

of 40 cm., and was so hot that the observer was unable to put his hand on it. At the explosion of the meteor several small portions weighing from 30-60 gr. were scattered, while the weight of the chief mass amounted to 22 kg. The description of the exterior says that it showed the general, smooth, black crust, while from the fracture it was noticed to be finely granulated; one could also see easily small particles of iron, which could without any difficulty be separated by pulverisation. Chemical analysis showed that nickel and cobalt was present in considerable quantities.

**JAHRBUCH DER ASTRONOMIE UND GEOPHYSIK.**—This volume, which is edited by Dr. Hermann J. Klein, contains a very interesting account and summary of the work done in various branches of astronomical science during the past year. Dunér's, Deslandres', Hale's, and Young's sun observations are referred to, while several other references to solar work are given. The numerous observations made with reference to the major and minor planets are here all brought together; Trouvelot's Venus observations, the opposition of Mars, and the recent discovery of Jupiter's fifth satellite being rather prominent. Under the heading of "The Moon" Wernik's enlargements, Böddiker's and Hartmann's researches and are referred to at some length. Comets, meteorites, and shooting stars also come in for a good share, and under the fixed stars, in which are included all variables, nebulae, &c., are included references to the Nova in Auriga, stellar spectroscopic observations, motion in line of sight, &c.

**THE OBSERVATORY.**—From the cover of the *Observatory* one quite misses the familiar name of Dr. Common, in place of which are now inserted Messrs. T. Lewis and H. P. Hollis. In an editorial notice Mr. Turner says a few words to account for this perturbation, mentioning that it is owing to pressure of work, which has made it impossible for either of them to conduct the magazine. He concludes by saying, "It would be with the keenest satisfaction that we should return to the management of the magazine if the future should have that in store for us."

#### GEOGRAPHICAL NOTES.

**THE Scottish Geographical Magazine** for April contains a paper of some value by Colonel Justin C. Ross on irrigation and agriculture in Egypt, giving the result of his experience as Director-General of Irrigation in that country. In consequence of the indisposition of Colonel Bailey the *Magazine* is now edited by Mr. W. A. Taylor, Librarian to the Royal Scottish Geographical Society, who has for several years had charge of the book reviews and geographical notes.

The April number of the *Deutsche Rundschau für Geographie* contains a coloured map of the density of population in Holland which illustrates in a manner very rare in continental map-work an ignorance of the first principles of map colouring. The objects of map colouring are two—one is to indicate the areas occupied by discontinuous and unlike conditions, such as countries, races of people, or geological formations. For this the colours have to be as strongly contrasted as possible and the map is necessarily and properly a patchwork. The other object is to show the distribution of a continuously varying quantity, like altitude, temperature, or rainfall, and in order to attain it the colours ought to merge one into the other so that the eye is carried from the lowest to the highest value by just perceptible gradations. The Austrian map referred to applies the first method to bring out the second result, each different density of population being coloured so as to contrast with the others, and to show no definite gradation from less to greater.

*Globus* states that the Russian Government, dissatisfied with the foreign sound of the names Dorpat and Düna, have resolved to rename those towns Jurjew and Dwinsk respectively.

The Paris Geographical Society held a special meeting in commemoration of the discoveries of Columbus on March 4, the four hundredth anniversary of his return from the first transatlantic voyage. A masterly address by M. Levasseur on the moral and material consequences of the discovery of America, and a paper by Dr. Hamy on the traces of Columbus in Spain and Italy were the principal features of the meeting.

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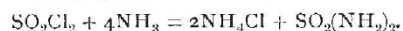
SOME recent measurements in Russia, noticed by M. Venukoff in the last number of the *Comptes Rendus* are valuable as leading to some conclusions regarding the form of the geoid. Determinations of the value of the degree of longitude along the parallels of  $47^{\circ}30'$  and  $52^{\circ}$  accord closely with Bessel's geoid (polar flattening  $\frac{1}{290}$ ) and are widely divergent from Clarke's result of  $\frac{1}{230}$ .

#### THE AMIDE AND IMIDE OF SULPHURIC ACID.

FURTHER details concerning these interesting substances are communicated by Dr. Traube of the laboratory of the Berlin University to the current number of the *Berichte*. It has long been surmised that an amide of sulphuric acid was capable of existence, and Regnault assumed that the product which he obtained by leading ammonia gas into a solution of sulphuryl dichloride in ethylene chloride consisted of that substance mixed with sal-ammoniac. Dr. Traube has further investigated the reaction and has at length isolated not only sulphuryl diamide,  $\text{SO}_2(\text{NH}_2)_2$ , but also sulphuryl imide,  $\text{SO}_2\text{NH}$ , the imide of sulphuric acid, and has, moreover, prepared several metallic derivatives of each.

##### *Sulphuryl Diamide.*

The most advantageous mode of preparing sulphuryl diamide consists in saturating a solution of sulphuryl dichloride,  $\text{SO}_2\text{Cl}_2$ , in chloroform with ammonia. It is necessary to dilute the sulphuryl dichloride with 15-20 times its volume of chloroform, and to maintain a low temperature by extraneous cooling in order that the reaction may be under complete control, and the ammonia gas must be carefully dried before being allowed to bubble through the liquid. The main reaction occurs in accordance with the following equation:—



The products are gradually deposited in the form of a white solid, which, after the completion of the reaction, is agitated with water until the whole of it is dissolved. The ammoniacal aqueous solution is then separated from the chloroform, acidified with nitric acid, and the whole of the chlorine removed by the addition of silver nitrate. After removal of the silver chloride by filtration the acid solution is neutralised with alkali and silver nitrate again added, when a crystalline precipitate is obtained consisting of a silver derivative of sulphuryl diamide,  $\text{SO}_2(\text{NHAg})_2$ , together with another silver compound, whose composition has not yet been definitely ascertained. In order to isolate the silver compound of sulphuryl diamide, the washed precipitate is decomposed with the calculated quantity of hydrochloric acid, and the resulting acid liquid carefully neutralised with ammonia; upon now adding silver nitrate only the silver compound of unknown and complex composition is deposited. The pure silver compound of sulphuryl diamide is finally deposited upon adding a further quantity of silver nitrate and sufficient ammonia to render the liquid strongly alkaline.

When the precipitated silver compound of sulphuryl diamide is decomposed with hydrochloric acid a feebly acid liquid is obtained, which, when evaporated to a syrup *in vacuo*, at a temperature not exceeding  $40^{\circ}$ , and afterwards allowed to stand *in vacuo* over oil of vitriol, gradually deposits large colourless crystals of pure sulphuryl diamide,  $\text{SO}_2(\text{NH}_2)_2$ .

Sulphuryl diamide is an extremely deliquescent substance. The crystals are rapidly dissolved by water, but are practically insoluble in organic solvents. They soften at  $75^{\circ}$  and melt at  $81^{\circ}$ . As the liquid cools, however, it exhibits the property of superfusion to a very marked extent, remaining liquid many degrees below its melting-point. The moment, however, it is disturbed by contact with a sharp body, it instantly solidifies. When heated above its melting-point sulphuryl diamide loses ammonia even below  $100^{\circ}$ ; up to  $250^{\circ}$  no further decomposition than the loss of ammonia occurs, the residual compound being the sulphuryl imide to be presently described. Above  $250^{\circ}$  complete decomposition ensues with the evolution of acid fumes.

The aqueous solution of sulphuryl diamide reacts neutral to litmus and possesses a bitter taste. It yields no precipitates in acid solutions either with salts of barium or platinum chloride. On long boiling with acids, however, it is gradually converted into sulphuric acid and ammonia, and then yields the usual

precipitates for those substances with barium or platinum chloride. Its behaviour with nitrous acid is interesting. Upon adding to an acid solution of sulphuryl diamide a few drops of the solution of a nitrite nitrogen is at once evolved, in the cold, and sulphuric acid is formed.

Sulphuryl diamide does not combine with acids. Alkalies appear to be only capable of removing one amido group, converting the diamide into sulphamic acid,  $\text{SO}_2(\text{NH}_2)(\text{OH})$ .

As described in the course of the preparation of sulphuryl diamide, ammonia precipitates from a solution mixed with silver nitrate a silver compound. If the precipitate is allowed to remain in contact with the excess of the reagents for some time, it invariably yields numbers upon analysis which agree with the formula  $\text{SO}_2(\text{NHAg})_2$ . If, however, it is at once separated, it is found to consist of a mixture of this salt with the salt  $\text{SO}_2(\text{NH}_2)(\text{NHAg})$ .

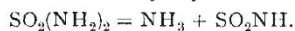
These silver compounds of sulphuryl diamide are amorphous, even after deposition from solution in hot water. When dry they are white powders very slightly sensitive to light. Upon heating to  $200^\circ$  they decompose with evolution of sulphur dioxide.

Sulphuryl diamide likewise forms a compound with mercuric oxide when its solution is mixed with one of mercuric nitrate. The composition of this precipitate, however, appears to vary with the degree of concentration of the solutions employed, and if chlorides are present a precipitate is only obtained with a very large excess of mercuric nitrate. Mercuric chloride produces no precipitate at all.

A somewhat similar lead compound is also formed when lead acetate is added to a moderately concentrated solution of sulphuryl diamide.

#### *Sulphuryl Imide.*

As previously mentioned, when sulphuryl diamide is heated for a considerable time above its melting-point it loses ammonia and becomes converted into sulphuryl imide :



The best temperature for the rapid production of sulphuryl imide is  $200^\circ$ – $210^\circ$ . The evolution of ammonia at this temperature is very vigorous, occurring with much frothing, but after a time diminishes and finally ceases, the mass becoming eventually solid. To purify it from impurities the solution in water is treated with a solution of silver nitrate when the silver compound of sulphuryl imide,  $\text{SO}_2\text{NHIAg}$ , is precipitated, and may be recrystallised in long acicular crystals, first from water slightly acidified with nitric acid, and finally from pure water.

Upon decomposing the silver compound with the calculated quantity of dilute hydrochloric acid an aqueous solution of free sulphuryl imide is obtained, which reacts strongly acid, and liberates carbon dioxide from carbonates. Upon evaporation, however, it decomposes, and deposits hydrogen ammonium sulphate. Even evaporation *in vacuo* is sufficient to decompose it, so that crystals of the imide itself have not been obtained. It exists, however, in the solid form, although somewhat contaminated with smaller quantities of other products, in the residue obtained by heating sulphuryl diamide as previously described.

Salts of sulphuryl imide, however, are readily obtained, either by decomposition of the silver salt with metallic chlorides, or by the neutralisation of solutions of sulphuryl imide with metallic oxides or carbonates.

The potassium salt,  $\text{SO}_2\text{NK}$ , was obtained in the form of well-developed colourless crystals by adding a quantity of the silver salt to a hot solution of the calculated quantity of potassium chloride, removing the precipitated silver chloride by filtration, and evaporating the solution. Both the solution and the salt are very stable; it requires long boiling with acids to convert it into sulphuric acid. When the dry salt is heated it decomposes with considerable violence and production of flame. Nitrogen and sulphur dioxide escape, and potassium sulphate and sulphide are left.

The sodium salt,  $\text{SO}_2\text{NNA}$ , obtained by neutralising a solution of sulphuryl imide with caustic soda and subsequent evaporation, forms small crystals, which decompose upon heating in a manner similar to the crystals of the potassium salt.

The ammonium salt,  $\text{SO}_2\text{NNH}_4$ , isomeric with sulphuryl diamide, was likewise obtained in colourless needles by neutralisation of the free imide with ammonia. It is interesting to note that this substance is not capable of being converted into its isomer by repeated crystallisation, but is partially so con-

verted by rapidly heating it to its melting-point over a small gas flame.

Acicular crystals of a hydrated barium salt,  $(\text{SO}_2\text{N})_2\text{Ba} \cdot 2\text{H}_2\text{O}$ , have been obtained by saturating a solution of the imide with barium carbonate and afterwards adding alcohol; also needles of a lead salt and a green amorphous copper salt.

The acid character of sulphuryl imide, so different from the neutral nature of sulphuryl diamide, is thus seen to be quite conclusively established.

A. E. TUTTON.

### THE DENSITIES OF THE PRINCIPAL GASES.<sup>1</sup>

IN former communications ("Roy. Soc. Proc.," February, 1888; February, 1892) I have described the arrangements by which I determined the ratio of densities of oxygen and hydrogen (15'882). For the purpose of that work it was not necessary to know with precision the actual volume of gas weighed, nor even the pressure at which the containing vessel was filled. But I was desirous before leaving the subject of ascertaining not merely the relative, but also the absolute, densities of the more important gases—that is, of comparing their weights with that of an equal volume of water: To effect this it was necessary to weigh the globe used to contain the gases when charged with water, an operation not quite so simple as at first sight it appears. And, further, in the corresponding work upon the gases, a precise absolute specification is required of the temperature and pressure at which a filling takes place. To render the former weighings available for this purpose, it would be necessary to determine the errors of the barometers then employed. There would, perhaps, be no great difficulty in doing this, but I was of opinion that it would be an improvement to use a manometer in direct connection with the globe, without the intervention of the atmosphere. With respect to temperature, also, it was thought better to avoid all further questions by surrounding the globe with ice, as in Regnault's original determinations.

#### *The Manometer.*

The arrangements adopted for the measurement of pressure must be described in some detail, as they offer several points of novelty.

The object in view was to avoid certain defects to which ordinary barometers are liable, when applied to absolute measurements. Of these three especially may be formulated:—

(a) It is difficult to be sure that the vacuum at the top of the mercury is suitable for the purpose.

(b) No measurements of a length can be regarded as satisfactory in which different methods of reading are used for the two extremities.

(c) There is necessarily some uncertainty due to irregular refraction by the walls of the tube. The apparent level of the mercury may deviate from the real position.

(d) To the above may be added that the accurate observation of the barometer, as used by Regnault and most of his successors, requires the use of a cathetometer, an expensive and not always satisfactory instrument.

The guiding idea of the present apparatus is the actual application of a measuring rod to the upper and lower mercury surfaces, arranged so as to be vertically superposed. The rod AA, fig. 1, is of iron (7 mm. in diameter), pointed below B. At the upper end, C, it divides at the level of the mercury into a sort of fork, and terminates in a point similar to that at B, and, like it, directed downwards. The coincidence of these points with their images reflected in the mercury surfaces, is observed with the aid of lenses of about 30 mm. focus, held in position upon the wooden framework of the apparatus. It is, of course, independent of any irregular refraction which the tube may exercise. The verticality of the line joining the points is tested without difficulty by a plumb-line.

The upper and lower chambers C, B are formed from tubing of the same diameter (about 21 mm. internal). The upper communicates through a tap, D, with the Töppler, by means of which a suitable vacuum can at any time be established and tested. In ordinary use, D stands permanently open, but its

<sup>1</sup> Abstract of a paper read by Lord Rayleigh before the Royal Society on March 23.