In the osmotic system

$$inv\,i \mid inv\,i_1 \qquad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (27)$$

in which the two invariant liquids are directly in osmotic contact with one another, the quantity of water diffusing per sec. is:

$$(i_1 - i)\,\omega\,K \qquad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (28)$$

Of course this is no longer the case in the tissues discussed above. In (22) $5 + 15 + 32 = 52$ quantities of water are given off by $i$ and taken in by $i_1$. As, however, these numbers must be multiplied by $(i_1 - i)\,\omega K : 93$ the quantity diffusing per second is:

$$52\,(i_1 - i)\,\omega\,K : 93 = 0.559\,\omega\,K\,(i_1 - i) \qquad . \quad . \quad . \quad (29)$$

For the quantity diffusing per second in (24) we find:

$$107\,(i_1 - i)\,\omega\,K : 213 = 0.502\,\omega\,K\,(i_1 - i) \quad . \quad . \quad . \quad (30)$$

and for the tissue (26):

$$283\,(i_1 - i)\,\omega\,K : 344 = 0.822\,\omega\,K\,(i_1 - i) \quad . \quad . \quad . \quad (31)$$

Summarising the preceding considerations, it appears that every change in the surface and the nature of one or more of the membranes and of the position of the cells and invariant liquids with respect to one another, causes:

a change of the O.W.A. and consequently also of the composition of the cells;

a change of the partition of the current of the water;

a change of the quantity of water diffusing per second through the tissue.

*(To be continued).*

*Leiden, Lab. of Inorg. Chemistry.*

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**Chemistry.** — *The Crystalstructure of Cesium-, Thallium- and Rubidium-Perrhenates.* By F. M. JAEGER and J. BEINTEMA.

(Communicated at the meeting of May 27, 1933).

§ 1. In connection with the determination [1]) of the crystal-structures of the *alkali-osmiamates* of the general formula: $Me^I\{Os\,NO_3\}$, it was of interest to extend these investigations to the series of the *alkali-perrhenates*: $Me^I\{Re\,O_4\}$, and to compare the two sets of structures with each other. Of these salts, the *potassium-* and *silverperrhenates*

[1]) F. M. JAEGER and J. E. ZANSTRA, these Proceed., **35**, (1932), 610, 787, 779; Recueil d. Trav. d. Chim. d. Pays-Bas, **51**, (1932), 1013—1053.

have already been investigated by BROCH [1]) and by BUSCHENDORF [2]): both are *tetragonal-bipyramidal* and have a structure completely analogous to *scheelite*:

$$K Re O_4: \quad a_0 : c_0 = 5{,}615 \overset{\circ}{A} : 12{,}50 \overset{\circ}{A} = 1 : 2{,}2261.$$

$$Ag Re O_4: \quad a_0 : c_0 = 5{,}349 \overset{\circ}{A} : 11{,}916 \overset{\circ}{A} = 1 : 2{,}2277.$$

The same structure has, as we shall soon see, the *rubidium-* salt:

$$Rb Re O_4: \quad a_0 : c_0 = 5{,}801 \overset{\circ}{A} : 13{,}171 \overset{\circ}{A} = 1 : 2{,}2707.$$

On the contrary, the *cesium-perrhenate* and the *thallous perrhenate* prove to be *orthorhombic*, but they possess a decidedly *pseudo-tetragonal* character:

$$Cs Re O_4: \quad a_0 : b_0 : c_0 = 5{,}73 \overset{\circ}{A} : 5{,}98 \overset{\circ}{A} : 14{,}26 \overset{\circ}{A} = 0{,}961 : 1 : 2{,}3901.$$

$$Tl Re O_4: \quad a_0 : b_0 : c_0 = 5{,}63 \overset{\circ}{A} : 5{,}80 \overset{\circ}{A} : 13{,}33 \overset{\circ}{A} = 0{,}970 : 1 : 2{,}2985.$$

This pseudo-tetragonal character is more strongly expressed in the case of the *Tl*-salt than in that of the *Cs*-salt, as is, for instance, immediately seen when comparing the LAUE-patterns of the two salts, obtained by means of a pencil of $X$-rays traversing a plate cut parallel to {001} in a direction perpendicular to it.

As one of us will shortly publish a more detailed description of the experiments and a full discussion of the spectrograms obtained, we will here only give a general review of the results obtained and compare the structures of these salts with those of the *osmiamates* previously studied.

## § 2. Cesiumperrhenate.

In many cases the apparently homogeneous crystals proved to be twins, both individuals being turned round the c-axis with respect to each other through an angle of almost 90°; the directions of extinction of both individuals made an angle of about 2° with each other. The plane of the optical axes of the optically-biaxial crystals is parallel to {100}. The crystals have the habitus of rhombic plates, flattened parallel to {001}, showing the forms: {001}, predominant and {112}, narrow. The LAUE-pattern on {001} showed a distinct rhombic symmetry.

By means of a series of rotation-spectrograms round [001], [100] and [010] respectively, the dimensions of the elementary cell were determined. The distances observed were corrected by means of a powder-spectogram, in which sodiumchloride was used as a standard-material, The spectrogram obtained by rotating the crystal round the c-axis, showed

[1]) E. BROCH, Zeits. f. phys. Chem., (13), **6**, (1929), 22.

[2]) F. BUSCHENDORF, Zeits. f. phys. Chem., (13), **20**, (1933), 237.

a principal spectrum and seven accessory spectra; the odd spectra showed no reflections of considerable intensity, while in the even spectra the most intensive reflections were those, for which $h$, $k$ and $\frac{1}{2}l$ were either all even, or all odd. The parameter $c_0$ (corrected) was: 14,26 Å.

The rotation-spectrograms round [010] ($\omega_\alpha = 60°-90°$ and $\omega_\alpha = 0°-30°$) showed a principal spectrum and three accessory spectra; a rotation-spectrogram round [100] ($\omega_\gamma = 60° - 90°$) a principal spectrum and two accessory spectra, — in all cases $Cu_\alpha$-radiation being used ($\lambda = 1,539$ Å). The parameters $a_0$ and $b_0$ were determined to be: $a_0 = 5,73$ Å; $b_0 = 5,98$ Å (corrected). The volume of the cell being 488,6 Å$^3$, the specific weight of the salt is calculated to be: 5,17, $N$ being 4. A powderspectrogram showed 22 diffraction-lines, of which (004), resp. (112) was the most intensive. The quadratic equation is:

$$sin^2\,\theta = 0{,}01807\,.\,h^2 + 0{,}01668\,.\,k^2 + 0{,}00292\,.\,l^2.$$

The LAUE-pattern on $\{001\}$ showed 90 well-defined spots in each quadrant, to which indices were attributed in the usual way, by taking into account the limits of the wave-lengths with respect to the voltage of the tube used in the experiments. From the intensities of the different spots, the parameters of the 4 Cs- and 4 Re-atoms:

$$4\,Cs : u,\,{}^1/_4,\,{}^1/_8\,;\,\bar{u},\,{}^3/_4,\,{}^7/_8\,;\,u + {}^1/_2,\,{}^1/_4,\,{}^3/_8\,;\,\text{and}\,{}^1/_2\!-\!u,\,{}^3/_4,\,{}^5/_8\,;$$

$$4\,Re : u',\,{}^1/_4,\,{}^5/_8\,;\,\bar{u}',\,{}^3/_4,\,{}^3/_8\,;\,u' + {}^1/_2,\,{}^1/_4,\,{}^7/_8\,;\,\text{and}\,{}^1/_2\!-\!u',\,{}^3/_4,\,{}^1/_8\,;$$

were calculated by:

$$|S| = 2\,Z\,.\,\{\cos 2\pi\,(u\,.\,h + \tfrac{1}{4}\,.\,k + \tfrac{1}{8}\,.\,l) + \cos 2\pi\,(u\,.\,h + \tfrac{1}{2}\,.\,h + \tfrac{1}{4}\,.\,k + \tfrac{3}{8}\,.\,l)\} +$$

$$+\,2\,Z'\,.\,\{\cos 2\pi\,(u'\,.\,h + \tfrac{1}{4}\,.\,k + \tfrac{5}{8}\,.\,l) + \cos 2\pi\,(u'\,.\,h + \tfrac{1}{2}\,.\,h + \tfrac{1}{4}\,.\,k + \tfrac{7}{8}\,.\,l)\}.$$

The values of $u$ and $u'$, — which must have *opposite* algebraic signs, as follows from the great intensities of (715), (717), (513), (515), (735), (535), (533), (623), (625) and (627), because of the collaboration of the Cs- and Re-atoms, — were supposed to be approximately equal, a supposition which was afterwards corroborated by the comparison of the intensities observed of (502) and (152) and of those of (512) and (152) with the calculated ones.

The most probable value of $u$ and $u'$ proved to be: $0{,}042 \pm 0{,}004$, which indeed is sufficiently different from *zero* to explain the less pronounced pseudotetragonal character of the Cs-salt, in comparison with the Tl-salt. The value $^1/_8$ for the $z$-coordinate follows from the total absence of the reflections (002) and (006). The space-group of the crystals is most probably: $V_H^{16}$, as the reflections $(Okl)$, for which $(k+l)$ is odd, and $(hk0)$, for which $h$ is odd, are completely absent.

The best agreement between calculated and observed values was obtained, if the parameters of the *Cs*- and *Re*-atoms were taken as:

4 *Cs*-atoms: (0,042 ; 0,250 ; 0,125).     4 *Re*-atoms: (0,542 ; 0,750 ; 0,125).

(0,958 ; 0,750 ; 0,875).          (0,458 ; 0,250 ; 0,875).

(0,542 ; 0,250 ; 0,375).          (0,042 ; 0,750 ; 0,375).

(0,458 ; 0,750 ; 0,625).          (0,958 ; 0,250 ; 0,625).

The situation of the *oxygen*-atoms cannot properly be deduced from the spectrographical data. If they are supposed to be arranged round the *Re*-atoms in such a way, that they are situated in the corners of an approximately regular tetrahedron, then two of these *O*-atoms must be situated within a plane of symmetry (010) of the crystal, the two others being placed at the two sides of it. The *Cs*-atoms in the upper half of the elementary cell are a little shifted in the direction of the *a*-axis with respect to those in the lower half of the cell.

### § 3. *Thallous-perrhenate.*

The crystals were rarely well developed; they had the shape of rhombic plates, flattened parallel to {001}, with angles only slightly different from 90°. The forms observed were: {001}, predominant; {112}, narrow, {011} and {101}, small and narrow. The LAUE-pattern on {001} showed rhombic, but very pronounced pseudotetragonal symmetry, — much more evident than in the case, of the *Cs*-salt.

Rotationspectrograms round [001] ($\varphi = 360°$) and round [100] ($\omega_\gamma = = 60° - 90°$) yielded the following results:

The spectrogram round [001] showed a principal spectrum and the $1^{st}$, $2^{nd}$, $4^{th}$, $5^{th}$, and $6^{th}$ accessory spectra. The value of $c_0$ was determined at: 13,33 Å. (corrected). The spectrogram round [100], which proved to be almost identical with that round [010], showed a principal spectrum and two accessory spectra. The (corrected) values of $a_0$ and $b_0$ proved to be: 5,63 Å. and 5,80 Å. respectively. The parameter values were corrected in all these cases by means of a powderspectrogram, in which calcite was used as a standard-material, — sodium-chloride being inadequate in this case. As the volume of the elementary cell is 434,9 Å³, the specific gravity calculated is: 6,90; $N = 4$.

The powderspectrogram ($\lambda = 1,539$ Å) showed 17 lines, of wich (112) appeared to have the greatest intensity; the corresponding quadratic equation was: $sin^2 \theta = 0,01871 . h^2 + 0,01761 . k^2 + 0,003348 . l^2$. No reflections $(O k l)$ occur, if $(k + l)$ is odd, neither such $(h k O)$, for which $h$ is odd, nor other reflections $(00l)$ than (004) and (008). The space-group most probably is: $V_H^{16}$. The most intensive reflections are those, for which $(h + k)$, $(h + \frac{1}{2} l)$ and $(k + \frac{1}{2} l)$ are *even* numbers; reflections not satisfying these conditions are absent or, at least, extremely feeble.

If the elementary cell is halved by a plane parallel to (001), both halved cells must be face-centred, as the reflections ($h\,k\,l$) not satisfying these conditions are practically absent. The parameters of the $Tl$- and $Re$-atoms, therefore, must be:

$4\,Tl$-atoms: $0,\,^1/_4,\,^1/_8$; $0,\,^3/_4,\,^7/_8$; $^1/_2,\,^1/_4,\,^3/_8$; and $^1/_2,\,^3/_4,\,^5/_8$.

$4\,Re$-atoms: $0,\,^1/_4,\,^5/_8$; $0,\,^3/_4,\,^3/_8$; $^1/_2,\,^1/_4,\,^7/_8$; and $^1/_2,\,^3/_4,\,^7/_8$.

If $Tl$ and $Re$ are present as ions, $Re^{VII}$ has 68 and $Tl^{I}$ has 80 electrons; as the $Re$ is surrounded by $4O^{II}$-ions, its action will be supported by those and thus $Tl$ and $Re$ apparently will manifest almost the same, or at least, comparable diffraction-power. In that case the elementary cell will apparently be twice as small and face-centred. There is only a slight difference in the $a_0$- and $b_0$-axes, so that the deviation from real tetragonal symmetry is only very small here.

The LAUE-pattern on {001} was analysed in the usual way; also here it became evident, that the reflections observed corresponded to faces ($h\,k\,l$), for which ($h + k$), ($h + \frac{1}{2}\,l$), and ($k + \frac{1}{2}\,l$) were all three *even*.
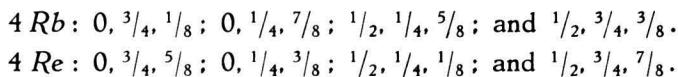
### § 4. *Rubidium-perrhenate.*

The small crystals obtained from hot aqueous solutions yielded rather good reflections. They showed {112} and {101}, both well developed; but {001} was absent. The symmetry of the crystals was tetragonal-bipyramidal; the absence of the vertical planes of symmetry was proved by means of a LAUE-pattern on {001}, obtained by radiating a crystal through in the direction of its c-axis.

By means of rotation-spectograms, the values of $c_0$ and $a_0$ were determined to be: $a_0 = 5,80$ Å; $c_0 = 13,17$ Å. The rotation-spectrogram round [001] ($\varphi = 360°$) showed a principal spectrum and six accessory spectra, the spectra of even order decidedly having a greater intensity than those of odd order. The elementary cell is bodily-centred, for ($h + k + l$) is always *even*, as was also proved by means of a powder-spectrogram, which showed about 18 diffraction-lines.

Sodiumchloride was used as a standard-material; the quadratic equation is: $sin^2\,\theta = 0,017587\,.\,(h^2 + k^2) + 0,003411\,.\,l^2$. The most intensive lines were (112) or (103), (200), (204), (220), (312) and (116). As the volume of the elementary cell is: $443,2$ Å$^3$, the specific gravity of the crystals is: 5,0; $N = 4$.

It is highly probable, that the structure corresponds to that of the mineral *scheelite*, just as in the case of *potassium-* and *silver-perrhenates*. because 1$^{st}$ the elementary cell is bodily-centred; 2$^{nd}$ the symmetry only very slightly deviates from a *di*tetragonal one, as is seen from the LAUE-pattern on {001}; 3$^{rd}$, because the reflections, for which $h$, $k$ and $\frac{1}{2}\,l$ are either all even or all odd, prove to have considerable intensities.

The *Rb-* and *Re*-atoms (-ions), therefore, have the positions:

$$4\,Rb: \ 0,\,{}^3/_4,\,{}^1/_8\,;\ \ 0,\,{}^1/_4,\,{}^7/_8\,;\ \ {}^1/_2,\,{}^1/_4,\,{}^5/_8\,;\ \text{and}\ {}^1/_2,\,{}^3/_4,\,{}^3/_8.$$
$$4\,Re: \ 0,\,{}^3/_4,\,{}^5/_8\,;\ \ 0,\,{}^1/_4,\,{}^3/_8\,;\ \ {}^1/_2,\,{}^1/_4,\,{}^1/_8\,;\ \text{and}\ {}^1/_2,\,{}^3/_4,\,{}^7/_8.$$

The sixteen *oxygen*-atoms occupy the 16-fold position:

$$x,y,z;\ {}^1/_2+x,\,{}^1/_2+y,\,{}^1/_2+z;\ {}^1/_4-y,\,{}^3/_4+x,\,{}^1/_4+z;$$
$${}^3/_4-y,\,{}^1/_4+x,\,{}^3/_4+z;\ \text{etc.}$$

The structure of the *Rb*-salt thus is in so far different from that of the *Cs-* and *Tl*-salts, that it is *truly* tetragonal, and that the position of the tetrahedrally arranged *O*-atoms round each *Re*-atom, is a more or less pronounced "diagonal" one with respect to the planes $\{100\}$ and $\{010\}$.

§ 5. The analogy of the structures of the *perrhenates* and those of the *alkali-osmiamates* now becomes very evident: the structure of *Cs-* and *Tl-perrhenates* is quite analogous [1]) to that of $(NH_4)$-, *Rb-* and *Tl-os-miamates*; *Cs-osmiamate* however has a structure apart from all the other salts. On the contrary, the structures of *K-*, *Rb-*, and *Ag-perrhe-nates* on the other hand are completely analogous to that of *potassium-osmiamate*; they all have the type of structure characteristic of the mineral *scheelite*.

> *Groningen, Laboratory for Inorganic and Physical Chemistry of the University.*

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[1]) There are slight differences between the structures of *Rb-osmiamate* and of $CsReO_4$; but they are of no real significance.

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Genetics. — *The Parentela* JOHANNES DE FREMERY $17 \times 34$ MARIA CORNELIA DE FREMERY, *a case of marriage between first cousins.* By J. F. VAN BEMMELEN.

(Communicated at the meeting of May 27, 1933).

What I want to express by the term Parentela, I have tried to explain in former publications [1]), but may be allowed to say again here in a few words. In Genetics, Parentela is a fit designation for the complete descen-

[1]) J. F. VAN BEMMELEN, Heredity of mental Faculties, Proc. R. Acad. of Science Amsterdam, Vol. XXX, p. 769, 1927.

J. F. VAN BEMMELEN, Familie-onderzoek en erfelijkheidsleer, vier Radiolezingen. Keming & Zn., Utrecht 1929.