ON

THE CHEMISTRY

OF THE

ANCIENT ASSYRIANS

BY

R. CAMPBELL THOMPSON,

M.A., D.Litt., F.S.A.

FELLOW OF MERTON COLLEGE, OXFORD

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LUZAC AND CO.,

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Hommage de l'auteur

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S e c t i o n 1. I n t r o d u c t o r y .

The following paper contains a discussion on Assyrian minerals, pigments, and glass.

It would be superfluous to say how much I am indebted to the valued assistance of my friends Mr N.V. Sidgwick, F.R.S.; Mr J.E.Marsh,F.R.S.; and Mr E. Stenhouse,B.Sc. To these gentlemen,whose knowledge of chemistry was always at my disposal,I owe my best thanksfor the help which they have given me in unravelling many knotty points. To my former colleague, Dr H.R.Hall,now Keeper of the Department of Egyptian and Assyrian Antiquities of the British Museum,I likewise owe my thanks for the numerous facilities which have been granted me while copying the tablets herein published: and I am indebted for much useful discussion to his two Assistants,Mr Sidney Smith and Mr C.J.Gadd . To Dr A.E.Cowley I owe my gratitude for much encouragement during this work. Finally I wish to acknowledge the courtesy which has been shewn me by the Trustees of the British Museum in allowing me to copy the unique series of tablets published herein.

S e c t i o n 2. T h e M e a n i n g o f t h e A s s y r i a n w o r d abnu "s t o n e".

In discussing the Assyrian "s t o n e s" we have first to decide what was meant by the definition "stone". It

will be noted also, from Sect. 29, that the determinative a b n u "stone" covers a very large field, from date-stones to hail-stones, from the "metal" (as the glass in the process of formation is called) to practically any inorganic chemical. This is by no means new: it was held by Jastrow, for one (PRSM 1914, 153). We can then appreciate more easily the wide field in chemistry and geology from which we can draw our identifications.

Hitherto the Assyrian words for minerals and stones have been much neglected. Boson in a French article L e s M é t a u x e t l e s P i e r r e s, Muenich, 1914, and an Italian article I Metalli (Rivista degli Studi Orientali, VII, 379) collected much material, particularly for the dating of the use of numerous stone-names, although, perhaps, he was not always successful in identifying them. But he certainly produced two works of great usefulness.

The point which appears to me to have been overlooked by Assyriologists in their identification of stone-names is the wide geological range which the large number of substances specified by the determinative for "stone" must necessarily cover. It is true that the occurrences of such "stones" are far less in the Medical Texts than the occurrences of plants: the total number of species of "stones" occurring in my Assyrian Medical Texts is about 120, less than half the number of plant-drugs, and the actual number of times these "stones" occur altogether in these medical texts is about 650, as against about 4600 occurrences of plant-drugs (see my AH, p. V).

I think that the custom has too commonly been to regard

(S e c t i o n I I)

will be noted also, from Sec.22, that the determinative a b n u "stone" covers a very large field, from stibium to haematite, from the "metal" (in the place in the process of formation is solid or practically any inorganic substance). This is by no means new to me here by Jastrow, (for example in M, [illegible]). We can thus appreciate more easily the wide field in chemistry and geology from which we can draw our identifications.

Hitherto the Assyrian words for minerals and stones have been much neglected, Boson in a French article, L e s N o m s d e s P i e r r e s, [illegible], and an Italian article, I minerali [illegible] (Giornale [illegible], VII, [illegible]) collected much material, particularly for the naming of the ore of [illegible], although [illegible], he was not always successful in identifying them. But he certainly produced two works of great usefulness.

The point which appears to me to have been overlooked by Assyriologists in their identification of stone-names is the wide geological range which the large number of substances specified by the determinative for "stone" must necessarily cover. It is true that the occurrences of such "stones" are far less in the Medical Texts than the occurrences of plants: the total number of species of "stone" occurring in my Assyrian Medical Texts is about 130, less than half the number of plant-drugs, and the actual number of times these "stones" occur altogether in these Medical texts is about 650, as against about 4000 occurrences of plant-drugs [illegible].

I think that the authors [illegible] the [illegible], [illegible] them as "precious stones" (and that, with some little mystery attaching to them), in spite of Jastrow's view. Indeed, the fact that the Assyrian physicians were as efficient in their own line as the other professional men of that remarkable nation is all too frequently ignored in the translating of their prescriptions. A more detailed collation of these mineral drugs (for that is what many of them are) will, I think, reveal a pharmacopoeia widely extended into the fields of practical chemistry. Similarly I believe that we must see in several of the "stones", which the Assyrian historians designate as "valuable minerals", the materials from which the Assyrian builders made their pigments for decorating the palaces. Of these I think only the u k n ū "lapis", i.e., the blue paint ultramarine, has been recognized[1], (and that rather sporadically), and perhaps I might add cinnabar (s a n d u), which I suggested last year (PRSM, 1924, 9).

S e c t i o n 3. T h e C u n e i f o r m T a b l e t s r e l a t i n g t o t h e M a n u f a c t u r e o f G l a s s.

Finally a note is necessary on these most interesting texts published herein, which give in actual details the methods in vogue in Assyria, in the Seventh Century B.C., not only of making the different frits and glasses, but also the various colouring agents added to them.

The first to publish one of these texts was Virolleaud, his copy of K.203 (as it was then, without the additional "joins" which have lately been added) being published in Babyloniaca, iii, 221. He gave no translation, but the credit of publishing

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(1) See Bolt. 405.

the view that the text related to the making of "Email" is his. Boson(in his Les Métaux,59) attempted a translation of this text,but I think that he would himself not claim more for his version than that it was tentative. This was the only text published; but some considerable time ago Zimmern had copied this and several tablets of a similar nature in the British Museum, recognizing that they dealt with formulae of this description,and to him must be given the credit of having identified thirteen more of the fifteen tablets given herein, as belonging to a separate class dealing with chemical results. He lent his copies to Meissner,who in Bab.Ass,ii,383,1924,published a further attempt at a translation of four sections in full(my Sect.25,"A","B","C", and "T")and of one in part (my "H"). His translations,following up the suggestions which had already been made,shew something of the Assyrian methods of making glass,but ,as I venture to think, his methods of identifying the components were a little too superficial to help a practical chemist to estimate the technique of the Assyrians in this branch of science.

In May of this year,when my edition was nearly complete in MS, I learnt from an advance note in the Zeitschrift fuer Assyriologie that Dr Zimmern was also proposing to issue an edition of them shortly. I therefore wrote to him at once, telling him how far my work had gone,and that I proposed to publish it, suggesting at the same time that as the problems were numerous and difficult,it might be well for our two editions to be kept entirely distinct and separate. I received a most courteous reply fom him,giving me an account of the history of the copying the view that the text related to the making of "Zuqû" [illegible], Boissier has not, however, yet attempted a translation of this text, but I think that he would himself not claim more for his version than that it was tentative. This was the only text published; but, some considerable time ago Zimmern had copied this and several tablets of a similar nature in the British Museum, recognizing that they dealt with formulae of this description, and to him must be given the credit of having identified thirteen more of the fifteen tablets given herein, as belonging to a separate class dealing with chemical recipes. He lent his copies to Meissner, who in Bab.Ass.ii, 303, 1924 published a further attempt at a translation of four sections in Fuller, sect.10, A, B, C, and E, and of one in part, by "A"), his translations, following up the suggestions which had already been made, show something of the Assyrian methods of making glass, but, as I venture to think, his methods of identifying the components were a little too superficial to help a practical chemist to estimate the technique of the Assyrians in this branch of science.

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With the exception of the Reverse of K.203, the texts herein given are now published for the first time. The numbers of the tablets are given by Meissner(l.c.)as he received them from Zimmern, to whom, as I have said, the credit must be given for recognizing their connection:-

K. 203 : K. 3889 : K.4266+8976 : K.4273 : K.4290+9477+9492: K. 4747+10493 : K.5839 : 6246+8157 : K. 6648 : K. 6920 : K. 7125 : K.7619 : K.7942+8167 : K.9551.

After my examination of these texts K.203 was joined to K.4747, and I was so fortunate as to find another fragment, K. 5862.

The first essential in solving any problems about ancient glass or glaze is, I take it, to compare the prinziples involved in the technique of modern methods. The fundamentals of all glass-making are so simple, at any rate in theory, that we should be able to arrive at absolute certainty in the identification of most of the Assyrian components. I make no apology, therefore, for quoting very fully from standard works on glass-making, as there must be many like myself, who have to begin at the beginning of the processes involved. The importance of these texts for the history of glass, dating as they do to the period of Assurbanipal (668-626, B.C.), cannot be overrated. Not only do they give the Assyrian names for the different kinds of glass and glazes, but also the actual formulae for the components and proportions for their manufacture.

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With the exception of the obverse of K.203, the texts here given are now published for the first time. The numbers of the tablets are given by K.-numbers (i.e.) as he received them from Gadd, to whom, as I have said, the credit must be given for recognising their connections:-

K. 203 + K. 2949 + K.4924+5970 : K.6375 : K.4920+8470+9492 : K. 12474+10000 : K.[illegible] : [illegible]+8147 : K. [illegible] : K. 6920 : K. 7160 : K.7610 : K.7692+8187 : K.9[illegible].

After my examination of these texts K.203 was joined to K.[illegible], and I was so fortunate as to find another fragment, K. [illegible].

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I propose to discuss these glass texts and their chemicals first, and then proceed to the pigments and other mineral products.

S e c t i o n 4. The Modern Technical Processes of making Glass compared with the Ancient.

Dillon (8) gives an admirable initial summary , which I venture to quote in full :-

"Glass Merret [our earliest writer on glass] tells us is ' a concrete of salt and sand or stones '.... But... you cannot make a glass fit for practical use from a pure quartz sand with the addition of nothing else than a salt of potash or soda. Such a glass --- a simple alkaline silicate--- would indeed be transparent, but it would be difficult to work and very fragile. In all cases there is need of a second base, and this, to speak generally, should be either lime or oxide of lead. The latter base we may for the present neglect; speaking generally , it is the presence of lime that gives the working qualities and the requisite toughness. These , then ,are the essential materials for the preparation of glass. Other substances may be present; alumina, for example,or one or other of the oxides of iron, but as a rule the presence of these latter bases is not desired ---- the glass would be better without them". This seems so admirable a summary of the facts that I have not hesitated to quote it. In our Assyrian texts, if we are to discover the Assyrian method of glass- or glaze- making, we have above all to seek therein first a p u r e

q u a r t z s a n d , then some a l k a l i , and then l i m e ,or less probably ,l e a d .

These are the details of the chief materials,as given in Roscoe(ii,571) :-

S i l i c a ,inthe form of quartz, ignited flints, white sand, and ordinary sand:

P o t a s h, in the form of purified potashes:

S o d a , in the form of native carbonate, trona, by the Egyptians, and in the form of artificial carbonate from kelp:

L i m e , in the form of calc-spar,marble,chalk, or limestone:

L e a d, in the form of red lead, white lead,litharge:

A decolourising agent (with the object of oxidising the iron and carbon) is usually added: this ,for l i m e - g l a s s ismanganese dioxide, arsenious oxide,or salt-petre: for f l i n t - g l a s s , red lead.

The lustrous glass known as " crystal " is made of silica, potash, and red lead.

The still more lustrous glass known as " strass "(which is the base of artificial gems) is made of silica, boric acid, potash , red lead(Findlay,146,ff.).

The following are given in Pellatt(33,34):-

C r o w n G l a s s -	Sand 5
	Ground Chalk 2
	Carbonate of Soda 1
	Sulphate of Soda 1

P l a t e G l a s s -	Lynn Sand washed and burnt, 400
	Carbonate of soda 250
	Ground Chalk 30
B o t t l e G l a s s -	Sand 100
	Soapers' Waste, 80
	Gas Lime 80
	Common Clay 5
	Rock Salt 3
F l i n t G l a s s -	Sand washed and burnt 3 cwt
	Red Lead, or Litharge 2 cwt
	Carbonate of Potash 1 cwt
	Saltpetre 14 lbs to 28 lbs
	Oxide of Manganese 4 oz to 12 z

This is called "Batch" when mixed.

S e c t i o n 5. T h e A n c i e n t C o m p o n e n t s.

Dillon gives the following components:-

	Silica	Soda	Lime	Iron Oxide	Alumina
Roman Lachrimatory	71.5%	16.5%	8%	1%	2%
English Plate Glass	72 %	17 %	6%	2%	2%

-p.9

Claudet (quoted by Hoefer, 158) gives the components of the window glass of Pompeii as

Silica, 69; Soda, 17; Lime, 7; Alumina, 3; Iron Oxide, 1; Manganese and copper, traces.

S e c t i o n 6. T h e C o l o u r i n g o f G l a s s.

The following table shews how the colours in glass are

and were produced :-

B L U E ... Assyrian (1): c o p p e r , without Cobalt, but some lead(2) (analysis, Layard, 106)

Egyptian: "a silicate of soda , lime , and copper" (Dillon, 27)

Alexandria, Pozzuoli (Vitruvius, quoted Hoefer 171), sand, carbonate of soda, and copper filings

Modern: blue transparent, 6 cwt "batch", 2 lbs oxide of cobalt: azure blue, 6 cwt "batch", 6 lbs oxide of copper (Pellatt, 34)

G R E E N . Persian, time of Darius, Copper with lead (Franchet, 103)

Theophrastus (c. 300, B.C.) copper (Roscoe, ii, 590)

Syriac, emerald, Ceruse 1, Glass 2, melt, cool, add asses' urine (symbolic for a salt of copper) (Berthelot, Hist. ii, 29): also 300 drachms of glass 5 drachms of "burnt copper" (ib. 95)

Cupric oxide was employed by the ancients for this purpose (Roscoe, ii 590)

Modern: cupric oxide (ib. 423): copper gives a bright green in the presence of lead (Franchet 99). For "emerald green," 6 cwt "batch", 12 lbs copper scale, 12 lbs iron ore (Pellatt, 34)

R E D .... Assyrian: suboxide of copper (Layard, 166)

Egyptian opaque: large quantities of basic oxide of copper, even to 15 or 20% (Dillon, 37)

Syriac: glass 300, alkali 5 (Berthelot, Hist. ii 95)

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(1) Analyses of Assyrian glazes are not given in Andrae (see his p. 8).
(2) Cobalt appears to have been known to the ancients (Berthelot, Coll. 245).

R E D (cont.). Compositiones ad tingenda(viii th Cent), cinnabar(?)(litharge?), burnt copper(ib. i, 33) (Dillon, 120)

Modern: ruby red, 6 cwt"batch", 4 oz. oxide of gold(Pellatt, 34)

The Purple of Cassius(see Sub-sect. 14,b) from a rich coloured precipitate of gold thrown down by tin, is the base of marone, ruby, carmine, purple, rose (Binns, 94)

Ferric oxide (Roscoe, ii, 590)

Y E L L O W. Assyrian: lead antimoniate(Layard, 166)

(The fine yellow glazes of the Chinese are due to ochry earth with an oxide of antimony(Dillon, 29)

Modern: sometimes lead antimonate in combination with oxide of tin(Binns, 89)

A receipt is given in Blancourt(159) for Topaz: 2 oz. natural crystal; 2 oz native cinnabar; 2 oz. aes ustum: 4 times as much calcined tin.

W H I T E ... Assyrian: tin oxide(Layard 166)

Compositiones ad tingenda(viii th Cent.), tin oxide produces a milky white(Berthelot, Hist, i, 11)

Modern: Tin oxide forms opaque glazes and enamels (Binns, 70)

Soft white opaque enamel: 6 cwt "batch", 24 lbs arsenic, 6 lbs antimony(Pellatt, 34)

It should be added here, that if oxide of tin is used for white enamels the least particle of iron is fatal. The tin itself sometimes assumes a pink cast (Binns, 91). Oxide of zinc also gives white, but less opaque. It is indispensable for toning various colours, and is used for the production of yellows, greens, blues, and browns (ib.70). Tin, according to Franchet (Cer. Prim. 103), was often used in Persia in the time of Darius to render glass opaque.

B R O W N (D A R K)... Manganese (Binns, 86).

"" "" (and F A W N)... Iron (ib., 84).

P U R P L E ... in Egyptian glaze, 1st Dynasty, oxide of manganese (Dillon, 28).

Modern, 6 cwt "batch", 20 lbs oxide of manganese (Pellatt, 34).

B L A C K ...Syr.-Arab. Treatise(IXth Cent. or later, Berthelot, Hist., ii, 194) 1 lb. borax: ½ lb pulverulent sand: a handful of iron scories. See also p.55.

S e c t i o n 7. Assyrian Glass.

It would be out of place here to go into the details of the ancient stories of the discovery of glass.

But it may here be briefly stated that in Babylonia beads of glazed frit have been found to be "common" in a cemetery of the Third Dynasty of Ur (c. 2450 B. C.) near Ur (Woolley, Antiquaries Journal, 1925, 19). Andrae has recently published a beautiful volume, *C o l o u r e d C e r a m i c s f r o m A s h u r*, in which some of the glazes from Ashur are as old as the XIIIth Cent. B.C. Finally the dated glass vessel of Sargon's reign (end of VIII th Cent.) should be mentioned as the earliest dated Assyrian glass.

With these details we can now examine the materials used by the Assyrians in their glazes and glass.

Section 8. The Alkali in Assyrian Glass.

First it should be premised that the *a l k a l i* used by the Assyrians has long been identified in the word *u h̲ u l u*, the equivalent of the Syriac *a h̲ l a* "lye" (HAB 43). The kind particularized as *u h̲ u l u q a r n a n u* lit. "horned", I identified with Salicornia, the name of two species of the alkaline *C h e n o p o d i a c e a e* abounding in soda (AH 116). Dillon (12) says that the maritime people of the South extracted their soda for the most part from the ashes of certain plants growing in salt marshes near the sea (Chenopodiaceae, Goosefoot, Salsola, Chenopodium, Salicornia, etc.). The roughly lixiviated ashes from Spain were called *B a r i l l a*; those from the Levant, *R o q u e t t a*, which came from Aden in large crude cakes from the *S u a e d a f r u t i c o s a*, while that from

Baghdad was taken from the Salsola kali. The Arabs still obtain lye from the ashes of these alkaline plants(Chesney Exp.,i,574: AH 116). The method of obtaining lye in India is by burning the sun-dried plants in pits, the fused alkali collecting at the bottom of the pits and thus becoming "barilla" ready for export(Kanhoba Ranchoddas,Indian Medical Plants,1069). Blancourt(34) says that all sorts of ashes which come from the East for making glass are called P o l v e r i n e , because they are truly pulverized,and that R o c h e t t a consists of hard lumps,better than ashes. So celebrated were the soda ash manufactures of the Levant in the Middle Ages, that they were imported into Europe, Bacon saying that the ashes of kali growing in the desert between Alexandria and Rosetta were compressed into masses like stones and sold to the Venetians for making glass(Nat. Hist.,viii,770, quoted by Fowler,A r c h a e o l o g i a , xlvi,95-note).

S e c t i o n 9. T h e S a n d i n A s s y r i a n G l a s s .

The Alkali having been discussed,the next problem is to identify the most important component ,S a n d . It will be obvious,almost after a casual glance at these glass-texts, that the essential silica-component must be concealed in the word which plays so important a part in these texts in the forms

IM.MA.NA (IM.MA.AN.NA in myAM, 47,3,32)

a m n a (k)k u (immanakku,as equivalent to

IM.MA.NA ,Geller,AOTU,i,310,25,and 357) .

The forms ending in -k u or -k k u are ,Messrs Smith and Gadd point out to me ,the usual Assyrian equivalent.

It is not , however, the usual word for sand in Assyrian. It must represent the special sand used for glass - making, probably a pure quartz sand. It will be remembered that for many ages(so Pliny,NH xxxvi,65)the only spot which afforded the sand for making glass was the traditional place where glass was first accidentally made,as the classical story relates. This was the river Belus,the modern Na'man,which flows out into the Mediterranean near Acre. Theophrastus, long before Pliny(3rd Cent.B.C.) mentions the sand of this river for the making of glass (Dillon,77), and this sand was long after transported to other countries for this purpose(Strabo,Geog.xvi,ii,25: Josephus,De Bell. Jud. ,ii,9:see Fowler,Archaeologia,xlvi,83).It would be conceivable that even the Sumerians might have purchased it for their glazes from Syrian caravans, and ,if this were so, there is just a possibility that the name of the river Na'man bears an echo ,indirectly, of the Sumerian IM.MA.NA,which ,as we have already mentioned,occurs in a Sumerian religious text

UR.SAG (tak)IM.MA.NA BA.GUB

"The hero came to the sand"

It would not be the first time that Na'man has had a philological connection with a foreign word, for is not the Greek word a n e m o n e supposed to be related? To go a step further into the domain of comparative philo-

logy (here again with very great wariness and hesitation) we might note the similarity in sound between the Assyrian i m m a n a k k u , a m n a k u , and the Greek a m m o - k o n i a , a calcareous sand.

S e c t i o n 10. T h e L i m e i n A s s y r i a n G l a s s.

Having now discussed the two main components of Assy - rian glass, alkali and sand, it remains to seek the third, either l i m e or l e a d .

The presence of L i m e is far more probable in Assyrian glass than L e a d . Of the two(although this is not a consideration of any great weight) lead must have been far more expensive and difficult to obtain than lime, which was probably in daily demand at Nineveh for house-building. Actually, lead appears to have been very uncommon in ancient glass generally:" Notwithstanding the use of oxide of lead by the ancients in their coloured glasses and artificial gems and enamels, the lightness of the fragments of their white cut glass indicates the absence of lead from the constituents of much of the ancient artificial crystal" (Pellatt,79). Dillon(26,note)also says that Prof. Buck-man in 1851 noted the absence of lead in his analysis of ancient glass.

Furthermore, it will be noticed in the following analysis of specimens of Greek and Roman glass by Klap-roth (quoted by Pellatt,76), that this use of oxide of lead in fairly large proportion does not appear to be an essential in the composition of the glass, since it

does not occur in the blue specimen, and yet is found in the red and the green.

	Red Glass	Blue Glass	Green Glass
SAND	162	163	130
OXIDE OF COPPER	15	1	20
OXIDE OF LEAD	28	-	15
OXIDE OF IRON	5	19	7
ALUMINA	2	3	11
KALKERDE,LIME	3	05	13

Taking all these points into consideration, and noting that the Assyrian word for lead (a n a k u) does not occur in the glass-texts proper (although it does in Section 25 QQ), we are entitled to expect that the third component is a form of lime and not lead.

This third component is obviously represented by the word n a m r u t u . Indeed, the amplification of this as we find it sometimes given in these texts ---"n a m - r u t u of the sea"--- must surely eliminate any possibility of lead. Meissner's suggestion "perlmutter" does not seem to me to meet the case as a translation for simple n a m r u t u (Section 25,T) especially as l u l ū (which I follow Virolleaud in translating probably "oyster-shell") occurs in the same receipt.

N a m r u t u "the bright thing" is suspiciously like the Arabic n ū r a (n a w r a) " lime". In Section 36 it will be seen that the mineral (tak)UD might be the Sumerian equivalent for n a m r u t u ,on the grounds that UD == n a m ā r u . When we consider also that (tak)UD.AŠ re-

presents the Assyrian way of saying "h a r d UD- mineral" (if I am right in Section 36,A),and that IM.UD == g a ṣ ṣ u " gesso,plaster",we shall probably not be far wrong in seeing in n a m r u t u some whitish mineral ,softer than (tak)UD.AŠ (limestone of some kind,Section 36),or in other words,l i m e or c h a l k . The latter appears to be the more probable ; it is the natural mineral, and also according to Franchet(94), c h a l k was the usual form in which the element of lime was introduced into ancient glass.

Section 11. The Details of Glass-Manufacture.

The following details in the making of glass,as given in Roscoe(ii,575,ff.) should be compared with those in the Assyrian translations:

"The materials ...are first fritted together in melting pots. ....The materials required for the formation of the glass are,if possible,always mixed with broken glass of the same kind,technically termed 'cullett',for the purpose of increasing the fusibility of the mass. .. The furnace is kept very hot until the first portion of the material added has been fused, and then a second portion is introduced ....Formerly,when impure materials were more generally employed... large quantities of..scum were formed [a layer of salts termed glass-gall or sandiver,which had escaped vitrification] . Now,however, its formation is avoided by the use of purer materials,and by the addition of charcoal

if salt-cake is employed, care being taken not to add an excess, as otherwise the glass assumes a yellow colour. The last process .. is termed the ' f i n i n g'... the glass must be brought into as liquid a state as possible, and consequently... the temperature is raised to the highest point.... All articles made of glass require to be very slowly and homogeneously cooled... all glass therefore requires to go through the annealing process. This consists in submitting the glass articles to a very slow cooling ."

Dillon (24) thus describes the making of Egyptian glass:

"First, with regard to the frits, the essential preliminary stage in the manufacture of glass;... some such half-fused material must have been long in use by the Egyptians in the preparation of their blue glazes. Complete freedom from iron was attained in this case (just as in after days by the Venetians) by the employment of crushed pebbles of white quartz as the source of the silica.... The fritting - pans , to judge from some large fragments of frit that turned up, were shallow bowls some ten inches across ... The shape and size of the crucibles in which the frit was subsequently melted may be inferred from some masses of glass found in the rubbish. These masses had been allowed to cool in the melting -pot , and the presence of frothy and worthless matter at the top was a proof that the glass was not merely remelted in them, but prepared on the spot from the above-mentioned frit. The glass was left to solidify in the crucible, and when cold , the crucible, as well as the scum on the top, was chipped away, leaving a clear lump of good glass."

Section 12. The Assyrian Methods of Making Glass.

Having now settled the three chief components in Assyrian glass-making

- IM.MA.NA, IM.MA.AN.NA, amnaku, immanakku == "Sand"
- Uhulu, uhulu qarnanu, amplified by digmenu "ash" == "Alkali"
- Namrutu =="Chalk"(or, Carbonate of lime)

we can now discuss the actual methods in vogue in Assyria in the Seventh Century B.C., and the components which are added to obtain the different colour-effects.

We may premise that, in all these texts dealing with glazes or glass, each receipt must surely contain some clear indication that the glass-base, frit, strass, or whatever it be, is included. It must either be referred to definitely by name, or else its full components must be detailed, or, as a third method, the previous receipt containing the glass must be referred to (as in Pl. 4, K.203, vi, 4). I mention this because it is a most important clue to the identification of several ingredients,, and yet I do not think it an unfair postulate, for we may surely regard these texts as having been made with great exactitude for the benefit of craftsmen of every capacity and degree. If we apply this postulate to the glass-receipts, we shall find that it will divide them into two classes marked respectively by

(1) the presence of such names for different kinds of glass as can be definitely identified from

the components which are given in detail in the special receipts devoted to their manufacture

(2)The absence of such names of easily - identified glass among the components.

In (2) we are entitled to maintain that the editor of this treatise, complying with the ordinary demands of uniformity, will either have included in his receipt some name for a particular kind of glass ,so far not recognised in our examination, or else he will have represented it by its components set out in full, or by a definite reference to a preceding part of the treatise. In a treatise such as this is we shall be right in expecting that all the details will have been carefully thought out, since the editor doubtless had to provide directions not only for the skilled craftsman but also the novice. I think ,therefore, we have no right to essay the identification of any of the minor components in a receipt until we are sure that we have recognised the reference to the glass base.

For example,there will be no difficulty in seeing that s i r ṣ u and d u š ū are the names of some forms of glass,for we are fortunate enough to know the components from Sections 25,T and CC. But in several other receipts we have no such certain guide to the word which indicates the glass base, and yet it is a first essential that it should be identified.

S e c t i o n 13. T h e S i m p l e s t A s s y r i a n G l a z e .

We can begin as the Assyrian does , with the simplest

form of glaze. The components are (Sect. 25,B)

30 parts S a n d

45 parts A l k a l i

5 parts * S t y r a x-g u m (1)

The first two ingredients give the " simple alkaline glaze " mentioned by Dillon(see Sect.4,p.6),transparent,but difficult to work,and very fragile,but doubtless adequate as a simple glaze on burnt brick. I am unable as yet to offer a satisfactory explanation of the gum,but I suggest that its inclusion isparalleled by the charcoal(another organic substance) indicated as a component in glass-making (Roscoe.ii,584) to prevent too great a proportion of sandiver or scum. Compare also the old receipt in Berthelot,Hist. ii,29, for softening crystal,where the crystal is to be placed in alum with vinegar for twenty days,taken out, put in the juice(c h y l o s) of anagallis,euphorbia,etc. and after the addition of mercury,it is to be mixed and fired. In Dillon(121) an old receipt for softening glass gives as the necessary ingredients " fat worms and vinegar ",also organic substances.

It is not until the next section that we are introduced to the copper which will give this glaze its excellent and famous blue colour. Moreover, according to Franchet(94) the glazed Egyptian ceramics of theXVIIIth Dynasty have like this a thin uncoloured alkaline glaze.

In one other receipt in these texts * Styrax-gum (six shekels,amounting to about 1/42 of the whole) is included(Sect.25,H).

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(1) For this identification , see my AH 135.

This first frit corresponds fairly closely to that given by Blancourt(44)

200 lbs of T a r s o ,or of fine sand

130 lbs of Alkali

It will be observed that in the Assyrian receipts the proportion of alkali is far greater than that prescribed in modern glass-making,probably because of the greater impurity of the Assyrian product.

With this discussion of the materials of the first frit comes the problem,What was it called? As will be seen, the heading of the receipt in the Assyrian text indicates that the making of u k n ū i b b u is given in detail. Are we to supply these words in the break which represents the lost name of the first frit in l. 20,or is it to be something else?

U k n ū has long been identified with lapis lazuli(see MA s. v.) and was compared by Jensen(see Brockelmann,Lex. s . v.) with the Syriac q u n a ' a ,cyaneus. But not only is u k n ū the actual stone,but it is also the blue colour as has been accepted for some time(e.g.,Koldewey,Exc.av.at Babyl.,45,ff) i.e. the pigment ultramarine obtained by grinding the stone(see Sect. 32). Later still its meaning of blue frit was recognized by Sidney Smith(JRAS ,1925, 39). It was specially used for the beards of statues(HWB 58) š a z i q n i u k n ī z a q n u (IV R,9,19-20) " mit niederhangendem Lasurfarbenem Barte".

In these glass-texts it will be noticed that u k n ū in various shades is given as the chief compound in the groups which form the actual Assyrian names of the different glazes. Obviously, first of all, it will stand for the

famous blue glaze for which the Babylonian artists were so well known, and doubtless the translucent slabs of a fine turquoise tint (3" square by ⅝" thick) in the Louvre[1] were known by this description. But besides the ultramarine colour, uknū is used in compound names such as "red-purple" (Br. 11730), "sapphire" (Br. 11707), and others which are lost (see Section 25, ll.73,74,75; l.7[illegible] gives u k-n ü s ā[m u], i.e. "red-purple".

(Tak)u k n ū i b b u is literally "clear lapis". The adjective i b b u is also applied to "crystal" (d u š ū) of which three kinds are recognized in these texts:-

(1) D u š ū , simply: from the fact that the components of this as given in Sect. 25, BB, l.6,[2] indicate a glass made with oxide of tin(?) we may infer that, ordinarily , simple d u š ū is an opaque glass.

(2) D u š ū i b b u "clear crystal", which, by its adjective again accentuates the difference in translucency between itself and ordinary d u š ū. Moreover this d u š ū i b b u is turned to opaque white by the addition of oxide of tin(?) (Sect. 25, W, l. 20).

(3) D u š ū a r q u , "green crystal" (Sect. 25, E, l. 4).

We may, I think, therefore accept "clear, translucent" as the meaning of i b b u.

It would, therefore, not appear to be a satisfactory solution of the problem if we supply u k n ū i b b u

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(1) Dillon, 40.

(2) Duplicate of T, l. 18.

in the gap in l. 20. We have to find a word for a simple frit, and since one of the most essential characteristics of u k n ū is its blue colour, we can hardly ignore this very definite characteristic. The probability is that some word other than u k n ū is lost from the gap, and that the u k n ū i b b u of l. 13 is a general heading to the next few sections. We must cast about for another word with which we may fill the gap.

Consider, therefore, the word a h̲ u s s a , a h̲ u s a, a h̲ u z z u , which occurs three times.

Its first appearance, as nearly as we can decide, is in the section following the making of copper oxide (copper scale) very early in these texts. Here it is the only component left in a mutilated receipt for making z u k ū.

Z u k ū must be a glass or glaze. What is left of the instructions for making it is very similar to other glass-receipts.(1) It is to be settled evenly between the fire-apertures of the furnace (cf. Sect. 25,F) : it is to be taken out after one day: it is again to be put down in the furnace which has been allowed to grow cool. Elsewhere (Sect. 25,DD,l.16) it will be seen to form the glass base in the receipt for the purple of Cassius (see Sect. 14,b): it is probably the glass base in Sect. 25,U,15 and 22: in Sect. 25,X,22, z u k ū forms the main glass base, the other components being only in small quantity, but in this receipt I am still doubtful about the actual product. In Sect. 25,J,72, it is used compounded with t e r s i t u,

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(1). Sect. 25,D,34.

(the glaze containing copper oxide) where it is in the proportion of 8 to 3. Everything points to its being a glass and probably a plain one.

But a h̲ u s s a is, as we have seen, one of the components of z u k ū, and p r i m a f a c i e, it is not unreasonable to start by suggesting that it is a simple frit on which z u k ū is based, and if it is not the same as the frit desdescribed in Sect. ?, BB (sand, alkali, and *styrax-gum) at all events it will be one very much like it. For instance, it appears to be the only glass base in making what I believe to be Aventurine (Sect. 40). It was composed of an unknown quantity of š a d d ā (probably the same as š a d ā, ferric oxide (Sect. 22), 10 m a n a of a h̲ u s s a, .. m a n a of unwashed "salt",(1) ½ mana of some form of arsenic. Since some form of glass must be indicated in each receipt in some way, it will be seen that a h̲ u s s a is the only possible representative. Finally, in the third instance in which a h̲ u - s s a occurs, (Sect. 25, N), 10 m a n a of a h u(s)s, a, and 10 m a n a of some lost substance are the components to make s i p a r r i a r h̲ u "a r h̲, u -bronze", for which I suggest bronze enamel, or inlay, such as is found in some of the bronze bulls in the British Museum.

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(1) Š a d ā may perhaps be the same as š a d a n u, or connected therewith (See Sect. 41, ff.). "Salt", m i l 'u, probably saltpetre.

(Sect. 24) Z a k a t i n u

(the glass containing copper oxide) where it is in the propor-tion of 9 to 2. Everything points to its being a glass and probably a plain one.

But a ḫ u s s a, is as we have seen, one of the components of z u k û, and p a r r a, f a s i, it is not unreasonable to start by suggesting that it is a simple frit on which z u k û is based, and if it is not the same as the frit described in Sect.7, as 'abnû', alkali, and 'mêtu-ešu') at all events it will be one very much like it. For instance, it appears to be the only glass base in making what I believe to be aventurine (Sect.34). It was composed of an unknown quantity of z a r d u (probably the same as z u r d, [illegible] oxide (Sect.33), 10 s i ḫ i of a ḫ u s s a, ½ m a n a of unwashed salt, 1 mana of some form of arsenic. Since some form of glass must be indicated in such receipt in some way, it will be seen that a ḫ u s s a is the only possible repre-sentative. Finally, in the third instance in which a ḫ u - s s a occurs, Sect. 28,B1,10 m a n a of z u ḫ i ḫ a, and m a n a of some lost substance are the components to make s i p p a r r i - s a r b u "a r b u-bronze", for which I suggest bronze enamel or inlay, such as is found in some of the bronze bulls in the British Museum.

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(1) Z a ḫ u may perhaps be the same as z a ḫ a n u, or connected therewith(?). Sect.43,ff.8. "salt", m i l ḫ, probably metalworker.

The root of a ḫ u z z u appears to be the same a that of the well-known Assyrian u ḫ ḫ u z u used to describe overlaid bowls (Del. HWB,43).

We shall, therefore, probably be right in seeing in a ḫ u s s a a simple glaze which helps to make glass and enamel, and we may perhaps see in it the correct restoration for Sect . 25,B,1.20, and if so, its components will be sand, alkali, and storax-gum.

S e c t i o n 14 The Assyrian Glass, S i r ṣ u and D u š u

The next considerations are the different forms of glass. Simple glass appears to have been called s i r ṣ u (less probably b u ṣ u, which is a possible reading) (1):

S i r ṣ u is composed of

60 parts Sand

180 parts Alkali of salicornia

5 parts m i l 'u - salt(petre)

2 parts chalk

-Sect. 25,CC

A special form of s i r ṣ u is defined by the adjective n a t k u , which I take to mean literally "melting", i.e., glass for fusing or melting with others;

? parts Sand(?)

180 parts alkali of salicornia

? parts m i l ' u- salt(petre)

3 parts chalk

-Sect. 25,P

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(1) I hardly venture to suggest that there might be some philological connection between s i r ṣ u and the Syr. š ī š ' t h a "glass" .Yet the letter R has a peculiar way in Semitic of disappearing in the neighbourhood of a sibilant, i. e., in the Syr. k u r s y a "chair", Ass. k u s s u : cf . the Hebrew ṣ'phardēa" and the Arabic ضفدع .

In this second text the simple glass s i r ṣ u is elaborated by the attribute which I take to be from n a - t a k u , the Heb. נתך "melt , fuse", and , as I suggested above, may mean a glass used in making compounds. Actually this section in which it occurs is followed immediately by a receipt for making ṣ i p r u " sapphire " (Sect. 36, A), and s i r ṣ u is one of the ingredients. In this receipt (P) there are instructions which probably indicate that the "metal" is to be poured into water, and perhaps we may find a parallel to this in Blancourt's instructions for making a very white clear crystal (57). He recommends taking some crystal frit from his vi th chapter, and adding little by little some manganese. Then the pot is to be taken out when the metal is melted, and is to be put into a great earthen vessel full of cold water: then put again into a clean pot , melted again, and cast into the water again, this being repeated until the crystal is separated from "all this sort of salt", and finally it is to be left in the pot in the oven for five or six days to boil.

We can leave s i r ṣ u as identified as a simple glass, but before discussing d u š ū it will be well to settle the exact meaning of m i l ' u, long compared (and that rightly) to the Heb. מלח "salt".

(Tak) m i l'u, (Tak) m i l' u p i ṣ ū , (== the white), (Tak) m i l 'u ṣ a l m u (== the black) occur in the same prescription (AM 97,4,9): (Tak) m i l' u IRA (male) (Sect. 25, P, l. 93; X, 94); (Tak) m i l'u ṣ a l m u UŠ u SAL "black m i l'u male and female" (Lutz. AJSL, XXXvi, 82, 186). The simple m i l'u is described in these glass-texts as m e - s a t "washed" (Sect. 25, S, l. 10) and l a m e s i t a "unwashed" (AA, l. 4).

(Section 24.)

In this second text the simple glass [illegible] is [illegible] by the attribute, [illegible] seems to be from [illegible] the Heb. [illegible] "melt", "fuse", and, as I suggested above, may be a glass used in making compounds. Actually this section in which it occurs is followed immediately by a receipt for making [illegible] "sapphire" (Sect. 25, [illegible]) and [illegible] is one of the ingredients. In this receipt [illegible] there are instructions which probably indicate that the "metal" is to be poured into water, and perhaps we may find a parallel to this in Blancourt's instructions for making a very white clear crystal [illegible]. He recommends taking some crystal frit [illegible], and adding little by little more manganese. Then the pot is to be taken out when the metal is melted, and is to be put into a great earthen vessel full of cold water, then put again into a clean pot, melted again, and cast into the water again; this being repeated until the crystal is separated from all this sort of salt, and finally it is to be left in the pot in the oven for five or six days to settle.

Let us leave [illegible] as identified as a simple glass, but before dismissing [illegible] it will be well to notice the exact meaning of [illegible], [illegible] the Heb. [illegible] "melt".

[illegible] the metal, [illegible] occur in the same [illegible] "thick [illegible]" [illegible] The simple [illegible] is described in these [illegible] "[illegible]" and [illegible] "[illegible] method" [illegible].

Now the ordinary word for "salt" in Assyrian is ṭ a b t u (in which meat is preserved, cf. my "Reports of the Magicians", ii, xci). Mil'u, therefore, while correctly compared philologically to מֶלַח, would appear to be a kind of salt distinct from ṭ a b t u : and we may provisionally accept it as "saltpetre", a chemical which agrees very well with what is wanted. As we saw in Sect. 4, saltpetre is one of the decolourising agents for lime glass.[1] At the same time this identification cannot be considered certain.[1]

In Assyrian medicine we find a black and a white m i l 'u prescribed:-

A. Mil'u, simply (about 12 tt.), ext. (97,4,9): temples (97,4,26) (dup., CT. xxxiii,44,3-5): eyes (85,2,8,?): for a blow(?) (77,1, 17): by penis, with arsenic (62,1,ii,7): uncertain, 4,4,7: 34,3,10; 62,1,iv,5; 66,7,1).

B. Mil'u pisû, "white mil'u", (about 6 tt.), ext. (97,4,9), temples (ib. 26); rub (89,2,6); eyes (16,3,5). Int., constipation (?), (40,5,19).

C. Mil'u ṣalmu, "black mil'u", (about 13 tt.) ext, (94,2,ii,19.: 97,4,9;) scorpion sting (91,1,r.7); eyes (15,6,12, alone; 16,3,5: 19,6,12 and 14); ears (34,1,18). Int., drink (39,6,9; 59,1,26; 60,1 10). Uncertain use, 89,1,18.

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(1) I have translated m i l'u herein as "salt(petre)". Ainsworth (A,118) says that there is an abundant efflorescence of nitre with carbonate of soda and sulphate of soda in Mesopotamia, and that the alluvial soil is in parts impregnated with nitre. According to EB, xxiv, 93, saltpetre is found on the surface in Persia and Arabia. Pliny (NH, xxxi, 46) says that a substance called "halmyrax" was found in Media. It has, however, been suggested to me that Ainsworth possibly mistook the natron carbonate of soda for nitre.

The difficulty of identifying any ancient salt is well known. As Hoefer (145) says, the epithets red, yellow, grey, blue, applied to the alkaline salts shew their impurity. Properly, carbonate of soda appears to have been called n a t r o n (ib. 58); n i t r o n was sometimes carbonate of potash, more rarely nitre, (azotate of potash), and finally the soda of commerce (ib. 146). Mil'u must surely be distinct from n i t i r u (BoFr. 60).

For the colours, cf. IB. 381;

Borax, which might be a possible identification (esp. from the medical examples) occurs near Urmia (G., 71), and is a chemical of great use in making glaze (Binns, 69).

Accepting m i l ' u as probably saltpetre, we can go on to d u š ū .

As we saw above , there appear to be three kinds (p. 23): simple," clear" (like u k n ū), and "green".

Simple d u š ū is made of

60 parts Sand
180parts alkali of salicornia
6 parts m i l 'u-salt(petre)
1/2 part Chalk
3 parts Oxide of tin(?)
3/10 part l u l ū (probably oyster or pearl)
-Sect. 25.T

Here again we have the usual components of glass to make d u š ū , which will be seen in Sect.31 to be one of the six chief materials from which seal-cylinders were made. The other five materials are:- black (haematite), Sect.41: blue(lapis lazuli), Sect.32: white(aragonite, etc.), Sect.36: green(serpentine), Sect.35: red(jasper), Sect.33. The remaining material, which we see here clearly was a name for a form of glass, must obviously have been originally the word for crystal, a material from which seal-cylinders were made(Sect.31).(1)

The difference between d u š ū -glass and s i r ṣ u -glass appears to be that the former was made with one part more salt(petre), 1½ parts less of chalk, and additionally, 3 parts of t u s k ū, which I suggest may be oxide of tin, and 3/10 part of pearl or oyster -shell.(2)

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(1)Boson must ,I think, be held to be wrong in his identification "c r i s o l i t o "(BoIt407). I doubt if Scheil's suggestion"une agate chalcédoine"(RA 1918,120) is better.

(2) Virolleaud's suggestion, the Arabic وذر (Bab.iii,222)

Our first problem in settling the minor components of d u š ū is the difficult word t u s k ū, and we had better discuss it in a sub-section:

S u b s e c t i o n 14,A. T u s k ū , Oxide of Tin(?)

As far as I know , the word does not occur outside these texts. A word t u š k a .. ,however, does occur in a receipt for some eye - trouble, to be used with arsenic(AM 18,4,6) which may possibly be the same.(1)

If we examine the other instances of tuskū in these glass-texts, we find it used in two cases as the necessary ingredient to make d u š ū i b b u "clear crystal-glass opaque red or whitish, according to the quantity used. These are

(a) 360 parts clear crystal-glass

1 part t u s k ū

"the composition(m a š k a n t i) for (tak)p a-r u t e a š š a k i "

-Sect.25,W.

Now p a r u t u, as is well known , is either marble or alabaster, and a š š a k i , hitherto unknown, must be referred(perhaps like the disease a š a k k u , MA 114,) to the Heb. חָשַׁךְ "be dark, have a dark colour, grow dim (of the eyes)", i . e., here meaning "opaque".(2) What can be identified with t u s k ū which can be shown to turn a clear glass into an opaque whitish substance?

---

(1)Possibly t u š k a .. has been confused with t u s k ū In SM(ii,86,ff.)"cadmia" is frequently used for eyes, and once with arsenic in a long prescription(ib.94). I hope further on to shew that in t u s k u we may perhaps have the original of the word t u t t y, t u t i a , t u c i a ==cadmia.

(2)This addition of the word "opaque" to parutu rather indicates that p a r u t u is normally translucent, i.e. "alabaster".

As was pointed out in Sect. 6, o x i d e o f t i n is one of the agents which produce an opaque white, and this chemical is actually found in the Assyrian glaze. But oxide of zinc also forms white, but less opaque, and arsenic is used with antimony(see Sect. 6), and we might perhaps mention bone-ash (Andrae, 9), but this latter == the bone -phosphate to make milk-glass, and it will probably not coincide in the Assyrian receipt for colouring glass red with t u s k ū.

The most probable solution at first sight seems to be oxide of tin. It was used in Assyria for a yellow glaze as far back as the XIIIth century(see Sect. 6): it was to be obtained from the Qara Dagh, less than three hundred miles crowfly from Nineveh(see Sect. 22). Tin appears in the Assyrian alloys of copper certainly in the VIIIth cent. (Berthelot, Coll., 220).

It is a solution which at least suggests a possible explanation for the next receipt(ib. 1. 18, actually the preceding one in the text), where directions are given for making "opaque sandu-stone" ("red-stone", jasper, or similar):

360 parts clear crystal-glass

one and a half parts t u s k ū

In other words, one half part more t u s k ū added to the ingredients for "opaque alabaster" will produce some kind of red.

Now, according to Binns(see Sect. 6) oxide of tin has a way of tingeing enamel pink. If this colour coincides(at least, in this instance) sufficiently nearly to the tint demanded by the words "opaque s a n d u - stone", there is the greatest probability that we are correct in our identification of t u s k ū with oxide of tin. Certainly I have been unable to find anything else which

appears to fit so well.

With this theory, that t u s k ū == oxide of tin, we can proceed to a third example of its use in glass, in a composition which appears to be a very close forerunner of the Purple of Cassius. This receipt appears to be for producing artificial pink coral, rather than rubies, and runs as follows:

S e c t i o n 14,B. T h e P u r p l e o f C a s s i u s

The components for making what I think must be meant for artificial pink or red coral are

7200 parts z u k ū - glass (p. 24)
332 parts t u s k ū (oxide of tin?, Sect. 14a)
20 parts a b a r u (antimony)
-- parts m i l ḫu - salt(petre, p. 27)
1 part gold(1)

~~Now the~~ introduction of this component "gold" at once leads us to suspect that we have here the prototype of the Purple of Cassius. The only one of its components which we have not yet discussed is a b a r u , a well-known problem, for which lead, tin, magnesite, and antimony have been suggested. I propose to discuss this at the end of this section, and meanwhile we can consider the question whether this really is a receipt for the Purple of Cassius.

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(1) In order that I may not mislead those who are not cuneiform scholars, I should like to draw their attention to the "break" in the latter half of the sign used for gold in this receipt. The first half of the sign only remains, but this is enough for us to say with certainty that it is either "gold" , or, the only other possibility, "silver", and the context will allow us to ignore this latter possibility.

It is proper here, I think, to quote Roscoe (ii, 388) on this subject:

"The older chemists were acquainted with the fact that glass could be coloured a ruby -- red tint by means of various gold compounds... General attention was drawn to this subject in the 17th century, after the discovery of the P u r p l e o f C a s s i u s, obtained as a dark-red powder by mixing the chlorides of gold and tin".

On p. 508 he says:-

"This body (Purple of Cassius), which is used in the preparation of ruby-glass, was discovered by Andreas Cassius, who, however, did not publish anything on the subject, though his son of the same name published a pamphlet in 1685.... In the previous year, however, a Hessian mining official Orschal published a paper... He declared that he had learned the process from Cassius and that it consisted in precipitating gold with tin... The process by which the finest purple is obtained is, according to Fuchs, to add stannous chloride to a solution of ferric chloride until the yellow colour is changed to a pale green, and then to precipitate the gold solution with this mixture. The precipitate contains tin oxide in varying quantities, and some chemists have supposed that the compound is a gold stannate, but this view is contradicted by the fact that when thpurple of Cassius is dried and then triturated, the powder assumes a metallic lustre and on heating does not evolve oxygen, On the other hand it is found that the freshly precipitated and moist pigment is soluble in ammonia forming a purple-coloured liquid which deposits gold when it is exposed to light or is heated: the excess of ammonia can also be removed by

dialysis leaving a colloidal solution of gold and stannic oxide... Moissan has obtained it (a similar colour) by the distillation in air of an alloy of gold and tin , when the tin burns to tin oxide and purple of Cassius is deposited in the cooler parts of the tube. This chemist has also obtained similar purple substances by distilling gold with alumina ,magnesia, zirconia, silica, lime, or other oxides, and concludes that purple of Cassius is a lake of tin oxide coloured by very finely divided gold"

Again, returning to p. 589:

"On the addition of purple of Cassius or of gold chloride to a melt of glass, the latter remains perfectly colourless when quickly cooled: but when reheated to the point at which it becomes soft, the whole mass attains a ruby-red colour. By the addition of tin or silver compounds, a variety of tints between a rose-red colour and red-purple colour can be obtained... The amount of gold contained in ruby glass isvery small, amounting to from 0.05 to 0.06 %".

This last proportion is given in Pellatt(39) as 1/20,000 of gold giving rose-colour. If my estimate of the k i s al is correct (Addenda) ,as sixty to the shekel, the Assyrian proportion works out at about 1 in 7250 or .014.%

H e re , then, presumably we have in our Assyrian text a receipt such as will give a ruby colour to glass, whereby rubies may be imitated. But as far as we know, the Assyrians did not know the ruby, nor did the Egyptians (Maspero, Eg. Arch. , 240). We must therefore seek some other reddish "stone" regarded as valuable , and similar in appearance to the ruby.

Now the alternative suggestionfor the Ruby in the

O.T. is "coral". Can we apply this here?

It will be observed that at the end of this receipt(always presuming that there is no division line where I have suggested such a possibility) the name of the god of the Sea and Tidal Swamps of the Persian Gulf, Ea, is mentioned in the line preceding that containing the remains of the name of the "stone" which is being imitated. This will be the first point which suggests the connection of the Sea with our "stone".

Next, the traces of the "stone"-name are ...ri-e. For this I suggest b a ḫ -r i - e , comparing CT.XIV,15,6 and 17,6

(tak)b a-a ḫ-r i-e == (tak)ḪAR.ḪUM.BA.ŠIR (1)

== (tak) m u - ṣ a l - t u

Now b a ḫ r ē , as I think Boson recognised(It 416),is an extraordinary form for a word in a grammatical list to assume, and the explanation probably is that it is foreign. Boson has very reasonably suggested a comparison with the Ethiopic b ā h r e i ,and the Arabic b a h r ī,lit. "of the sea",and so "pearl". While agreeing with him in his philological comparison,I suggest that this "stone of the sea" should be "coral " rather than "pearl".

(tak) ḪAR.ḪUM.BA.ŠIR must have some definite point of similarity with the plant of the same name(AH 272) which appears to be called "Yellow(green) Ring of the Field", "Wolf-bond", and to be used for tooth-ache. If the resemblance be that its fruit or berries are like coral, we may probably seek its identification in the Withania Somnifera, one of the Solanaceae, the red berries of which were given me by a Mosul priest,and were to be used in fumigation

against toothache. This plant grows in the Kurdish Hills.

(Tak) b a h r ē is , I think, not found in lists of spoil or booty for the good reason ,if it be coral, the source (the Persian Gulf, Sect. 28) had been in Babylonian hands for thousands of years, and also, it might be added , the value of coral is not very great. Pliny (NH XXXII, 11) gives its provenance as the Persian Gulf, where it was known by the name of "i a c e ". Like the Assyrians he compares it to a red berry (the cultivated cornel) . The modern Arab is as fond of it as an amulet as ,according to Pliny, the Indians were.

The fact that Coral came from the Persian Gulf would account for its borrowed Arabic name. We can compare the Assyrian (tak) a l g a m i š, which has ,I believe , no connection with the Hebrew a l g ā b i š "hail" (Hommel, Sum. Lesest., 123, n. 1), but is the Arabic جمشت "amethyst" with the Arabic article attached. I need hardly add that the the a l as the Arabic article had long been recognized in a l g ā b i š.

(Tak) m u s a l t u is curious here. It is the equivalent (also on the same tablet, CT. XIV, 15) for (tak) š a-ḿ a i t u m "blue vitriol" (Sect. 39). It may well be an entirely different word .

To sum up this receipt, which I suggest is the Purple of Cassius:-

(1). It is a receipt prescribing a colouring agent consisting of about 0.014% of gold, 4 % of oxide of tin (?), 28 % antimony and some saltpetre). Even in the against togthech. This plant grows in the Karnish hills.

(Dkk) h a n r a td. I think, not found in lists of spoil or booty for the good reason, if it be coral, the source (the Persian gulf, cf. 100,36) had been in Babylonian hands for thousands of years, and also, it might be added, the value of coral is not very great. Pliny (NH XXXII, 11) gives the provenance as the Persian gulf where it was known by the name of l a c e r, like the Assyrians he compares it to a red berry (the cultivated coral). The modern Arab is as fond of it as an amulet as, according to Pliny, the Indians were.

The fact that coral came from the Persian gulf would account for its borrowed Arabic name. We can compare the Assyrian (SpK) a l g a m i š, which has, I believe, no connection with the Hebrew a l g ā b i š "hail" (Gesenius, Gen. Lesest., 135,n.1), but is the Arabic ... "amethyst" with the Arabic article attached. I need hardly add that the the. a l of the Arabic article had long been recognised in a l g ā m i š.

(SpK) n u ḫ a l š u is curious here. It is the equivalent of the same tablet, CT, XIV, 13) for (iṣṣu) a m a l l u m "blue vitriol" (Cnm., 24). It may well be an entirely different word.

To sum up this receipt, which I suggest is the purple of Cassius,-

(1). It is a receipt prescribing a colouring agent consisting of about 0.0142 gold, 4 % of oxide of tin (?), 28 % antimony and some sal-Nature, given in the modern way of making ruby paste antimony is included. "Topaz is formed by adding to 1000 parts of strass, 40 parts of antimony-glass(a fused and imperfectly oxidised sulphide of antimony) and 1 part of purple of Cassius. Ruby is obtained from the ingredients of the topaz mixture by fusing 1 part of this with 8 parts of strass and allowing the fused mass to remain at the temperature of the furnace for thirty hours" (Roscoe,ii591,590).

(2). The comparison with b a ḫ r ē(== Arab. "of the sea"), Ea,the god of the sea, and probably certain berries, add great weight to the view that the glass is like red coral.[1]

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(1) A note on a b a r u should be added here. It was identified by Oppert with antimony or tin(see MA 9), his evidence being an inscription of Sargon wherein it was stated that the king had dedicated seven tablets,of gold, silver,copper, lead, a b a r u , lapis,and ǦIŠ.ŠIR.GAL respectively. Four of these tablets actually survive,the gold, silver,copper, and one of a substance which was suspected of being antimony. But Berthelot's analysis(of the facts, after the tablet had been re-examined(COLL.219) shewed that the substance was not antimony, but magnesite; "shining, white, opaque, compact, hard, cut,and polished...not a sliver of central metal in the thickness...(but)"carbonate of magnesia,pure and crystallised"... "certainly traces of silica". A b a r u was then identified with magnesite.

But magnesite here as elsewhere is surely the white rock (commonly chalk-like)(Rutley,165),and therefore I suggest that this is not the equivalent of a b a r u , but of ǦIŠ.ŠIR.GAL,the usual word for alabaster (Sect. 30),and that the a-b a r u tablet is not in existence.

A b a r u was long ago compared to the Syriac a b b ā r ā some metal,lead, and the Arab. el-abar,collyrium(IB.13)==antimony,which is the sense demanded for LIŠ.A. BAR , some form of a b a r u used particularly for the eyes in medical texts(PRSM,1924,15).

Meissner(Reallexicon,ed.Ebert,197) quotes Thureau-Dangin(RA 1907,142) as showing that in Sumerian times antimony was added to copper to make an alloy(cf.also the vase made from pure antimony,Berthelot, Compts rendus,1887,104,265'quoted,Roscoeii,964) The alloy mentioned is ,I presume, the same as that which is described in Harper, Letters,461,7ff.: ḫ a š i n e r i 3 Š i q l u A.BAR 3 šiqlu e r i 4 Š E k a s p i.

Tiglath Pileser took a b a r u from Malatia(V,39),which is only 30 miles S.W. of Keban Maden, where a sulphide of antimony and tin is found.

For another receipt containing a b a r u cf.Sect.25,U.

S e c t i o n 14, C. Does t u s k ū == tutia, cadmia?

In the works of the alchemists of the Middle Ages will be found the name of a metal , t u t i a , (in French, t u - c i a) which has become in modern times t u t t y. This word replaced the c a d m i a of the ancients (Berthelot, Coll., 241), which had several meanings: it was the ore by which c o p p e r c o u l d b e c o l o u r e d y e l l o w (Diosc., and Pliny, Roscoeii, 642) , and according to Berthelot(ib. 26) it was an i m p u r e o x i d e o f z i n c , m i x e d w i t h o x i d e o f c o p - p e r , n a y , e v e n w i t h o x i d e o f l e a d, a n d o x i d e o f a n t i m o n y , a r s e n i - o u s a c i d , etc. Ibn Beithar (No. 437) says that t u - t i a , like cadmia, is found in furnaces where copper is melted, and that there are three kinds. To go back further, I may quote Roscoe(ii, 642) on cadmia: "Aristotle, in the fourth century B.C., mentions the preparation of brass under the name of Mossinoecian copper, which he describes as being bright and light-coloured, not produced by the addition of tin, but by its having been melted with a peculiar earth found on the shores of the Black Sea". ....
"The same word is also used ...(by Pliny) to desinate the sublimate, consisting of impure oxide of zinc found in the brass-founders' furnaces".

Now our problem is therefore two-fold : can t u s k ū be reconciled philologically to t u t i a , and can t u t - i a be made to represent or include at any period of its

use our oxide of tin, with which we have identified t u s - k ū ?

It is a questionwhich cannot be answered definitely. T u t i a is a strange word appearing in Arabic none can tell whence, and it would be within the bounds of possibility that the word had suffered in being, let us assume, borrowed by merchants or chemists from the Assyrian t u s k ū. Moreover certain parallels can be adduced for such varies: S and K, for instance, become transposed in the Arabic form of Alexander, I s k a n d e r ; and Š with Ḫ merges into Z, as in the Assyrian ḫ a š ḫ u r u , becoming the Syriac ḥ a z ū r ā "apple". Of Š into TH it would not be necessary to quote examples. Of X from SH (Greek from Persian) under the influence of another X, we can find an example in K h s h y a r s h a , Xerxes. It is clear that S and K or Š and Ḫ may play strange tricks.

On the other hand t i n is not reckoned as one of the possible equivalents for t u t i a . Yet it must not be forgotten that the earlier classical chemists were prone to confuse all white metals: cf. Berthelot, (Coll., 230):

" Tout métal et alliage rouge ou jaune , altérable au feu, s'appelait χαλκὸς ou aes : tout métal ou alliage blanc , fusible ou altérable au feu, s'appelait a l'origine plomb. Plus tard on distingua deux variétés; le plomb noir, qui comprenait notre plomb et , plus rarement ,notre antimoine, etc. ; et le plomb blanc, qui comprenait notre étain et certaines alliages de plomb et d'argent " . Franchet(98) says much the same thing.

There is an interesting detail quoted by Fergusson

(Palaces, 169) from a Persian author , concerning the great hall of Xerxes at Persepolis:-

" A Persian author quoting a more ancient one says ' it is related that in ancient times persons ascended to the summits of these columns, now fallen, and took earth and clay therefrom, which they crushed, and found amongst it Indian tutty, useful as a medicine for the eyes' ".

Presumably this tutty came from the ancient glaze, and the story will then form a small piece of additional evidence that the word t u š k a.., already mentioned as used in an eye-salve, may really be the same word as t u s k ū , and so — assuming the possibility that t u š k a .. represents the zinc of eye-salves, but equivalent to t u s k ū, oxide of tin—— perhaps add a little weight to the suggested etymology for t u t i a .

Lastly we find a noun used in conjunction with t u s k ū, š i k ṭ u (Sect. 25, Rand T , vi, 2 and 11), which I take to be the Syriac š'y ā g ' t h ā lotio. The washing of pompholyx (an impure form of the oxide of zinc) is described in Diosc., V, lxxxv, and a chapter is given to it in Zosimus (Berthelot, Coll., 201).

To sum up: We may , I think, reasonably consider that o x i d e o f t i n produces the results for which t u s k ū is prescribed, at least, in sufficient measure for us to accept the identification as plausible.

As tin was within fairly easy reach of Nineveh, and as tin appears to have been used in glazes as early as the XIIIth century, there is nothing improbable in our identification. Moreover, it must not be overlooked that we have as yet no satisfactory word for "tin" in Assyrian.

whether there is any etymological connection between t u š-k ū and t u t i a is uncertain but there is no little attractiveness about the suggestion.

(Sect. 14, continued)

To continue with the Assyrian glass.

The next kind of d u š ū is that described as "green." Sect. 25,S (a repetition of Pl. 5,qiv, 1,ff.) ,the passage in which the receipt is given, contains no mention of a glass base to which the colouring agent is to be added,but it begins with the remains of a single character which is almost certainly the "ditto" sign, such as is common at the beginning of medical receipts,whenever a repetition of the initial clause of a preceding medical prescription is intended. Here it must refer to the preceding receipt for some form of d u š ū.

The components for making "green d u š ū" (crystal) are as follow:-

("As before")

Add Arsenic

Put in a mould, fire for seven days, take out after ten days

Add 3600 parts of iron rust(?)

1 part washed m i l'u - salt(petre)

Some washings of oxide of tin(?)

1 part chalk

1 part alkali

Crush, sift, mix, and fire again.

S e c t i o n 15 . A r s e n i c

In the above receipt I take the first ingredient (hitherto unidentified) to be arsenic in some form for the following reasons;

In disc ussing this mineral (tak) AŠ.GE.GE , we must also consider alongside it another which from its apparent similarity must be connected with it. This is (tak) AS. H̲AR or (tak)AŠ.H̲AR , with which I identified arsenic in some form(PRSM 1924, 24). We can now go agood deal further.

Let me premise by putting forward and augmenting the arguments given there:

Consider the following

ŠIM.BI == e l l u (Br. 5179)

ŠIM.BI.ZI == e g ū (Br. 5180)

ŠIM.BI.ZI.DA == e g ū , a m a m ū , g u h̲ l u (.Br. 5181, 5182: SAI 13546)

ŠIM.BI.ZI.DA.SIG.SIG (1) == AS.HAR (CT.XIV,8,obv.14)

ŠIM.BI.ZI.IGI.TAR.NU =="e g ū for colouring the eye"

== e g ū š a e k ī

IM.SIG.SIG (2) == e g ū (CT.XIV,8,obv. 11)

ŠIM.BI.GUŠKIN == l ē r u , š ī p u (Br. 5187, 5188)

ŠIM.GUŠKIN == l ē r u , š ī p u , d a m a t u (BR. 5198-5200) and probably š i n d u h̲ u r a ṣ u on CT.XIV,8,8, the še. ṭu being a glass (see SAI 3564)

IM.ŠIM.GUŠKIN == š ī p u , š i n d i h̲ u r a ṣ i (SAI 6297)

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(1) "Yellow e g ū ".

(2) "Yellow earth". Cf. IM.GUŠKIN and IM.GUŠKIN.SIG (Scheil, RA, 1921, 64).

IM.GUŠKIN = š ī p u , i l l u r p a n i , k a l ū
(Br. 8487, SAI 6352)

IM.ŠIM.TAK.IŠ = l ō r u , š i n d i n i ...(SAI 6296)

G u ḫ l u was rightly identified by Zimmern (see MA 215) with k o h l "eye-paint".

ŠIM.BI.GUŠKIN "gold paint" etc., I identified with orpiment, auri pigmentum, the yellow trisulphide of arsenic (PRSM 1924,24). I took ŠIM.BI.SIG.SIG by analogy to have been read š i n d u a r q u "yellow paint", and thus, (in spite of a small difficulty) to be the origin, by a "merchants garbling", of s a n d a r a k e, sandarach. The difficulty was that sandarach is rather the orange sulphide of arsenic than the paler orpiment: but such a confusion is quite probable. Sandrachos, according to some, covers both the red and yellow forms of arsenic (Berthelot, Hist. ii, 129). Moreover, it will be noticed that both ŠIM.BI.GUŠKIN and ŠIM.BI. SIG.SIG = l ē r u and š ī p u, so that even in Assyria such a confusion may have occurred.

(Tak) AŠ.ḪAR[1] in its close connection to the above list I took to be some form of arsenic, but one slightly different from ŠIM.BI.GUŠKIN, since both these drugs are used side by side in AM 12,8,6. On the preceding page it will be seen to be defined (in the form AŠ.ḪAR) as = "yellow e g ū", e g ū being the synonym of g u ḫ l u "kohl".[2]

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(1) There can be no doubt that this is the same as (tak) AŠ.ḪAR: the former occurs in AM 10 times, the latter 6 times.

(2) Sargon (VIIIth cent.) took ŠIM.BI.ZI.DA from near the town of Kinaki, and Tukulti-Ninurta took it from Ḫindani (BoFr.46,41

Exactly parallel to IM.SIG.SIG "yellow earth" is the Syr. ܥܦܪܐ ܕܕܗܒܐ "earth of gold"== arsenic. The Syr. MS. in Berthelot(ii,15) gives "a reference to "the earth of Armenia which is very yellow: it is the golden arsenic".

The medical texts bear out the theory of its being arsenic, (tak)AŠ.ḪAR being used chiefly for eyes(see my article,PRSM,1924,25).

Working on the base, therefore, that (tak)AŠ.ḪAR is a form of arsenic, we can follow up this idea in seeking a meaning for (tak) AŠ.GE.GE , which would appear to be built up on the same base AŠ.

(tak) AŠ.GE.GE may be written with its first sign or , and the form (tak) AŠ is the same word, as Thureau-Dangin shewed (RA, 1921, 164). There is therefore no no doubt about the pronunciation AŠ. A third drug occurs as (tak) UḪ.AŠ.GE.GE.

If we take the base AŠ as the foundation of these two words AŠ.ḪAR and AŠ .GE.GE , the first one of which we presume to be a form of arsenic, we shall find an amusing confirmation of our theory in Assyrian botany. In AH 265 I identified the plant (u)AŠ as a s a f o e t i d a on several grounds which appeared to me to be satisfactory. What connection is there between a s a f o e tid a and arsenic?

ḪAR == e ṣ ē n u "smell" (Br.8524) so that with this idea of "smell" (tak) AŠ.ḪAR gives the idea of being "the mineral smelling of a s a fo e t i d a ", i. e., a notoriously evil-smelling plant, known for this reason as alliaceous from its garlic-like smell or taste. Now this garlic smell is exactly one of the tests of compounds

of arsenic: "Arsenic compounds, when heated on charcoal give a white encrustation far from the assay, and at the same time fumes having a garlic odour are emitted" (Rutley, 284). This applies to native arsenic , realgar, and orpiment. We have thus a mutual confirmation of the two identifications, asa foetida and arsenic.

To define (AŠ.GE.GE a little more closely:
GE == d ā k u (SAI 4520) 'crush" : š a b ā r u (Br. 6326) "break" , so that perhaps we may see in the word (tak)AŠ.GE. GE some powdered form of arsenic. It is used in AM about 10 times: for t e m p l e s (KU.KU.(tak)AŠ.GE.GE ,i.e.,powder of arsenic ,19,1,6: cf.SM ii,63 arsenic for temples): for eyes(85,2,7: cf. SM ii,94,arsenic for eyes) : for ears (33, 1,26 : 37,2,r.4,8:) .Other occurrences,7,1,r.ii 6: 29,2,9 : 29,4,r.6 :46,1,25: 47,3,31).

(tak)MUḪ.AŠ.GE.GE, lit."marrow of arsenic", would appear to be gold powder ,probably as a paste,for it is used for redecorating a crown of alabaster(see Langdon,Neubab. Koenigsinschr.,270,36), so that it would again seem that (tak)AŠ.GE.GE is some kind of orpiment in powder, which is made into a paste for painting,which is called (tak) MUḪ.AŠ.GE.GE . It is possibly the Syriac n ū r ' t h ā "paste of arsenic". In the form (tak)MUḪ.AŠ.GE.GE d i-g i-l i "arsenical paste for the sight",collyrium, it was brought as booty by Sargon from Babylon(Oppert and Menant, La Gde. Inscr. de Khors.,1.142) . (Tak) MUḪ.AŠ. GE.GE occurs AM 7,1,iv,6.but probably not as a medicament.

A lump of auripigmentum was found at Zinjirli (V. Luschan, Ausgrab.,261,quoted by Meissner, in Ebert, Reallexicon 278)

In our present text for the making of green glass (tak) [illegible] arsenic compounds, when heated on charcoal give a white incrustation far from the assay, and at the same time [illegible] a garlic odour are emitted" (Smith, 2647). This applies to native arsenic, realgar, and orpiment. We have thus a mutual confirmation of the two identifications, viz. [illegible] and arsenic.

To define (A[illegible]) a little more closely: [illegible] (as, 4196) "brass", so that perhaps we may see in the word [illegible] of more powdered form of arsenic. It is used in AF about [illegible] for [illegible] (as 4, ...), powder of arsenic, [illegible] arsenic for [illegible]. For [illegible] cf. [illegible] arsenic for [illegible] for [illegible] (AH, 1, [illegible]). Other occurrences, [illegible].

(ŠAM) [illegible] 112, "[illegible] of arsenic", would appear to be [illegible] powder, probably as a paste, for it is used for [illegible] a crown of alabaster (see [illegible] [illegible], 270, 70), so that it would again seem that [illegible] is some kind of orpiment in powder, which is made into a paste for painting, which is called [illegible] [illegible]. It is possibly the Syriac [illegible] "paste of arsenic". In the form [illegible] "arsenical paste for the nipple", [illegible], it was brought as booty by Sargon from [illegible] and [illegible], in [illegible], [illegible] [illegible] ([illegible]) but probably not as a medicament. A lump of orpiment was found in [illegible] (W. [illegible], quoted by [illegible], [illegible]).

In our present text for the making of [illegible] glass ([illegible])

AŠ.GE.GE "arsenic" as one of the components. In Sect. 25, AA, we find IM.SIG.SIG "yellow earth" (i.e., arsenic) added in the making of aventurine. Actually 1 % of arsenic is used in the making of crown glass(Pellatt,44).

S e c t i o n 16. B a r u m m u (?), I r o n R u s t (?).

The word b a- r u m (?)- m u(?) is the next problem. R u m is fairly certain : m u is possible. This word obviously represents the chemical addition which is to turn the glass green, or (owing to the unfortunate inability of the Semite to distinguish between green and yellow), possibly yellow. Here ,however, when we remember the popularity of green glass in ancient times, the probability is that it is green.

Now the usual agent for making glass green appears to have been copper, but here we have no indication of this. Ferrous oxide, however, was another agent for the same purpose(Roscoe, ii, 591) and we might perhaps see the Syriac root [illegible] corrosit, in b a- r u m(?)-m u(?) with a meaning(I suggest) "rust"(1). Unfortunately all our premises are so doubtful that we cannot arrive at any definite conclusion.

S e c t i o n 17. S u m m a r y o f t h e P r e c e d i n g

We may thus summarize the preceding identifications.

First Frit was called A h̲ u s s u.

(1). Cf . Powell(22):"Ferric oxide when exposed to heat has a tendency to part with oxygen and become ferrous oxide. Metallic iron, mixed with the ingredients of glass, combines with oxygen to form the ferrous or the magnetic oxide". Roscoe, ii, 1223, says Freshly formed rust usually contains considerable quantities of ferrous hydroxide and carbonate.

[illegible] "arsenic" as one of the components. On p. [illegible] 75, and we find in 217.510 "yellow earth" (i.e. arsenic) used in the [illegible] of [illegible]. Actually 5% of arsenic is used in the making of green glass (Thorpe, [illegible]).

S e c t i o n 16. Ḫ a r a m m a n (?), i r o n d u s t (?).

The word ḫ a - r a m (?)-m a n(?) is the next problem. m a n is fairly certain t a m is possible. This word obviously represents the chemical addition which is to turn the glass green, [illegible] owing to the unfortunate inability of the [illegible] to distinguish between green and yellow, possibly yellow. Here, however, when we remember the popularity of green glass in ancient times, the probability is that it is green.

Now the usual agent for making glass green appears to have been copper but here we have no indication of this. Ferrous oxide, however, was another agent for the same purpose (Thorpe, ii 59?) and we might perhaps see the Syriac root [illegible] carpenti(?), in ḫ a - r a m (?)-m a n(?) with a meaning (I suggest) "dust". Unfortunately all our premises are so doubtful that we cannot arrive at any definite conclusion.

S e c t i o n 17. S u m m a r y o f t h e P r e c e d i n g

We may thus summarize the preceding identifications.

First frit was called a ḫ u s s u.

(1) Or possibly (cf.?) "Ferric oxide when exposed to heat has a tendency to part with oxygen and become ferrous oxide. Metallic iron, mixed with the ingredients of glass, combines with oxygen to form the ferrous or the magnetic oxide", Thorpe, ii, 1922, 709. "Freshly formed rust usually contains considerable quantities of ferrous hydroxide and carbonate."

The simplest form of glass appears to have been called s i r ṣ u , and this appears to have been used in a special form, s i r ṣ u n a t k u ,"melting(?) glass",perhaps for mixing with others.

D u š ū ,the name for "crystal glass" contained the components of the preceding glass s i r ṣ u, with a little variation in the proportions, with the addition of t u s- k ū (either oxide of tin(?), or, with an extended possibility,"tutty") and oyster shell, or pearl(?), and this was probably used as a base for making "green Crystal". Another form is called d u š ū i b b u "clear crystal".

S e c t i o n 18 O t h e r F o r m s o f G l a s s .

We can proceed to two other forms,of which the ingredients are lost. These are t e r s i t u and z u k ū . Z u k ū,as I have already tried to show, appears to be a form of glass or glaze (Sect. 13). T e r s i t u is obviously a glaze, since it is to be poured on burnt brick (Sect. 25,E).

This latter,t ers i t u , comes fourth in order in the successive receipts given in these texts thus:-

1). Simple clear glaze or frit.

2). The making of oxide of copper.

3). The making of z u k ū

4). The making of t e r s i t u

The natural explanation here is that these results are to be taken in their progressive order, although , I admit, this cannot be maintained consistently throughout these texts. But we can see, not only from the internal evidence of the receipt for t e r s i t u (LL. 44 and 47) that cop-

per was one of the ingredients :and, since it was to be spread on burnt brick,it must have been a glaze: we have thus at the fourth process arrived at the making of blue glaze.

Again,still seeking for the components of t e r s i t u, we find in the next section , themaking of b l u e gl a s s, which, when finally melted,is to be poured into a hot ṭ a p- t i

30 parts t e r s i t u

30 parts s i r ṣ u(simple glass)

? parts alkali(in some special form)

2 parts chalk

roasted s a n d u (red mineral, here mercury?) (1)

This is to make u k n ū.

Clearly we have to find some agent in the components which will cause the glass to become blue, and I think the only solution is contained in t e r s i t u which ,as I tried to show above, was a blue glaze containing copper. This , when melted with the other ingredients , will doubtless produce the blue-colour.

Hence t e r s i t u would definitely appear to be a glaze or glass made with oxide of copper.

There is an interesting piece of practical direction in 1.47, in the receipt for making t e r s i t u, the blue

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(1)On s a n d u as cinnabar, see Sect.33. On cinnabar in glass see Sect.6. But I am uncertain whether we should see "cinnabar"here,and yet it is difficult to find another "red stone"so satisfactory. It can hardly be minium,red lead, because minium is already roasted(from white lead), and besides, the Assyrian for red lead is s ā s u (Sect.34). Nor can it well be red oxide of iron, for that would be either (tak) KA or one ofits compounds(Sect.41). It is curious that no quantity is stated: cf. Sect 25,5,1.11).

glaze : the chemist appears to have given a note on the proper moment for adding the glaze to the copper. This appears to depend on the "boiling" (?) of the metal before some wine which is presumably put on the furnace, or otherwise brought into connection with it. It need hardly be mentioned that alcohol boils at 173°, so that obviously it is not intended that the wine should be put alongside the metal.

Leaving t e r s i t u as the blue glaze made with oxide of copper, we can discuss the other glass z u k ū . As we saw on p. 24, it is composed of a ḫ u s s a (possibly the simple frit on p. 25), and something else which is lost. It follows the preparation of copper oxide, and precedes the making of the blue glass or glaze which we know definitely contains the copper. The natural presumption is that z u k ū is the plain glass base to which the copper must be added to make t e r - s i t u . It will differ from the simple glass s i r ṣ u in some way, probably in the omission of some proportion of salt-petre or carbonate of lime. It may possibly be connected with the Hebrew זכוכית which (on the analogy of the Heb. חלתית, i.e., the Assyrian ḫ ī l u t i y a t u ==asa foetida (AH 133)) may represent two Assyrian words in one, the זכו representing z u k ū , and the כית some corruption: it must not be forgotten that זגוגית is the same as זכוכית, a duplication of form which at once indicates some corruption, or borrowing of a foreign word.

The natural derivation of z u k ū -"glass" would be z a-k ū "clear"

Section 19. The Making of Copper Scale.

Sect. 25,C gives the receipt for making the copper scale which will give the blue colour to the glaze.
This receipt is correctly inserted by the Assyrian chemist between the simple frit and the glass which is to lead to the resulting blue glass. Unfortunately the latter part of the directions for making the copper scale(oxide) is broken, but it seems clear that the method is the common ancient one. 10 mana of copper are to be heated, beaten, and spread in the sun.

Roscoe(ii,421) thus describes cuprous and cupric oxide:-

"Copper scale, which falls from hot metallic copper when it is worked withthehammer, is a mixture of these two oxides. The portion of the scale next to the metal consists of the red cuprous oxide, while the outside portion is composed of the black cuprous oxide. Dioscorides and Pliny mention the existence of the red compound, indeed they distinguished two varieties, the one obtained in the form of a finely divided powder by pouring water on the surface of freshly melted copper, and termed *flos aeris*, and the other obtained as copper scale and termed *aeris squama*".

Pliny's description is as follows:-

"The flower, too, of copper is also used in medicine: a substance which is procured by fusing copper, and then removing it into another furnace, where the repeated action of the bellows makes the metal separate into small scales, like the husks of millet, and known as "flower of copper". These scales are also separated, when the cakes of metal are plunged into water: they become red, too, like the scales of copper known as "*lepis*", by means of which the genuine

flower of copper is adulterated, it being also sold under that name. This last is made by hammering nails that are forged from the cakes of metal" (NH XXXIV, 24).

The method given in Blancourt (77) directs that the copper should be burnt in a closed crucible for four days (but not melted): then it should be beaten on a porphyry stone, sieved, and a black powder will be the result. This should be spread on the tiles: then put back in the furnace for four days more, taken out, and the ashes blown off, reduced to powder and sieved.

For the method in the Syr.-Arab. MS of Berthelot, see his Coll., ii, 31 . Here , too, the result is to be exposed to the sun. It will be noticed that in Sect. 25, C, there is a mention made of "the roof", which, I presume, is for the same purpose.

S e c t i o n 20. U k n ū m e r k u

We saw in Section 18 how "blue (lapis)" was to be made. This is followed in sequence (Sect. 25, C) with directions for making u k n ū m e r k u =="m e r k u - blue". M e r k u I take to be from e r ē k u , comparable with the Heb. ערך "to mould bread". It is hardly likely, I think, that m e r k u indicates a different shade of blue : the mention of t a m-š i l t u "mould", as distinct from the ordinary word ṭ a p-t i " a melting pot" is a very good indication of the meaning. Reduced to the same common denominator as the preceding the receipt gives

30 parts fine t e r s i t u

10 parts crushed s i r ṣ u -glass

10 parts sand

1/24 parts chalk

flour of copper is well rotted, it being also said only that now, this last is made by hammering nails that are formed from the edges of metal" (Cp. XXXIV, 20).

The method given in [illegible] (79) directs that the copper should be burnt in a closed crucible for four days (but not melted): then it should be heated on a porphyry stone, sieved, and a black powder will be the result. This should be spread on the silver then put back in the furnace for four days more, taken out, and the ashes blown off, reduced to powder and sieved.

For the method in the [illegible], see his coll. II, [illegible], there, the result is to be exposed to the sun. It will be noticed that in sect. [illegible], there is a mention made of "the rose", which is presumably for the same purpose.

S e c t i o n 20. O t h e r B l u e

We saw in Section 17 how "blue (lapis)" was to be made. This is followed in sequence (Sect. 20.) with directions for making a n o t h e r k i n d of "blue". [illegible] I take to be from [illegible], comparable with the [illegible] "to mould bread". It is hardly likely, I think, that [illegible] indicates a different shade of blue; the mention of [illegible] "mould", as distinct from the ordinary word [illegible] "a melting pot" is a very good indication of the meaning. Reduced to the same common denominator as the preceding, the recipe gives:

35 parts flint [illegible]

10 parts crushed [illegible]

10 parts sand

1/2 parts alkali

The proportion of glass containing copper oxide in this receipt is nearly half as much again as in the preceding.

Sect. 25,h contains as many as ten ingredients. Several of them may be merely decolourising agents, especially the two forms of arsenic. *Styrax-gum occurs , as in the first frit. Unfortunately the colour of the resulting glass is partly lost, but the name appears , from what is left, to have some similarity with the preceding (== u k n ū m e[r k u]). It is not unreasonable to suspect some additional tint, which is to be introduced by the unknown main component, which is prescribed in so large a proportion.

The components are

30 parts t e r s i t u (glass made with copper)
90 parts t a r a b a n u š a d d a
1/12 part of s i r ṣ u -glass
1/24 part of chalk of the sea
s a n d u (cinnabar)
1/60 part of m i l ' u - salt(petre)
1½ parts arsenic (realgar?)
1/24 part of male red alum
1/20 part of orpiment
3 parts *styrax-gum

More clearly the main addition to the blue glass is t a r a b a n u š a d d a : the others are unimportant. At first sight t a r a b a n u appears to be an -anu form, like so many of the plants or plant - products (AH XX), and it may be philologically connected with the Arabic تراب "soil, dust, earth." Š a d d a is an adjective from š a d a d u "to draw", so that if these premises are correct the words would mean "earthy product which attracts", for which I suggest

l a p i s m a g n e s.

It will, however, be seen in Sect. 42 that the true magnetic iron is (tak)KA.GI.NA.DIB.BA , an entirely different word. How are the two to be reconciled?

First, it is clear that the most probable mineral here would be oxide of manganese, which will produce a purple,or a dark brown(Sect.6),or violet(black oxide of manganese and nitre,Roscoe,ii,591) . In fact ,it might almost be claimed that oxide of manganese is really the only possibility left for us,unless we include cobalt.

It would seem that the ancient confusion between m a g - n e s and manganese is present here. Pliny(NH XXXVI,66),as is well known ,confuses manganese with the magnet-stone , for he says that the latter was added to glass. According to Dillon(77)"the magnes lapis--- magnetic iron ore- -or load-stone--- is the last substance in the world anyone would think of adding to glass" The confusion is explained by Beckmann (Hist.of Inventions,ii,237,quoted Bostock,Pliny,NH VI,380)by saying that manganeseis "a substance which has a resemblance to the magnet". If they could confuse the two in Pliny's time, how much more would they be likely to do so in the Seventh Century B.C.? After all, the word manganese is nothing more than a corruption of the word m a g n e s (Berthelot,Coll.,256),or m a g n e s i a (Oxford Concise Dict.,498). As I mentioned above, t a r a b a n u š a d- d a is definitely <u>not</u> the Assyrian for magnet. The real word--- (tak)KA.GI.NA.DIB.BA--- does not occur in these texts. But,when we remember that the Egyptians used manganese to obtain a purple tint as far back as the First Dynsty(Sect.6) we must surely concede that such capable chemists as the Assyrians knew it in the seventh century, and yet, at the

same time ,they may have fallen into the same error as Pliny, in confusing manganese with the magnet-stone.

We must , therefore, confine ourselves to saying that there is a reasonable probability that t a r a b a n u š a d d a is to be translated " magnetic earth product";that it is used as a chemical agent to produce some colour in a glass ,the name of which appears to be a compound and is certainly in part described with the Assyrian word for "blue"; that if this glass be purple, manganese is the right chemical to use; and that the similarity of the two minerals, manganese and magnetic iron ore,may have led the Assyrian chemists into the same error as the Classical naturalists.

It must be noted that,although the Assyrian word for magnetic iron ore does not occur in these texts, s a d ā ,which is probably a form of š a d a n u "ferric oxide, haematite", or allied to it, appears to have been used(see Section 22). The Sumerian forthis word is (tak) KA . GI. NA, the base of the word for "magnetic iron ore". But the distinction of t a r a b a n u š a d d a and š a d ā appears to be clear.

S e c t i o n 21. P a l e B l u e (?) Gl a s s.

Sect. 25,J, would appear ,from the large proportion of plain glass to blue glass,to be the receipt for a pale blue. Unfortunately, one of the ingredients is lost.

30 parts t e r s i t u (glass with copper)

80 parts z u k ū - glass

15 parts of ....

1/30 part m i l ' u- salt(petre)

S e c t i o n 22. F e r r i c o x i d e

Sections 25,K and L, contain compounds of t e rs i t u (glass with copper oxide) and different proportions of š a d ā (mineral?), producing two different tones designated as some shade of uknū-blue . Now ,as we shall see in Sect.41, the stone š a d a n u , the -anu product of the š a d ū or mountain(?),is certainly haematite, i,e. ,"one of the most important ores of iron", Ferric Oxide (Roscoe,ii,1221),an important colouring agent in glass. It gives a red colour to glass(ib.590),and,more important for us is that"a common black glass is prepared by adding large quantities of ferric oxide , with which c o p p e r o x i d e or c o b a l t o x i d e is frequently mixed" (Roscoe,ii,591).

We can hardly be far wrong, therefore, if we suggest that š a d ā is merely a form of š a d a n u ,haematite, ferric oxide. K,containing the larger proportion of š a d ā ,will, in composition with the copper oxide in the t e r s i t u - glass,produce either a black glass,or at all events, a nearly black glass, while L , with its smaller proportion, will be nearer the brown of Sect.6.

K.

30 parts t e r s i t u(glass with copper)

60 parts š a d ā (ferric oxide)

L.

30 parts t e r s i t u

45 parts š a d ā

S e c t ion 23. R e d - p u r p l e

In Section 25,M, we are so fortunate as to have the beginning of the first word after u k n ū ,i.e. s\u0301 a - ...(on the analogy of u k n ū s ā m u in l. 91,must be restored s ā - m u "red" . U k n ū s ā m u represents ~~literally~~ the

the Sumerian Z A G I N.D I R (Br. 11780), given as *a r-g a m a n u "r e d p u r p l e." The components of this are

30 parts t o r s i t u (glass with copper)

45 parts s i r ṣ u (glass)

15 parts sand

After being crushed together, they are to be fired continuously(?) for seven days and nights.

The reddening agent is doubtless the copper scale in the t e r s i t u -glass (see Sect. 6).

S e c t i o n 2 4, B r o n z e I n l a y (?)

Section 25,N, as I suggested in Sect. 13, may perhaps be the directions for making the enamel for bronze inlay. The receipt is for bronze defined by the adjective a r ḫ u : I cannot offer any philological connection for a r ḫ u , unless it be related to a r ḫ u "road" ,with reference to the copper guides or p a r t i t i o n s which keep the enamel cloisonné . The components are ten m a n a of simple glaze or frit ,and ten m a n a of some mineral, and perhaps something else.

We can now proceed to the literal translation of the texts.

....

the Sumerian [illegible], given as [illegible]
[illegible]. The components of this/are

30 parts [illegible] (glass with copper)

40 parts [illegible]

10 parts [illegible]

After being crushed together they are to be fired continuously(1) for seven days and nights.

The reddening agent is doubtless the copper and [illegible] in the [illegible]-glass (see Sect. [illegible]).

[illegible]

Section [illegible], as I suggested in Sect. [illegible], may perhaps be the directions for making the enamel for bronze rings. The receipt is for bronze defined by the adjective [illegible]. I cannot offer any philological connection [illegible], unless it be related to [illegible] "head", with reference to the copper [illegible] of [illegible] which form the enamel [illegible]. The components are [illegible] of simple glass or frit, and [illegible] of [illegible], and perhaps something else.

We can now proceed to the literal translation of the text.

T R A N S L A T I O N   O F   T H E   T E X T S

S e c t i o n 25

A. T h e P r e p a r a t i o n o f t h e F u r n a c e

L.1 When thou settest out the (ground)plan of a furnace for "minerals", thou shalt seek out a favourable day in a fortunate month, and thou shalt set out the (ground)plan of the furnace. While they are making the furnace, thou shalt watch(them), and shalt work thyself(?) (in the house of the furnace) : thou shalt bring in embryos (born before their time)... : another(?), a stranger, shall not enter, nor shall one that is unclean tread before them : thou shalt offer the due libations before them: the day when thou puttest down the "mineral" into the furnace thou shalt make a sacrifice before the embryos: thou shalt set a censer of pine-incense , thou shalt pour k u r u n n u - beer before them.

Thou shalt kindle a fire underneath the furnace and shalt put down the "mineral" into the furnace. The men whom thou shalt bring to be over the furnace shall cleanse themselves, and (then) thou shalt set them to be over the furnace.

The wood which thou shalt burn underneath the furnace shall be *styrax, thick, decorticated billets which have not lain(exposed) in bundles, (but) have been kept in leather coverings, cut in the month of Ab. This wood shall go underneath thy furnace.

B. T h e M a k i n g o f t h e F r i t.

L. 13. If clear (i b b u) blue glaze is for thee to make, thou shalt crush separately

10 m a n a of sand

15 m a n a of alkali-ash

1 2/3 m a n a of *styrax-gum

Thou shalt mix them together, and put them down in the furnace whereof the floor of the apertures is cold, and settle (them) (evenly) between the apertures. Thou shalt keep a good, smokeless fire burning until [the "metal"] is at a white heat: (then) thou shalt take (it) out and let (it) cool: thou shalt again crush (it): thou shalt collect (it) into a clean melting-pot: thou shalt put (it) down into the furnace which has been let grow cold: (then) thou shalt keep a good, [smokeless] fire burning until it [liquefies]: (then) thou shalt [pour] it on burnt brick, and its name is "..."

C. T h e M a k i n g o f C o p p e r O x i d e

L. 21. Thou shalt put 10 m a n a of copper in [to] a clean [melting-pot], thou shalt [put it down in] to the [fur] nace which has been let grow hot: (then) [thou shalt keep] a fierce fire [burning] until the copper [fus] es. Thou shalt beat ....thou shalt open... until the z u k ū -glass (?).... and [thou shalt spread (?)] the copper....on the ro [of (?)]..

D. T h e M a k i n g o f z u k ū -g l a s s.

L. 34. [If z u k ū - glass is for thee to make?] thou shalt [put down into the furnace] ...(1) [m a n] a of a ḫ u z z u -frit and [settle (it)] (evenly) between the apertures,.... it, and (after)

(1) See l. 18?

one day thou shalt take (it) out, and shalt [let it cool] : thou shalt put (it) down (again) [into the fu]rnace which has been let grow cold.... ....thou shalt take (it) out : its name is z u k ū -glass.

E. T h e M a k i n g o f T e r s i t u (b l u e f r i t o r g l a z e f r o m c o p p e r.)

L. 40. Thou shalt put.... [m a n a(?) of z u k ū -glass ?] down into the furnace which has been let grow hot: thou shalt keep [a good, smokeless [fire] burning:..thou shalt beat and crush (it).... and thou shalt again crush (?) .... copper. .... [thou shalt put (?)] on the fire a stone [jar (?) of wine (?)]... If the "metal" boils (?) before the wine (does so), then thou shalt mix (?)(1) the "metal" with the copper; (then) thou shalt pour (it) on the burnt brick, and its name is t e r-s i t u (blue frit with copper).

F. T h e M a k i n g o f B l u e G l a s s (L a p i s).

L. 49. Thou shalt crush separately

10 m a n a of t e r s i t u (blue frit)

10 m a n a of s i r ṣ u -glass

... ... of alkali, in small pieces (?), not round lumps (?)

2/3 m a n a of chalk of the sea (2)

Roasted Cinnabar (== mercury?)

Thou shalt mix (them) together, collect (them) into a clean melting-pot, put (it) down into the furnace whereof the floor

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(1). But see note to Sect. 25, F, l. 59.

(2). Or some form of lime.

of the apertures is cold, and thou shalt put (it) on a support (evenly) between the apertures, the base of the melting-pot not touching the furnace; thou shalt keep a good, smokeless [fire] burning; when the fire from the middle of the apertures has driven forth the bubbles . '... [and the "metal"] glows, thou shalt draw the fire: when the furnace is cold, thou shalt take (it) out and crush (it); (then) thou shalt collect (it) into a clean [melting-pot], and put (it) down into the furnace which has been let grow cold : thou shalt keep a good, smokeless [fire] burning. While the "metal" is fusing thou shalt not shut [the door of the furnace, (but) after the "metal" has fused, thou shalt shut the door of the furnace, and they [shall pi]erce the outside in front of thee with a hole; after they have pierced the..., thou shalt look, and if the "metal" runs, thou shalt pour (it) into a hot melting-pot, and when the furnace is cold, u k n ū ("blue glass") will come out.

G. T h e M a k i n g o f M o u l d e d B l u e G l a s s.

L. 61. Thou shalt add to

1 m a n a of fine t e r s i t u ("blue frit")
1/3 m a n a of crushed s i r ṣ u -glass
1/3 m a n a of sand
5 kisal of chalk

and thou shalt crush (it) again; thou shalt collect (it) into a mould, closing it with a duplicate (mould) : thou shalt place (it) (evenly) between the apertures, and u k n ū m e r k u ("moulded blue glass") will come out.

H. T h e M a k i n g o f M o u l d e d [P u r p l e , o r V i o l e t] G l a s s .

H. T h e M a k i n g of M o u l d e d [P u r p l e , o r V i o l e t] G l a s s .

L.65. Thou shalt keep a fire burning in the furnace for seven days ; (then) thou shalt add to

1 m a n a of t e r s i t u ("blue frit")

3 m a n a of t a r a b a n u š a d d a (manganese?)

10 k i s a l of s i r ṣ u - glass ,"which..."

5 k i s a l of chalk(or lime) of the sea,of the middle [of the sea?]

Cinnabar

2 k i s a l of salt(petre)

3 shekels of arsenic

5 k i s a l of male red alum

6 k i s a l of orpiment

6 shekels of *styrax-gum

and thou shalt crush it again , and collect (it) in a mould. U k n ū m [e r k u ....] will come out.

I . S a n d i v e r

L. 71. Whatever will not sink to the bottom thou shalt put into the furnace,keeping the fire burning for seven days.

J. T h e M a k i n g o f [P a l e]-B l u e (?) G l a s s.

L.72. 3 m a n a of t e r s i t u ("blue frit")

8 m a n a of z u k ū -glass

$1\frac{1}{2}$ m a n a of ....

12 k i s a l of salt(petre)

the composition for u k n ū,...

K. The Making of [Black?] Glass

1 m a n a of t e r s i t u ("blue frit ")

2 m a n a of š a d ā (ferric oxide ?)

the composition for u k n ū ... (black (?) glass).

L. The Making of [Brown?] Glass.

1 m a n a of t e r s i t u ("blue glass")

1 1/2 m a n a of š a d ā (ferric oxide?)

the composition for u k n ū ... (brown (?) glass).

M. The Making of Red-purple Glass.

L. 76. Thou shalt crush

1 m a n a of t e r s i t u ("blue frit")

1 1/2 m a n a of s i r ṣ u -glass

1/2 m a n a of sand,

add (together), and collect (it) in a mould: thou shalt put (it) into the furnace and shalt (keep) a fire [burning] for seven days, night and all day.... (and) u k n ū s ā m u ("red-purple glass") will come out.

N. The Making of inlaid (?) Bronze.

L. 80.(1) If inlaid(?)(or, enamelled(?)) bronze is for [thee] to [make], thou shalt put down into the cold furnace

10(?) m a n a of a ḫ u s s a - frit

10 m a n a of .... thou shalt crush...

(The rest of the receipt on Pl. 4 mentions u k n ū ("blue glass") and bronze, and some procedure with water).

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(1) Restored from the text which may be a duplicate, K. 203, Pl. 4, Col. V.

O. T h e M a k i n g o f R e d - P u r p l e G l a s s .

L. 86. (Practically all is lost except the directions to pour the "metal" on burnt brick, the result being u k n ū s ā m u.)

P. T h e M a k i n g o f s i r ṣ u n a t k u ("m e lt- i n g G l a s s ?).

L.92. If s i r ṣ u n a t k u ("melting(?) glass") be for thee to make, thou shalt mix together

5 m a n a of ash of salicornia - alkali

? m a n a of sand (?)

? ? of male salt(petre)

5 shekels of chalk

Thou shalt put(it) down [in] a cold [furnace], thou shalt keep a good fire burning, thou shalt pour it into water?], thou shalt put(it)down in ḫ a r a g i uncovered .... thou shalt pour (it)into water .This is S i r ṣ u n a t k u ("melting(?) glass"

Q. T h e M a k i n g o f S a p p h i r e.

L. 97. Thou shalt add to

.. m a n a of t e r s i t u u k n ū (" blue frit made with copper")

1 m a n a of s i r ṣ u - glass

pound and rub together: thou shalt put(them)down into a cold furnace, keep a good fire burning, until they amalgamate. (Then) into the furnace which thou art keeping(?) thou shalt put (them) down in ḫ a r a g i closed ,uncovered(1) ; thou shalt keep the fire burning, thou shalt pour (it) into water; thou shalt put(it) down in ḫ a r a g i covered, ceasing(?)

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(1)I am entirely at a loss how to explain this passage.

the moistening : thou shalt open (it) in four days, thou shalt take out s i p r u (sapphire) for bronze inlay(?) of the apprentice(?)(or, learner(?)).

C a t c h - l i n e:-

"T e r s i t u("blue frit") of lapis, complete: the rest of the furnace -products(?) not complete".

R e v e r s e o f K. 2 0 3

Col. VI. (Sect. 25,R).

Ll. 1-3 give a mutilated receipt in which "sand", "washing of oxide of tin(?)", and "chalk" form components.

S. T h e M a k i n g o f G r e e n C r y s t a l .

L.4 (Add Pl. 5,K.4266,IV,1,ff.)

[Thou shalt add (?) the] same(?) to arsenic, and thou shalt again collect (it) into a mould: thou shalt cover the lower part of thy mould, [put] (it) on [a support[1]], put (it) into the middle of the furnace, and seven days.... thou shalt close up the furnace. On the tenth day thou shalt open (it), take it out, and thou shalt add to

1 m a n a of rust(?)
1 k i s a l of washed salt(petre)
washings of oxide of tin(?)
1 k i s a l of chalk
1 k i s a l of alkali

again crushing and powdering thy second batch: thou shalt mix (it), and when it has been sifted, thou shalt let the fire burn up thou shalt take out "green crystal", which has been turned

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(1)Cf. Sect. F. ,Pl. 2,l.52.

twice. This[1] latter

is (the agent for) clearing (it), without(?) shammy-leather.

T. T h e M a k i n g o f C r y s t a l.

L. 18 (Add Pl. 5,K.4266,V,8,ff.)

T o

20 m a n a of sand

1 talent(60 m a n a) of salicornia-alkali

2 m a n a of salt(petre)

10 shekels of chalk

1 m a n a of oxide of tin(?)

6 shekels of pearl(?)

There will come forth d u š ū (crystal-glass).

C a t c h - l i n e :-

"If s i r ṣ u -glass is for thee to make".

N o t e at e n d :-

" T e r s i t u ("blue-glaze") of u k n ū (lapis) and d u š ū (crystal glass) , complete.

Plate 5 . K. 4266,R e v e r s e.

(Col. IV, 1-7, repetition of Sect. S. Ll. 8-14, repetition of Sects. J,K,L).

U. T h e M a k i n g o f Y e l l o w (?) G l a s s .

L. 15. 1 m a n a of z u k ū - glass

15 k i s a l of [salt(petre)(?)]

10 k i s a l of antimony

The composition for [Yellow(?) glass].

A discovery (or, the science) of the hands of Nur(?)-...

(1) Does this a n n i t u belong to this Sect.,or to the next?

V. The Making of Opaque Carnelian.

L. 18. 1 mana of dušū-glass

15 kisal of oxide of tin(?)

The composition for opaque red-stone(carnelian).

W. The Making of Opaque Alabaster.

L. 20. 1 mana of dušū- glass

10 kisal of oxide of tin(?)

The composition for opaque alabaster.

X. A Preparation (magical?) in Advance.

L. 22. Thou shalt add to

1 mana 5 shekels of zukū-glass

(That?) which is used(?) for soldering(?) gold

3 kisal of male salt(petre)

3 kisal of kalgugu (rubrica?)

and the em[bryo] thou shalt break up into its pieces, taking three parts of each: when thou hast taken them, thou shalt... Thou shalt put (them) into a cauldron(?) in dung(?): thou shalt mix (them) up, (and then) cover the dung(?) with two spoonfuls of sand; thou shalt prepare it beforehand, when (the ingredients) are plentiful(?) for thee.

....

Y. L. 34. In thy A.GUB(?) - vessel thou shalt heat the above; take out the embryo; take a sacrifice, make offerings (for the dead) for the workmen; collect the rest(?) into a mould, put (it) down into the furnace....

Z. The Making of ...-idu

All lost except that a fire is used.

AA The Making of Aventurine.

(V,3).

.. mana of šaddā (ferric oxide (?))

10 mana of ahussa-frit

.. mana of unwashed salt(petre)

½ mana of arsenic

(this is the clearing agent)

Thou shalt take out (tak) sandu marhašitu,

(== sandaresos, spangled red stone, aventurine)

BB. A repetition of Sect. T.

CC. The Making of Sirṣu-glass

(V, 13). To

20 mana of amnakki-sand

1 talent(60 mana) of salicornia-alkali

1 2/3 mana of salt(petre)

2/3 mana of chalk

Sirṣu-glass [will come out].

DD. The Making of Baḫrē (?) (Red Coral?)

(V, 16) To

1 mana of zukū-glass

16 kisal of oxide of tin(?)

10 kisal of antimony

... of salt(petre)

½ kisal of gold

(This is) the discovery (or, the science) of ...-dayani

(The next six lines apparently mention oxide of tin(?),(or, z u k ū-glass), fire, the god Ea, and the name of the product(presuming that no horizontal line intervenes to make a new section) is (tak)baḫ(?)-ri-e "coral").

EE. L.28,ff. In this Section s i r ṣ u -glass and "roasted cinnabar(?)" (see Sect. F) are part of a receipt for making "...-m(?)a-ia".

Sections GG,HH,some form of glass, much mutilated.

Section II. Mutilated and difficult. L. 1, ḫ a i ṭ a may be the Arabic خيط "thread" (= wire). L. 2, š a m r a k a perhaps Syriac ܫܡܪܟ "made to flow",i.e.,"flux". L.3, "if the metal bubbles",i r a ḫ u t = Syr. ܪܗܛ . L. 7, "if the metal says z i q z i (q i)", connected with Heb. זעק ,to cry.

Sections JJ,KK(dup.of K. 6920,Pl.4) mutilated.

LL. (K. 6920,continuing). For Making Rouge(?)

Thou shalt mix together

.. of k a l g u g u (rubrica?)

1 shekel of tragacanth-gum

This is ....

Sections MM,NN,mutilated

Section PP is so much mutilated that I am regretfully compelled to leave it practically untranslated. But from the last line it is clearly similar to Sect. QQ,and deals with the overlay of silver. L.2 ,t u ṣ a d indicates the heating of the metal to a red heat. L.7,ff. ,indicates a second heating, mixing(?),casting in water and taking out:"2 ŠU IM.

Q u e s t i o n 26,30,47,R .

the next six lines apparently mention skins of [illegible], [illegible] [illegible]), fire, the red [illegible], and the [illegible] of the pro- duct(producing) that no horizontal line [illegible] [illegible] to the new section) in [illegible] "[illegible]").

[illegible], in this section [illegible] — [illegible] who "[illegible] [illegible]", are part of a recipe for making "...[illegible]".

Sections 10,11, some form of glass, much mutilated.

Section 11, mutilated and difficult, [illegible] [illegible] by the [illegible] "bread" [illegible] [illegible], [illegible] perhaps [illegible] "[illegible]" [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] connected with [illegible] [illegible]

Sections 17,18,[illegible] [illegible] mutilated.

[illegible] [illegible] mutilated). [illegible] [illegible] [illegible]

Then [illegible] [illegible]

... of [illegible]

[illegible] of [illegible]

That is ....

Sections [illegible] mutilated.

Section [illegible] is so much mutilated that I am [illegible] [illegible] led to leave it practically untranslated. But from the [illegible] line it is clearly similar to sect. [illegible] and deals with the [illegible] [illegible] of silver. [illegible] indicates the heating of the metal to a red heat; [illegible] indicates a second [illegible] then, similarly, cooling in water and taking out". So [illegible]

GIT.TA to 1 m a n a of [washed] copper, 6 shekels of bronze, the mixture(?), (billu), for the silver they shall pou[r]:it shall be cast, and it shall be ...with rosin, until they shall finish (it):it shall be cleaned and bright[ened](u t t a b- [b i b]): the overlay of false(?) silver, the silver..."

Section QQ is simpler, and better preserved. Similarly it appears to be a receipt for casting a bronze (vessel?) for silver-overlay, with the same application of rosin(1): "In 1 m a n a of washed copper, 10 shekels of lead, 2 shekels of... shall be smelted(heated red) ,it shall be cast:it shall be ... with rosin: it shall be cleansed ,brightened: the overlay of silver, the silver ..."

Some similarity to these compounds can be found in the methods of the Middle Ages for making mirrors. A surface of metallic lead was employed for obtaining a mirror as early as the thirteenth century, when such mirrors were common. These were prepared (as Beckman describes in his Hist. of Inventions) from large glass globes ,into the interior of which a mixture of rosin, molten lead, and sulphide of antimony was introduced, the fluid mass being brought over the surface until it was all covered with a thin film(Roscoe, ii, 853).

It should be added that lead was used as an alloy with copper as early as the time of Bur-Sin (see Handcock, Mesopotamian Archaeology, 253), and the same form of alloy is mention- by Thureau-Dangin(RA. 1907, 142).

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(1)Mr. J.E.Marsh suggests to me that a most likely reason that rosin was introduced was to prevent oxidisation.

N o t e s t o t h e P r e c e d i n g T e x t s.

A. This, and the following Section ,B, were translated by Meissner,Bab.-Ass.,ii,383,ff.

L.1. On a b n u "stone", as meaning any inorganic substance, see Section 2.

L.3. T e t t u ,from a t ū. T e t e p š u ,variant,K.7619, t e t e b b i .

L.4 . AN.KU.BU.HEŠ . Meissner was probably right in seeing in this the well known word for an embryo.

This use of foetus or embryos in the preparation of the furnace is more a question for the anthropologist than the chemist. It may be mentioned, however, that Frazer(Immortality,ii,49,note) says that abortions appear to be regarded as most malignant. In later Hebrew times the dwellings of the "heathen" were considered unclean because t h e y b u r i e d t h e i r m i s c a r r i a g e s t h e r e i n(Rodkinson, Pesachim,V,14; Horst, Zauberbibliothek,ii,391). Clearly the Assyrian idea is that the spiritsof incomplete beings must be propitiated,on the grounds that they would have some mysterious influence over incomplete substances,i.e.,the glass which is in the process of being made. This must be compared with the traditions of the early alchemists,e.g.,Olympiodorus(Berthelot,Coll.92,traduction) " the demons are jealous",with regard to the fabrication of some receipt(cf.also ib.303,the same re-

mark). Perhaps something of the same kind lies at the back of the warning in John, the High Priest (ib. 255), possibly an echo of the old fear of connection with abortions:- "care must be taken with births that abortion must not be brought about. Abortions of the flesh are produced and give place to beings who share not in the light of the world because of the imperfection, and because the favourable moment for birth was not observed. Equally in our fabrication, when (the work) is not accomplished according to proper rules, the results promised in the receipt are not successful".

L. 10. (Iṣu) A.TU.GAB.LIŠ, ṣ a r b a t u , probably *styrax-wood, a gummy wood, of which there were large plantations near Harran in the VIIIth century B.C. (U)UD, in the next section, l. 14, is the gum of this tree (AH 135, ff.). Officinal storax is the inspissated juice of the inner bark, so that presumably the wood after decortication has no value as a source of gum (see l. 10), but as a gum-bearing tree its wood, when burnt, will be excellent as a producer of heat. As an additional piece of evidence to my identification in AH 135, it is worthy of notice that Ibn Beithar (NO. 2196) remarks that the r e s i n of styrax is called l o b n a "perfect white", which bears on the meaning of (U)UD "the white drug, or plant". I had already noted this whiteness in regard to the actual blossoms, but not with the gum (AH 137).

L. 11. Q u r u . I disagree with Meissner in his translation "Palmkohl(?)", doubtless comparing ܩܘܪܐ . In the first place the actual meaning of ܩܘܪܐ is given by Brockelmann as m e d u l l a p a l m a e,[1] which would (if it means the eatable heart at the top) be hardly inflammable; in any case, the palm- wood would be unnecessarily difficult to obtain at Nineveh, since the palm does not grow properly above

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(1) קוֹר is given by Dalman as Palmkohl (Gipfeltrieb der Palme).

Q u e s t i o n M I

muck), Perhaps something of the same kind lies at the back of the writing in John, the high priest (ib, 733), possibly an echo of the old fear of connection with abortions- "care must be taken with births that abortion must not be brought about, abortions of the flesh are produced and give place to [illegible] not in the light of the world because of the [illegible] and [illegible] the favourable moment for birth was not observed, equally in [illegible] fabrication, when (the work) is not accomplished according to proper rules, the remedies produced in the receipt are not successful".

1. 10. [illegible] probably styrax-wood, a gummy wood, of which there were large plantations near Harran in the VIIth century B.C. [illegible] in the next section, 1. 1, is the gum of this tree (AH 136, ff.), official storax is the inspissated juice of the inner bark, so that presumably the wood after decortication has no value as a source of gum (see 1. 10), but as a gum-producing tree its wood, then [illegible] will be useful as a producer of heat, is an additional piece of evidence to my identification in AH 136. It is worthy of notice that the Rabbinic [illegible] remarks that the [illegible] of styrax is called [illegible] "perfect white", which bears on the meaning of [illegible] "the white drug, or plant", I had already noted this whiteness in regard to the actual blossoms, but not with the gum (AH 137).

1. 11. [illegible], I disagree with Meissner in his translation "Palmetto(?)", doubtless comparing [illegible], in the first place the actual meaning of [illegible] is given by Brockelmann as [illegible], which would fit in quite well with the [illegible]; but in any case, the palm-wood would be uncommonly difficult to obtain in Nineveh, since the palm does not grow properly above

[illegible]

Tuz Khurmati: and it is also one of the most valuable trees in Mesopotamia. I suggest that q u r u is the Heb. קוֹרִי (Dalman, Aram. - Neuheb. Lex., 357), "beams, timber", and that this refers to the logs of *styrax-wood. Since the styrax grew plentifully on the latitude of Harran there should be no difficulty in accepting its habitat as nearer Nineveh.

Q i ṣ r a . Again I must ddisagree with Meissner in his translation "der keinen Knoten hat" : I cannot see what objection there could be to wood with knots in it. Moreover, a knot in a tree is usually the mark of the place whence a branch has shot forth : the palm tree owes its serrated appearance to the innumerable close-clipped stumps which mark the original branches, all carefully cut off close to the trunk. If these branches mark the knots on the palm, no palm wood would be without knots. For that matter, I am inclined to think it would be difficult to find any wood for firing without knots.

The glass-maker is here advised to use wood which will give the maximum of heat; a wood fire is, in any case, a poor heat-producer, compared with coal, and doubtless the difficulty of making a fire sufficiently hot was the greatest problem with which the Assyrian glass-maker was concerned. Hence his wood above all things must be dry ; it must not have lain exposed to damp, it must have been kept under cover, and it must have been cut in Ab, the hottest and driest month of the year.

(Mašku) a-p i I take to be the same as the Syr. ܡܫܟܐ "cloak".

B... L. 13. On u k n ū i b b u see Sect. 13. On IM.MA.NA see Sect. 9.

L. 14 . D i g m e n u , Meissner rightly "Asche(?)". It is one

of the Assyrian equivalents for BIL (=="fire"), SAl 3086. On the alkalis in use, see Sect. 8 . On (U)UD, see Sect. 26, p.71. On a ḫ ē "separately" , cf. AM 13,6,19, and 96,1,4, and my article PRSM, 1924, 29.

L. 15. A n a k ū r i š a ŠA ē n ā^{pl} - š a k a ṣ i - t i . I cannot agree with Meissner "in einen Ofen dessen 4 Augen (?) kalt sind" . The parallel passage in l. 51 definitely says š a ŠA ē n ā^{ii} - š a k a ṣ i t i "the ŠA of its two eyes". Besides , k a ṣ i t i is singular feminine, not plural , a point which should have been noticed. The "eyes" must be the openings in the floor of the upper part of the furnace through which the flames are drawn : for a picture of an ancient Assyrian kiln, see Andrae, fig. 37, in which those holes will be plainly seen.

T a r i d d i , from r i d ū in its sense of "pursue", must mean "push", and so, "settle".

L. 16. I p i ṣ ṣ ū , cf. Pl. 4, K.7125, l.19.

L. 17. T u k a ṣ ṣ i must be from the well-known root k a ṣ ū "be cold", in iii,I, "make cold". T a m a r r a q , the Heb. מרק "rub", as Virolleaud suggests (Babyloniaca, iii, 222): cf. PRSM, 1924, 27. Ṭ a p t i z a k u t i (cf. ll. 21,51,55: l.52 i š i d ṭ a p t i k ū r a l a i k a š š a d , and l. 59, ṭ a p t i e m e t i (cf. Pl.4, K.7125, 10, ṭ a p t i e - š i t i). I cannot agree with Meissner's "in eine gute (Form)". Ṭ a p t u (not ṭ a b t u) must mean a fritting- or melting-pot here, and as such will be connected with the Aram. טוף , the Syr. ܛܳܦ "be inundated", and in Afel "made to flow". There would be little use in putting this first frit into a mould "of good form", which will be seen further on to be t a m š i l t u.

L. 18. *ana kūri ša takkanni kaṣiti-*. I doubt if Meissner is right : "schliesslich sollst Du sie in einen Ofen, dessen Innenraum kalt ist, hinabbringen". *Takkanni* would surely have a possessive pronoun after it, if this translation is to be defended. The phrase occurs also in ll.37 and 55, and on pl.6, K.5862,7 : cf.ll.21 and 40, *ana kūri ša takkanni immeti* . I am inclined to think that, as *kūri* is a feminine (see l.15), we have a hif'al here from √*kanū* ,ii,1, "prepare carefully". In l\.199 we have *ina kūri ša tukkanni ina ḫaragi šaktumte* , where *tukkanni* is a difficulty, and may be a mistake for *takkanni* . I suggest that it means "thou shalt put the mineral down into the furnace , which has been allowed to grow(or , is being allowed to grow) cold, hot". But it is not entirely satisfactory.

L. 20. For the restoration of the name of the first frit , see Sect. 13.

L. 23. For [ir]aššušu , see note to l.56.

C. L.26. We must surely restore *mu-uṣ-la-li* "roof" , in accordance with the directions given in the Syro-Arab. treatise in Berthelot(ii,31) that "burnt copper", after its manufacture, should be exposed to the sun for three days (See Sect. 19).

D. L. 34. For *ahuzzu* , see Sect. 13.

L. 39. For *zukū* , see Sect. 18.

E. L. 48. *Tanaṣṣalamma* (also in l. 60; *tanaṣal* , in ll. 96,100) obviously the Syr. "to pour on".
For *tersitu*, see Sect. 18.

l. 10, a n a k u r i a n t a k k a n n i K i p i t t
i doubt if Zimmern is right : "Amputation sollst Du nic
in a ofen.d.=sen inneren Kalt ist,hineinbringen". T a k
k a n n i would surely have a possessive pronoun after it,if
this translation is to be defended. The phrase occurs also
in ll.37 and 53,and on pl.C.S.Sect.7 : cf.l2,22 and 40, a
k u r i a n a t a k k a n n i i m m e t t i . I am inclin
to think that ,as k u r i is a feminine (see l.17), we hav
a kit'al here from k a n u ,ll,l, "prepare carefully".In
ll,100 we have i n a k u r i a n a t u k k a n n i i
ū a r r u ū a k k u u t d ,where t u k k a n n i is
difficulty,and may be a mistake for t a k k a n n i . I
suggest that it means "thou shalt put the minded down into
the furnace ,which has been allowed to grow 'cr , is being
allowed to grow) cold,hot? But it is not entirely satisfact

l. 20. For the restoration of the name of the first Tell s
Sect. 10.

l. 23. For [i r]a s u u a , see note to l.59.

O. l.28. without surely renters; a a - u g - i a - l i
"roof" ,in accordance with the directions given in the Syr
arab. treatise in Berthelot(ii,53) that "burnt copper",aft
its manufacture,should be exposed to the sun for three day
(See Sect. 13).

R. l. 34. For a h u s u , see Sect.13.

l. 38. For z u k u , see Sect.20.

R. l. 41. T a n a ş a l i m m a (also in l. 69): a n
ş u l ,in ll. 98,100) obviously the Ar. ✓ "to pour o
For t u r a l t u , see Sect.19.

F. L. 49. For s i r ṣ u , see Sect. 14. Ḫ a r ṣ u and l a t a i a r u , describing alkali, are difficult. It may be that these two words refer to the distinction which is made between the "hard lumps" of rochetta, roquetta (see Sect. 8), and the ash. Since the "hard lumps" are better than the ash, and as we have already (in l. 14) the mention of d i g m e n u "ash" in connection with the alkali, I suggest that the ḫ a r-ṣ u refers to the lumps, and that the meaning is to be sought in the Heb. חָרוּץ "sharp" (here hard?), while t a i a r u , the equivalent for the inferior ash, can be referred to the ordinary t a i a r u == "turning, merciful", and so perhaps "yielding, soft" But it is uncertain.

L. 50. On n a m r u t u , see Sect. 10. On s a n d u , see Sect. 18.

L. 53. Š i b l u k k u : from its connection here we may surely identify this word with the Syr. ܫܒܠܘܩܐ "bubbles". The elimination of bubbles in the manufacture of glass is discussed in Roscoe (ii, 584).

L. 56. I r a š š u š u , used of the glass-"metal", and copper. (L. 23: Pl. 4, K. 7125, 5; i r t a š š u, l. 57). The sense demands "melt", but it is not easy to find any satisfactory Semitic comparison, unless رشّ "sprinkle" is at the base of it.

L. 58. L a n u would appear to be the object of the first verb in the line, and may be the same word as the second l ā n u in MA 491 (Del., HWB. 382) " wall , enclosure".

T a b i l t u, like the name of the canal T e b i l t u, from a b ā l u "to conduct", either a channel, or a hole.
K. 4266 adds a few words after "if the metal runs": "... glass (crystal) will be formed (?), ... it boils".

L. 60. For Z A G I N , see Sect. 32.

G. This Section was attempted by Meissner.(Bab-Ass.,ii,384).

L. 61. Marqa, applied to sirṣu - glass must be from marāqu "rub, crush" (see note to l. 17).

L. 63. Tamšiltu, fairly frequent in these texts, from mašālu "be like", i.e., a mould. Tašnū, from šanū " repeat".

L. 64. Merku, see Sect. 20.

H. Part quoted by Meissner, Bab.- Ass.,ii,384. For the various components, see Sect. 20.

L. 73. Maškantu, from šakānu "put", occurs frequently in these texts, but I cannot see that it has any special meaning beyond "composition".

J. See Sect. 21.

K. L. 74. See Sect. 22 for šadā.

N. L.80. For siparru arḫu see Sect. 24.

P. L. 95. Ḫaragi, a difficult word. See Sect. 14. Ešetu, fem. from ešū, again occurring in a similar connection with the negative in 1.99, and without in 1.100. As a verb the root occurs on Pl.5,K.4266,iv,32: "2 tamrata (tak)amnaka teššī ṣita ==thou shalt cover the excrement(?) with two spoonfuls of sand": and Pl. 4,K.203,vi,6; išdi tamšiltika teššī == thou shalt cover the bottom of thy mould". The idea "cover" is shewn by MA 111, where a comparison is rightly made with the Arabic غشى .

Q. L.97. Tusamaḫ, Küchler, Medizin,K. 71,b,ii,43,"verreiben". See also my forthcoming translations of my Medical Texts, NO. 78.

L. 98. Ikapiluni, Semitic comparison doubtful.

(S e c t i o n 20)

a. This Section was attempted by Holzinger, (Keb-ass.,ii,3041).

b. 61. R a r q u , applied to s i r q u - gloss must be from r a r a q u "rub, crush" see note to l. 171.

c. 68. T a n a l l t u , fairly frequent in these texts, from n a d a l u "be like" , i.e., a model. T a n n u, from s a n u " repeat".

d. 64. k a r k u , see Sect. 20.

e. Part quoted by Weissner, Bab.- ass.,ii,354. For the various components, see Sect. 20.

f. 73. N a s k a n t u, from s a k a n u "put", occurs frequently in these texts, but I cannot see that it has any special meaning beyond "composition".

g. See Sect. 21.

h. l. 74. See Sect. 22 for s a d a .

i. l.80. For a t p a r r u a r b u see Sect. 24.

j. l. 98. H u r a n i , a difficult word. See Sect. 34.

k. a s l t u ,fem. from a s u , a w o r d occurring in a similar connection with the negative in l.99, and without in l.100. The verb the root occurs on VI.R.,4904, iv,32: " s i n n a t a (var: s a n n a k a t e s i e i t a =thou shalt cover the storehouse(?) with two measures of sand") and Pl. 4,R.,205,vi,9: l i s i t a m i l i k a t a s i = thou shalt cover the bottom of thy mould". The idea "cover" is shown by ii 111,where a comparison is rightly made with the Arabic

l. l.97.T a s a w a h, Thompson, Medizin,K. 71,b,ii,49,"water-falls". See also my forthcoming translations of my Medical Texts,20, 79.

m. l.98. k a p i l a n i ,Semitic comparison doubtful.

L. 101. T u p a k k u , perhaps Arab. فلّ " loose, separate".

L. 102. On ṣ i p r u see Sect. 36, A.

S. (K. 203, Pl. 4):

L. 4. On (tak)AŠ.GE.GE see Sect. 15.

L. 9. On b a r u m m u see Sect. 16.

L. 11. On š i k t u and t u s k ū see Sect. 14, A.

L. 14. Ḳ a ṭ p a n i , permansive from q a t ā p u , doubtless the equivalent of the Arabic قطز "sift".

L. 16. On d u š ū see Sect. 14.

L. 17. M a š š i t u == n i š i t u, the former from m a š ū "forget", and the latter from n i š ū "forget". But I doubt if this is the word here, and am inclined to think that here and in K. 4266, V, 6, where the same phrase occurs, annitu maššitu, that it is a derivative of m a š š u "bright", with reference to its property in the latter case of the arsenic (see Sect. 4).(1)

T. This section was attempted by Meissner, Bab.-Ass., ii, 384.

L. 21. For l u l ū see Sect. 14.

X. L. 23. ZU == i d ū "know" (possibly here in its sexual sense, i.e., be mated to) and r u d d ū "add". Very doubtful.

L. 25. K a l g u g u. In my forthcoming translations of my Medical Texts (second part), No. 59, AM 75, 2, K. 6629, I am discussing this word. Briefly k a l ū (IM.MAL.LI) may be a condition set up in the eye (probably reddish, through their being bloodshot): K a l ū (SAI 6352) == IM.GUŠKIN ("golden earth"), illur pani ("face-bloom"), followed on CT XIX, 21, 32, by IM.DIR == šaršarru (vermilion, red earth). Illur pani, as I am suggesting, perhaps represents a rouge, and if so, an oxide of iron, jewel-

(1). Having regard to the repetition of the firing in the present instance, we can compare Blancourt (57), where he describes the making of "a very fine and perfect crystal", laying down that the melting with the addition of a little manganese and putting in water shall be repeated" until the crystal be separated from all this sort of salt".

lers' rouge, or perhaps r u b r i c a . In Sect. LL it is mixed with IN.NU.[UŠ], which as I had begun to think in AH 269, was gum- tragacanth rather than savin, which I had also suggested. If k a l g u g u means "rouge", some substance is necessary to make it adhere to the cheeks, and hence IN.NU.UŠ (== m a š t a k a l) may well be the gum of the tragacanth. The similarity of the strange word m a š t a k a l to astragalus must not be forgotten.

L. 30. Ṣ i - e - ṭ u, perhaps צֹאָה "dung".

L. 31. T u b a l , Heb. בּוּל "mix". T a m r a t a, Syr. ܬܡܪܬܐ "spoon".

Y. L. 34. On BE-ir == t e s i ḫ ḫ i r "thou shalt heat", see my forthcoming translations of Medical Texts.

PP. L. 2. T u ṣ a d, cf. ṣ a- a- du š a e r ē (MA 869).

L. 13. I p p a t t i k , cf. p i t i k , of casting half-shekel pieces, by Sennacherib, (King, CT. XXVI, 26, 18).

Ll. 16, 22, ṣ i p p a t , צִפָּה "overlay".

Section 27. Some other Chemicals.

With the completion of the Chemical Texts we can consider some of the other minerals. The first step is to limit our range to those minerals with which the Assyrians themselves were familiar(Sect. 28), after which, by identifying the stones used for making seal - cylinders, the substances used for pigments, and so forth, we can consider several closely allied to them which, if I am right in my identification, really come under the head of what we should call chemicals, and, if so, we must concede to the Assyrians a great knowledge of practical geology and chemistry.

Section 28. A Table of the Minerals of Mesopotamia.

The following is a table of the minerals found in Mesopotamia with their relative distance from Nineveh(Mosul). This distance is given in miles as the crow flies, and I have in most cases given only the nearest occurrence. I am indebted for my facts to *The Geology of Mesopotamia* (Admiralty Staff Handbook, here abbreviated to "G") and Ainsworth, Assyria(abbreviated to "A"). The points of the compass are given before the reference.

. . . .

Distance in Miles from Nineveh.	Mineral(direction, authority).
1 -- 25.....	Calcareous Gypsum(Mosul Marble),(A.257). Coarse limestone (A.,257-259). Sulphur (A.,259: cf. Berthelot,Hist.,ii,132, (quoting Bar Bahlul) a yellow sulphur found in a Mt. Barimma,between Mosul and Tekrit). Petroleum (S.,G.,fig.8).
25 -- 50...	Chalk(A.,26: G.,fig. 14).
50 -- 75...	Iron(NE., G.,fig.8). Cinnabar(at Kerkuk Baba,SE,A.,243). Serpentine,jasper(SE.,A,249).
75 -- 100..	Sandstone (S.,A.,115). Copper (NE.,G.,fig.8). Lead (N.,G.,fig. 8). Basalts (N., A.,266). Coal (SE.,G.,fig.8). Breccia (N.,A.,265).
100 -- 125..	Salt (NW.,G.,fig.8). Haematites (Mardin, A.,269
125 --150...	Gold (NE.,G.,fig.8).
150 -- 175..	Antimony (NW.,G.,fig.8). Borax (near Lake Urmia,A.,71).

175 -- 200...	Platinum (NW.,G.,fig.8). Breccia (W. A.,28,73,74). Manganese(Birejik,A.,57). Basalt,dolerite(Diarbekr, A.,270).
200 -- 225..	Mercury,Orpiment,Realgar,Chrome Iron in Serpentine (SE.,G.,70).
225 -- 250	....
250 -- 275	Tin (Qara Dagh,G.,69). Manganese (NE.,G.,fig. 8). Copper (at Arghana Ma'den,the great mines,NW. Chesney, Narrative,523: A.,273): also jasper, calc-spar ,coppr pyrites,asbestos , (A., 273)
275 -- 300..	Zinc (NE.,G.,fig.8). Granite,gneiss,limestone,diorites, mica schist (NW. ,A., 19). Mines of Keban Ma'den,silver,argentiferous galena,white carbonate of lead,sulphate of copper, arseniate of lead, diallage,serpentine(A.,19,280).
300 -- 325	Topaz,beryl(Dimbu Dagh,near Divrigi River,NW. A.,285).
325 -- 350..	Carnallite, mamanite(SW corner, Caspian,G.,71).
350 -- 375	Cobalt(G.,fig.8).

It may be added that T u r q u o i s e comes from Serabut-el-Khadem, (Sinai Peninsula) and from Meshed in Persia(L.J. Spencer, The World's Minerals, 141): T o p a z from Mûkla in Asia Minor, and E m e r a l d from Kosseir(Upper Egypt) (L. J. Spencer, Precious Stones, 339, 310): there are old C o r a l reefs at Bahrein (Persian Gulf)(G., 28).

S e c t i o n 29. T h e A s s y r i a n P i g m e n t s.

It has already been noted in Sect. 2, that the Assyrian word a b n u "stone" covers the inorganic substances. Like the Heb. אֶבֶן, it includes both hailstones(Jos. x, 11) and ores (Dt. viii, 9: Job, xxviii, 2).

With this clue we can begin with a series which will be found, I think, to supply us with the names of some of the minerals used as paints. This has certainly been recognized, I think, in the case of u k n ū (see Sect. 13), and perhaps I may add my identification of s a n d u with cinnabar(PRSM, 1924, 9), a meaning which it appears to have, as well as carnelian. Otherwise we have not gone beyond repeating the Assyrian names of the "stones" with which the Assyrian kings decorated their palaces, except such well-known stones as p a r u t u, TUR.MI.NA.BANDA, and u š ū; e.g., Luckenbill, (Annals, 1924, 138) "Silver, gold, sandu-stone(cornelian?), lapis-lazuli, ḫ u l a l u , m u s h g a r r u, UD.ASH -stone, UD.ASH. ASH -stone". When we remember that these were meant to be used for the palace, it would not be unreasonable to see in the unidentified substances, or, at least, some of them, the paint for decorating the walls.

S e c t i o n 30. T h e C h i e f S t o n e s u s e d i n B u i l d i n g.

Before beginning a discussion of the pigment-substances, it will be as well to eliminate the known names of the building stones in use;-[1]

(1). (tak)K A L == u š ū . This is the material used for the Gudea statues, and is, consequently, diorite or dolerite (see Amiaud, ZK., i, 249: Jensen, KB., iii, I, 40: Geller, AOTU, i, 335 : BoFr., 35). (TAK)š u - u is once used to define diorite (Weissbach, Bab. Misc., 7), possibly incorrectly, since this mineral is given as an equivalent of (tak)DUB.MAL and (tak)kašari (CT. xiv, 15, 8: 17, 8, a).

(2). (Tak)GIŠ.ŠIR.GAL == p a r u t u . This actually describes a stone of a very fine calcareous kind (Scheil, RA, 1918, 119). It has also been held to be a l a b a s t e r (Haupt, Delitzsch), or m a r b l e (Winckler, Thureau-Dangin)[2], and not improbably it was used in a wide sense; Sect. 14, b, shewing that it was also probably magnesite. The fact that about 1 part of t u s-k ū turns 360 parts of clear glass into "opaque p a r u t u" indicates that normally p a r u t u was translucent, and hence, scientifically, represented a l a b a s t e r.

(3). p ī l u p i ṣ ū == limestone , and (tak)TUR.MI.NA BANDA == breccia, both so described as such on the material of the Procession - Way of Marduk in Babylon (Koldewey, Aiburschabu, 6: BoFr66).

(4). (Tak)K a š u r r u == basalt, the material of a doorstone so described (Meissner, AF., ii, 55: Thureau-Dangin, RA, 1921, 167, n.3).

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(1). For the materials in general, see Meissner, Bab.-Ass., i, 319.

(2). See Geller, AOTU, i, 4, 340: Meissner, Bab.- Ass., i, 349 takes it as "Marmor".

S e c t i o n 31. T h e S t o n e s u s e d f o r C y l i n d e r - S e a l s.

Next we can consider the list of materials given for seal-cylinders(KAR. 185, rev. (?), i, 10-16: cf. also the tablet Rm. 203). It is unnecessary here to quote the properties which each stone possesses, whereby the fortunate owner is benefited, although these are added in each case;-

(10) (tak)k u n u k k u (tak)KA.GI.NA

(11) (tak)k u n u k k u (tak)ZAGIN(u k n ū)

(12) (tak)k u n u k k u (tak)DU.ŠI.A(d u š ū)

(13) (tak)k u n u k k u (tak)ZA.ṬU UD.AŠ

(14) (tak)k u n u k k u (tak)ZA.ṬU MUŠ.GIR(m u š g a r r u)

(15) (tak)k u n u k k u (tak)GUG (s a n d u)

These must represent six distinct classes of stones from which seal-cylinders are made, and, we may reasonably claim, six h a r d stones. We can proceed further in this by comparing the actual stones found in the collections of existing seal-cylinders, as given by Hayes Ward (Seal Cylinders of Western Asia;

B L A C K	:	black serpentine, haematite
B L U E	:	lapis lazuli
TRANSLUCENT	:	quartz crystal, green glass
W H I T E	:	aragonite, white (dolomitic) marble, white limestone, shell
G R E E N	:	serpentine (green calcite, green marble) (1)
R E D	:	jasper, red carnelian

It will be noticed that f o u r of the Assyrian words for seal materials occur among the substances used for decorations in Sect. 29 (with the exception that ZA.ṬU has been prefixed to the two seal-materials, UD.AŠ and m u š g a r r u). I suggest that, following up the clue provided by u k n ū "lapis, blue material for paint", and probably also s a n d u "cinnabar",

(1) For these two last, see Sect 37 note towards the end

"vermilion paint", we shall find other pigment materials in the "stones" mentioned in the Assyrian building-texts.

S e c t i o n 32. U k n ū , lapis lazuli, blue pigment.

U k n ū was long ago shewn to be lapis-lazuli (see MA, s.v.). It came from Mt. Bikni in Persia (1), Mitanni (NW. Assyria) (2) Kuṣaṣir (3), Mt. Dapara (4). Various objects made of u k n ū, as well as different shades of colour of the stone, are given on a cuneiform list (Scheil, RA, 1918, 115, r. 52, ff., and cf. CT. VI, Bu. 91-5-9, 285). Noticeable is (tak) ZAGIN. AŠ and (tak) ZAGIN. AŠ. AŠ == ṣ i p r u (Br. 11777, 11778), of the same form as (tak) UD. AŠ and (tak) UD. AŠ. AŠ (see Sect. 36, a). Note also (tak) NA. ZAGIN. NA (CT. XIV, 16, S. 1805, 7), probably the mill used for grinding the u k n ū, lapis, into the ultramarine powder used as paint.

Interesting also are the groups

a) SIG. ZAGIN. DIR == * a r g a m a n u "red- purple" (of wool, (Br. 11780).

b) SIG. ZAGIN. MI == * t a k i l t u (dark blue, of wool, Br. 11783).

c) (tak) ZAGIN. ZUN. GUŠKIN == ("lapis: plural: gold"), ṣ i p i r h̲ u r a ṣ i (Br. 11782), i.e. "the mineral is often spangled with iron pyrites" (Rutley, 255) (5).

The important point about u k n ū is that it is not only lapis, the mineral, as used to make seals, but also the same stone powdered to make that pigment known as ultramarine (of which Theophrastus speaks, De Lapid., Sect. C). It is a paint of which the modern Persians and Indians are

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(1). For the latest theory of its position see Haupt (AJPhil: 1924, 245), who puts it at the edge of the Salt Desert, i.e., Dasht-i-kevir, in Khorasan, which seems to me to be too far from Nineveh. (2). BoFr. 37. (3). Thureau-Dangin, Huit. Camp. 1. 350. (4). II R. 51, No 13, b. (5) On s i p r u == sapphire see Sect. 36, a, and Pliny NH, xxxvii, 39.

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S e c t i o n 32. U k n ū , lapis lazuli, blue pigment.

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Interesting also are the groups

a) giš ZAGIN, GIN = a r g a m a n u "red- purple" (of wool, (Br.11780).

b) SIG, ZAGIN,MI == t a k i l t u (dark blue ,of wool,Br. 11784).

c)(tak) ZAGIN. ŠIN. GUŠKIN = ("lapislazuli gold"),g i p i r ḫ u r a ṣ i (Br.11782),i.e.,"the mineral is often spangled with iron pyrites"(Bailey,235) [(5)].

The important point a bout u k n ū is that it is not only lapis,the mineral, as used to make seals, but also the same stone powdered to make that pigment known as ultramarine of which Theophrastus speaks ,De Lapid., Sect. 31, lazuli a paint of which the modern Persians and Indians are

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so fond. Lapis was known in Babylonia as far back as the Third Dynasty of Kish.[1]

S e c t i on 33 . S a n d u , Cinnabar, Vermilion, Carnelian'.

Literally "red - stone".[2] It is used in making cylinder - seals (See Sect. 31), so that the accepted identification with carnelian is sound: equally, it might be the red jasper.[3]

But its use in the medical texts also indicates a red drug, which certainly cannot be a hard stone, and I therefore suggested that it might be c i n n a b a r (PRSM, 1924, 9), which is found at less than 75 miles distance from Nineveh, and is the well known paint vermilion. I suggested also that it might be the original (by a "merchants' garbling") of the Greek [illegible] " minium" (cinnabar). It is possible (but I am not by any means certain) that IM.KAL.GUG may mean "vapour of cinnabar"==mercury (ib.), The use of (tak) GUG, s a n d u, in the decoration of the palace , certainly points to a red paint, parallel to u k n ū "ultramarine", and cinnabar will therefore be the obvious one. "Red lead" is ruled out, because that is s ā s u (Sect. 34).

(Tak) s a n d u in Assyrian times came from Meluhha, (II R 51, 1, 17), it being expressly defined as "(tak) s a n d u of Meluhha" (V R, 30, 68, 6: CT. VI 11, 1, 6). Meluhha has been variously defined as being in Arabia or Sinai (see HA 537). (Tak)

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(1) Circa middle of Fourth Millennium, B.C. (Langdon, Camb. Anc. Hist., i, 369. Cf. Meissner, Bab.-Ass., i, 350, "before Sargon's time". (2). I was wrong in PRSM, 1924, 9, in suggesting any connection with [illegible] "haematite", which will be seen (Sect. 41) to be š a d a n u. (3). The more exact word for jasper (or, at all events, agalmatolith), judging from the Assyrian word specially describing the material of which the seal of Urzanna is made, is (tak) AN.KAL (see BoFr., 44).

s a n d u came also from Muṣaṣir (Thureau-Dangin, Huit. Camp. l. 350). A stone GUG. GI. RIN. E from Meluḫḫa occurs as early as Gudea (BoFr. 15). I might add here that while digging for the British Museum at Eridu I found a small pot containing traces of a red colour (not yet analysed, Archaeologia, lxx, 111).

(Tak) S a n d u would therefore appear to be, in general, "red stone", carnelian, cinnabar (cf. Thureau-Dangin, Huit. Camp 52). The former is used for the seals, the latter for vermilic paint (certainly in classical times, Pliny, NH, xxxiii, 36, 37, and Rutley, 363).

With these two notable pigments identified, it remains to be seen whether we can identify any of the other "stones" with substances used as pigments.

S e c t i o n 34. Ḫ u l a l u, Ceruse, White Lead.

(Tak) ZA.ṬU,(1) ḫ u l a l u , is another common "stone" used in the building-texts . But it must first be noted that not only is (tak) ZA.ṬU used thus alone, as representing the distinct substance ḫ u l a l u , but it is also used as a prefix compounded with other "stones". In one case only, in these compounds in the vocabularies, do we find the ZA. ṬU specifically translated: (tak) ZA.ṬU.IGI is given equivalent to ḫ u l a - l u i -ni, "h u l a l u of the eye". In the others defined by ZA.ṬU all reference to ḫ u l a l u is omitted in the translation, so that we are entitled to suppose that ḫ u l a l u would here be incorrect, and we must seek some other (but allied explanation.

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(1) And also (tak) ZA.SU, .ZA.NIM. ZA would appear to be some kind of definition, but that it == a b n u here (Br. 11721) is not very attractive. From the groups of stones in which it occurs as the first component, it might almost seem to mean "colour" ((tak) ZA.GIN "blue", (tak) GUG == ZA and GUL, "red", (tak) ZA. ṬU "white" (tak) ZA.SUH "black". (BoFr., 4, "shining").

Consider first the following list from CT.XIV,17(K.4548):

....	....
[(tak)]....................	di - ik - rum
(tak)HE(?). GUG	(")
(tak)KIL. GUG	"
(tak)BIR. GUG	"
(tak) ZA.ṬU	ḫu - la - lu
(tak)ZA.ṬU. BAD	sa - a - su
(tak)ZA.ṬU. IGI	ḫu-la-lu i- ni
[(tak)]ZA.ṬU.PA.ḪU.NA	ša kap-pi iṣ-ṣu-ri
[(tak)]ZA.ṬU. e-lal-lum	ŠU
[(tak)ZA.]ṬU.ma-dal-lum	ŠU
[(tak)ZA.]ṬU. MUŠ.GIR	muš- gar - ru
[(tak)ZA.ṬU.]IGI.MUŠ.GIR	i-ni muš-gar-ri
[(tak)ZA.ṬU.] UD.AŠ(1)	šu-u
[(tak)ZA.ṬU.UD]AŠ.AŠ	....
[(tak)ZA.ṬU.]ŠUBA	....

Ll.6,7,thus shew a mineral ḫ u l a l u which by the addition of the epithet BAD becomes in Assyrian s ā s u . Now, although BAD commonly means "old",it may also mean "roasted" or "heated"(see Sect.26,note to Y). The latter seems to be its meaning here. The Semitic equivalent here is s i k e r u (SAI 872) the Arabic سقر "heated,melted" as I am pointing out in my forthcoming translations of the second part of my Kedi-

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(1) For the certainty of these restorations,see CT.VI,11,Bu. 91-5-9,285,I,53-54.

cal Texts.

Now, on our assumption that we are still dealing with words meaning colours, we can find an admirable Semitic equivalent for s ā s u in the Syr. ܣܳܣܓ݂ܽܘܢܳܐ "purpureus", literally, when it is broken up into its two component words, s ā s and g ū n ā, "s ā s - col our". That is to say, h̠ u l a l u is, on our assumption, a colour - substance which, after roasting, becomes r e d . The answer to the problem appears now to be simple: h̠ u l a l u must be the white lead used in painting, which, after roasting ,as is well k nown, becomes r e d l e a d.

We have thus a good Semitic parallel for s ā s u in ܣܣܓܘܢܐ : with what can we compare h̠ u l a l u? And, fur ther, what does ZA.ṬU (=h̠ u l a l u) mean when it is prefixed to UD.AŠ, UD..AŠ.AŠ, MUŠ.GIR, and ŠUBA?

Now w h i t e l e a d, the ancient c e r u s e, is prepared by the action of acetic acid on metallic lead, a method well known to the ancients. " White lead has long been known, being called ψιμυθιον by Theophrastus. The process of manufacture as described by him consisted in the action of vinegar on lead, the material formed being scraped off after a time from the surface of the metal. Pliny mentions the same subject under the name of c e r u s s a, and describes the above method of manufacture" (Roscoe, ii, 900: Diosc. v, ciii: Pliny, NH, xxxiv, 54). The directions actually given by Theophrastus for making c e r u s e are as follow (Hist. of Stones, trans. Sir John Hill, ci):- "Lead is placed in earthen vessels over sharp vinegar, and after it has acquired some thickness of a kind of rust, which it commonly does in about ten days, they open the vessels and scrape it off, as it were in a kind

of foulness ; they then place the lead over the vinegar again, repeating over and over the same method of scraping it , till it is wholly dissolved ; what has been scraped off they then beat topowder, and boil for a long time ; and what at last subsides to the bottom of the vessel is the ceruse. (cii). In a manner also, something resembling this is verdigrise made ; for copper is placed over the lees of wine and the rust which it acquires by this means is taken off for use." (1)

Now there is a most striking Semitic comparison for h̲ u-l a l u (if we are to follow this clue of treatment with acetic acid) to be seen in the Syr. ܚܠܐ (from the root ܚܠ ,خَلّ) "vinegar". If this be correct we have good warranty for our theory that h̲ u l a l u ,as the substance obtained by the action of ܚܠܐ "vinegar" ,i.e. literally "the acetated thing", which, as we have seen becomes s ā s u "red lead", by the simple addition of the sign BAD meaning "roasted".(2)

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(1) Theophrastus died in287 B.C.

(2) The form h̲ u l a l u is ,of course, exactly the same as the Syr. ܚܘܠܠܐ purgamentum, sordities. It is a nice question whether these two words are in any way connected: ܚܘܠܠܐ is referred to the root ܚܠܠ purgavit, and as such will have nothing to do with our word ܚܠܐ : on the other hand , the remark about "a kind of foulness", for the lead scraped off in making the ceruse, has a curiously similar ring. It is conceivable that there has been some confusion between h̲ u l a l u, "the acetated substance" (i.e. "white lead"), the Syr. ܚܘܠܠܐ sordities, from the "kind of foulness" scraped off in the manufacture, and the root which gives ܚܠܐ "vinegar".

There is, however, one point which demands explanation. As far as I know, there is no Assyrian word for "vinegar" comparable philologically to the Syr. ܚܠܐ, the Assyrian equivalents being e m ṣ u (as I shewed in PRSM, 1924, 21) and ṭ a b a t u . In other words, we are attempting to identify what may be described as a "secondary" form ("acetated"), before the "primary" ("vinegar") of the same root has been discovered. If this really be a problem (and I, for one, am inclined to think it is), how is it to be explained?

One explanation may be that in the Assyrian word ḫ u l a l u we have a reference to some form of acid stronger than the ordinary vinegar. Roscoe (ii, 91) says: "It was also well known that vinegar acted as a solvent upon many substances, as in the celebrated story of Cleopatra dissolving pearls.[1] The Arabians were acquainted with many other acids. The Latin Geber termed nitric acid aqua dissolitiva, and he gave the same name to the liquid obtained by strongly heating alum in a retort, which was probably dilute sulphuric acid".

Another explanation, but one less probable, is that ḫ u l a l u was a special word in use among the lead-miners of the North-west (say Keban Ma'den, the lead mines), who may have come from a different Semitic stock from the Assyrians, and, like the Syrians, used the word ܚܠܐ, and the Assyrians took over the word ḫ u l a l u with the product.

Another point is worth noticing. Tushratta, king of Mitanni (the country to the North-west of Assyria) sends to Egypt

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(1) I propose to discuss in Sect. 37 the debated question of the traditional acid on rocks in classical times.

in the Fifteenth Century B.C. a great quantity of gifts decorated or embellished with h u l a l u . The mines of Keban Ma'den (silver and lead) ,if not actually within his domain were very near to it, and easily accessible to his merchants, a detail which adds a little weight to the view that h u l a-l u is "white lead".(1)

The provenance of h u l a l u is given as Irkab in II R,51,No.1,14,b.(2)

In Assyrian Medicine we find h u l a l u used ,but its particular value as a drug is not always easy to define,owing to the mutilated condition of the texts. In AM it occurs some 12 times,but of those occurrences not all are medicinal. It is ,however , certainly prescribed for external use(temples, 20,1,31, with which cf. IB,73, recommending white lead for the forehead in embrocation): apparently applied in oil(41,2, 6). One instance must be carefully noted in which "one šu" of h u l a l u is prescribed with several other drugs,and at the end of the receipt either these or some different portion of the receipt(which has got lost in the break) are to be drunk(4,4,2). We are therefore in doubt whether the prescription indicates that the "one šu" of h u l a l u is to be drunk or applied. It is hardly necessary to point out that white lead is a poison, a fact which Pliny knew(NH xxxiv,54), but Roscoe points out (ii,900) that the descriptions given by Pliny would lead us to suppose that to this writer the difference between white lead and sugar of lead(acetate of lead) was

(1) See the Tushratta letters and inventory in Knudtzon,Die El-Amarna Tafeln.
(2)Is it too remote from possibility that the name Mitanni, the country either including,or very near to the two great mines Keban Ma'den and Arghana Ma'den,may be connected philologically with m a ' d e n "a mine"?. Can Irkab be associated with A r g o v a n near Keban Ma'den?

not known: and if this confusion between the two existed in Assyria as well, our medical text (presuming that the "one $\check{s}$ u" is to be drunk) would not then be against the theory "white lead", since a c e t a t e of l e a d is prescribed to be drunk in small doses as a sedative. We should, however, have to recognize that the Assyrian physicians (if, indeed, they prescribed h̲ u l a l u to be drunk) were able to keep the acetate and the "white lead" produced by acid distinct. This is the more challenging passage of the two in AM offering a possibility of h̲ u l a l u being drunk, and I have put forward the pros and cons as best I can, that the evidence against h̲ u l a l u == "white lead" may not be overlooked. (1)

The other passages in AM are: 10,1,iii,1: 29,4 r.6: 31, 2,6:46,1,ii,2:47,3,31:52,6,5 (stomachic, external(?)); 71,1,10: 92,2,5: 102,21. Pliny prescribes white lead or carbonate of lead apparently in the same way as molybdaena, as an ointment and in plasters, and warm in fomentations for dysentery and tenesmus (NH, 53, 54).

The other mineral in which h̲ u l a l u plays a composite part is h̲ u l a l u i n i (see p.87). This must mean "h̲ u- l a l u of the eye", and it is no small addition to our proof that h u l a l u =="white lead", that we find IB (73, quoting Diosc., V, 103) saying that the best c e r u s e, from the first sifting, is used as a remedy for the eyes. It is also prescribed for eyes (SM, "ii.86.87, 89, 91, 94, 97, 98, 101. Pliny says that ceruse is used by females to whiten the complexion. (l.c.). (Tak)h u l a l u i ni occurs in AM 46,1,ii,2.

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(1) As will have been noticed, I have taken 41,2,6 as prescribing h̲ u l a l u to be applied in oil: the text actually runs "...cinnabar, h̲ u l a l u in oi[l]... ...cannabis he shall drink and [shall recover]."

With regard to the difficult problems of (tak)ZA.ṬU used as a prefix in compound words for minerals, I propose to discuss them in Sect.37.

Section 35. M u š g a r r u, Malachite, Serpentine, Green stone, Smaragdus.

We have postulated that m u š g a r r u may be a colouring agent. If we accept that u k n ū is "blue", s a n d u "red", and h̲ u l a l u "white (-lead)", the range of colour for m u š g a r r u will be limited.

Of course, like u k n ū and s a n d u, we may expect to find in m u š g a r r u the hard stone of the same colour as the pigment it represents. In the list of seal - materials in Sect.31, we have already seen the r e d and b l u e represented by u k n ū and s a n d u, h̲ u l a - l u , representing "white lead", and not a hard white stone, is naturally absent from the list (we shall find the place of the "white" stone for seals taken by (tak)UD.AŠ (Sect.36)). Out of the remaining materials for seals, one, d u š ū, is glass or crystal (Sect. 14), and therefore the most probable colours remaining are black, green, and less probably, yellow, which is rare as a seal colour. For two out of these three colours we have left the stones (tak)KA.GI.NA and (tak) m u š g a r - r u . The former of these being haematite (see Sect.41), we are left with m u š g a r r u to represent green.

This fits admirably. M u š g a r r u means some kind of reptile, and therefore Boson (It.407) was quite correct in his identification ὀφίτις , serpentine. We have thus m u š - g a r r u as the green hard stone used for seals.

But besides serpentine(a name parallel to m u š g a r r u) this green stone must have covered the green calcite and green marble also used for seals.(1)

Another green stone compared to a reptile is μαράχιον "malachite","vert de montaigne"(Hoefer,257), with which I also propose to identify m u š g a r r u, although, I admit, it appears to have been rarely(or never?) found in Assyrian ruins. But what is convincing that the Assyrians had it is that we find (tak) m u š g a r r u prescribed by itself in curd(?) as a remedy for some eye-trouble(AM. 16,3,11). Here clearly serpentine is of no value, but malachite, a carbonate of copper, is exactly what is wanted. Malachite is properly the green hydrated carbonate of copper which occurs naturally in the weathering of copper lodes, and is used as a p i g m e n t under the name of green verditer(Rutley,355,ff.:PC.vii, 504).It was the c h r y s o c o l l a of Pliny(NH,xxxvii,26)(2) the green most approved by the ancients(Wm. Smith,Dict.of Gk. and Roman Antiquities,263). Pliny actually prescribes it as an eye-salve(NH xxxiii,28).

(Tak) m u š g a r r u is used about 8 times in AM in composition with other drugs, besides the instance quoted, almost certainly for eyes: for temples(20,1,31:102,21).

Again, Pliny speaks of "m o l o c h i t i s" as a native of Arabia, highly esteemed for making seals(NH,xxxvii,36). Jensen derived the word "m a l a c h i t e" from Meluhha, (Arabia or Sinai) probably rightly, although in this instance it was s a n d u which he thought was malachite, not m u š- g a r r u : but if his identification of the origin of the

(1) I might mention here Strassm. Nab.No.321,"52 (tak)MUŠ.GIR."

(2)See K.C.Bailey,Nature,May 16,1925,764.

word "malachite" is correct, the provenance of Pliny's m o l o c h i t i s adds its evidence to our theory.

It is worth noting that Pliny gives yet another stone, the name of which is due to its similarity to a reptile, b a t r a c h i t i s, which came from Coptos(NH, xxxvii, 55).

But we may perhaps go still further afield in our group of green stones covered by m u š g a r r u . Pliny appears to have had the idea that the word s m a r a g d u s "emerald" covered not only the emerald ,but also some much larger (green) stone. In NH, xxxvii, 17, he gives t w e l v e k i n d s of smaragdus, one of which may have been malachite, an equation which Hoefer (Hist., 63), considers satisfactory. Pliny has a story(ib. 19) of the king of Babylon sending a smaragdus four cubits long by three broad to the king of Egypt, which is comparable to the gifts of m u š g a r r u sent , although sparingly, by Tushratta.(1) The similarity of the two words m u š g a r r u and s m a r a g d u s would suggest the possibility of the latter's being only a "merchants' garbling" of the former.

According to the Assyrians themselves, m u š g a r r u came from Akkala, and Malikanu(II.R, 51, 1, 14, b, and 15), but both localities are as yet unidentified. Pliny says that the most esteemed c h r y s o c o l l a paint came from Armenia(NH, xxxiii, 27).

We may thus some up (tak)m u š g a r r u as practically any green stone, the hard green stones used for making seals, and malachite , especially in its powdered form green verditer, for paint, and even "emerald", smaragdus, of which word it may be the origin.

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(1) A crystal of beryl from Royalston in Massachusetts weighs nearly two and ahalf tons(Rutley, 266).

word "smaragdus" in general, the provenance of Pliny's [illegible] adds little evidence to our theory.

It is worth noting, that Pliny gives yet another stone, the name of which, due to its similarity to [illegible], [illegible] which [illegible] (xxxvii,77).

But we may perhaps go still further afield in our group of green stones covered by s m a r a g d u s . Pliny appears to have had the idea that the word s m a r a g d u s "covered" not only the [illegible], but also some much larger (green) stones. In H.N.,xxxvii,17, he gives [illegible] of Tyrians, etc, of which may have been malachite, or jasper, which [illegible] (Hist., 82), considers satisfactory. Pliny has a story (ib.,19) of the king of Babylon sending a smaragdus four cubits long by three broad to the king of Egypt, which in comparison to the pillar of [illegible], although apparently, by Theophrastus[1] the similarity of this word [illegible] could not [illegible] possibility [illegible] "smaragdus" [illegible] ling of the former.

According to [illegible] [illegible] from xxxvii, and [illegible] 12, 6, 71, 3, 34, 5, and 151, but both [illegible] Pliny says that the [illegible] (xxxvii,27).

[illegible] that some of [illegible] practically any green stone, the name green stone used for [illegible] and [illegible], especially in its [illegible] form [illegible] for paints, and even "emerald" [illegible], of which word it [illegible]

[illegible]

For (tak) ZA.TU.MUŠ.GIR see Sect. 37.

Section 36. (Tak)UD.AŠ and (tak)UD.AŠ.AŠ

Consider Šurpu, viii,68 : (tak)UD (tak)UD.AŠ, , (tak)UD.AŠ.AŠ . Here we have in succession not only both the minerals at the head of this section, but also the mineral (tak)UD on which they are obviously based . They must obviously have something in common as a base, and yet must be in some ways distinct.

(Tak)UD , which is known elsewhere(V.R,30,65,g: CT.VI,11, 30,b: see SAI 5811) means literally "the white stone". We do not know the Assyrian equivalent,but since UD == namāru (SAI 5785),it is not unreasonable to see in it the mineral namrutu ,as we have already suggested in Sect.10. This is the third main component of Assyrian glass, and is lime or perhaps more probably chalk. Moreover, the group IM.UD (== gaṣṣu),lit. "white earth, clay",means "gypsum, plaster, gesso",and is thus an additional piece of evidence for our identification. The meaning of (tak) UD would therefore appear to be certainly either the white lime or white chalk.

(Tak) UD.AŠ occurs in the compound(tak) ZA .TU.UD.AŠ in the list of seal materials (Sect. 31) . The latter must therefore be a hard stone,and from its obvious connection with whiteness,not only from its name,but also from (tak)UD =="chalk" above, must be the word which represents the white stone from which seals are made, i.e.,aragonite or white marble. (Tak)UD.AŠ is the material from which the eyes of statues are made,so that again it is a hard white stone (See Legrain,Hist.Frag.,No. 80,obv.18-19; S.Smith,JRAS,1925, 39).

In a text of Nabonidus' time four shekels of silver are paid for two (tak)UD.AŠ (Strassm.,Nab.No.245,12), and in another (No.321) four (tak)Ṣi-kir(biš)-tum UD.AŠ are mentioned, so that the material is shewn here also to be hard enough to be divided up. In an Assyrian letter(Harper,1194) ša (tak)UD.AŠ *ša ina Bīt niṣirti ša (ilu)Sin* "of the UD.AŠ-stone of the treasury of the Moon-god" affords some further evidence that this stone was a white kind, becuuse white has always been the colour sacred to the Moon; cf. John Schroder, *Compleat chymical Dispensatory*, 1669, 12, where "all white and green" things are said to be lunary things.

(Tak)UD.AŠ and (tak)ZA.ṬU.UD.AŠ would therefore seem to have their hardness and their whiteness in common, (and, if I may anticipate Sect.37 by a few pages, ZA.ṬU, I believe, is a prefix indicating that acid will have some effect on the stone, a lapidaries' method of identification.).

(Tak) UD.AŠ.AŠ cannot be far remote in meaning from (tak) UD.AŠ[1], but it is not easy at first to see where the difference lies. But the parallel use of (tak)ZAGIN.AŠ and (tak)ZAGIN.AŠ.AŠ will, I think, give us the clue.

Sub-Section 36,A. *Ṣipru*.

(Tak)ZAGIN.AŠ, (tak)ZAGIN.AŠ.AŠ, (tak)ZAGIN.TIK, (tak)ZAGIN.ZUN, and (tak)ZAGIN.SIG are all equivalent to *ṣ i b(p)r u* (Br.11777-11779, 11781, 11787), and (tak) ZAGIN.ZUN.GUŠKIN and (tak)A.TIK.ZAG.GA are equivalent to *ṣ i b(p)ir ḫ u r a ṣ i* (Br.11782. KA 860: Del., HWB, 559).

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1) K.1277(Bezold, Cat., 256) mentions *n a p ḫ a r i š* 27 (tak)UD.AŠ.AŠ (l.14)== "total 27 UD.AŠ.AŠ stones".

In this special use of ZAGIN, u k n ū, we must, of course, see some variety of blue stone like lapis lazuli. Philologically the first stone which suggests itself is the blue Sapphire, the Arabic صفير, the correct Semitic equivalent (at least in its consonants) for ṣ i p r u . Indeed, the Greek S a p p h e i r o s is supposed to be some form of lapis rather than our sapphire.(1) This, as has already been noted in Sect. 32, is borne out by the variety described as s i p i r ḫ u r a ṣ i "golden sap phire" as distinct from the ordinary ṣ i p r u , and u k n ū "lapis", exactly paralleled by the two varieties of s a p p h e i r o s given by Theophrastus (Hist. of Stones, S.v.) as c y a n e (="blue"), and c h r y s e (="gold"), the latter being the variety of lapis spangled with iron pyrites. These two kinds are fully described by Pliny (NH, xxxvii, 38, 39) under c y a n o s , the s a p - p h e i r o s being said also to have spots like gold.

Here, then, we find the Assyrians, not unlike Pliny, using the word for lapis lazuli as a general word for a (dark) blue stone as a philological starting-point from which they may coin a name for "s a p p h i r e", by adding the terminations AŠ, or AŠ.AŠ , just as they do with (tak)UD.

We have seen that (tak)UD= "chalk", and that (tak)UD.AŠ and (tak)ZA.ṬU .UD.AŠ are harder white stones, marked by some distinction. Can we show that this addition of AŠ , and

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(1). What exactly is Pliny's Sapphire is uncertain. But the S a p p i r of the OT appears to have some claims to be our sapphire, as well as lapis (for references, see Briggs-Driver, Heb. Dict., s.v.; Wm. Smith, Dict. of the Bible, iii, 1138).
The other Sumerian groups for ṣ i p r u , i.e, (tak)ZAGIN.TIK, (tak)ZAGIN.SIG mean "lapis of the neck", i.e., a gem for a necklace, and "weak lapis" respectively. (Tak)ZAGIN.ZUN appears to mean "numerous lapis" literally. It is important to remember that (tak)ZAGIN.SIG can be made artificially (See Sect. 25; Q).

still more ,of AS.AS to a mineral refers to stones of the same appearance, but distinguished by their relative hardness?

I think that this must be the explanation. The geologists of the present day say that hardness is the first test which should be made in determining a mineral(Rutley,48),and I here quote the scale of relative hardness, known as Mohs' scale:

1- T a l c ....common foliated variety.

2- R o c k S a l t........or g y p s u m.

3- C a l c - s p a r .. transparent variety.

4- F l u o r -s p a r ..crystallized variety.

5- A p a t i t e...transparent crystallized variety.

6- F e l s p a r ..(Orthoclase)cleavable variety.

7-Q u a r t z ... transparent variety.

8- T o p a z .... transparent crystal.

9- S a p p h i r e..cleavable variety,or corundum.

10-D i a m o n d .

-Rutley,39.

Here the outstanding point is that sapphire has the remarkable quality of being almost the hardest mineral,second only to diamond. It is well worth noting what Rutley says about Corundum(170) :-

"The ruby, sapphire,oriental amethyst,oriental emerald, and oriental topaz,are varieties of corundum coloured red, blue,purple,green,and yellow respectively,and are used as gem-stones. .....Emery is a greyish-black variety of corundum containing much admixed magnetite or hematite. Crushed,ground , and sifted, its powder is used for polishing hard surfaces." And he says (39) ,in describing the method of testing for hardness "the trial may also be made by endeavouring to scratch the specimens enumerated in the list with the mineral under

examination".

In this word "scratch" we can at once see a clue to the philological origin of ṣ i p r u . It is the same as the Syr. ܛܦܪܐ "a nail, claw", which has also the meaningofof "onyx" (distinct from ܣܦܝܠܐ , ܫܦܝܪܐ). Apart, therefore, from itss presumed equivalence qwith the Arabic ظفر , which is not the correct philological equivalent for the Syr. ܛܦܪܐ and must probably be a late loan- word, like the Heb. טְפִיר , which again is not an equivalent for ܛܦܪܐ), we can seek the original meaning of s i p r u in the Assyrian root ṣ a p ā r u "scratch", and its cognates for "finger-nail, claw", and ṣ i p r u ,"p oint of a weapon" (MA886). Ṣ i p r u "sapphire", the second hardest mineral, and also a form of corundum, of which e m e r y is a form, must thus mean "the S c r a t c h i n g S t o n e", with a curious parallel in the Heb. ṣ i p p ō r e n š ā m ī r (Jer., xvii, 1)"point of š ā m ī r - stone".(1)

The probability is that sapphire or corundum was the hardest test the ancients had. Pliny's description of a d a m a s rather indicates that it is doubtful if he had any acquaintance with the diamond, and the opinion is that the word a d a m a s was applied by the ancients to quartz, specular iron ore, and emery (Bostock, Pliny, vi, 405 quoting Dana). Hayes Ward (9) also suggests corundum or emery , and not diamond, as the probable tool for cutting seals.

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(1). Š ā m ī r , of doubtful meaning, is a stone used as figurative of hardness (Ez. iii, 9; Zech. vii, 12). Gesenius connects it with σμυρις e m e r y (Smith, Dict. of the Bible, I, 21), which Petrie (Hastings, Dict. of the Bible, iv, 619) follows.

Interesting in this connection is Pliny's description of one kind :-

" When ... this stone does happen to be broken, it divides into fragments so minute as to be almost imperceptible. These particles are held in great request by engravers, who enclose them in iron, and are enabled thereby, with the greatest facility, to cut the very hardest substances known".

Theophrastus actually mentions a stone from Armenia which was used for cutting others(Hill, Theophr., 185).

A final piece of evidence that ṣ i p r u was used as a hard stone in a manner similar to corundum, is found in CT. XIV, 15, 22, 23:-

(tak)ṣ i - i p - r u == (tak)ZAGIN.[AŠ]

(tak)ṣ i - i p - r u == (tak)k u - n u -[k u]

(The restoration is suggested by MA 860).

In the last word, k u n u k u , we must see, not "seal", but either "seal-stone", i.e., the stone for making seals, or else the "engraving stone", Obviously the writer cannot have meant simply "cylinder-seal", which would unreasonably single out this particular stone ṣ i p r u as a material for seals, which we cannot accept as at all likely, when there are so many others with better claim to be so described.

To sum up ṣ i p r u . It is the Assyrian equivalent of both (tak) ZAGIN.AŠ and (tak)ZAGIN.AŠ.AŠ , and is etymologically the equivalent of the Syr. ܛܦܪܐ, "claw, onyx", and was probably taken over into Arabic in the word صفير sapphire. Properly ṣ i p r u means "the scratching thing"; and when we consider that, just as (tak)UD is the soft chalk, and (tak)UD.AŠ is the harder white stone from which seals are made, and (tak)ZAGIN is the moderately soft lapis which can

be ground into ultramarine, while its harder form is (tak) ZAGIN.AŠ and (tak)ZAGIN.AŠ.AŠ (== ṣ i p r u "sapphire"), probably the hardest stone known to the ancients, we shall not be wrong in seeing in the affixes AŠ and AŠ.AŠ the meaning "hard" and "very hard" respectively. In (tak)ZAGIN. TIK "blue stone of the neck", called ṣ i p r u, we must see sapphire, the gem:(1) in (tak)ZAGIN.SIG(==ṣ i p r u) we have some form of sapphire which can be made artificially(the reference being to its tint, rather than to its hardness, since we have no indication that the glass is to be toughened by being plunged into fat heated to a high pitch). Another variety of ṣ i p r u, perhaps the"very hard"one, will be the "a d a - m a s" with which the jewellers cut other stones, particularly seal - cylinders. This last mineral must be a point rather than a powder like emery, and hence will be the common corundum, the variety known as "adamantine spar", from its extreme hardness, occurring commonly as greenish or greyish. It is used in the East Indies for cutting and polishing precious stones(PC viii,66). Perhaps we are to see "e m e r y p o w - d e r" in (tak)ZAGIN.ZUN, literally"numerous lapis". It may be mentioned with advantage that Turkey is the largest producer of emery(Rutley,168).

We have, I venture to think, solved the problem of the affixes AŠ and AŠ.AŠ, the various kinds of (tak)UD and(tak) ZAGIN minerals being divided into classes in relation to their degrees of hardness. But besides this distinction, we have seen that there are subdivisions of the (tak)UD.AŠ

(1) Jensen's reading ṣ i b r i - i a for (tak)ZAGIN.TIK-ia in the Gilgamish Epic(KB vi,i,240-241)except that it should be ṣipri-ia, is thus correct, and in this carcanet of Ishtar we can see a necklace of sapphires.

and (tak)UD. AŠ. AŠ which are denoted by the prefix ZA.ṬU. Before trying to settle definitely the kinds of stone indicated by (tak)UD. AŠ and (tak)UD. AŠ. AŠ, we must obviously consider the meaning of ZA. ṬU.

S e c t i o n 37. T h e M e a n i n g o f ZA.ṬU i n c o m p o u n d s .

We have in Sect. 34 a list of certain stones marked with the prefix ZA.ṬU.

It will be noticed that, except in h̲ u l a l u "white lead", and h̲ u l a l u i n i "white lead for the eye", no attempt is made to introduce the Assyrian word h̲ u l a l u into the translation of the Sumerian names.

It will be seen that ZA.ṬU is a prefix to the two white stones (tak)UD. AŠ and (tak)UD. AŠ. AŠ, which are relatively harder than (tak)UD "chalk". Equally, ZA.ṬU is a prefix to the green stone, mušgarru. We have thus, without counting the other groups at present unidentified, the prefix ZA.ṬU added both to white stones and green stones. It therefore cannot have any reference to their colour, for, although a green can be qualified with such a word as "pale "or "dark", the same can hardly be said of white. Moreover, it will be observed that ZA.ṬU is not added to red or blue stones.

Again, ZA.ṬU cannot refer to the relative hardness of these stones, for that is settled by AŠ and AŠ. AŠ.

Let us examine the problem on the evidence that we already have, leaving out the unidentified groups. It is obvious that the prefix ZA.ṬU marks some subdivision of the classes of stones to which it is prefixed: the Assyrian scribes and lapidaries were far too clever to waste breath or space on unnecessary adjuncts. We have h̲ u l a l u literally "something

treated with acid".

I suggest that this prefix to certain fairly hard white and green stones is an indication that the Assyrian stonemasons and lapidaries were well aware that certain classes of rocks could be easily identified by the effervescing of acids applied to them. This is ,of course, a well known modern test. But it is a peculiarity which was known even to the Hebrews, (who were far behind the Assyrians in practical civilisation) as is shown by Prov.xxv,20: " as he that taketh away a garment in cold weather,and as vinegar upon nitre,so is he that singeth songs to a heavy heart". I have already suggested that we do not yet know enough about the power of the acids or vinegar known to the Assyrians, and Hoefer's ingenious suggestion (117)that Pliny refers to h y d r o c h l o r i c a c i d may aptly be quoted here:-

"On met,dit-il(Pliny),avec l'or,dans un vase de terre,deux parties de sel commun,trois parties de misy(probably sulphate of iron or copper),et de nouveau deux parties d'un autre sel, et une partie d'une pierre appelée schiste(terre argileuse):on expose ce vase a l' action du feu : le mélange s'empare alors de tout ce qui est étranger a l'or,qui demeure pur.[1]

"Nous enregistrons ces paroles de Pline :elles sont d'une haute importance pour l'histoire de la chimie. Car un mélange de sel commun (chlorure de sodium),de vitriol(sulphate de fer ou de cuivre) et d'argile(alumine),produisait ,sous l'influde la chaleur,une réaction, de laquelle devrait résulter un des acides minoraux les plus énergiques ,l'esprit du sel appelé aujourd'hui acide chlorhydrique.

"Quel était cet autre sel que l'auteur ne nomme pas? Si c'est le nitrate de potasse,les Romains auront connu l'eau

(1)Nh,xxxiii,24.

régale. Or la vraie chimie ne date que de l'emploi bien établi des acides minéraux, qui sont les véritables dissolvants des métaux".

The peculiar treatment of rocks with acids or vinegar was certainly well known to the ancients : and this question of decomposing rocks by this treatment(as, for example, Hannibal crossing the Alps) is very fully discussed by Berthelot(Hist. i, 370). He says that the action of fire on rocks is noted in many ancient passages, and, since fire is enough to decompose calcareous rock, he cannot see why they should have preferred vinegar. Yet the texts dealing with this subject are numerous and to the point, and he quotes Pliny (NH xxiv, 21) as saying that the hard stones met with in the mines are broken by the means of fire and vinegar. Vitruvius also says :-

"If an egg is left too long in vinegar, its shell will soften and dissolve... so also lead... changes into ceruse... copper into vert-de-gris. Also a pearl dissolves. This action is equally exercised on hard rocks which neither iron nor fire alone can decompose. But when they are heated well with fire, it is enough to water them with vinegar to break them". (viii, c. iii). Pliny (NH xxxiii, 27) says that the strength of vinegar does not exercise itself against food only, but on many other things. If it be applied to stones it will break them after they have resisted the action of fire. Galen(De fac. simp. Med., i, 22) says that vinegar actslike fire in attacking stones, copper, iron, lead. Berthelot quotes other ancient authors , notably Dion Cassius(xxxv), who tells a story how , at the taking of Eleuthera in Crete, traitors watered a great tower with vinegar to make it friable. Berthelot then gives the opinion of M. Havet, who considers that cal-

careous rocks are hardly likely to be much more affected by vinegar than by water after they have been calcined. The result of concentrated hydrochloric acid would be different.

I have quoted M. Berthelot fully, in order to shew how very definite a belief existed in the ancient world about the power of vinegar on certain rocks.

If we accept the theory that ZA.ṬU is prefixed to those rocks which effervesce or otherwise shew some effect when acid is applied to their surface, it will exclude from the stones so indicated all granites, porphyries, quartzes, and silicious rocks, but include the calcareous rocks, marbles, limestones, and the like.

With this in view, we may make a tentative identification of the (tak)UD and (tak)MUŠ.GIR groups by their classification in terms (a) of relative hardness as shewn by AŠ and AŠ . AŠ ; (b) of the effervescent effect of acid upon them, as marked by ZA.ṬU.

(Tak)UD: not marked by ZA.ṬU.. It is the softest of the UD-group, i.e., chalk; it is distinguished from gypsum (which does not effervesce under acids) by the latter being called IM.UD.

(Tak)UD.AŠ : "the moderately hard (white) UD-stone": by our theory distinct from (tak)ZA.ṬU.UD.AŠ which is the stone affected by acids.

(Tak)ZA.ṬU.UD.AŠ is specially mentioned as the white stone from which seals are made (Sect. 31): its name shews that it effervesces under acid. It is moderately hard (less hard than (tak)UD.AŠ.AŠ AŠ. This description will agree with either

A l a b a s t e r (index of hardness, 3)

White marble, or Aragonite (the latter with index of 3.5 to 4).

If 3,or 3.5 ,is the index of hardness here, we may perhaps see in (tak)UD.AŠ(without ZA.ṬU) the modern alabaster,hydrous sulphate of lime, which does not effervesce under acid, with an index of 1.5to 2.

(Tak) UD.AŠ.AŠ "the very hard (white) stone",distinguished from (tak)ZA.ṬU.UD.AŠ.AŠ,the latter being by our theory affected by acids. We have estimated the hardness of (tak)UD.AŠ as approximately 3 or 3.5 so that this will be some stone of greater hardness. Important here is the tablet K.1277,already quoted, (Bezold,Cat.,256),1.14 "total 27 (tak)UD.AŠ.AŠ" and r.,1.7 "total 6 (tak) UD.AŠ.AŠ ",which indicates that the (tak)UD.AŠ.AŠ were reckoned in pieces in fairly large quantity. If they were beads,as seems probable,they were very likely of chalcedony,a very common jewellers' material in Assyria. This is a white stone with a high index of hardness,and unaffected by acids.

(Tak)ZA.ṬU.UD.AŠ.AŠ will be some white rock of a hardness greater than 3,or 3.5,affected by acids, e.g.,perhaps fluorspar(index 4) or apatite(index 5),

(If we accept the lower figure of 3 for (tak)UD.AŠ, it might be possible to include here aragonite(3.5 to 4)).

(Tak)UD.AŠ came from the mountains Dudpiš and Dulupiš (unknown,IIR,51,No.15,ll.15,16).

From these we can proceed to the green stones distinguished in the same way.

(Tak)M u š g a r r u, written both (tak)MUŠ.GIR and (tak) ZA.ṬU.MUŠ.GIR, which indicates a difference between the two classes of stones, the latter being, on our theory, affected by acids, and from Sect.31 a material used for seals.

In one case, which, I suggest, may be by accident, we find (tak)MUŠ.GIR used where our theory demands (tak)ZA.ṬU.MUŠ.GIR: this is in a medical text already quoted (AM 16,3,11) where (tak)MUŠ.GIR is used by itself in curd(?) for eyes. This must be malachite, chrysocolla, carbonate of copper, which will effervesce under acid. It is, however, not unreasonable to expect some latitude if there was no doubt which drug was intended.

Malachite is, as I have admitted, rarely if ever found in Assyria, but other carbonates are frequent, and will, of course, effervesce under acid, notably g r e e n c a l c i t e, or green marble (Ashmolean Museum: Menant, Cat. des Cylindres, Nos. 61,124,130, etc.: "calcaire vert", ib. No, 110: green steatite, A 1007, Delaporte, Catalogue, ii, 200).

(Tak) Î n i m u š g a r r i, written with ZA.ṬU, "eyes of m u š g a r r u", green- or blue-green)- coloured stones, may well be the t u r q u o i s e, soluble in hydrochloric acid. "6 ē n ā t i m u š g a r r i of Bit - Innibi" occurs (BoFr 59) : cf "13 ē n ā t u m m u š g a r r i (Knudtzon, TA, 25, ii 19). Agum put (tak)ZA.ṬU ēni m u š g a r r i and (tak)me-nisuti at the top of the crown which he made (V R,33,iii,5). This word ē n u "eye" occurs several times in connection with stones. The same Agum (ib.ii,39) speaks of (tak)ē n ā t Meluhha "eye-stones of Meluhha".-

S e c t i o n 38. (Tak)Šubū, (tak)sihru.

The mineral (tak)ZA.SUḪ (== šubū) takes on several forms :-

(tak)ZA.SUḪ == šubū (Br.11745 : SAI 9018)
(ŠUBA)
== siḫru (SAI 9017, and cf. Br.6641,
(tak)ID.ZA.SUḪ == si-iḫ-rum

(tak)ZA.SUḪ.DIR == "red šubū" == iaraḫu
== (SAI 9019), uriaḫu (CT.xiv,17,i,14)
== (tak)TU (SAI 9019).

(tak)ZA.SUḪ.SIG == "green šubū", the same as the next group in CT. xiv, 15, 11, and equivalence ib. 17, 10.

(tak)ZA.SUḪ.UNU.KI == ianibu, or zanibu, nibu (SAI 9021)

(tak)ZA.SUḪ.UNU.KI.GAL == "great nibu" == kibaltu (SAI 9023), nibu burru[mu] (SAI 9024)

(tak)ID.ZA.SUḪ == siḫru (Br.6641)

(tak)ZA.TU.ID.ZA.SUḪ. == ? (SAI 9067)

(tak)ZA.SUḪ.GAL (SAI 9027)

(tak)ZA.SUḪ.DU (SAI 9020)

(tak)ZA.SUḪ.ID.ZI.DA (SAI 9025)

(tak)ZA.SUḪ.ID.KAB.BA (SAI 9026)

A seal of ZA.SUḪ and another of (tak)KUR-nu(== šadanu,

haematite)are mentioned in CT.xxiii,I,10(see BoFr.73). CT VI, 11,14,a, shows that a seal-cylinder can be made from the stone ID.ZA.SUḪ .

Š u b ū has long been identified with the Heb. שְׁבוֹ, translated(probably quite erroneously) "a g a t e", the stone in the High Priest's breastplate. But s i ḫ r u , the synonym for š u b ū , leads us to consider the two following comparisons side by side :-

š u b ū == Arabic شبة "brass" ?

s i ḫ r u == Syriac ܫܚܪܐ (1) "vitriol" ?

Now this latter, vitriol, is f e r r o u s s u l p h a t e, or green vitriol, which is used for dyeing black, and is usually obtained from the decomposition of pyrites or as a bye-product in the manufacture of copper sulphate or blue vitriol (Roscoe,ii,1236). Obviously, if my suggestions are right for the Semitic comparison of the word, š u b ū, with its synonym s i ḫ r u, will correspond (through its philological relation to brass and vitriol) with the C h a l c a n t h u m of Pliny(NH xxxiv,32), of which he says "The Greeks ,by the name which they have given it(chalcanthum), have indicated the relation between shoe-makers'black and copper", and Bostock, in his note referring to Beckmann, Hist. of Inv., i, 181, says that Pliny probably includes under this name g r e e n v i t r i o l and b l u e v i t r i o l. Roscoe(ii,434) says that the two were for a long time confounded together. Since we have identified s i ḫ r u with the Syr. ܫܚܪܐ, we can go a step farther and see in it Pliny's s o r i , which the Arabs say is r e d v i t r i o l (Berthelot, Hist., ii, 242).

Pliny's descripttion of the manufacture of Chalcanthum affords us several points which help in our identification:-

"It is prepared in Spain, from the water of wells or pits which contain it in dissolution. This water is boiled with an equal quantity of pure water, and is then poured into large wooden reservoirs. Across these reservoirs there are a number of immovable beams, to which cords are fastened, and then sunk into the water by means of stones; upon which a slimy sediment attaches itself to the cords, in drops of a vitreous appearance, somewhat resembling a bunch of grapes. Upon being removed, it is dried for thirty days. It is of azure colour, and of a brilliant lustre, and is often taken for glass. When dissolved, it forms the black dye that is used for colouring leather".

Now this description, that the sediment which forms the chalcanthum is like a bunch of grapes, confirms the view that we are on the right track with "vitriol". The proper equivalent in Assyrian for "g r e e n ZA.SUḪ" is i a n i b u, a form confirmed by the medical text AM 3, 2, 16, two other forms being found elsewhere, z a n i b u (incorrect?) and n i b u. I a n i b u, like several other words for stones, begins with this curious syllable i a, and it is not impossible that it is a borrowed word. The Heb. ענב "grape" has presumably no philological equivalent in Assyrian, unless it be i n b u, about which there is some doubt, the proper Assyrian word for "grape" being k a r a n u. Surely we may see this Hebrew word in i a n i b u, the comparison being drawn between i a n i b u and the resemblance of g r e e n v i t r i o l to a bunch of grapes.

I a n i b u also represents the value of (tak) ZUR.ŠAR.GUB.(BA) (SAI 6834), and a comparison of CT. xiv, 3, 22, c, and 5, 13, c, with CT. xviii, 26, Rm., 339, 14, gives the equation

(tak)Z U R.Š A R. G U B. B A == šu - u == i a - n i - b u.
Like (tak)Z A. S U Ḫ. S I G in CT. XIV, 17, it is close to š a-m a i t u (which I hope to shew a little further on == the sky-blue crystals of blue vitriol), and therefore must be the same[1] i a n i b u.

In Assyrian medicine we find the following uses :-

(Tak)š u b ū, for t e m p l e s (AM 102,22) : e y e s (1?,4,4): not medicinal (23,7,4). In Pliny we find c h a l - c a n t h u m recommended for granulations upon the eye-lids, pains and films on the eyes, and when applied to the forehead with a sponge, it acts as a check upon defluxions of the eyes (NH, xxxiv, 32).

(Tak)i a n i b u (written both (tak)ZA.SUḪ.SIG and spelt out): for h a i r (3,2,16) : for t e m p l e s(102,32:104,10): various(7,1,5:29,2,11:40,5,20 : 47,3,30: 102,23).

(Tak)Z A. S U Ḫ. I D. Z I D. D A (one š u, 30,12,4).

Now, if our equation

š u b ū, s i ḫ r u == c h a l c a n t h u m,

blue and green vitriol,

be correct, it should lead to our determining the other forms of (tak)Z A. S U Ḫ. We can therefore consider the different kinds of "vitriol", as given by Berthelot, Coll., 241, 242:

(Chalcanthon), couperose ; blue vitriol== sulphate of copper
green vitriol ==sulphate of iron and basic sulphate of copper
yellow and red vitriol== basic

---

(1) Cf. (tak)GI.RIN.ŠAR.GUB.BA, AM, 102, 34.

(S e c t i o n 3 F)

		Sulphate of iron
White vitriol	==	sulphate of zinc, sulphate of alumina

Or, in his Hist., ii, 307, where he quotes Bubacar (circa X-XIth Cent.) as saying that there are six vitriols (atramenta), one to give a black colour, one white, chalcanthum, "calcande", calcathar, surianum. One is a yellow employed by goldsmiths, and one a green used by leather-dressers.

We should therefore see in our " r e d ZA.SUḪ " the basic sulphate of iron of Berthelot. Can we arrive at any satisfactory Semitic comparison for i a r a ḫ u to bear this out?

A word i a r a ḫ [t u?] exists, having the equivalent in Sumerian ŠE.SAG, lit. "corn-top", and as it appears from its occurrence in a list to be connected with corn (see MA, 361: HWB 310) we may not be far out in considering it as "h u s k ", and thus equal to the Greek λεπίς "husk", "flakes of copper or iron", Latin s q u a m a . Iron "scale", according to Dioscorides, is similar to rust (hydrated ferric oxide), but possesses less active medicinal properties. It might be added that ferric oxide acts as a basic oxide. We may therefore be on the right track in translating i a r a ḫ u as a bye-form of i a r a ḫ [t u] "husk" (?), with parallelism to the Greek λεπίς as a chemical term.

The other problems, notably (tak) ZA.SUḪ.UNU.KI, and the larger mineral of the same name which == k i b a l t u , must be left for the present. But some little additional evidence may be drawn for the equivalence "vitriol" to this section from the presence of the word m a r ḫ u š u, marcasite,

pyrites, (see Sect.40) which follows immediately in order after š a m a i t u m "blue vitriol" (Sect.39), which in its turn immediately follows the Z A. S U Ḫ group. All forms of vitriol are to be obtained from the spontaneous decomposition of pyrites. We may surely accept it that the Assyrians, who have thus arranged their lists, knew this.

We can thus sum up our results, as far as we have gone, for the equivalence of the Z A. S U Ḫ groups with various forms of vitriol. First, various forms of vitriol exist, blue, green, yellow, red , and white, which may well in part coincide with the "red", "green", and even b u r r u m u "variegated" kinds of Z A. S U Ḫ mineral. Then, the Assyrian equivalents of Z A. S U Ḫ, š u b ū and s i ḫ r u, would appear to be connected philologically with شَبَه "brass", and [illegible] "vitriol", while the "green Z A. S U Ḫ" is represented in Assyrian by i a n i b u , perhaps allied to ענב "grape" from the botryoidal appearance of the Chalcanthum in process of formation. I a r a ḫ u , the equivalent of the "red Z A. S U Ḫ", in its similarity to i a r a ḫ [t u], perhaps "husk", may be compared to the Greek λεπίς, considered in its meaning of "iron scale". Finally , (tak) š a m a- i t u ,"the sky-blue mineral", i.e., blue vitriol, which is placed alongside both this series, and m a r ḫ u š u "pyrites", a connection which is scientifically correct.

Noticeable is AM 3, 2, 16 (see Gadd, Liv. Ann., 1925, 151), (tak) PA (= ia'ertu, Langdon, JSOR, iii, 39) ša VII DAR.MEŠ ša (tak)ianiba, i.e., "a ia'ertu with seven spots of ianiba", which may thus refer to the chalcanthum which dyes black. This will perhaps give the clue to the meaning of "the seal of ZA.SUḪ (p. 110). for the Assyrians must have known of the property of certain stones to absorb a dye.

Finally, a word is necessary on the peculiar form (tak)ZA. TU.ID.ZA.SUH. (Tak)ID.ZA.SUH (without ZA.TU) == s i h r u, so that, by our theory that ZA.TU == "treated with acid", we ought to see in this some form of vitriol treated in this way.

The chemical most likely to be connected with this, as far as I can see, is V e r t-d e - g r i s, which is, of course, a copper product, not iron. At the same time, it is clear that the blue vitriol is a copper, and that chalcanthum appears to have been a confusion of the blue and the green vitriol. Vert-de-gris is prepared (according to Berthelot, Hist., ii, 93) by treating a copper ingot with sulphide of arsenic steeped in water, and then placing it above a vessel in which there is strong vinegar.

Dioscorides and Pliny certainly know of the acetate of copper, which was obtained by watering copper filings with vinegar, and shaking them (Hoefer, 130).

Section 39. Š a m a i t u ==B l u e v i t r i o l.

Š a m a i t u is the next mineral apparently connected with the above. It occurs following the ZA.SUH-groups in CT. XIV, 15, and 17, and preceding (tak)ZUR.ŠAR.GUB.BA (==i a n i b u) and (tak)m a r h u š u (pyrites, Sect. 40), and it is given as equivalent to)(tak)m u ṣ a l t u m on CT.XIV, 15, 13 and 17, 15, a-b

Since we have just dealt with a form of copper for a series of words placed alongside š a m a i t u in the lists, we are entitled to seek a similar chemical as its equivalent.

Š a m a i t u, since it would appear to be derived from

š a m ū would appear to be "the s k y – b l u e mineral". We have seen that š u b ū is probably both green and blue vitriol, so that š a m a i t u will then be either the beautiful blue crystals obtained by the process of evaporation described by Pliny (above in Sect. 38) or, less probably, the natural blue vitriol, c h a l c a n t h i t e, hydrated sulphate of copper.

There is no difficulty in finding a philological equivalent for m u ṣ a l t u m (doubtless the "stone" m u ṣ i l – t u m, Meissner, Supp., 59). The Syriac [illegible] "vitriolum cuprinum", the same mineral, appears so obviously a garbling of our word, that we need not hesitate to accept it, if we accept "blue vitriol" for š a m a i t u . A parallel to this curiously mutilated form is to be seen in ܫܠܕܐ "a corpse", from the Assyrian š a l a m t u (Haupt, quoted MA 1043), the same phenomenon of a liquid being merged in a following dental, and then a d resulting. Something similar occurs in Assyrian, where the final feminine t becomes a d after m, which in turn becomes n, as in s ā n d u (= s ā m t u).

The root of m u ṣ a l t u may perhaps be the same as the Arabic صوّل " to steep, macerate", used of plaster, the reference to "macerating" being the process described above. (Tak)m u ṣ a l t u m is also the equivalent of (tak)b a ḫ r ē, which I take to be coral. (Sect. 14, b).

S e c t i o n 40. M a r ḫ a š i , or M a r ḫ u š u , marcasite, pyrites.

As we have already noted, (tak)m a r ḫ u š u follows

(tak)š a m a i t u m "blue vitriol" in some form, and (tak) ZUR.ŠAR.GUB.BA, which is i a n i b u , chalcanthum (CT.XIV, 3 and 5). If there is anything in the sequence of these minerals in these lists, this is a most important point to notice.

(Tak) m a r ḫ u š u appears to be a variant form of (tak) m a r ḫ a š i , which occurs simply, and also in the compounds

(tak)KA marḫaši arqa (V R., 33,ii,36)

(tak)GUG marḫaši (CT. xxxii,37,8), and in the form

(tak)GUG marḫašitu (Pl. 5,V,7)

(tak) d u š ū marḫaši == " p a r a s ī (Scheil, RA,1917,115,26)

Jensen identified marḫaši with a country (ZA x,370). The word (tak) m a r ḫ u š u occurs in the Drehem tablets (Genouillac, Drehem, 5529, quoted BoFr., 24).[1]

If we now examine our evidence we get from (1) "a yellow(green) mineral of iron oxide[2] m a r ḫ a š i". As we saw at the head of this Section, there may well be some connection between the vitriols and m a r ḫ u š u . Since the vitriols are the product of p y r i t e s , we have some initial grounds for believing that m a r ḫ a š i, m a r ḫ u š u , represent p y r i t e s.

At once the natural comparison is the Syriac ܡܪܩܫܝܬܐ marchesita, pyrites, the marcasite of the modern geologists. Marcasite is a mineral identical in composition with pyrites, (Rutley, 327), and it was taken over by the alchemists in the form m a r c h e s i t a evidently from the East. This

(1)Geller, AOTU, 1,347,1917, " infolgedessen ist eine Bestimmung des Steines noch nicht moeglich".

(2) See Sect. 41.

word was applied by them as a synonym for pyrites, and to the sulphides and arseniosulphides and analogous minerals (Berthelot, Coll., 277: see Church, Hist., 31). Pyrites, a mineral of bronze yellow to pale yellow, with a metallic and splendent lustre (Rutley, 326) is found in the Zagros Mountains to the East of Assyria, (a locality which would satisfy the claims of the district Marḫaši), and is associated in this district with rock salt, haematite, dolomite, etc.

The difficulty here is that the Arabic (رقش) "variegated, speckled" rather indicates that [illegible] is the correct form. But even so, it may be urged (1) that the Assyrians may well have borrowed the word, since we have two distinct forms, m a r ḫ a š i and m a r ḫ u š u: and (2), if so, that such a loss of the hard sound q becoming ḫ is paralleled by Nusku == Našḫu (see my chapter in Woolley, Carchemish, ii, 139), and still more in the place-name Marqasi == Mar'ash, and the modern Arabic forms a"ul for aqul (etc.).

The following clue afforded by the chemical texts would certainly seem strongly confirmatory of the value "pyrites". On Pl. 5, 3, ff. (Sect. 25, AA) we have directions for making (tak)s a n d u m a r ḫ a š i t u, which appears to mean either "red pyrites mineral" or "red spangled mineral" (as is indicated above by the Arabic (رقش) "speckled"), the spangles being the characteristic of pyrites. This would seem to shew that the Assyrians had a method of imitating some "red spangled stone" in glass, or, in other words, they were able to make the famous A v e n t u r i n e glass, which is supposed to have been first made by the Venetians in the

XIIIth Century (Roscoe,ii,591). Aventurine is the name for a " brownish glass with gold spangles", as well as for a variety of quartz resembling this. The glass is made nowadays in the following way :-

"From the cuprous oxide the rich blood-coloured ruby of Bohemian glass is obtained. The cuprous oxide passes readily into the cupric condition by the assimilation of oxygen. For this reason, in the preparation of copper ruby glass, not only must all oxidizing agents be avoided, but powerful reducing agents must be added. If the reduction is carried beyond a certain point, the spangled effect of a v a n t u r i n e, due to reflection from particles of reduced metal, is produced". (Powell, 26). Similarly, H. Cunynghame (Art-Enamelling, 123) says:-

"When black oxide of copper is added in larger quantity as say 6%, and then when molted, some iron filings are added and slowly cooled, we obtain the sparkling mass known as 'aventurine!"

Unfortunately our text is a little broken at the beginning. As it stands, the receipt (Pl.5,V,3) gives

[... m a n a(?)] of š a(?)-a d-da-a
10 m a n a of simple frit (a ḫ u z z a)
Some unwashed salt(petre)
½ m a n a of IM.SIG.SIG (arsenic)

The first character of the first chemical might be equally well r a or d a (i.e., r a d d ā or d a d d ā), so that any comparison with s a d ā (which I take to be a form of the mineral š a d a n u, haematite, ferric oxide, p.55 and Sect.41), would be dubious. We are thus in doubt whether we are to see ferric oxide as the main component of this receipt, and , even so, we have no evidence of the presence of copper in

it: nor is it likely that anything more than the signs giving the amount of š a d d ā are missing at the beginning, or we might have suggested the restoration of a "ditto" sign, indicating a reference to the preceding section, as in Pl.4, K.203, VI, 1.4. The broken text therefore leaves us in the dark about the meaning of the first component.

But there is little doubt that s a n d u m a r ḫ a š i - t u means "aventurine". S a n d u means "red" (mineral), and m a r ḫ a š i t u "spangled" (like pyrites). But in addition a curious confirmation comes from Pliny (NH xxxvii, 28), where he gives a description of a stone which is the product of India and South Arabia, which has all the appearance of fire placed behind a transparent substance, burning with star-like scintillations within. This stone Bostock (Pliny, ib.) quotes Ajasson as identifying with A v e n t u r i n e Q u a r t z, which, he says, is found in Persia. The point of contact here is that Pliny, who says that the Chaldeans used it in their rituals, gives its name as s a n d a s t r o s or s a n d - r a s i t a e, adding that from the similarity of its name it has often been confused with another called s a n d a r o - s o s, s a n d a s e r i o n. The phonetic similarity of these words to s a n d u m a r ḫ a š i t u is most striking.

S e c t i o n 4 1. T h e I r o n O x i d e s

We can now turn to a series of minerals based on the Sumerian K A . Consider CT. VI, 12, 1, b :-

1 - (Tak) K A

2 - (Tak) K A.G I. N A . T I L . L A

it; nor is it likely that anything more than the signs giving the amount of š i d d a are missing at the beginning, or we might have suggested the restoration of a "ditto" sign, indicating a reference to the preceding section, as in VI,4,K,??,VI,1,4. The broken text therefore leaves us in the dark about the meaning of the first component.

But there is little doubt that s a n d u . m a r ḫ a š ī - t u means "aventurine". S a n d u means "red" (mineral), and m a r ḫ a š ī t u "sparkles" (like pyrites); but in addition a curious confirmation comes from Pliny (NH xxxvii, 28), where he gives a description of a stone which is the product of India and south Arabia, which has all the appearance of fire placed behind a transparent substance, burning with star-like scintillations within. This stone sandaresos (Pliny, ib.) quotes as identifying with a v e n t u r i n e Q u a r t z which, he says, is found in Persia. The point of contact here is that Pliny, who says that the Chaldeans used it in their rituals, gives its name as s a n d a s t r o s or s a n d a r e s o s, adding that from the similarity of its name it has often been confused with another called s a n d a r e s o s [illegible] s a n d a s e r i o n; the phonetic similarity of those words to s a n d u . m a r ḫ a š ī t u is most striking.

S e c t i o n 4 1 . T h e I r o n S e r i e s .

We can now turn to a series of minerals based on the element K A . Consider CT, VI, 12, 1, b :-

1. (na4) K A

2. (na4) K A . G I . N A . T I L . L A

3.- (Tak)K A. G I. N A. L A Ḫ (?). G A

which is augmented by Scheil, RA, 1918, 115, 2, ff. :-

2- (Tak)K A. G I. N A		==	š a - d a - n u	
3.-	"	.TIL.LA	==	"	bal-ṭu
4.-	"	.LAḪ	==	"	nam-ri
5.-	"	.ŠIG	==	"	dam-qa
6.-	"	.KAL.GA	==	"	dan-nu
7.-	"	.DIB.BA	==	"	ṣa-bi-tum

(Tak)K A. G I. N A is also quoted in Br.620 as š a d a n u In the Assyrian Medical Texts we find also the following varieties :-

(Tak) K A. M I i.e., "black KA-stone"

(Tak) K A. U D i.e.,"white KA-stone"

(Tak) K A.SIG i.e.,"yellow K A-stone"

We can first discuss the base (tak) KA. Tiglath-pPileser about 1100 B.C. brought (tak) K A -stone, (tak)ḫ a l - t a,(1) and (tak)K A. G I. N A from Nairi, a large district to the North-West of Assyria in the Taurus Mountains, and deposited them in the Storehouse of Adad for future use(Tigl.Pil., VIII. 11). Sennacherib used burnt brick, (tak)K A, and (tak) u k n ū in building his palace(King, CT., xxvi, 24, 42). The association of u k n ū and burnt brick suggests a blue glaze here for u k n ū : can we see anything similar in (tak)K A ?

The clue to the meaning of the (tak)K A-group really lies in the equation (tak)K A. G I. N A == š a d a n u .This last

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(1). Thureau-Dangin (RA, 1921, 167) ~~points out the occurrence~~ of (tak)ḫ a l - t u in KAR, No. 213, 16: No. 194, 4.

must clearly be the Arabic شادنة and Syriac ܫܐܕܢܐ h a e m a t i t e s, haematite, and the red iron ore associated with it.[1] Dioscorides (IV, cxliii) says the best is that which breaks easily, and is either of blood - colour or black (cf. also IB. 1267). Pliny (NH, xxxvi, 25) speaks of the "magnet called Haematites, of a blood-red colour which, when bruised, yields a tint like that of blood, as also of saffron." The Syriac MS. of Berthelot (Hist., ii, 15) says that it produces a liquid as red as blood.

Conclusive evidence is to be found in the list of materials used for seal-cylinders (Sect. 31), where the first stone quoted is (tak)K A. G I. N A . The most common material actually in use for Assyro-Babylonian seal-cylinders is haematite, and as we have already settled the principal colours for the seal-stones except black, we may reasonably consider as certain the equivalence (tak)K A. G I. N A == Š a d a n u = the black stone used for seals == haematite.

Here, then, we have the base from which we can start. Since we have now (tak)K A. G I. N A as the hard haematite, a form of ferric oxide, the other compounds of (tak)K A will be connected in some way with the same mineral.

Consider the following details about iron ores. Rutley (319) says that the chief iron ores are the o x i d e s (red haema-

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(1) Š a d a n u means literally "mountain - stone " (Geller, AOTU, 1917, 1, 4, 261), but I cannot for a moment agree with him that (tak)K A (Š a d a n u) can perhaps mean "Bergkrystall" (ib., 339, and cf. Meissner, Bab. Ass, 1920, 351). I erroneously suggested in Prsm 1924, 9, that s a n d u might have an echo in شادنة .

ti te,brown haematite,magnetite): that the natural oxides and silicates are used in the manufacture of paints,e.g.,ochres are hydrated ferric oxides, sienna and umber are silicates of iron and aluminium, containing iron and manganese, and "reddle" is the most earthy variety of haematite(ib.323).(1) Ferric oxide (colcothar) also imparts a red colour to glass (Roscoe,ii,590).

As we saw in Sect. 26,i r o n occurs within 75 miles, h a e m a t i t e within 125 miles,and b l a c k m a g n e t i c i r o n s a n d within 200 miles of Nineveh respectively, all to the north of Assyria,i.e.,Armenia and the Taurus, a district representing,in part, N a i r i. This locality thus coincides with the provenance of (tak)K A and (tak) K A. G I. N A as given in Tiglath-Pileser 's inscription(p. 121).

Next, taking the inscription of Sennacherib, also quoted on p.121, it will be noticed that he speaks of (tak)KA and u k n $\bar{u}$ in conjunction with burnt brick, presumably to overlay this brick in some way. he does not however mention (tak) K A.G I. N A , the hard haematite,in this connection, and it is therefore not unreasonable to infer that (tak)K A represents a softer form of ferric oxide. What he intends to shew is that the u k n $\bar{u}$ was used for the "blue" effect (whether as ultramarine, or as the name of the blue glaze used) and that the (tak) K A was used for another colour, most probably red in contrast to blue, and therefore f e r r i c o x i d e, which will produce a red colour either as a paint or a glaze, will be the chemical which satisfies the demands of (tak)K A.

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(1)Cf . also Roscoe ,ii,1217.

This suggestion, that Sennacherib is speaking of a glaze here, was long ago made by Winckler (KB ii, 139), in a note to a similar passage in Esarhaddon's description of a building; Winckler had not the right meaning for u k n ū ("perhaps quartz-crystal"), and, of course, he leaves (tak)K A untranslated, but the idea that it refers to a glaze is his.

The Esarhaddon passage (Prisms A and C, vi, 3) s i h̬ i r t i e k a l l i š ā t u n i b i h̬ u p a š q u š a (tak) K A (tak)u k n ī u š e p i š, obviously (although it is full of technical building terms) indicates what is apparently a decoration of glaze, which again surely must be red and blue, especially as he describes an arch in the next line as "like the rainbow". The view that (tak) K A provides a red appears to be borne out by Sargon's Khorsabad Inscription (142), where (tak) K A presumably takes the place of s a n d u, the red stone or pigment, i.e., (tak) K A (tak)u k n ū (tak) U D . A Š (?)( ) (tak)M U H̬. A Š . G E.G E d i-g i-l i (tak)U D. A Š (tak)M U Š. G I R "ferric oxide, ultramarine, UD. AŠ (?)[2], arsenic for eyes, UD. AŠ (alabaster?), serpentine", which seems to point to its taking the place of the red.

Actually the dark brown in use as a paint in Assyrian times was an iron.[3]

Section 42. (Tak)K A . G I . N A.D IB. B A[1] "magnet"

The confirmation that (tak)K A is an iron ore or oxide comes

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(1) It is entirely different in the inscription of Tiglath Pileser: he merely stores up his (tak)K A and (tak) K A. G I. N A in the Storehouse of Adad, and does not speak of their being especially used in decoration.
(2) It is obvious that one of these (tak)UD. AŠ must be wrong.
(3) Olmstead, History, 563; see also herein, p. 10.

in a most interesting way from (tak)K A. G I. N A. D I B. B A, for which the Assyrian equivalent is š a d a n u ṣ a b i t u "the haematite which grasps, attracts".

This can surely be no other than Pliny's m a g n e s (NH xxxvi,25),the magnet,known as S i d e r i t i s, "iron earth" (see Bostock's note,ibid.): " the moment the metal(iron) comes near it,it springs towards the magnet,and as it clasps it ,is held fast in the magnet's embraces". The properties of magnetic iron ore can be traced earlier than Pliny: it was certainly known to Aristotle,(4th cent.B.C.),and the properties of the lodestone were known to the Greeks in the 8th century. There is,therefore,nothing astonishing in our finding that the Assyrians of the first half of the first millennium B.C. knew it too.

An additional piece of evidence is found in the Medical Texts. The softer "black K A -stone"(Aethiops Martis,Sect.44) is found used as a drug several times,and so is (tak)K A. G I. N A. D I B. B A,"magnetic iron ore": but the hard haematite, (tak)K A. G I. N A does not occur. The magnetic iron ore is usedas a drug: for temples(AM 13,5,2: 14,4,6: 97,4,27: 102, 17,34):for mouth(30,3,ii,6): anoint body(90,1,r.5): mix for "hand of ghost"(16,3,14,an eye text): apply(13,6,10) . Diosc. (V,cxliii)and Pliny(NH,xxxvi,25) prescribe "haematites" for e y e s, b u r n s ,and to drink for s t r a n g u r y and m e n s e s: and in BM ii,90,92,it is to be pounded and applied to eyes.

A curious form of this(?)mineral is found in the account of the campaign of Esarhaddon against the land of Bazu "140 b ē r e (980 miles),a land of sand, thistles, and (tak)K A ṣ a b i t i", the latter being written as though ṣ a b i t i meant here"gazelle". 20 b ē r e further is a desert of

snakes and scorpions, and 20 b $\bar{e}$ r e further is Ḫazu, the mountain which produces (tak)SAG.GIL.MUT stones.

Before leaving (tak)K A. G I. N A, we should notice one interesting point. K A literally means "a sound", and so we might arrive at the meaning of (tak)K A. G I.N A either as "the firm(hard?) K A stone"(as haematite might well be described), or "the stone of true sound", possibly with reference to the ringing of iron, the sound which it gives out when struck, which perhaps might be referred to a period anterior to the iron age. The former seems the more probable meaning, but there is a passage in KAR14, 24-25, which adds some weight to the other suggestion : (tak)K A. G I. N A šaina māti nukurti rigma ezza taškunu "Haematite, which didst utter a loud cry in a foreign land". If it were not too fanciful, we might press this quotation as a parallel to Pliny, NH, xxxvii, 60, where he says of haematites that the possession of it reveals treacherous designs on the part of the barbarians. The value of haematite as an amulet is shown in the text referred to in Sect. 31(the list of materials used for seal cylinders) where it is said that he who possesses it "will destroy". Pliny(ib.)says that Zachalias of Babylon says that haematite ensures success in petitions, plays a part in lawsuits, and that to be rubbed with it on the field of battle gives a beneficent result. The Syriac of Berthelot, Hist., ii, 160, calls it "gracious".

S e c t i o n 4 3 . (Tak)š a d a n u b a l ṭ u "living ironstone" = lodestone.

Passing on to the mineral (tak)K A. G I. N A. T I L. L A

(= š a d a n u b a l ṭ u), which, by the theory which I have put forward, should mean "living haematite","living iron ore",we may identify it at once with Pliny's f e r r u m v i v u m (NH xxxiv,42), which latter appears again to have been the lodestone.

With this use of "balṭu "living" applied to metals we may compare U R U D U . T I L. L A (1/3 m a n a)"living copper" (period of Epoch of Ur, Scheil,RA,1921,51,17).

S e c t i o n 44 . The Other Varieties of Iron Ore.

The varieties indicated by the adjectives n a m r i "bright", d a m q u "fortunate", d a n n u " strong", are difficult to identify, but the"black","white",and "yellow" kinds are obviously the different ochres, distinguished by their colours. Particularly striking is the absence of any variety of the (tak)K A -mineral exactly defined by the colour "red", a good indication that the prime colour of the (tak)K A was r e d , without further definition, which is all in accordance with the theory I put forward above, that (tak) K A represents a red (and ochreous)colouring matter.

It may be added here that the Alchemists valued the oxides of iron highly: r e d o x i d e of iron was called C r o - c u s M a r t i s by Geber, and an artificially-prepared b l a c k o x i d e was termed Aethiops Martis(Roscoe,ii,12 1217).

In Assyrian medicine we find the following prescribed:-

(tak)K A . M I ,"black iron ore",Aethiops Martis(about 10 times): eyes,(AM 1 ,9,2),and brayed alone in "mountain oil" i.e.,petroleum, naphtha,(16,3,12): bind on temples(20,1,iv,31:

102,22 : 104,1,9): put round eyes(46,1,1,25): on throat(88, 4,r.8): other passages(2,1,9: 7,1,r,IV,8: 17,3,2:29,2,9): note that (tak)K A.M I forms part of a bronze weapon(1 Z A - B A R. S A G. K U L (tak)K A. M I, Genouillac., Drehem,7).

(Tak)K A. U D, "white iron ore" (AM52,6,8:also CT.XIV,17, K.13713,5). (Tak)K A.U D[pl] are to be threaded on a cord(Thureau-Dangin,RA,1921,167).

(Tak)K A. S I G,"yellow iron ore(ochre)",(AM29,2,8).

A D D E N D A 1

T h e W e i g h t K i s a l .

The K i s a l is a fraction of a shekel which has not yet been settled. Meissner,in his translation of the Glass-text,Sect.25,G(Pl.2,l.61,ff.)renders it as "Halbsekel(?)"(Bab. Ass.,ii,384),but says that it is unknown. I cannot agree with him that "Halbsekel" is near the mark.

The sign for this weight occurs fairly frequently in the Medical Texts, and is once spelt out k i-s a - a l(AM,41,1, 30). In these glass texts the highest amount indicated is 16 k i s a l(Sect.25,DD). What is most important is the amount given twice in Pl.6,K.4273,13,and 14:-"One k i s a l , twenty - two and a half Š E".

Now the Š E ,the grain of corn, is the lowest unit on which Assyrian weights are based. This was shewn by Reisner(Sitz.

Koen. Preuss. Akad., 1896, 418, quoted by Johns, ADD, ii, 266) to have the value

180 ŠE == 1 Shekel

Johns then says "taking the wheat grain as .046 gram we should obtain a mina for early Babylonian times of 504 grams. This is a confirmation of the duck-weight evidence, it gives the light mina of Assyria also. Of course other grain may be meant, and these would give a slightly different result".

For convenience I append here the Assyrian system of weights giving the values of the first three from Thureau-Dangin's article in RA, 1921, 136 :-

1 Talent (biltu)	== 60 mâna	==30 k. 300 grammes
1 Mana	== 60 shekels	==505 grammes
1 Shekel	==180 ŠE	== 8 grammes 416 2/3 m
1 ŠE	== .046 grammes.	

We have now to insert the kisal between the ŠE and the shekel.

We have seen that there are quoted as many as 16 kisal, and 22½ ŠE. There is no reason to believe that the kisal is anything but a part of the shekel, so that in the face of these two amounts, it is obvious that it is not used as an independent unit between the ŠE and the shekel (inasmuch as there are 180 ŠE to the shekel). The problem thus resolves itself into the following:-

(1).- Is 16 kisal more than 1 shekel,

or

(2).-Is 22½ ŠE more than 1 kisal ?

It will, of course, have been noted that the 22½ ŠE represents an exact fraction of the shekel, i.e., 1/8.

The natural expectation would be that the Assyrians adhered to their sexagesimal system, and reckoned 60 k i s a l to the shekel. 3 ŠE would then represent the weight of the k i s a l . This would be particularly attractive as the older division of the shekel made the GIN.TUR as equivalent to 3 ŠE.(1)

We cannot, however, settle it definitely, but there is a confirmation that the k i s a l is a small fraction of the shekel (and not a large one) in the Section (25, "DD") which gives the proportions for the "Purple of Cassius".

It may be added that the same ideogram which stands for k i s a l represents š a m n u "oil". This can hardly represent the liquid unit of one drop, minim, for even if the k i s a l represent a weight of only 3 ŠE, it will be two or three times too heavy.

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(1) Thureau-Dangin, RA, 1921, 137.

2.

The Transliteration of the Chemical Texts.

K. 203+4747+10493 : K.5839: K. 6246+8157 : K.7619.

PLATE 1.

Section A.

Ê-nu-ma uš-ši ku-u-ri ša[1] abni tanadû(du)..
i-na arhi šal-me[2] ûmi magari taš'i-ma uš-ši ku-u-
(ri ta-nam-di
a-di ku-u-ra u-te-it-tu-ma[3] [4] te-te-ip-šu[5]
AN.KÙ.BU^{pl} tu-..-m a ša-nu-u a-ḫu-u la irrub(ub) la
(ellu a-na pa-ni-šu-nu la ikabbas
gi-na-a si-ir-q[i (or qa)]..a-na pa-ni-šu-nu ta-šar-raq
ûm(um) abna ana lib ku-[u-ri tušeridu] niqê ana pân
(AN.KÙ.BU^{pl} teppuš(uš)
niqnaqqi ^{š}buraši tašakan(an) kurunni tu-ša[r - raq]
(išata ina šaplita(ta) ku-u[7]ri tanapaḫ(aḫ)-ma
abna a-na lib ku-u-ri tu-šer-ri-da ameli^{pl} ša a-na
(eli ku-u-ri tu-qar-ra-bu
u-tab-ba-bu-ma ana eli ku-u-ri tu-q[ar-rab] iṣê^{zun}
(ša ina šaplita(ta) ku-u-ri
ta-šar-ra-pu ^{iṣu}ṣarbata kab-bar-ta qa-li-ip-tu
qu-ru-u sa qi-iṣ-ra la na-du-u i-na ^{masku}a-pi ṣab-
(tu ina ^{arḫu}Abi innakasu(su)
iṣê^{zun} an-nu-u ina šaplita(ta) ku-ri-ka lil-lik

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(1)K.7619 ša (Br.11952). (2)K.203 mi. (3)Probably thus. (4) K.203 adds i-na bît ku-u-ri ... (5) K.7619 bi. (6) K.7619 probably tu-šar-...(Br.4297). (7)K.203 u(Br. 6020).

Section B.

šum-ma tak uknû itbu a-na(8) e-pi-ši-ka(9) 10 ma-na IM.KA.NA

15 ma-na digmenu u uhûli 1 2/3 ma-na u UD(10) a-hi-e ta-[m]a-

(raq ešteniš(niš) tuballal

a-na ku-u-ri ša šiknat ēni pl -ša ka-ṣi-ti tu-šer(11)-rid-ma i-na

(bi-rit ēni pl ta-rid-di

išata ṭa-ab-ta la qa-tir-ta ta-šar(12)-rap a-di....i-pi-iṣ-ṣu-u(13)

tu-šel-lam-ma tu-kaṣ-ṣi tatar-ma ta-mar-raq a-na ṭa-ap-ti za-

([ku(?)]-ti te-iṣ-ṣi-ip

a-na ku-u-ri ša(14) tak-kan-ni ka-ṣi-ti tušerrid(id) išata

(ṭa-ab-ta

[la qa-tir-ta] ta-šar-rap a-di i-[pi-iṣ-ṣu--u ?] a-na eli

(a-gur-ri

ta-[na-aṣ-ṣa-al]-šum-ma ..... šum-šu

Section C.

(15) 10 ma-na ēri zun i-[na ṭa-ap -ti(?)] za-ku-ti ...v.......(16) ta-šak-kan

(a-[na ku-u-ri ša tak-kan-ni

im-me-ti tu-[šer-rid]... išata dan-na-ta

........zûn.(16)

[ta-šar-rap] a-di ēri [i- r] aš-šu-šu

..............(16)

ta-tar-rak ....ta-pi-it-ti

... . (16)

..........a-di zu-ku-[u?] ....-di-e-ma

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*Note: At the last moment I received a most kind indication from Mr Sidney Smith that Dr Robert Eisler has published an article on "Der Babylonische Ursprung der Alchemie", in the Chemiker Zeitung (Cothen), dealing with Meissner's translations. I have not been able to see this article unfortunately, but I understand from Mr Smith that the author deals particularly with the "Tor des Ofens" and the foetus-gods.

(8) K. 203 ana. (9) K. 203 and 5839 DU-ka. 10 K. 5839 ...-su. (11) K. 203 še . (12) K. 203 and 5839 šar (Br. 8208). (13) K. 5839 ...(pl). (14) K. 203 ša (Br. 11952). (15) The text to 1.27 is a composite, but is approximately correct. (16) Approximate position.

..............(16)

ēri^{zun} ina .... i-na mu-uṣ-la-li ....
..................(16)

..................tak..

....

S e c t i o n D.

...........[ma-n] a a-ḫu-uz-zu ....

[ana ku-u-ri ša šiknat ēni^{pl}-ša kašiti tu-š]er-rid-
(ma ina bi-rit ēni^{pl}- ta-[rid-di]

..............-šu-ma 1 ūme(me) tu-šel-lam-ma tu-[kaṣ-ṣi]

.... ana ku-u-r]i ša tak-kan-ni ka-ṣi-ti tu-še-rid

.... ṣu-tu-u

...................[tu-še]l-lam-ma zu-ku-u šum-šu

S e c t i o n E.

...............[ana ku-u]-ri ša tak-kan-ni im-me-ti
(tu[šerrid(i]d)

[išate ṭa-ab-ta la qa]-tir-ta ta-šar-rap
[tu-šel-lam-ma(?) ta-tar]-rak-ma ta-mar-raq

....................-ma tatar-ma t[a]............

................ēri^{zun} k[a]......................

..........ri la(?) a pi(?) ma..................

ina išati abna(?)..................................

šum-ma abnu pe-an ^{iṣu}karaṇi ba-aš-li$^{(2)}$ abna ina
(ēri^{zun} t[u-bal-li]l

ana$^{(3)}$ eli a-gur-ri ta-na-aṣ-ṣal --lam-ma ter-si-ta šum-šu

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S e c t i o n F.

10 ma-na ter-si-tu 10 ma-na sir-ṣu.. ^{u}uḫulu ḫar-ṣu
(la ta-a-a-ru

---

(16)Approximate position. (2)Composite. (3)K.9551 a-na.

2/3 ma-na nam-ru-tum ša tamti [ša]-an-di qa-li-tu
(a-li-e ta-mar-raq

šteniš(niš) tuballal ana ṭa-ap-tim za-ku-ti te-is-
(sip a-na ku-u-ri ša šiknat ēna[ii] -ša ka-ṣi-ti

tu-šer-rid-ma i-na [bi]-rit ēna[ii] ina eli ni-me-di
(tašakan(an) išid ṭa-ap-ti ku-u-ra la ikaššad

[išata ṭ]a-ab-ta la qa-tir-ta ta-šar-ra-ap išatu ul-
(tu lib ēni[pl] ki-i šiblukki ušeṣâ[pl] -a

[u abnu ?]i-ṣu-ud-du išata ta-šad-da-ad i-na ku-u-ri
(kaṣiti[(4)] tu-šel-lam-ma ta-mar-raq

[ana ṭa-ap]-ti za-ku-ti te-is-si-ip-ma a-na ku-u-ri
(ša tak-kan-ni ka-ṣi-ti tušerrid[(5)]-ma

[isatiṭâ]-ab-ti[(6)] la qa-tir-ta ta-šar-rap[(7)]...... a-di abnu
(i-raš-šu-šu

[bāb ku]-u-ri la takattam(tam) ul-tu abnu ir-taš-šu
.... (7)
(bāb ku-u-ri takattam-ma

REVERSE

[i-har-r]a-ṣu-ma la-ni ina pa-ni-ka ta-bi-el-tu ul-tu
(ih-tar-ṣu

....-ma tam-mar-ma šum-ma abnu ub-bu-uk[(9)] ana ṭa-ap-ti
(e-me-ti

[ta]-na-aṣ-ṣa-lam-ma i-na[(10)] ku-ri takaṣi(ṣi)[(11)]il-lam-
(ma [tak]uknū

Section G.

a-na 1 ma-na te-ir-si-[t]u dam̄iqtu 1/3 ma-na sir-ṣa mar-
(qa 1/3 ma-ra [tak]am - na-ku

---

(4) Or, perhaps, following K.4266, [i]-kaṣ-ṣi, i.e., "in the furnace it shall cool", or, [tu]-kaṣ-ṣi, "thou shalt cool".
(5) K.4266, tu. (6) K.4266, ta. (7)....(7) K.4266 omits.
(9) K.4266 inserts ...-su dušû it-taš-lik(?) .... [tu]-ba-aš-ši-il. (10) K.5266, ina. (11) K.4266.... -kaṣ-ṣi.

5 kisal nam-ru-tum tu-ul-ta-bal-ma ta-sa-ḫar-ma ta-mar-
(raq

a-na tam-šil-te te-si-ip ta-pi-ḫi-šu-ma ina ta-aš-ni-e
ina bi-rit ēni^{pl} ta-ša-kan-ma el-la-ma ^{tak}uknū me-ir-ku

Section H.

I-na utuni ūmu 7^{kam} išata ta-šar-rap a-na 1 ma-na
(te-ir-si-tu

5 ma-na ta-ra-ba-nu ša-ad-da 10 kisal sir-ṣa ša 1(?)..
5 kisal nam-ru-tum ša tāmti ša lib t[āmti, or me^{pl} ?]
sa-an-di 2 kisal mil'u 3 šiqlu šīpi 5 kisal ^{tak}ga-
(bi-e sāmi IRA

6 kisal lēri 6 šiqlu ^{u}UD tu-ul-ta-bal-ma ta-sa-[ḫar-ma]
ta-ma-ra-aq-šu-ma a-na tam-šil-te te-si-ip el-la-ma
(^{tak}uknu me-[ir-ku(?)]

Section I.

ša la it-ṭi-ib-bu-u(1) ana(2) utuni tašakan(an)-ma išata
(ūmu 7^{kam} ta-ša-r[a-ap]

Section J.

(3) 3 ma-na te-ir-si-tu 8 ma-na zu-ku-u 1½ ma-na ^{tak}...
12 kisal mil'u maš-ka-an-ti ^{tak}uknū ...

Section K.

1 ma-na te-ir-si-tu 2 ma-na ša-da-a maš-ka-an-ti
(^{tak}uknū ...

Section L.

1 ma-na te-ir-si-tu 1½ ma-na ša-da-a maš-ka-an-ti
(^{tak}uknū....

---

(1)K. 3889 u (Br.No. 8645). (2)K.3889 a-na . (3)At this point K.4266 has a different receipt, ...ma-na (tak)am-na-ku 1 ma-na (u) uḫulu ...

S e c t i o n M

1 ma-na te-ir-si-tu 1½ ma-na sir-ṣa ½ ma-na am-n[a-ku]
ta-mar-raq tul-ta-bal-ma a-na tam-šil-te te-s[i-ip]
a-na utuni ta-ša-ka-an išati 7 ūmē(me) mu-ša u kal
(ūmē(me) ta-[šar-ra-ap]
e-la-ma ᵗᵃᵏuknū sa-a-mu]

S e c t i o n N. (To be restored from K.203,V, 1, ff.?)

80. Šum-ma UD.KA.BAR ar-ḫu a-na e-[pi-si-ka]
10(?) ma-na a-ḫu-sa 10 ma-na ᵗᵃᵏ.....
[ina ku-ri] ka-ṣi-ti tu-še-rad..........
...........tu-pa-aṣ-ṣa- ....
..........[tu]-pa-aṣ-ṣa-..................
....

S e c t i o n O.
(86)... ... (87) ....-mar (88).... [ᵗᵃᵏuk]nū sāmu
(89)...e-pu-uš (90) .... [ina] a-gur-ri tašakan(an)
(91)... -ti(= maškanti?) ᵗᵃᵏuknū sāmu

S e c t i o n P. (Restored from K.203,V,23,ff.)

Šumma ᵗᵃᵏsir-ṣu [ana epiši]-ka 5 ma-na di-ig-mi-
(nu ša ᵘaḫuli qarnani
..... ᵗᵃᵏmil'u IRA 5 šiqlu nam-ru-u-ti ešteniš(niš) tu-
(ballal
[ina ku-ri] ka-ṣi-ti tu-še-rad išatu ṭa-ab-tum ta-šar-rap
95.[ina lib mePl ta-na-ṣa-al?] ina ḫa-ra-gi la e-še-te
(ta-še-rad

...... [ina lib] me^{pl} ta-na-ṣa-al an-nu-u sir-ṣu nat-ku

S e c t i o n Q.

... ma-na te-ir-si-ti ^{tak}uknī 1 ma-na sir-ṣu ešteniš
((niš) taḫašal tu-sa-maḫ
ina ku-ri ka-ṣi-ti tu-še-rad išatu ṭabtu(tu) ta-šar-
(rap a-di i-ka-pi-lu-u-ni
ina ku-ri ša tuk-kan-ni ina ḫa-ra-gi šak-tum-te la
(e-še-te tu-še-rad išata ta-šar-rap
ina lib me^{pl} ta-na-ṣa-al ina ḫa-ra-gi e-še-te tušerad
tu-pa-ak-ku ru-ṭib-bat ina 4 ūme(me) tapatte(te)
tušelā-ma ^{tak}ṣipru ša UD.KA.BAR ar-ḫi ša-mal-li
ter-si-it ^{tak}uknū AL.BAD ši-it-ti ? ku-u-ri NU.AL.BAD

S e c t i o n R (Rev. of K.203, col.vi, Pl.4.).

(1)... ^{tak}am-na-[ku].... (2).. [ši]-iq-(tu) tu-us-ku-u....
(3)...nam-ru-tum maš-ka-an-t[i].....

S e c t i o n S.

Ditto(?) a-na ^{tak}AŠ.GE.GE ....
ta-sa-ḫar -ma a-na tam-šil-te te-si-ip
iš-di tam-šil-ti-ka te-eš-ši ina eli [nimedi?]
a-na lib utuni tašakan(an) - ma ūmu 7^{kam}....
utuni te-pi-ḫi-ma a-na ūmu 10^{kam} te-pi-[ti]
tu-še-la-šu-ma a-na 1 ma-na ^{tak}ba-rum(?)-mu(?)
1 kisal ^{tak}mil'u me-sa-at
ši-iq-tu tu-us-ku-u 1 kisal nam-ru-tum
1 kisal ^{u}uḫuli ta-sa-ḫar-ma ša-nu-te-ka

ta-tar-rak ta-mar-raq tul-ta-bal

ta-ma-ra-as(uk <u>sic</u>)-ma ki-i qa-at-pa-ni-ma

išata ta-šar-rap tu-še-lam-ma

^{tak}dušū arqu ša 2-šu tu-ur-ru an-ni-tu

---

maš-ši-tu ša la-a ša-rat še-e

Section T.

A-na 20 ma-na ^{tak}an-na-ku

1 biltu ^{u}uḫulu qarnanu

2 ma-na mil'u 10 šiqlu nam-ru-tum

1 ma-na tu-us-ku-u 6 šiqlu lu-lu-u

il-la-ma ^{tak}dušū

Šum-ma sir-ṣu a-na epiši-ka

Ter(<u>sic</u>)-ir-si-te ^{tak}uknū u ^{tak}dušū AL.BAD

Section U. (K.4266 IV. 15, Pl.5).

1 ma-na ^{tak}zu-ku-u 15 kisal mil'u(?)

10 kisal a-ba-ru maš-ka-an-ti ......

e-lam-me-ti ša qata^{-ii} ^{m}Nur-....

Section V.

1 ma-na ^{tak}dušū ibbu 15 kisal tu-us-k[a-a]

maš-ka-an-ti ^{tak}sandi aš-ša-ki

---

1 ma-na ^{tak}dušū ibbu 10 šiqlu tu-us-ka-a

maš-ka-an-ti ^{tak}pa-ru-te aš-ša-ki

Section X.

A-na 1 ma-na 3 šiqlu ẓu-ku-u

ša ZÚ ḫuraṣi ša-ak-nu

3 kisal mil'u I[RA]

3 kisal ka-al-gu-ga-ma AN.[KÙ.BU?]

a-na ḫi-sip(?)-šu ta-mar-...

3 ta-a-an ta-na-aš-[ši]

ki-ma ta-at-ta-šu-u ta-m[a-ra-aq]

tul-ta-bal i-na kal-li šu-ḫar-[ra-ti]

i-na ṣi-e-ti tašakan(an)..

tu-bal 2 ta-am-ra-ta

^{tak}am-na-ka te-eš-ši ṣi-ta

ta-ma-ḫar-ma tašakan(an) ūma(ma) i-ma-an-du-ni-ku-ma

S e c t i o n Y.

I-na A.GUB-ku II tesikkir(ir) AN.KÙ.BU tu-še-el

niqī ta-ṣa-bat a-na um-ma-ni

ki-is-pa ta-ka-si-ip

..-ši-it a-na tam-šil-te te-si-ir

a-na utuni tu-še-ri-d[aš]..

....

S e c t i o n Z. (K.4266,V, Pl.5).

(1)... ta-šar -rap (2) ....-i-du

S e c t i o n AA.

...[š]a(?)-ad-da-a 10 ma-na a -ḫu-us-sa

..ma -na mil'u la me-si-ta

½ ma-na IM.SIG.SIG an-ni-tu

maš-ši-tu tu-še-la-ma

^{tak}sandu mar-ḫa-ši-tu

Section BB.

A-na 20 ma-na ^{tak}aḫ-na-ku

1 biltu ^{u}uḫulu qarnanu

2 ma-na mil'u 10 šiqlu nam-ru-tum

1 ma-na tu-us-ku-u 6 šiqlu lu-lu-u

il-la-ma ^{tak}dušū

Section CC.

A-na 20 ma-na am-nak-ki 1 biltu uḫulu qarnanu

1 2/3 ma-na mil'u

2/3 ma-na nam-ru-tum [il-la]-ma sir-ṣu

Section DD.

A-na 1 ma-na z[u- k]i-i

16 kisal [tu-us]-ku-u

10 kisal a-ba-[ru]..... mil'u

½ ḫura[su]........ e-la-me-te

..................-daiāni

(20)...-ku-u(21)...NE(22)...-ba(23)...niš(24)..[tu-u]s-ku-u

(25)....^{ilu}E-a (26) ....[^{tak}ba]ḫ-ri-e

Section EE.

(27)...sir-ṣu (28)....-li-tu (29)...-ma(?) (or,la)-ia

Section FF.

(30)....IM II (31)....LU. IRA (32).... IRA

....

Section GG. (K.7125,Pl.4).

(1).... e-pi-[ši](or e-me-[ti])...(2)...$^{ta]k}$mil'u ṣalmu

(3)[ana ku]u-ri ša šiknat ēni[^{pl}-ša kaṣiti tušerrid

-ma (4) ina birit ēni^{pl}]ta-rid-[di (5)[a-di bil]-lu-

-ka[1] i-raš-šu-[šu]..(6)... tu-ka-aṣ-[ṣi] ..(7)[ana ṭapti
zakuti?] te-is-si-ip...(8)...tu-šar-[ra-ap]. (8)(9)...[tu]-
ša-ar-ra-a[p]..(10)[ana] ṭa-ap-ti e-ši-t[i]...(11)[ina
kūri]i-ka-aṣ-ṣi ...(12)...[ta?]-a-a-ru ša ...(13)...TUR...

S e c t i o n HH.

(14)...^{tak}im-ma-na-ku...(15)...mil'u lu UŠ lu ŠAL...
(16)...ṭe-mi (or,mil'u ṣalmu)-šu ta-mar-[raq](17)....tu-
še-ir-rid-ma...(18)...ta-šar-ra-ap... (19)...i(?)-pi-iṣ-
ṣu-u...(20)...tu-kaṣ-ṣi...(21)...l me ...

....

S e c t i o n II. (K.6920,Pl.6).

Ḫa-a-a-ṭa te-pi-....
Šam-ra-ka ta-nam-[di]
Šum-ma abnu i-ra-ḫu-ut la i-......
tu-tar-ma te-pi-....
ki-i u-ba-an it-tab(?) a-na .....
a-na pa-an abnu Šam-ra-ka ta-nam-d[i]....
Šum-ma abnu zi-iq-, zi-[iq]
i-ša-as-si tu-tar-ma te-pi-....
...-ma te-ip-te-ḫi na-aš-ra-....
....-ba-la-a te-pi-te..
...u iz(?) ta-ma-da-ad...
....i-ra-ši-ka tu-še-ri-[id]....
....la u di iz(?)il-.....
.... ša ^{tak}me-.....
.............-di-ka tu-še-....
..........-tam-mar..-ma...

---

(1)See K.5862,5,Pl.6.

(.(17)...im-ta-... (18)...mi...(19)...la-a(?)...

Section JJ. (K.4273,Pl.6).

(1)u(?)...(2)te-...(3)l...(4)a-di...(5)ša ;...(6)tu-še-[rid?]..
(7)su-u-... (8) u IM.IŠ.[TAK.KUR.RA?]...(9)tu-še-la-ma....
(10)ta-tar-rak...

Section KK.(dup.of K.6920,rev.,Pl.4).

a-na 2 ma-na ^{tak}me-....

5/6 ma-na ^{tak}am-na-ku 2/3 ma-na ....

1 kisal 22½ ŠE.....

1 kisal 22½ ŠE. .ka-....

15.ki-ma ta-at-ta-šu-u.......

ta-mar-(ra)(1)-as-ma illa- ma...

Section LL(continuance of K.6920).

..[ka]-al-gu-ga 1 šiqlu IN.NU.[UŠ]
[ešteniš(niš) tuballal an-nu-u tu(or,li)...

Section MM.

10...šum-ma si-ir-du-u(?) ....
[ta]-šar-ra-[ap]..........................
[a-n]a lib-bi tanadi ....

Section NN.

..šum-ma ši-ir-......................
....

Section OO.(K.5862,Pl.6)

(1)...(2)ešteniš(niš) tuballal...(3)tu-šar-r[id]...(4)išata ṭa-ab-t[a].....(5)a-di bil-lu-ka ...(6)tatar-ma ta-mar-raq a- na.....(7)-a-na ku-u-ri ša tak-kan-[ni].....

(1)Added from K.6920.

(8) išata ṭa-ab-ta la qa-[tir-ta tašarrap]

(9) a-di i-ḫar-ra-........

[(10) ana eli a-gur-ri tašakan.......

Section PP. (K.7942 8167, Pl.6).

....

........šu a ,,...

. ina išati tu-ṣa-ad arki-........................

/.....AN.ID. MULU.RU.TIG...........................

..-ṣu-ti ŠAR-as î-n[a]..........................

arki šuati ŠI.ŠA.GAL.LA tak.....................

i-na lu-ba-ri-e sa-mu-du(?).......................

ina išati tu-ṣa-ad eštenîš tu-...................

[ana] lib mē tanadi-ma tušela-ma ....

na(?)-at-ku la ta-mi-iš man-ma la ....

2 šu IM.GIṬ.ṬA a-na lib 1 ma-na ēri ....

6 šiqlu UD.KA.BAR bi-il-.........................

a-na kaspi i-bal-la-...........................

ip-pat-ti-ik-ma i-na šaman iṣu ašuḫi................

a-di i-ga-ma-ru in-nap-pa-......................

ik-kap-pa-ar-ma . ut-tap-........................

ṣip-pat kaspi lim(?)-na kaspu šu(?)-u-nu.........

Section QQ.

A-na lib 1 ma-na ēri mi-si-i ....

10 šiqlu anaku 2 šiqlu ....

i-ṣa-ad ip-pat-ti-[ik] ....

ina šaman iṣu ašuḫi in-nap-......................

ik-kap-par ut-tap-........................

ṣip-pat kaspi kaspu šu-u-[nu]....................

(K.6648, Pl.6 perhaps does not belong to this series).

- . - . - . - , -

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AH : R. Campbell Thompson, The Assyrian Herbal, 1924

AJPhil. :American Journal of Philology.

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HWB, Delitzsch, Assyrisches Handwoerterbuch.

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JSOR: Journal of the Society of Oriental Research.

KAR: Ebeling, Keilschrifttexte aus Assur, Religioesen Inhalts.

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NH: Pliny, Natural History, ed. Bostock.

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Pliny, see NH.

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PRSM: Proceedings of the Royal Society of Medicine.

R.: Rawlinson, Cuneiform Inscriptions of Western Asia.

RA: Revue d'Assyriologie.

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SM: Budge, The Syriac Book of Medicines.

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INDEX 1

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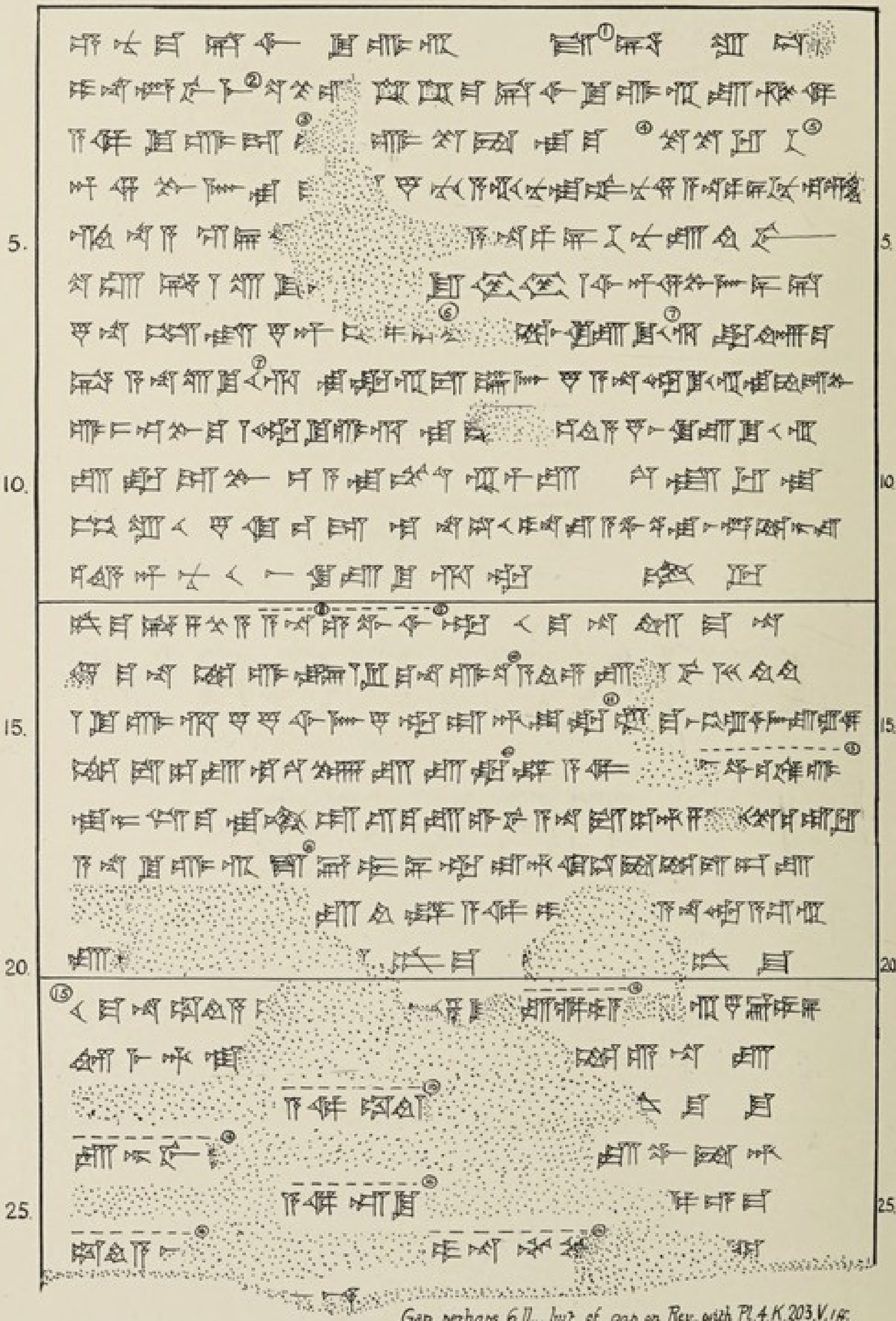
THE CUNEIFORM TEXTS

K. 203 + 4747 + 10493 : K. 5839 : K. 6246 + 8157 : K. 7619 : OBVERSE.



Gap perhaps 6 ll., but cf. gap on Rev. with Pl. 4, K. 203, V, 19 f.

Variants from K. 203 : (2) . (3) Thus traces: but it may be the beginning of the next character . (4) Additional: and rest of l. 3 lost; l. 4 begins etc. (7) . (8) . (9) and K. 5839 . (11) . (12) and K. 5839: . (14) .

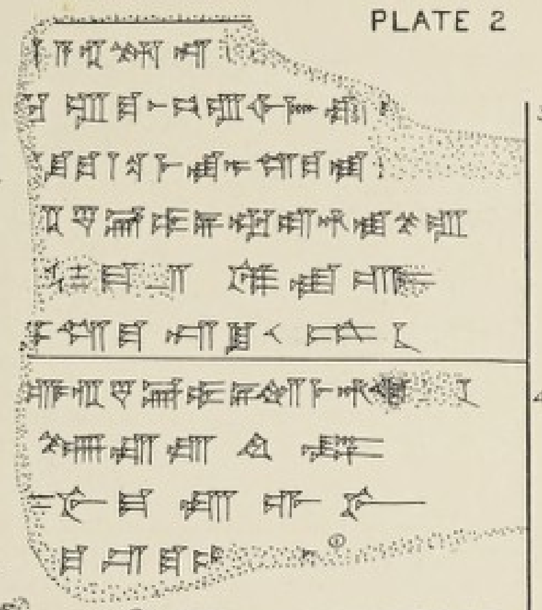
From K. 7619: (1) . (5) . (6) Probably here .

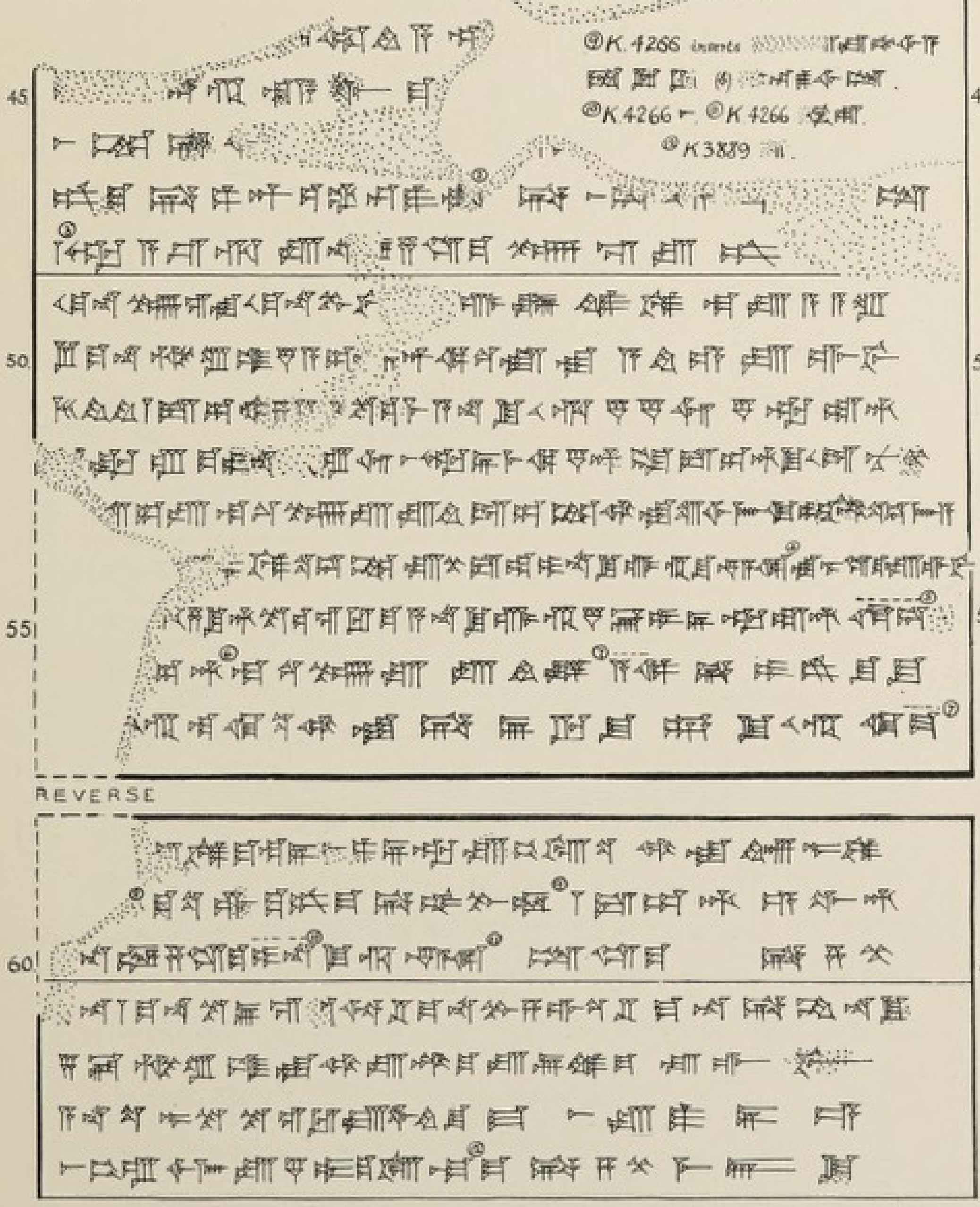
From K. 5839: (10) . (13) .

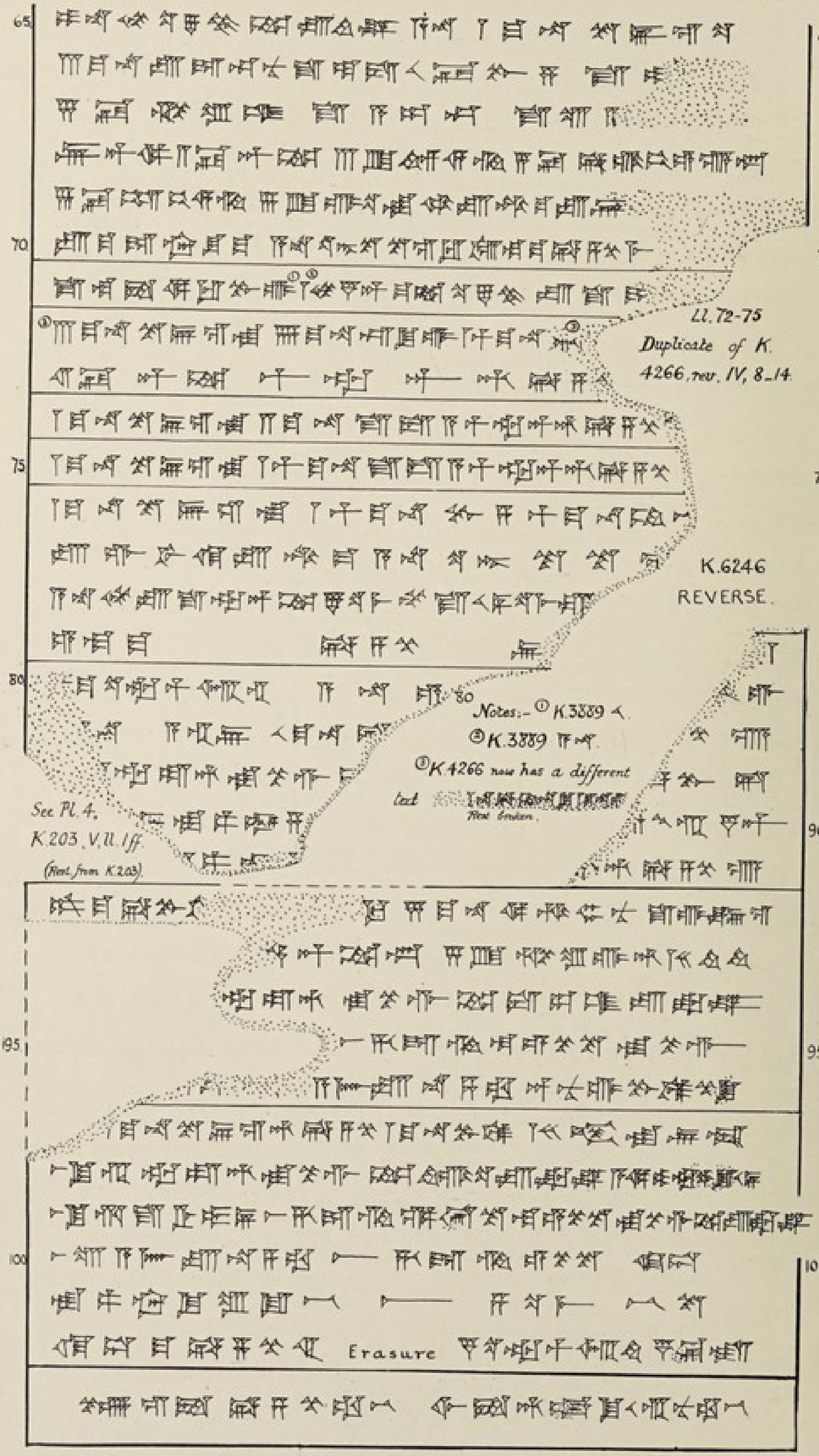
Note: (15) The text henceforward is a composite one, but approximately correct. (16) Approximate position.

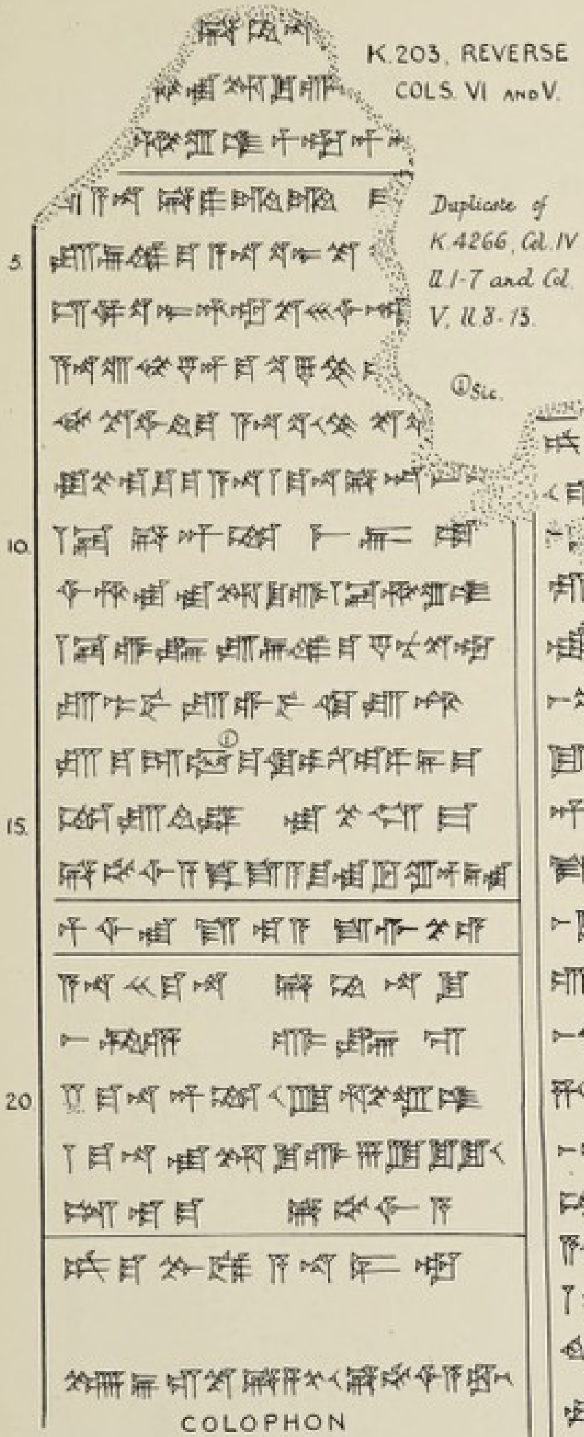
K.4290 + 9477 + 9492.
OBVERSE. (*Lower half of K.6246*). K.9551 : K.4266 + 8976 (*Parts of same tablet*), OBVERSE. K3889.

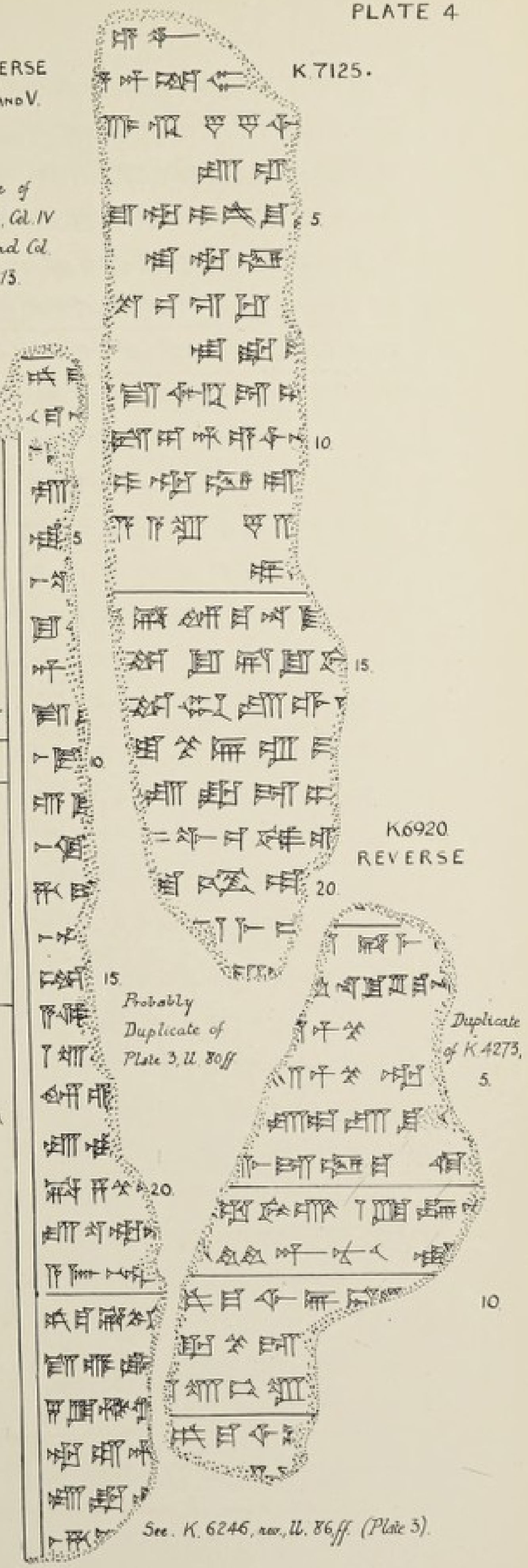
Notes:- 1.1 *The first line of K.9551 may contain the last word of l.43 of K.4290*: 2 *Composite, made up from two texts, but practically certain.* 3 *K.9551* 4 *K.4266* 5 *K.4266* 6 *K.4266*. 7--7 *K.4266 omits.* 8 *K.4290 for the preceding traces*





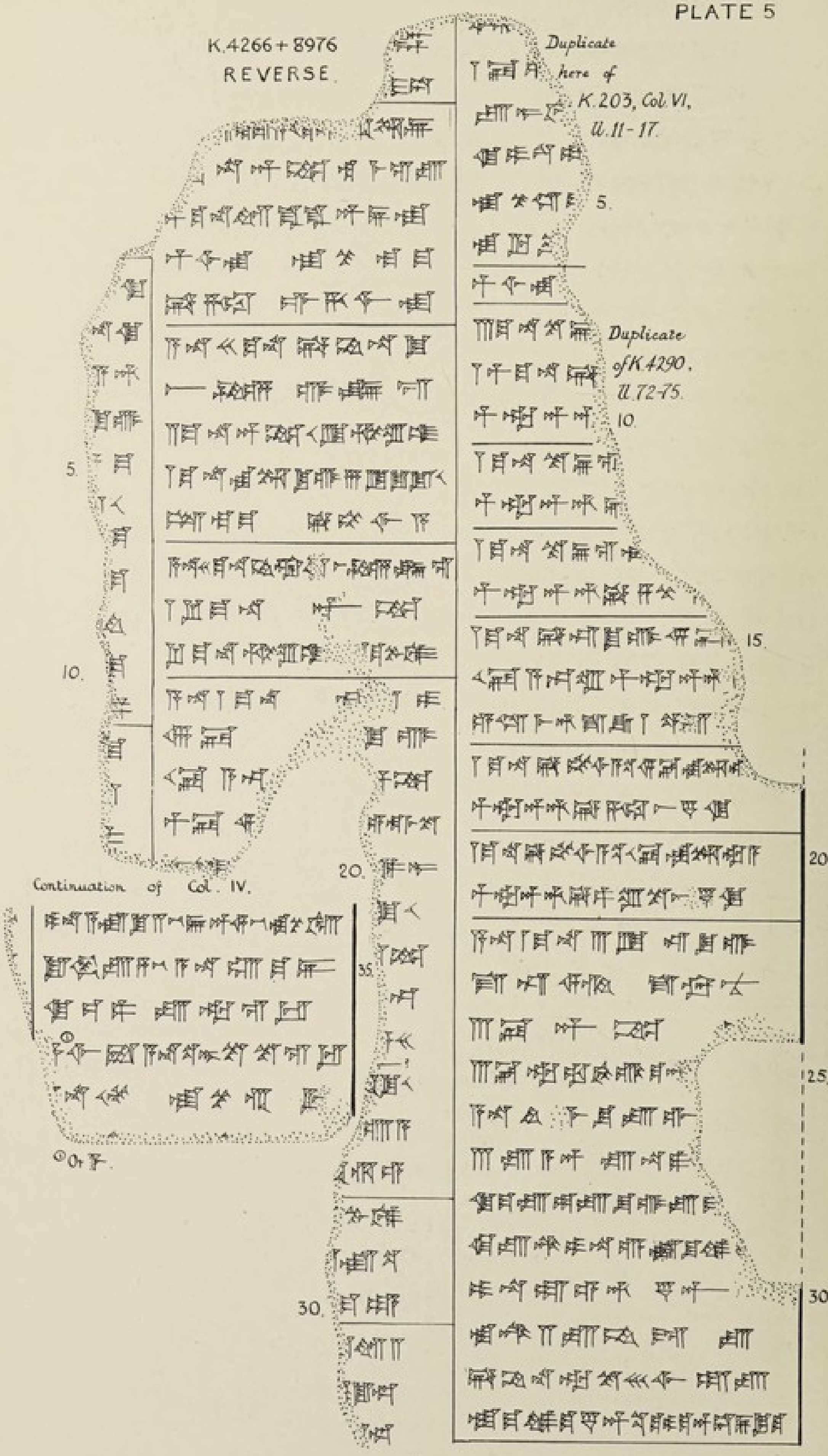

Ll. 72-75
Duplicate of K.
4266, rev. IV, 8-14
K.6246
REVERSE.
Notes:- ① K.3889
② K.3889
③ K.4266 now has a different
text
Rest broken.
See Pl. 4,
K.203, V, ll. 1ff.
(Rest from K.203)
Erasure



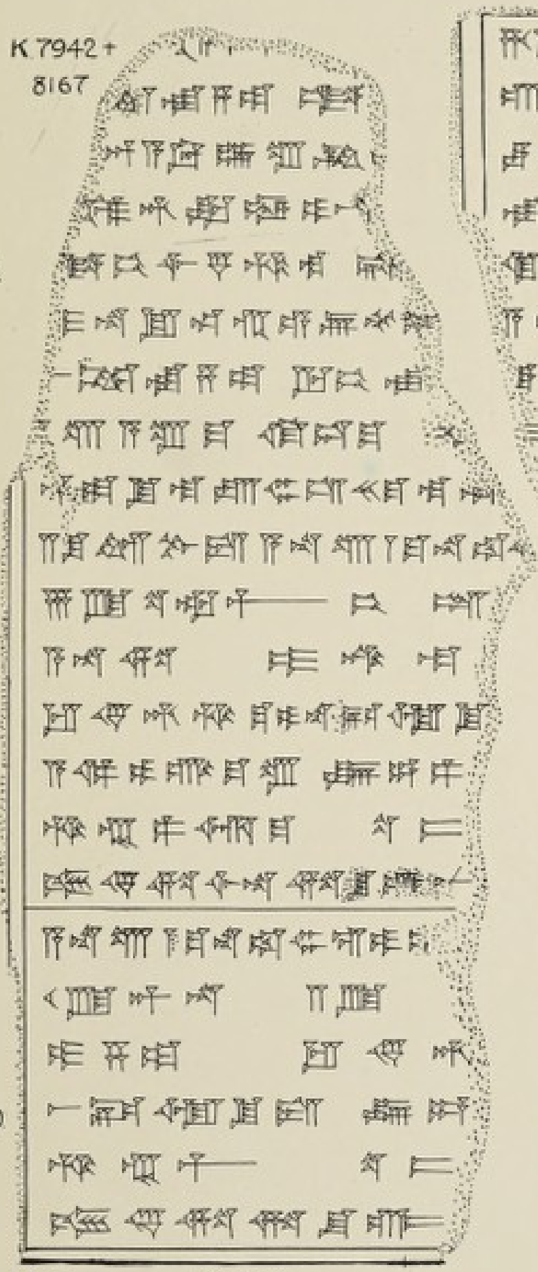


Notes :- KK. 4266, 4273, 5839, and 9551 are probably parts of the same tablet; KK. 203, 3889, 5862, and 7942 are probably parts of another tablet (and perhaps also K. 6920).

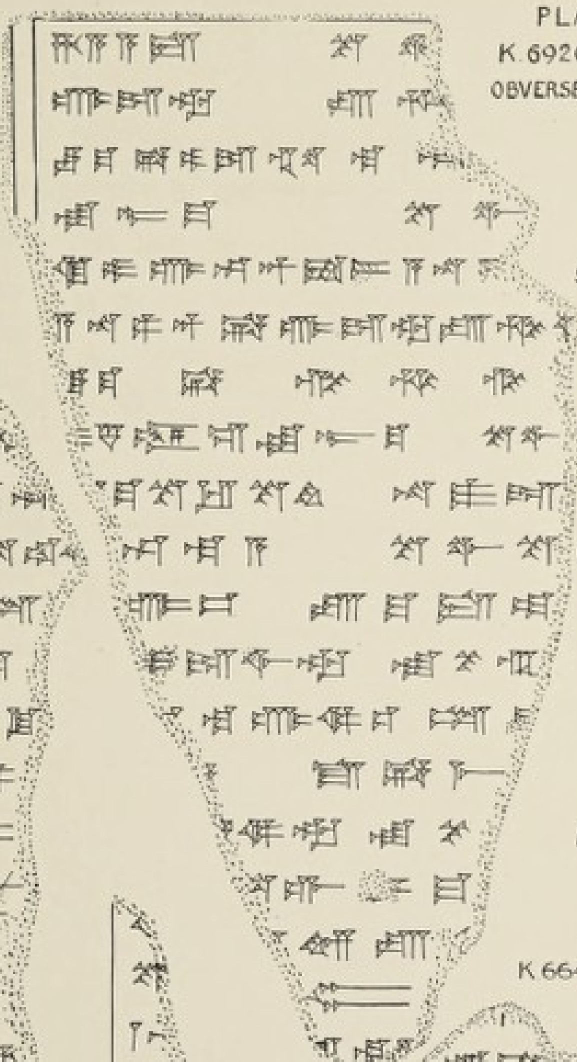
K.4266 + 8976
REVERSE



K.7942 + 8167

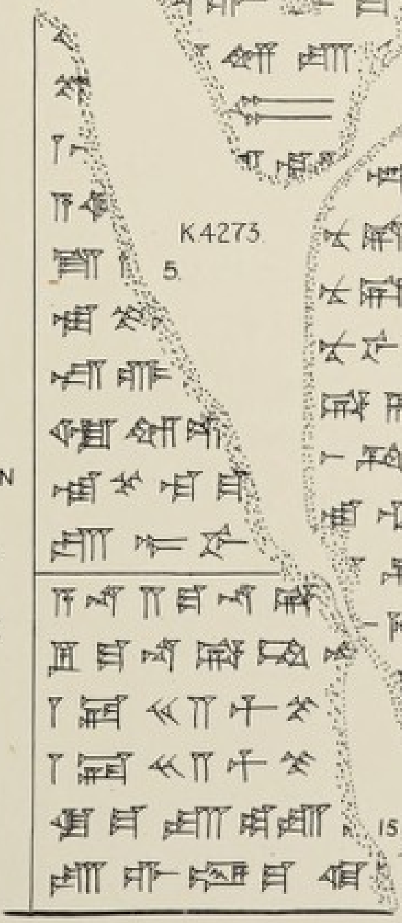


K.6920
OBVERSE.

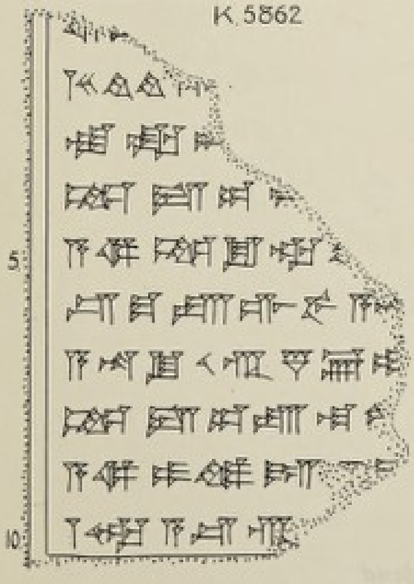


K.6648.

K.4275.



K.5862



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Duplicate of K.6920, pl. 4.

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P R I N T E D   I N   E N G L A N D

The Stencils have been typed by me (who am responsible for all errors), and have been printed off partly by Miss Helen Goalen, 25, Regent Street, Oxford, and partly by Mr W. Hunt, Broad Street, Oxford. The Cuneiform Texts have been printed by the Euston Company, Bell Yard, London. The Cover and Title - page have been printed by Messrs Bridge and Co., Oxford.

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