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3d, A sky-rocket, of a large diameter, would be of equal service. It would also carry, from the vessel to the shore, a string capable of drawing a rope after it. C. Ruggieri, whom I have consulted on this subject, told me, that he made some four inches in diameter, which rose to a great height; and that, with a string attached to them, they would go to the distance of four or five hundred fathoms, which is more than would be necessary. They may be kept in a state fit for service two years, if deposited in a dry place.

Lastly, A fourth plan for saving the crew of a shipwrecked vessel, is that of throwing from the vessel into the sea an empty cask with a cord attached to it. The wind and the waves would drive the cask to the shore, and afford the means of establishing that rope of communication already mentioned. Each of these methods may be improved, but I cannot at present enter into any detail*.

V. *On the different Kinds of Cadmia, and particularly those of Zinc and Cobalt.* By I. I. BINDHEIM of Moscow †.

THE surest method of classing minerals is without doubt to arrange them, not according to their external characters, but according to their internal component parts. For, though the former in some measure serve for discrimination, and are therefore not altogether useless, they are not so precise and certain as to form a basis for a system of mineralogy,

* The author of the above papers says, that he announced his discovery in the *Affiches de Paris* on the 29th of January 1794. However this may be, we know that one of his methods, that of conveying a rope to the shore, by attaching it to a bullet or bomb to be afterwards fired from a cannon or mortar, was proposed a few years ago by a serjeant or officer of artillery at Woolwich, named Bell. Some experiments of the same kind made at Portsmouth, we believe, answered expectation. The use of a kite or rocket seems to deserve attention; and we do not hesitate to say, that the former could hardly fail of producing the desired effect. At any rate it might be easily tried. EDITOR.

† From *Neus Nordische Beytraege*, by Professor Pallas, Vol. VI.

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since the attentive naturalist is sufficiently taught, by experience, that in the mineral kingdom substances of the same genus, though different in external form, consist often of the same component parts; and that other bodies of the like kind differ in their component parts, though perfectly alike in their external appearance. As this is the case, we can find no better guide to conduct us to an invariable classification, arrangement, and definition of mineral bodies than chemistry; a knowledge which must be united with that of the external characters of minerals.

To give an instance of the uncertainty which arises when these are separated, I shall here mention those ores which are known by the name of *cadmia*; for it would seem, by the many improper denominations which are often founded on their external characters, as if we were almost conducted back to the dark age of Cadmus, from whom the Europeans are said to have first learnt the art of fusing ores on a large scale, and from whom, in all probability, the term *cadmia* had its origin. In this respect chemical knowledge is a better guide than external characters, and the names thence deduced, and often very improperly; it enables us to define minerals with more accuracy, and conducts us nearer than the latter to the real knowledge of nature in this department, without which all mineralogical knowledge must be uncertain and imperfect. As it would be superfluous to say more on this subject, I shall, for the present, confine myself to the *cadmias*, and those ores alone which, when decomposed in a proper manner, and fully purified, yield those metals called zinc and cobalt,

Of ZINC.

Ores that contain zinc are found in numerous varieties and of different forms. Sometimes they are combined with oxygen and the sulphuric acid; and sometimes there are found in them, besides zinc, various foreign component parts, such as argil and siliceous earth, a little iron, lead,
and,

and, at times, also a small portion of copper. In blende the sulphur is combined with iron, and the particles of zinc are scattered through the mixture. The so called furnace calamine is obtained by the fusion of some kinds of lead ore when the particles of zinc are sublimated by strong heat to a cooler place of the furnace called the *zinc stool*, where they adhere in the form of a grey or yellowish stone. In preparing brass, and other operations of the like kind, the sublimated zinc calx is collected under the name of *white nicht*; but what adheres lower down, and becomes a hard mass, is called *grey tutia*; and this substance, as some sulphureous vapour seems to adhere to it the longer it lies exposed near the smelting houses, becomes, by the effects of the atmosphere, always more proper for use. Besides the above, we have zinc calx, zinc spar, tutanago ore, the last of which was first discovered in China; but I am convinced, by experiments, that a like ore, which is natural flowers of zinc, is found in Germany in the Thomas-stollen at Bleiberg. We have also zeolite-formed calamine, zinc blende, glittering blende, black blende, reddish brown, phosphorised, greenish-yellow, white, and yellow blende. Such kinds are found in England, Siberia, China, Sweden, Silesia, Saxony, &c.

In examining these substances various chemists have rendered great service to mineralogy, particularly Brand and Schwab, counsellors of the mines in Sweden; and these were followed by Justi, Pott, Henkel, and, above all, Margraaf, who employed great care and accuracy in fusing and examining them; but Bergmann, to whom science is so much indebted, has given most excellent models for the decomposition of these ores. Whether there be native zinc or not, has never yet been fully ascertained; and we must still remain in doubt until the account of its being found in the island of Naxos, in the Archipelago, be better confirmed. The zinc ore of Gosslar, that found in Cornwall, and a little of the Swedish, can be rendered useful and pro-

ductive. The zinc obtained from China, under the name of *tuianego*, is considered to be purer than the German, and therefore a small difference is observed in their specific gravities.

The properties of zinc separated from its ore, and purified, are, that it scarcely undergoes any variation in atmospheric air or in water; and that, by the addition of copper, in different proportions, you obtain brass, pinchbeck, prince's metal, Manheim gold, &c. All acids deprive it of its inflammable matter, and dissolve it with effervescence. With the vitriolic acid it gives a crystalline salt, which is sulphat of zinc, or, as it is commonly called, white vitriol. That white vitriol which is obtained not in a crystalline form, but in white masses like refined sugar, contains often a mixture of foreign metallic particles, such as iron, copper, and lead; but it may be purified by adding to a solution of it pure zinc, by which the above metals will be precipitated: if the solution be then filtered, and exposed to crystallize, you will obtain pure white vitriol.

By the nitrous acid, zinc is dissolved with a strong effervescence and in great quantity producing crystals: if you pour alcohol over these and distil them, you will obtain very good edulcorated spirit of nitre. It dissolves also in the muriatic acid, and emits a strong offensive vapour; this clear solution saturated cannot be brought to shoot into crystals: if you reduce it by evaporation to a gelatinous mass, and place it in a retort over the fire, you obtain, in the same manner as when you distil zinc with sal-ammoniac and corrosive sublimate, butter of zinc of a somewhat thick consistence.

It is soluble also in aqua-regia, and by that acid gives a triple neutral salt, in the same manner as sal-ammoniac. It dissolves likewise in concentrated acetic acid, and shoots into crystals: the remaining acids, viz. of sparry fluor, arsenic, borax, sugar, tartar, sorrel, citrons, ants, phosphorus, and fat, exercise an action over zinc also. The alkaline solvents do the same; and the process succeeds best with a concentrated

trated solution of the volatile, not caustic alkali, during which an effervescence is observed, and by which the zinc exhibits traces of an acid: the produce is crystals of a neutral salt.

Flowers of zinc, like zinc itself, are soluble in an acid; but with this difference, that no effervescence takes place. These flowers are produced during the fusion of zinc in an open crucible, when the heat is increased to above 370 degrees. The metal then inflames with a whitish-green flame of a dazzling brightness, which seems to diffuse over the faces of those present a death-like paleness; and the metal, by being deprived of its inflammable matter, (united to oxygen,) is converted into a tender calx, which, by the violence of the inflammation, is, on account of its lightness, carried upwards like wool or a cobweb. Zinc, calcined in this manner, is called the flowers of zinc, and also *philosophic wool*, not to mention other singular appellations of the alchemists. During this operation zinc exhibits some phenomena, such as the smell, the flame, &c. which are similar to those that occur during the combustion of phosphorus; and therefore people were led to suppose that the phosphoric acid was contained in zinc. By the above process the weight of this calx is increased a tenth part, and, as some have remarked, even more, and at the same time it becomes fixed. When exposed on coals to the blow-pipe, it becomes yellow, and on cooling resumes its whiteness, which is a proof that the flowers of zinc are genuine. It can be fused into a yellowish-brown glass, and, by adding the inflammable matter, can be reduced in close vessels.

In a close vessel, exposed to a violent heat, zinc goes over in a metallic form, and by these means acquires the property of creaking, when it breaks like tin. It can also be brought to such a state that it may be drawn out into thin plates, and be flatted between metal cylinders; some specimens of which, by M. Sage of Paris, and M. Kratz of Berlin, I have in my possession. Zinc may be combined with the
greater

greater part of metals, but not with lead, iron, or bismuth; and it may be amalgamated with quicksilver. This amalgam of zinc is very proper for strengthening the power of an electric machine, and Higgins has given a prescription for preparing it. In the dry way it has the greatest affinity with copper, and produces with it a more or less yellow composition, which can be obtained by no other metal. In this respect, then, it is essentially different from all other metals, and becomes itself a very useful one, as it is used for brass, pinchbeck, prince's metal, bronze, Manheim gold, and in fire-works, &c.

It is very remarkable, in regard to zinc, that neither sulphur nor liver of sulphur * produces on it any effect; whereas gold, which sulphur cannot overcome, is dissolved by liver of sulphur.

On this occasion I cannot omit making mention of the celebrated alkahest of Respur, who believed, that when he alcalified zinc and rendered it caustic, and had obtained from it a purple-coloured mass, volatile in the open air, he had found out a menstruum, by which he could radically dissolve all metals. A paradoxical position, which was long adopted by the gold-making alchemists, but which has never been realized.

[To be concluded in next Number.]

VI. *Description of an Assay-furnace, with an Apparatus for measuring the Degree of Heat employed. By Mr. DAVID MUSHET of the Clyde Iron Works. Communicated by the Author.*

IN my last paper I mentioned, that, in order to facilitate the operations of the assay-furnace, and to compare the various degrees of heat in which different experiments are

* It has been ascertained that zinc and sulphur can be united; but the process is difficult, on account of the easy oxidation and volatility of the zinc. See *Mem. de Dijon*, 1783.

effected,