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VIII. *A further Account of the great Mass of Native Iron of Bitburg. By Messrs. STEININGER and NÖGGERATH: with Observations, by Dr. C. F. F. CHLADNI*.*

THERE is no doubt that the mass of native iron found in the vicinity of Bitburg, near Treves, weighing from 3300 to 3400 pounds (mentioned in this Journal for 1825) †, which was afterwards through ignorance melted down, was of the meteoric kind; since Colonel Gibbs, of New York, has found it to be similar to other meteoric iron, and to contain nickel. For the first intelligence of the discovery of this iron I am indebted to my very worthy friend Dr. Nöggerath, of Bonn, who after my communication respecting the further investigations given on this subject in the American Mineralogical Journal, examined it more closely on the spot, caused the melted mass—which had been buried, on account of its unfitness for being wrought, and from a fear of its giving the establishment a bad name—to be dug up again; and he was kind enough to distribute some fragments of it to myself and other individuals. The original crystalline structure had been destroyed by the process of melting the mass, so that by etching a polished surface, no regular figures either did, or could appear; nevertheless there appear to be traces of its former crystalline structure on some of the projections and small imperfectly melted lumps. Professor Bischof and Counsellor Karsten have also found nickel in it: Counsellor Stromeyer, 81·8 of iron, 11·9 of nickel, 1·0 of cobalt, 0·2 of manganese, 5·1 of sulphur, = 100·0: and Professor John, 78·82 of iron, 8·10 of nickel, 3·00 of cobalt, 4·50 of sulphur, 0·08 of silicium, 5·50 of silica, alumina, oxide of iron, as well as a trace of selenium,—differences of analysis which may have been produced in part by the agents used in the process. Counsellor Stromeyer intends to examine this iron for chrome, which he has not yet done. It was however regretted that with the exception of some fragments that might perhaps be found in America, none was left for investigation in its natural state. Having therefore learned that some of it was still extant in a collection at Treves, I wrote to M. Steininger, (teacher of natural history and mathematics in the Gymnasium of that city,) a gentleman distinguished by several works he has written on the geology of the country along the Rhine, &c. and especially by his knowledge concerning the former volcanos of the Eifel.

* From Schweigger's Journal, N.R. Band xvi. p. 385.

† See Phil. Mag. vol. lxx. p. 401.

He was also kind enough to lay my request before the Society for Useful Investigations, in whose possession those fragments were, and to send me, with their consent, some parts of them, together with an earlier essay of his, on the subject, the publication of which he left to my option.

M. Steininger writes:

"After the communications made by Messrs. Bischof and Nöggerath in Bonn, concerning the problematic meteoric mass of Bitburg in Schweigger's Journal, it may not be uninteresting to state that two pieces of this mass in its natural and unaltered condition are still extant in the cabinet of the Society for Useful Investigations at Treves; which, being sufficiently large to show the original physical characters and external appearances of that mass, will in some measure console us for the loss sustained by science of the mass itself, which was melted down at the forge of Pulwig.

"At first sight they appear like a tolerably pure kind of iron, the produce of art; and I also find the pieces at Treves, which had been presented by Dr. Schmitz, of Hillesheim, in the Eifel, to the late dean H. Castello, to have been marked in the latter gentleman's catalogue of minerals, as problematic meteoric native iron; a designation which was subsequently erased, with the observation that this mass had been produced by art,—and this opinion was founded on the supposition of a distinguished mineralogist.

"The specific gravity of the pieces at Treves, is 6·14 in a temperature of about 61°·25 Fahr.; and to judge by the impressions the fragments received on being knocked off, and the experiments made on a third fragment at Treves, they are rather of a tough nature. They are much corroded and perforated with holes, and the small cavities are in part covered with oxide of iron, and lined with small grains of quartz, some of which may be distinguished by the naked eye. But it may be seen by means of a lens, and in parts acted upon by an acid, that these grains of quartz are more or less mingled with the whole mass, which in many parts has the appearance of peroxide of iron, and has only a metallic glimmering lustre in detached places, but on the whole has an earthy look and dense structure. In parts where the mass of metal is pure, it is either hackly or granular. The colour of the larger metallic granules is a bright white, and their brilliancy perfectly metallic. They do not seem to be oxidated readily in atmospheric air, as they appear quite fresh although exposed to it for many years. In some parts may be recognized through a lens, a black dross with small cavities in it, the sides of which
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are vitrified, and the pure metallic mass seems only to form a sort of skeleton, in which the oxidated mass, mixed with granules of quartz, is distributed.

"In muriatic or nitric acid, even when heated, the mass dissolves slowly; but in aqua-regia, quickly, and with a development of nitrous acid gas. Sometimes I observed during the process of solution, that a turbidity was occasioned round the metal, and yellowish white flakes came off it. The surfaces of the metallic pieces then showed in some parts the colour of iron-pyrites, although the flakes were too small in quantity and number to allow me to collect and distinguish them separately; and I am of opinion that they clearly indicate the presence of sulphur in the mass. For the rest, the mass of metal was completely dissolved, with the exception of the grains of quartz intermixed with it.

"By separating the oxide of iron from the solution by saturation with caustic ammonia, the solution will pass colourless through the filter. But if it is condensed in a watch-glass, it assumes a greenish colour, and on being completely evaporated, leaves a grayish brown residuum. By volatilizing the sal ammoniac, the residue turns into a yellowish red; and at one end the colour turned to a greenish yellow. The residuum still somewhat warm, heated with a drop of caustic ammonia, crumbled down and dissolved, assuming different hues, at first blue, then violet, and at last bright red, forming however a blue solution. When evaporated, this solution left a residuum of a pomona green with a somewhat brownish mass in the centre. A drop of caustic ammonia rapidly dissolved the green border, turning the colour of the brown mass in the centre, first into a bluish, and subsequently into a reddish violet*, producing also a brown powder, but finally completely dissolving it.

"I now again caused the ammonia to evaporate, poured on the residuum a solution of chlorine, caused it to evaporate in its turn, and brought the residuum, now nearly red hot, in contact with ammonia, by which the green oxide of nickel was dissolved, and a brown residuum was left. Collecting this residuum on a filter, and adding some water to the fluid, after it had passed, white flakes, subsequently turning brown, were produced, which showed also the presence of manganese, besides the nickel. I then dissolved the residuum on the filter by means of nitric acid, and added cautiously some ammonia to the solution, which remained perfectly clear. I again made the nitro-ammoniacal solution evaporate, dissolved the brown

* "A circumstance which seems to indicate the presence of cobalt, pure manganese not furnishing these appearances."

oxide in muriatic acid, and added prussiate of potash to the solution, whereby I obtained the same result as is obtained from the ferriferous oxide of manganese of Wadern, under similar circumstances; viz. a white precipitate is formed slightly of a prussian-blue tint, yet so that the white substance may be distinguished as the precipitate of the solution, which is at first of a greenish, and afterwards of a dark blue colour, and continues so distinguished till it is mixed with the rest by a continued stirring; at the same time pellicles of a purple violet show themselves on the surface of the blue liquor. I entertain, therefore, no doubt but that the meteoric mass of Bitburg contains manganese.

"I could, however, discover neither lime nor magnesia in the solution of the meteoric mass, freed from oxide of iron. It appears therefore that metallic oxides only constitute the scoria mixed with it.

"Thus the mass of Bitburg would appear to consist of iron, manganese, nickel (cobalt?), and sulphur, with a considerable intermixture of grains of quartz.

"Would it not appear from the latter constituent that the mass in falling to the ground was in a state of fusion, and became mixed with those grains of quartz on the surface only."

Thus far M. Steininger.—On exhibiting the fragment of the Bitburg iron to Dr. Noeggerath, during my residence in Bonn, he was kind enough to communicate to me the following observations for publication.

"There can be no doubt of the genuineness of the fragment of meteoric iron received by my friend Dr. Chladni from M. Steininger, of Treves, even with respect to the spot where it is said to have been found; since it came from Dr. Schmitz at Hillesheim, the same gentleman from whom I received, in 1814, the first verbal account of the existence of this mass near Bitburg.

"The rough condition of the fragment shows that the mass had been filled with cavities; a circumstance which may also have caused the comparatively low specific gravity of 6.14, mentioned by M. Steininger.

"The melted mass, although still porous, according to the experiment made by Professor Bischof and myself, has a specific gravity of 6.859. The irregular cavities formed by a less perfect ramose form than in the Siberian meteoric iron, show on their surface but few shining metallic points, on which the pure metallic mass appears; most of it is black, in part rough and dull, or smooth and of the ordinary lustre. The surfaces of the cavities combine the character of the crystalline with that of the melted substance. One may distinctly perceive

ceive detached surfaces, angles, &c. of crystals no longer definable, but probably octahedral, which cover the surfaces of the cavities in groups, and are partly melted themselves, and covered over by a scoriaceous substance. The latter forms the black dull surface, which is perceived in the above-mentioned state of brilliancy, wherever it became attached during the original fusion in a purer form, and in the shape of small hemispheres.

"The light-grayish-white substances which appear either singly or in small groups incorporated in the surface like splinters in the shape of small angular grains, appear to me to be too soft for quartz, and may perhaps be the same granular body as that which forms the principal part of meteoric stones. There are, however, too few of them in the fragment before me, to allow of any certain decision on this point.

"The pure meteoric iron of Bitburg itself is somewhat lighter in colour than the melted mass. It is malleable and softer than the latter; it may be splintered a little with the knife. It is possible that this difference arises from the unmelted substance having no *admixture* of sulphur, which may have been added during the fusion by the intermixture of pyrites. There is, however, no appearance of such a mixture in the specimen before me: perhaps the mixture was not equal throughout the mass, from which circumstance it may be entirely missing in some fragments; a supposition that seems to be confirmed by the great differences in the quantity of sulphur found in the various analyses made of the melted mass of Bitburg."

I beg now to add a few observations to the above.

I assume as a fact, that all masses of native iron which may actually be considered as meteoric, must, as far as we are acquainted with them, be divided into two principal classes*: viz. 1st, The ramose specimens, the cavities of which are filled with a substance resembling olivine or chrysolite; and 2ndly, The solid specimens, the structure of which is for the most part crystalline. The mass of Bitburg belongs to the second of these classes. Several other masses of this kind show,

* I saw many years ago, when I was less acquainted with masses of native iron, a piece which I do not know what to think of, at Würzburg, with the late estimable Bonavita Blanc, whose collection has been since acquired by the University of that city. If I recollect it right, it had a flattish round form, and was of about two ounces in weight, and seemed a rough mixture of a gray mineral, more resembling some kinds of meteoric stone than olivine and meteoric iron, and unlike any other kind of native iron I had ever seen. It will probably be found in the cabinet of minerals of the university of Würzburg, by the side of a fragment of the Siberian mass; and it would be very desirable that some one should undertake to investigate it.

like this, greater and lesser cavities, on the surface of which some crystalline appearance is found; but never, as far as I know, a filling-up of olivine or any other mineral substance. Among all the fragments of meteoric iron in my possession, or that I have ever seen, I found none so greatly resembling the fragment of Bitburg described here, as that from the Montanna de Santa Rosa in Colombia, first made known by Mariano de Rivero; a piece of which, weighing several ounces, was presented to the university of Berlin by de Humboldt, and of which I possess a fragment of about three drachms in weight. They fully correspond as to colour, softness and porosity. On a smooth and etched surface of my fragment of the Colombian metal, no regular figures are seen, but only a slight indication of a crystalline structure; nor would they, as I think I may conclude from its external appearance and porous state, appear in the fragment of the Bitburg iron: nor indeed can it be expected from such porous pieces of the extremities of the mass; but certainly towards the interior, where the structure is closer and more crystalline.

Concerning the grains of an earthy substance found in the cavities of the Bitburg iron, either singly or in aggregates, I imagine that they may have existed before its fall, and have an affinity with meteoric stones.

The difference of the quantities of sulphur in natural and melted pieces, may originate from a mixture of iron pyrites with the latter; and also from the circumstance that in several masses of native iron, the sulphureous iron is added to the remaining mass in distinct parts, as I have shown in the *Annalen der Physik* for 1822, which sometimes render it difficult to saw, and may cause a difference in the quantities of sulphur found in the analyses.

IX. *On Meteoric Iron from Mexico. By Dr. J. NÆGGERATH.
In a Letter to Dr. Chladni*.*

Bonn, 25th of June 1826.

I AM now enabled to give you a better account of the place where that meteoric iron was found which I received during your late visit to Bonn, and of which I had a small fragment cut off for you. It was sent to the directors of the German-American Mining Association at Ebberfeld, accompanied by a letter from their principal agent in Mexico, Mr. W. Stein.—Mr. S. expresses himself in the following terms:

* From Schweigger's Journal, N. R. Band xvii. p. 74.

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