III. *Analysis of a new Species of Copper Ore. By* Thomas Thomson, *M.D. F.R.S. L. and E.*

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The mineral which constitutes the subject of this paper was discovered by Dr. Benjamin Heyne about the year 1800 in the peninsula of Indostan, near the eastern border of the Mysore. From Dr. Heyne's description, it is probable that it occurs in nests in primitive rocks, which seem to be green stone, or at least connected with primitive trap. These rocks appear to be subordinate to mica slate. But I purposely omit all particular details, because I understand Dr. Heyne has himself a work in the press, in which the mineralogy of this country will be particularly described.

Copper mines had been wrought in these mountains some centuries ago; but they had been abandoned probably on account of the various revolutions to which this part of India has been subjected. The most common ore which occurs in these mountains is malachite, and it seems to occupy very extensive veins; but the species which I propose to describe here, occurs also in considerable quantity. It had been already made the subject of various experiments, with a view to determine how much copper it contained, but I am not aware that any person had subjected it to a regular chemical analysis, or recognised it as a new species.

All the specimens of this ore which I have seen are amorphous; so that, as far as is known at present, it never occurs crystallized. Quartz crystals indeed are imbedded in it abundantly and very irregularly. Sometimes they are single, sometimes they constitute the lining of small cavities to be found in it. These crystals are all translucent. In some rare cases they are colourless; but by far the greater number of them are tinged of a yellowish red, and some few of them are green. The mineral is likewise interspersed with small specks of malachite; and with dark, brownish red, soft, particles, which I found to consist of red oxide of iron.

The colour varies in consequence of the irregular distribution of these extraneous substances. One specimen, which was the most free from the malachite and the red particles, was of a dark blackish brown colour. But in general the colour is a mixture of green, red, and brown; sometimes one, and sometimes another prevailing. Small green veins of malachite likewise traverse it in different directions.

The fracture is small conchoidal, and in some parts of the mineral there is a tendency to a foliated fracture. The lustre is glimmering, owing, I conceive, to the minute quartz crystals scattered through it. The kind of lustre is resinous; and on that account and the variety of colours, this ore has a good deal of the aspect of serpentine.

It is soft, being easily scratched by the knife. It is sectile. The streak reddish brown. The specific gravity 2,620.

It effervesces in acids and dissolves, letting fall a red powder. The solution is green, or blue, according to the acid, indicating that it consists chiefly of copper.

After a few preliminary trials to ascertain the nature of the constituents of this ore, I adopted the following mode of analysis.

1. 100 grains in the state of a coarse powder were put into a phial containing diluted sulphuric acid, and the mouth of the phial was stopped with cotton wool. The loss of weight, when the effervescence was at an end, amounted to 16.7 grains. This loss was owing to the escape of carbonic acid gas.

2. 100 grains of the ore were treated in the same way with muriatic acid. The green solution was decanted off, and evaporated nearly to dryness, to get rid of the excess of acid. A plate of zinc was then put into the liquid previously diluted with water. The copper precipitated weighed 48.5 grains.

On repeating the analysis, I found that the muriatic acid had likewise taken up a portion of iron. I therefore supersaturated the solution with ammonia, and threw the whole upon a filter. By this means the red oxide of iron was separated. The ammoniacal solution was then neutralized by muriatic acid, and the copper thrown down by a plate of zinc. But during my first analysis, none of the iron was taken up by the cold muriatic acid, owing, no doubt, to the state of its aggregation.

3. The red powder, which remained undissolved after the muriatic solution was drawn off, was boiled for several hours in nitromuriatic acid. The matter gradually diminished in bulk and became white, while the acid acquired a golden yellow colour. The acid was now separated from the undissolved powder, evaporated nearly to dryness to get rid of the excess of acid, diluted with water, and mixed with an excess of ammonia. A brown powder fell, which was separated by the filter, and which, after being exposed to a red heat, weighed

19.5 grains. A little of this powder being dissolved in muriatic acid was precipitated dark blue by prussiate of potash. The remainder being mixed with tallow, and suddenly heated in a covered crucible, became black, and was attracted by the magnet. These properties leave no doubt that the powder was peroxide of iron.

4. The ammoniacal solution had a light blue colour, I therefore neutralized it by muriatic acid, and put into it a polished plate of zinc. I obtained a sensible deposit of copper; but so small, that I was unable to collect and weigh it. I estimate it at about 0.1 grain.

5. The white undissolved matter being heated to redness weighed 2.1 grains. On examining this matter attentively, I found it entirely composed of fragments of quartz crystals which had been interspersed through the ore, and had from their minuteness escaped my observation.

6. From the facility with which the copper dissolved in muriatic and sulphuric acids, there could be no doubt that it existed in the ore in the state of an oxide. But the red colour of the ore made me uncertain whether the oxide was the red or the black. I therefore put 100 grains of the ore into a tall narrow phial, filled the phial full of water, and then by means of a funnel poured a quantity of muriatic acid into the bottom of the vessel. The ore was immediately attacked, and the solution from the very commencement appeared green. This I consider as a demonstration that the copper in the ore was in the state of black oxide. Now, black oxide of copper is a compound of 100 metal + 25 oxygen. So that the 48.6 grains of copper, extracted from the ore when in the state of black oxide, must have weighed 60.75 grains.

From the preceding analysis, it appears that the ore is composed as follows:

Carbonic acid - -	16.70
Peroxide of copper	60.75
Peroxide of iron -	19.50
Silica - -	2.10
Loss - -	0.95
	100.00

The silica was obviously accidental, and derived from the quartz crystals; so that the ore, in fact, consists of carbonic acid, peroxide of copper, and red oxide of iron. In the different analyses, I have found the copper to vary a little. The least quantity I obtained was 48.6, the greatest 51 grains. The red oxide of iron and siliceous matter varied also somewhat. The least quantity obtained was 19 grains, the greatest 25 grains. These variations are owing chiefly to the admixture of quartz crystals, and partly to the specks of malachite and red oxide of iron with which the ore is interspersed.

The carbonic acid is obviously combined with the black oxide of copper, so as to constitute carbonate of copper. Now carbonate of copper, as I ascertained by a direct analysis, is composed of an integrant particle of carbonic acid, and an integrant particle of black oxide of copper. An integrant particle of carbonic acid, as I have shewn elsewhere, weighs 2.751, and an integrant particle of peroxide of copper weighs 10. Now 2.751 is to 10 as 16.7 is to 60.75, so that there can be no doubt that the carbonic acid and oxide of copper are united in the ore. As to the oxide of iron, I am disposed to consider it as only mechanically mixed; because in one experiment I dissolved almost all the copper without touching the iron. Yet it deserves attention, that 77.4 and 19.5, the weight of carbonate of copper and oxide of iron found by the preceding analysis, correspond with three integrant particles of carbonate of copper, and one integrant particle of peroxide of iron.

We were previously acquainted with two other native species of this salt, namely, *malachite* and *blue carbonate* or *copper azure*. But both of these are hydrous carbonates containing water as a constituent, and if any confidence be put in the analyses of KLAPROTH, whose precision is sufficiently known, malachite contains twice as much water as the blue carbonate. Blue carbonate is a compound of one integrant particle of water, and one integrant particle of carbonate of copper, while malachite contains two particles of water. Our ore is an *anhydrous carbonate of copper*. When heated to redness, it loses its carbonic acid, but undergoes no further change. Some specimens lost about half a grain more than their carbonic acid. This I ascribed to the water in the malachite, with which the ore was occasionally mixed.