



# XLVIII. On the cause of the changes of colour in mineral cameleon

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furnish the means of directing a steam-vessel to any given point, even in opposition to a moderate wind and tide, without the aid of a man aboard, for a limited time:—if therefore such a vessel had been fitted up as a fire-ship, the Algerine navy might have been destroyed without the loss of a man on our part.

On some future occasion I may, perhaps, send you some observations on the subject of towing vessels by means of steam-boats; On the best forms to give steam-vessels intended for the sea; On the utility of a change likewise in the form of sailing-vessels; On the practicability of employing steam as a moving power aboard vessels without the possibility of an explosion:—but for the present I feel I have already trespassed too much on your valuable space; and therefore remain

Yours, &c.

4, George's Place, Dublin,  
Sept. 14, 1817.

JAMES DAWSON.

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XLVIII. *On the Cause of the Changes of Colour in Mineral Cameleon.* By M. CHEVREUL\*.

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1. SINCE the time of the illustrious Scheele many important facts have been added to the history of manganese; but no person, to my knowledge, has made any particular inquiry into the cause of the changes of colour exhibited by mineral cameleon†. I will endeavour in this note to deduce from observations of my own, an explanation which, if it is admitted, will be susceptible of many new applications.

2. I must begin by stating the properties which Scheele has recognised in mineral cameleon. 1. On the solution of cameleon in water, a deposition of a fine yellow powder takes place, and the liquor passes insensibly to a blue colour. Scheele believes that the yellow powder consists chiefly of the oxide of iron; that the blue is the true colour of the cameleon, and is only changed when iron is in conjunction. 2. Cameleon mixed in water becomes decomposed; the mixture appears violet, then red; and when the red particles combine, the red colour disappears and the deposit of cameleon presents nothing more than the natural colour of the oxide of manganese. 3. Lastly, the same effect takes place when a few drops of acid are added to the solution, or when it is exposed for some days to the open air: in this last case the alkali unites itself to the carbonic acid of the atmosphere. Let us now pass to the facts which I have observed.

\* From a work on Manganese, by M. Chevreul.

† The substance so called is a combination of potash with an oxide of manganese.

3. I have prepared the cameleon of which I have made use, by exposing in a crucible of platinum to the action of a red heat for twenty minutes, a mixture of a *gramme* (about a scruple) of oxide, red-brown, obtained by the calcination of the carbonate of pure manganese with eight *grammes* of potash. The green mass produced by this operation was twelve hours afterwards immersed in water. Whatever was the proportion of water employed, there was always a large enough quantity of the oxide which did not dissolve. I do not think that the whole of the oxide has ever been separated by the action of the water; I believe that there is a portion of it, which, after being incorporated with the alkali, separates itself from it upon the solidification of the cameleon by cooling. This last portion appears often under the form of little brilliant spangles, similar to the sulphuret of molybdenum.

4. When the cameleon dissolved in water passes to blue, it is not by depositing from the oxide of iron yellow; for cameleon which has been prepared with the pure oxide of manganese yields a similar deposit, and the liquid when perfectly clear, being evaporated to dryness, leaves a residue, *which takes, when it is exposed to a red heat, a beautiful green colour, and communicates the same to water when immersed in it.* Now, if the colour of cameleon was naturally blue, it ought to be obtained of that colour, upon dissolving with potash the oxide which has been deprived of its pretended oxide of iron. Either then the colour of cameleon is not blue, or the observation of Scheele is not proved.

5. When cameleon passes more or less slowly from green to red, it presents a series of colours in the order of the iris; viz. green, blue, violet, indigo, purple, red. Not only cold water, but even carbonic acid, carbonate of potash, subcarbonate of ammonia, and lastly hot water, when added to cameleon, produce these colours. It is observed that the latter even produce them with more rapidity than cold water.

6. According as it appears to me, the green solution of cameleon is the combination of caustic potash with the oxide of manganese, and the solution which becomes red by carbonic acid (of which alone I at present speak) is a triple combination of potash, the oxide of manganese, and carbonic acid. It may be also necessary to take account of the water which holds these combinations in solution: but the proportion of water does not seem to me to have any sensible influence on their coloration; for if we saturate with carbonic gas, a green solution, formed of one part of cameleon and ten parts of water, it will pass to red, depositing at the same time a little of the oxide; then on putting into this red liquor some dry caustic potash it resumes the green colour;

colour; and afterwards, on saturating the alkali added by the carbonic gas, the red colour is reproduced, accompanied with a deposition of a little of the oxide. In the last place, I have observed that precipitating by the water of barytes a part of the carbonic acid from a red solution of cameleon, changes it into green cameleon\*.

7. Cameleons which become blue, violet, indigo, and purple, by the action of carbonic acid, appear to me to be mixtures of green and red cameleon. In proportion, accordingly, as we add more and more considerable quantities of green cameleon, we obtain *successively* purple, indigo, violet, and blue liquids. It is easy from this to conceive, how by adding at intervals to a green cameleon some small quantities of carbonic acid or carbonate of potash, blue, violet, indigo, and purple liquids will be obtained; and again, how the liquids may be obtained in the inverse series, by adding, at intervals, to a red cameleon small quantities of potash.

8. Let us now endeavour to prove by analysis the nature of the intermediate cameleons between green and red. If we filter some green cameleon a certain number of times upon a filter† of sufficient size, the cameleon will be decomposed into potash, which will remain in the water, and into oxide of manganese of a brownish yellow, which will attach itself to the slips of paper, in virtue of an affinity analogous to that which occasions the combination of cloths with the mordants employed in dyeing. A similar decomposition will take place, if we introduce a piece of paper into a solution of green cameleon, separated from all contact with the air;—the results are the same with red cameleon. The chemical action of paper on solutions of cameleon being thus demonstrated, the possibility may be conceived of reducing by filtration a liquor containing the two cameleons to a simple solution of one of them, provided there exists always a difference in the tendency which the oxide of manganese of the green combination and the carbonated combination have to unite with the paper; and so in fact we find the case to be: for if we filter blue, violet, indigo, and purple cameleons, the red cameleon is decomposed, while the green cameleon passes to the side of the filter.

9. The preceding explanation is applicable to changes pro-

\* It is not necessary to use as much of the barytes as will saturate all the carbonic acid; for it would precipitate with it a rose-lilac combination of the oxide of manganese and the acid. This combination, which is a species of cameleon, may perhaps be spoiled by the admixture of acetic acid of carbonate, which there is no doubt exists in compounds of this sort.

† Which ought to be washed with hydrochloric acid, to prevent any foreign matters from attaching to the slips of paper.

duced by the subcarbonate of ammonia and the carbonate of potash;—but is it equally so to the changes produced by distilled water? I do not think it is, although indeed the purest water which I have been able to obtain has always presented some sensible quantity of carbonic acid, or of subcarbonate of ammonia. Thus much I can affirm, that the intermediary cameleons produced by water are invariably formed of green cameleon and a red liquor; for all of them become green after being filtered, and when potash is added are converted into green cameleons. What proves, besides, that the carbonic acid has no influence on the colour of the red liquor of these cameleons is, that water which has been reduced by boiling to a fifth of its volume, and which ought to contain less carbonic acid than cold water which has not been boiled, being mixed when hot with green cameleon, reddens it much more rapidly than cold water: and again, that when a little more hydrate of barytes is added to boiling water than is necessary to precipitate all the carbonic acid contained in the water, if it is afterwards turned into green cameleon, it will change to red, *although the carbonic acid has been wholly extracted*. Is it not possible that this red colour may be the result of an action of the potash upon the oxide less strong than that exercised by the same alkali upon the oxide of green cameleon? And is it not also possible, when carbonic acid is present, that it may have the effect of weakening the action of the potash?

10. The oxide of green cameleon possesses without doubt the same degree of oxidation as the oxide of red cameleon, and that oxide contains more oxygen than that of salts of manganese uncoloured; so that on heating hydrochloric acid with green or red cameleon, the former disengages itself from the chlorine, and the latter becomes discoloured. Scheele has before remarked, that a great number of matters susceptible of absorbing oxygen produce the same effect of discoloration as hydrochloric acid. But it may be asked, Does the cameleon contain the natural oxide, or the oxide which is produced by exposing the latter to the action of fire? If we consider the impossibility of uniting the first to acids without subjecting it to a previous deoxidation; that cameleon supersaturated with sulphuric, nitric, and other acids forms red salts, in the same manner as the second of the oxides referred to; and further, that carbonic acid reddens green cameleon without producing any effervescence,—it would seem to follow that the oxide of cameleon is less oxidated than the natural oxide. I have made several experiments to ascertain the correctness of this conclusion. I heated in a stone jar 25 grammes of the oxide of native manganese with 200 grammes of potash  
à l'alcool;

*à l'alcool*; I collected from the water a little azote, with carbonic and inflammable acid; which last indicated that an alcoholic matter remained with the alkali. The jar was speedily penetrated by the potash. I repeated the same experiment with potash *à la chaux*. I did not obtain any inflammable gas; but the jar was penetrated as in the preceding experiment. The cameleon of the first experiment was green; but when diluted in water it did not yield a permanently coloured dissolution. The cameleon of the second experiment, being put into water, did not disengage any remarkable quantity of oxygen; the liquor which it yielded was of a permanent green; heated by mercury without the contact of the air, it became discoloured without presenting any of the colours of the series; but when carbonic acid was added it presented the whole series. In order to prevent the corrosive action of the potash upon the jar, I made another experiment, in which I heated 30 gr. of oxide with 270 gr. of carbonate of potash which had been reduced in a great measure by the heat into subcarbonate. The jar was not in this instance affected, and the result I obtained was a mixture of about two volumes of carbonic acid and one of oxygen. The cameleon produced was of a greenish blue; put into water, it precipitated a good deal of the oxide, of which part was micaceous and part was dissolved, and imparted a green colour to the water; but this solution lost its colour so quickly, and was besides so slightly charged with oxide, in comparison to the quantity which had been heated, that I do not regard this experiment as absolutely conclusive of the supposition, that the native oxide of manganese loses oxygen on uniting itself to potash—though it certainly renders it very probable.

11. If the explanation which we have given of the colours of cameleon is exact, is it not probable that some minerals may be enamelled with blue, with violet, and with purple, by green and red combinations of manganese? Is it not probable that the alkaline substances, earthy or vitreous, which become tinged with red by the oxide of manganese, exercise upon it the same action as the acids? And may not a combination of this sort along with a green alkaline combination of the same oxide, form mixtures of colours analogous to blue, violet, indigo, and purple cameleons? In short, does there not seem some analogy as to chemical action between the oxide of manganese and certain vegetable colouring principles, which become green by the alkalies, and red by the acids?