

great fertility, but also mosquitoes, sand-flies, and sand-fleas, besides the danger of climatic fevers, intermittent fevers, bilious fevers, and putrid fevers; on the east coast the yellow fever appears, which is only met with on the shores of the Atlantic.

From 2500 to 4500 feet above the sea a sub-tropical climate is found, with an average temperature of 18° Reaumur. Many tropical plants flourish here even; but the air is fresher, the disposition to fever is not met with unless local causes are at hand, for example, marshes; the troublesome insects occur only in the dense forests, and near the streams, as during the summer in Europe.

On the mountains, up to 6000 feet, the average temperature is from 15 to 16° Reaumur, the climate of a European spring; it is perfectly healthy, and fit for the cultivation of the cerealiæ, and all the fruits of Southern Europe. All the plains and hills, situated from 6000 to 8000 feet above the sea, have a temperature, on the average not exceeding 14°. They exhibit the products of Central Europe, have a pure wholesome air, and so equal a climate, that the natives of every zone can settle here without anxiety.

It will hardly be necessary to observe, that this is only a medium estimation. From the 16th to the 34th degree of north latitude, the isothermal lines cannot be the same; they decline towards the north, and ascend towards the south; thus, in order to be precise, one would be compelled to possess the meteorological observations of a long series of years, of different transverse sections from one sea to the other. These, however, do not exist. The result, however, is certain, that we find in Mexico every climate, the proper elevation for every branch of agriculture; and that this country can grow all the vegetable products of the earth, and thus be independent of every other country.

VIII.

VOLCANOES.

The workings of Nature in her profoundest laboratories are concealed from us; we see merely the results of mighty forces, sometimes heaving up mountains from the abyss, sometimes crumbling them to atoms, and often changing the appearance of whole districts within a few hours. In Mexico vast revolutions have been effected by volcanic agency; the cyclopean forges, indeed, are for the most part cold, but the subterranean fires are not everywhere extinct, and occasionally burst forth here or there, committing the most extensive ravages, or convulsing the earth with terrific spasms.

In the south a succession of volcanoes passing from Oajaca through Chiapas are connected with the burning mountains of Guatemala. Cempoaltepec, one of



VOLCAN JORULLO

the loftiest points of the Cordilleras of Oajaca, is a volcanic cone; the frequent earthquakes on the plateaus of Oajaca always appear at the same time as those of Guatemala, so that a complete assemblage of volcanic agencies would appear to exist here.

The chief range of the Mexican volcanoes lies between the 19th and 20th degrees of north latitude, and may be traced from the Atlantic to the South Sea across the whole country. Near the Gulf shores, about 60 miles from Vera Cruz, the isolated mountain range of Tustla or San Martin rears itself above the plain. It is evident that the whole range must have swollen up like a vast bladder, and subsequently have been cleft by repeated eruptions and falling in. The highest point is about 3000 feet above the sea; several craters are visible, and also a round, very deep lake of fresh water on a little plateau on the south-west side, indicating a sunken hollow. In 1789 the last eruption of this volcano took place, which was preceded by an earthquake and subterranean thunder. A vast cloud of ashes was cast up to an incredible height, and carried off by the east-west current of air. In the towns situated 20 miles to the west, the ashes lay several inches deep in the streets and on the roofs, and even on the opposite side of the mountain, 8 miles off, in the village of Perote, everything was covered with ashes. Since then the volcano has been at rest, but in the depths sounds as of distant thunder may be remarked. I have ever heard it myself, especially towards the autumn. From the western heights it may distinctly be observed in the direction of Tustla, and the natives then say: "The Tustla grows!" The dwellers on the Tustla range, however, fancy they distinguish it in the direction of the Peak of Orizava, and call it, the thunder of Orizava. There is evidently a subterranean communication between the two mountains, as not only several volcanic summits rise on this line, but the earthquakes are felt most distinctly in this direction.

Orizava, the loftiest mountain of the eastern chain, exhibits at the first glance its volcanic origin; it forms a majestic cone, whilst on the magnificent snowy peak, somewhat to the east of the highest ridge, the vast crater is distinctly seen. Fifty years after the arrival of the Spaniards in Mexico, in 1569, the last eruption happened, which appears, however, not to have been accompanied by a discharge of lava. The eruption lasted almost without interruption twenty years, and this, perhaps, accounts for the opinion entertained in the following centuries, that the ascent of the mountain was impossible. In 1848 some North American officers were said to have attained the summit, but no one in the country believed it. Three years later, on the 26th March 1851, a party of 18 young men undertook the ascent. They passed the night at the point where vegetation ceases, at sunrise (6 o'clock) reached the ice, and commenced their dangerous expedition. Few only of the party (which consisted of two Frenchmen, one Englishman, one American, one Belgian, and 13 Mexicans) reached the edge of the crater; after a slight attempt, half of them returned exhausted. Six of the others attained a ridge of rocks, about half way up the snowy cone, on the north side, whence the ascent

took place, and which can be perceived from the sea. Here they rested, enjoyed the magnificent prospect, and then returned. The Frenchman, Alexander Doignon, after a fatiguing ascent of five hours and a half reached the highest point. The day was perfectly clear, the air pure and transparent, and not the slightest cloud obscured the lowlands. To the east the blue surface of the Atlantic, and Vera Cruz were distinctly seen, the whole of the coast and the bright prairies; the towns of Orizava and Cordova, St. Juan, Huatusco and Jalapa, the indented mountain-chain from north and south, the plateaus with their numerous villages and lakes, bounded by the snowy range of Popocatepetl; the immense landscape lay extended before the astonished gaze of the adventurer like a gigantic drawing. The crater lies something to the south-east of the highest point, and the crater is some hundred feet lower down. At the edge of the crater Doignon found a flag-staff six feet long, bearing the date 1848, and part of a North American flag, affording proof that the honour of having made the first ascent is due to the Americans. Only two of Doignon's companions, Majorus, a Belgian, and Contreras, a Mexican, reached the edge of the crater, though completely exhausted; the rarity of the atmosphere rendered the respiratory process difficult, blood flowed from their mouths, so that they were soon forced to return. Experiments made with the thermometer and with boiling water, shewed the height to be 18,178 feet (?). Severe headache, and extremely painful inflammation of the eyes was the consequence of this ascent.

The inhabitants of the little town of St. Andres, on the west side of the volcano, doubted the truth of Doignon's story, and this incited his ambition to venture on a second ascent, a week subsequent to the first, on the 4th April 1851. He was accompanied by a number of Mexicans, who, however, after a slight attempt, quitted him when they had reached the snow. This time the ascent was attended with great risk. Fresh snow had fallen, and covered the former track, the chasms and fissures were concealed by it, at every step he sank in the loose snow, carrying at the same time a flag staff 18 feet long (2½ inches thick), and a large flag, which he had wound about his body like a scarf. He arrived at the above-mentioned lofty rocks in safety. Here he missed the path, and went more eastwards (to the left) than the first time. An enormous chasm extending about half a league in a semi-circle, 25 feet wide, and 400 deep, consisting within of terrace-like masses of ice, impeded his progress. Some fragile bridges of ice afforded the only means of passing it. He ventured across, met with and crossed several fissures, encountered the greatest dangers, owing his miraculous preservation to his mental and bodily elasticity. Near the summit a steep wall of ice interposed itself, the exertion of climbing which called for all his remaining energies; exhausted, trembling, every moment in danger of being precipitated into the abyss, he at length surmounted this last obstacle, and was now able to rest for a time. At first he was shrouded in a dense fog, which, however, soon fell below the snowy cone. To the north-east, he perceived a succession of isolated rocks, several hundred feet high, rising like a ruined wall. The snow extended to the edge of the crater, within which, on the

"From the hills of Aguascalco nearly to the villages of Teipan and Petatlan, both known for their excellent cotton-plantations, a wide plain extends, about 2200 to 2500 feet above the sea. Some basalt ranges rise in the midst of a district, in which green-stone porphyry predominates. The summits are decked with olive-leaved and willow-leaved oaks, alternating with graceful palms — a beautiful vegetation, contrasting strangely with the bare plain, burnt up by volcanic fire.

"Till the middle of the eighteenth century, there were large fields of sugarcane and indigo between the rivulets of Cuitimba and San Pedro; they were surrounded with basalt-mountains, whose formation seems to indicate, that in remote antiquity, the country was much disturbed by volcanoes. The fields belonged to the "hacienda" San Pedro Jorullo, one of the largest and richest in the neighbourhood. In the month of June 1759 subterranean rumblings were heard: terrific peals of thunder were accompanied by frequent shocks of an earthquake, which for fifty or sixty days filled the population with fear and dismay.

"At the beginning of September everything seemed to announce perfect tranquillity, when suddenly on the night of the 28th, an awful subterranean disturbance broke out. The terrified Indians fled to the mountains of Aguascalco, and soon after, a whole district, some square miles in extent, called Malpais, rose like a bladder. The limits of the phenomenon may be recognized by the stratification of the soil. At its edge the raised mass is only 12 metres above the old level of the plain of Jorullo. But towards the centre the elevation gradually increases till it attains the height of 160 metres.

"The witnesses of this grand phenomenon, which they observed from the mountains of Aguascalco, affirm, that they saw flames issuing from a space of more than half a square league in extent, that large red-hot masses of rock were hurled up to an enormous height, and that, through a dense cloud of ashes, they beheld reflected in the volcanic fire, the mollified surface of the earth swelling up like a turbulent sea. The rivulets Cuitimba and San Pedro were then lost in the burning scoræ. The decomposition of the water increased the ardour of the flames, so that the fire was seen in Pascuaro, a town nineteen leagues from Jorullo, situated on a plateau, 1400 metres higher than the volcano.

"Thousands of small cones, from 6 to 10 feet high, termed by the natives hornitos, (little stoves), cover the rounded surface of Malpais. In the midst of these little cones on a rent from south-south-west, to north-north-east, six mountains were heaved up above the original level of the plain, each being from 400 to 500 metres high. The loftiest is the volcano of Jorullo; it is still in operation, and on the north side has discharged an infinite mass of scoriated basaltic lava, containing fragments of primitive rock.

"The chief eruptions lasted till 1760, when they became rarer. The Indians, who in their terror at the fearful rumblings of the new volcano, had quitted their villages for six or eight leagues round, gradually accustomed themselves to the awful spectacle. They returned to their huts, and ventured to descend from the mountains

of Aguascalco and Santa Inés, in order to admire the magnificent fiery fountains, cast up through numerous larger and smaller openings. On this occasion the ashes covered the roofs of Queretaro, 48 leagues from the volcano in a straight line."

Forty four years after Humboldt had visited the volcanoes, the subterranean fire was less active, and vegetation appeared on all sides; nevertheless the thermometer rose in the shade to 43° C. Persons well acquainted with the fact, affirm, that for several years after the eruption the heat was insufferable, and the vast plain therefore uninhabited. To the present day the traveller is shewn the beds of Cuatimba and San Pedro, whose crystal waters once fertilised the estate of Don Andres Pimentel. In the fatal night of the 29th September the sources were dried up, but 3000 paces further to the west, in the raised district, two brooks now burst forth from the calcareous cones of the "hornitos" as hot springs, their temperature being about 50° C. Far below the surface the sound of a great mass of water is heard flowing from east to west, and near the hacienda "Presentacion" runs a brook, 14 to 18 feet wide, developing an extraordinary quantity of sulphurated hydrogen gas.

According to the latest measurements, the absolute height of this volcano is 4004 feet, the elevation above the plain 1223 feet. The cone is very steep, with a slope of 45°. The principal crater is on a great cleft; and it has several smaller craters; the temperature of the exhalations is now from 45 to 55° C., that of the sides and clefts much higher. In the crater, there are everywhere deposits of pure sulphur of every gradation of colour, from scarlet to pale yellow. The temperature of the atmosphere in the raised plain, which Humboldt found to be 43°, is now only 24° in the shade.

The list of active volcanoes ends with Colima, which was formerly deemed extinct, but of late years exhibited several eruptions, casting forth ashes only, and discharging mud.

The whole succession of volcanic mountains in Mexico, from Tustla on the Gulf, to Colima, traverses the mountain-range at right angles, and all seem to stand on a great rent or cleft in the firm crust of the earth; even Jorullo, the most recent in its origin, exhibits a cleft far down in the crater, at a right angle with the mountains. Frequent observations have shewn that, for the last twenty years the earthquakes were most severely felt in the volcanic line, and that the shocks were more from east to west, or *vice versa*. They were also remarked on the whole line from the South Sea to the Atlantic, with a variation of but few minutes, and decreased in severity towards the north and south, so that, whilst they cast down buildings, or rent the earth on the chief line, the shocks were scarcely felt at a distance of a few miles on either side.

Of the many earthquakes I have experienced there, one in particular is impressed on my recollection, which I observed between the volcanoes of Toluca and Popocatepetl. It was on a hot summer's afternoon; I was sitting with my friend St. . . before a miner's hut, on a hill affording an uninterrupted view of the plain towards Toluca. The air was sultry, and the calm atmosphere filled with a greyish

violet vapour. Suddenly a low rumbling, like thunder, was heard, proceeding, as it were, from the depths of Toluca, which seemed to approach with an undulating motion. We started up, and gazed anxiously in the direction of the phenomenon. The trees in the plain and on the mountains, rocked as though on the point of being uprooted; our horses, which were tied up at a short distance from us, snorted and reared; the ground trembled, the beams of the house creaked, and the shingles of the roofs rattled as in a mill-work. The people rushed out of their dwellings, fell on their knees, and sang: "Santo Dios, santo fuerte, santo imortal, libra nos Sennor de todo mal." All this was the appearance of a few moments. The subterranean thunder had subsided eastwards, before we well knew what had happened. The agitated appearance of the people, and the trembling of the horses alone assured us that the mighty spirit of earth had shaken the foundations of his abode.

Never shall I forget the impression made on me by an earthquake in the profound depths of a mine. The awful roll of the thunder seemed to issue from the rocks on every side, the solid mountain reeled, stones fell here and there, and amidst all was heard the hymn of the miners resounding from the pits and galleries. The shock lasted about 10 seconds, and after a slight pause, was repeated; but was of shorter duration. In both cases no misfortune happened. Mexico, however, does not always escape with such impunity; for only a year or two ago several buildings were destroyed in the capital, and many injured. The shock was very severely felt on the whole volcanic line, and moreover almost at the same instant from one sea to the other.

IX.

THE CHASMS (BARRANCAS), CAVES, WATERFALLS.

Amongst the peculiarities of Mexico, are the deep, almost perpendicular rents, those wonderful chasms, which are so frequent in all parts of the country. The greater part are met with between the mountains and the sea; but even on the tableland they are not uncommon. A great part of the east coast is so rent by chasms, mostly directing their course from east to west, that one can scarcely travel a league from south to north, without finding the road interrupted by these perpendicular abysses. Many of these chasms may have been formed when the country was convulsed by plutonic agency, and the horizontal deposits of the conglomerate would seem to bear out this opinion; others, on the contrary are clearly volcanic hollows; whilst others are doubtless produced by the resistless force of the mountain-torrents.