Discovering The Alkali Metals

— A Classic of Science

Chemistry

At The Dawn of Our History Man Knew The Oldest Alkalies--The Newest of These Elements Has Been Found Just This Year.

The lyes or alkalies soda and potash were known from earliest times. Davy proved them to be compounds of metals. Three new alkali metals have been isolated and proved similar to the original ones. Only a few months ago came news of the sixth and last member of the group.

Lithium

Analyses de quelques minéraux de la mine d'Utò en Suède, dans lesquels on a trouvé un nouvel alcali fixe. Par M. Auguste Arfwedson. Traduit de Afhandlingar i Kemi, Fysik och Mineralogie; tom. VI. Stockholm, 1818.

Published in Annales de Chimie et de Physique, Vol. X, Paris, 1819. Tanslated for the SCIENCE NEWS-LETTER *by Helen M. Davis.*

IN the mine of Utò, which from a remote time has been one of great importance in mineralogy, there have been found from time to time different minerals on which much work has been done to try to determine their chemical composition, especially during recent years. There are nevertheless among them some which, although well known so far as their external characteristics go, have never been the object of a chemical examination; and among those which have already been examined, there is too little agreement between the results of the analyses to enable a positive conclusion to be drawn about their composition. It is for these reasons that I have made several of these minerals the object of my researches. . . . .

[*The mineral Pétalite was selected and subjected to a program of analysis, from which it was found to contain silica, alumina and sulphates. —Ed.*]

But it was still necessary to learn the base of the salt. Its solution could not be precipitated either by tartaric acid in excess or by platinum chloride. Consequently it could not be potassium. I mixed another portion of a solution of the same salt with a few drops of pure potash, but without its becoming cloudy. Therefore, it contained no more magnesia: hence it must be a salt with soda for a base. I calculated the quantity of soda which would be necessary to form it; but it always resulted in an excess of about 5 parts in 100 of the mineral analyzed. So, since it seemed to me probable that the different substances might not have been well washed, or that the analysis in other ways might not have been made with sufficient exactness, I repeated it twice more with all the care possible, but always with results very little different. I obtained: Silica: 78.45, 79.85; Alumina: 17.20, 17.30; Sulphate: 19.50, 17.75.

At last, having studied more closely the sulphate in question, I soon found that it contained a definite fixed alkali, whose nature had not previously been known. M. Berzelius proposed to give it the name of *lithion* (from the Greek word *lithios, stone*), because this alkali is the first found in the mineral kingdom.

Sodium and Potassium

The Bakerian Lecture, on some new Phenomena of chemical changes produced by electricity, particularly the decomposition of the fixed alkalies, and the exhibition of the new substances which constitute their bases; and on the general nature of alkaline bodies. By Humphry Davy. Read Nov. 19, 1807. Reprinted by the Alembic Club, Edinburgh, 1901.

A SMALL piece of pure potash, which had been exposed for a few seconds to the atmosphere, so as to give conducting power to the surface, was placed upon an insulated disc of platina, connected with the negative side of the battery of the power of 250 of 6 and 4, in a state of intense activity; and a platina wire, communicating with the positive side, was brought in contact with the upper surface of the alkali. The whole apparatus was in the open atmosphere.

Under these circumstances a vivid action was soon observed to take place. The potash began to fuse at both its points of electrization. There was a violent effervescence at the upper surface; at the lower, or negative surface, there was no liberation of elastic fluid; but small globules having a high metallic lustre, and being precisely similar in visible characters to quicksilver, appeared, some of which burnt with explosion and bright flame, as soon as they were formed, and others remained, and were merely tarnished, and finally covered by a white film which formed on their surfaces.

These globules, numerous experiments soon shewed to be the substance I was in search of, and a peculiar inflammable principle the basis of potash. I found that the platina was in no way connected with the result, except as the medium for exhibiting the electrical powers of decomposition; and a substance of the same kind was produced when pieces of copper, silver, gold, plumbago, or even charcoal were employed for compleating the circuit. . . . .

Soda, when acted upon in the same manner as potash, exhibited an analogous result; but the decomposition demanded greater intensity of action in the batteries, or the alkali was required to be in much thinner and smaller pieces. With the battery of 100 of 6 inches in full activity I obtained good results from pieces of potash weighing from 40 to 70 grains, and of a thickness which made the distance of the electrified metallic surfaces nearly a quarter of an inch; but with a similar power it was impossible to produce the effects of decomposition on pieces of soda of more than 15 or 20 grains in weight, and that only when the distance between the wires was about one-eighth or one-tenth of an inch.

The substance produced from potash remained fluid at the temperature of the atmosphere at the time of its production; that from soda, which was fluid in the degree of heat of the alkali during its formation, became solid on cooling, and appeared having the lustre of silver.

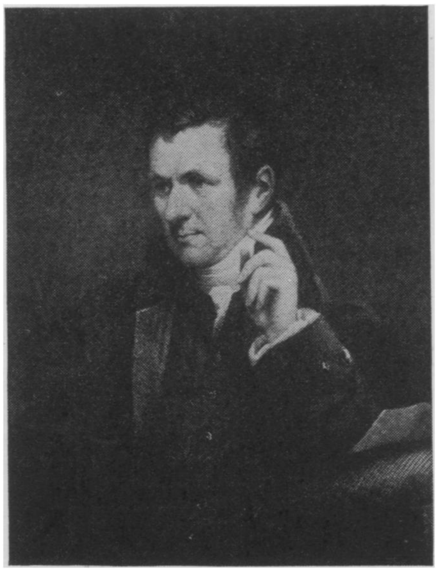
Cesium

On a New Alkali-Metal, by MM. Bunsen and Kirchhoff. In Chemical News, London, Nov. 24, 1860.

IN a recent number of the *Philosophical Magazine* there is given an account of some researches by MM. Bunsen and Kirchhoff on the effect produced by various metals on the spectrum of a flame in which their chlorides are volatilised. That part of their investigation which is more particularly interesting consists of a method of photochemical analysis of exquisite delicacy, which the authors have specially studied in relation to the alkali-metals.

These metals have been employed in the form of chlorides which have been purified with the greatest care. When these are introduced into a jet of flame they volatilise to a greater or less extent, and then communicate to the flame the special character above alluded to, and which is observable when the spectrum produced by the flame is examined by a sufficient magnifying power.

The above-named memoir is accompanied by a colored plate which illustrates the spectra of the alkali-metals with their characteristic rays. These rays are the more visible in proportion as the flame is less luminous and its temperature higher. The ordinary Bunsen gas-burner answers admirably for these experiments. The rays shown by the chlorides of potassium, sodium, and lithium are perfectly well-defined; those of barium, strontium, and calcium are more complicated, and require a somewhat experienced eye for their identification. They are, however, quite distinct enough to be easily recognized, even when the salts of these metals are mixed together; for the great advantage of this method of analysis is, that foreign matters have no influence on the results, the authors being able to detect with certainty the different elements in a mixture containing the tenth of a milligramme of the metals mentioned above. Sodium, with its yellow ray, first appears; after that the well-defined red ray of lithium; next is seen the paler rays indicating potassium; and, after these rays have disappeared, they are replaced by those of calcium and strontium, which remain visible for some time. The absence of one or other of these sets of rays shows the absence of the corresponding metals. . . . .



HUMPHRY DAVY

The man who found the metallic bases in the caustic alkalies.

With so delicate a reaction as the one just described, of an almost infinite sensibility, and applicable to all metals, the presence of elements, existing in so small quantities as to entirely escape ordinary analysis, may be rendered visible. Many observations tended to this point, and MM. Bunsen and Kirchhoff now announce definitely (*Annal. der Physik und Chemie*) that they have discovered a new alkali-metal, the fourth member of the group of potassium, sodium, and lithium. At present they have only found it in very small quantities in the mineral water of Kreuznach, in the saline water of Dürckheim, and in one of the sources of the Bade—the Umgemach.

The chloride of the new metal differs from those of sodium and lithium by the yellow precipitate which it produces in the presence of bichloride of platinum. It is distinguished from potassium by its nitrate being soluble in alcohol. Introduced into a flame, and examined with a prism, the vapors of the new chloride show a very interesting spectrum, consisting of two blue lines, one of which, the fainter, almost corresponds with the blue of strontium; the other, also a well-defined blue line, is situated a little further towards the violet extremity of the spectrum, and rivals the lithium line in brightness and distinctness of outline.

Rubidium

On a Fifth Element belonging to the Alkali Group, by Professor Bunsen. Reported from Bericht. der Akad. der Wissensch. zu Berlin, 1861, in Chemical News, London, June 15, 1861.

IN the investigation of the new metal having so close an affinity to potassium, and which has been called caesium by Bunsen, there appears to exist, besides this caesium, yet a fifth alkali metal, which has hitherto escaped notice, and which appears to resemble potassium quite as much as caesium does.

The platinum salt of caesium is with much more difficulty soluble in water than that of potassium. If we attempt to separate the latter from the former by repeated boiling with water, we find that in proportion as the quantity of potassium diminishes, and the continuous potassium spectrum between Ka *alpha* and Ka *beta* becomes faint, new lines appear, and among these in particular two very intense ones in the violet between Sr *delta* and Ka *beta*. A point is soon reached at which the quantity of potassium is no longer diminished by boiling with water. This occurs when the united atomic weight of the metals combined with chlorine and platinum is 109 ($H = 1$). If, now, a mixture of the hydrates of potassium and caesium be prepared from the platinum compounds, and about a fifth of this mixture be converted into carbonate, then absolute alcohol will abstract from the dried mixture almost exclusively hydrate of caesium. If this operation be repeated, a limit is at length reached at which that which is dissolved in the alcohol has a constant composition. This occurs when the atomic weight has risen from 109 to 123.4 ($H = 1$. The substance which possesses this enormous atomic weight (next to gold and iodine, the greatest known[1]) forms a deliquescent hydrate, as caustic as hydrate of potassium; it forms an equally deliquescent car-

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[1] Atomic weights of the elements were imperfectly known in 1861. Gold is exceeded in atomic weight by mercury, lead, and bismuth, all well known at that time, and iodine is also exceeded by barium. Bunsen was working with a mixture of cesium and rubidium. The weight of cesium turned out to be higher than that of his heavier fraction, that of rubidium lower than his lighter one.

bonate, which, at ordinary temperatures, is soluble to the extent of 10 parts in 100 of absolute alcohol; and an anhydrous nitrate, which crystallizes, not rhombic, like nitre, but hexagonally, and by a hemiedral form, is isomorphous with nitrate of sodium, etc.

The spectrum of this substance, purified up to an atomic weight of 123.4, shows the blue caesium lines with great intensity, but the violet lines of the unpurified substances (atomic weight 109) so faintly, that a slight addition of chloride of potassium, which scarcely affects the lines Cs *alpha,* makes them disappear at once, on account of the brightness of the ground produced by the potassium. The few grams of material for this investigation were obtained from 44,000 kilograms of the Dürkheim mineral water. By a repetition of the process, from 150 kilograms of Saxon lepidolite, there was obtained by the first treatment with chloride of platinum, a product which exhibited the violet lines between Sr *delta* and Ka *beta* with the utmost intensity, but no traces of the lines Cs *alpha.* If this platinum salt from lepidolite had been a mixture of the caesium and potassium compounds, the blue lines Cs *alpha* must have been visible along with the violet ones, because in the product obtained from the Dürkheim water, the violet ones disappear, first on the addition of chloride of potassium, and the caesium lines much later, and, indeed, only when the potassium salt is in very great excess. It follows that there must exist, besides, potassium, sodium, lithium, and caesium, yet a fifth alkali-metal, which occurs in Dürkheim, Kreuznach, and other mineral springs, in small, but in lepidolite in larger quantities.

Element 87

Evidence of the Presence of Element 87 in Samples of Pollucite and Lepidolite Ores, by Fred Allison and Edgar J. Murphy, Alabama Polytechnic Institute, January 11, 1930, published in the Physical Review, February, 1930.[2]

ELEMENT 87 is peculiarly well placed in the periodic table for detection by a new and very sensitive method recently reported by us. (Phys. Rev. 35, 124 [1930].) We have accordingly made a search for this element in samples of pollucite and lepidolite ores supplied by the Research Laboratory of the General Electric Company, and we have consistently found minima at points of the scale which correspond to an element of the atomic weight and the valence ascribed to eka-caesium. We have studied the substance in the chloride, sulphate, nitrate and hydroxide compounds, in each case finding the minima at points of the scale characteristic of an element of the chemical equivalent of eka-caesium. Since the same element in different compounds produces its characteristic minima of light at different points of the scale, the fact that minima are observed in each of the four compounds at the points appropriate to element 87 affords evidence of considerable weight for its presence in the sample under test. The element appears to have several isotopes, as judged by the number of its characteristic minima. The method employed is sufficiently delicate to detect less than one part of a compound in 10^{10} parts of water. The work is still in progress.

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[2] For popular account of this discovery, see Science News-Letter, Vol. XVII, No. 462, Feb. 15, 1930.

Peyote Button Induces Religious Fervor

Ethnology

Strange Indian Cult Studied by Scientist

WITH a tall pointing tipi for a church and the buttons of a peyote plant as a source of religious inspiration and power, Indians of Oklahoma conduct one of the old, least understood religious cults in America. The incorporated name is the Native American Church.

To straighten out the tangle of scattered facts and incomplete understanding about this church and its use of peyote, Dr. Maurice Smith of the University of Oklahoma, and his wife have just spent ten weeks among Oklahoma tribes that are the fountain source of the spreading cult. Dr. Smith attended several of the long peyote ceremonies. The Smiths interviewed the leading theologians and many dozen followers of the cult and also Indians who hold no faith in the powers of peyote.

"The peyote ceremony is an all night affair," said Dr. Smith, when in Washington to consult old, unpublished material on peyote in the possession of the Bureau of American Ethnology. "The Indian leader places a button of the sacred peyote plant on the altar fire. Other buttons are passed around and chewed by the Indians, who then sing and pray."

The effect of the buttons has been reported by a number of white men who tried small quantities on themselves, but their reports do not altogether jibe with the reports of Indians long accustomed to taking the drug, Dr. Smith found. In general, peyote affects the senses. Space and perspective alter, colors become more brilliant, and time flows by at a leisurely pace.

Peyote has no serious after effects, according to Havelock Ellis and other investigators, except that white men unaccustomed to its use are likely to be made even sicker than a small boy with his first cigar. To the Indian, the white man's observations on how peyote alters the world about him would seem obvious and unimportant, for the Indian is concerned with peyote as a medicine and as a source of religious feeling.

"At the peyote ceremony, among some tribes, it is customary for speakers to tell their religious experiences, if the spirit moves them." Dr. Smith said. "Through the night they sing, even as many as two hundred different songs, to the accompaniment of the kettledrum and the gourd rattle. Sometimes a healing ceremony is held for some sick person. Whether the peyote has any therapeutic value is one of the points that we know nothing about.

"We observed particularly the infusion of Christian ideas into the speeches and prayers. Bible ideas blend simply and naturally in the Indian mind with the old native theology."

Dr. Smith and his wife have been delving into the great collection of unpublished notes on peyote assembled by the late James Mooney for the Bureau of American Ethnology during a period of thirty years. Mr. Mooney was the first to try to understand the Indian's use of peyote and to explain it to science.

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