take place along these lines of force, and result in the formation of great quantities of ozone, are no more to be disregarded than are the chains of metathetical reactions in the fluid surrounding the plates of a galvanic battery.

ON A NEW CHROMIUM OXYCHLORIDE.

By T. E. THORPE, PH. D.

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WHEN chromyl dichloride $\text{CrO}_2 \left\{ \begin{smallmatrix} \text{Cl} \\ \text{Cl} \end{smallmatrix} \right\}$ prepared by heating a mixture of potassium dichromate, sodium chloride, and sulphuric acid, is maintained at a temperature of 180° — 190° in a sealed tube for three or four hours, it is almost completely converted into a black solid substance, and on opening the tube when cold a considerable quantity of free chlorine escapes. By exhausting the tubes containing the liquid chloride before subjecting them to heat, I have ascertained that chlorine is the only gaseous product of this decomposition. The black compound invariably contains more or less of the liquid chloride which has escaped decomposition: the greater part of this is easily expelled on gently heating the mass after opening the tube. In order to free it completely from the latter body, the black substance was transferred to a clean tube and heated to 120° (*i. e.* about 2° above the boiling point of chromyl dichloride) in a current of dry carbonic acid gas until its weight appeared constant. The following determination of the amount of chlorine contained in the volatile portion shows that it is simply chromyl dichloride which has remained undecomposed.

0.8741 grammes liquid chloride gave 1.6458 grammes silver chloride.

Calculated for $\text{CrO}_2 \text{Cl}_2$,
45.7 per cent.

Found,
46.5 per cent.

The solid substance dried in the manner above described appears as a black uncrystalline powder, which, when exposed to the air, rapidly deliquesces to a dark reddish brown syrupy liquid smelling of free chlorine. When thrown into water it quickly dissolves, forming a dark brown solution, which on standing also evolves chlorine. In the nitric acid solution hypochlorous acid appears to be produced. In strong hydrochloric acid the substance dissolves with a dark brown coloration; and on boiling the solution chlorine is evolved, the liquid becomes greenish yellow, and ultimately changes to the dark green color peculiar to a solution of chromium sesquioxide in hydrochloric acid. When it is thrown into dilute ammonia, chromic acid is dissolved, together with all the chlorine, and a precipitate is formed possessing the properties of the chro-

mate of chrome sesquioxide ($\text{Cr}_2\text{O}_3\cdot\text{CrO}_3$) described by Storer and Eliot. Upon this decomposition is based the method which I have employed for the estimation of the amount of chlorine contained in this body. The weighed quantity of the substance was treated with very dilute ammonia; the solution boiled for a few minutes and filtered; the precipitate well washed by hot water; an excess of nitric acid added to the filtrate; and the chlorine precipitated by the addition of silver nitrate. Two determinations of chlorine carried out in this manner on preparations made at different times gave the following results:—

Preparation I.

0.5900 gram substance gave 0.4870 gram silver chloride, and
0.0069 gram metallic silver.

Preparation II.

0.493 gram substance gave 0.4250 gram silver chloride.

Preparation I..... 21.80 per cent. Cl.

Preparation II..... 21.32 “

Mean.....21.06½

In order to determine the amount of chromium it contains, a weighed portion of the substance was repeatedly heated with strong hydrochloric acid on a water-bath until the evolution of chlorine entirely ceased: the solution was then diluted with water, heated to boiling, ammonia added in slight excess, and the solution again boiled until the supernatant liquid appeared perfectly colorless. The precipitated chrome sesquioxide was then filtered, dried and weighed.

Preparation I.

0.3442 gram substance gave 0.2470 gram chrome sesquioxide.
0.5900 “ “ “ 0.4235 “ “ “

Preparation II.

0.5082 gram substance gave 0.3590 gram chrome sesquioxide.
0.5942 “ “ “ 0.4210 “ “ “

Preparation I..... 49.30 per cent. Cr.

..... 49.25 “

Preparation II..... 48.45 “

..... 48.62 “

Mean..... 48.91

Hence the percentage composition of the substance is as follows:

	Found.	Ratios.	Calculated.
Chlorine.....	21.06	2	21.86
Chromium.....	48.91	3	48.54
Oxygen	30.03	6	29.60
	100.00		100.00

I have attempted to control the above empirical formula ($\text{Cr}_3\text{O}_6\text{Cl}_2$) by heating a weighed portion of the substance in hydrogen. The action of hydrogen upon the new chloride when heated is extremely

energetic. At a comparatively low temperature it takes fire, combustion proceeds rapidly throughout the mass, and ultimately the substance is converted into chrome sesquioxide, hydrochloric acid and water. Care must be taken to regulate the current of hydrogen, since, if it is too rapid, particles of the finely divided sesquioxide are apt to be mechanically carried away. From an experiment in which the gas was carefully purified from oxygen by passing it through strongly alkaline pyrogallate solution and over heated metallic copper, and then dried by transmitting it through tubes containing pumice moistened with strong sulphuric acid, the following numbers were obtained :—

0.8715 gram substance gave 0.6150 gram chrome sesquioxide.
 Found 70.58 per cent Cr_2O_3 .
 $\text{Cr}_2\text{O}_3 \cdot \text{Cl}_2$ gives by calculation 70.72 “

I had an additional object in thus studying the action of hydrogen upon the new chloride. I considered that this action might possibly throw some light on the constitution of this compound. The new oxychloride may, in conformity with the analytical results, be regarded as a compound of chromous chloride with two equivalents of chromium trioxide. Now, chromous chloride, according to Moberg, may be heated in hydrogen to the softening point of glass without suffering decomposition; and if it were found that water was the only volatile product of the reaction, we should possess a certain amount of evidence for supposing that the formula $\text{CrCl}_2 \cdot 2\text{CrO}_3$ represents the constitution of this substance. Experiment showed, however, that the chlorine was not so firmly united in this compound as in the chromous chloride; on gently heating the substance in hydrogen, hydrochloric acid was immediately evolved.

Péligot has described a series of salts to which are assigned the general formula $\text{M Cl} \cdot \text{CrO}_3$ and $\text{M}''\text{Cl}_2 \cdot 2\text{CrO}_3$, where M represents a univalent metal and M'' a bivalent metal. The following are the names and formulæ of the salts prepared by Péligot :—

$\text{K Cl} \cdot \text{CrO}_3$	Potassium chlorochromate.
$\text{Na Cl} \cdot \text{CrO}_3$	Sodium chlorochromate.
$\text{NH}_4 \text{Cl} \cdot \text{CrO}_3$	Ammonium chlorochromate.
$\text{Mg Cl}_2 \cdot 2\text{CrO}_3$	Magnesium chlorochromate.
$\text{Ca Cl}_2 \cdot 2\text{CrO}_3$	Calcium chlorochromate.

Now the new oxychloride stands in a very evident relation to these compounds. Supposing for a moment that the formulæ given to these substances correctly represent their constitution, then the new oxychloride may be regarded as the chromium term of the series—bivalent chromium replacing magnesium or calcium.

a formula identical with that of which I have just attempted to show the impropriety. But there is still another reason for sup-

posing that a compound thus constituted could not exist. Chromous chloride is one of the most energetic deoxidizing agents known, and we can hardly conceive it to be united in a stable compound with a substance which so readily parts with its oxygen as chromium tri-oxide. Hence I am disposed to regard the constitution of the salts of Pélilot as very different from that implied by the above method of representation: indeed, to the best of my knowledge, the general formula assigned to these salts expresses not a single experimental fact, unless it be the mode of their decomposition by water, probably it had reference to the views of Rose and Berzelius respecting the constitution of the so-called chlorochromic acid. The following structural formulæ better represent in my opinion the constitution of these compounds and their relation to chromyl dichloride.

Magnesium Chlorochromate.

Chromium Chlorochromate.

These substances may also be thus represented:—

The relation of the new oxychloride to chromyl dichloride is thus very apparent. Three molecules of chromyl dichloride when heated are resolved into one molecule of chromium chlorochromate and four atoms of chlorine.

ON NONTRONITE.

By T. E. THORPE, PH. D.

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THERE exists some doubt among mineralogists as to whether Nontronite is to be regarded as a distinct mineral species. Owing to the difficulty of obtaining it in a fit state for investigation, the few analyses hitherto published by Berthier, Dufrénoy, Jacquelin