

**ART. IV.-**  
***On the Reality of the Rise of the Coast of Chile, in 1822,***  
***as stated by MRS. GRAHAM.***

[Transcription of article in *The American Journal of Science and Arts*, 28 (July, 1835), pp. 236-247]

**[p. 236]**

*Introductory Remark.*- The question of the reality of the rise of the coast of Chile, during the earthquakes in that region, in the month of Nov., 1822, is so interesting to geology, that we readily comply with the request of a much respected foreign correspondent, by inserting the subsequent papers in this Journal. As Mrs. Graham, now Mrs. Callcott, gave her name in support of the important statements, whose correctness has been recently denied by a geologist, whose name is deservedly respected and honored, wherever science is known, it is due both to the lady and to geology, that there should be a fair hearing, to which Mr. Greenough will be the last to object.-*Ed.*

1. *An account of some effects of the late Earthquake in Chile, Extracted from a letter to H. WARBURTON, Esq. by Mrs. MARIA GRAHAM.*

London, March 4, 1824

*Dear Sir,*-I send you, at your request, some extracts from my journal concerning the great Earthquakes which visited Chile, during my residence in that country, in 1822-3.

The first shock, by which the towns of Valparaiso, Melipilla, Quillota, and Casa Blanca, were almost destroyed, and Santiago much damaged, was felt at a quarter past ten o'clock in the evening [p. 237] of Tuesday, the 19<sup>th</sup> November, 1822. It lasted three minutes. I was then residing about a mile from the coast of Quintero, situated on a promontory, about thirty miles to the north of Valparaiso. It was a very clear, still, and moon light night; the aurora australis had been visible, and some lightning had been seen over the Andes. In a few minutes after the first shock, there was another, less severe; and from that time the whole night long successive shocks were felt twice in every five minutes, each lasting from half to a minute. On the morning of the 20<sup>th</sup>, a little before two, at four, and a quarter before six o'clock, there were three more violent shocks, and the earth continued trembling in the intervals: this day was hot and sunny, with wind; the night was clear and windy. On the morning of the 21<sup>st</sup>, at half past two, ten minutes before three, a quarter before eight, a quarter past nine, and half past ten; and in the afternoon, at a quarter past one, and at two, violent shocks were felt: the weather of this day was like the preceding. On the morning of the 22<sup>nd</sup>, at half past four, half past seven, and a quarter past nine, there were violent shocks. A little before ten, three successive loud explosions were heard, like the sound of heavy artillery; the earth trembling very much after each explosion. At eleven there was another violent shock, and between that and one o'clock there were three slight ones; the earth then remained quiet until half past seven: this day there was a thick fog, with cold drizzling rain. On 23<sup>rd</sup> the shocks were less violent and frequent. On the 24<sup>th</sup> there were continual Earthquakes until eleven at night. On the 25<sup>th</sup> there was a severe shock, at a quarter past eight in the morning, and others until a little before ten. On the morning of the 26<sup>th</sup>, at a quarter before three, there was a shock, which lasted nearly two minutes: this day we had a violent northerly wind, with rain, which was considered very unusual at this season. During my stay in Chile, from this time until the 18<sup>th</sup> of January, 1823, continual Earthquakes, more or less severe, were felt every day. Those on the 10<sup>th</sup> and 25<sup>th</sup> of December, were the most violent after that of the 19<sup>th</sup> November. I have learned that after my departure the Earthquakes

continued, that they were very violent last July, and had not ceased altogether so late as last September.

The sensation experienced during the more violent shocks, was that of the earth being suddenly heaved in a direction from north to south, and then falling down again; a transverse motion also being now and then felt. There was on the 19<sup>th</sup> November a general [p. 238] tremor felt, and a sound heard like that of vapor bursting out, similar to the tremor and sound which I remembered to have observed at each jet of fire, while standing on the cone of Vesuvius, during the eruption of 1818. The tremor between the shocks was shown to be real by the agitation of water in a glass; and during the shocks, water, or mercury, placed in a glass, was thrown over the edge in every direction. In the house where I resided, the furniture was all displaced, with some degree of regularity, so as to range, not parallel to the walls, which fronted to the north and south, but at a given angle diagonally. The sensations experienced on board the ships that lay in the harbour of Valparaiso, was as if they were moving very rapidly through the water, and occasionally touching the ground. On the first shock, on the night of the 19<sup>th</sup> of November, the sea, in Valparaiso harbor, rose to a great height, and then receded, so as to leave the small vessels, that were before afloat dry on the beach; it then returned again, but, as compared with the level of the land, not to its original level. All this is stated to have happened in a quarter of an hour.

On the morning of the 20<sup>th</sup>, all the rivers and lakes connected with them, in consequence of the dislodgement of snow from the mountains, were much swollen. In all the small valleys, the earth of the gardens was rent, and quantities of water and sand were forced up through the cracks to the surface. In the alluvial valley of Vina-a-la-Mar, the whole plain was covered with cones of earth, about four feet high, occasioned by the water and sand which had been forced up through funnel-shaped hollows beneath them; the whole surface being thus reduced to the consistence of quick-sand. At the roots of all the trees, between the surrounding earth and stem, large hollows were seen, into which the hand could be introduced, occasioned by the violence with which the trunks had been lashed to and fro. The bed of the Lake of Quintero was full of large cracks, and the alluvial soil on its shore, was divided so as to look like a sponge. The level of the lake, which communicates with the sea, had apparently sunk very much. The promontory of Quintero consists of granite, covered by sandy soil. The granite on the beach which is intersected by parallel veins, from a line to an inch in thickness, most of which are filled with a shining matter, but some are only coated with it on their sides, and present hollow fissures. After the Earthquake of the 19<sup>th</sup>, the whole rock was found rent by sharp recent clefts, very distinguishable from the older ones, [p. 239] but running in the same direction. Many of the larger of these clefts might be traced from the beach to the distance of a mile and a half across the neighboring promontory, where, in some instances, the earth parted, and left the stony base of the hill exposed.

It appeared on the morning of the 20<sup>th</sup>, that the whole line of coast, from north to south, to the distance of one hundred miles, had been raised above its former level. I perceived, from a small hill near Quintero, that an old wreck of a ship, which before could not be approached, was now accessible from the land, although its place on the shore had not been shifted. The alteration of the level at Valparaiso was about three feet, and some rocks were thus newly exposed, on which the fishermen collected the scollop-shell fish, which was not known to exist before the Earthquake. At Quintero, the elevation was about four feet. When I went to examine the coast, accompanied by Lord Cochrane, although it was high water, I found the ancient bed of the sea laid bare, and dry, with beds of oysters, muscles, and other shells, adhering to the rocks on which they grew, the fish being all dead, and exhaling most offensive efluvia. I found good reason to

believe that the coast had been raised by Earthquakes, at former periods, in a similar manner, several ancient lines of beach, consisting of shingle, mixed with shells, extending in a parallel direction to the shore, to the height of fifty feet above the sea. The country has, in former years, been visited by Earthquakes, the last of any consequence having been ninety-three years ago.

The shock of the 19<sup>th</sup> was felt as far as Lima to the north, by the ships there riding in the bay of Calao. To the south, it was experienced at least as far as Conception, and to the east, beyond the Andes, at Mendoza, and at St. Juan. The distance from Conception to Lima is about twenty degrees of latitude, or 1400 miles.

I am, dear Sir, your's, &c.

MARIA GRAHAM.

2. *Extract from Mr. President GREENOUGH'S Address to the Geological Society, delivered on the 4<sup>th</sup> of June, 1834.*

The Earthquake in Chile in 1822 has been so much\* insisted on, that it requires detailed consideration. Of this event, an account by [p. 240] Mrs. Graham is inserted in our Transactions. I am deeply sensible of the honor that lady conferred on the Society by her obliging compliance with the request which elicited her narrative, and it is only the importance of its contents which could induce me to subject them to the test of rigid examination.

According to this account, "it appeared, on the morning after the Earthquake, that the whole line of coast, from north to south, to the distance of above 100 miles, had been *raised* above its former level." But by what standard was the former level ascertained? Who, on the morrow of so fearful a catastrophe, could command sufficient leisure and calmness to determine and compute a series of changes, which extended 100 miles in length, and embraced (according to a statement in the Journal of Science), an estimated area of 100,000 square miles? How could a range of country so extensive be surveyed while the ground was still rocking, which it continued to do on that day, and for several successive months? What was the average number of observations per square mile? Who made, checked, and registered them? By what means did the surveyors acquaint themselves with what had been the levels and contour before the catastrophe took place, by which, as we are told, all the landmarks were removed, and the soundings at sea completely changed?

Mrs. Graham states, that by the dislodgement of snow from the mountains, and the consequent swellings of the rivers and lakes, much detritus was brought from the coast; and further, that sand and mud were brought up through the cracks to the surface. Amid so many agents, it would not be easy to assign to each its share in the general result.

The fishes lay dead on the shore, may prove only that there had been a storm. In her published travels, Mrs. Graham represents them as lying on the beach, which may very well have been thrown up, as the Chesil bank has been, by a violent sea. Some muscles, oysters, &c. still adhered, she says, to the rocks on which they grew; but we know not the nature or dimensions of these rocks, whether fixed or drifted. The occurrence of a shelly beach above the actual sea-level is an observation which must not be lost sight of. I propose to speak of it hereafter: in the mean time be it recollected, that these beaches are said to occur along the

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\*BAKEWELL'S *Geology*, 4<sup>th</sup> Lond. edit., pp. 98, 504. and 2<sup>nd</sup> Amer. edit., pp. 67, 344. LYELL, Vol. 1. pp. 401, 455. DE LA BECHE'S *Manual*, 2<sup>nd</sup> edit. SCROPE *on Volcanoes*, p. 209.

shore at *various* heights, along the summit of the highest hills, and even among the Andes.

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Neither in the paper of Mrs. Graham, nor in the anonymous account, published about the same time in the Journal of Science, can I find any paragraph to justify the position (which from the seductive character of the work\* in which it appears, may, if not now assailed, soon be deemed unassailable), that a district in Chile, one thousand miles in area, "was *uplifted* to the average height of a foot or more, and the cubic contents of the *granitic mass* added in a few hours to the land". By what means we get the average I do not know. Mrs. Graham says, the alteration of level at Valparaiso, was about three feet; at Quintero, about four feet; but the *granitic mass*!- has the geological surface of Chile been sufficiently examined to assure us that granite extends over one hundred thousand square miles?

In the well-known work of Molini, a Jesuit who passed a greater part of his life in Chile, and wrote a natural history of that country, I find no ground for supposing that in any Earthquakes which took place there, from the time the Spaniards first landed on its shores to the days of his publication, any similar phenomena had been noticed. Moreover, the statement of Mrs. Graham, and the writer before alluded to, respecting the *elevation of land* which occurred during the Earthquake of 1822, has not been confirmed by Capt. King, nor by any naval officer or naturalist who has since visited that region, although many have visited it who had heard the circumstance, and who would willingly have corroborated it if they could. But they saw no traces of any such an event; and the natives with whom they conversed neither recollected nor could be induced to believe it.

The 16<sup>th</sup> number of the *Mercurio Chileno*, a scientific Journal, contains an account of this Earthquake, by Don Camilo Enriquez, which I have not been able to procure. A later number refers to this account, and to another published in the *Abeja Argentina*, a work of considerable reputation, which, by the kindness of Mr. Woodbine Parish, I have been enabled to consult. The account there given of the Earthquake of 1822, is strongly recommended to the reader, "as a sensible, straight-forward description of what actually took place, without the high coloring in which ignorance, and terror, and exaggeration, are apt to indulge."

No notice is here taken of the permanent *elevation of the land*, and the account concludes thus: -

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"The earth certainly cracked in places that were sandy or marshy; I saw cracks too in some of the hills, but mostly in the low nook where much earth had run together; the sea was not much altered; it retired a little, but came back to its old place. Don Onofri Bunster, who, on the night of the Earthquake, was walking on the shore at Valparaiso, in front of his house, had a mind to go up on the hill, but could not, so great was the quantity of falling dust and stones: he repaired to his boat, therefore, and with some difficulty got aboard; this done, he made observations on the motion of the sea; on sounding, the depth was thirteen fathoms; he heaved the lead a second time, and the depth was no more than eight fathoms: this alternate ebbing and flowing lasted the whole night, *but did not the slightest harm on shore.*"

These are the only cases I remember to have met with, in which the testimony of eye-witnesses has been adduced to prove the rise of land by Earthquakes. That such rise may have taken place, at different times, without being recorded,

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\* LYELL, Vol. 1. p. 473

perhaps even without being observed, is not very improbable; but if I am to pronounce a verdict according to the evidence, I believe there is not as yet one well authenticated instance in any part of the world, of a non-volcanic rock having been seen to rise above its natural level in consequence of an earthquake.

Before I quit this subject, it may not be amiss to mention, that on comparing the times at which the successive shocks took place in Chile, as given by Mrs. Graham, and the other authorities to which I have had occasion to refer, the discrepancy is extraordinary.

### 3. *To the President and Members of the Geological Society.*

*Gentlemen*-Mrs. CALLCOTT (formerly Mrs. Graham) has read with surprise, in the Athenaeum of June 14, an extract from Mr. Greenough's Anniversary Address to your Society, in which there is an uncourteous attack upon her letter, addressed to Mr. Warburton, in the year 1824, giving an account of the Earthquake which occurred in Chile, on the 19<sup>th</sup> of November, 1822.

This attack implies, in the first place, a suspicion of wilful falsehood on the part of Mrs. Callcott.- Secondly, it charges her with that high coloring, which "ignorance, terror and exaggeration, are apt to indulge," (the words of the second accusation being quoted from the *Abeja Argentina*).- And thirdly, in case Mrs. Callcott should be prepared to rebut the first and second charges, the insinuation contained in the words quoted below, would tend to throw discredit on her whole statement. "Before I quit the subject, it may not be amiss to mention, that on comparing the times at which the successive shocks took place in Chile, as given by Mrs. Graham, and the other authorities to which I have had occasion to refer, the discrepancy is extraordinary."

Mrs. Callcott, in answer to these observations, begs the attention of the Society, and of Mr. Greenough himself, to the following pages.

The facts detailed by her to Mr. Warburton, and stated more at large in her published journal, are strictly true. Mrs. Callcott had ample means and leisure to examine the coast at Quintero and Valparaiso, places distant from each other thirty miles; and she saw the difference between the old high water marks on the cliffs, beach and rocks, from three to four feet higher than the high water ever reached again during the two months she remained in Chile, after the first great shock. She is indifferent whether Mr. Greenough ascribes this to a partial elevation of the coast of Chile, or to a change of level of the whole mighty Pacific Ocean, which must have extended to Polynesia, India and China: the fact is, that there was a change in the relative position of the land and water; and to save circumlocution, Mrs. Callcott will continue to use the word, raised, or elevated, in describing that change.

Mrs. Callcott has reason to think, that nothing less than a similar catastrophe to that of the night of the 19<sup>th</sup> of November, will ever restore the land and water to their former relative positions; especially because other sea-shores appear at various heights, well defined on the cliffs of the Heradura Bay, countenancing the idea that they have been hoven up by successive earthquakes. Mrs. Callcott learned, on unquestionable authority, that the earthquake was felt at the same moment she felt it, at Coquimbo and Copiapo, North of Quintero, and at Concepcion, South of Valparaiso: and had reason to believe, from general reports, that its effects extended much farther in both directions. Mrs. Callcott has, in her letter to Mr. Warburton, and in her published journal, related these facts simply; but she has never, as Mr. Greenough insinuates, stated such an absurdity, as that

any one set about, much less accomplished, a regular geological survey of an estimated area of 100,000 square miles on the morrow of that fearful catastrophe, or at any other time.

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Mr. Greenough mentions Mrs. Callcott's published journal, and accounts for the dead fish on the shore\* by an imaginary storm. Common candor would have lead that gentleman to have stated that, in that very journal, it is distinctly printed, that a "delightful and calm moon-light night followed a quiet and moderately warm day."<sup>1</sup>

Mr. Greenough says, further in p. 18 of his address- "some muscles and oysters still adhere, she says, to the rocks on which they grew: but we know not of the nature of these rocks, whether fixed or drifted." Mrs. Callcott was ignorant that there were, or might have been, drifted rocks, until she learned it from Mr. Greenough; for much as she has been at sea, she never met with one. The rocks at Quintero, and at Valparaiso, are of grey granite, and where they lift themselves through the sand and shingle of the beach, they give the notion of bald mountain tops. At all events, they are fixed sufficiently to have caused the wreck of more than one Spanish ship of war; and when she saw them the morning after the Earthquake, that on which the wreck of the *Aquila* lay, was certainly so far above the water, that the vessel could be approached dry-shod, which had never happened before, even at the lowest tides. The beds of muscles, of other shell-fish, and of sea-weed, were equally rocks of grey granite, fixed far below the sands of the ocean. These circumstances are stated in the published journal: but Mr. Greenough has suppressed them, and many others of the like nature, particularly the notice of some rocks and stones, that the lowest tides never left dry, but have now a passage between them and the low-water mark, sufficient to ride round without difficulty, p. 313.

That Mrs. Callcott's observations were not confirmed by any naval officer, may, perhaps, be accounted for in common candor, by the consideration, that, at the time of the Earthquake, there was not a ship of war, belonging either to England, the United States, or France on the coast.

Capt. King, whose testimony, had he been present, would have been uncontrovertible, was not on the coast till several years afterwards, and therefore could have had no knowledge of the state of the coast, or the exact soundings, as they existed before.

As to the testimony of the natives, Mrs. Callcott feels sure that Mr. Greenough himself, had he been among them, would attach no value to their testimony, one way or another. *They* assured Mrs. Callcott, that the *Virgin Mary* had visibly hovered over the sea on **[p. 245]** the night of the 19<sup>th</sup>, and that the Earthquake itself was a judgment on the country and government, for opening the ports to heretics.

At p. 19 of Mr. Greenough's Address, he makes his quotation from the *Abeja Argentina*, and uses the respectable name of Mr. Woodbine Parish, so as to persuade his hearers, or readers, that he and Don Camillo Enriquez, consider Mrs. Callcott's account as "fraught with the high coloring, that ignorance, terror and exaggeration are apt to indulge." Mrs. Callcott begs to observe, that Mr. Parish was not then in Chile, nor was Don Camillo near the coast, but fully occupied with his business as secretary to one of the parties then engaged in civil war: they

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\* Journal of a Residence in Chile, p. 331.

<sup>1</sup> Journal, p. 305.

could therefore only have had hearsay evidence to place against the statements of Mrs. Callcott, founded upon her own personal observations.

As to ignorance of the science of Geology, Mrs. Callcott confesses it: and, perhaps, that circumstance, and her consequent indifference to all theories connected with it, render her unbiassed testimony of the more value. Terror she cannot plead in extenuation of mis-statement; for she did not, she could not, give way to personal fear on that occasion, because she had with her an invalid relation, under peculiar circumstances, and her whole attention was given to him. She did not lose her presence of mind for a single moment; nor her power of thinking and acting for others. Mrs. Callcott is not apt to exaggerate.

Again, at the same page of his address, Mr. Greenough allows that a person, whom he calls Don Onofri Bunster, was walking the beach, and making observations at the moment of the great shock, at the very time that the great swell of the sea occurred, which threatened to overwhelm the town, and when no man was likely to return alive from such a walk. Yet Mr. Greenough denies to Mrs. Callcott sufficient composure of mind to observe, several hours afterwards, what had taken place during the night!

Mr. Bunster, who kept a shop, or store, in Valparaiso, was really prevented from going up the hill, as Mr. Greenough states. It happened that that portion of the granite rock, which is the substratum of the red clay or earth which forms the most of the cliffs of the heights of Valparaiso, running immediately under the government house, being disturbed, and visibly cracked, by the great shock, the clay or earth of the low cliff on which the house was built, slipped off on both sides, and, nearly filling up the ravines or quebradas on each side, carried with it the houses formerly on the cliff, and all [p. 246] those built on the sides. Here Mr. Bunster's statement corroborates that of Mrs. Callcott, although Mr. Greenough makes use of it in contradiction.

Mrs. Callcott must here repeat that, at the conclusion of that portion of his address in which Mr. Greenough's attack on her is contained, p. 19, he says, evidently with a desire to throw discredit upon her- "Before I quit the subject, it may not be amiss to mention, that on comparing the times at which the successive shocks took place in Chile, as given by Mrs. Graham, and the other authorities to which I have had occasion to refer, the discrepancy is extraordinary." Mrs. Callcott, in reply, states, that she had her watch, a very good one, made by Grimaldi and Johnson, chronometer makers, in her hand at the very moment of the first shock. She found that her friends at Concon and Valparaiso estimated the time as she did. Several ship's chronometers, which were stopped by the shock, indicated the same moment. Mr. Clarke, an English merchant, whom Mrs. Callcott saw on his arrival at Valparaiso from Concepcion, told her he had observed the time of the shock at Concepcion, and that it agreed with that observed at Quintero. Don Fausto del Hoyo, a colonel in the King of Spain's service, and a prisoner on parole, was in the market-place of Quillota when the great shock ruined that town. He also agreed with Mrs. Callcott and her friends, as to the time; and so did the wretched miners of Illapel. As to the intervals between the shocks, Mrs. Callcott kept a register sheet of paper, on which, when she happened to be absent from the spot where the writing materials of the party were kept, some one of the others entered the time and duration of the shock, and the degree of the motion, as indicated by mercury dashing against the side of a glass vessel placed upon the ground; therefore, she presumes that her estimate of the times of the shocks is likely to be, at least, as accurate as that of any person to whose observations Mr. Greenough can possibly have referred.

On reading the extracts from Mr. Greenough's Address, as published in the Athenaeum, Mrs. Callcott opened her private journal (which had been locked up for some years), whence both the published travels and the letter to Mr. Warburton were extracted, and read it carefully over, being unwilling to trust her memory, however lively the impression she necessarily received at the time of the Earthquake, of the events that accompanied and followed it. She is happy to say that the daily, nay, almost hourly, entries in the journal, [p. 247] are such as support all she has printed, or written, or said upon the subject. Twelve years have elapsed since these entries were made; and she feels confident that any stranger, even Mr. Greenough himself, would perceive, on looking over them, in the minuteness of the observations, in the mixture of common and household notices, and the remarks on the progress of the civil war, which was then rife, tokens of that desire for the exact truth, which has always guided her.

Mrs. Callcott would have been happy to have furnished any explanation of what Mr. Greenough thinks doubtful parts of her statements, had he thought it worth while to have made any application to her. And as her relation and friend, Mr. Glennie, a lieutenant in the Royal Navy, no longer an invalid, now resides with his wife in Kensington, Mr. Greenough might have had, what he appears to desire - Some *Officer's corroboration*. (See p.18 of the Address.) And, moreover, Mrs. Callcott would have been spared the disagreeable necessity of appealing, as she now does, to Mr. Greenough's own sense of justice, and to that of the society over which he presides, for some explanation of his motives for making so uncandid and uncourteous an attack upon her.

Mrs. Callcott cannot feel that it is a light thing to be suspected of wilful falsehood. She made no pretensions to science in any of her statements, nor did she presume to draw conclusions, or frame theories. She stated the facts that came under her own observation, and she must be permitted to claim for herself, one qualification for an observer, namely, a mind more at ease than it was likely most other persons in Chile could have possessed, because she had no family in that country - she had neither political nor commercial connexions in South America no interests that could be affected, by either the civil war or the Earthquake; while there was not one other person, whose friends or whose property were not, more or less, deeply involved in both.

Mrs. Callcott is very sorry to have been forced to say so much of herself: but she thinks it due to her family and friends, and to the society in which she has always moved, to repel so disgraceful a suspicion, which, if it were in the smallest degree founded, must render her unworthy, either of society or friends.