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PLATINUM AND THE METALS OF THE PLATINUM GROUP

WHAT promises to be the most complete and authoritative work on platinum and platinum deposits is about to be published in Geneva, Switzerland. The author, Louis Duparc, is professor of chemistry and petrology in the University of Geneva; the name of Marguerite N. Tikonovitch is announced as that of the associate author.¹

Professor Duparc has long been known as the writer of many papers on the great platinum deposits of the Ural region in Russia, of which he has made special study. He has also investigated personally the notable platinum deposits in other parts of the world, and he gives in the present work the ripe results of more than twenty years investigation of the sources of this rare metal.

The first chapter will be devoted to the topography and geological aspects of the Ural region. This is followed by a chapter treating of the "mother rocks" of platinum, and by others on the petrography of the primary platiniferous centers, the dunites and peridotites. Then, in turn, are offered considerations on the pyroxenites and koswites, the rocks of the gabbro family and various vein rocks. The view is then extended to cover the metamorphic rocks accompanying the eruptive platiniferous zone.

Turning then to what more immediately concerns the metal itself, the constituent elements of native platinum are studied, and its state in the different primary deposits, as well as the probable genesis of these deposits. The writer now passes to the analysis and chemical

¹ Louis Duparc and Marguerite N. Tikonovitch, "Platinum and Platinum Deposits," pub. by "Société Anonyme des Editions 'Sonor,'" 46 Rue du Stand, Geneva, Switzerland, 600 pp., 99 text ill., 90 stereotype pls., 11 in black and color, 8 of dredges, etc., atlas of Ural deposits, 4°.

composition of platinum, as investigated by the ordinary methods used and certain new ones that have been applied. The average content of deposits is presented as a test of the eventual results of working them, and the differences in the composition of native platinum from the principal deposits are noted. Secondary deposits and platiniferous alluvial, and the extraction of platinum from alluvial, form the subject of two chapters.

The dunitic deposits of the Urals are very fully and extensively presented by Professor Duparc, who has investigated the occurrences of platinum in this region with especial care and thoroughness. The succeeding chapter is devoted to an equally exhaustive examination of the pyroxenitic platinum deposits of this region. Then comes a chapter on the deposits in other parts of the world; in San Domingo, Honduras, equatorial Colombia, Brazil and French Guiana, as well as in North America, where the deposits of the United States, of Mexico and of British Columbia are studied. To these succeed the deposits of Oceania, of Borneo, of New South Wales, Australia, of New Zealand and of Tasmania. Nor are the African deposits in the Transvaal forgotten, while the alleged deposits on the Island of Madagascar are duly mentioned. Asiatic deposits of the Wilui and the Oldoi rivers, and of the Altai, close this comprehensive description.

The treatment of the ore and the metallurgy of platinum are then gone into very fully, and the extraction and separation from one another of the various metals of the platinum group, such as palladium, iridium, rhodium, osmium and ruthenium. The melting and moulding of platinum closes this chapter.

The uses of platinum in the arts and industry are then presented, whether for apparatus employed in sulphuric acid concentration, for colalytic mixtures, in photography, in the manufacture of electrodes, in dentistry, in incandescent lamps, in laboratory apparatus, or for various other minor uses. Its employment in jewelry is also duly noted.

A concluding chapter gives a recapitulation of the main results and statistics of the world's

production of the metal. This is followed by a bibliographical list.

The whole will form a quarto volume of 600 pages, with 99 text illustrations, 90 stereotype plates, 11 plates in black and colors, an atlas with 5 geological colored maps of the Ural deposits, and 8 plates giving illustrations of the principal installations of buddles, dredges, etc.

The work is issued by the "Société Anonyme des Editions 'Sonor,'" 46 Rue du Stand, Geneva, Switzerland. The first hundred numbered copies are not in trade; for the 500 numbered copies, running from No. 101 to No. 600, the price to subscribers is 100 francs; if purchased through booksellers, 125 francs will be charged.

An interesting recent publication of Professor Duparc (in collaboration with A. Grossett) is a study of the lately discovered platiniferous deposits of the Sierra de Ronda, Spain, in which he draws attention to the similarity of the conditions there to those observable in certain parts of the Ural region.²

The new edition of Professor James Lewis Howe's "Bibliography of the Metals of the Platinum Group," which has just appeared, may confidently be pronounced to be a realization of just what a bibliography ought to be.³ Professor Howe acknowledges his indebtedness to a supplement of his earlier bibliography, issued in 1897, bringing this down to 1910, which was prepared by Dr. Hendrick Coenraad Holtz, then of Amsterdam; the few references in this supplement to American and English works were completed by Professor Howe, and the amplified record was brought down to the end of 1916.

² L. Duparc and A. Grossett, "Étude comparée des gîtes platinifères de la Sierra de Ronda (Espagne) et de l'Oural," *Mém. Soc. phys. et hist. nat. Genève*, Vol. 38, fasc. 5, p. 253, 1916.

³ "Bibliography of the Metals of the Platinum Group, Platinum, Palladium, Iridium, Rhodium, Osmium, Ruthenium, 1748-1917," by Jas. Lewis Howe and H. C. Holtz, Washington, D. C., 1919, 558 pp., 8vo; U. S. Geol. Surv. Bulletin 694. The first previous edition of 1897 (under the same title) bears only the name of Jas. Lewis Howe; published by the Smithsonian Institution, Washington, D. C., 1897, 318 pp. 8vo.

Professor Howe notes the value of an earlier bibliography he was able to consult, that of Professor C. Claus, contained in his pamphlet entitled "Fragment einer Monographie des Platins und der Platinmetalle." This was published in 1883 by the St. Petersburg Académie des Sciences, from manuscript sheets found among Claus's papers after his death, which had occurred more than twenty years before. The bibliography extends to the year 1861, but, owing probably to the illegibility of the manuscript, many errors have crept in; nevertheless the unique knowledge of this author in the domain of the platinum metals made it of great value. As only 300 copies were printed, this pamphlet is now very rare.

In Professor Howe's earlier edition (of 1897) there were given 61 titles before 1800; 737 between 1800 and 1849, and 1,642 between 1850 and 1896, making in all 2,440 titles. The following recapitulation shows the notable increase in the second edition:

Titles before 1800	65
1800-1849	749
1850-1899	1,823
1900-1916	1,924
Total	4,561

As will be noted, the literature for the seventeen years 1900-1916, gave a larger number of titles than were offered by the preceding half-century. This well indicates the growing importance of this rare and valuable metal. The titles are disposed chronologically, those of each year being separately numbered. In the indexes both the year and the number are given for each title, not the page of the bibliography. The author index, alphabetically arranged, covers 29 pages and embraces nearly 2,500 names. This is followed by an exceptionally full subject-index of 74 pages; under such subject the literature is given in chronological order, with year, number and author's name. It will be seen that no pains have been spared to facilitate the task of any one who is seeking for sources of information as to platinum or any of the platinum metals.

It is to be hoped that this bibliography will be continued, as Professor Howe is still in the

prime of life, having been born August 4, 1859, at Newburyport, Mass. He graduated at Amherst in 1880, and received the degree of Ph.D. from Göttingen, Berlin, and Massachusetts Institute of Technology, successively. Since 1894, he has occupied the chair of chemistry in Washington and Lee University. He has done especially valuable work in the study of ruthenium and other platinum metals. He has published a very attractively written biographical notice of the French chemist, Chabaneau (1754-1842), the first maker of a platinum ingot. This weighed some 23 kilograms (about 50 pounds). The writer gives many details of Chabaneau's skill in using the newly-found metal for ornaments, after he had discovered the secret of making it malleable, by taking platinum sponge at a white heat, at the moment of formation, and hammering it repeatedly while in this state.

The titles dating from before 1800, beginning with the first printed mention of the metal in Don Antonio de Ulloa's "Relación histórica del viaje á la América meridional," Madrid, 1748, show that Sweden shares with France and England in the earliest investigations as to its composition and the best methods of refining it. With the names of Watson, Brownrigg, Lewis, Morin, Macquer and Buffon, must be associated those of Scheffer, Cronstedt and Bergman, nor should we forget the Germans, Marggraf and Count von Sickingen. The earliest records of the various platinum metals naturally attract one's attention. The first notice of palladium is in a communication of R. Chenevix to the "Philosophical Transactions," London, Vol. 93 (180-3), p. 290. Tennant's paper on iridium appeared in the *Transactions* for 1804, Vol. 94, p. 411, but his discovery dates from a year or two previous to this time; in 1804, A. F. Fourcroy and L. N. Vauquelin describe it in the *Annales de Chimie*, Paris, Vol. 49, pp. 188, 219. To W. H. Wollaston in 1804 is due the credit of the discovery and determination of rhodium (*Phil. Trans.*, London, Vol. 94 (1804), p. 419), and in the same year Tennant gives the first description of osmium, in connection with that of iridium. The discovery of the sixth mem-

ber of the group, ruthenium, came much later, and was made by C. Claus in 1844; it was first announced in Russian, in his essay for the Demidov Prize, published at Kazan in 1844.

Professor Howe states that the compilation of his first platinum bibliography was probably due to a suggestion made by Dr. H. Carrington Bolton, and his special interest in the platinum group of metals was aroused by a chance remark of Dr. F. W. Clarke, who expressed surprise the chemists were not more interested in them.⁴ The series of valuable studies in ruthenium, the least known metal of the group, and the indispensable bibliography, are fruits of thirty-five years of devoted application to the study of this series of metals.

The bibliography takes due notice of those indispensable aids to the investigator and student of the platinum metals, the annual reports of "Mineral Resources" by the United States Geological Survey, and those comprised in the year book entitled "Mineral Industry." In the former this subject has been successively treated since 1904, by David T. Day, F. W. Horton, Joseph Struthers, Waldemar Lindgren, and for several years past by Dr. J. W. Hill, who has contributed a particularly able study of the platinum deposits of the world to the *Engineering and Mining Journal* for 1917, Vol. 103, p. 1145. In *Mineral Industry*, from 1892, the reports have been furnished, in succession, by Charles Bullman, Henry Louis, Joseph Struthers, L. Tovey, Frederick W. Horton, F. Lynwood Garrison, and in the years 1916-1919 by the writer of the present notice, who also contributed the platinum data for the Eleventh Census (of 1890) with photographs he took while studying the deposits and has published in the *Bulletin of the Pan-American Union* for November, 1917, a paper entitled "Platinum: with especial reference to Latin America" (23 pp., with many illustrations), as well as another paper, in a later issue of the *Bulletin*, on the palladium deposits of Brazil.

A work of this kind makes a special appeal at the present time, when the manifold uses to

which platinum and the platinum metals can be put, are better known than ever before. The intense demand for the metal in the munition factories, because of its superior resistance to the action of acids, brought it to the notice of many who had barely heard of it in times past. Still the fact that before the war some 500,000 ounces of it had already found employment for catalyzing purposes, as much more for electrical apparatus, at least 1,000,000 ounces for dental work, and another 1,000,000 ounces for chemical vessels, retorts, crucibles, etc., shows that its peculiar merits were recognized by many. Of late years it had become a favorite metal for gem-setting, more especially for diamond-setting, because of the refined beauty of its silvery hue, and its great durability. Another, analogous use, was in the finer articles of jewelry, wherein more truly artistic effects could be secured by its employment than by that of gold.

The gradual increase in value due to these circumstances had already been quite marked before the war. In January, 1909, an ounce of platinum was worth \$24.10, only a few dollars more than an ounce of gold (\$20.67) but by July, 1914, just before the outbreak of the World War its price had risen to \$43.50; indeed it had commanded as much as \$46.25 for a brief time in 1911. However, as a result of the special war demand, and of the interruption of the supply from Russia, which had produced annually 90 per cent. of the world's platinum, prices began to soar, until by the early part of 1918 the government set an official limit of \$105 an ounce, and took at that figure the entire imports of the metal as well as part of the stocks on hand.

The end of the war, and the removal of this price-restriction, coupled with the sale of the stock accumulated by the government, brought about, for a very brief time, a trifling reaction to be soon followed by a resumption of the upward movement, so that at present, in February, 1920, as much as \$165 has been paid for an ounce of platinum, making it worth considerably more than eight times as much as gold. Many coin collectors are familiar with the Russian platinum coins issued be-

⁴ From a personal communication of Professor Howe's dated February 17, 1920.

tween 1828 and 1845, during which period 1,373,091 three-ruble pieces were minted, besides a few six-ruble and 12-ruble pieces. The three-ruble piece was worth \$2.33 and it weighed 10.3 grams, for platinum was then worth but \$7 an ounce; with platinum at \$165 an ounce, the intrinsic value of such a coin to-day would be more than \$54 of our money.

In view of the fact that the platinum output continues to be much smaller than some years ago, while the increasing demand for jewelry purposes offsets the falling off in the demand for munitions processes, it appears likely that the price will continue to go up, at least until the full resumption of platinum mining in Russia serves as a check. The search for the discovery of new sources is being diligently prosecuted, and Colombia seems the most hopeful of all the regions except Russia.

The newspaper notoriety given to platinum, because of the great legitimate demand for it and the consequent astonishing rise in value, before long excited the cupidity of dishonest persons. As a consequence of this there have been numerous thefts of the material. In several cases, valuable specimens of platinum have been purloined from museum collections, and chemical utensils made of platinum have been stolen from a number of chemical laboratories. Indeed, in one instance an entire university laboratory was burned down to hide the theft of platinum.

As to future prospects, an extensive development of the platinum resources in the republic of Colombia is in active progress. Possibly Canada may contribute somewhat improved methods of refining the copper-nickel ores, and similar ores mined elsewhere may also furnish considerable platinum. However, the most encouraging sign is the reported determination of Soviet Russia to issue platinum certificates, that is to say, certificates secured by the platinum stock that has been accumulated in Russia and has not fallen into the hands of the Allies, or will be needed now and in the future.

GEORGE F. KUNZ

SEXUALITY IN MUCORS. II

"NEUTRAL" RACES

As regards the intensity of sexual reaction, however, a gradation is clearly shown. A more detailed view of the complete table showing the combinations only where reactions might be expected, can be seen more clearly (Table I.). The higher grades of A and B predominate at the upper left-hand corner while at the opposite corner are only O's with C's and D's between. There is therefore in this species, varying degrees of sexual activity from the strongest down through the weakest to so-called "neutrals" which fail to show any sexual reaction under the conditions of the experiment. The word "neutral" is obviously only a relative term since, if the two races Nos. 811 and 367 had not been used as testers, No. 370 would have been classed as a neutral. It is possible that the 3 so-called neutrals would have taken part in zygospore formation if strong enough testers of the proper sex had been available or if more favorable environmental factors had been present. The fewer the number of tests made and the more unfavorable the environmental conditions, the larger will be the number of races listed as neutral from any collection of races of a given species.

A change in sexual activity tending toward neutrality may be brought about by environmental factors. Thus we have obtained a temporarily neutral condition in both the plus and minus races of *Mucor Mucedo* by growing them for several non-sexual generations at unfavorably high temperatures. The sexual activity can be regained in a few generations by cultivating them at low temperatures. In the same species the spores in a germ sporangium frequently are neutral in reaction but later become sexually active. One of my most active forms (*Mucor* V) has become much reduced in sexual activity since its opposite races were first separated some sixteen years ago. A similar reduction in sexual vigor resulting in neutrality has been reported in a number of species by other investigators. In *Phycomyces* the plus and minus spores in a germ sporan-