XIII. *On the Relative Value of Specimens of Native Gold from the different Countries whence it is brought to Market in these Colonies.* *By* His Excellency Sir W. T. Denison, F.R.S. [*Read 22nd March*, 1852.]

The circumstances in which these Colonies are now placed give a special interest to communications which may in any way tend to elucidate the structure and combinations of the metals generally, more especially of that precious metal, the discovery of which on the Main-land of Australia has been productive of such serious effects upon the inhabitants of Van Diemen's Land.

The extent to which Gold is daily bought and sold renders it very desirable to establish, within as narrow limits as possible, the value of a commodity whose intrinsic worth, great in itself, is very liable to deterioration by admixture with foreign bodies.

I propose in this communication to bring before the Society the results of a series of experiments which I have lately made, the object of which has been to establish, as far as possible, some simple mode of determining the relative value of the native Gold from the different countries whence it is brought to market; and, secondly, after having established this point in a satisfactory manner, to point out also a simple mode of determining the value of mixed specimens or samples of Gold, such as are brought to market, containing generally some portions of quartz, or other extraneous material, mixed with the Gold, but not chemically combined with it.

I do not bring these experiments before the Society as in any respect perfect, but merely as indicating a course of

investigation which may be pursued with advantage; and I trust that others will not only follow up the course herein marked out, but will turn their attention to the chemical analysis of the materials found in connection with Gold, for by this only can positive and definite results be obtained; although by the mode in which I have worked, the deductions are sufficiently accurate to serve as a guide to persons engaged in the purchase and sale of Gold, as a matter of mercantile speculation.

The first object to which I turned my attention was the establishment, if possible, of the average value of the pure native Gold from the different fields,—and when I use the term *pure*, I mean only that the specimens were free from any admixture of extraneous matter, as quartz, &c. It is evident that if, by a well-conducted series of experiments, it could be proved that the Gold from any given locality was chemically combined in some fixed proportion with some other metal, while that from another locality was alloyed, not only in different proportions, but perhaps with a different metal, keeping yet its own combination uniform and regular, within certain narrow limits, much would be done to establish the mercantile value of the Gold from each of these districts. Again, should the result of the experiments go to prove that the quality of the Gold varied very much in the same district, it would be of use, inasmuch as it would prove the necessity of a special investigation into the quality of each sample.

I think that the experiments which I have made are sufficient to prove, at all events with regard to the Mount Alexander diggings, such a uniformity of structure as is quite sufficient to form the basis of some calculations which will very much facilitate the operations of those who are engaged in the sale or purchase of Gold; but to this I shall allude

more specifically hereafter. Before I enter into the detail of these experiments, it may be desirable that I should give some brief explanation of the different forms under which the Gold generally presents itself. Gold is found in all cases in a metallic form, or, as it is called, native Gold. In this state, however, it is by no means pure, being generally combined chemically with some other metals, as platina, silver, copper, &c.

In many instances it is brought to market in lumps, or "nuggets" as they are called, which contain, besides the Gold alloyed with some metal, portions of quartz or other extraneous material, forming the matrix in which the Gold was originally deposited, or with which it had become combined accidentally. In other cases it is brought to market in dust, or grains of a greater or less degree of fineness, the product of the washing of the earthy strata in which the Gold had been deposited, this dust of course containing more or less extraneous matter, in proportion to the care with which the washing had been conducted, and consisting very commonly of iron ore, sand, earth, particles of quartz, &c.

The object of the experiments which I am now about to lay before the Society was to discover the quantity of the alloy combined with the native Gold, in the first place; and, having established this, to ascertain the amount of the extraneous matter either in the lumps or the dust. Should I be able to show that this can be done with facility, I shall have done something towards establishing a standard by which the dealers in Gold may regulate their transactions.

Now, every material whose structure is definite has a given specific gravity; that is, a given bulk of such material will weigh a certain number of ounces or grains. The standard of comparison in all cases is water: a cubic foot of distilled water, at a temperature of 60° of Fahrenheit, the barometer

standing at 30 inches, will weigh 1000 ounces; and this is taken as the specific gravity of water. Tables of specific gravities are given for a variety of other substances, and these tabular values are, in point of fact, the actual weights of a cubic foot of each: for instance, the specific gravity of pure Gold cast is 19258; of pure Gold hammered, or laminated, 19361. In point of fact, these numbers represent in each case the weight in ounces of a cubic foot of this material; the greater weight of the hammered Gold being due, as may be easily imagined, to the compression of the particles, a greater number having been crowded into the same space.

Gold, with the exception of platina, is the heaviest metal with which we are acquainted: any admixture or alloy of the Gold with other metals will diminish its specific gravity, and, as a matter of course, its value in some proportion to the quantity, weight, and value of the metal with which it is combined;—for instance, Standard Gold, as it is called, that is, the Gold of which the circulating medium in England is composed, contains 2 parts of copper in 24; and the admixture of this proportion of copper, a metal whose specific gravity is 8878, reduces the specific gravity of Standard Gold to 17486, if cast; and to 17589, if hammered, or laminated, as it is when in coin.

These are facts which have been carefully examined and recorded, and they afford the principal elements which are required in discussing the subject, affording a standard of comparison not only as regards the specific gravity of metallic compounds, but as regards the exchangeable value of the precious metal.

In carrying out a series of experiments as to the specific gravities of various metallic compounds, my first object was to ascertain the degree of confidence which I could place on

a delicate apparatus which I have used on several occasions for the purpose of ascertaining the specific gravities of bodies. A careful comparison was first made of the various weights employed, and an experiment of the amount of accuracy with which the specific gravity of a known material could be determined gave me every reason to be satisfied with the character and condition of the balance. The following detail will enable the Society to judge how far this confidence was well founded. The standard value of Gold is £3 17*s.* 10½*d.* per ounce, and according to this a sovereign should weigh 123·27 grains, and its specific gravity should be, as before stated, 17589.

Every day's circulation, however, must diminish the weight of a sovereign, though it does not affect its specific gravity. A sovereign, not of a very old date, being placed in the scale, its weight was found to be 123·12 grains, showing a loss of ·15 of a grain, while its specific gravity appeared to be 17588, a difference from the standard specific gravity of too trifling an amount to merit notice. Having thus shown that confidence might be placed in the instruments employed, I will explain the mode in which the experiments were conducted.

The specimens were first weighed very carefully, the balance being delicate enough to turn with a very small fraction of a grain when loaded with upwards of 2 ounces. The smallest weight employed was the $\frac{1}{10}$ of a grain. The weight being noted, the specimen was then suspended by a fine hair to a hook on the underside of the scale in a glass of distilled water, care being taken to free it from any bubbles of air which might perhaps exist in cavities on the metal, or adhere to its surface. Allowance was made for the hair used in suspending the specimen, and the weight with the necessary deductions was recorded. The difference

between the weight in air and the weight in water is in point of fact the weight of a quantity of water equal in bulk to the specimen, and a simple proportion will thus give the specific gravity, or the weight of a cubic foot of the material experimented on, as follows:—As the difference between the two weights is to the weight of a cubic foot of water, or 1000, so is the weight of the specimen in air to its specific gravity; or, more shortly, if W be the weight of the specimen in air, w that in water, G the specific gravity $G = \frac{W}{W-w} \times 1000$.

Where the specimen consisted of dust, a small silver scale was suspended by fine hairs to the under part of the principal scale, and exactly balanced when in the water by weights, the amount of which was recorded. The dust was then placed in the scale, and when the whole was accurately balanced, the sum of the weights in the opposite scale, less the recorded weight of the scale itself, gave the weight in water of the dust.

The first experiments were made on coin:—

	Grains.
No. 1, a sovereign weighed in air	123·12
„ „ „ in water	116·12
Difference.....	7·

Thus $\frac{123{\cdot}12}{7{\cdot}} \times 1000 = 17588$ Specific Gravity.

17589 Tabular Specific Gravity.

1 Difference.

	Grains.
No. 2, a Napoleon weighed in air	99·5
„ „ „ in water	93·75
Difference.....	5·75

$\frac{99{\cdot}5}{5{\cdot}75} \times 1000 = 17304$ Sp. Gr.

French standard Gold is said to contain $\frac{1}{10}$ of Copper

in which case its specific gravity would be 17316: the difference between this and the specific gravity, as determined by experiment, is very trifling.

3. An American gold coin of the value of 50 dollars from the Californian Mint,

	Grains.
Weighed in air	1310
Weighed in water	1235
Difference	75

$$\frac{1310}{75} \times 1000 = 17466 \text{ Sp. Gr.}$$

4. An American gold coin of the value of 20 dollars from the United States Mint,

	Grains.
Weighed in air	515·75
Weighed in water	486·20
Difference	29·55

$$\frac{515{\cdot}7}{29{\cdot}55} \times 1000 = 17453{\cdot}5$$

On reference to Table No. 1, showing the value of alloys of Gold with Silver, it will be seen that these American coins are not worth more than £10 5*s* 3*d*. and £4 0*s*. 8½*d*. respectively at the mint price of Gold and Silver; and therefore in these Colonies, where deduction must be made for freight, insurance, and other charges incidental to the transmission of these coins as bullion, their market value will be very much reduced: indeed, they appear to be inferior in value to the ordinary Californian Gold, if we may judge from the sample, an analysis of which is given further on in the proportion of 75*s*. 3*d*. to 77*s*. 2*d*. per ounce. If these coins are to be taken as the representatives of a given number of dollars, the value of that coin in sterling money would appear to be 4*s*. 1½*d*. and 4*s*. 0¼*d*. The specific gravities of

these two coins approximat every nearly to each other, but their actual value depends upon the character of the metal with which the Gold is alloyed. This is a matter of importance, and the more so as an impression may very probably exist that the more valuable the metal combined with the Gold the more valuable the compound will be; whereas the reverse is the case.

I have shown before that the specific gravity of pure Gold which, when cast, is 19258, and when hammered 19361, is reduced to 17486 in the one case, and to 17589 in the other, by an admixture of one-twelfth part of Copper at a specific gravity of 8878. Now the value of Copper in the state of coin as compared with Gold may be taken at $\frac{1}{10\frac{1}{2}0}$; and as the value of 480 grains of Standard Gold, consisting of 440 grains of pure Gold and 40 of Copper, is 77*s*. 10·5*d*., the Gold in the compound is worth 77*s*. 10·42*d*., while the Copper is not worth more than ·08 of a penny. Pure Gold may then be taken to be worth 2·1237*d*. per grain, and in all the calculations into which the value of Gold enters this will be used as representing it

When, however, Gold is alloyed with any other metal, of course a separate calculation will be required; and as the Gold of California and Australia is combined very generally with Silver, it will be desirable to determine the amount of that metal which, when mixed with pure Gold, will bring down the specific gravity to that of the standard, viz., 17486. The specific gravity of Silver is given in the Tables as 10474; and the following formula will, when the proper substitutions are made, give the amount of Silver contained in any specimen of mixed Silver and Gold whose specific gravity is known. Let x be put for the weight of Silver in the compound, S the specific gravity of Gold = 19258. s the specific gravity of Silver = 10474. f the specific gravity

of the compound in this case 17486. c the weight of the compound, or 480 grains—

$x = \frac{(S-f)\,s}{(S-s)\,f} c \cdot\cdot x$ in this case will be equal to 58 grs.; there will therefore be 422 grains of Gold and 58 grains of Silver in a specimen of mixed Silver and Gold weighing 480 grains, and whose specific gravity is 17486. In this case the Silver is pure; and in order to decide as to the market value of this ingredient, it will be necessary to ascertain the amount of alloy by which pure Silver is reduced to standard, the value of which, at the established ratio which it bears to Gold, namely, 1 to $15\frac{1}{2}\frac{3}{2}$, is 60·78*d.*, or about $60\frac{3}{4}d.$ per ounce. The proportion of copper which is introduced in order to lower pure Silver to standard is $\frac{3}{40}$; that is, 37 parts of pure Silver and 3 of Copper make 40 parts of Standard Silver: the value of this compound is, as we have seen, 60·78*d.* per ounce, of which 444 grains consist of pure Silver, and 36 of Copper. The value of the Copper is $36 \times \cdot002 = \cdot072$. The value of the Silver is equal to $\frac{60\cdot78d - \cdot072}{444} = \frac{60\cdot708d.}{444} = 0\cdot13678$ of a penny per grain.

As there are 58 grains of pure Silver and 422 grains of pure Gold in an ounce of the mixed metal, whose specific gravity is 17486, the actual value of the compound will be—

Grains.		*s.*	*d*
422 at	2·1237 =	74	8·2
58 at	·1367 =		7·93
		75	4·13
And as the value of the same quantity of Standard Gold alloyed with Copper is		77	10·5
the difference, or.....		*s*2	6·37

is the measure of the inferiority of the value of this alloy of Silver as compared with that of Copper in the Standard Gold coin of England.

This result is easily explained, for it is evident that the lighter the material combined with the Gold, the less amount will be required to reduce its specific gravity, and, therefore, that the compound will contain more of the most valuable metal, and less of the inferior.

Silver, with the exception of platina, is the heaviest of the metals usually found in combination with Gold; and as the value of platina is equal, if not superior, to that of Gold, it is not of importance, in a mercantile point of view, to attempt to determine a matter which can have little or no effect upon the market price of the commodity. I have therefore assumed that Silver is the alloy generally found with the native Gold both of California and these Colonies. It is known to be the case as regards California; and in taking it for granted here, any calculations which I may make will err in defect rather than in excess.

The following experiments were made for the purpose of determining the specific gravity of different specimens of Gold completely free from extraneous matters:—

5. A specimen of Californian Gold, apparently crystallized,

	Grains.
Weighed in air	28·5
Weighed in water	26·85
Difference	1·65

$$\frac{28{\cdot}5}{1{\cdot}65} \times 1000 = 17272 \text{ Sp. Gr.}$$

6. A specimen of Californian Gold containing a quantity of Quartz,

	Grains.
Weighed in air	279·87
Weighed in water	260·25
Difference	19·62

$$\frac{279{\cdot}87}{19{\cdot}62} \times 1000 = 14264 \text{ Sp. Gr.}$$

This Gold was fused into a button,

	Grains.
Weighed in air	257·68
Weighed in water	243·06
Difference	14·62

$$\frac{257{\cdot}68}{14{\cdot}62} \times 1000 = 17625 \text{ Sp. Gr.}$$

7. Specimen of Gold from Mount Alexander, apparently pure,

	Grains.
Weighed in air	16· 0
Weighed in water	15·12
Difference	·88

$$\frac{16{\cdot}0}{{\cdot}88} \times 1000 = 18181 \text{ Sp. Gr.}$$

8. Specimen from Mount Alexander,

	Grains.
Weighed in air	64·80
Weighed in water	61·25
Difference	3·55

$$\frac{64{\cdot}80}{3{\cdot}55} \times 1000 = 18253 \text{ Sp. Gr.}$$

9. Specimen from Mount Alexander,

	Grains.
Weighed in air.....	228·80
Weighed in water	216·25
Difference	12·55

$$\frac{228{\cdot}80}{12{\cdot}55} \times 1000 = 18231 \text{ Sp. Gr.}$$

10. Same specimen,

	Grains.
Weighed a second time in air..	228·32
Weighed a second time in water	215·75
Difference.....	12 57

$$\frac{228{\cdot}32}{12{\cdot}57} \times 1000 = 18164 \text{ Sp. Gr.}$$

11. A specimen of Gold cast from some clean-looking nuggets from Mount Alexander,

	Grains.
Weighed in air.....	231·75
Weighed in water	219·00
Difference.....	12·75

$$\frac{231{\cdot}75}{12{\cdot}75} \times 1000 = 18176 \text{ Sp. Gr.}$$

12. Five specimens which were experimented on separately, and the details of which will be given hereafter, were fused into a button. In their original state they weighed 365·1 grains; when the button came out of the crucible with the slag adhering to it the weight was 365·185, this increase of ·085 being due probably to the borax used as flux. The slag was removed, and the specimen then

	Grains.
Weighed in air	361·625
Weighed in water	342 27
Difference	19·355

$$\frac{361{\cdot}625}{19{\cdot}355} = 18688 \text{ Sp. Gr.}$$

13. Gold from Mount Alexander cast and then hammered,

	Grains.
Weighed in air.....	238·28
Weighed in water	225·54
Difference.....	12·74

$$\frac{238{\cdot}28}{12{\cdot}74} \times 1000 = 18703 \text{ Sp. Gr.}$$

If then this be reduced in the proportion of 17486: 17589, its specific gravity previous to being hammered, would be 18703—103 = 18600.

14. A quantity of Gold-dust, apparently very clean and weighing 962 grains, was carefully examined, and iron-sand and quartz to the amount of 1 57 grains removed; the whole was then carefully experimented on, and the specific gravity determined: the Gold was then fused into a button, and the specific gravity again determined.

	Grains.
Original weight	962
Iron-sand and quartz removed	1 57
Weight of gold, apparently pure	960·43
Weight when cast into a button and cleaned of the slag.....	955·00
Loss in melting	5·43
Weight in air	955·00
Weight in water	903·13
Difference.....	51·87

$$\frac{955{\cdot}00}{51{\cdot}87} \times 1000 = 18411{\cdot}4 \text{ Sp. Gr.}$$

It may fairly be assumed from these experiments that the specific gravity of the Gold from Mount Alexander ranges

from 18176 to 18703, and, therefore, that in its pure state, unmixed with any extraneous matter, its value exceeds that of Standard Gold; while, as far as can be judged from the few experiments which I have been able to make, as well as from the returns which have been furnished to me of the actual chemical analysis of certain specimens, the Gold from California will range in its specific gravity from 17272 to 17809. I have not data at present to determine the matter more closely. The following Table has been computed in order to enable any person to ascertain at once the amount of Gold and Silver contained in an ounce of mixed metal of various specific gravities ranging from 18500 down to 17100, and at the same time the actual value of the compound at the rates before stated. The range of the Table is limited, but it is hardly probable that any native Gold will fall below 17100, or exceed materially 18500. It would, however, should such a case occur, be easy to extend the Table, for it is evident from an inspection of the column of differences, that there is a steady law of progression, the differences being nearly constant.

TABLE.

Specific Gravity of Sample.	Total Weight	Weight of Pure Gold.	Weight of Pure Silver.	Value of Gold at 77*s.* 10·42*d.*	Value of Silver at 65·65	Value per Ounce of Mixed Metal.	Difference
						s. *d*	
18500	480	456·55	23·45	80 9·58	3·20	81 0·78	
							12·99
18300		450·05	29 95	79 7·77	4·09	79 11·79	
							14·01
18100		443 38	36·62	78 5·6	5·00	78 10 6	
							13·5
17900		436·58	43·42	77 3 17	5·93	77 9 10	
							13·83
17700		429·61	50·39	76 0·36	6·88	76 7·24	
							14·12
17500		422·5	57·5	74 9·26	7·86	75 5·12	
							15·45
17300		415·22	64·78	73 5·8	8·85	74 2·65	
							14·80
17100		407·77	72·23	72 1·98	9·87	72 11·85	

Having thus arrived at the value of specimens of Gold alloyed with Silver, but unmixed with any earthy or stoney particles, upon the supposition that the specific gravity of such specimens can be obtained to a moderate degree of accuracy, the next step is to determine the amount of extraneous matter in specimens containing evidently masses of quartz, or other analogous material, and the reduction in value consequent upon such an admixture.

In order to arrive at a reasonable amount of accuracy in such a calculation, it will be necessary to assume an average specific gravity as that of the unmixed native Gold of any given district:—

	Sp. Gr.
No. 7	18181
„ 8	18253
„ 9	18231
„ 10	18164
„ 11	18176
„ 12	18688
„ 13	18606
„ 14	18411
8 |	146710

18338·75 Mean Specific Gravity.

For instance, from the above experiments, it may be assumed that the average specific gravity of Mount Alexander Gold is 18338·75, or say 18300. If, then, this be taken as the starting point, it will be easy to calculate the reduction in the specific gravity caused by the presence of extraneous matter, on the supposition that the specific gravity of such matter be known. Now, as a general rule, this matter may be taken to be quartz, or some material nearly allied to it. Clay and sand can be removed by washing, and need not, therefore, be noticed. The stoney particles imbedded in the Gold are of such a character

as to differ little from quartz in weight. The following experiments were made in order to determine the average specific gravity of auriferous quartz :—

15. Quartz from the Turon,

	Grains.
Weighed in air.....	535·5
Weighed in water	330·15
Difference.....	205·35

$$\frac{535{\cdot}5}{205{\cdot}35} \times 1000 = 2607 \text{ Sp. Gr.}$$

16. Veined Quartz, with a trace of Gold, from Mount Alexander,

	Grains.
Weighed in air.....	639·5
Weighed in water	396·5
Difference	243·0

$$\frac{639{\cdot}5}{243{\cdot}0} \times 1000 = 2631 \text{ Sp. Gr.}$$

17. Veined Quartz from the spurs of Ben Lomond, near Fingal,

	Grains.
Weighed in air.....	234·75
Weighed in water	145·25
Difference	89·50

$$\frac{234{\cdot}75}{89{\cdot}50} \times 1000 = 2623 \text{ Sp. Gr.}$$

18. Quartz from Fingal,

	Grains.
Weighed in air	1201
Weighed in water	740·75
Difference	460·25

$$\frac{1201}{460{\cdot}25} \times 1000 = 2606{\cdot}6 \text{ Sp. Gr.}$$

19. Second specimen of same,

	Grains.
Weighed in air	899
Weighed in water	556·5
Difference	342·5

$$\frac{899}{342{\cdot}5} \times 1000 = 2624{\cdot}6$$

20. Third specimen,

	Grains.
Weighed in air	284·25
Weighed in water	175·5
Difference	108·75

$$\frac{284{\cdot}25}{108{\cdot}75} \times 1000 = 2614{\cdot}7$$

There is but a trifling difference in the result of these experiments; the mean of the different specific gravities may therefore safely be taken as the standard specific gravity of Gold-bearing Quartz.

	Sp. Gr.
No. 15.	2607
„ 16.	2631
„ 17.	2623
„ 18.	2606·6
„ 19.	2624·6
„ 20.	2614 7
6 |	15706·9

2617·8 Mean Specific Gravity,

Which agrees very nearly with that given in the Tables.

Adopting, then, the former expression $x = \frac{(S-f)\ s}{(S-s)\ f}\ c$

when x is the quantity of quartz,—S specific gravity of native Gold as settled by experiment, 18300,—s the specific gravity of Quartz similarly determined, 2618,—$c = 480$—or the number of grains in an ounce,—f varying number from 18000 to 7000. The following Table will show the deduction to be made for the impurities existing in Mount Alexander Gold when the specific gravity of the sample falls between the numbers in the Table, the scale of which is sufficiently

extensive to embrace all the average specimens, and which can easily be carried lower if necessary:—

Specific Gravity of Sample.	Weight of Sample.	Quantity of Gold.	Quantity of Extraneous Matter.	Value of Gold.	Loss.
				s. *d.*	*s.* *d.*
18000	480	478·66	1·34	79 9 1	0 2·69
17000		473·87	6·13	78 11·53	1 0·26
16000		468·48	11·52	78 0·75	1 11·04
15000		462·37	17·63	77 0·53	2 11·26
14000		455·39	24·61	75 10·58	4 1·21
13000		447·34	32·66	74 6·48	5 5·31
12000		437·93	42·07	72 11·66	7 0·13
11000		426·82	53·18	71 1·45	8 10·34
10000		413·49	66·51	68 10·79	11 1·0
9000		397·20	82·8	66 2·23	13 9·56
8000		376 83	103·17	62 9·5	17 2·29
7000		350·65	129·35	58 5·14	21 6·61

This Table needs but little explanation: the value of the Gold is deduced from that given in the former Table opposite the specific gravity 18300, which is here taken as the point of commencement. It will be seen on inspection, that a large decrease in the specific gravity of a sample does not produce a corresponding diminution in its value; for instance, a decrease in the specific gravity from 18300 to 12000, or upwards of 33 per cent., only takes off about 10 per cent. of the value.

The following experiments will show the extent to which the Table may be trusted in determining the quantity of Gold in any mixed specimen:—

	Grains.
21. Weight of specimen in air.....	1375
Weight in water	1276·75
Difference	98·25

$$\frac{1375}{98{\cdot}25} \times 1000 = 13994{\cdot}9 \text{ Sp. Gr.}$$

By referring to the Table it will be seen that a specimen whose specific gravity is 14000 contains 24·61 grains of

quartz in an ounce; as this specimen weighed 1375 grains, the quantity of quartz, according to the Table, would amount to 70·49 grains, while by independent calculation the quantity was found to be 69·835 grains, a difference not worthy of notice.

22. Weight of mixed specimen of Gold and Quartz,

	Grains.
In air	111·75
In water	102·60
Difference	9·15

$$\frac{111{\cdot}75}{9{\cdot}15} \times 1000 = 12231{\cdot}1 \text{ Sp. Gr.}$$

Weight of Quartz according to Table	9·28
„ by calculation	9·22

23. Mixed specimen of Gold and Quartz,

	Grains.
Weighed in air	236
Weighed in water	209·75
Difference	26·25

$$\frac{236}{26{\cdot}25} \times 1000 = 8990{\cdot}4 \text{ Sp. Gr.}$$

Weight of Quartz by Table, 82·8 grains to the ounce, or 40·7 grains in the specimen.

24. Specimens of Gold and Quartz,

	Grains.
Weighed in air	103
Weighed in water	96·75
Difference	6·25

$$\frac{103}{6{\cdot}25} \times 1000 = 16480 \text{ Sp. Gr.}$$

Quantity of Quartz by Table, 1·95 grains.

25. Specimen of Gold, apparently clean.

	Grains.
Weighed in air	175
Weighed in water	165
Difference	10

$$\frac{175}{10} \times 1000 = 17500 \text{ Sp. Gr.}$$

Quantity of Quartz 1·41 grains.

26. Large specimen from Mount Alexander,

	Grains.
Weighed in air	1311·06
Weighed in water	1219·81
Difference	91·25

$\frac{1311{\cdot}06}{91{\cdot}25} \times 1000 = 14367$ Sp. Gr.

Quantity of Quartz from Table, 60·22 grains.

27. Specimen from Mount Alexander.

	Grains.
Weighed in air	963·935
Weighed in water	899·12
Difference	64·815

$\frac{963{\cdot}935}{64{\cdot}815} \times 1000 = 14872.$

Quantity of Quartz from Table, 37·05 grains.

28. Five small pieces of Gold from Mount Alexander, apparently clean and free from quartz,

	Grains.
Weighed in air.....	365·1
Weighed in water	344·23
Difference.....	20·87

$\frac{365{\cdot}1}{20{\cdot}87} \times 1000 = 17494$ Sp. Gr.

Weight of Quartz by Table, 2·92 grains.

These same specimens on being fused in a crucible, and when the slag which adhered to the button was removed, weighed 361·625, the difference, 3·475, being the actual amount of the impurity contained in them. The specific gravity of the metal being 18688, instead of 18300, will explain this difference.

29. A quantity of Gold-dust well cleaned,

	Grains.
Weighed in air.....	960·43
Weighed in water	905·
Difference.....	55·43

$\frac{960{\cdot}43}{55{\cdot}43} \times 1000 = 17337$

Quantity of Quartz per Table, 8·68.

This Gold-dust being fused into a button of Gold, and cleaned from the slag, weighed 955 grains, the difference between this and the original weight being 5·43 grains,—therefore the allowance in the Table is in excess. In this case it is possible that the specific gravity of the matter in combination with the Gold was inferior to that of quartz, in which case it would require less to bring down the specific gravity to the point shown in the experiment.

30. Twelve specimens of Gold crystallized in various forms,

	Grains.
Weighed in air	83 0
Weighed in water	78·195
Difference	4·805

$$\frac{83}{4{\cdot}805} \times 1000 = 17273.$$

31. Small specimens of Gold in the form of a crystal,

	Grains.
Weighed in air	29·45
Weighed in water	27·75
Difference	1·70

$$\frac{29{\cdot}45}{1{\cdot}70} \times 1000 = 17323.$$

32. Golden crystals,

	Grains.
Weighed in air	152·75
Weighed in water	143·81
Difference	8·94

$$\frac{152.75}{8{\cdot}94} \times 1000 = 17086.$$

These specimens being apparently clean, it would appear that there is something in the arrangement of the particles in a crystalline form which tends to diminish the specific gravity of the mass; or, what is perhaps more probable, that there is a central nucleus round which the particles of Gold have arranged themselves in a crystalline form.

The previous experiments, and the deductions from them,

especially as regards the comparative amount of Gold and extraneous matter in mixed specimens, apply in strictness only to Gold from Mount Alexander: but there is much that will apply to Gold from California and New South Wales; or, indeed, to that from any part of the world which is alloyed principally with Silver.

I have not been able to procure specimens from California or from Sydney sufficient to enable me to carry on a series of experiments with regard to them, but I am in possession of the analysis of a considerable quantity both from California and Sydney; and it will be interesting to compare the results obtained by analysis with those which I have deduced from my experiments,—and the Society will then be able to judge of the amount of confidence which can be placed in the Tables which form part of this communication.

First, with regard to the Gold from California.

The quantity of metal forwarded to the assayer was 21 lbs. 9 oz. 6 dwts.: this, when melted and cast into an ingot, weighed 21 lbs. 1 oz. 0 dwts. 12 grs., showing a loss from the presence of extraneous matter of 8 oz. 5 dwts. 12 grs. Upon analysis this quantity of metal was found to contain 527 dwts. of pure Silver, or at the rate of 21 dwts. 13 grs. in the pound; or the proportion of Gold to Silver in metal was as 9·3 to 1.

If a reference be now made to the first Table to ascertain the specific gravity of a specimen in which the Gold bears to the Silver, the proportion stated above, which, when ounces are taken as the total weight, will be equivalent to 433·4 grains of Gold to 46·6 of Silver, we shall find that it lies somewhere between 17700 and 17900; and by making the proper allowance for the difference, the actual specific gravity will be 17809.

Now, the value given in the Table of an ounce of Gold alloyed with Silver, whose specific gravity is 17·809, is 77*s.*

2·79*d.*; and in reference to the return of sales it was found that 21 lbs. 1 oz. 0 dwts. 12 grs. of mixed metal was valued at £960 5*s.* 3*d.*, which is at the rate of 75*s.* 10·8*d.* per ounce: the value of the Standard Gold, however, is taken in this return at 77*s.* 9*d.*, whereas in the Tables it is calculated at 77*s.* 10·5*d.*, or 1½*d.* per ounce more. The value too of Standard Silver is taken at 60⅛, whereas in the Tables it is taken at 60⅝. Making allowances for these differences, the value of the mixed metal will be 77*s.* 0·4*d.* per ounce, which approximates very closely to that given in the Table. From this it appears that Gold from California, having a specific gravity of 17800 or thereabouts, is inferior in value to the Standard Gold coinage of England to the extent of about 1 shilling per ounce.

With regard to the Sydney Gold, the data in my possession are not so precise as with reference to Californian Gold: they consist of account sales extracted from the *Sydney Morning Herald*, and republished in the *Courier* newspaper of 17th March. From this it appears that eleven large pieces of Gold weighed before melting 4 lbs. 2 oz.; after melting 3 lbs. 6 oz. 15 dwts. 12 grs., showing a loss of 7 oz. 4 dwts. 12 grs.* On assay these were found to be equal to 3 lbs. 7 oz. 17 dwts. 9 grs. of Standard Gold. The quantity of Silver contained in these specimens is not given, but it may be got at by reference to the Table:—thus, 3 lbs. 7 oz. 17 dwts. 9 grs., at the tabular value of 77*s.* 10½*d.*, is worth a certain sum, but 3 lbs. 6 oz. 15 dwts. 12 grs. of native Gold is of the same value,—therefore, one ounce of the latter will be worth 79*s.* 8·79*d.*; and on reference to the Table the specific gravity of Gold alloyed with Silver, worth 79*s.* 8·79*d.*, is 18255, and the quantity of Silver contained in an ounce 31·47 grains.

* The loss in melting in this case amounting to 10·28 per cent. is so great as to create a doubt of the accuracy of the data.

Some small pieces of Gold weighed before melting 11 lbs. 3 oz. 18 dwts., and after melting 10 lbs. 8 oz. 14 dwts. 12 grs., showing a loss from the presence of extraneous matter of 7 oz. 3 dwts. 12 grs. On assay these were found to be equal to 11 lbs. 0 oz. 7 dwts. 15 grs. of Standard Gold; and the value of an ounce of metal is from this 80*s.* 1·04*d.*, and its specific gravity 18319.

Again, two lumps of Australian Gold weighed before melting 5 lbs. 4 oz. 0 dwts. 12 grs. After melting 4 lbs. 9 oz. 16 dwts. 12 grs.

The difference, 6 oz. 4 dwts., is the amount of extraneous matter. The assay showed these specimens to be equal to 4 lbs. 10 oz. 12 dwts. 22 grs. of Standard Gold; and the value per ounce will therefore be 79*s.* 11·6*d.*, and the specific gravity 18300.

These latter results, agreeing as they do with each other, and with those deduced by experiment upon the Gold from Mount Alexander, establish beyond a doubt the relative value of the Australian Gold. It would be desirable of course to ascertain whether the Californian Gold, of which the assay has been given, was a fair average specimen; but this can only be arrived at by more detailed experiments. The only two specimens which I have been able to procure gave specific gravities of 17272 and 17625 respectively; the former probably containing some small amount of extraneous matter. We have no exact information as to the character of the extraneous matter in these specimens of Gold submitted to analysis, but if we assume it to be equal in gravity to quartz, we shall not be far wrong; and the following comparison will be interesting:—

The weight of all the specimens of Australian Gold was 20 lbs. 9 oz. 18 dwts. 12 grs.; the weight after melting 19 lbs. 1 oz. 6 dwts. 12 grs. The weight of extraneous matter

1 lb. 8 oz. 1 dwt., equal to 38·6 grains to the ounce. On reference to the second Table, it will be seen that the specific gravity of a mixed specimen containing 38·6 grains of quartz to the ounce will be 12369, and its value 73*s.* 6·6*d.* per ounce. The value given in the return as that of all the specimens is £913 10*s.* 1*d.*; but Standard Gold is taken at 77*s.* 9*d.*, while in the Table it is valued at 77*s.* 10½*d.* Making allowance for the difference, the return from this Gold would be £914 9*s.* 4*d.*, or at the rate of 73*s.* 4·46*d.*, a result very slightly different from that given in the Table.

The conclusion which I should be disposed to draw from the experiments which I have here submitted is, that the value of specimens of Gold, carefully washed and freed by the use of the magnet from magnetic iron ore, can be estimated with every necessary degree of accuracy by means of delicate scales; the specific gravity being an accurate test not only of the amount of extraneous matter mixed with such Gold, but also of the character and value of the metal itself.

The subject, however, is far from being exhausted. Accurate experiments in the specific gravity of Californian Gold are much wanted: analysis of Australian Gold, showing all the elements which enter into its composition, will be most valuable: enquiries into the molecular arrangement of those specimens which appear to be crystallized will be very interesting.

I trust, therefore, that other Members of the Society will turn their attention to these points, and to such others as may appear to them to be of importance, and communicate the results to the Society; while I for my part will continue the series I have already commenced, extending it so as to include Sydney and Californian Gold, or that from any other country from which I am able to procure specimens.