for South America is wonderfully exorbitant.

June 26th.—I hired a guide and eight mules to take me into the Cordillera by a different line from my last excursion. As the country was utterly desert, we took a cargo and a half of barley mixed with chopped straw. About two leagues above the town, a broad valley called the “Despoblado,” or uninhabited, branches off from that one by which we had arrived. Although a valley of the grandest dimensions, and leading to a pass across the Cordillera, yet it is completely dry, excepting perhaps for a few days during some very rainy winter. The sides of the crumbling mountains were furrowed by scarcely any ravines; and the bottom of the main valley, filled with shingle, was smooth and nearly level. No considerable torrent could ever have flowed down this bed of shingle; for if it had, a great cliff-bounded channel, as in all the southern valleys, would assuredly have been formed. I feel little doubt that this valley, as well as those mentioned by travellers in Peru, were left in the state we now see them by the waves of the sea, as the land slowly rose. I observed in one place, where the Despoblado was joined by a ravine (which in almost any other chain would have been called a grand valley), that its bed, though composed merely of sand and gravel, was higher than that of its tributary. A mere rivulet of water, in the course of an hour, would have cut a channel for itself; but it was evident that ages had passed away, and no such rivulet had drained this great tributary. It was curious to behold the machinery, if such a term may be used, for the drainage, all, with the last trifling exception, perfect, yet without any signs of action. Every one must have remarked how mud-banks, left

by the retiring tide, imitate in miniature a country with hill and dale; and here we have the original model in rock, formed as the continent rose during the secular retirement of the ocean, instead of during the ebbing and flowing of the tides. If a shower of rain falls on the mud-bank, when left dry, it deepens the already formed shallow lines of excavation; and so is it with the rain of successive centuries on the bank of rock and soil, which we call a continent.

We rode on after it was dark, till we reached a side ravine with a small well, called "Agua amarga." The water deserved its name, for besides being saline it was most offensively putrid and bitter; so that we could not force ourselves to drink either tea or maté. I suppose the distance from the river of Copiapó to this spot was at least twenty-five or thirty English miles; in the whole space there was not a single drop of water, the country deserving the name of desert in the strictest sense. Yet about halfway we passed some old Indian ruins near Punta Gorda: I noticed also in front of some of the valleys, which branch off from the Despoblado, two piles of stones placed a little way apart, and directed so as to point up the mouths of these small valleys. My companions knew nothing about them, and only answered my queries by their imperturbable "quien sabe?"

I observed Indian ruins in several parts of the Cordillera: the most perfect, which I saw, were the Ruinas de Tambillos, in the Uspallata Pass. Small square rooms were there huddled together in separate groups: some of the doorways were yet standing; they were formed by a cross slab of stone only about three feet high. Ulloa has remarked on the lowness of the doors in the ancient Peruvian dwellings. These houses, when perfect, must have been capable of containing a considerable number of persons. Tradition says, that they were used as halting places for the Incas, when they crossed the mountains. Traces of Indian habitations have been discovered in many other parts, where it does not appear probable that they were used as mere resting-places, but yet where the land is as utterly unfit for any kind of cultivation as it is near the Tambillos or at the Incas Bridge, or in the Portillo Pass, at all which places I saw ruins. In the ravine of Jajuel, near Aconcagua, where there is no pass, I heard of remains of houses situated at a great height, where it is extremely cold and sterile. At first I imagined that these buildings had been places of refuge, built by the Indians on the first arrival of the Spaniards; but

I have since been inclined to speculate on the probability of a small change of climate.

In this northern part of Chile, within the Cordillera, old Indian houses are said to be especially numerous: by digging amongst the ruins, bits of woollen articles, instruments of precious metals, and heads of Indian corn, are not unfrequently discovered: an arrow-head made of agate, and of precisely the same form with those now used in Tierra del Fuego, was given me. I am aware that the Peruvian Indians now frequently inhabit most lofty and bleak situation; but at Copiapó I was assured by men who had spent their lives in travelling through the Andes, that there were very many (*muchisimas*) buildings at heights so great as almost to border on the perpetual snow, and in parts where there exist no passes, and where the land produces absolutely nothing, and what is still more extraordinary, where there is no water. Nevertheless it is the opinion of the people of the country (although they are much puzzled by the circumstance), that, from the appearance of the houses, the Indians must have used them as places of residence. In this valley, at Punta Gorda, the remains consisted of seven or eight square little rooms, which were of a similar form with those at Tambillos, but built chiefly of mud, which the present inhabitants cannot, either here or, according to Ulloa, in Peru, imitate in durability. They were situated in the most conspicuous and defenceless position, at the bottom of the flat broad valley. There was no water nearer than three or four leagues, and that only in very small quantity, and bad: the soil was absolutely sterile; I looked in vain even for a lichen adhering to the rocks. At the present day, with the advantage of beasts of burden, a mine, unless it were very rich, could scarcely be worked here with profit. Yet the Indians formerly chose it as a place of residence! If at the present time two or three showers of rain were to fall annually, instead of one, as now is the case, during as many years, a small rill of water would probably be formed in this great valley; and then, by irrigation (which was formerly so well understood by the Indians), the soil would easily be rendered sufficiently productive to support a few families.

I have convincing proofs that this part of the continent of South America has been elevated near the coast at least from 400 to 500, and in some parts from 1000 to 1300 feet, since the epoch of existing shells; and further inland the rise possibly may have been greater. As

the peculiarly arid character of the climate is evidently a consequence of the height of the Cordillera, we may feel almost sure that before the later elevations, the atmosphere could not have been so completely drained of its moisture as it now is; and as the rise has been gradual, so would have been the change in climate. On this notion of a change of climate since the buildings were inhabited, the ruins must be of extreme antiquity, but I do not think their preservation under the Chilian climate any great difficulty. We must also admit on this notion, (and this perhaps is a greater difficulty) that man has inhabited South America for an immensely long period, inasmuch as any change of climate effected by the elevation of the land must have been extremely gradual. At Valparaiso, within the last 220 years, the rise has been somewhat less than 19 feet: at Lima a sea-beach has certainly been upheaved from 80 to 90 feet, within the Indio-human period: but such small elevations could have had little power in deflecting the moisture-bringing atmospheric currents. Dr. Lund, however, found human skeletons in the caves of Brazil, the appearance of which induced him to believe that the Indian race has existed during a vast lapse of time in South America.

When at Lima, I conversed on these subjects with Mr. Gill, a civil engineer, who had seen much of the interior country. He told me that a conjecture of a change of climate had sometimes crossed his mind; but that he thought that the greater portion of land, now incapable of cultivation, but covered with Indian ruins, had been reduced to this state by the water-conduits, which the Indians formerly constructed on so wonderful a scale, having been injured by neglect and by subterranean movements. I may here mention, that the Peruvians actually carried their irrigating streams in tunnels through hills of solid rock. Mr. Gill told me, he had been employed professionally to examine one; he found the passage low, narrow, crooked, and not of uniform breadth, but of very considerable length. Is it not most wonderful that men should have attempted such operations, without the use of iron or gunpowder? Mr. Gill also mentioned to me a most

* Temple, in his travels through Upper Peru, or Bolivia, in going from Potosi to Oruro, says, "I saw many Indian villages or dwellings in ruins, up even to the very tops of the mountains, attesting a former population where now all is desolate." He makes similar remarks in another place; but I cannot tell whether this desolation has been caused by a want of population, or by an altered condition of the land.

interesting, and, as far as I am aware, quite unparalleled case, of a subterranean disturbance having changed the drainage of a country. Travelling from Casma to Huaraz (not very far distant from Lima), he found a plain covered with ruins and marks of ancient cultivation, but now quite barren. Near it was the dry course of a considerable river, whence the water for irrigation had formerly been conducted. There was nothing in the appearance of the watercourse, to indicate that the river had not flowed there a few years previously; in some parts, beds of sand and gravel were spread out; in others, the solid rock had been worn into a broad channel, which in one spot was about 40 yards in breadth and 8 feet deep. It is self-evident that a person following up the course of a stream, will always ascend at a greater or less inclination: Mr. Gill, therefore, was much astonished, when walking up the bed of this ancient river, to find himself suddenly going down hill. He imagined that the downward slope had a fall of about 40 or 50 feet perpendicular. We here have unequivocal evidence that a ridge had been uplifted right across the old bed of a stream. From the moment the river-course was thus arched, the water must necessarily have been thrown back, and a new channel formed. From that moment, also, the neighbouring plain must have lost its fertilizing stream, and become a desert.

June 27th.—We set out early in the morning, and by mid-day reached the ravine of Paypote, where there is a tiny rill of water, with a little vegetation, and even a few algarroba trees, a kind of mimosa. From having fire-wood, a smelting-furnace had formerly been built here: we found a solitary man in charge of it, whose sole employment was hunting guanacos. At night it froze sharply; but having plenty of wood for our fire, we kept ourselves warm.

28th.—We continued gradually ascending, and the valley now changed into a ravine. During the day we saw several guanacos, and the track of the closely-allied species, the Vicuña: this latter animal is pre-eminently alpine in its habits; it seldom descends much below the limit of perpetual snow, and therefore haunts even a more lofty and sterile situation than the guanaco. The only other animal which we saw in any number was a small fox: I suppose this animal preys on the mice and other small rodents, which, as long as there is the least vegetation, subsist in considerable numbers in very desert places. In

Patagonia, even on the borders of the salinas, where a drop of fresh water can never be found, excepting dew, these little animals swarm. Next to lizards, mice appear to be able to support existence on the smallest and driest portions of the earth,—even on islets in the midst of great oceans.

The scene on all sides showed desolation, brightened and made palpable by a clear, unclouded sky. For a time such scenery is sublime, but this feeling cannot last, and then it becomes uninteresting. We bivouacked at the foot of the “*primera linea*,” or the first line of the partition of the waters. The streams, however, on the east side do not flow to the Atlantic, but into an elevated district, in the middle of which there is a large salina, or salt lake;—thus forming a little Caspian Sea at the height, perhaps, of ten thousand feet. Where we slept, there were some considerable patches of snow, but they do not remain throughout the year. The winds in these lofty regions obey very regular laws: every day a fresh breeze blows up the valley, and at night, an hour or two after sunset, the air from the cold regions above descends as through a funnel. This night it blew a gale of wind, and the temperature must have been considerably below the freezing-point, for water in a vessel soon became a block of ice. No clothes seemed to oppose any obstacle to the air; I suffered very much from the cold, so that I could not sleep, and in the morning rose with my body quite dull and benumbed.

In the Cordillera further southward, people lose their lives from snow-storms; here, it sometimes happens from another cause. My guide, when a boy of fourteen years old, was passing the Cordillera with a party in the month of May; and while in the central parts, a furious gale of wind arose, so that the men could hardly cling on their mules, and stones were flying along the ground. The day was cloudless, and not a speck of snow fell, but the temperature was low. It is probable that the thermometer would not have stood very many degrees below the freezing-point, but the effect on their bodies, ill protected by clothing, must have been in proportion to the rapidity of the current of cold air. The gale lasted for more than a day; the men began to lose their strength, and the mules would not move onwards. My guide’s brother tried to return, but he perished, and his body was found two years afterwards, lying by the side of his mule near the road, with the bridle still in his hand. Two other men in

the party lost their fingers and toes; and out of two hundred mules and thirty cows, only fourteen mules escaped alive. Many years ago the whole of a large party are supposed to have perished from a similar cause, but their bodies to this day have never been discovered. The union of a cloudless sky, low temperature, and a furious gale of wind, must be, I should think, in all parts of the world, an unusual occurrence.

June 29th.—We gladly travelled down the valley to our former night's lodging, and thence to near the Agua amarga. On July 1st we reached the valley of Copiapô. The smell of the fresh clover was quite delightful, after the scentless air of the dry sterile Desoblado. Whilst staying in the town I heard an account from several of the inhabitants, of a hill in the neighbourhood which they called "El Bramador,"—the roarer or bellower. I did not at the time pay sufficient attention to the account; but, as far as I understood, the hill was covered by sand, and the noise was produced only when people, by ascending it, put the sand in motion. The same circumstances are described in detail on the authority of Seetzen and Ehrenberg,* as the cause of the sounds which have been heard by many travellers on Mount Sinai near the Red Sea. One person with whom I conversed, had himself heard the noise; he described it as very surprising; and he distinctly stated that, although he could not understand how it was caused, yet it was necessary to set the sand rolling down the acclivity. A horse walking over dry and coarse sand, causes a peculiar chirping noise from the friction of the particles; a circumstance which I several times noticed on the coast of Brazil.

Three days afterwards I heard of the Beagle's arrival at the Port, distant eighteen leagues from the town. There is very little land cultivated down the valley; its wide expanse supports a wretched wiry grass, which even the donkeys can hardly eat. This poorness of the vegetation is owing to the quantity of saline matter with which the soil is impregnated. The Port consists of an assemblage of miserable little hovels, situated at the foot of a sterile plain. At present, as the river contains water enough to reach the sea, the inhabitants enjoy the advantage of having fresh water within a mile and a half. On

* Edinburgh Phil. Journ., Jan. 1830, p. 74; and April, 1830, p. 258.—Also Daubeny on Volcanoes, p. 438; and Bengal Journ., vol. vii. p. 324.

the beach there were large piles of merchandise, and the little place had an air of activity. In the evening I gave my adios, with a hearty good-will, to my companion Mariano Gonzales, with whom I had ridden so many leagues in Chile. The next morning the Beagle sailed for Iquique.

July 12th.—We anchored in the port of Iquique, in lat. $20^{\circ} 12'$, on the coast of Peru. The town contains about a thousand inhabitants, and stands on a little plain of sand at the foot of a great wall of rock, 2000 feet in height, here forming the coast. The whole is utterly desert. A light shower of rain falls only once in very many years; and the ravines consequently are filled with detritus, and the mountain-sides covered by piles of fine white sand, even to a height of a thousand feet. During this season of the year a heavy bank of clouds, stretched over the ocean, seldom rises above the wall of rocks on the coast. The aspect of the place was most gloomy; the little port, with its few vessels, and small group of wretched houses, seemed overwhelmed and out of all proportion with the rest of the scene.

The inhabitants live like persons on board a ship: every necessary comes from a distance: water is brought in boats from Pisagua, about forty miles northward, and is sold at the rate of nine reals (4s. 6d.) an eighteen-gallon cask: I bought a wine-bottle full for threepence. In like manner firewood, and of course every article of food, is imported. Very few animals can be maintained in such a place: on the ensuing morning I hired with difficulty, at the price of four pounds sterling, two mules and a guide to take me to the nitrate of soda works. These are at present the support of Iquique. This salt was first exported in 1830: in one year an amount in value of one hundred thousand pounds sterling, was sent to France and England. It is principally used as a manure and in the manufacture of nitric acid: owing to its deliquescent property it will not serve for gunpowder. Formerly there were two exceedingly rich silver-mines in this neighbourhood, but their produce is now very small.

Our arrival in the offing caused some little apprehension. Peru was in a state of anarchy; and each party having demanded a contribution, the poor town of Iquique was in tribulation, thinking the evil hour was come. The people had also their domestic troubles; a short time before, three French carpenters had broken open, during the

same night, the two churches, and stolen all the plate: one of the robbers, however, subsequently confessed, and the plate was recovered. The convicts were sent to Arequipa, which, though the capital of this province, is two hundred leagues distant; the government there thought it a pity to punish such useful workmen, who could make all sorts of furniture; and accordingly liberated them. Things being in this state, the churches were again broken open, but this time the plate was not recovered. The inhabitants became dreadfully enraged, and declaring that none but heretics would thus “eat God Almighty,” proceeded to torture some Englishmen, with the intention of afterwards shooting them. At last the authorities interfered, and peace was established.

13th.—In the morning I started for the saltpetre-works, a distance of fourteen leagues. Having ascended the steep coast-mountains by a zigzag sandy track, we soon came in view of the mines of Guantajaya and St. Rosa. These two small villages are placed at the very mouths of the mines; and being perched up on hills, they had a still more unnatural and desolate appearance than the town of Iquique. We did not reach the saltpetre-works till after sunset, having ridden all day across an undulating country, a complete and utter desert. The road was strewed with the bones and dried skins of the many beasts of burden which had perished on it from fatigue. Excepting the Vultur aura, which preys on the carcasses, I saw neither bird, quadruped, reptile, nor insect. On the coast-mountains, at the height of about 2000 feet, where during this season the clouds generally hang, a very few cacti were growing in the clefts of rock; and the loose sand was strewed over with a lichen, which lies on the surface quite unattached. This plant belongs to the genus *Cladonia*, and somewhat resembles the reindeer lichen. In some parts it was in sufficient quantity to tinge the sand, as seen from a distance, of a pale yellowish colour. Further inland, during the whole ride of fourteen leagues, I saw only one other vegetable production, and that was a most minute yellow lichen, growing on the bones of the dead mules. This was the first true desert which I had seen: the effect on me was not impressive; but I believe this was owing to my having become gradually accustomed to such scenes, as I rode northward from Valparaiso, through Coquimbo, to Copiapó. The appearance of the country was remarkable, from being covered by a thick crust of common salt, and

of a stratified saliferous alluvium, which seems to have been deposited as the land slowly rose above the level of the sea. The salt is white, very hard, and compact: it occurs in water-worn nodules projecting from the agglutinated sand, and is associated with much gypsum. The appearance of this superficial mass very closely resembled that of a country after snow, before the last dirty patches are thawed. The existence of this crust of a soluble substance over the whole face of the country, shows how extraordinarily dry the climate must have been for a long period.

At night I slept at the house of the owner of one of the saltpetre mines. The country is here as unproductive as near the coast; but water, having rather a bitter and brackish taste, can be procured by digging wells. The well at this house was thirty-six yards deep: as scarcely any rain falls, it is evident the water is not thus derived; indeed if it were, it could not fail to be as salt as brine, for the whole surrounding country is incrustated with various saline substances. We must therefore conclude that it percolates under ground from the Cordillera, though distant many leagues. In that direction there are a few small villages, where the inhabitants, having more water, are enabled to irrigate a little land, and raise hay, on which the mules and asses, employed in carrying the saltpetre, are fed. The nitrate of soda was now selling at the ship's side at fourteen shillings per hundred pounds: the chief expense is its transport to the sea-coast. The mine consists of a hard stratum, between two and three feet thick, of the nitrate mingled with a little of the sulphate of soda and a good deal of common salt. It lies close beneath the surface, and follows for a length of one hundred and fifty miles the margin of a grand basin or plain; this, from its outline, manifestly must once have been a lake, or more probably an inland arm of the sea, as may be inferred from the presence of iodide salts in the saline stratum. The surface of the plain is 3300 feet above the Pacific.

19th.—We anchored in the Bay of Callao, the seaport of Lima, the capital of Peru. We stayed here six weeks, but from the troubled state of public affairs, I saw very little of the country. During our whole visit the climate was far from being so delightful, as it is generally represented. A dull heavy bank of clouds constantly hung over the land, so that during the first sixteen days I had only one view of the

Cordillera behind Lima. These mountains, seen in stages, one above the other, through openings in the clouds, had a very grand appearance. It is almost become a proverb, that rain never falls in the lower part of Peru. Yet this can hardly be considered correct; for during almost every day of our visit there was a thick drizzling mist, which was sufficient to make the streets muddy and one's clothes damp: this the people are pleased to call Peruvian dew. That much rain does not fall is very certain, for the houses are covered only with flat roofs made of hardened mud; and on the mole ship-loads of wheat were piled up, being thus left for weeks together without any shelter.

I cannot say I liked the very little I saw of Peru: in summer, however, it is said that the climate is much pleasanter. In all seasons, both inhabitants and foreigners suffer from severe attacks of ague. This disease is common on the whole coast of Peru, but is unknown in the interior. The attacks of illness which arise from miasma never fail to appear most mysterious. So difficult is it to judge from the aspect of a country, whether or not it is healthy, that if a person had been told to choose within the tropics a situation appearing favourable for health, very probably he would have named this coast. The plain round the outskirts of Callao is sparingly covered with a coarse grass, and in some parts there are a few stagnant, though very small, pools of water. The miasma, in all probability, arises from these: for the town of Arica was similarly circumstanced, and its healthiness was much improved by the drainage of some little pools. Miasma is not always produced by a luxuriant vegetation with an ardent climate; for many parts of Brazil, even where there are marshes and a rank vegetation, are much more healthy than this sterile coast of Peru. The densest forests in a temperate climate, as in Chiloe, do not seem in the slightest degree to affect the healthy condition of the atmosphere.

The island of St. Jago, at the Cape de Verds, offers another strongly-marked instance of a country, which any one would have expected to find most healthy, being very much the contrary. I have described the bare and open plains as supporting, during a few weeks after the rainy season, a thin vegetation, which directly withers away and dries up: at this period the air appears to become quite poisonous; both natives and foreigners often being affected with violent fevers. On the other hand, the Galapagos Archipelago, in the Pacific, with a similar soil, and periodically subject to the same process of veg-

etation, is perfectly healthy. Humboldt has observed, that, “under the torrid zone, the smallest marshes are the most dangerous, being surrounded, as at Vera Cruz and Carthagena, with an arid and sandy soil, which raises the temperature of the ambient air.”* On the coast of Peru, however, the temperature is not hot to any excessive degree; and perhaps in consequence, the intermittent fevers are not of the most malignant order. In all unhealthy countries the greatest risk is run by sleeping on shore. Is this owing to the state of the body during sleep, or to a greater abundance of miasma at such times? It appears certain that those who stay on board a vessel, though anchored at only a short distance from the coast, generally suffer less than those actually on shore. On the other hand, I have heard of one remarkable case where a fever broke out among the crew of a man-of-war some hundred miles off the coast of Africa, and at the very same time that one of those fearful periods[†] of death commenced at Sierra Leone.

No State in South America, since the declaration of independence, has suffered more from anarchy than Peru. At the time of our visit, there were four chiefs in arms contending for supremacy in the government: if one succeeded in becoming for a time very powerful, the others coalesced against him; but no sooner were they victorious, than they were again hostile to each other. The other day, at the Anniversary of the Independence, high mass was performed, the President partaking of the sacrament: during the *Te Deum laudamus*, instead of each regiment displaying the Peruvian flag, a black one with death's head was unfurled. Imagine a government under which such a scene could be ordered, on such an occasion, to be typical of their determination of fighting to death! This state of affairs happened at a time very unfortunately for me, as I was precluded from taking any excursions much beyond the limits of the town. The barren island of S. Lorenzo, which forms the harbour, was nearly the only place where one could walk securely. The upper part, which is upwards of 1000 feet in height, during this season of the year (winter), comes within the lower limit of the clouds; and in consequence, an abun-

* Political Essay on the Kingdom of New Spain, vol. iv. p. 199.

† A similar interesting case is recorded in the Madras Medical Quart. Journ., 1839, p. 340. Dr. Ferguson, in his admirable Paper (see 9th vol. of Edinburgh Royal Trans.), shows clearly that the poison is generated in the drying process; and hence that dry hot countries are often the most unhealthy.

dant cryptogamic vegetation, and a few flowers, cover the summit. On the hills near Lima, at a height but little greater, the ground is carpeted with moss, and beds of beautiful yellow lilies, called Amancaes. This indicates a very much greater degree of humidity, than at a corresponding height at Iquique. Proceeding northward of Lima, the climate becomes damper, till on the banks of the Guyaquil, nearly under the equator, we find the most luxuriant forests. The change, however, from the sterile coast of Peru to that fertile land is described as taking place rather abruptly in the latitude of Cape Blanco, two degrees south of Guyaquil.

Callao is a filthy, ill-built, small seaport. The inhabitants, both here and at Lima, present every imaginable shade of mixture, between European, Negro, and Indian blood. They appear a depraved, drunken set of people. The atmosphere is loaded with foul smells, and that peculiar one, which may be perceived in almost every town within the tropics, was here very strong. The fortress, which withstood Lord Cochrane's long siege, has an imposing appearance. But the President, during our stay, sold the brass guns, and proceeded to dismantle parts of it. The reason assigned was, that he had not an officer to whom he could trust so important a charge. He himself had good reasons for thinking so, as he had obtained the presidency by rebelling while in charge of this same fortress. After we left South America, he paid the penalty in the usual manner, by being conquered, taken prisoner, and shot.

Lima stands on a plain in a valley, formed during the gradual retreat of the sea. It is seven miles from Callao, and is elevated 500 feet above it; but from the slope being very gradual, the road appears absolutely level; so that when at Lima it is difficult to believe one has ascended even one hundred feet: Humboldt has remarked on this singularly deceptive case. Steep, barren hills rise like islands from the plain, which is divided, by straight mud-walls, into large green fields. In these scarcely a tree grows excepting a few willows, and an occasional clump of bananas and of oranges. The city of Lima is now in a wretched state of decay: the streets are nearly unpaved; and heaps of filth are piled up in all directions, where the black gallinazos, tame as poultry, pick up bits of carrion. The houses have generally an upper story, built, on account of the earthquakes, of plastered woodwork; but some of the old ones, which are now used by several families, are

immensely large, and would rival in suites of apartments the most magnificent in any place. Lima, the City of the Kings, must formerly have been a splendid town. The extraordinary number of churches gives it, even at the present day, a peculiar and striking character, especially when viewed from a short distance.

One day I went out with some merchants to hunt in the immediate vicinity of the city. Our sport was very poor; but I had an opportunity of seeing the ruins of one of the ancient Indian villages, with its mound like a natural hill in the centre. The remains of houses, enclosures, irrigating streams, and burial mounds, scattered over this plain, cannot fail to give one a high idea of the condition and number of the ancient population. When their earthenware, woollen clothes, utensils of elegant forms cut out of the hardest rocks, tools of copper, ornaments of precious stones, palaces, and hydraulic works, are considered, it is impossible not to respect the considerable advance made by them in the arts of civilization. The burial mounds, called Huacas, are really stupendous; although in some places they appear to be natural hills incased and modelled.

There is also another and very different class of ruins, which possesses some interest, namely, those of old Callao, overwhelmed by the great earthquake of 1746, and its accompanying wave. The destruction must have been more complete even than at Talcahuano. Quantities of shingle almost conceal the foundations of the walls, and vast masses of brickwork appear to have been whirled about like pebbles by the retiring waves. It has been stated that the land subsided during this memorable shock: I could not discover any proof of this; yet it seems far from improbable, for the form of the coast must certainly have undergone some change since the foundation of the old town; as no people in their senses would willingly have chosen for their building place, the narrow spit of shingle on which the ruins now stand. Since our voyage, M. Tschudi has come to the conclusion, by the comparison of old and modern maps, that the coast both north and south of Lima has certainly subsided.

On the island of San Lorenzo, there are very satisfactory proofs of elevation within the recent period; this of course is not opposed to the belief, of a small sinking of the ground having subsequently taken place. The side of this island fronting the Bay of Callao, is worn into three obscure terraces, the lower one of which is covered by a

bed a mile in length, almost wholly composed of shells of eighteen species, now living in the adjoining sea. The height of this bed is eighty-five feet. Many of the shells are deeply corroded, and have a much older and more decayed appearance than those at the height of 500 or 600 feet on the coast of Chile. These shells are associated with much common salt, a little sulphate of lime (both probably left by the evaporation of the spray, as the land slowly rose), together with sulphate of soda and muriate of lime. They rest on fragments of the underlying sandstone, and are covered by a few inches thick of detritus. The shells, higher up on this terrace, could be traced scaling off in flakes, and falling into an impalpable powder; and on an upper terrace, at the height of 170 feet, and likewise at some considerably higher points, I found a layer of saline powder of exactly similar appearance, and lying in the same relative position. I have no doubt that this upper layer originally existed as a bed of shells, like that on the eighty-five-foot ledge; but it does not now contain even a trace of organic structure. The powder has been analysed for me by Mr. T. Reeks; it consists of sulphates and muriates both of lime and soda, with very little carbonate of lime. It is known that common salt and carbonate of lime left in a mass for some time together, partly decompose each other; though this does not happen with small quantities in solution. As the half-decomposed shells in the lower parts are associated with much common salt, together with some of the saline substances composing the upper saline layer, and as these shells are corroded and decayed in a remarkable manner, I strongly suspect that this double decomposition has here taken place. The resultant salts, however, ought to be carbonate of soda and muriate of lime; the latter is present, but not the carbonate of soda. Hence I am led to imagine that by some unexplained means, the carbonate of soda becomes changed into the sulphate. It is obvious that the saline layer could not have been preserved in any country in which abundant rain occasionally fell: on the other hand, this very circumstance, which at first sight appears so highly favourable to the long preservation of exposed shells, has probably been the indirect means, through the common salt not having been washed away, of their decomposition and early decay.

I was much interested by finding on the terrace, at the height of eighty-five feet, *embedded* amidst the shells and much sea-drift-

ed rubbish, some bits of cotton thread, plaited rush, and the head of a stalk of Indian corn: I compared these relics with similar ones taken out of the Huacas, or old Peruvian tombs, and found them identical in appearance. On the mainland in front of San Lorenzo, near Bellavista, there is an extensive and level plain about a hundred feet high, of which the lower part is formed of alternating layers of sand and impure clay, together with some gravel, and the surface, to the depth of from three to six feet, of a reddish loam, containing a few scattered sea-shells and numerous small fragments of coarse red earthenware, more abundant at certain spots than at others. At first I was inclined to believe that this superficial bed, from its wide extent and smoothness, must have been deposited beneath the sea; but I afterwards found in one spot, that it lay on an artificial floor of round stones. It seems, therefore, most probable that at a period when the land stood at a lower level, there was a plain very similar to that now surrounding Callao, which being protected by a shingle beach, is raised but very little above the level of the sea. On this plain, with its underlying red-clay beds, I imagine that the Indians manufactured their earthen vessels; and that, during some violent earthquake, the sea broke over the beach, and converted the plain into a temporary lake, as happened round Callao in 1713 and 1746. The water would then have deposited mud, containing fragments of pottery from the kilns, more abundant at some spots than at others, and shells from the sea. This bed with fossil earthenware, stands at about the same height with the shells on the lower terrace of San Lorenzo, in which the cotton-thread and other relics were embedded. Hence we may safely conclude, that within the Indo-human period there has been an elevation, as before alluded to, of more than eighty-five feet; for some little elevation must have been lost by the coast having subsided since the old maps were engraved. At Valparaiso, although in the 220 years before our visit, the elevation cannot have exceeded nineteen feet, yet subsequently to 1817 there has been a rise, partly insensible and partly by a start during the shock of 1822, of ten or eleven feet. The antiquity of the Indo-human race here, judging by the eighty-five feet rise of the land since the relics were embedded, is the more remarkable, as on the coast of Patagonia, when the land stood about the same number of feet lower, the *Macrauchenia* was a living beast; but as the Patagonian coast is some way distant from the

Cordillera, the rising there may have been slower than here. At Bahia Blanca, the elevation has been only a few feet since the numerous gigantic quadrupeds were there entombed; and, according to the generally received opinion, when these extinct animals were living, man did not exist. But the rising of that part of the coast of Patagonia, is perhaps noways connected with the Cordillera, but rather with a line of old volcanic rocks in Banda Oriental, so that it may have been infinitely slower than on the shores of Peru. All these speculations, however, must be vague; for who will pretend to say, that there may not have been several periods of subsidence, intercalated between the movements of elevation; for we know that along the whole coast of Patagonia, there have certainly been many and long pauses in the upward action of the elevatory forces.