ination in all of the branches of medicine and surgery in order to secure a license to practice in the state of his adoption.

To correct this evil it has been suggested by a member of the American Medical Association, and concurred in by others, that a national board of medical examiners be organized; that the board hold examinations at different seasons of the year in the various large cities, and that the diploma so obtained shall be recognized as a license to practice in any one or all of the states and territories. The measure suggested seems to be practical and feasible.

In addition to this plan, it remains to be said that the degree granted by the future university medical school will be undoubtedly recognized as an evidence of fitness to practice in any state in the Union. When we shall have a less number of schools and annual graduates the various states may safely and rationally become more liberal and discriminating in the conduct of their office.

THE INFLUENCE OF THE AMERICAN MEDICAL ASSOCIATION.

The American Medical Association should maintain its interest in the elevation of the standard of medical education, one of the chief reasons of its organization. Its influence in former years was principally moral. This was of considerable value, for the reason chiefly of the high ideals of the founders and first members of the association, who advocated and fought for a higher standard of medical education. In the future its influence should be many fold that of the past, for with the reorganization of the profession, the better methods of conducting its affairs, the increased and probably very large membership, and its great medical journal, it should wield a great influence for good.

As the direct agent by which the American Medical Association may exert its influence in the elevation and control of medical education, the Committee on Medical Colleges and Medical Education should be made permanent and should be given adequate power and sufficient annual appropriation to make its work effective.

This association should, therefore, stand for, and should use its whole power to improve, medical education in this country. It is said that we never exceed our ideals in practice, and that if we lower our ideals our conduct sinks to a lower level.

The American Medical Association should take as its ideal and standard of medical education the university medical college, with all the name implies in regard to the fundamental medical sciences, and to the clinical branches. It should use its influence to drive out of existence those proprietary medical schools which are conducted solely as money-making institutions. These measures can not be accomplished at once; but medical science demands it, the profession demand it, the people demand it, and look to the American Medical Association as the chief influence which shall accomplish this end.

Frank Billings.

Chicago.

THE RARE EARTH CRUSADE; WHAT IT PORTENDS, SCIENTIFICALLY AND TECHNICALLY.[*]

In the movement of economic and social forces the closed century knew four periods of intensified activity. In 1775, a memorable date in American history, Watt began the manufacture of the steam-engine. During the adolescence of our own country revolutions were wrought in the commercial world by the invention of the locomotive by Trevethick (1801), the loom by Jacquard (1801), and Fulton steamed upon the Seine. By the beginning of the nineteenth century the inventions of Watt and

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[*] A lecture delivered before the Chemists' Club, New York, by request, April 8.

Boulton, Arkwright and Hargreaves, were completed and something like the modern factory system was begun. From industrial history we gather that 'England increased her wealth tenfold and gained a hundred years' start in front of the nations of Europe.'

While vigorous protests, some even violent, as the riots at Lyons and the destruction of Hargreaves' home in England, were made against this rampant spirit of industrialism, there was witnessed a literary renaissance in Great Britain second only to 'the spacious times of great Elizabeth.' That age nourished Keats, Shelley, Byron, Scott, Coleridge, Wordsworth, Burns and Burke. C. Alphonso Smith in his exquisite essay on 'Literature and Industrialism' says: 'In a love of nature that made all seasons seem as spring, in devotion to democratic ideals, in variety of range and intensity of feeling, this period takes precedence of Elizabeth's reign.' It was of this age that Wordsworth said:

> "Joy it was in that dawn to be alive,
> But to be young was very heaven."

Granting Tolstoi's definition of science as a 'mere gratification of human curiosity,' we realize that 'science is history making,' for it was in this period that Volta and Galvani (1801) gave us a source of power and a means of applying it. At the close of the time Dalton had announced the atomic theory and Davy had obtained the alkali and alkaline earth metals.

In the second period, about 1840, there accumulated the potentialities that shaped what is termed the Victorian Era. Quoting Smith again, "In those years railroads first began to intersect the land, telegraph lines were first stretched and the ocean was crossed for the first time by steam-propelled vessels. All these mechanical triumphs tended to annihilate time and space. The products of manufacture could now be sent with dispatch to the most distant quarters. Nations came closer together. The two hemispheres became, and have continued, one vast arena of industrial and scientific interchange. * * * "

The literary record of this period contains the names of Tennyson, Goethe and the Brownings as poets; Dickens, Thackeray and George Eliot in fiction; Ruskin and Carlyle in miscellaneous literature. In America, during this Mexican War period, we had Longfellow, Lowell, Whittier, Hawthorne, Emerson and Holmes, 'the six names that have given the New England states their incontestable supremacy in American literature.'

The part played by the south in literature during these periods was not prominent. The preeminence of that part of our country in forensic art and oratory need not be considered, nor need we discuss the social conditions, and honest difference of opinion as to the proper interpretation of the true relationship of the government as a whole and the integral states which constituted it, other than to say that the south, conquered, as was necessary, came out of the Civil War with new economic ideas, with a renewed and 'ever-increasing development of her natural resources, with a more flexible industrial system, a more rational attitude toward labor, and more enlightened methods of education and with it there came a literary and scientific inspiration impossible before.' In the year 1870, our third period, which statisticians take as the birth year of the new industrial movement in the south, flashed out new literary stars such as Sidney Lanier, Charles Egbert Craddock and George W. Cable. That year can not be named in the presence of scientific men without our thoughts reverting at once to the names of Mendeleeff and Meyer.

The last period is but as yesterday, even to-day.

> "All the world's a stage
> And all the men and women merely players."

It has been called the age of trusts and mistrusts. In it we must realize that science and its applications must face vested interests; these must be overwhelmed or its universal monopolistic rights be pigeonholed by purchase. Let us realize, however, in this time, as Boyle has said, that 'men often suffer as much cold and wet and dive as deep to fetch up sponges as to fetch up pearls.'

In 1788 Geyer discovered the new mineral, gadolinite, and in 1794, the Finnish chemist, Gadolin, separated a new earth, or oxide, in a black mineral found at Ytterby near Stockholm, and called it yttria. In 1803 another Scandinavian mineral, then known as 'the heavy stone of Bastnäs,' or cerite, was discovered by Berzelius and Hisinger and Klaproth in Germany.

In 1839 Mosander discovered lanthanum in this earth. Three years later he resolved it into two elements, one giving a white oxide and the other a pink, namely true lanthanum and didymium. Scheerer noted that yttria, which is white when heated in a closed vessel, becomes yellow when heated exposed to the air. He, in consequence, assumed that it was a complex substance and the year following (1843) Mosander proved that it could be resolved into three earths, one being colorless (true yttria), the second rose-colored (terbia), and the third (erbia) giving colored salts, but a deep yellow peroxide.

H. Rose in 1839 analyzed samarskite and showed it to be a columbo-tantalate of iron and calcium on the one hand and yttrium and cerium mainly on the other. Satisfactory analyses of this mineral, however, were not had for almost a half-century (Swallow, Allen and Smith), when its comparatively abundant occurrence was noted in North Carolina.

Shortly after the discovery of the spectroscope, Gladstone in 1859 observed the surprising fact that certain substances gave absorption spectra, especially didymium. This constituted the first important and is now, perhaps, the most valuable criterion in the investigations of many of the rare earths.

In 1860, Berlin, by means of partial decomposition of the fused nitrates, showed the presence of but two earths where Mosander had reported three, namely, yttria, as given above, and a rose-colored body, which was termed erbia. A reversal of names occurred, for two years later Bahr observed the characteristic absorption spectrum of erbia and Delafontaine found it in Gadolin's yttria and Mosander's yellow peroxide. The typical oxide was assumed to be RO, and it remained for Mendeleeff in the enunciation of the Periodic Law (1870) to give lanthanum the present accepted formula for its oxide, La_2O_3.

These elements were obtained as metals —in the then accepted pure form—and Hillebrand and Norton determined the specific heats, which data have aided subsequent workers materially. These determinations, in the light of knowledge gained within recent years, possess a quondam value, however much care and energy may have been expended in securing them.

In 1878 Delafontaine stated that samarskite contained much terbia. He separated a more soluble formate and announced the new element philippium, which Roscoe, although he noted band λ 450, proved to be a mixture of yttrium and terbium. This band in reality belongs to dysprosium, discovered by Lecoq de Boisbaudran. The same year Delafontaine, having found a mare's nest in samarskite, from which Mosander separated erbium, announced decipium. The absorption bands attributed to this element were λ 416 and λ 478, which were subsequently appropriated by samarium, reported as a constituent of didymium by de Boisbaudran. Samarium would now have the name of decipium, but for the fact that, in 1881, Delafontaine declared his decipia could be resolved into an oxide without absorption spectrum (true decipia) and one with these lines, or samarium.

J. Lawrence Smith, of Kentucky, in the seventies, announced mosandrum in samarskite. Marignac and Delafontaine independently pointed out that mosandrum was the same as terbium, while later de Boisbaudran demonstrated that it was a mixture of terbia and gadolinia. This 'nebula of elementary matter,' as Petterson puts it in that charming account of the life work of Nilson, appeared to clear up through the work of the English, French and Swiss chemists, Roscoe, de Boisbaudran and Marignac. While 'the beginning of creation is light,' as Carlyle says, the millennium has not yet arrived, for the earths obtained from gadolinite began to break up into a number of new earths.

Cleve (1873) found that the bands of erbium with an atomic weight of 170.5 could be split into those belonging to one element forming a red oxide with the characteristic emission spectrum (by incandescence) of old erbium and another group of two absorption bands in the visible spectrum. These were shown to belong to thulium.

Five years later Marignac found all the absorption bands could be eliminated by successive fractioning, whilst the atomic weight of the remaining oxide increased. This oxide gave colorless salts without absorption bands, and the name ytterbium was assigned to it, with an atomic weight of 172.5. In the erbia fractions Soret found bands which could not be attributed to erbium. This body, designated X, subsequently proved to be Cleve's holmium.

Material giving out, Marignac, with the true scientific spirit, begged other and younger men to take up the work, using larger amounts. This Nilson did and verified Marignac's work. Just before reaching the same point Marignac arrived at, however, Nilson obtained a nitrate of a less basic material of lower atomic weight. One fraction continued to drop, while the other rose until, in the year following (1879), assisted by Thalèn, who examined the products with the spectroscope, Nilson separated probably the two best defined of the rare earths, scandium (44.1) and ytterbium (173). Nilson showed the location of these elements in the Mendeleeff table, the properties of the former having been predicted.

Referring to these elements Mendeleeff says: 'These metals which are rare in nature, resemble each other in many respects, always accompany each other, are with difficulty isolated from each other and *stand together in the periodic system of the elements.*' The last statement is based largely upon analogy, a most valuable method of argument in scientific generalizations without doubt, but, as Davy once said: 'Analogy is the fruitful parent of error.'

In 1880 Marignac attacked samarskite, and by fractioning the double potassium sulphate obtained two oxides in almost pure state, as follows:

Yα giving a white oxide, colorless salts and no absorption bands. Six years later it was called gadolinium and the atomic weight 156 assigned it by Marignac, de Boisbaudran, Cleve and Bettendorff.

Yβ proved to be samarium of de Boisbaudran, or Delafontaine's original decipium. Marignac, Cleve, Brauner and Bettendorff determined its atomic weight (149–150). While the elementary character of samarium was questioned by de Boisbaudran and Demarçay, as late as 1893, the latter stated that no real proof of the complexity of samarium had been offered. What an exquisite illustration we have here of Tyndall's dictum, 'Every system must be plastic to the extent that the growth of knowledge demands'; for, but a few years have passed before Demarçay (1901) announces europium, with atomic weight of 151 (approximately), obtained by prolonged fractionation of the double magnesium-samarium nitrate. His observations are reported as proved by reversal, absorption, spark and electric phosphorescent spectra. The element appears to lie between samarium and gadolinium, with several strong lines in the violet and ultraviolet.

In 1883 Crookes brought into consideration phosphorescent spectra obtained in a vacuum tube under the influence of an electric discharge. The year following Lecoq de Boisbaudran obtained another method of securing a phosphorescent spectrum. It is in fact an inverse spectrum, nearly related to that of Crookes, very delicate, being greatly influenced by small amounts of foreign bodies and other conditions. The brilliancy of the bands thus obtained does not depend upon the proportion of the active substance present. A small amount of the body with much inert material gives a bright spectrum, consequently it offered little promise as a method for following the process of fractionation.

Up to this time holmia and thulia had not been freed from the other earths. In 1886 de Boisbaudran showed that holmia was composed of true holmium (162) and dysprosium (?), adverted to, characterized by several bands, the one to which Sir Wm. Crookes called especial attention being λ 451.5. This Englishman later (1889) subjected yttrium salts to a great number of fractionations, several thousand, finding the bands of the original material distributed among the different fractions. From this work he assumed that yttrium could be split into a number of elementary substances, which he termed 'meta-elements,' naming one victorium after the lamented queen. Without doubt Sir William Crookes enunciated in this paper an important principle in inorganic research, namely, what may be termed 'partial cleavage'; that is, the fractioning of a complex mixture of elements may be pushed to an extreme with one compound and the bodies appear elementary. On applying another method, or the same method to another compound of the assumed elementary substance, the cleavage may be brought about in another direction, and so on. The 'genesis of the elements' was the natural theory offered by that master mind. It was strongly combated in the main, however, by de Boisbaudran, who showed that two of the bands obtained, $Z\alpha$ and $Z\beta$, are not at all related to yttria, as the former follows holmium and the latter is identical with terbium. He says, further: 'Perfectly pure yttria gives no phosphorescent spectrum.' Dennis, the American worker on the element in question, appears to agree with the French chemist.

It may be recalled that Delafontaine extracted samarium (his original decipium) from Mosander's didymium. The theoretical work referred to naturally gave rise to the complexity of didymium, which has an absorption spectrum characterized by a number of well-defined bands. In fact, Cleve made the prediction of the presence of another element in lanthanum and didymium in 1878. Carl Auer (von Welsbach), in 1885, by prolonged fractional crystallization of the double ammonium nitrate, obtained from the pink solution green salts of praseodidymium (140) and rose-red salts of neodidymium (143). The absorption spectra of these two are complementary. The next year Crookes eliminated band after band of the didymium until only λ 443 remained. Krüss and Nilson and Kieserwetter and Krüss prepared didymium from several sources, fractioned the preparations and arrived at a similar conclusion. It is now known, as shown above, that erbium has been resolved into seven other well-characterized elements, viz., besides erbium (166.3), scandium (44.1), yttrium (89), terbium (160), ytterbium (173), thulium (170.7), holmium (162) and dysprosium (?). After the elimination of samarium, didymium shows at least nine distinct absorption bands: λ 728.3, 679.4, 579.2 to 575.4 (which is easily resolved into two), 521.5, 512.2, 482, 469, 445.1 and 444.7 (443) (ultra-violet and infra-red not considered). In short, these two elements neo- and praseodidymium consist of at least nine elements. The full conclusion of Krüss and Nilson may be stated in their own words: 'Nach obigen Auseinandersetzungen hätten wir an Stelle des Erbiums, Holmiums, Thuliums, Didyms, und Samariums die Existenz von mehr als zwanzig Elementen anzunehman.'

While the acceptance of such conclusions without question would be wholly unscientific, we must carefully consider the general idea involved, and the investigations upon which the conclusions were founded and the investigations carried out subsequently to test them. Absorption bands determined under variable conditions are not to be accepted as essential characteristics of new elementary substances, as they have been shown to vary with the salts used. Sorby and Liveing have shown that the character of the solvents and traces of impurities bear importantly upon the intensity of the absorption bands. Lawrence Smith and de Boisbaudran and latterly Dennis and Chamot have called attention to variations in the absorption spectrum of didymium, when nitric acid is present. Becquerel showed there were variations in the spectra of crystalline compounds of the same element. Very recently Muthmann and Stützel have shown that, if a substance be regarded undecomposable, its absorption spectrum varies considerably with dilution and amount of free acid present. Demarçay has urged the necessity of giving the thickness of the medium used, with a statement of its strength.

C. M. Thompson reported that didymium salts from various sources showed no material differences in absorption spectra. Schottländer remarks, however, that the material used contained several oxides, giving absorption bands, so the intensity of certain bands of a particular element may have been increased by the superposition of bands of other elements.

Crookes and Dennis independently made the extremely interesting observation that the heavy orange bands (575–579), which were resolved by Auer, were not altered in their fractions when the remaining lines had undegone some changes, hence the former stated that probably 'didymium will be found to split up in more than one direction, according to the method adopted.' The work of Dennis on the relative intensities of the bands observed, by varying the procedure of fractionation, is in direct accord with the observations of previous investigators as to the compound nature of neo- and praseodidymium.

Von Scheele (1898) carried out a series of investigations looking toward the proof of the elementary character of praseodidymium. Bettendorff, by a spectroscopic examination of the mother liquors obtained by the Welsbach method, confirmed the observations of Krüss and Nilson, especially with regard to the absorption bands in the blue portion of the spectrum. Schottländer, working with the same object in view, came by no means to the same conclusion. He held it probable that praseodidymium consists of a mixture of two elements, whose oxides burned in air give R_2O_3 and RO_2 (*i. e.*, $R_2O_3 + 2RO_2 = R_4O_7$, the accepted peroxide). His conclusion was founded upon the small per cent. of oxygen present in the peroxide. Forshing confirmed Bettendorff's results spectroscopically and reported Pr α characterized by the yellow bands, and Pr β, which has the three bands in the blue, indigo and violet. Boudouard arrived at the same conclusions. Brauner concluded, in his work on the oxides, 'from the tendency of them both (praseodidymium and neodidymium) to become more highly oxidized than would correspond to the formulæ Pr_2O_4 and Nd_2O_5, that praseodidymium and neodidymium may be further split up.'

Von Scheele maintains that none of the savants has proved Krüss and Nilson's theory that there are four elements present in praseodidymium. By long repetition of the Welsbach process he failed to bring about any variation in the yellow bands, which Bettendorff maintained could be fractioned away, and demonstrated to his own satisfaction the elementary composition of praseodidymium in a paper reciting much careful and patient experimentation. Unfortunately, he ignored the work of Crookes and Dennis, which is dependent upon variation of the finer details of manipulation. In our laboratory, following entirely novel lines of research for this element, we have apparently verified the conclusion of the complexity of the element in question.

The material used was generously presented by Mr. H. S. Miner, the long-time associate and successor of the lamented Shapleigh. It was quite free from neodidymium, but contained a notable amount of lanthanum. The presence of lanthanum facilitates the fractioning of didymium by the Auer method, as pointed out by Dennis. A pure praseodidymium compound is readily had by using the method of Baskerville and Turrentine, namely, fractioning a citric acid solution saturated with the hydroxide, and heating. The citrate obtained was converted into the oxide. This oxide was free from the other elements giving absorption bands in the visible spectrum. So far we have not been able to examine the ultra-violet, but shortly expect the arrival of one of Wood's nitrosodimethylaniline screens, which I am having made for my spectroscope. The instrument is a Steinheil plane grating (made by Brashear) with 14,438 lines to the inch, essentially the same as that described by Dennis in his work with Dales on yttrium, except a size larger. It was purchased by a grant from the Bache Fund of the National Academy. The oxide was proved to be free from elements which give no absorption band, especially lanthanum, by means of photographs of the arc spectrum obtained with a Rowland concave grating (15,000 lines to the inch and twenty-one-foot diameter). The spectrograph work was done by my friend Dr. W. J. Humphreys, of the Department of Physics, University of Virginia, and will be published by us in full at the proper time. The oxide was very carefully treated with hydrochloric acid, bringing about partial solution, whereby a distinct brown oxide was obtained different from the normal black peroxide; further, a separation has been secured by fusion with sodium peroxide.

Other methods of attack have been followed, as, for example, fractional crystallization from a concentrated chloride solution by means of gaseous hydrogen chloride, fusing with alkaline hydroxides, sodium dioxide, etc. The details will be given in the full papers when published.* Suffice it to say that we have succeeded in obtaining a preparation, which has lost entirely the absorption line λ 443 and another, very small in amount, which shows only that line. The oxide is bright green when heated in the air. The work of Crookes and Dennis is thus verified by entirely novel methods. Drossbach reports the existence of an element in monazite sand with an atomic weight of 100, that is, eka-manganese, but it is discredited by Urbain.

It may be interesting at this point to call the attention of the scientific men of America to the fact that from the locality, Ytterby, where cerite was found, four elements, yttrium, erbium, terbium and ytterbium, have secured a name. From the occurrence of samarskite and monazite (Mitchell and McDowell and other counties in North Carolina and Brazil), which contain most of these rare earths and have furnished so much of the material for the researches, not a single element is named, except the tentative carolinium, which will now receive attention.

The other rare earths to which I wish to direct your indulgent attention in a few words are those which possess radio-activity, a property accidentally rediscovered by Becquerel. It may be remarked that Sir George Stokes fifty years ago addressed the physicists of the British Association on the curious action of certain bodies in emitting light at ordinary temperatures. Little was then known of the phenomenon of fluorescence. There is not time to attempt a discussion of the origin and nature of radio-activity. It appears that our satisfactory Maxwellian theory of the progression of ethereal stresses may yet be harmonized with the older corpuscular view of Descartes and Newton by the recent elegant researches of Becquerel, J. J. Thomson, Rutherford, Giesel and others.

M. and Mme. Curie have been pioneers in utilizing this physical activity, which serves to detect the presence of minute amounts of certain elements contaminating hitherto well-defined bodies. J. J. Thomson, in his recent extremely interesting address at Belfast, brings out a point demanding the chemist's closest attention, namely, that the radio-activity is five thousand times as delicate as the spectroscope, it matters not whether the arc, spark, absorption or phosphorescent spectrum be made use of.

By prolonged fractionation the Curies separated radium from barium salts. Demarçay has prepared the spectrograph showing the characteristic lines of the element, while Madame Curie determined its atomic weight (225). It fits beautifully in Mendeleeff's table. The Curies have also announced polonium, or the active constituent of bismuth. Uranium appears to have been the first to show this property, as noted by Becquerel. Actinium, it seems, is the elusive body found in pitchblende by Curie, and appears to be the same as Crookes' uranium X.

Chroustschoff a dozen years ago announced that thorium contained another element, which he called russium. I have been unable to secure a copy of this paper or even to learn where it appeared. I am informed by Professor Mendeleeff, who

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* I have been assisted in the numerous researches barely summarized in this address by Messrs. J. E. Mills, R. O. E. Davis, J. W. Turrentine, James Thorpe, Reston Stevenson, W. O. Heard, Hazel Holland, E. B. Moss, H. H. Bennett, Geo. F. Catlell and F. H. Lemly. The separate papers will shortly be published. Three grants of fifty dollars each have been made by the American Association for the Advancement of Science to aid in the work on the rare earths.

mentions it in his 'Principles of Chemistry,' that Chroustschoff made the announcement before the Russian Chemical Society, but had published no complete investigation. Two years ago, Brauner, working along one line, and I, on another, independently announced the complexity of that element.

It is generally accepted now from the published work that the property of emitting rays which affect the photographic plate is not a specific property of thorium, but characteristic of a constant contaminating constituent of that element. It is well known also that, while some of these radiations or emanations affect the photographic plate, some do not. The electrical method of measurement (quantitative) has been substituted in our work and improved methods of fractionation are being used, whereby we seem to be approaching a non-radio-active thorium and one possessing that property in high degree. Further, similar compounds of thorium fractions similarly treated show almost no difference with the Rowland grating referred to, yet show marked divergence in their radio-active properties. The radio-active work is being done by Mr. G. B. Pegram, of the Department of Physics in Columbia University.

I have not come from 'away down south' to the center of commercial activity of all the Americas to tell you how these rare substances are to be had at low cost, advertise their uses, form a combination and arrange for their sale at a good profit, although one of my neighbors ranks high among Knickerbocker mergers. The fourth period in rare earth activity is coexistent with the extension of the use of some of them for illuminating purposes. The price of thorium nitrate fifteen years ago was over five hundred dollars per pound. Now the market price is about five dollars per pound. Commerce required thorium compounds; they were provided. Commerce demanded thorium compounds at a reasonable price; the demands were met. The prices of certain of the impure rare earths occurring in nature with thorium are high, but their values do not follow well-known economic laws and are purely fictitious. When uses are found, the prices of these by-products will fit the demand.

In this maze of an enticing problem one imagines much and many speculate more. Not unfrequently, especially of late, have we been treated with irenic disquisitions as to the location of these rare elements in the natural system. It appears to be forgotten that Mendeleeff used his table to correct the formulas of the typical oxides of certain elements, as, for example, lanthanum (LaO to La_2O_3). The fact is forgotten that the atomic weights, now ascribed, would be materially different were the type different. The ascribed atomic weights are dependent upon the synthesis or analysis of the sulphates almost without exception. It is forgotten that '-yl' salts, like uranyl, chromyl sulphates are possible for these elements, as recently shown by Blandel for titanium and Matignon for praseodidymium and neodidymium. Furthermore, it is forgotten that the sulphate method is absolutely defective, as Schützenberger pointed out. This has been verified by Wyrouboff, Dennis, Brauner and Pavlicek, and Demarçay, as well as myself. Therefore, all attempts to arrange these elements, some of which are known to be complex, in the periodic table are veriest speculation, which can profit little. It is quite as true also that the table should receive no discredit because it fails to account for them with our present knowledge. According to its author the table reserves twenty-three places for their occupancy.

Two desiderata may be mentioned: (1) Satisfactory tests, preferably colorimetric, which may be quickly applied, as Hillebrand has remarked about titanium. This supplied, perhaps these earths would not be so rare. I have shown the universal occurrence of titanium. (2) Spectral data from more highly purified substances, for much that is now at hand has been obtained from impure earths.

The methods of attack at present are mainly based upon the same phenomena of oxidation, reduction and saturation. The applications are different, however. As typical examples, a few may be cited as follows: Melikow has been using the hypochlorites, virtually the Lawrence Smith method; Muthmann, hydrogen dioxide and acetate solutions; Dennis is using organic acids, as did Metzger for thorium; Jefferson and Allen have applied certain organic bases for analytical purposes, while in our laboratory we have saturated the stable alkalies, fused with sodium peroxide, and reduced with such basic reducing agents as hydrazine and phenylhydrazine, and so forth.

All is not dark, for rifts in the clouds are making. Old Watt said: 'Nature has always a weak side, if we can only find it out.' Looking back and with that century of experiences we can frequently in a measure judge of the future and those things which make toward the true end.

Naturally a sequel is due this paper, and I look forward to presenting it in my vice-presidential address before Section C of the American Association at the St. Louis meeting. Some sequels are better than their predecessors; most of them, however, are not so good.

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SCIENTIFIC BOOKS.

Inorganic Chemistry, with the Elements of Physical and Theoretical Chemistry. By J. I. D. HINDS, Ph.D., Professor of Chemistry in the University of Nashville. New York, John Wiley & Son; London, Chapman & Hall, Limited. 1902. Large 8vo. Pp. viii + 566.

Chemistry by Observation, Experiment and Induction. A Laboratory Manual for Students. By J. I. D. HINDS, Ph.D., Professor of Chemistry in the University of Nashville. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 12mo. viii + 192.

Principles of Inorganic Chemistry. By HARRY C. JONES, Associate Professor of Physical Chemistry in the Johns Hopkins University. New York, The Macmillan Company; London, Macmillan & Co., Ltd. 1903. Large 8vo. Pp. xx + 521.

A Text-Book of Inorganic Chemistry. By Dr. A. F. HOLLEMAN, Professor Ordinarius in the University of Groningen, Netherlands. Rendered into English by HERMAN C. COOPER, Ph.D., Instructor in Syracuse University, with the cooperation of the author. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1902. Large 8vo. Pp. viii + 458.

While the number of smaller and introductory text-books on chemistry which have appeared in this country during the past few years is very large, it is a long time since any new work on inorganic chemistry, which aims to be even tolerably complete, has been published. That three such works should appear within a few months of each other is evidence that a need was felt in this field. This is, of course, due to the revolution, as it might well be called, which has taken place in the fundamental conceptions of inorganic chemistry, and the recognition of the fact that these must be utilized in teaching the subject. This was early seen by Ostwald, and he must be considered the pioneer of the new didactic chemistry.

It is interesting to note how the authors before us have utilized the wealth of ma-