

KRISUVIK SULPHUR MINES, ICELAND – Notes & References

The existence of sulphur mines on Iceland has been long known. The map ‘Islandia’ by Ortelius (?) in 1585 shows the text ‘*Fodinae sulphuræ præstantiſimæ*’ (Excellent sulphur mines).

Ref: <http://www.orteliusmaps.com/book/ort161.html>

Without a better look at the map it is hard to say whether that comment refers to the Krisuvik locality or not.

Eighteenth Century Activity

S. Thorarinsson in Geografisk Tidsskrift, Bind 52 (1952 - 1953) writing of the lakes Grænavatn and Gestsstadavatn notes,

‘These lakes are situated short SE of the solfatara areas of Engjafell and Seltün, commonly called the Krisuvik area, where sulphur was mined during the times of the Danish Trade Monopoly.*

Seen at a distance, e. g. from the solfatara area at Engjafell, the two lakes are of similar appearance and they have up to now been regarded as being both of the same origin, although opinions have differed as to what that origin is.

In written records these lakes are first mentioned in a paper on the sulphur mining in Krisuvik written by a Norwegian, O. Henchel, who later was appointed director of the Silver mines at Kongsberg. He spent some weeks studying the solfatara areas at Krisuvik in 1775. On the sketch map accompanying his paper both lakes are shown with their names. Henchel mentions that Grænavatn (Green Lake) derives its name from the colour of the water and states that the water tastes somewhat of vitriol whereas Gestsstadavatn neither has that taste nor the green colour (Henchel 1780, p. 680).’

** The Danish trade monopoly was established in 1602 and forced on Iceland. It was intended to promote Danish commerce. The trade monopoly caused chaos in the economy. The trade monopoly was modified in 1787 and all subjects of the Danish king were given the right to trade in Iceland. In 1845 the Icelandic ‘parliament’ the Althingi was re-established as a consultative assembly. Foreign trade was liberalised entirely in 1855.*

Sir George Mackenzie

Sir George Steuart Mackenzie (1780-1848) was a renowned mineralogist, who is largely remembered for having demonstrated in 1800 via experimenting with his mother's collection of jewellery, that diamond was composed of the element carbon. In 1810 he journeyed to Iceland to examine the geology and mineralogy of the island. Along with his fellow travellers Richard Bright and Henry Holland he published an account entitled ‘*Travels in the island of Iceland*’.

Reference: <http://www.kcl.ac.uk/depsta/iss/library/speccoll/exhibitions/nf/arctic.html>

His account of the Sulphur Mountains near Krisuvik follows and is one of the earliest references to the mineralisation:

‘Having taken an early breakfast, we set out towards the Sulphur Mountain, which is about three miles distant from Krisuvik. At the foot of the mountain was a small bank, composed chiefly of white clay mixed with sulphur, from all parts of which steam issued. Ascending it, we got upon a ridge immediately above a deep hollow, from which a profusion of vapour arose, and heard a confused noise of boiling and splashing, joined to the roaring of steam escaping from narrow crevices in the rock. This hollow, together with the whole side of the mountain opposite, as far up as we could see, was covered with sulphur and clay, chiefly of a white or yellowish colour. Walking over this soft and steaming surface, we found to be very hazardous, and we were frequently very uneasy when the vapour concealed us from each other.

The day, however, being dry and warm, the surface was not so slippery as to occasion much risk of our falling. The danger of the crust of sulphur breaking, or of the clay sinking with us, was great; and we were several times in imminent peril of being scalded. Mr. Bright ran at one time a great hazard, and suffered considerable pain from accidentally plunging one of his legs into the hot clay.

From whatever spot the sulphur was removed, steam instantly escaped; and in many places, the sulphur was so hot that we could scarcely handle it. From the smell, we perceived that the steam was mixed with a small quantity of sulphuretted hydrogen gas. When the thermometer was sunk a few inches into the clay, it rose generally to within a few degrees of the boiling point. By stepping cautiously, and avoiding every little hole from which steam issued, we soon discovered how far we might venture. Our good fortune, however, ought not to tempt any person to examine this wonderful place, without being provided with two boards, with which every part of the banks may be traversed in perfect safety.

At the bottom of this hollow, we found a caldron of boiling mud, about fifteen feet in diameter, similar to that on the top of the mountain, which we had seen the evening before; but this boiled with much more vehemence. We went within a few yards of it, the wind happening to be remarkably favourable for our viewing every part of this singular place. The mud was in constant agitation, and often thrown up to the height of six or eight feet. Near this spot was an irregular space, filled with water boiling briskly. At the foot of the hill, is a hollow formed by a bank of clay and sulphur, whence steam rushed with great force and noise from among the loose fragments of rock.

Further up the mountain, we met with a spring of cold water, a circumstance little expected in a place like this. Ascending still higher, we came to a ridge composed entirely of sulphur and clay, joining two summits of the mountain. Here we found a much greater quantity of sulphur than on any other part of the surface, over which we had yet gone. It formed a smooth crust, from a quarter of an inch to several inches in thickness. The crust was beautifully crystallized, and immediately beneath it we found a quantity of loose granular sulphur, which appeared to be collecting and crystallizing, as it was sublimed along with the steam. Sometimes we met with clay of different colours, white, red, and blue, under the crust; but we could not examine this place to any depth, as, the moment the crust was removed, steam issued, and proved extremely annoying. We found several pieces of wood, which were probably the remains of planks that had been formerly used in collecting the sulphur, small crystals of which partially covered them.

There appeared to be a constant sublimation of this substance; and were artificial chambers constructed for the reception and condensation of vapours, much of it might probably be collected. As it is, there is a large quantity on the surface; and, by searching, there is little doubt that great stores may be found. The inconvenience proceeding from the steam issuing on every side, and from the heat, is certainly considerable; but, by proper precautions, neither would be felt so much as to render the collection of the sulphur a matter of any great difficulty. The chief obstacle to working these mines, is their distance from a port whence the produce could be shipped. But there are so many horses in the country, whose original price is trifling, and whose maintenance during summer costs nothing, that the conveyance of sulphur to Reikiavik, presents no difficulties which might not probably be surmounted.

Below the ridge on the farther side of this great bed of sulphur, we saw a great deal of vapour escaping with much noise. We crossed to the opposite side of the mountain, and found the surface sufficiently

firm to admit of walking cautiously upon it. We had now to make our way towards the principal spring, as it is called ; and this was a task of much apparent danger, as the side of the mountain, for the extent of about half a mile, is covered with loose clay, into which our feet sunk at every step. In many places there was a thin crust, below which the clay was wet, and extremely hot. Good fortune attended us; and without any serious inconvenience, we reached the object we had in view. A dense column of steam, mixed with a little water, was forcing its way impetuously through a crevice in the rock, at the head of a narrow valley, or break in the mountain. The violence with which it rushes out is so great, that the noise thus occasioned, may often be heard at the distance of several miles; and, during night, while lying in our tent at Krisuvik, we more than once listened to it with mingled emotions of awe and astonishment. Behind the column of vapour was a dark-coloured rock, which gave it its full effect.

It is quite beyond our power to offer such a description of this extraordinary place, as to convey adequate ideas of its wonders or its terrors. The sensations of a person, even of firm nerves, standing on a support which feebly sustains him, over an abyss, where, literally, fire and brimstone are in dreadful and incessant action, - having before his eyes tremendous proofs of what is going on beneath him, - enveloped in thick vapours. - and his ears stunned with thundering noises must be experienced before they can be understood.'

Ida Pfeiffer

Another early account of a visit to the Krisuvik sulphur deposits was written by Ida Pfeiffer (1794 – 1858), a German visitor. For her time, Ida must rank as a very adventurous woman and in 1845 she set out to explore Scandinavia and Iceland and recounted her journey in 'A Visit to Iceland and the Scandinavian North'. Danuta Bois contributed a summary of Ida Pfeiffer's travels to the following web site in 1996:

Reference: <http://www.distinguishedwomen.com/biographies/pfeiffer.html>

Bois commented that 'Unlike other travelers to Iceland of the time, Ida traveled alone and on a tight budget. She made her way around on pony carts and lived like the Icelanders. She complained that the local people were crude, their homes dirty and their meals boring, composed of mostly porridge and fish. After a six month stay, she returned home and wrote her observations as *Journey to Iceland, and Travels in Sweden and Norway*. She also brought back samples of plants and rocks she had collected in Iceland which she sold to museums.'

The following translation into English is dated from 1853 and comes from the Ingram, Cooke, and Co. edition.

Reference: <http://www.gutenberg.org/files/1894/1894.txt>

'THE SULPHUR-SPRINGS AND SULPHUR-MOUNTAINS OF KRISUVIK.'

'The 4th of June was fixed for my departure. I had only to pack up some bread and cheese, sugar and coffee, then the horses were saddled, and at seven o'clock the journey was happily commenced. I was alone with my guide, who, like the rest of his class, could not be considered as a very favourable specimen of humanity. He was very lazy, exceedingly self-interested, and singularly loath to devote any part of his attention either to me or to the horses, preferring to concentrate it upon brandy, an article which can unfortunately be procured throughout the whole country.

I had already seen the district between Reikjavik and Havenfiord at my first arrival in Iceland. At the present advanced season of the year it wore a less gloomy aspect: strawberry-plants and violets,--the former, however, without blossoms, and the latter inodorous,--were springing up between the blocks of lava, together with beautiful ferns eight or ten inches high. In spite of the trifling distance, I noticed, as a rule, that vegetation was here more luxuriant than at Reikjavik; for at the latter place I had found no strawberry-plants, and the violets were not yet in blossom. This difference in the vegetation is, I think,

to be ascribed to the high walls of lava existing in great abundance round Havenfiord; they protect the tender plants and ferns from the piercing winds. I noticed that both the grass and the plants before mentioned thrived capitally in the little hollows formed by masses of lava.

A couple of miles beyond Havenfiord I saw the first birch-trees, which, however, did not exceed two or three feet in height, also some bilberry-plants. A number of little butterflies, all of one colour, and, as it seemed to me, of the same species, fluttered among the shrubs and plants.

The manifold forms and varied outline of the lava-fields present a remarkable and really a marvellous appearance. Short as this journey is--for ten hours are amply sufficient for the trip to Krisuvik,--it presents innumerable features for contemplation. I could only gaze and wonder. I forgot every thing around me, felt neither cold nor storm, and let my horse pick his way as slowly as he chose, so that I had once almost become separated from my guide.

One of the most considerable of the streams of lava lay in a spacious broad valley. The lava-stream itself, about two miles long, and of a considerable breadth, traversing the whole of the plain, seemed to have been called into existence by magic, as there was no mountain to be seen in the neighbourhood from which it could have emerged. It appeared to be the covering of an immense crater, formed, not of separate stones and blocks, but of a single and slightly porous mass of rock ten or twelve feet thick, broken here and there by clefts about a foot in breadth.

Another, and a still larger valley, many miles in circumference, was filled with masses of lava shaped like waves, reminding the beholder of a petrified sea. From the midst rose a high black mountain, contrasting beautifully with the surrounding masses of light-grey lava. At first I supposed the lava must have streamed forth from this mountain, but soon found that the latter was perfectly smooth on all sides, and terminated in a sharp peak. The remaining mountains which shut in the valley were also perfectly closed, and I looked in vain for any trace of a crater.

We now reached a small lake, and soon afterwards arrived at a larger one, called Kleinfarvatne. Both were hemmed in by mountains, which frequently rose abruptly from the waters, leaving no room for the passage of the horses. We were obliged sometimes to climb the mountains by fearfully dizzy paths; at others to scramble downwards, almost clinging to the face of the rock. At some points we were even compelled to dismount from our horses, and scramble forward on our hands and knees. In a word, these dangerous points, which extended over a space of about seven miles, were certainly quite as bad as any I had encountered in Syria; if any thing, they were even more formidable.

I was, however, assured that I should have no more such places to encounter during all my further journeys in Iceland, and this information quite reconciled me to the roads in this country. For the rest, the path was generally tolerably safe even during this tour, which continually led me across fields of lava.

A journey of some eight-and-twenty miles brought us at length into a friendly valley; clouds of smoke, both small and great, were soon discovered rising from the surrounding heights, and also from the valley itself; these were the sulphur-springs and sulphur-mountains.

I could hardly restrain my impatience while we traversed the couple of miles which separated us from Krisuvik. A few small lakes were still to be crossed; and at length, at six o'clock in the evening, we reached our destination.

With the exception of a morsel of bread and cheese, I had eaten nothing since the morning; still I could not spare time to make coffee, but at once dismounted, summoned my guide, and commenced my pilgrimage to the smoking mountains. At the outset our way lay across swampy places and meadow lands; but soon we had to climb the mountains themselves, a task rendered extremely difficult by the elastic, yielding soil, in which every footstep imprinted itself deeply, suggesting to the traveller the unpleasant possibility of his sinking through,--a contingency rendered any thing but agreeable by the neighbourhood of the boiling springs. At length I gained the summit, and saw around me numerous basins filled with boiling water, while on all sides, from hill and valley, columns of vapour rose out of numberless clefts in the rocks. From a cleft in one rock in particular a mighty column of vapour whirled into the air. On the windward side I could approach this place very closely. The ground was only lukewarm in some places, and I could hold my hand for several moments to the gaps from which

steam issued. No trace of a crater was to be seen. The bubbling and hissing of the steam, added to the noise of the wind, occasioned such a deafening clamour, that I was very glad to feel firmer ground beneath my feet, and to leave the place in haste. It really seemed as if the interior of the mountain had been a boiling caldron. The prospect from these mountains is very fine. Numerous valleys and mountains innumerable offered themselves to my view, and I could even discern the isolated black rock past which I had ridden five or six hours previously.

I now commenced my descent into the valley; at a few hundred paces the bubbling and hissing were already inaudible. I supposed that I had seen every thing worthy of notice; but much that was remarkable still remained. I particularly noticed a basin some five or six feet in diameter, filled with boiling mud. This mud has quite the appearance of fine clay dissolved in water; its colour was a light grey.

From another basin, hardly two feet in diameter, a mighty column of steam shot continually into the air with so much force and noise that I started back half stunned, and could have fancied the vault of heaven would burst. This basin is situated in a corner of the valley, closely shut in on three sides by hills. In the neighbourhood many hot springs gushed forth; but I saw no columns of water, and my guide assured me that such a phenomenon was never witnessed here.

There is more danger in passing these spots than even in traversing the mountains. In spite of the greatest precautions, I frequently sank in above the ankles, and would then draw back with a start, and find my foot covered with hot mud. From the place where I had broken through, steam and hot mud, or boiling water, rose into the air.

Though my guide, who walked before me, carefully probed the ground with his stick, he several times sank through half-way to the knee. These men are, however, so much accustomed to contingencies of this kind that they take little account of them. My guide would quietly repair to the next spring and cleanse his clothes from mud. As I was covered with it to above the ankles, I thought it best to follow his example.

For excursions like these it is best to come provided with a few boards, five or six feet in length, with which to cover the most dangerous places.

At nine o'clock in the evening, but yet in the full glare of the sun, we arrived at Krisuvik. I now took time to look at this place, which I found to consist of a small church and a few miserable huts.'

An unknown author, writing in *The friend Religious and Literary Journal* Vol XXVIII 1855 on page 382 extracted from an earlier publication 'Rambles in Iceland' teh following:

The Sulphur Mines in Iceland.—Some sharp climbing up the mountain, nearly a thousand feet, brought me to the sulphur mines, a scene I shall never forget—a literal pool of fire and brimstone. Had Milton ever visited the sulphur mountains of Iceland, I could have forgiven him his description of the infernal regions. Here was a little hollow scooped out of the side of the mountain; and all over and through it yellow sulphur, burning hillocks of stone and clay, and stifling sulphurous smoke. The surface, too, was semi-liquid—in fact, as nearly a literal lake of fire and brimstone as this world probably shows. The earth itself here was principally a fine pink or flesh-coloured clay; and all over this I could see holes communicating with the mighty laboratory of nature below; and as the steam and smoke came out of these holes, the fine particles of sulphur seemed to be brought up to the surface. The clayey ground where the sulphur lay was in most places soft, and could not be walked over without the greatest danger of sinking down through it, perhaps into the very depths in the bowels of the mountain. Indeed, it possesses a kind of horrible and fascinating interest. Around the edges and in certain places the soil is hard, and some stones are seen where one can walk in safety. By having a couple of boards, a man might walk all over the ground. In some places the sulphur was a foot thick, and as it gathered it seemed to consolidate, and I found I could break up large pieces beautifully crystallized. This sulphur appeared about as pure as the sulphur sold in the shops, but not so dense. It had not half that strong odour that sulphur and brimstone have in a prepared state. These mines showed signs that they have been worked, as some bits of boards and planks lay about, and there were some paths to be seen. The

sulphur is taken off the surface, and then the ground is left for two or three years for it to collect again. Sulphur is so cheap, and these mines are so far from a seaport, (Havnefiord, some twenty miles north, being the nearest,) and roads and means of transport are so scanty, that gathering it is not very profitable, nor carried on to any great extent. There are sulphur mines in the north; some productive ones near Kravla mountain, on the shores of Mount Lake Myvatn.—Rambles in Iceland.

Richard Francis Burton

Burton of Burton and Speke fame visited the area to report to a potential investor.

Ref: <http://burtoniana.org/biography/1906-The%20Life%20of%20Sir%20Richard%20Burton%20-%20Wright/HTML/chapter15.html>

‘In January 1872, the Burtons were at Knowsley,²⁵⁶ the Earl of Derby’s, whence Mrs. Burton wrote an affectionate letter to Miss Stisted. She says,²⁵⁷ “I hope you are taking care of yourself. Good people are scarce, and I don’t want to lose my little pet.” Later, Burton visited Lady Stisted at Edinburgh, and about that time met a Mr. Lock, who was in need of a trusty emissary to report on some sulphur mines in Iceland, for which he had a concession. The two came to terms, and it was decided that Burton should start in May.’

Ref: <http://ebooks.adelaide.edu.au/b/burton/isabel/romance/chapter29.html>

‘Early in June, 1872, Burton sailed for Iceland at the request of a certain capitalist, who wished to obtain reports of some sulphur mines there, and who promised him a liberal remuneration, which eventually he did not pay. He, however, paid for Burton’s passage and travelling expenses;’

Ref: http://www.howgego.co.uk/explorers/richard_francis_burton.htm

‘In May 1872, on behalf of a private sulphur-mining company, he set out for Iceland and, after stopping briefly in the Orkneys and Shetlands, landed at Reykjavik on 8.6.72. Burton spent only three months in Iceland but accumulated enough information to fill a 794-page book on the island: Burton, Richard Francis, *Ultima Thule; or a summer in Iceland* (London 1875, 2 vols).’

Charles W. Vincent

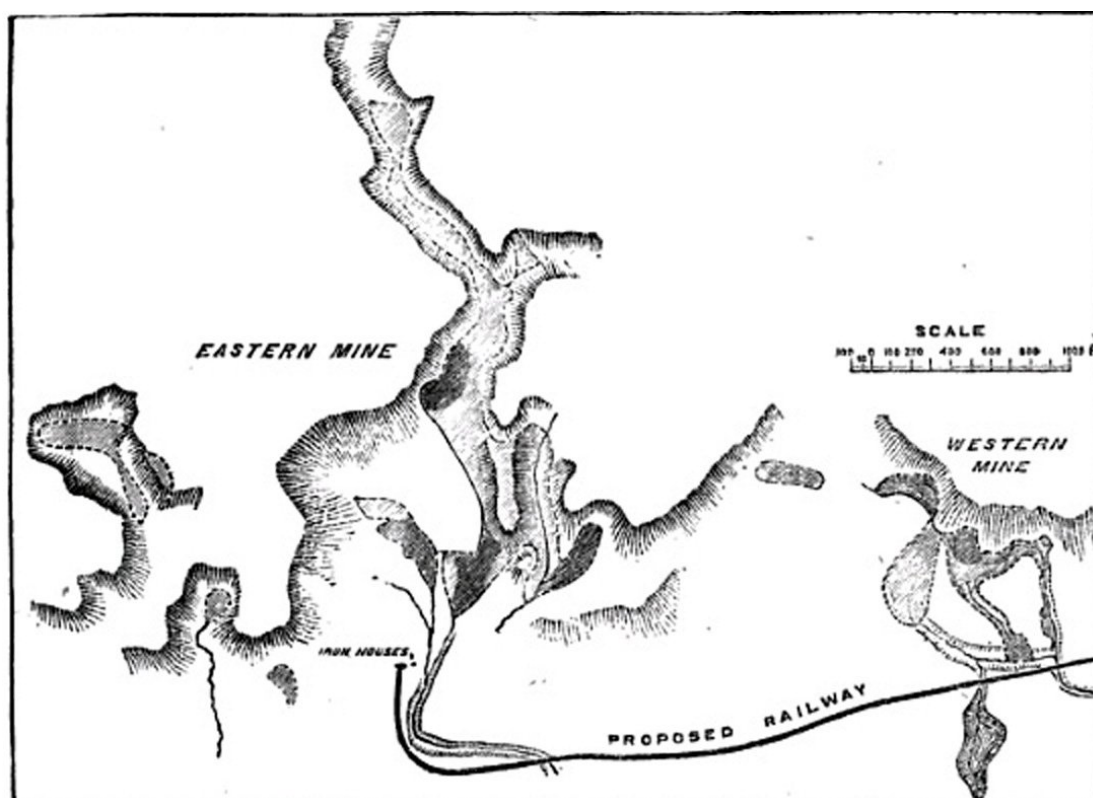
Charles W. Vincent F.C.S. wrote an article for the *Chemical news and journal of industrial science* (Volumes 27-28, pp 111-114). The first part of the article is dated March 7, 1873 while the second part, (Volumes 27-28, pp 126-129) is dated March 14, 1873.

‘On the Sulphur Deposits of Krisuvik, Iceland’

The canton of Krisuvik, in the district of Gullbringu, in the south-west corner of Iceland, has long attracted great interest on account of its boiling mud cauldrons, hot springs, and, above all, its “living” sulphur mines; these are all arranged in lines, evidently corresponding to the great volcanic diagonal line stretching from Cape Reykjanes to the lake of Myvatn. At the present time, the greatest amount of volcanic activity is manifested at the southern end of this line, in the district some peculiarities of which I now propose to bring before you.

In the last century it was the northern end of the volcanic diagonal, near about Myvatn, where, according to the Icelandic records, the kind of pseudo-volcanic action was most vigorous, by which the boiling springs are set in operation and the sulphur deposits are formed; but a violent eruption of the mud volcano, Krabla, to a great extent buried the then active strata beneath enormous masses of volcanic mud and ashes, so that the energy has been probably transferred along the line southwards.

The Krisuvik springs are in a valley beneath some high mountains (see plan; the shaded portions represents the sulphur beds surrounding the active springs). They are reached by a track, so narrow that there is no more than room to enable horses to pass along it – across the brink and along the side of a vast hollow, termed the “kettle.” Following this rude track, the “Ketilstip,” the summit of the range of hills, is reached which overlooks Krisuvik. In the midst of a green and extensive morass, interspersed with a few lakes, are cauldrons of boiling mud, some of them 15 feet in diameter, numberless jets of steam, and boiling mud issuing from the ground, in many instances to a height of 6 or 8 feet. Sir George Mackenzie (who was accompanied by Sir Henry, then Doctor, Holland, now the President of the Royal Institution), in his justly-celebrated “Travels in Iceland, in 1810,” gives a vivid word-picture of the scene. “It is impossible” he writes, “to convey adequate ideas of the wonders of its terrors. The sensation of a person, even of firm nerves, standing on a support which feebly sustains him, where literally fire and brimstone are in incessant action, having before his eyes tremendous proof of what is going on beneath him, enveloped in thick vapours, his ears stunned with thundering noises. These can hardly be expressed in words, and can only be conceived by those who have experienced them.”



The photographs which I have the honour to exhibit are many of them taken from paintings made on the spot by Mr. Waller, a nephew of Prof. Huxley, who certainly, by his faculty of close and accurate observations, does great credit to his distinguished relative. I have obtained from him corroboration of many facts which, though they might be expected to be noted by a chemist, or physicist, do not lie within the ordinary vocation of an artist.

On the southern side of the mountains, subterranean heat is also manifested, and hot springs, accompanied by sulphur beds, are also found; but they have not been as thoroughly examined as those in the valley, and are represented as being less active.

Mr. Seymour, who has spent many months at Krisuvik, tells me that the sulphur beds on this side have been submerged by the clays washed down by the winter rains, and are, for the most part, now completely overgrown with grass. On digging beneath the surface, however, the sulphur earth is found to be only a short distance down, and on analysis the percentage of sulphur in one bed, 116 yards long, running up the side of the mountain was discovered to range between 46 and 65.5. Here the earth was completely cold, and all further deposition of sulphur appears to have ceased.

In the valley itself the springs are not always visible at the surface, being so completely covered by the earth, that it is only by piercing through the crust of indurated sulphur earth that their presence is discovered. Sometimes the explorer is made unpleasantly aware of the insecure nature of his footing by falling through, and thus opening up a fresh thermal spring. The late Sir William Hooker, when visiting this place, in endeavouring to escape a sudden gust of strongly odorous vapour, jumped in to a mass of semi-liquid hot earth and sulphur – and but for his presence of mind, in throwing himself flat upon the ground, would have sunk to a considerable depth; as it was, the difficulty of extricating himself was very considerable.

The surface of the ground is covered in many places with a crust of 2 to 3 feet in depth of almost pure sulphur; and in the valley, where the steam jets are protected from the extreme violence of the wind, the sulphur is deposited tolerably evenly over the whole surface. If it were not for the ever-varying direction of the wind, the sulphur would, Captain Forbes is of opinion, be precipitated in regular banks, but it hardly ever falls for twenty-four hours in one direction, the wind capriciously distributing the shower in every direction.

It has been suggested by those who wish to utilise the immense sulphur-producing power of this wonderful locality, that chambers should be erected (Sir George Mackenzie), or walls built up (Dr. Perkins), by which means, the force of the wind being broken, the sulphur would be quietly floated to the ground, instead of being carried up the sides of the hills, and thus more widely distributed.

With little variation the general appearance of the “solfataras,” over the space of 25 miles along the volcanic diagonal, is much alike; an elevation about 2 feet high and 3 feet in diameter, which is composed of a dark bluish-black viscid clay, forms a complete circle round the mouth of a medium-sized spring. The water is sometimes quiescent, and sunk about 2 feet within the aperture; at other times it is ejected, with great hissing and roaring noise, to the height of from 5 to 8 feet. At all times clouds of steam, strongly impregnated with sulphuretted hydrogen and sulphurous acid gas issue from the orifice, both of which, during an eruption of the water, are greatly augmented in quantity. From the dark-coloured and elevated margin of the fountain the yellow crust of crystallised sulphur extends a great distance in every direction. Columns of steam ascend from numberless points in the whole district, which are thus impregnated; and thus it is that, apparently for ages past, sulphur has been gradually heaped up in this locality until there are actually hills which, as far as they have yet been pierced, show sulphur-earth to be their main constituents; hence they have acquired the name of the Sulphur Mountains.

The soil is of different colours, but most generally white. It is, in the vicinity of the springs, a viscid earth, less plastic than clay, and more readily broken.

When excavations are made into this earth, it is found to be composed of multitudinous layers, of different colour and shades of colour, each layer being quite distinctly divisible from those above and below it, though frequently no more than an inch or two in thickness.

It is much to be regretted that the good example set by Olafsen and Povelsen, of investigating the nature of the earth’s crust round about the solfataras by piercing the soil, has not been more frequently carried out. In the summer of last year one of the suggestions which I made, for the instruction of an expedition to this place, was that boring implements should be taken out and extensively used: but accident prevented the necessary appliances being forthcoming at the right time. I believe, however, that one of the chief features in the expedition, which is to set out in March, will be the thorough examination, to as great a depth as practicable, of the strata in various parts of the sulphur-valley.

The spring chosen by Olafsen and Povelsen as the subject of their first experiment, was one which had made its appearance since the preceding winter, and which was just beginning to be surrounded by other mud-springs and jets of steam. The ground was still covered with lovely verdure, and charming flowers were abundant, even at the very verge of the cauldron of hideous hue and odour. A short distance from this opening the established their boring apparatus. The sequence of the layers was as follows:-

1. Three feet of reddish brown-earth, of a fatty consistence, of the ordinary temperature; at the bottom heat was perceptible to the touch.
2. Two feet of a firmer kind of earth, nearly the same in colour as the first layer, unctuous to the touch.

3. One foot of a lighter kind of soil.
4. Five feet of a very fine earth of different colours, the first 2 feet being veined red and yellow, with streaks of blue, green, red and white intermingled. The lower portion of this earth was somewhat firmer than that which covered it. The heat of this thick bed was so great that the soil extracted by the auger could not be handled until it had been some time exposed to the air.
5. One foot of a compact greyish-blue earth.
6. In tapping this bed, which was 4 feet 9 inches in thickness, and consequently at a depth of about 12 feet, water was first met with. It was found by comparison that the level of the water in the boiling mud spring coincided with that of the water thus discovered. The heat was now very great, and a constant hissing and bubbling could be heard as proceeding from the bottom of the hole which had been made.
7. Nine inches of greyish-blue earth.
8. One foot six inches of a similar unctuous earth, containing many small white stones. This was the hottest layer of any yet pierced; the buzzing humming noise was now much louder than before.
9. Three feet of the same kind of clay, but much harder and more compact; this layer was also full of small, round, white stones.
10. Six inches of a violet-tinged earth, very greasy to the touch. In this bed the heat sensibly diminished.
11. One foot six inches of red and blue clay intermingled. The heat continued to diminish very fast.
12. One foot of reddish-looking clay, the temperature remaining about the same.
13. Six inches of yellow and red clay.
14. One foot of a greenish-coloured earth, much less coherent than the previous layers. Here the heat again began to increase.
15. One foot six inches of blue clay, filled with small pieces of white tufa. This bed was much hotter than either that above or that below it.
16. One foot three inches of soft blue clay.
17. Nine inches of an earth, easily pulverised when dry, which, whilst moist, was of a violet colour; on exposure to the air, however, this rapidly changed to a chocolate-brown. The heat was again augmented as the centre of the bed was approached.

At thirty-two feet the full length of the boring implement was used up; but, from the set of the country in the vicinity, the experimenters believed they were close upon basaltic rock, when the heat probably ceased.

In digging for the peculiar kind of browncoal, which they call "surturbrand" (a kind of fuel very much resembling Irish bog-oak, which can be used for like purposes), the inhabitants frequently go as deep as 28 feet. They report that before reaching this depth they frequently pass through three or four beds of blue, yellow, and brown clay, and almost invariably find that the layers of blue clay are much better than any of the other strata.

A second trial of the soil was made in the neighbourhood of some recent springs, further to the east. The activity of the agencies at work here appeared to be greater than in the former case, and to have been longer in operation. The whole surface was thickly covered with sulphur in a finely-divided state; there was much gypsum, and a large efflorescence of feathery alum. Thousands of very minute holes were discovered on close examination through which continuous jets of steam, sulphuretted hydrogen, and sulphurous acid gases were emitted.

An attempt was made to dig with spades, but the soil was found to be so hot, whilst the footing was at the same time so insecure, that it could not be persisted in. A spot some distance further off was therefore pitched upon, where the earth was firmer and colder. The borer pierced through 6 feet of blue clay with great facility, the lowest portion being extremely hot. After this depth the earth became rapidly softer; at the depth of 7 feet the same peculiar bubbling noise before noticed was heard. Continuing to bore, the bottom of the hole appeared to be in a state of ebullition, a boiling liquid being ejected from the orifice to the height of several feet. A short time afterwards the jet ceased, the subterranean fire appeared to have expended its fury, but it soon re-commenced with re-doubled activity to dart forth fresh jets of steam and black muddy water, continuing to boil and dance with but slight intermission. It appeared, therefore, evident that the result of this experiment was the premature formation of a fresh hot spring, which would otherwise have been, perhaps, a considerable time in forcing its way to the surface. (To be continued).

(Concluded from p. 114).

It is somewhat to be regretted that no one amongst the numerous eminent men, men accustomed to experimental investigations and acute observers, who have since traversed this region, should have investigated the question of the origin of these hot springs and sulphur deposits from the point of view which was thus displayed by these careful and painstaking philosophers.

The phlogistic theory being generally accepted in their day, and the chemistry of the earths and metals being in a very undeveloped state, we cannot now accept to its full extent the explanation they put forth of these phenomena; but the facts they disclose appear to me to be of the highest value, and to afford a clue which, if carefully followed, may lead to discoveries of much importance in the domain of volcanic energy.

The conclusion they drew from their investigation is, that the hidden fires of Iceland dwell in the crust of the earth, and not in its interior; that the boiling springs and the mud cauldrons certainly do not derive their heat from the depths of our globe, but that the fire which nourishes them is to be found frequently at only a few feet below the surface in fermenting matters, which are deposited in certain strata.

By their theory the gases from the more central parts of the earth penetrate these beds by subterranean channels, and so set up the chemical action, producing fermentation and heat, these channels also forming the means of intercommunication between the separate sites of activity, and equalising and transferring pressure.

To return to their facts. They further observed that the heat is invariably found to be greatest in the blue and bluish-grey earth; that these earths almost always contain sulphuric acid; that they contain also sulphur, iron, alum, and gypsum; and lastly, that finely-divided particles of brass-coloured pyrites are visible throughout the whole of the beds when heat exists.

Sulphuric acid is found in the hot beds above and below that which is the hottest, but this latter manifests no acidity that is sensible to the taste.

Sulphuretted hydrogen is continually evolved from the clays containing the brass-coloured pyrites. Silver coins dropped into a hole made in these strata become rapidly reddened, and brass becomes quite black if held over it for a short time.

Lastly, not only does the heat increase and diminish in various successive layers of the earth in the neighbourhood of the active springs, but the locality of the heat, as might be expected from their previous observations, travels very considerably in different years.

The solfatara of Krisuvik, with the mountains about it, is shown in the accompanying sketch by M. Eugene Roberts. It appears from afar to occupy the place of an ancient crater, but, as we have already seen, it is not near the crater about the centre of the drawing, but at a considerable distance from the old volcanic centre, that the thermal springs and sulphurous exhalations have their present origin.

Wherever they may have been previously, the springs are now situated between two mountains; the one, Badstofur, on the right, originally composed of lava, the other, Vesturhals, on the left, of basaltic formation. Both by the action of the thermal springs are undergoing a process of disintegration and reconstruction.

The kind of hills which form the solfataras, properly so called, increase in extent day by day, by the addition to the disintegrated rock of sulphur, and of sulphurous and sulphuric acids.

The yellow sulphur earth contains about four per cent of free sulphuric acid; sometimes a little free hydrochloric acid, and a variety of sulphates, as might be supposed. Treated with distilled water the filtered solution reddens litmus strongly; on addition of acetate of lead a flocculent precipitate is produced, which, when heated with carbon, disengages sulphurous acid.

The sulphur is found in many different conditions, but for the most part in the same finely-divided, whitish yellow form in which it is precipitated from sulphuretted hydrogen solutions. Where it assumes

other states, crystallised in tears on the surface of the rocks, or coagulated in veins, it is on account of its having undergone subsequent heating. Of its primary origin by the decomposition of sulphuretted hydrogen, there is in my opinion no doubt.

Prof. Bunsen visited Krisuvik in 1845: his opinion is that sulphurous acid is evolved from the earth's interior, which, oxidised either at the surface by the atmosphere, or at subterranean depths by atmospheric oxygen dissolved in cold water, is converted into sulphuric acid. The sulphuric acid thus generated is diffused among the constituents of the decomposed beds. This process represents the first stage of the fumerole action, which is manifested in the namar or solfatara of Krisuvik.

Sulphur is now generally regarded as emanating from the stage of intermittent lethargy of a volcano, and the sulphides of iron, copper, arsenic, zinc, selenium, &c., fall in the same category as sulphur; they are secondary, not primary, formations. In the stage further off we have the host of sulphates produced by the oxidation of the sulphur into sulphuric acid, and its subsequent reaction on the metals and earths with which it becomes associated.

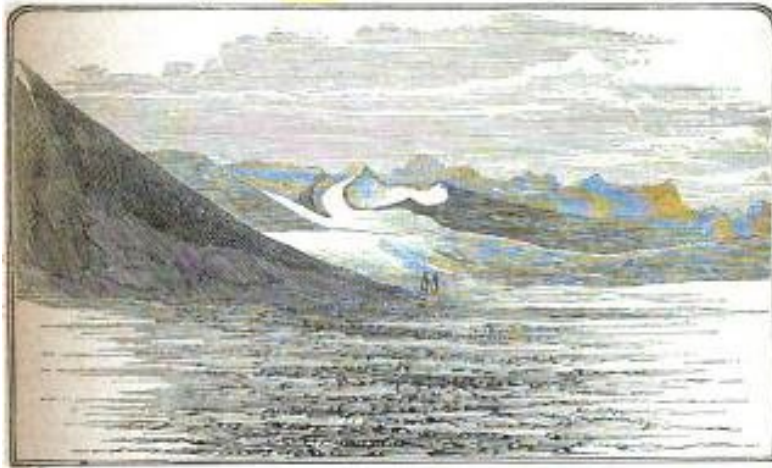
The description of the Sicilian sulphur beds coincides so very exactly with that of the Icelandic mines, that one might pass very well for the other. D'Aubigny pictures nearly the whole of the central portion of Sicily as being occupied by a vast bed of blue clay or marl, in which are numerous and thick beds of gypsum and sulphur, and a combination of this mineral with iron and copper. The natural process by which they have been formed must, I think, be the same in each case. At Krisuvik copper has been found only in small quantities, but that is probably because it has not been sought for below the surface. Carbonate of copper, associated with sulphate of lime, is of frequent occurrence, and native copper has to a limited extent been discovered.

A district in America, very similar in most of its characteristics, has recently been explored. The great hot-spring region of the sources of the Yellowstone and Missouri rivers, in the United States, has, on account of the wonderful natural phenomena there manifested, been set apart by the United States Congress as a great national park for all time.

The whole of this district is covered with rocks of volcanic origin of comparatively modern date. At present there are no signs of direct volcanic action going on, but the secondary kind of action, resulting probably as at Krisuvik, from the disintegration and decomposition of beds of volcanic origin, is in full progress. Boiling springs, mud cauldrons, and geysers are found in all parts of the region, and the description given by Mr. V. Hayden, of the Yellowstone lake and its vicinity, in every respect coincides with those of the geysers, mud cauldrons, and hot springs of Iceland.

In all cases there was found to be free access of water; free sulphur was widely dispersed, and the steam-jets were invariably accompanied by large quantities of sulphuretted hydrogen. The subterranean action in this country does not appear to have continued long enough to produce beds of sulphur and sulphur earths; but has, nevertheless, been of sufficiently long standing to build up geyser tubes of so great a length that the internal pressure has formed other vents, rather than lift the immense column of water above it.

The water of the springs contains sulphuretted hydrogen, lime, soda, alumina, and a slight amount of magnesia; some of these are only occasionally at the boiling-point, and these, when the temperature is reduced below 150°?, deposit great quantities of the sesquioxide of iron, which lines the insides of the funnels, and covers the surface of the ground wherever the water flows. If the reaction consists in the decomposition of iron pyrites, and the sulphur is carried sufficiently far off to prevent its re-combination with the iron to form iron sulphate, the formation of the iron sesquioxide is fully accounted for.



As a rule, the groups of hot springs are, as in Iceland, in the lower valleys, and either along the margins of streams, or nearly on a level with them. The grand area where they occur is within the drainage of the Yellowstone, where a space of 40 miles in length with an average width of 15 miles, is either at the present time, or has been in the past, occupied by hot springs.

That the quantity of sulphuric acid here produced is very large is proved by the immense quantity of alum which is found, for the streams, the mud, the earth are thoroughly impregnated with it. The funnel-shaped craters from which the boiling mud is ejected, are so similar to those at Krisuvik that the figure on page 113 will answer for both places. The circular rim varies from a few inches to several feet in diameter. Sometimes these are clustered close together, yet each one being separate and distinct from the others.

The foregoing are the most prominent facts connected with the development of sulphur from the earth in the elementary state. The full explanation of all the phenomena accompanying it appears to me to be the key by which the great secret of volcanic energy may be ultimately unlocked. At present it appears to be doubtful whether the sulphur results from the decomposition of metallic sulphides, by heat and water combined, or by sulphuric acid formed by the oxidation of sulphurous acid. In the one case, the whole action is so far within our reach that it should not be an insurmountable difficulty to establish the point as to whether the whole action does not depend on the percolation of water into beds of pyrites surrounded by other beds which are non-conductors of heat.

The other view, viz., that the sulphur proceeds as sulphurous acid from a lower depth, is, on account of the more complicated action required, far from being as satisfactory to my mind as the more simple supposition above.

Until boring experiments have been made, conducted with great care, and to considerable depths, no positive conclusion can be arrived at. It is also an element in the question of much importance to discover whether the beds penetrated by the water are already heated, whether the water is heated before it reaches the sulphur-bearing strata (the clays containing pyrites), or whether both are not alike cold till they have been for some time in contact. Less than a quarter of a mile from the hot springs is a lake, Geslratn, formed by the filling up of an extinct crater. This the inhabitants describe as being fathomless (Mr. Seymour, last year, found no bottom at five and twenty fathoms). The depth is, at any rate, very considerable. Although so close to a spot where the ground is, even at the surface, scorching to the feet, the water in this lake is ice-cold. Sir George Mackenzie also remarked a somewhat similar fact. On the side of the sulphur mountain, amidst the seething, steaming hills of almost burning earth, a spring of clear cold water was met with. To my mind these facts are most in accordance with the view that the action is local and self-dependent.

The Krisuvik sulphur mines have been worked at various times, but want of proper roads, and ignorance of the proper method of extracting and refining the sulphur, have prevented their proper development. The Sicilian mines can be worked at a considerable profit, where, more than 390 feet below the surface, beds are met with containing only 15 per cent of sulphur. At Krisuvik, absolutely on

the surface, clays are met with which contain from 15 to 90 per cent of sulphur. Under proper and careful supervision their future should be prosperous.

Two German gentlemen, under the auspices of the Danish Government, worked these mines in the early part of the last century, and so much was exported to Copenhagen during the time the excavations were carried on, that a sufficiently large stock was laid up to serve the consumption of Denmark and Norway from 1729 to 1753. Horrebow describes the sulphur mines as being actively worked from 1722 to 1728, to the great advantage of the inhabitants, who reaped much profit from its extraction.

By his account of their mode of prosecuting this enterprise, the sulphur does not appear to have been refined in the island, but exported in its crude state. The less active mines were chosen for cutting into. He says:- There is always a layer of barren earth upon the sulphur, which is of several colours, white, yellow, green, red, and blue. When this is removed the sulphur earth is discovered, and may be taken up with shovels. By digging 3 feet down the sulphur is found in proper order. They seldom dig deeper, because the place is generally too hot, and requires too much labour, also because sulphur may be had at an easier rate, and in greater plenty, in the proper places. Fourscore horses may be loaded in an hour's time, each horse carrying 250 lbs. weight. The best veins of sulphur are known by a kind of bank or rising in the ground, which is cracked in the middle. From hence a thick vapour issues, and a greater heat felt than in any other part. These are the places they choose for digging, and after removing a layer or two of earth, they come to the sulphur, which they find best just under the rising of the ground, when it (the sulphur) looks just like sugar candy. The farther from the middle of the bank the more it crumbles, at last appearing as mere dust. But the middle of the bank is an entire hard lump, and is with difficulty broken through. The brimstone, when first taken out, is so hot that it can hardly be handled, but grows cooler by degrees.

In two or three years these veins are again filled with sulphur. The death of the person at Copenhagen who had the sole and exclusive privilege of exporting sulphur from Iceland put an end to what had promised to be a very thriving industry. The inhabitants continued to collect the sulphur-earth for some time after its exportation had ceased; and many of them lost considerably by it, large quantities having been gathered which they were never able to dispose of.

According to Dr. Perkins, the sulphur mines were again worked by the Danish Government for fifteen years, but the method of purifying adopted was very imperfect. The sulphur-earth was heated in iron boilers, and, when the sulphur was melted, fish oil was added, and the whole mass stirred up. On allowing the mixture to stand for a time, the earthy matter formed a soap on the top of the molten mass; this being removed, tolerably pure sulphur remained behind.

In 1832, these mines were visited by K. von Nidda, the celebrated geologist, by whose advice a Danish merchant, named Kruntynon, purchased them. He only worked them for a short period. The sulphur-earth was collected without much regard being paid to the relative richness of the beds. It was taken on the backs of horses to Havnafiord, and thence shipped to Copenhagen. The cost of transport brought the sulphur to too high a price to render the undertaking successful.

In 1857, political matters caused the attention of Her Majesty's Government to be directed to finding a new source of sulphur supply. Commander J. E. Commerell, of Her Majesty's ship *Snake*, was sent to Iceland by the Lords Commissioners of the Admiralty, to visit and report upon the capabilities of the mines of Krisuvik and Husavik. He found that the nearest safe port to the Krisuvik beds was Havnafiord; this port is 14 miles from the sulphur-beds by the present roads, and 9 miles from Reikjavik. The harbour is well sheltered, with good anchorage of 7 or 8 fathoms three cables length from the beach; it at present enjoys as much traffic as Reikjavik. The road from Krisuvik might be much shortened, and a tramway might also be laid down. During the past year a survey has been made, and plans drawn, for a railway or tramway to Havnafiord.

The actual extent of the sulphur-beds it is quite impossible to calculate; forty-seven have been already discovered. The deposit of sulphur Commander Commerell personally saw he describes as amounting to many thousands of tons, and, all the mines being in what is called a "living" state, the sulphur taken away is reproduced in two or three years. He considers that sulphur in a pure state could be shipped at Havnafiord for £1 per ton.

The sulphur at Myvatn, though great in quantity, is, he considers, at too great a distance from a port of embarkation to permit its extraction being carried on with any chance of competing with that from the Krisuvik mines.

No further steps were taken in the matter by the British Government, the political complications which led to the expedition having been removed; but the attention of English merchants having been drawn to these rich deposits by the highly favourable character of Commander Commerell's remarks, renewed attempts are being made to render commercially available the immense sulphur-producing power which the Krisuvik solfataras undoubtedly possess. To some of these gentlemen I am greatly indebted for much valuable information, put at my disposal for the purposes of this paper, and, amongst them, I have specially to tender my thanks to Mr. Ramsdale and Messrs. Thorne, of Gracechurch Street, and particularly for the use of numerous and carefully-selected samples of the sulphur-earths which were freely placed at my disposal. These samples I hope to make the subject of a future paper.

Since writing the foregoing paper, I mentioned, in the course of conversation with Sir Henry Holland, the conclusions which are derived from the examination of all the trustworthy facts relating to the sulphur deposits. This led him to examine entries in his unpublished diary, made at Krisuvik in 1810. The theory which he then conceived so thoroughly agrees with all that has been learnt respecting the phenomena in question, that I, with his kind permission, print an extract from his note-book :-

"The theory of these sulphurous springs (if springs they may be termed) at Krisuvik is an interesting object of inquiry. They are situated in a country decidedly of volcanic origin. The high ground on which they appear is composed principally of the conglomerate or volcanic tufa, which has before been noticed. The source of the heat which can generate permanently so enormous a quantity of steam must, doubtless, reside below this rock; whether it be the same which produces the volcanic phenomena may be doubted, at least if the Wernerian theory of volcanoes be admitted. It certainly seems most probable that the appearances depend upon the action of water on vast beds of pyrites. The heat produced by this action is sufficient to raise an additional quantity of water in the form of steam, which makes its way to the surface, and is there emitted through the different clefts in the rocks. The sulphates of lime and alumina, appearing upon the surface, are doubtless produced, in process of time, by these operations. In corroboration of this view it may be observed that the quantity of steam issuing from the springs at Krisuvik is always greater after a long continuance of wet weather, and that whenever earthquakes occur on this spot it is during the prevalence of weather of this kind."

The learned, and now aged, author expressed the highest gratification that the views which he formed at twenty-two years of age should possess so much value so many years after.

During the reading of the paper Mr. Vincent illustrated his subject by several experiments, showing how the deposition of sulphur might have been effected. He also showed a spectrum obtained by burning some of the sulphur-earth, and it appeared that the thallium line became visible in the spectrum. Specimens of the various sulphur-yielding earths from Iceland were exhibited, and Dr. Clement Le Neve Foster showed samples from the Italian sulphur districts.

Elizabeth Jane Oswald

A later visitor in 1882, Elizabeth Jane Oswald (1830 – 1905) gave a good account of the Krisuvik district in her book 'By Fell and Fjord; Or, Scenes and Studies in Iceland, the text of which is reproduced below:

'KRISUVIK – SULPHUR MINES'

The range of purple hills at Krisuvik rises about twenty miles to the south of Reykjavik, in pleasant contrast to the dark flats which intervene. We longed to see the hills nearer; and so, with no small satisfaction, one fine morning we started with nine ponies on a three days' excursion to their recesses. First by an excellent bridle-road, we reached Hafnafjord, a village seven miles distant, prettily situated on a sea inlet, which is so much safer for shipping than the more open roadstead of Reykjavik that it

has been suggested to transplant the capital to its shores. There are many wooden houses and stores dotted along the edge of the sea; but the lava-rock, over which some of the road is carried on causeways, crops out everywhere, and gives little room for building. There are some small houses built into this lava, which is very dry, but so hard to work that the inhabitants must just accept its natural fantastic shape if they make use of it.

Beyond this little fjord, with its bustle, shipping, and neat houses, we came out on the great lava-stream which spreads over most of the south-west promontory of Reykjanes, and our ponies had to pick their way up and down rocks, and over perpetually recurring rifts and crevices. I had formerly stood on the edge of the red lava-streams on the side of Vesuvius during an eruption, and thus I could easily imagine the scene when all this enormous extent of lava was liquid fire and glowing red. The rocks often lay in round swirling ripples, and circular bubbles, and twisted spires – to all appearances suddenly petrified while boiling high. In places they are forced into strange contortions, where some fresher fire-fall has crushed the half-cooled masses; sometimes a series of cracks, made in cooling, will stretch, widening across, till they enlarge into gaping caverns, where delicate ferns and yellow cistus nestle, while above nothing grows but the melancholy grey lichen, planting a seal of long ago on the lava which, with all these signs of violent motion, is now so changeless and still.

We found ourselves about mid-day reclining on a green slope, an oasis in the desert. Grass and crowberries grew around, and we gazed as we sat there at the magnificent prospect before us. Looking back to the north-west, the great tract of lava, variegated here and there with pale yellowish-green moss, was in the foreground; then came the sea, which was quite calm and a deep blue, and beyond it the long mountain-range which skirts the Faxafjord, with the Snaefell Jökull towering above all in its snow-capped splendour. All this, with the contorted black rocks across which we had ridden, presented a contrast of vivid colours never to be forgotten. These large masses of lava appear often in grotesque and distorted forms, which suggest to the imagination demons or wizards; they seem to triumph over the waste places of the earth, devoured by fire, and their fertility stamped out for ever.

All those wild shapes were black – and the Krisuvik Hills so softly purple in the distance, now we neared them, resolved themselves into gigantic cinders, still smoking in places. They looked as if they were the ashy remains of fires lit by the giants of the Edda. We crossed them where a cone had evidently fallen in and formed a cauldron-shaped valley or crater called the “Kettle.” On the other side steaming yellow streamlets with red mud banks ran down black gullies, shapeless blocks of lava strewn the valley, jets of steam and trailing folds of mist confused the dreary scene. There was a forlorn horror about this burnt-out place, which looked like a lunar landscape in a telescope; and the Danish proverb. “God made the world, but the devil made Iceland,” which seemed such a libel among the soft valleys in the west or the fine hills in the north, we felt at last was in a degree accounted for. A rain-storm added to the mess; but we splashed through a dismal marsh, which, being green, seemed comparatively cheerful, to the little farm of Krisuvik, beneath a startling hill which rears right up in a cone in front of it. Here we took refuge in a tiny chapel where service is held once in six weeks. McKenzie says it is eighteen feet by eight, and he is probably right. Viewed ecclesiastically, it seems calculated for one hermit only; but it reminded us rather of an old-clothes shop from the garments hanging from the beams. We shut the shutters, lit the candles, unpacked the bread and ham, while hot coffee and *skyr* came from the farm, and we thought ourselves most comfortable, reading aloud from a saga until bedtime, when my friend spread her cork bed on a bag of beans, and I poised mine on the top of the family chest, while the wind and the rain battered outside, and before long lulled us to sleep.

News of a fine day came with the lassie who brought the morning coffee, and we were soon afoot looking at the then un-worked mines, and very curious they were. A valley and hillside of hot white clay were traversed by a little yellowish streamlet, above were black rocks and red mud banks sloped down to the white mud below. Bright-coloured varieties of stones and clay were strewn about, formed no doubt by the play of sulphur and ferric compounds; and the whole place was dotted with puffs of vapour, in which some of the sulphur was escaping into the air, in combination, to judge by the smell, with hydrogen – but a good deal was deposited in powder or crystals round each little crater, and more no doubt might be condensed. In the wide valley below lay a little lake of as intense a blue-green as any in Switzerland; great boulders strewn in verdureless shores, and cinder-like hills trended away northward, glowing red and purple in the brilliant atmosphere. Following carefully in our guide’s footsteps over the white clay and the red mud, we climbed to the top of the little hill. The ground was everywhere hot and treacherous; sometimes we sank in deeper than was pleasant, in spite of little planks with which we bridged the worst places; and we hardly knew whether it was singing or

scalding that was to be dreaded – our boots suffered from both. We gathered some specimens of the mineral called here *krisuvik*, copper carbonates, and pretty crystals of sulphur; and we also cooked a nice hot little dinner just below the surface, - it was slightly flavoured with sulphur, but we hoped only the more wholesome for that.

These mines were not worked at that time, though the sulphur is plentiful¹ and of excellent quality. The difficulty of transport over the bad lava was a serious drawback. Circumstances had, however, altered; the neighbouring lake of Kleyfirvatn has been obliging enough of late years to sink so much in its bed as to leave a good route round by its shore – a far easier way to Hafnafjord than over the lava, which was formerly the only one. The mines have been profitably worked of late by Mr Paterson, a Scotsman, who puts his own shoulder to the wheel; and so much sulphur has been found that a company has just been formed called the “Icelandic Sulphur and Copper Company,” which is likely to prove very remunerative as soon as the first expense of laying down a tramway about twelve miles to Hafnafjord has been surmounted.

Next day we returned to Reykjavik, by the shores of the clear green lake of Kleyfirvatn; and it was a very pretty ride on that lovely day, though nothing could be gloomier than the scarred barren mountains all round where no grass grew. Beyond the lake we stopped on grassy slopes, lit an aromatic fire of bog-myrtle and juniper, and dined there, reclining luxuriously in the enjoyment of a beautiful view, a good appetite, and food that seemed excellent under the circumstances. Thence we cantered gaily over sound grass between low lava-cliffs, accompanied by some unbroken colts that frolicked alongside, till we reached the flat country and stopped by the edge of the Kallirà or Cold Water – a mysterious river which, after a brawling course, disappears suddenly into a cleft in the lava-crust, and finds some unknown way to the distant sea. The people of a neighbouring little farm brought out fragrant coffee and cream, and set the tray before us on the grass, and we loitered there till the twilight warned us to go on to Hafnafjord. There it became quite dark but as the road was excellent it did not matter. Fireworks disrupted the empire of the sky with the Northern Lights – the former the farewell salute of the departing French frigate, the latter the first greeting of winter, for August was nearly gone. As we rode by an inland creek, the rockets and the merry dancers looked beautiful reflected in the water, and cheered all the dark way to Reykjavik.

¹ Professor Geikie, who inspected the mines last year (1881), estimates the total quantity of ore in sight as 250,000 tones – roughly equal, according to the average quality of the ore, to 120,000 tons of commercially pure sulphur.

Waterman Spaulding Chapman Russell

In his 1914 book ‘Iceland; Horseback Tours in Saga Land’ W.S.C. Russell wrote of Krisuvik:

Reference: <http://www.archive.org/details/cu31924073087805>

‘The columns of steam rising from the hills beyond the meadow and the roar of the escaping gases attracted our attention and it was with impatience that we changed the riding habit for a lighter one and started across the fields to examine the spot which Hooker in 1813 described as, "One of the most awfully impressive scenes that the world can furnish, or even imagination can conceive." This is strong language. Had Hooker visited the solfatara of Krafla his description would have been of interest. We shall see that Krafla is intensely more interesting than Krisuvik.

It seemed but a short walk, a quarter of a mile at most, from the house to the columns of steam belching from the side of the hill. Although we were accustomed to the deceptive distances in this clear atmosphere, this time we were thoroughly deluded. That walk of ten minutes lengthened into one of an hour as the distance proved to be fully three miles. Crossing the meadow we climbed a gentle slope of clay and sulfur to the very edge of the solfatara. What a weird and impressive scene it is! Every beauty of form and color, every horror of sound and odor are here united. Unnumbered tons of sublimed sulfur are piled in banks and pyramids at the base of the cliffs. Great pools of boiling bolus hiss, splutter and stink. The air is foul with hot hydrogen sulfid and stifling with sulfur dioxid. Wavering columns of steam render the walking dangerous as oftentimes one can not see the place where he is about to set his

foot. We crunched through the beds of monoclinic crystals and frequently slumped into them to the knee and when we pulled the leg from the hole a new column of steam shot into the air. Geologists who have examined this place have had unpleasant experiences because of approaching too near to the centers of activity. Hooker states that "In endeavoring to avoid one of these unpleasant gusts, (of steam), which threatened to annoy me while I was gathering some specimens, I jumped up to my knees in a semi-liquid mass of hot sulphur." What a thing of beauty is a hole in these warm sulfur needles ! They are like needles, three to six inches long and glisten with the purest amber glow. The viscid mass of clay and mineral earths stick to the boots and it is often a task to withdraw the feet from the clinging mess. The appearance of the surface is deceitful, for often when it seems most secure the crust breaks and a spurt of hot steam shoots up beside the leg in a very unpleasant manner. A thin hard crust of sulfur often conceals a seething mass of the same material and one literally walks, "Perignes, suppositos cineri doloso." (Through fires placed under deceitful ashes) Elevated rims about the sizzling pools hold the viscid mass in place except when a sudden eruption of steam causes the material to slop over the sides of the basins in a frightful manner. Add to this the steam-filled air, the moaning of the cauldrons, the roar of the escaping gases from a hole high up in the side of the talus and the thought that the whole area may collapse into the bowels of the earth or explode with volcanic force and the mental situation is complete.

That vent in the cliff pours out its hot gases with such a force that it sounds like the whistle of a locomotive and the sound is plainly audible in the bedchamber three miles distant. Day after day and century after century this safety valve has been sounding and it is sounding as we write, — an awful sound to unaccustomed ears, a pleasant one to those who live within the radius of this wide belt of volcanic activity, for it signifies safety from violent eruption as long as the generating forces beneath the surface are continually spent.

It has been estimated that there are no less than 250,000 tons of sulfur in this place and it is constantly increasing by sublimation from below. The hot area is on a line with hundreds of others of a like character, active or temporally quiet, extending in a line from Krisuvik to Thingvallavatn, a distance of thirty miles. This line is also on the main diagonal of volcanic activity extending from Reykjanes to Myvatn in the northeast. Over five hundred square miles of the fire peninsular is of recent volcanic origin and the subarea is highly heated. Numerous hot springs abound, fumaroles are without number, earthquakes are many, lava frequently issues from the fissures in the mountain sides and there is evidently beneath the crust of earth another Phlegethon, that flaming river of the under world in whose channel flowed flames instead of water.

Other References

[Notes on the geography, geology, agriculture, and economics of Iceland](#)

H. J. Johnston-Lavis M.D., M.R.C.S., B.ès.Sc., F.G.S., Etc.

[Scottish Geographical Journal](#), Volume 11, Issue 9 September 1895 , pages 441 – 466
Above not reviewed.

Journal Of A Tour In Iceland in the Summer Of 1809 (pub 1813) by William Jackson Hooker

http://books.google.com.au/books?id=1pYaAAAAYAAJ&dq=tour+of+iceland+1809+-+william+jackson+hooker&source=gbs_navlinks_s

That's Volume 2, the appendices – where is the text ?

by I. Hodkinson, January 2010.