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tine upon the bichloride of platinum. I also intend to examine some other metallic chlorides and haloid bodies under the same circumstances.

XVIII. *On the Composition of certain Mineral Substances of Organic Origin.* Nos. VI. VII. VIII. *Mineral Resins.*
By JAMES F. W. JOHNSTON, M.A., F.R.SS. L. & E., F.G.S.,
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No. VI. *Highgate Resin or Fossil Copal.*

THIS substance derives its names from the locality in which it was first found in any quantity, the blue clay of Highgate Hill near London, and from its similarity to copal resin in hardness, colour, lustre, transparency, and difficult solubility in alcohol†. For the two fragments which have afforded me the following results I am indebted to the liberality of my friend Mr. Brooke.

1. The first fragment analysed was translucent, of a dirty gray colour, and when broken emitting a resinous odour. In the air it volatilized by a gentle heat, leaving a small residue of charcoal and earthy matter. The former being burned away, the latter weighed 0·136 per cent.

9·905 grs. burned with oxide of copper gave 10·508 grs. of water and 30·795 of carbonic acid. This is equal to

Carbon.....	=	85·408
Hydrogen.....	=	11·787
Oxygen	=	2·669
Ashes	=	0·136—100·000.

2. The second fragment was clear, pale yellow, and semi-transparent. It was covered with a thin coating of a browner apparently altered variety, of which, from the smallness of the quantity at my disposal, I was not able wholly to divest it.

5·509 grs. gave 5·69 grs. of water and 17·07 of carbonic acid. This is equal to

Carbon.....	=	85·677
Hydrogen.....	=	11·476
Oxygen	=	2·847—100·000.

Assuming the latter specimen to be the purer, this substance is represented by the formula $C_{40}H_{32}O_1$, since

		Calculated.	Found.
40 Carbon	=	3057·480	85·968
32 Hydrogen	=	399·347	11·228
1 Oxygen	=	100·000	2·804
		3556·827	100·000
			100·000

* Communicated by the Author.

† For a description of this substance see Phillips's Mineralogy.

The small defect of carbon and excess of hydrogen in the analysis are both on the side in which they ought to appear when experimental results are compared with an accurate formula.

This resin therefore presents another example of the connexion of resinous substances with oil of turpentine $C_{40}H_{32}$; and if the rational formula $C_{40}H_{32} + O$ be the true one, it exhibits the lowest state of oxidation of this radical with which we are yet acquainted. It is very slightly acted on by alcohol, but the solution gives a white precipitate with an alcoholic solution of acetate of lead. It is either altogether an acid resin therefore, or it contains a small quantity of a more soluble resin which is so.

VII. *Resin from Settling Stones.*

In Brewster's Edinburgh Journal of Science, N.S., vol. iv. p. 122, I described as *a new variety of mineral resin*, a substance I had met with among the old heaps of a lead-mine in Northumberland known by the name of Settling Stones, the working of which has been recently resumed. This mine is situated at the point of junction of a number of intersecting faults and veins, along which the strata are thrown up and down in various directions. By one of these faults the great whin sill of that district is brought to day, and forms an escarpment over which the waters of a little rivulet descend from a height of 20 or 30 feet. Near the veins the trap is much impregnated with lime, and the cheeks or walls of the vein are sometimes almost a perfect limestone, and have a gray or bluish gray colour. It is on these walls of the vein, resting on and occasionally covered by calc spar, brown spar, or pearl spar, that the resinous substance occurs. It is in the form of drops or flattened portions, more or less rounded, as if it had once been in a fluid or softened state. It is hard, brittle under the hammer, but exceedingly difficult to reduce to fine powder in the mortar: even after long rubbing the angular fragments can still be recognised. Its colour varies from pale yellow to deep red, its specific gravity from 1.16 to 1.54, and it exhibits a pale green opalescence. It does not melt at 400° Fahr., but it burns in the flame of a candle, and gives empyreumatic products when fused in a close tube over a spirit-lamp. It is insoluble in water and is very slightly acted upon by alcohol.

Having a small quantity of this resinous substance at my disposal I availed myself of the opportunity of determining its composition, with the view of comparing it with that of the fossil copal above analysed. In external appearance they

possess some resemblance, but their origin must be considered as entirely different. The one occurs in a vast deposit of tertiary clay, the other in a mountain limestone district, and in the centre of an enormous intruding mass of stratiform basalt.

5·83 grs. gave 5·695 of water and 17·95 of carbonic acid: 1·29 grs. left on burning in the air 0·042 of brown ash = 3·256 per cent. These are equal to

Carbon	85·133 or 40 atoms.
Hydrogen...	10·853 or 31·2 atoms.
Ashes	3·256—99·242.

It is therefore doubtful whether this resinoid substance really contains any oxygen or not. It may be only an impure carbohydrogen = $C_4 H_3$, agreeing in composition with the hypothetical acetylene, or it may, like petroline, contain the elements in the proportions in which they exist in oil of turpentine $C_{40} H_{32}$. I regret that my supply of the substance did not permit me to repeat the analysis; and though I have revisited the mine in the hopes of obtaining a fresh supply, I have not been fortunate enough to meet with a single specimen.

VIII. *Berengelite*.

The specimens of the substance for which I propose the name of Berengelite were given to me by my friend Mr. Fryer, of Whitley House, near North Shields, and were obtained by him during his residence in South America. Of the circumstances under which it occurs Mr. Fryer thus writes to me:

“Of the resin or asphaltum from South America, I can unfortunately give you but a very imperfect account. I one day found in the yard of the Custom House at Arica a large convoy of llamas loaded with it, and all the information I could obtain from the men having charge of it was that they brought it from the province of St. Juan de Berengela, about 100 miles from Arica, that it was found in very large quantities, and formed, according to their description, something like a lake resembling the pitch lake of Trinidad. It is extensively used for paying boats and vessels at Arica, and, I believe, on the whole coast of Peru.”

This substance is hard, brittle, may be scratched by the nail, has a resinous fracture and lustre, is of a dark-brown colour with a tinge of green, but gives a yellow powder. The external appearance of the masses as they were brought home appears to indicate that the whole had formerly been in a softer state so as to yield easily to compression. It is insoluble in water, but dissolves readily and in large quantity in

cold alcohol or æther, giving brown solutions. A small residue of earthy impurities is left. By evaporating the alcoholic solution, the resin is obtained of greater transparency, transmitting light of a bright red colour, fusing easily on the water-bath, and remaining soft and unctuous at the ordinary temperature of the atmosphere. It gradually recovers its brittleness, but after the lapse of three or four months it is still soft, and adheres in some measure to the fingers. This property appears to be possessed by many other resinous substances and explains the semifused appearance of the imported masses.

It has a peculiar, unpleasant, resinous odour. After fusion for some time at 212° Fahr., the unpleasant odour disappears, and is succeeded by an agreeable fragrance. On cooling again, it resumes after some time its original smell. When chewed in the mouth it imparts a slight sensation of bitterness; but the alcoholic solution has a disagreeable very bitter taste.

Like most other resins it is nearly insoluble in a concentrated solution of caustic potash. Boiled in more dilute alkali it gives a yellow solution, from which the resin is again precipitated by acids. The alcoholic solution gives with a similar solution of acetate of lead a copious yellow precipitate. It is therefore an acid resin. Its alcoholic solution is rendered milky by liquid ammonia and passes milky through the filter.

Burned with oxide of copper

12·732 grs. gave 33·37 of carbonic acid and 10·54 of water.

12·40 grs. gave 32·44 of carbonic acid and 10·445 of water.

These are equivalent to

	1.	2.
Carbon	72·472	72·338
Hydrogen.....	9·198	9·359
Oxygen	18·330	18·303
	<hr/>	<hr/>
	100·000	100·000

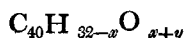
These results agree very nearly with the formula $C_{40} H_{31} O_8$, which gives

40 Carbon ...	=	3057·480	=	72·036
31 Hydrogen =		386·8676	=	9·115
8 Oxygen ...	=	800·000	=	18·849
		<hr/>		<hr/>
		4244·3476		100·000

and represents a constitution analogous to that of colophony and some other resins of which oil of turpentine is the radical. But as the quantity of carbon indicated by this formula is less than that found by analysis, we ought probably to prefer one or other of the two formulæ

$C_{41} H_{31} O_8 = \left\{ \begin{array}{l} \text{Carbon} \quad 72.533 \\ \text{Hydrogen} \quad 8.929 \\ \text{Oxygen} \quad 18.538 \end{array} \right.$		or $C_{41} H_{32} O_8 = \left\{ \begin{array}{l} \text{Carbon} \quad 72.322 \\ \text{Hydrogen} \quad 9.215 \\ \text{Oxygen} \quad 18.463 \end{array} \right.$	
<hr/>		<hr/>	
100.000		100.000	

I am inclined, therefore, in the mean time to prefer the former of these two $C_{41} H_{31} O_8$, though the discovery of any mixture or impurity in the resin may hereafter show either of the others to be a more correct representation of its elementary constitution. The establishment of the first, $C_{40} H_{31} O_8$, from its analogy with the formula for colophony, would appear from theory the most likely, were there not other resins, the analyses of which I have already published, which appear to deviate from the general formula



by which many of the resins may be represented. To this subject I shall return in a future paper.

Origin of the Mineral Resins.

As I am not in possession of any other mineral substance of organic origin exhibiting the characters of a resin, it may not be improper here to advert to the probable origin of this class of substances.

1. *Fossil Copal*.—The composition of this substance clearly indicates a vegetable origin. It has been found in small quantities disseminated through the London clay. Under what circumstances could this vast deposit of clay be formed? Most probably along the course, or in the estuary of some great river, or in the bottom of a lake into which its waters were poured. And if at this period the climate were warmer in these latitudes than it now is, a circumstance in regard to which geologists seem agreed, we should expect to find (recent) resins similar to the fossil copal in similar localities, if any now exist and under a similar sun. From what we know of the Guianas stretching between the river Orinoco on the north and that of the Amazons on the south, a country abounding in rivers and lakes, liable to heavy rains and floods with a climate hot and moist, we should suppose it to be not very unlike that which poured its muddy rivers into the London basin, and buried beneath its waters occasional fragments of its trees, its resins, and its other vegetable productions.

From the island of Cayenne on this coast, and probably from the interior of French Guiana, is imported a resin the produce of the locust tree, which like the Highgate resin has much resemblance to copal, and is known in commerce by the name of animé resin. This resin has been analysed by

Laurent, and found by him to have a composition approaching very nearly to that above given for the fossil copal. The comparative results are as follows:

Animé Resin.	Fossil Copal.	
	1.	2.
Carbon 84.6	85.408	85.677
Hydrogen ... 11.5	11.787	11.476
Oxygen ... 3.9	2.669	2.847
100.0	99.864	100.

From the above result he deduces for animé resin the formula $C_{40}H_{83}O$, which gives per cent.

Carbon	85.66
Hydrogen	11.538
Oxygen	2.802
100.	

The numbers given by this formula differ from those obtained by Laurent in the oxygen and carbon to the amount of one per cent., while they are almost identical with those given by the analysis of the fossil copal. As the hydrogen however is always in excess, the formula $C_{40}H_{82}O$ above deduced from my analysis is to be preferred.

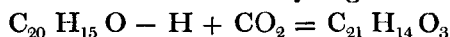
Without, however, dwelling upon this discrepancy, it is interesting to find a resin still growing nearly if not absolutely identical in constitution with one produced and buried at a period so remote; and while this fact establishes the vegetable origin of the fossil copal, it may be considered as throwing some additional light on the nature of the climate at that remote epoch and as confirming the evidence of other facts in regard to the temperature of these latitudes during the deposition of the London clay.

2. *Resin of Retinasphalt* * = $C_{21}H_{14}O_3$.

The origin of this substance, found in the tertiary formation of Bovey in Devonshire, of nearly the same age as the London clay, is clearly indicated by the mode in which it occurs. It is scattered throughout the deposits of lignite, and is penetrated by twigs and hollow quadrangular spines, apparently the leaves of a coniferous tree. That it is the resin of some such trees is therefore very probable; that it has flowed in a liquid state is also probable from its being mixed with so much clay, and it is not unlikely that it may have undergone some change of composition since it was first deposited. We know as yet however too little in regard to the composition

* See Lond. and Edinb. Phil. Mag., vol. xii. p. 560.

of the resins which exude from the pines of warm climates to justify us in attaching much weight to this last conjecture that it has undergone a change since it was deposited. Colophony is $C_{20}H_{15}O$, so that this resin *might* be formed by substituting an atom of carbonic acid for one of hydrogen, since



3. *Middletonite* * = $C_{20}H_{11}O$.

From the circumstances under which this substance occurs in the coal of Yorkshire and Staffordshire in thin layers and masses in the body of the coal, I have already stated that it is to be regarded as the *altered* resin of the trees of the epoch of the great coal formation. That it has undergone a change is evident not merely from its properties, but from the apparent impossibility that a resinous substance should remain unaltered while the wood which enveloped it was converted into coal. Mr. Embleton, the intelligent viewer of the Middleton coal mines, considers the opinion of its being a changed resin to be confirmed by the appearance of the coal with which it is in contact, which appears to him to bear a close resemblance to a *changed bark*.

The pseudo resin of Settling stones is probably no further of vegetable origin than that it may have been distilled or volatilized out of vegetable matters scattered throughout the dark shale and other rocks with which the trap, near which it is found, had come into contact while in a fluid state.

4. and 5. $\begin{cases} \text{Guyaquillite} \dagger = C_{40}H_{26}O_6 \\ \text{Berengelite} = C_{41}H_{31}O_8 \end{cases}$

With the geological position of these two substances I am wholly unacquainted. The one is said to form large deposits in the neighbourhood of Guyaquil, the other to occur at least 15 degrees further south, forming a species of lake. The proximity of the volcanic chain to both localities, the former being almost at the foot of Chimborazo, renders it not unlikely that they may be, or may have been, distilled from vegetable deposits lying beneath; and though true resins have seldom been met with except in substances of known vegetable origin, yet since the petroline of Boussingault contains carbon and hydrogen in the same proportions as in oil of turpentine, there is no difficulty in conceiving that under favourable circumstances this and other compounds of similar constitution, existing in deposits of petroleum, may undergo oxidation and produce resins similar to those actually found as mineral productions in South America. Before we can obtain clear ideas on the subject however, we must obtain more exact in-

* See L. and E. Phil. Mag., vol. xii, p. 261. † See vol. xiii, p. 329.

formation regarding the circumstances under which they actually occur.

The pastò varnish described by Boussingault* is closely allied in constitution to the berengelite. This substance when freed by digestion in alcohol from a little green resin with which it is mixed, is colourless and possesses many of the properties of caoutchouc. It is very tenacious, and stretches into thin membranes, which are applied as a varnish to wooden vessels. It adheres strongly and after a time hardens, but never cracks. It forms a soap with caustic potash, from which acetic acid separates it. When dried and heated to 130° Cent. = 266° Fahr., the varnish thus separated melts, and on cooling is brown, tenacious, and (*now*) soluble in all proportions in alcohol, æther, and oil of turpentine. It does not appear from Boussingault's paper whether the previous solution in caustic potash be necessary to the production of this change, though he does speak of a remarkable modification being caused by caustic potash. The composition of the pure varnish (A) and of the *resin* or modified varnish (B) are thus given, the first being a mean of three, the second of two analyses.

	A.	B.	Calculated.
Carbon	= 71·766	71·25	71·825
Hydrogen	= 9·633	10·30	9·381
Oxygen	= 18·600	18·45	18·794
	99·999	100·000	100·000

The third column is calculated according to the formula $C_{40} H_{32} O_8$, which agrees very well with the analyses of the varnish. It is not improbable however that the *resin* should be represented by a formula somewhat different.

The pastò varnish is brought to the neighbourhood of Quito from the high land of Macao, on the eastern slope of the Andes, from which the waters descend to the river of the Amazons. Except that it is of vegetable origin nothing is known regarding it, the tribes of Indians from whom it is obtained being still independent. The difference of its properties previously to fusion forbid the supposition that it is identical with the berengelite; were a distance of 20 degrees of latitude between the places from which they are respectively brought, not sufficient to render a common origin highly improbable.

It may not be uninteresting to present here a comparative view of the formulæ by which the several resins of which analyses have hitherto been published may be represented.

* *An. de Chim. et de Physique*, vol. lvi. p. 216.

Resin from the root of

<i>Arbrea Brai</i>	=	$C_{36} H_{30} O$	Dumas.
Animé resin	=	$C_{40} H_{33} O$	Laurent.
Fossil copal.....	=	$C_{40} H_{32} O$	
Elemi resin.....	=	$C_{40} H_{32} O_2$	Rose.
Colophony (pinic and syl- vic acid)	=	$C_{40} H_{30} O_4$	{ Liebig and Trommsdorf.
Pastò varnish.....	=	$C_{40} H_{32} O_8$	Boussingault.
Berengelite	{	$C_{40} H_{31} O_8$? or $C_{41} H_{31} O_8$	
Middletonite	=	$C_{40} H_{22} O_2$	
Guyaquillite	=	$C_{40} H_{26} O_6$	
Resin of retinasphalt } (retinic acid)	=	$C_{40} H_{27} O_6$? or $C_{42} H_{28} O_6$?	
Gamboge.....	{	$C_{40} H_{24} O_8$? or $C_{48} H_{29} O_{10}$	
Eblanin	{	$C_{40} H_{20} O_8$? } $C_{43} H_{18} O_8$	Apjohn and Gregory.

In these formulæ, which from the nature of the substances may all be subject to future corrections, we see a mode of representing, at least approximately, all the analysed resins (with one exception) by quantities in which that of carbon is constant. It would be a very beautiful general expression which in the form of $C_{40} H_{32-x} O_{x+y}$ should represent the constitution of all or of one great group of the resins. Our data, however, are not yet sufficiently extensive to enable us to form a decided opinion on the subject. In a future paper I shall give the composition of some other resins, and consider this point at greater length than it would be proper to do at the close of the present paper.

Durham, Dec. 6, 1838.

XIX. *Meteorological Observations during a Residence in Colombia between the Years 1820 and 1830.* By Colonel RICHARD WRIGHT, Governor of the Province of Loxa, Confidential Agent of the Republic of the Equator, &c. &c.

[Continued from p. 18.]

ALTHOUGH it scarcely falls within the limits of a mere meteorological journal to expatiate on the wide field of inference which opens to our view when we reflect on the influence of temperature, not merely on animal but on social life, yet the operation of local circumstances has been so striking, and will probably play so important a part in the future destinies of the South American continent, that it is difficult to forbear some remarks on so interesting a subject.