V. *An* ACCOUNT *of the* HOT SPRINGS *near Rykum in Iceland: In a Letter to Dr* BLACK *from* JOHN THOMAS STANLEY, *Esq;* M. P. F. S. A. A. LOND. and F. R. S. EDIN.

[*Read Nov.* 7. 1791.]

DEAR SIR, *Alderley, Auguſt* 15. 1791.

I HAVE been prevented hitherto, by various occupations, from acquitting myſelf of a promiſe you received from me, (I am aſhamed to think how long a time ſince), that I would ſend you an account of the hot ſprings in Iceland, from whence the water was brought which you have lately analyſed. I have truſted you would excuſe a delay not altogether voluntary. It will be now my endeavour to gratify your curioſity as far as I am able; and to acquaint you with every particular, as well concerning the ſprings as the country near them, which I think you may find in the leaſt intereſting.

WE ſaw many ſprings in the courſe of our journey beſides thoſe I am going to deſcribe; nor indeed are they confined to the part of the iſland we viſited, but break out in every diviſion of it. For a general account of the moſt remarkable, I refer you to a letter, written by Dr VAN TROIL, (the preſent Archbiſhop of Upſal), to Profeſſor BERGMAN, publiſhed with ſome others concerning Iceland in the year 1777.

THE deſcriptions given by this author are ſo accurate, that it will not be in my power to give you much new information.

I muſt, in a great meaſure, repeat what he has ſaid. It may be ſatisfactory, however, to you to have his relations corroborated; and ſome further details, with an account of the changes which, in a few inſtances, have taken place ſince he viſited theſe particular ſprings in 1772, may contribute to explain their hiſtory, and the cauſe of their very ſingular appearances.

You received two kinds of water, one from a ſpring near a farm called Rykum, and the other from the fountain known by the name of the Geyzer, the moſt remarkable in the iſland. It riſes near the farm of Haukadal, about forty miles from Rykum. They are both ſituated in the S. W. diviſion of the iſland.

I shall begin with a deſcription of the country and the ſprings near Rykum, and of the firſt view we had of them in our way from Rykavick to Mount Hecla. Rykum is ſituated in a valley, which, on account of its fertility, and the ſtrong contraſt it made with the dreary ſcenes we had paſſed ſince our laſt ſtation, appeared to us with great advantage while we approached it. We had traverſed a country, ſeven or eight miles in breadth, entirely overſpread with lava, and other volcanic matter. It was ſurrounded with hills, not ſufficiently high to be majeſtic, and too rugged and too barren to be pleaſing. We were told by our guides, that, on a clear day, the ſummits of Hecla might be ſeen above thoſe which were immediately before us; but heavy and lowering clouds, which threatened us inceſſantly with a ſtorm, concealed every diſtant object from our ſight.

We ſaw many diſtricts in Iceland covered with lava; but I do not recollect one ſo uncouth and deſolate as this. No vegetation was to be ſeen but that of a few ſtunted buſhes of willow and birch, growing between the crevices and hollows of the lava, into which the wind had drifted ſufficient ſoil for them to take root. We could diſcover no mount or crater from whence

we

we could conjecture, with any degree of probability, the lava to have iſſued. It extended round us like a ſea; and it had burſt perhaps from ſome part of the country it now covered, while the fire to which it owed its origin, had eſcaped with its ſhowers of cinders and aſhes, from ſome other orifice, and had formed one of the numberleſs cones we could diſcover amidſt the neighbouring hills.

THE unpleaſantneſs of our ride over this country was increaſed by the continual danger to which we were expoſed of our horſes falling. The road was no other than what the few travellers of the country, as they paſſed from their farms to Rykavick, had tracked over the lava where it was leaſt rough; but even this was interrupted by many breaks and crevices, formed by the cooling of the matter and the contraction of its parts.

TO this uncomfortable ſcene ſucceeded the view of a rich valley, opening into an extenſive green plain bounded by the ſea. A river was ſeen winding between ſeveral fertile meadows; and beyond theſe, the valley was terminated by a range of high and bold rocks. But our attention was chiefly attracted by the clouds of ſteam, which aſcended in various parts of the valley from the hot ſprings, and by jets of water which, from ſome of them, were inceſſantly darted into the air.

WE deſcended into the valley by a road winding over the lava, which, in one place, had flowed from the upper plain into the country below. On each ſide it had ſtopped abruptly, and had thus formed a perpendicular wall, at leaſt ſixty feet high.

WE pitched our tents in a pleaſant field, on the ſide of the river, oppoſite to the farm, and not far from it, and at the foot of the hills which bounded the valley. Several fragments of rocks, which had fallen from theſe, lay ſcattered round our ſtation. Theſe were entirely volcanic; ſome of dark blue lava, not unlike baſalte; others of a yellow ſubſtance; and again others of a gray lava, mixed with a great quantity of white

glaſs: But the moſt curious conſiſted of an heterogeneous mixture of various ſubſtances, cemented indiſcriminately together by ſome operation, ſubſequent to their original formation, and ſo ſtrongly, that the rock was broken with difficulty by our hammers. It conſiſted of pieces of black glaſs, (a lava in all probability much vitrified), and large pieces of a cloſe, gray lava, the cavities and pores of which were filled with zeolites finely radiated. Some pieces of black lava, in parts compact, and in other parts ſo porous as to approach nearly to a pumice ſtone, were mixed with the reſt of the maſs. A mixture of theſe ſame ſubſtances, (the lavas, the glaſs and the zeolites), pounded in ſmall grains, filled the ſpaces between the larger pieces, and connected the whole into a ſolid rock. The heat (if heat it was) which had cemented theſe materials, had not been ſtrong enough to reduce any one to a ſtate of fuſion; for the angles of the fragments were as ſharply defined as if newly ſeparated from their reſpective original beds.

THE rocks from whence theſe different maſſes have been detached, lay heaped together in ſo disjointed and irregular a manner, that ſome violent convulſion has evidently taken place among them ſince their firſt formation; but ſimilar appearances of diſorder are to be ſeen in every range of hills in the country. Regular ſtrata are no where to be met with. It appears as if all this part of the iſland, at different periods, had been thrown up from its foundations.

THE valley is in this place fertile, and nearly half a mile in breadth. It becomes more narrow towards the north; and it is there rendered barren by heaps of crumbled lava, or other rubbiſh, brought down from the hills by the waters. Theſe have the appearance of artificial mounds, and a great number of ſprings are continually boiling through them. Below the ſurface, a general decompoſition ſeems taking place; for almoſt wherever the ground is turned up, a ſtrong heat is felt, and the looſe earth and ſtones are changing gradually into a clay or bole

of

of various colours, and beautifully veined, reſembling a variegated jaſper. The heat may poſſibly proceed from a fermentation of the materials compoſing theſe mounds; but more probably (I ſhould conjecture) from the ſprings and ſteam forced up through them. The ſprings muſt have acquired their heat at ſome greater depth, from ſome conſtant, ſteady cauſe, (however difficult to explain), adequate to the length of time they have been known to exiſt, with the ſame unvaried force and temperature.

SPRINGS do not boil on or near theſe banks only. They riſe in every part of the valley, and within the circumference of a mile and an half, more than an hundred might eaſily be counted. Moſt of them are very ſmall, and may be juſt perceived ſimmering in the hole from whence the ſteam is iſſuing. This, trailing on the ground, depoſits in ſome places a thin coat of ſulphur. The proportion varies; for near ſome of theſe ſmall ſprings, ſcarce any is perceptible, whilſt the channels by which the water eſcapes from others, are entirely lined with it for ſeveral yards. Neither the water, nor the ſteam from the larger ſprings, ever appear to depoſit the ſmalleſt proportion of ſulphur; nor can the ſulphureous vapour they contain be diſcovered, otherwiſe than by the taſte of what has been boiled in them for a long time.

MANY ſprings boil in great caldrons or baſons, of two, three or four feet diameter. The water in theſe is agitated with a violent ebullition, and vaſt clouds of ſteam fly off from its ſurface. Several little ſtreams are formed by the water which eſcapes from the baſons; and as theſe retain their heat for a conſiderable way, no little caution is required to walk among them with ſafety.

THE thermometer conſtantly roſe in theſe ſprings to the 212th degree; and in one ſmall opening, from whence a quantity of ſteam iſſued with great impetuoſity, Dr WRIGHT obſerved the mercury riſe, in two ſucceſſive trials, to the 213th degree.

I HAVE already ſaid, that the ground, through which many of the ſprings were boiling, was reduced to a clay of various colours. In ſome, the water is quite turbid; and, according to the colour of the clay through which it has paſſed, is red, yellow or gray.

THE ſprings, however, from whence the water overflows in any great quantity, are to appearance perfectly pure. The moſt remarkable of theſe was about fifty or ſixty yards from our ſtation, and was diſtinguiſhed by the people of the neighbourhood, by the name of the little Geyzer. The water of it boiled with a loud and rumbling noiſe in a well of an irregular form, of about ſix feet in its greateſt diameter; from thence it burſt forth into the air, and ſubſided again, nearly every minute. The jets were daſhed into ſpray as they roſe, and were from twenty to thirty feet high. Volumes of ſteam or vapour aſcended with them, and produced a moſt magnificent effect, particularly if the dark hills, which almoſt hung over the fountain, formed a back ground to the picture. The jets are forced in riſing to take an oblique direction, by two or three large ſtones, which lay on the edge of the baſon. Between theſe and the hill, the ground (to a diſtance of eight or nine feet) is remarkably hot, and entirely bare of vegetation. If the earth is ſtirred, a ſteam inſtantly riſes, and in ſome places it was covered with a thin coat of ſulphur, or rather, I ſhould ſay, ſome looſe ſtones only were covered with flakes of it. In one place, there was a ſlight efflorescence on the ſurface of the ſoil, which, by the taſte, ſeemed to be alum.

THE ſpray fell towards the valley, and in that direction covered the ground with a thick incruſtation of matter which it depoſited. Cloſe to this, and in one ſpot very near the well itſelf, the graſs grows with great luxuriance.

WHERE the ſoil was heated, it was gradually (as on the mounds) changing into a clay. But it was here more beautiful than in any other place. The colours were more varied and bright,

bright, and the veins were marked with more delicacy. The tranſition likewiſe from one ſubſtance into the other, was more evident and ſatisfactory.

To the depth of a few inches, the ground conſiſted of looſe lavas, broken and pounded together, of blue, red and yellow colours. The blue lava was hardeſt; and ſeveral pieces of it remained firm and unaltered, while the reſt were reduced to a duſt. The colours became brighter as the decompoſition of the ſubſtances advanced, and they were changed at the depth of nine or ten inches into a clay; excepting, however, the pieces of dark blue lava, which ſtill retained ſufficient hardneſs to reſiſt the preſſure of the finger. Round theſe, (which appeared inſulated in the midſt of the red and yellow clay), ſeveral veins or circles were formed of various ſhades and colours. A few inches deeper, theſe alſo became part of the clay, but ſtill appearing diſtinct, by their circles, from the ſurrounding maſs. The whole of this variegated ſubſtance reſted on a thick bed of dark blue clay, which had evidently been formed in the ſame manner from ſome large fragment of blue lava, or ſtratum of it, broken into pieces.

THE reſemblance of theſe clays to jaſper is ſo ſtriking to the eye, that I cannot forbear believing their origin to be ſimilar, at leaſt, that ſome circumſtances in the formation of each are the ſame. You will ſay, with reaſon, that the difference, notwithſtanding the apparent ſimilitude, is in reality very wide; that theſe clays, before they can be converted into jaſpers, require to be conſolidated, and impregnated with a conſiderable proportion of ſiliceous earth. It is ſomething, however, to have detected nature in the act of forming, in any ſubſtance, the veins and figures common to marbles and jaſpers. What ſtill remains of the proceſs, after thus much of it has been traced, may not long continue unknown; and in Iceland, probably ſooner than elſewhere, will be diſcovered beds of clay, like this, hardening into ſtone, either by the effect of ſubterraneous heat

or

or preſſure promoting an adheſion of the particles, or by ſome inſinuation of matter (perhaps ſiliceous) into the pores of the maſs.

THERE is another fountain in the valley not much inferior in beauty to that which I have deſcribed. It breaks out from under one of the mounds cloſe to the river. Its eruptions are, I think, in ſome reſpects, more beautiful than thoſe of the former. They riſe nearly to the ſame height, and the quantity of water thrown up at one time is greater, and not ſo much ſcattered into ſpray. The jets continue ſeldom longer than a minute, and the intervals between them are from five to ſix minutes. They are forced to bend forwards from the well, by the ſhelving of the bank, or probably their height would be very conſiderable; for they appear to be thrown up with great force. We never dared approach near enough to look deep into the well; but we could perceive the water boiling near its ſurface, from time to time, with much violence. The ground in front of it, was covered with a white incruſtation, of a more beautiful appearance than the depoſition near any other ſpring in this place. By a trial of it with acids, it ſeemed almoſt entirely calcareous.

I HAVE now deſcribed to you the two moſt remarkable fountains in the valley of Rykum, the only two which throw up water to a conſiderable height with any regularity. There are ſome from whence, in the courſe of every hour or half hour, beautiful jets burſt out unexpectedly; but their eruptions continue only a few ſeconds, and between them the water boils in the ſame manner as in the other baſons.

TOWARDS the upper end of the valley, there was a very curious hole, which attracted much of our attention. It ſeemed to have ſerved at ſome former period as the well of a fountain. It was of an irregular form, and from four to five feet in diameter. It was divided into different hollows or cavities at the depth of a few feet, into which we could not ſee a great way,

on

on account of their direction. A quantity of ſteam iſſued from theſe receſſes, which prevented us from examining them very cloſely. We were ſtunned while ſtanding near this cavern, and in ſome meaſure alarmed, by an amazing loud and continued noiſe which came from the bottom. It was as loud as the blaſt of air forced into the furnace from the four great cylinders at the Carron iron-works.

We could diſcover no water in any of the cavities; but we found near the place many beautiful petrifactions of leaves and moſſes. They were formed with extreme delicacy, but were brittle, and would not bear much handling; their ſubſtance ſeemed chiefly argillaceous.

We perceived ſmoke iſſuing from the ground in many places in the higher parts of the valley, much further than we extended our walks. I am ſorry to ſay we left many things in this wonderful country unexamined; but we were checked in our journey by many circumſtances, which allowed us neither the leiſure nor the opportunity for exploring every part of it as we could have wiſhed. The ſubſtances depoſited near the different ſprings ſeemed to me, in general, a mixture of calcareous and argillaceous earths; but near one ſpring, not far from our tents, there ſeemed to be a ſlight depoſition of ſiliceous matter. To the eye it reſembled calcedony; but with its tranſparency, it had not the ſame hardneſs, and, if preſſed, would break to pieces. The water you have analyſed came from this ſpring, and we were obliged to take ſome care in filling the bottles; for though gradually heated, they would break when the water was poured into them, if it had not been previouſly expoſed to the air for ſome minutes in an open veſſel.

The water of this ſpring boiled, as in moſt of the others, in a cauldron four or five feet broad. I do not recollect to have ſeen any of it ever thrown up above a foot, and ſome meat we dreſſed in it taſted very ſtrongly of ſulphur.

Mr

Mr BAINE, by a meaſurement of the depth, the breadth and the velocity of the ſtream flowing from the little Geyzer, found the quantity of water thrown up every minute by it to be 590.64 wine gallons, or 78.96 cubic feet. Mr WRIGHT and myſelf followed the ſtream, to obſerve how far any matter continued to be depoſited by the water. We found ſome little ſtill depoſited where it joined the river, a quarter of a mile at leaſt from its ſource. At that place, it retained the heat of 83 degrees by FAHRENHEIT's thermometer.

THE vegetation on the banks of the ſtream, and in the pleaſant meadows through which it flows, is exceedingly luxuriant. The farmer and his people were at this time employed in cutting the hay in them, which, though not high, was thick, and remarkably ſweet. The plants which Mr WRIGHT found in the greateſt perfection, were the ſedum acre *, the veronica becabunga †, the polygonum viviparum ‡, and the comarum paluſtre ‖.

A LITTLE above, where the current from the little Geyzer falls into the river, part of the lava, which has deſcended from the upper into the lower plain, has aſſumed cloſe to its banks, for the ſpace of ſome yards, a regular columnar ſhape. The pillars are ſhort, and have five or ſix ſides. I cannot be very exact in my account of them, as they were on the oppoſite ſide of the river. I ſhould ſuppoſe they were nearly a foot and an half in diameter. Some were horizontal, and others vertical. We obſerved the ſame appearance in many of the tracts of lava we traverſed on our journey, and, in one or two inſtances, in thoſe which had flowed from the ſides of Mount Hecla, though the pillars there were leſs perfectly defined.

So many ſtreams of hot water fall into the river, that it receives from thence a very perceptible degree of heat. The thermometer,

* Pepper ſtone crop.

† Brook lime.

‡ Snake weed.

‖ Purple marſh ariquefoil.

thermometer, immerſed in it above where it is joined by the waters of the Little Geyzer, roſe to 67 degrees, while in the open air it ſtood at 60. The breadth of the river in the ſame place is forty feet; its mean depth two feet and an half, and its courſe is rather rapid. Several kinds of fiſh are found in it; in particular, numbers of very fine ſalmon.

THE village of Rykum or Ryka, called either indiſcriminately, from *Ryk*, an Icelandic word, ſignifying ſmoke, is ſituated in the middle of the valley, and, by an obſervation made by Mr BAINE, is in latitude 64° 4′ 38″ N. about twenty miles from Rykiavick, and eight or ten from Oreback, a ſmall harbour on the ſouthern coaſt of the iſland. The village conſiſts of the farmer's houſe, and the houſes of his ſervants or dependants, and a ſmall church. All the adjacent lands belong to him, and he keeps a conſiderable number of ſheep and cattle, and ſome few horſes. Theſe conſtitute his riches; and he purchaſes at Rykiavick, with ſkins, wool and butter, whatever he requires, of which the chief article is fiſh, for his winter's proviſion.

I HAVE now related to you every circumſtance that has occurred to me worth mentioning concerning this intereſting valley. I have regretted much, however, my inability to give you a more accurate account of ſome parts of it; in particular, of the many ſprings which break out near the hills to the north, and of the rocks above the field where we placed our tents, which deſerved more attention than I gave to them. But we remained in this valley a ſhort time only, and the weather, during our continuance there, was very unfavourable. I ſhall here cloſe this letter, and reſerve for another (which you may very ſoon expect) the account I have yet to ſend you of the Great Geyzer and the ſprings near Haukadal. I am, Dear Sir, with great eſteem, your moſt obedient ſervant,

JOHN THO. STANLEY.