

III. *An Account of the great Earthquake experienced in Chile on the 20th of February, 1835 ; with a Map.* By ALEXANDER CALDCLEUGH, Esq. F.R.S. F.G.S., &c.

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THE phenomena attending this great disturbance of the surface of the earth have been so varied, and the extent of its effects so considerable, that I should almost deviate from my duty if I did not endeavour to draw up and transmit to the Royal Society some account of a convulsion which has laid in ruins three provinces, and caused incalculable damage to the southern part of this country. I am the more inclined to take this step from a happy concurrence of circumstances having drawn several scientific observers to Concepcion shortly after the catastrophe, who have obligingly confided their notes to me. I trust therefore the Royal Society will not consider that I am about to trespass upon its time.

An idea, in some degree fanciful, prevailed for some time after the conquest of these countries by the Spaniards, that these convulsions of the earth's crust occurred at intervals of a century ; afterwards it was supposed that about fifty years was the term which usually elapsed between great shocks ; but, since the commencement of this century, the repeated catastrophes which have occurred, especially in the years 1812 in Caraccas, 1818 in Copiapo, 1822 in the province of Santiago, 1827 in Bogota, 1828 in Lima, 1829 in Santiago, and 1832 in Huasco, have prepared the minds of the inhabitants to expect at all times these frightful oscillations of the earth, which, although they cause little sensation at first, after some time affect the nerves in a manner not easy to account for by ordinary causes. That they happen at all times and in all states of the atmosphere seems clearly decided. The finest weather, and the most variable, equally prevail at the moment ; but many are the fancied signs by which the coming earthquakes are predicted, and in the faith of which the inhabitants confide, as they think their experience bears them out. While some place great confidence in rats running violently over the ceilings of the room, others prepare for a shock when they observe the stars twinkling more than usual, and all fears are removed when much lightning coruscates in the Cordillera. As far as my own observations go, little reliance can be placed on the two former prognostics ; something more certain seems to be due to the latter. A few hours previous to the earthquake which I am about to describe, immense flocks of sea birds proceeded from the coast towards the Cordillera, a circumstance which occurred prior to the great shock of 1822 ; and it is affirmed by too many respectable persons not to be

entitled to some degree of credit, that on the morning of the convulsion all the dogs disappeared from Talcahuano.

The summer in Chile had been rather colder than in preceding years. The mean of the thermometer in Santiago (two thousand feet above the level of the sea) for the months of January and February was  $72^{\circ}$  of FAHR. The mean of the barometer for the same period was 28.25, which is about one tenth of an inch below its usual height.

From the 1st of February the barometer was unusually low in Santiago; and on the 14th, six days prior to the earthquake, the barometer at half past 6 A.M. stood at 28.1, the thermometer at the same time being  $73^{\circ}$ . A slight oscillation, which lasted twenty seconds, was felt on this day; on the 20th the barometer marked 28.17, and the thermometer rose to  $76^{\circ}$ : the weather fine. In Concepcion, in the night of the 17th to 18th the barometer fell four tenths of an inch, but gradually recovered itself, and indicated nothing extraordinary on the morning of the 20th. In Valdivia, according to the observations most obligingly communicated to me by Capt. FRIZROY, of the Beagle Surveying Ship, the barometer stood on the 16th of February at 29.92, and continued to rise gradually until the end of the month, with an increased temperature. From my own observations, deduced from many oscillations, I have remarked that the barometer usually falls shortly before any considerable shock, and then returns to its ordinary mean. On the 26th of September 1829, a very severe earthquake was experienced in this city, which did much damage to most buildings; the front of the house I then inhabited fell down; and it is worthy of remark, that the instant after every shock a burst of rain fell, which soon moderated, until a fresh tremor caused it to recommence.

The igneous vents of the whole range of the Cordillera may be said to have been in remarkable activity both preceding and at the moment of the late convulsion. From the flat-topped volcano of Yanteles, in front of Chiloe, to the lofty range of the Andes in Central America, all the information which has been obtained gives details of violent eruptions. On the 20th of January the volcano of Osorno, north-east of Chiloe, burst forth with inconceivable fury; and the lava was seen at night rushing out of the crater and rolling down the side of the mountain, elevated 3900 feet above the level of the sea. The reflection of the flame reached double that height, and is described to me by Mr. P. G. KING, of the Beagle, as presenting the most magnificent object he had ever beheld. From the plains of Talca, eighty leagues to the south of the capital, two volcanos were observed in activity a few days after the 20th of February. They are both situate near the lake of Mondaca, twenty-five leagues eastward in the Cordillera: and another new rent was observed on the estate called Cerro Colorado, on the right bank of the river Maule, and near its source. The volcano of Petoroa, and another near it whence a stream of asphaltum flows, and those of Maypu and Aconchagua have also been for some months in a state of activity.

In the month of January the volcano of Coseguina in Central America became

exceedingly active, and ejected a body of lava which covered a circumference of eight leagues three yards and a half deep, burying all the farm-houses, sugar-works, and cattle: the ashes continued falling for five days, and reached upwards of three hundred leagues from the centre of desolation and ruin.

It was at half past eleven o'clock on the morning of the 20th that the earthquake commenced, with an atmosphere as serene and beautiful as the elements beneath were convulsed and threatening. The first oscillation, gentle, and attended with little noise, was but the precursor of the two succeeding undulations, which were extremely violent; the duration from the first to the last vibration was about two minutes and a half, and the direction appeared to be from south-west to north-east. The sensation occasioned by the undulatory movements, seemed to me to be similar to that which would be produced by standing on a plank the ends of which rose and fell two feet from the ground. The small streams of water which run down the streets were checked and thrown over the edges of their channels. In Talca, eighty leagues to the south, the effects were still more violent: the oscillation commenced without being accompanied by that rumbling noise which usually is the forerunner of these awful phenomena. In Concepcion, where the great violence of the earthquake was felt, it was the second undulation which caused the havoc in the buildings; and previous to that and the many succeeding shocks, a violent report was heard, proceeding from the southward, as from a volcano in that direction. All the houses in the port of Talcahuano, which were situate on the low lands beneath the hills, were laid prostrate; and about half an hour after the vibration, when the inhabitants were returning to their houses from the heights and open spaces, it was remarked that the sea had retired so much beyond its usual limits that all the rocks and shoals in the bay were visible. It flowed again, and again retired, leaving the ships dry which were at anchor in the harbour. Then an enormous wave was seen slowly approaching the devoted town, from the direction of the Boca Chica. For ten minutes it rolled majestically on, giving time to the inhabitants to run to the heights, whence they saw the whole place swallowed up by this immense breaker.

In this moment of terror, men saw the roller with little accordance as to size; some compared it to the height of the loftiest ship, others to the height of the island of Quiriquina. It carried all before it, and rose by accurate measurement twenty-eight feet above high-water mark. A small schooner of eighty tons, nearly ready for launching, was lifted over the remains of the walls, and found lying among the ruins three hundred yards from her stocks. The reflux of this roller carried everything to the ocean. Another and a larger wave succeeded; but taking a more easterly direction, the ruins of Talcahuano escaped, but the Isla del Rey was ravaged by it. A fourth and last roller, of small dimensions, advanced, but nothing was left for further devastation. While these great waves were rushing on, two eruptions of dense smoke were observed to issue from the sea. One, in shape like a lofty tower, occurred in the offing; the other took place in the small bay of San Vicente,

and after it had disappeared, a whirlpool succeeded, hollow, in shape like an inverted cone, as if the sea were pouring into a cavity of the earth. In every direction in this bay, as well as in Talcahuano, vast bubbles broke, as if an immense evolution of gas were taking place, turning the colour of the water black, and exhaling a fetid sulphureous odour.

At San Tomé, on the other side of the bay, the roller did immense damage; and on the island of Quiriquina the cattle dashed off the cliffs from panic. In this island the waves injured houses forty feet above the present level of high water, and during the three following days the sea ebbed and flowed irregularly.

In the bay of Concepcion, the strata of clay slate have been visibly elevated, from about three to four feet. This alteration of the relative position of sea and land is clearly distinguishable, by a rock off the landing-place, which previous to the shock was nearly level with high water, being subsequently found to be raised three feet higher; and the buoy on the Belen Bank has now four feet less water than formerly. A vessel lying at anchor had one fathom less water alongside her than before the shock; but it is very likely that she changed her position. At the port of San Vicente, a little to the south of Talcahuano, the land has also risen about a foot and a half; and along the shore of the latter bay, even at high water, beds of dead muscles were left as proofs of the upheaval of the strata.

To the southward, of the entrance of the bay of Concepcion there is a small island called Santa Maria, about seven miles long and two wide. Capt. FRIZROY examined with great care the line of beach in the southern cove, as well as the northern part of the island; and from the visible evidence of beds of dead shell-fish, from soundings, and from unbiassed oral testimony, it appears placed beyond the shadow of doubt, that on the latter side the elevation of the land has not been less than ten feet, in the centre of the island about nine, and in the southern cove about eight feet. This upheaving has almost destroyed the southern port of the island, for it now affords but little shelter to vessels, and the landing is bad. Everywhere around the island the soundings have been diminished a fathom and a half, and the cliffs, of the height of 150 or 200 feet, are split and rent in all directions, and huge masses precipitated below. Both Capt. FRIZROY and Capt. SIMPSON, of the Chilian Navy, are of opinion that the uprising of the strata, both in this island and in Concepcion, at the time of the earthquake, was considerably greater, and that the many subsequent minor oscillations may have caused a subsidence to the level before recorded. At Subul, a little to the south-east of Santa Maria, the elevation of the strata appears to have been about six feet.

At Nuevo Bilbao, the port of the river Maule, seventy leagues north of Concepcion, about an hour and a half after the shock, the sea flowed above the usual water mark, and continued for half an hour in that state before a reflux took place. Fifty minutes afterwards the sea, greatly agitated, rolled on the coast and up the river with extraordinary violence, and reached a height of twelve feet above the water mark.

By this last inroad, two schooners, anchored in the port, carried away their cables, and were found among the bushes one hundred and fifty yards from the beach.

A third rush of the sea occurred half an hour afterwards, which ascended to a height of nine feet; and for the space of forty-eight hours repeated rollers came forward, but with diminished violence. No elevation of the coast has been discovered at this port, but on the bar at the mouth of the river, which has always rendered the entrance to the port both difficult and dangerous, two feet more water has been remarked; and in consequence of the fall of an immense point of a mountain into the sea, it is hoped that, owing to the new direction given to the current, no further accumulation of sand will take place.

In Valparaiso the sea was observed to advance and recede rapidly, but gently and without violence.

It would be of little avail to distress the Society with the details of the ruin caused in all the southern provinces of Chile by this convulsion. To the southward of Talca scarcely a wall has been left standing, and even to the north of this line the damage caused to every description of building has been most serious. Throughout the provinces of Canqueues and Concepcion, the entire crust of the earth has been rent and shattered in every direction. In some places fissures of several feet in depth and width have been discovered intersecting the country for considerable distances. On one estate near Chillan, thirty leagues from the coast, extensive fissures have been the vents of muddy eruptions of salt water, which have made large deposits of a kind of grey pulverulent tufa; and on the same estate a great many circular pools were discovered of salt water, and many new thermal springs have burst forth. In many places the ground swelled like a large bubble, and then bursting, poured forth black and extraordinarily fetid water.

The limits to which the oscillations extended were, to the north as far as Coquimbo, and to Mendoza on the eastern ridge of the great chain of the Andes. Vessels navigating the Pacific within a hundred miles of the coast experienced the shock with considerable force. The bark *Glenmalia*, bound to Valparaiso, when ninety-five miles from the coast and in front of the Maule, had her course through the water suddenly checked, and her rate of sailing altered from seven knots to one, and the master conceived the vessel was dragging over a sand-bank. The sea was strongly agitated, and appeared to lift the vessel twenty feet. Such was the alarm that the boats were nearly lowered: no soundings were met with.

The Island of Juan Fernandez, a mass of basalt three hundred and sixty miles from the coast, experienced the earthquake, but with less violence; the sea rose to the height of the Mole in a similar manner to that of Concepcion, and then receded, leaving the bottom of Cumberland Bay dry to some distance from the shore, and in the second rush rose fifteen feet above the usual level, carrying all before it. At the same time the Governor, Major SUTCLIFFE, observed a dense column of smoke issuing from the sea about a mile off the Point Bacalao, which lasted until 2 o'clock

in the morning, when an immense explosion took place, which threw the water in every direction; during the rest of the night great bursts of flame rising from the same spot illumined the whole island. Captain SIMPSON, about a month after, sounded near the spot in every direction and found no bottom in less than sixty-nine fathoms. It is worthy of remark, that when on the 24th of May 1751 the city of Concepcion was destroyed by an earthquake, and by the inroad of the sea, the rising colony of Juan Fernandez was swallowed up in a similar manner by immense rollers. The Governor, his family, and thirty-five persons perished by the catastrophe.

After the earthquake the usual atmospheric changes occurred. In many places the most awful hurricanes completed the dismay of the inhabitants and added to the catastrophe. To these succeeded deluges of rain, a circumstance most unusual at that period of the year. At the Hot Springs of Canqueues, where the water issues at the temperature of  $118^{\circ}$  of FAHR., the heat was lowered after the earthquake to  $92^{\circ}$ , a circumstance which occurred after the shock of 1822. The diminished temperature lasted but a short time.

At the risk of being tedious, I have given a detail to the Society of the changes effected in the earth's surface by this violent convulsion. After examining the extensive area of its vibration, after observing the uprising of an island and the adjacent coast, together with the eruption of a submarine volcano, it is difficult to deny that the same causes are still in operation which ages since raised tertiary formations to their present lofty site in the great range of the Cordillera. Surrounded with these continued changes on the surface of the earth, it is impossible not to respect the opinions of those philosophers who conceive that the Continent of America has risen into existence at a more modern period than that which therefore may, with more propriety, be termed the Old World.

Owing to the early hour on the 20th that the oscillation commenced, comparatively few lives were lost, but the frequent occurrence of these catastrophes, by causing organic defects, may very probably explain the causes of the short duration of human existence in these countries.

*Santiago de Chile,*  
12th June, 1835.

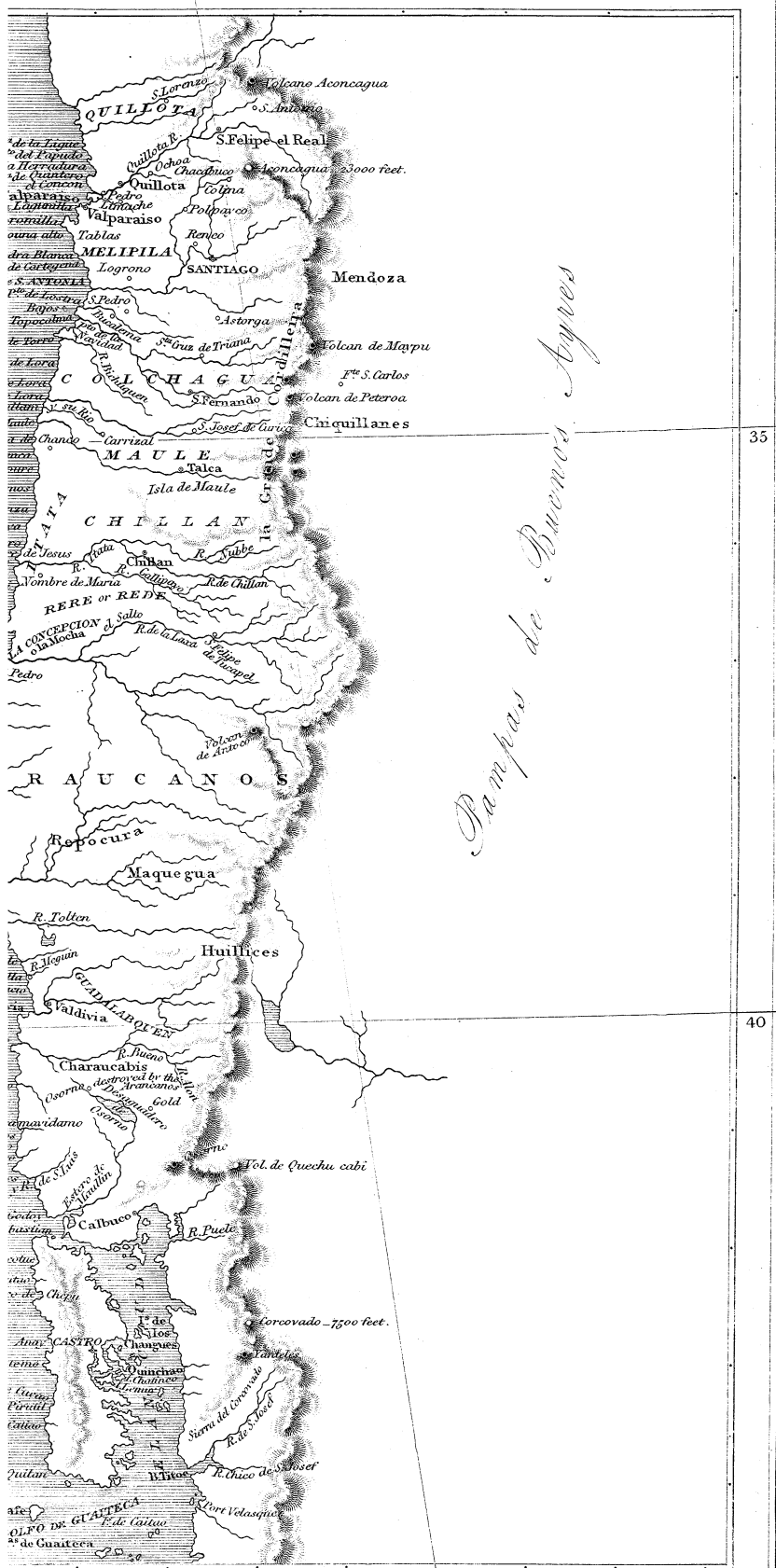
*Isla de Tierra* Bahía (Cumberland Bay)  
*Isla de Agua*  
*Isla de Juan Fernandez* del Este  
*Pto. Español*

*pto de la Ligua*  
*pto del Espudo*  
*Ensenada de la Herradura*  
*pto de Quintero*  
*pto de Valparaiso*  
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*pto de Coronilla*  
*pto de Coronilla alto*  
*Piedra Blanca*  
*Playas de Cartagena*  
*pto de S. ANTONIA*  
*pto de Puchura*  
*pto de Topocalma*  
*pto de Lora*  
*Quebrada de Lora*  
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*Mataquito o de Lora*  
*R. Maipo*  
*Capilla de Chanco*  
*pto de Barrancón*  
*Huachapura*  
*pto de Huanos*  
*pto de Curruana*  
*pto de Camaya*  
*Ensenada del Zorro*  
*R. de Tulla*  
*pto de Boquillo*  
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*pto de la Concepción*  
*El Penco*  
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*pto de Lora*  
*pto de S. María*  
*pto de Laxapue*  
*pto de Huanos*  
*Ensenada del Concepción*  
*R. de Quintero*  
*Alto de Tucapel Vieja*  
*pto de Tucapel*  
*where the Indians killed Governor Valdivia*  
*la Mocha*  
*pto de Tucapel*  
*R. Camero*  
*de la Ligua*  
*Pelchun*  
*R. Tolten*  
*R. y Altos de Coate*  
*la Estancia*  
*Morro de Valdivia*  
*pto de Valdivia*  
*Ensenada y Río Bueno*  
*R. y Caleta del Maipo*  
*Chara*  
*Ensenada de los Juncos*  
*pto de S. Antonio*  
*Caleta y Río de S. Pedro*  
*pto de Quicuil*  
*pto de Capitanes*  
*Caleta y Río de S. Pedro*  
*pto de Godoy*  
*La de S. Bastian*  
*Cocul*  
*R. y Baxos de Linton*  
*Chico de Chigu*  
*Chico*  
*Ana*  
*CASTRO*  
*pto de Huenteina*  
*pto de Curas*  
*pto de Pual*  
*R. Cúlico*  
*pto de Quilán*  
*Pto Volcan del Guase*  
*GOLFO DE GUATECA*  
*pto de Guateca*

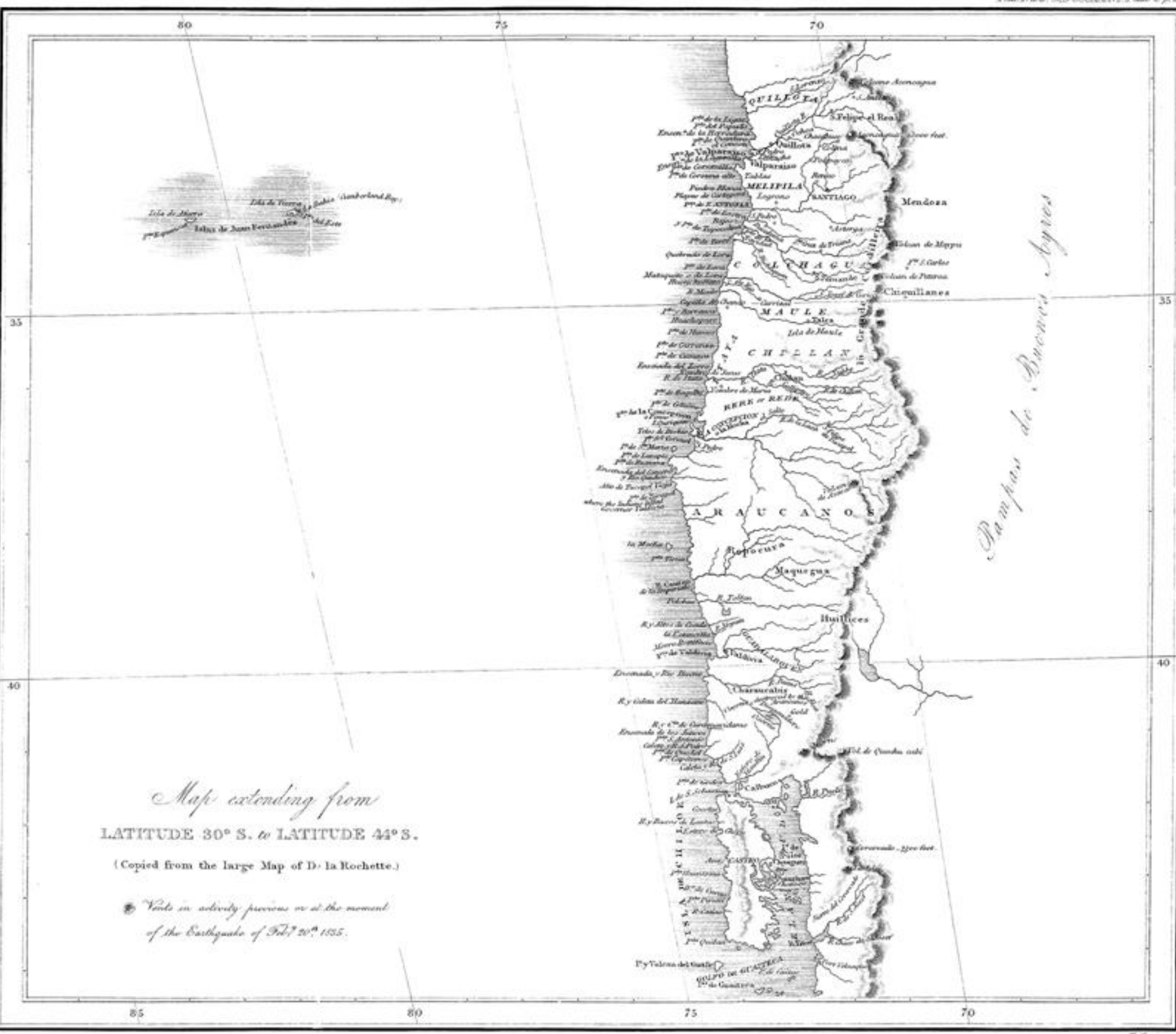
*Map extending from*  
 LATITUDE 30° S. to LATITUDE 44° S.

(Copied from the large Map of De la Rochette.)

• Vents in activity previous or at the moment  
 of the Earthquake of Feb. 20<sup>th</sup> 1835.







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*Pampas de Buenos Ayres*