Jan. 15, 1849.

Colonel Philip Yorke in the Chair.

The following presents were announced :—" On the Phosphoric Strata of the Chalk Formation," by Messrs. J. M. Paine and J. T. Way, from the authors ; " Report on the Analysis of the Ashes of Plants," Part III., by Messrs. J. T. Way and G. Ogston, from the authors.

The following communications were read :

V.—*On the Salts of Selenious Acid. By* DR. SHERIDAN MUSPRATT, *Professor to the Liverpool College of Chemistry.*

PRELIMINARY REMARKS.

I undertook the investigation of the salts of selenious acid, with the view of ascertaining whether they were analogous to those of sulphurous acid.

Mitscherlich has remarked, that the selenic and sulphuric acids are not only analogous in composition and in many of their properties, but that the similarity runs through their salts, which resemble one another, in chemical comportment, constitution, and form. We might infer from this, that the selenites and sulphites would be isomorphous, sulphur and selenium being so analogous. In a former paper,* I mentioned the great similarity between carbon and sulphur, which also extends to the carbonates and sulphites. For nearly every carbonate, I obtained a corresponding sulphite. The formulæ of the three acids are appended, in order to show their striking analogies :

Carbonic acid	CO_2
Sulphurous acid	SO_2
Selenious acid	SeO_2.

We see, on referring to the above, that they all contain the same amount of oxygen, *i. e.* 2 equivs of oxygen united to either carbon, sulphur, or selenium.

Although I proved the isomorphism with regard to the first two, my results with selenious acid are only in a few cases similar to those with sulphurous acid. One of the great causes of this may be the persistency of the former, and the instability of the latter. There were numerous difficulties to contend with in the preparation and analysis of the salts of this acid, as will be hereafter mentioned.

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* Liebig's Annalen der Chemie, Band L. p. 259.

PREPARATION OF THE ACID.

Selenium was dissolved in pure, fuming, nitric acid, and the solution evaporated on a sand-bath to dryness. The nitric acid, when added, caused a most violent action, large quantities of nitrous fumes being disengaged. The residue was a white powder, possessing a sour and styptic taste, which, heated on a sand-bath, afforded as a sublimate, most magnificent silvery-looking, very long, four-sided needles of selenious acid.

This acid is also formed by acting upon selenium with *aqua regia.* The former method, however, is preferable.

$$9\ Se + 6\ NO_5 = 9\ SeO_2 + 6\ NO_2.$$

GENERAL PROPERTIES OF THE ACID AND SALTS.

Berzelius has made allusion to many of the following properties of selenious acid and its salts. In some cases, this illustrious Swede has not been sufficiently specific, owing, no doubt, to the enormous number of facts he had to contend with in other departments of the Science. It is stated in Turner's Chemistry,* "*when sulphurous acid is added to a solution of selenious acid, pure selenium is thrown down.*" In the cold, I could not obtain this reaction, but when the two acids are mixed together *and boiled,* a vermilion-coloured precipitate, selenium, separates. Strong hydrosulphuric acid decomposes selenious acid immediately in the cold, an orange-yellow powder subsiding; a sulphide of selenium. The preceding decompositions may be represented as follows:

$$SeO_2 + 2\ SO_2 = Se + 2\ SO_3$$
$$SeO_2 + 2\ HS = SeS_2 + 2\ HO.$$

Hydrochloric acid has not the slightest effect upon selenious acid.

Selenious acid is reduced when heated on charcoal before the blow-pipe, the selenium imparting a beautiful blue colour to the flame. The fumes evolved are yellowish, and have the smell of decayed horseradish; a most characteristic test for the acid. The smell is so persistent, that for days my clothes have retained it. This acid very seldom forms basic salts, and then only with those metallic oxides which readily afford them with other acids.

It easily produces a basic salt with oxide of copper, in this respect materially differing from sulphurous acid.

On passing sulphurous acid into water, holding oxide of copper in suspension, a reduction takes place, the sub-oxide of copper being formed.

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* Eighth Edition, p. 265.

$$2\ CuO + SO_2 = SO_3 + Cu_2\ O.$$

When a selenite is heated in contact with any organic matter, reduction immediately occurs; great care has, therefore, to be exercised in the preparation of the salts, not to allow any of the filtering paper to adhere to them.

Charcoal reduces the salts immediately at a high temperature. If charcoal is fused with selenite of soda, selenide of sodium and carbonic acid are obtained.

$$+2\ (NaO,\ SeO_2) + 3\ C = 2\ (Na\ Se) + 3\ CO_2.$$

Chloride of ammonium distilled with a selenite affords selenium, which condenses in the neck of the retort. The decomposition may be exhibited by the following equation:

$$3\ (NaO,SeO_2) + 3\ (NH_4Cl) =$$
$$3\ Se + 2\ N + NH_4O + 3\ NaCl + 8\ HO.$$

Three equivalents of selenite of soda and 3 equivalents of chloride of ammonium contain the elements of 3 equivalents of selenium, 2 of nitrogen, 3 of chloride of sodium, 8 of water, and 1 equivalent of oxide of ammonium. Selenious acid liquefies on exposure to the air.

The neutral salts of selenious acid, with potash, soda and ammonia, have a very caustic taste, and react alkaline. They are extremely soluble in water.

When aqueous selenious acid is neutralized by the alkalies, and the liquid is treated with alcohol, under certain circumstances, an oily substance separates; this, when kept for a long time, becomes crystalline.

Selenites of the alkalies are most difficult to prepare. They are remarkably deliquescent, and liable to undergo decomposition, unless carefully dried over sulphuric acid. The neutral salts taste and react alkaline. They dissolve with a slight reddish colour, owing to a trace of reduced selenium; a remarkable circumstance.

Selenious acid is extremely stable. When the crystals of the acid are exposed to the air for weeks, although they liquefy, still I could not detect in them any *selenic* acid. How different is the case with sulphurous acid, which cannot be exposed to the air for an hour without a portion being converted into sulphuric acid. Selenious acid, according to Berzelius, has a great tendency to form acid salts, even in the relation of *four* of acid to one of base. I obtained a syrupy mass in one instance, which, when analysed, agreed with the statement above. I could not, however, obtain any quadracid salt in a perfectly dry state. My intention in the present paper is to embrace all that is known respecting the selenites, so that future investigators may have a full reference.

I find, as did Berzelius, when an alkali is treated with selenious acid, until the liquid reacts neither acid nor alkaline, that on evaporation, crystals of a bisalt are deposited; a neutral salt remaining in solution.

Rose has remarked, that hyposulphite of ammonia only partially precipitates selenium in the cold; more is precipitated by boiling, and still more on the addition of hydrochloric acid. In the cold, the decomposition takes place extremely slowly, if at all; on boiling, however, bisulphide of selenium is deposited—a large quantity is precipitated in the presence of hydrochloric acid:

$$SeO_2 + 2\ (S_2\ O_2) = SeS_2 + 2\ SO_3.$$

When *aqua regia* is added to the bisulphide of selenium, it is immediately decomposed.

Boracic, phosphoric, and sulphuric acids, expel selenious acid from its compounds at a high temperature. I employed sulphuric acid for this purpose in analysing the salts.

Hydrochloric acid *has not the slightest effect,* even when boiled with selenious acid; selenic acid, however, is reduced by it to the state of selenious acid:

$$SeO_3 + HCl, = SeO_2 + HO + Cl.$$

Many of the salts of selenious acid lose their acid when heated; others part with only a portion, and some do not evolve any, as will be seen under the description of the various salts.

SELENITES OF POTASH.

The neutral selenite is obtained by saturating carbonate of potash with selenious acid, and evaporating quickly to dryness. I could not obtain the salt for a long time in a fit state for analysis, owing to there always being an excess of selenious acid. A definite salt is also extremely difficult to prepare, on account of traces of selenium separating. Selenite of potash is remarkably soluble in water. It is almost insoluble in alcohol; but, strange to say, I could not precipitate it from its aqueous solution in a crystalline state by alcohol. An oily substance always appeared. It possesses a disagreeable taste, is very alkaline to test-paper, and deliquescent; on which account, great care has to be exercised in weighing the salt.

0·251 grms. salt gave:
0·210 „ sulphate of potash =
0·113 „ potash,

leading to the formula:

$$KO, SeO_2.$$

Centesimally represented:

		Theory.	Exp.
1 eq. of selenious acid .	56	53·85	
1 „ of potash . . .	48	46·15	45·02
	104	100·00	

Biselenite of potash gives satiny-looking crystals. It is obtained by decomposing carbonate of potash with an excess of selenious acid, and allowing the solution to evaporate over sulphuric acid; or by precipitating the solution with alcohol, in which menstruum the biselinite is only slightly soluble. The difficulty attending the preparation of this salt is very great. Too much selenious acid must not be added to the carbonate of potash, or crystallization will never take place. When the liquid is made slightly acid, the crystals are not more than two days in forming.

Alcohol nearly always precipitates an oily liquid from the slightly acid aqueous solution, which speedily, however, becomes crystalline. The crystals, dried for eight days over sulphuric acid, were analysed:

0·894 grm. salt gave
8·351 „ sulphate of potash,

leading to the formula:

$$KO, SeO_2, + HO, SeO_2$$

		Theory.	Experiment.
2 eqs. of selenious acid .	112	66·272	
1 „ of potash . .	48	28·402	28·05
1 „ of water . .	9	5·326	
	169	100·000	

Biselenite of potash is analogous to the bisulphite of the same base:

$$KO, SeO_2, + HO, SeO_2$$
$$KO, SeO_2, + HO, SO_2.$$

On heating the biselenite in a dry test-tube, water first passes off, and is followed by selenious acid. The whole mass then fuses to a red fluid, which ultimately becomes colourless, and on cooling, solidifies into a fine crystalline mass, soluble in water, and precipitable by alcohol. It is the neutral selenite of potash.

A most disagreeable odour of horseradish is evolved as the liquid reddens. The quadriselenite of potassa described by Berzelius—

$$KO, 4\ SeO_2, \text{ or}$$
$$KO, SeO_2, +3\ (HO, SeO_2)\ ?$$

is not attainable in a fit state for analysis. This salt is styptic to the taste, and when heated, evolves most stifling fumes. It is in a high degree deliquescent.

SELENITES OF SODA.

When carbonate of soda, saturated with selenious acid, is allowed to evaporate under a bell-jar, the syrupy mass becomes filled with radiated crystals; which will be subsequently described. The liquid gives a neutral salt on the addition of alcohol. This salt, not being deliquescent, is more easily obtained than the salt of potash. It was desiccated between folds of bibulous paper, and then left over sulphuric acid for some days:

0·400 grms. of salt gave:
0·320 „ sulphate of soda=
0·142 „ soda,

agreeing with the formula:

$$NaO, SeO_2.$$

		Theory.	Experiment.
1 eq. selenious acid . .	56	63·63	
1 „ soda. . . .	32	36·37	35·50
	88	100·00	

The above corresponds with the formulæ for dry carbonate and sulphite of soda:

$$NaO, CO_2$$
$$NaO, SO_2$$
$$NaO, SeO_2.$$

Selenite of soda, heated in a test-tube, gives off a mere trace of water, the salt fuses, but does not suffer decomposition. From the aqueous solution, I could not succeed in obtaining the neutral salt with water of crystallization. Biselenite of soda forms acicular crystals.

0·2410 grms. of salt gave:
0·0251 „ water.

The annexed formula is deduced from the above:

$$NaO, SeO_2, + HO, SeO_2 + 2\ aq.$$

Represented in 100 parts:

		Theory.	Experiment.
1 eq. of selenite of soda .	88	51·46	
1 „ „ „ „ water .	65	38·02	
2 eqs. „ water . . .	18	10·52	10·41
	171	100·00	

The biselenite does not suffer decomposition except at a very high temperature. On a sand-bath *it parts only with its water of crystallization.* At a red heat, it fuses into a yellowish liquid, water passing off with selenious acid; the neutral salt remains as a fine silvery-white, crystalline mass.

QUADRISELENITE OF SODA.

I dissolved biselenite of soda in selenious acid, and put aside the liquid to evaporate spontaneously. After some days, needle-like crystals separated, which were not very deliquescent. When dried over sulphuric acid and analysed:

I. { 0·862 grm. salt gave:
0·241 „ sulphate of soda =
0·107 „ soda.

II. { 0·804 grm. salt gave:
0·210 „ sulphate of soda =
0·093 „ soda.

The preceding results agree closely with the following singular formula:

$$NaO, SeO_2 + 3 (HO\ SeO_2) + aq.$$

		Theory.	Experiment. I.	Experiment. II.
4 eq. selenious acid .	224	76·712		
1 „ soda. . .	32	10·958		
4 „ water . .	36	12·33	12·41	11·56
	292	100·000		

This salt fuses readily into a yellowish-red liquid, evolving selenious acid and water, while selenite and traces of selenate of soda remain.

SELENITES OF AMMONIA.

These salts are extremely difficult to prepare. I could not obtain a selenite of ammonia from an aqueous solution in a fit state for analysis.

After a number of vain attempts, alcohol was resorted to. Selenious acid, dissolved in alcohol, and treated with ammoniacal gas, afforded magnificent shining crystals, which, however, were deliquescent. This salt is also obtained by dissolving selenious acid in strong aqueous ammonia, and precipitating by alcohol. When a drop of strong ammonia is added to crystallized selenious acid, combination immediately takes place, great heat is evolved, and particles of selenium sometimes separate.

Selenite of ammonia is strongly alkaline to the taste, and smells *slightly of ammonia*. It is very soluble in water—perfectly insoluble in ether:

0·2505 grm. salt gave:	0·25050
0·3100 „ platinum =	0·31000
0·08141 „ oxide of ammonium,	0·08141

agreeing with the formula:

$$NH_4O,\ SeO_2.$$

		Theory.	Found.
1 eq. selenious acid . .	56	68·30	
1 „ oxide of ammonium .	26	31·70	32·49
	82	100·00	

Selenite of ammonia, heated in a dry test-tube, gives off, first water and ammonia, then water and nitrogen, while an acid salt condenses in the upper part of the tube; lastly, large quantities of selenium sublime. The decomposition is represented in its several stages by the annexed equation.

$$5\ (NH_4O,\ SeO_2)\ =$$
$$HO,\ +\ 2\ NH_4O,\ +\ 7\ HO,\ +\ 2\ N,\ +NH_4O{\cdot}2\ SeO_2,\ +\ 3\ Se.$$

Biselenite of ammonia does not deliquesce, it is composed, according to Berzelius, as follows:—

$$NH_4O,\ 2\ SeO_2.$$

Its formula is probably:

$$NH_4O,\ SeO_2\ +\ HO,\ SeO_2\,?$$

Quadriselenite of ammonia is not crystallizable.

SELENITES OF BARYTA.

Selenious acid produces no precipitate with solutions of baryta. By this reaction it is at once distinguished from sulphurous acid. When neutral selenite of potash is added to nitrate of baryta, decomposition takes place, selenite of baryta is deposited in fine shining plumose crystals, which are soluble in selenious, nitric, and hydrochloric acids. From the acid solution, the baryta is immediately precipitated by sulphuric acid.

0·308 grm. salt gave
0 271 „ sulphate of baryta =
0·177 „ baryta.

Numbers agreeing with the formula:

$$BaO, SeO_2$$

Centesimally represented:

		Theory.	Berzelius.	Experiment.
1 equiv. selenious acid .	56	42·42	42·07	—
1 „ barytes . . .	76	57·58	57·93	57·46
	132	100·00	100·00	

Biselenite of baryta is obtained by expelling the carbonic acid from the carbonate of baryta with selenious acid, and allowing the liquid to evaporate spontaneously. It is with difficulty dissolved in water. Ammonia, when added to it, precipitates the neutral salt. At a high temperature, the biselenite evolves water and white fumes of selenious acid.

SELENITES OF STRONTIA.

These salts are obtained in a similar manner to those of baryta. Selenite of strontia is a white insoluble powder. It does not contain water. The following is its formula:

$$SrO, SeO_2.$$

Biselenite of strontia does not crystallize. Its behaviour, when heated, corresponds to the acid salt of baryta. It is slightly soluble in water.

SELENITES OF LIME.

Carbonate of lime with selenious acid yields gritty crystals of selenite of lime. Berzelius has remarked the singular effect of this salt upon glass. At a red heat the tube is sometimes eaten through. A most remarkable characteristic of this and a few other of the salts of selenious acid.

Formula—CaO, SeO_2

The selenite of lime dissolves in selenious acid, giving a biselenite, which is very persistent in the air.

SELENITES OF MAGNESIA.

When all the carbonic acid is expelled from carbonate of magnesia by selenious acid, there remains a heavy neutral crystalline salt, which dissolves in boiling water, and crystallizes from it in rhombic prisms. Selenite of magnesia, heated over the lamp, gives off only its water of crystallization. It fuses at a red heat in a glass tube, corroding and passing through it like the selenite of lime.

0·209 grm. of salt, strongly heated, gave:
0·056 „ „ water.

Formula—$MgO, SeO_2 + 3$ aq.

		Theory.	Experiment.
1 eq. Selenious acid . .	56	54·36	—
1 „ Magnesia . .	20	19·42	—
3 „ Water . . .	27	26·22	26·79
	103	100·00	

This salt is isomorphous with the sulphite and carbonate of the same base:

$$MgO, SeO_2 + 3 \text{ aq.}$$
$$MgO, SO_2 + 3 \text{ aq.}$$
$$MgO, CO_2 + 3 \text{ aq.}$$

Selenite of magnesia dissolves in selenious acid, yielding a biselenite, precipitable in an unctuous state by alcohol. It is extremely deliquescent.

SELENITES OF ALUMINA.

Alum is not precipitated by selenious acid. A selenite of an alkali, however, precipitates a selenite of alumina. Great care must be taken that the precipitant is neutral. Selenite of alumina is amorphous. When heated it gives off water, and lastly, all its acid.

0·197 grm. of dry salt gave:
0·150 „ selenious acid, and
0·046 „ alumina.

		Theory.	Experiment.
3 eqs. Selenious acid . . .	168	76·36	76·14
1 „ Alumina	52	23·64	23·36
Loss	—	—	·50
	220	100·00	100·00

I also determined the water in the salt dried over sulphuric acid.

0·112 grm. of salt gave:
0·012 „ „ water.

Centesimally represented:

		Theory.	Experiment.
3 eqs. Selenious acid . . .	168	68·01	—
1 „ Alumina	52	21·17	—
3 „ Water	17	10·82	10·71
	247	100·00	

Formula—$Al_2\ O_3,\ 3\ SeO_2 + 3$ aq.

The composition of the selenite of alumina is greatly different from the sulphite, as represented by the formula:

$Al_2\ O_3,\ SO_2 + 4$ aq.

Biselenite of alumina is obtained when the above salt is dissolved in selenious acid. It is transparent and gummy to the feel. According to Berzelius, it contains six equivalents of acid.

$Al_2\ O_3,\ 6\ SeO_2$

In all probability its composition is the following:

$Al_2\ O_3,\ 3\ SeO_2 + 3\ (HO\ SeO_2)$?

SELENITES OF GLUCINA.

This selenite is, in every way, analogous to that of alumina, the biselenite is extremely soluble, and does not crystallize.

SELENITE OF CHROMIUM.

This salt is obtained by decomposing the chloride of chromium by selenite of ammonia. It is a fine green amorphous powder.

0·3006 grm. salt gave:
0·0980 „ oxide of chromium.

Formula—$Cr_2\ O_3,\ 3\ SeO_2$

		Theory.	Experiment.
3 eqs. Selenious acid . . .	168	67·74	—
1 „ Oxide of chromium . .	80	32·26	32·60
	248	100·00	

Selenite of chromium dissolves in selenious acid, giving on evaporation a green varnish.

SELENITES OF IRON.

Metallic iron is not dissolved by selenious acid. Selenium is deposited on its surface in red flakes. Selenite of iron precipitates as a white powder from a mixture of an alkaline selenite and sulphate of iron. It becomes darker on exposure to the air, and after some time partakes of a yellow colour, owing to the formation of some sesquioxide. When the white precipitate is dissolved in hydrochloric acid, a portion of selenium separates, and sesquichloride of iron with selenious acid remain in solution.

$$4\ (FeO,\ SeO_2) + 6\ HCl =$$
$$Se, + 2\ (Fe_2\ Cl_3,) + 6\ HO, + 3\ SeO_2.$$

Biselenite of iron is formed by dissolving the selenite in selenious acid. When the liquid is boiled, a brown powder separates, containing selenite of the sesquioxide of iron with selenium.

Selenite of the sesquioxide of iron falls as a white powder when selenite of ammonia is added to sesquichloride of iron. It is yellowish when dry, and loses water, in the heat, becoming darker, and as the temperature augments, all its acid volatilizes.

0·1015 grm. salt gave :
0·0720 „ selenious acid and water,

which agrees sufficiently with the formula :

$$Fe_2\ O_3,\ 3\ SeO_2 + 4\ aq.$$

Calculated on 100 parts :

		Theory.	Experiment.
1 eq. Sesquioxide of iron . .	80	28·16	—
3 „ Selenious acid . . .	168	59·15	70·94
4 „ Water	36	12·69	
	284	100·00	

According to Berzelius, the bisalt is formed when iron is dissolved in a hot mixture of nitric and selenious acids. The salt is deposited, on cooling, in green plates, which contain water of crystallization. They are not soluble in water, but dissolve readily in hydrochloric acid, imparting a yellowish colour :

The formula for the salt, is :

$$Fe_2\ O_3,\ 3\ SeO_2 + 3\ (HO\ SeO_2)\ ?$$

A basic salt is obtained when either of the two preceding salts is digested in ammonia, the formula for which is :

$$2\ Fe_2\ O_3,\ 3\ SeO_2.$$

SELENITES OF MANGANESE.

I dissolved carbonate of manganese in selenious acid, and obtained a white gritty powder, which readily fused to a dark liquid in a glass tube, corroding it more even than the magnesia-salt. Selenious acid sublimed, and sesquioxide of manganese, with some selenium, remained:

0·200 grm. salt fused with nitrate of potash, gave
0·250 grm. selenate of baryta =
0·100 grm. selenious acid.

The formula is therefore

$$MnO, SeO_2 + 2\ aq.$$

Represented in 100 parts.

		Theory.	Experiment.
1 eq. selenious acid	56	50·90	50·00
1 „ oxide of manganese .	36	32·73	—
2 „ water	18	16·37	—
	110	100·00	—

This salt agrees in composition with the carbonate and sulphite of manganese:

$$MnO, SeO_2 + 2\ aq.$$
$$MnO, CO_2 + 2\ aq.$$
$$MnO, SO_2 + 2\ aq.$$

Selenite of manganese is insoluble in water, it forms a colourless solution in cold, and a pink solution in hot, hydrochloric acid. With selenious acid, it yields a soluble biselenite.

SELENITES OF NICKEL.

The neutral salt falls as a greenish powder when selenite of potassa is added to sulphate of nickel. In its dry state the salt is white. Dried over sulphuric acid:

0·207 grm. salt gave:
0·019 „ water.

Numbers corresponding to the formula:

$$NiO, SeO_2 + aq.$$

Calculated on 100 parts.

		Theory.	Experiment.
1 eq. selenious acid	56	54·36	—
1 „ oxide of nickel . .	38	36·89	—
1 „ water	9	8·75	9·17
	103	100·00	

Selenite of nickel dissolves in selenious acid with a greenish colour. The liquid, on evaporation, yields a gummy acid salt.

SELENITES OF COBALT.

The neutral salt procured by double decomposition is an insoluble rose-coloured powder. In all probability its composition is similar to the nickel compound. Carbonate of cobalt dissolves in selenious acid with a fine pink colour. The liquid, on evaporation, yields a magnificent transparent violet-coloured gum—an acid salt. This resinous substance, when heated on a sand-bath, gives off selenious acid, which condenses on the sides of the vessel in beautiful white needles.

SELENITES OF ZINC.

Selenious acid does not precipitate salts of zinc; in combination with an alkali, however, it gives, when added to sulphate of zinc, white crystalline grains of selenite of zinc. When this salt is heated, it evolves water, but as the temperature augments, the salt fuses to a yellow liquid, which, on cooling, presents a fine crystalline striated appearance. At a white heat the mass gives off selenious acid, leaving a basic salt:

0·0522 grm. salt gave:
0·0087 „ water.

From which the following formula is deduced:

$$ZnO, SeO_2 + 2\ aq.$$

Represented in 100 parts:

		Theory.	Experiment.
1 eq. selenious acid	56	49·12	—
1 „ oxide of zinc	40	35·08	—
2 „ water	18	15·80	16·66
	114	100·00	

This salt corresponds to the sulphite of zinc:

$$ZnO, SeO_2 + 2\ aq.$$
$$ZnO, SO_2 + 2\ aq.$$

Selenite of zinc dissolves in selenious acid, yielding an uncrystallizable biselenite.

SELENITES OF CADMIUM.

Selenious acid does not precipitate salts of cadmium. Selenite of ammonia gives, with chloride of cadmium, a white argillaceous looking precipitate. This becomes orange on exposure to the air. Selenite of cadmium contains no water. It is soluble in selenious acid. When heated in a test-tube, it gives a sublimate of a yellowish-red colour.

SELENITES OF COPPER.

When biselenite of ammonia is added to a hot solution of sulphate of copper, a dirty greenish-yellow precipitate falls, which after some time becomes a fine bluish-green crystalline salt. This compound, dried over sulphuric acid, acquires a beautiful bright blue colour.

I. 0·5260 grm. salt gave
0·2133 " oxide of copper.
0·0526 " salt gave
0·0018 " water,

and

II. 0·0534 grm. salt gave
0·0017 " water.

The above results agree very closely with the formula:

$$3\,(CuO,\ SeO_2) + aq.$$

Centesimally represented:

	Theory.		Experiment.	
			I.	II.
3 eq. selenious acid . . .	168	56·56	—	—
3 " oxide of copper . .	120	40·40	40·55	—
1 " water	9	3·04	3·42	3·18
	297	100·00		

This salt does not dissolve in aqueous selenious acid. At a high temperature it first becomes brown, lastly black, parting with all its acid. A green basic selenite of copper is formed when selenite of ammonia is added to sulphate of copper. It is insoluble in water, but dissolves in ammonia. Freshly precipitated suboxide of copper combines with selenious acid, producing a whitish salt. The formula for which is:

$$Cu_2\,O,\ SeO_2 + aq.\,?$$

SELENITES OF LEAD.

Selenious acid gives a white curdy precipitate with acetate of lead, which is slightly soluble in water. The precipitate contains no water. It is with difficulty decomposed by sulphuric acid. When heated very strongly, it fuses into a yellowish fluid, selenious acid sublimes, and a basic salt remains. The formula for this salt is:

$$PbO, SeO_2.$$

SELENITE OF SILVER.

Berzelius analysed the selenite of silver. It is thrown down in the form of a white powder on the addition of aqueous selenious acid to nitrate of silver; it is fusible, and at a red heat loses its acid and all its oxygen, leaving metallic silver. When perfectly dry, it is not blackened on exposure to light. It is slightly dissolved by cold, more by boiling water, is easily soluble in hot nitric acid, from which it crystallizes in needles. The salt is obtained perfectly pure in this way. The formula for the salt is:

$$AgO, SeO_2.$$

SELENITES OF MERCURY.

The selenite of the suboxide of mercury is obtained by adding selenious acid to a solution of subnitrate of mercury; also by double decomposition. It is a white powder, insoluble in water. Heated in a tube, it blackens, water is liberated, and a yellow powder sublimes. When the latter is heated, it fuses into beautiful red globules, which become of an orange colour on cooling; in fact a series of cameleon-like changes occur with this salt. As the tube gradually cools, splendent golden yellow crystals become visible. Caustic potash takes the selenious acid from the selenite. It dissolves in hydrochloric acid, giving chloride of mercury, water, selenious acid, and selenium.

$$\begin{aligned}&2\ (Hg_2\ O,\ SeO_2) + 4\ HCl = \\ &4\ (Hg\ Cl) + 4\ HO + SeO_2 + Se.\end{aligned}$$

Selenite of the protoxide of mercury is a white insoluble powder. The bisalt, according to Berzelius, is obtained by digesting the oxide of mercury for a long time in selenious acid. On filtering and evaporating the filtrate, prismatic crystals are deposited, containing a large quantity of water.

The salt fuses easily in its water of crystallization; as the heat is increased, the selenite sublimes unchanged. Sulphurous acid precipitates from the selenite a mixture of sulphate of mercury and selenium:

$$\begin{aligned}&2\ (HgO,\ 2\ SeO_2) + 9\ SO_2 = \\ &Hg_2\ O,\ SO_3 + 8\ SO_3 + Se.\end{aligned}$$

SELENITE OF LITHIA.

This salt is obtained by double decomposition. It is deliquescent. When heated, it fuses to a yellow liquid, and on cooling solidifies into an opaque crystalline mass, resembling mother-of-pearl. Selenite of lithia is soluble in selenious acid.

SELENITE OF YTTRIA.

Berzelius obtained the above as a white argillaceous precipitate, which was insoluble in selenious acid. When dry, it is a white amorphous powder, which at first gives off water when heated, and then acid.

SELENITES OF CERIUM.

Selenite of the protoxide of cerium is a white powder, insoluble in water. A biselenite of the same oxide is obtained by dissolving the former in selenious acid. Selenite of the sesquioxide of cerium is a citron-yellow powder, easily parting with its acid. The biselenite is obtained by dissolving the above in selenious acid. When evaporated on a water-bath, it leaves a yellow gummy mass, which, when heated, loses water, and becomes opaque and crystalline. It is soluble in water.

SELENITES OF ZIRCONIA.

The neutral salt is a white insoluble powder, obtained by double decomposition. It loses its acid when heated, and is soluble in selenious acid, yielding an acid salt.

SELENITES OF URANIUM.

Selenite of uranium is a citron-yellow powder that gives off acid when strongly heated, leaving a lower oxide; the bisalt yields, on evaporation, an opaque gum, behaving like the selenite of the sesquioxide of cerium. The formula for this salt is:

$$U_2\,O_3,\ 3\ SeO_2.$$

SELENITE OF TIN.

This salt is a white insoluble powder. It is soluble in hydrochloric acid, from which solution it is reprecipitated by water. Heated, it evolves first water, selenious acid then sublimes, and pure oxide of tin remains. The formula for the dry salt is:

$$SnO_2,\ 2\ SeO_2$$

I have now described the various compounds of this interesting acid. The difficulty of preparing the salts can only be known to the experimenter. Spontaneous evaporation, or double decomposition is the best way to obtain the desired end. Alcohol can seldom be employed as a precipitant, for it generally separates an oily liquid, which becomes crystalline only in rare instances. The determination of selenious acid is very difficult; fusion with nitrate of potash is the first step to convert the selenious into selenic acid, which latter can then be precipitated by nitrate of baryta; selenate of baryta must not be burned in the filter, as reduction readily takes place. To prevent loss, when the selenate of baryta is perfectly dry, it should be scraped from the filter into a weighed crucible, and the filter burned over it. The selenites seldom correspond with the sulphites or carbonates; where such is the case the analogy has been noticed. The great stability of selenious acid has been previously discussed. Its salts, when not deliquescent, are most persistent.

I shall close this memoir with a table of all the salts of selenious acid.

Selenite of potash	KO, SeO_2
Biselenite of potash	$KO, SeO_2 + HO, SeO_2$
Quadriselenite of potash	$KO, SeO + {}_{2}3(HO, SeO_2)$?
Selenite of soda	NaO, SeO_2
Biselenite of soda	$NaO, SeO_2 + HO, SeO_2 + 2$ aq.
Quadriselenite of soda	$NaO, SeO_2 + 3(HO, SeO_2)$ + aq.
Selenite of ammonia	$NH_4 O, SeO_2$
Biselenite of ammonia	$NH_4 O, SeO_2 + HO, SeO_2$?
Selenite of baryta	BaO, SeO_2
„ „ strontia	SrO, SeO_2
„ „ lime	CaO, SeO_2
Biselenite of lime	$CaO, SeO_2 + HO, SeO_2$?
Selenite of magnesia	$MgO, SeO_2 + 3$ aq.
„ „ alumina	$Al_2 O_3, 3 SeO_2 + 3$ aq.
Biselenite of alumina	$Al_2 O_3, 3 SeO_2 + 3 (HO, SeO_2)$?
Selenite of glucina	$Gl_2 O_3, 3 SeO_2 + 3$ aq. ?
„ „ chromium	$Cr_2 O_3, 3 SOe_2$
„ „ iron	FeO, SeO_2
Biselenite of iron	$FeO, SeO_2 + HO, SeO_2$?
Selenite of the sesquioxide of iron	$Fe_2 O_3, 3 SeO_2 + 4$ aq.
Sesquiselenite of the sesquioxide of iron	$2 Fe_2 O_3, 3 SeO_2$
Biselenite of the sesquioxide of iron	$Fe_2 O_3, 3 SeO_2 + 3 (HO, SeO_2)$?
Selenite of manganese	$MnO, Se_2 O + 2$ aq.

Selenite of nickel	$NiO, SeO_2 + aq.$
,, ,, cobalt	$CoO, SeO_2 + aq.$?
,, ,, zinc	$ZnO, SeO_2 + 2 aq.$
,, ,, cadmium.	CdO, SeO_2
,, ,, copper	$3 (CuO, SeO_2) + aq.$
,, ,, the suboxide of copper	$Cu_2O, SeO_2 + aq.$?
,, ,, lead	PbO, SeO_2
,, ,, silver	AgO, SeO_2
,, ,, the suboxide of mercury	$Hg_2 O, SeO_2$
,, ,, the oxide of mercury	HgO, SeO_2
Biselenite of the oxide of mercury	$HgO, SeO_2 + HO, SeO_2$?
Selenite of lithia	LiO, SeO_2
,, ,, yttria	YO, SeO_2
,, ,, the oxide of cerium	CeO, SeO_2 ?
Biselenite of the oxide of cerium.	$CeO, SeO_2 + HO, SeO_2$?
Selenite of the sesquioxide of cerium.	$Ce_2 O_3, 3 SeO_2$?
Biselenite of the sesquioxide of cerium.	$Ce_2 O_3, 3 SeO_2 + 3 (HO, SeO_2)$?
Selenite of zirconia	$Zr_2 O_3, 3 SeO_2$
,, ,, uranium	$U_2 O_3, 3 SeO_2$
,, ,, tin	$SnO_2, 2 SeO_2$

All the preceding salts, heated on charcoal before the blow-pipe, impart a magnificent blue colour to the flame, emitting the unmistakeable and offensive smell of foul horse-radish. That many of them were obtained in definite crystals, is due in a measure to the extreme coldness of the weather. It is valuable, and interesting, to ascertain the composition of the salts of some of those acids, having *ous* for their termination. I purpose shortly communicating to the Society a paper on the Tellurites.