mens in botany, which formed the types included in his "Flora of Yucatan," and considerable material for exchange to augment the small herbarium in his department. He also secured about four hundred specimens in zoology, principally conchology, and a number of excellent negatives relating to geology, botany, ethnology and travel. Prof. Holmes secured altogether about one thousand specimens in archæology from Yucatan, Chiapas, Oaxaca, Vera Cruz and the valley of Mexico, and made a number of important observations. An expedition to San Domingo, conducted by Mr. Geo. K. Cherrie, Assistant Curator in the Department of Ornithology, resulted in the collection of 1958 bird skins, 16 mammals, 80 reptiles; and a number of specimens of fish and Crustacea. Among the birds, two species proved new to science, and a number of others are very interesting as representing rare and little-known forms. Captain Miner W. Bruce was fitted out by the Museum for an expedition to Alaska and Siberia in June 1894, and he acquired valuable ethnological material from North Alaska. A number of minor expeditions were also organised in the interests of the Museum, and they have resulted in numerous additions to the collections in different departments, as well as the acquisition of information of great scientific value, which information is made known through the admirable series of publications issued by the Museum.

THE additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, a White-throated Monitor (*Varanus albogularis*) from South Africa, presented by Sir Gilbert Carter; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. Henry Russell; a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Mr. E. Kirby; a Striped Hyæna (*Hyæna striata*) from Arabia, presented by Mr. C. A. Osborne; a Hamster (*Cricetus frumentarius*), European, presented by Miss Hilton; three Yellow-bellied Liothrix (*Liothrix luteus*) from India, presented by Mr. Robert E. Graves; an Iceland Falcon (*Hierofalco islandus*) from Iceland, eight Horsfield's Tortoises (*Homopus horsfieldi*) from Central Asia, two Giant Toads (*Bufo marinus*) from Brazil, a Reticulated Python (*Python recticulata*) from Malacca, deposited; two Lettered Aracari (*Pteroglossus inscriptus*) from Para, a Black-necked Swan (*Cygnus nigricollis*) from Antarctic America, purchased; a Burrhel Wild Sheep (*Ovis burrhel*), two Glossy Ibisis (*Plegadis falcinellus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE CLUSTER IN COMA BERENICES.—The results of a triangulation of the more conspicuous stars in this group have been recently issued from the astronomical observatory of Yale College. This contribution to a class of observations that is now receiving much attention, has been made with the heliometer by Mr. F. L. Chase at the suggestion of Dr. Elkin. The instrument employed is the same that Dr. Elkin used in his measurements of the Pleiades group, and the method of reduction follows generally the same lines that were then adopted; but the different configuration of the fundamental stars on which the measures are based, has enabled the observer to dispense in some degree with measures of position angle, the less trustworthy coordinate in heliometer observations, and to rely upon measures of distance from six selected stars, five of which form nearly an equilateral pentagon, the sixth being approximately in the centre. Two lines of stars roughly crossing the pentagon at right angles, and extending some six degrees, have been utilised for determining the scale value. The final result is to give the coordinates of thirty-three stars (Equinox 1892·0) limited to about the 8·5 mag., below which magnitude the most satisfactory observations cannot be made with the Yale instrument. An examination of the probable errors of the measures, classified according to the magnitude of the stars, does not disclose any law dependent on brightness, so that Mr. Chase has not overstepped prudence in this respect. At the same time the position of so many well-scattered points of reference has been determined, that it should be an easy task, and one worthy of accomplishment, to derive the places of the remaining and fainter stars of the group by means of photography.

OBJECTIVE GRATINGS.—Messrs. Hall and Wadsworth describe in the June number of the *Astrophysical Journal* the results of a fairly successful application of an objective grating, constructed on the original Fraunhofer method, and attached to a 12-inch photographic object-glass, whose ratio of aperture to its focal length is as 1:18. Two screws 27 cm. long, and with 63 threads to the centimetre, were cut in two along their axes, and the half-screws mounted, parallel to each other, on the opposite sides of rectangular frames. Copper wire was wound across in the successive threads, and soldered to the screws so as to produce a grating. When applied to the telescope, photographic spectra of both the first and second order could be obtained, and cases are quoted showing the agreement of the deduced wave-length with Rowland's values. One of the difficulties experienced in the use of this form of grating arises from the wind disturbing the lines of the grating, an annoyance which, it is suggested, might be prevented by soldering light rods across the wires parallel to the half-screws. The time required for exposure with objective gratings is of course longer than with the objective prism; but against these two disadvantages is to be set the comparative small cost of construction. In the one used in the experiments at Chicago, the cost was only one-thirtieth of that of an equally large objective prism of small angle, and evidently the advantage on the side of economy increases as the aperture increases. In the case of the Yerkes telescope, it is computed that the grating would cost about the two-hundredth part of the prism of the same size.

DISTORTION OF THE EARTH'S SURFACE.—Under the title of "An Earth-bending Experiment," Prof. H. H. Turner gives a description of a series of observations undertaken at Oxford by Prof. J. Milne (*Observatory*, July). In his investigation of terrestrial disturbances in the Isle of Wight, Prof. Milne found evidence of their being due to several causes. For instance, some are due to real local earthquakes on a small scale, some owing to faint echoes of very distant earthquakes, while it appears that others may have their origin in the various states produced on the surface of the ground by meteorological causes. These last have specially attracted attention, as it is quite possible that the considerable load represented by a shower of rain or snow, or a heavy fall of dew, may be capable of bending the surface of the ground to such a degree as to affect the stability of any astronomical instruments not having very deep foundations. In looking for these effects, it might be expected that tilts due to rainfall, though irregular, would show some evidence of an *annual* periodicity, while those produced by dew would show a *diurnal* variation. To test whether any of these causes might have an appreciable disturbing effect, the University Observatory at Oxford was chosen as being particularly suitable, standing alone in a grassy park. The instruments for detecting and recording any difference of level consisted of one of Prof. Milne's horizontal pendulums and the level of the Barclay transit circle. The effect of a sudden shower was imitated by securing the services of seventy-six people, who were marched, in various degrees of compactness, up to and away from the slate slab supporting the registering apparatus. The result of these experiments was that a small depression was observed, always towards the crowd, the maximum value, however, being only 0″·5, when the load was concentrated and close to the instrument. The load employed being estimated greater than is likely ever to be produced by rain, &c., it is concluded that on that particular site at least no disturbance due to meteorological causes need be feared.

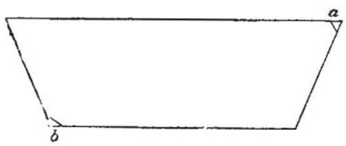
ON THE LIQUATION OF CERTAIN ALLOYS OF GOLD.[1]

THE molecular distribution of the metal in alloys of gold and of metals of the platinum group has been described by me in several papers, the most important of which has been published in the *Philosophical Transactions*. New

[1] Abridged from a paper read before the Royal Society, May 7.

interest in the subject has however arisen in connection with the extraordinary development in various parts of the world, and especially in South Africa, of certain processes which are now employed for extracting gold from its ores. Their use has been attended with the introduction into this country of a series of alloys of gold and of the base metals, which have hitherto rarely been met with in metallurgical industry. The base metals associated with the gold in these cases are usually the very ordinary ones lead and zinc; but their presence in the gold has given rise to unexpected difficulties, as the distribution of the precious metals in the ingots which now reach this country is so peculiar, that it is not possible to estimate the value of the ingots by taking the pieces of metal required for assay, by any of the well-known methods at present in use.

Investigation of the cause of the singular molecular arrangement of the ingots, has revealed many facts of scientific as well as industrial interest, which the author describes at length. The following case of an ingot of gold may be taken as typical.



Four assays were made on a portion of metal cut from the points marked *a*, at the top of the ignot; the highest of the results of assay indicated that 664 parts of gold were present in 1000 parts of the alloy, while the lowest assay gave only 465 parts. On the other hand, three assays on a piece of metal cut from the bottom of the ingot, at *b*, gave 652 parts of gold in 1000 as the highest, and 332·5 as the lowest. Clearly, therefore, the action of gravity does not explain the distribution of the precious metal.

The ordinary course, where divergent results of assay are obtained on portions of metal cut from such an ingot, would be to melt the entire mass, and take a "dip" assay piece, that is, to remove a portion of metal from the well-stirred fluid mass. This was done in all the cases cited in the paper here abridged, and as regards the mass of gold to which reference has just been made, assays on the portion of metal removed from the fluid mass gave results which were still very conflicting, the lowest assay showing the presence of 562·3 parts of gold, and the highest 653·5. It was evident therefore, that rearrangement could take place within the limits of a fragment of metal which did not weigh more than a few grammes.

The only method of ascertaining the value of the ingot consisted in separating the precious and base metals in mass, and the result of this operation showed the value of the ingot to be £1028, while the value, as calculated from the average of the assays previously made, would only have been £965, or a difference in value of £63 on an ingot weighing 12·223 kilograms. The importance of the question from an industrial point of view will at once be recognised when it is remembered that gold to the value of many millions sterling of the quality represented by the above results, now reaches this country annually.

Coming now to the scientific side of the problem, analysis of the ingot, to which reference has been made above, showed that it contained the following metals in addition to gold:

Silver	8·1 per cent.
Lead	16·4 ,,
Zinc	9·5 ,,
Copper	4·0 ,,
Iron	·3 ,,

Suspicion at once fell on the lead and zinc as disturbing elements, and their influence was systematically investigated by a lengthy series of experiments, in the course of which gold alloys, containing different proportions of gold and of impurities, were cast in spherical moulds two and three inches in diameter, the solidified masses being explored by assays made on metal representing all parts of the mass. The general result of these experiments was to show that lead exerts a greater disturbing influence than zinc. The problem was then attacked from a different point of view. I availed myself of Roberts-Austen's method of fixing the solidifying points of metals on "cooling curves" obtained by the aid of thermo-junctions connected with autographic recorders. Such curves showed that a triple alloy of lead, gold, and zinc has three "freezing points." The mass sets as a whole at a single main point of solidification, but the lead and the zinc associated with some gold retain a certain amount of individual independence, and by falling out of solution, separately destroy the uniformity of the mass, even though the mass itself be small.

After a long series of experiments, a metallic solvent which would enter into union with the gold, the zinc, and the lead was sought. Silver proved to be such a solvent, and solidified alloys of gold containing not more than 30 per cent. of lead and of zinc, may be made practically uniform in composition by adding 15 per cent. of silver to the mass when fluid. The result is singular, as it shows that there are cases in which the uniformity of a gold alloy may be improved by lowering its standard fineness; and another proof of scientific interest is afforded of the fact that alloys behave like saline solutions.

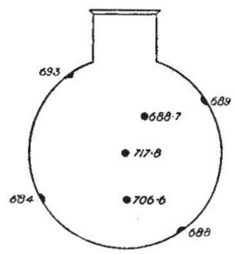


FIG. 1.—Gold 700 parts, lead 300 parts; weight about two kilograms.

The result shows a decided tendency of the gold *to liquate to the centre of the mass.*

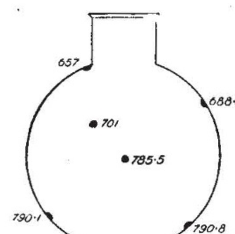


FIG. 2.—Gold 75 parts, lead 15 parts, zinc 10 parts; weight about two kilograms.

There is evidence of rearrangement by liquation in this case which sends gold to the centre, but the result is complicated, as gravity appears also to send gold to the lower portion of the spherical mass.

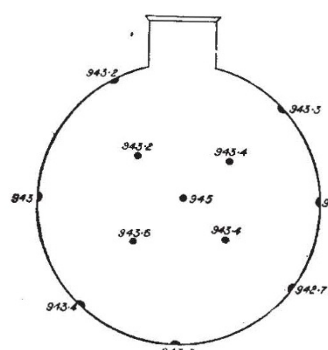


FIG. 5.—Gold 95 parts, zinc 5 parts; weight 4·430 kilograms.

A slight but decided tendency of liquation of gold towards the centre.

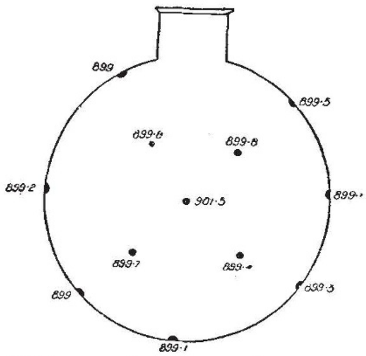
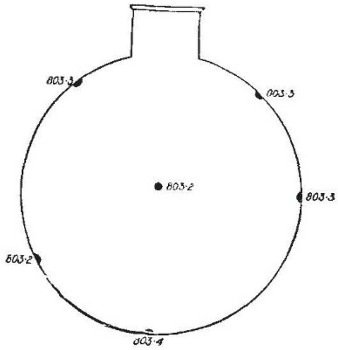


FIG. 7.—Gold 90 parts, zinc 10 parts; weight 4·200 kilograms.

This shows that there is still a tendency in this gold alloy with 10 per cent. of zinc to become enriched towards the centre.



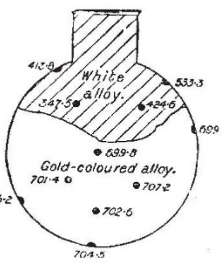


FIG. 9.—Gold 77·5 parts, silver 7·5 parts, zinc 15 parts; weight 3·930 kilograms.

FIG. 11.—Gold 63 parts, silver 7 parts, lead 20 parts, zinc 10 parts.

Very marked separation takes place here, the difference at various points of the sphere being very remarkable, and forcibly illustrating the difficulties to which reference is made at the commencement of this paper.

As, however, it appears, that when a certain amount of silver is present, the irregularity in composition disappears, this mixture of—

Zinc...	10
Lead	20
Silver	7
Gold	63

was alloyed with more silver, so that it contained 15 per cent. of silver (nearly half the united amounts of zinc and lead present in the alloy).

This, cast into the 3-in. spherical mould, showed the following results at the points indicated. In *appearance*, the metal, when sawn in two, was homogeneous.

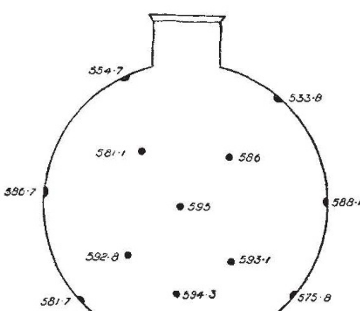


FIG. 12.—Alloyed so as to contain 15 per cent. silver; weight 3·450 kilograms.

There is here still evidence of liquation of gold towards the centre, but comparison of Fig. 12 with that which immediately precedes it will show how greatly the arrangement of the alloy has been modified by the presence of the additional 8 per cent. of silver. The proportion of silver in this alloy was proved by assay to be 15·5 per cent.

As there was still evidence of liquation, the metal was cast with still more silver, making 20 per cent. of silver in all. The alloy, when cast into a mould, proved to be almost uniform in composition, the difference between the centre and the extreme portions being very slight.

Liquation had practically ceased, a fact which proves incontestably that silver is the solvent for the base metals, zinc, and lead, when they are alloyed with gold.

Conclusions.—(1) Alloys of gold with base metals, notably with lead and zinc, now often met with in industry, have the gold concentrated towards the centre and lower portions, which renders it impossible to ascertain their true value with even an approximation to accuracy.

(2) When silver is also present these irregularities are greatly modified.

The method of obtaining "cooling-curves" of the alloys shows that the freezing points are very different when silver is present in the alloy and when it is absent from it.

(3) This fact naturally leads to the belief that if the base metal present does not exceed 30 per cent., silver will dissolve it and form a uniform alloy with gold.

(4) This conclusion is sustained by the experiments illustrated by Figs. 9, 11 and 12, which, in fact gradually lead up to it, and enable a question of much interest to be solved.

EDWARD MATTHEY.

THE ATOMIC WEIGHT OF OXYGEN.[1]

THIS monograph embraces a complete collection of the results obtained by Dr. Morley while working on this subject, and gives a detailed account of the various apparatus used. The experiments described extended over a very lengthened period. They consisted of the determination of the ratio between oxygen and hydrogen by two distinct methods, viz. by actually weighing the gases and by synthetising water. In all his experiments Dr. Morley dealt with far larger volumes of purer gases than previous experimenters had used, and in weighing them he reduced with surprising completeness every possible source of error. In his work on the synthesis of water, Dr. Morley succeeded in weighing the hydrogen and oxygen burned, and also the water produced thereby, achieving an exactness not attained by any previous experimenter, as none before had weighed all three factors. All experiments dealing quantitatively with gases are naturally extremely difficult, but Dr. Morley has, by paying attention to every detail, brought each process to a great pitch of accuracy.

The major corrections that were introduced into the determinations were as follows.

(1) The expansion of the glass of the globes.
(2) The errors of the mercurial thermometers.
(3) The deviation of the mercurial from the hydrogen thermometer.
(4) The difference between the coefficients of expansion of oxygen and hydrogen.
(5) The elevation of the cistern of the barometer above the centre of the globe when reading pressure.
(6) The correction of the scale of the barometer.
(7) The force of gravity at the laboratory.

In weighing the gases Dr. Morley employed large glass globes varying in capacity from nine to twenty-one litres. All data connected with the capacity of these were accurately determined. As the globes were so large it was found impossible to weigh them full of water to measure their capacity, and a different method had to be adopted. The globes were first weighed in air, then sunk in water, the weights being determined to keep the globes immersed; lastly the globes were filled with water, and again weighed in water. From these were obtained the external volume, the solid contents, and the capacity within ·02 per cent. In introducing a correction for the compression of the globes when exhausted, Dr. Morley devised an exceedingly ingenious plan. The compression itself was determined by placing the globe in a copper cylinder, which was then closed

1 "On the Densities of Oxygen and Hydrogen, and on the Ratios of their Atomic Weights," by Dr. E. W. Morley. *Smithsonian Contributions to Knowledge*, No. 980. (Washington, 1895.)