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Professors ASA GRAY, and WOLCOTT GIBBS,
OF CAMBRIDGE,

AND

Professors S. W. JOHNSON, GEO. J. BRUSH, and
H. A. NEWTON, OF NEW HAVEN.

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dic acid, 10 grains of molybdic acid thus prepared were mixed with 15 grs. of cyanid of potassium placed in a porcelain crucible, which porcelain crucible with the lid luted was placed in another crucible, then surrounded by powdered animal charcoal and exposed to a white heat for 12 minutes. At that time the crucibles were removed, allowed to cool, and examined; the porcelain crucible was found lined with a brilliant silver-white metal of a sp. gr. 8·5, which was not attacked by chlorhydric acid, but violently attacked by nitric acid with evolution of hyponitric acid fumes; it reduced oxyd of mercury and oxyd of silver when triturated with these substances. An analysis of this showed it to consist of—

Molybdenum,	98·7
Impurities SiO_2, C,	1·3
	100·0

By the same process, using sesquioxyd of chromium in place of molybdic acid, chromium was obtained possessing a sp. gr. 6·. The best results were procured by using a reducing mixture of cyanid of potassium and animal charcoal.

II. MINERALOGY AND GEOLOGY.

1. *A System of Mineralogy: Descriptive Mineralogy comprising the most recent discoveries;* by JAMES DWIGHT DANA, Silliman Professor of Geology and Mineralogy in Yale College, etc., aided by GEORGE JARVIS BRUSH, Professor of Mineralogy and Metallurgy in the Sheffield Scientific School of Yale College. Fifth edition, rewritten and illustrated with upward of six hundred wood cuts. xlviii and 828 pp., 8vo. New York, 1868. (John Wiley & Son, No. 2, Clinton Place. $10 in cloth.)—Mineralogy is a growing science, as is very evident from the size of the volume before us. Instead of the 530 pages of the last edition of the work, Descriptive Mineralogy here covers 825 pages, exclusive of an introductory chapter of near 40 pages. Moreover the page of the letter press is large enough nearly for a quarto (4½ inches across) exceeding in area by a fifth that of the last edition. As three-fourths of the volume is in small type and the analyses and chemical formulæ and other parts are presented with the greatest possible condensation and brevity, the covers contain material enough to make four or five ordinary octavo volumes.

The author opens his preface with several reasons for the large size of the work, alluding first to the 14 years that have elapsed since the last edition appeared, and the changes and progress of the science in that time; then to the introduction in this edition of some new features—namely, systematic and detailed descriptions of *varieties* of species; a *historical* synonymy in place of a mere list of names; chemical formulas on the *new system* of chemistry in addition to those on the old; fuller as well as completely revised blowpipe characters;—to which might be added 250 more wood cuts.

In the historical synonymy, as the preface states, "the first author

and first place of publication of a species, and of each name it has borne, and of the names of all its varieties, are stated in chronological order, with the dates of all publications cited; and besides, remarks are added in the text when the subject is one of special interest. The author further observes that "the facts and conclusions have been derived in almost all cases from the study of the original works themselves, and the treatise has thereby become to some extent, a work on ancient as well as modern mineralogy." The historical inquiries here alluded to "were prompted by a desire to place the nomenclature of mineralogy on a permanent basis; they were incident to a search after a reason for choosing one name rather than another from among the number that stand as claimants," in order thereby to escape the increasing confusion in names by applying "the methods which has proved so successful in the other natural sciences, viz: the recognition, under proper restrictions, of the law of priority."

The classification of the species is in system similar to that of the preceding edition, the progress of chemistry and the kindred species not only requiring, in the author's view, no modification of its general plan, but instead giving it new support. Yet in the minor details, the changes made are numerous and important.

The Introductory Chapter supplies such tables and simple information on chemistry and crystallography as were needed to make the volume convenient of use, even for those not familiar with these sciences. Tables of atomic weights are here included, both according to the new and old system; and also multiples of the oxygen percentages by the nine digits, to facilitate calculations. The volume is thereby complete in itself independently of the first part, which we understand will be early issued as a separate work. The introduction contains also sections on nomenclature in which the history and true principles of mineralogical nomenclature are discussed at length; a Bibliography giving a long catalogue of books consulted, and showing that the work is an authority on historical questions connected with the science; and an annotated index to the useful metals and metallic ores.

The title page, as above cited, bears the name of Prof. Brush, and the author acknowledges his important aid as follows in the preface. "In the preparation of this volume, the author owes much to the coöperation of his friend, Prof. George J. Brush. Prof. Brush has had sole charge of the blowpipe department. The pyrognostic characters have been entirely rewritten by him; and while he has had the works of Plattner and von Kobell always at hand, he has, for much the larger part of the species, made personal trials of the reactions before writing them out; so that, although the facts stated are not generally new, they still are mostly from his own observations. His skill also in analytical chemistry, and his thorough knowledge of minerals, have enabled him to remove doubts, afford aid and advice, and furnish new facts on various points throughout the progress of the work. Prof. Brush has also given the proofs, while the work was in the press, the benefit of his revision."

Speaking of the enlargement of the work and the changes it had undergone, Prof. Dana observes that "not a page and scarcely a paragraph of the preceding edition remains unaltered, and full five-sixths of the volume have been printed from *manuscript* copy;" and he adds that, "notwithstanding the impaired state of his health, this manuscript—the paragraphs on the pyrognostic characters excepted—was almost solely in his own hand writing, or in that of a copyist from it, "neither the consultation of original authorities, the drawing of conclusions, nor the putting of the results on paper, having been delegated to another."

The preface closes with the announcement (as a sequel to the statement that the work had been posted up, as far as was possible, to the date of publication) that "a series of Supplements may be looked for, from time to time, in the American Journal of Science." It is to be hoped that the publishers will have an edition of these Supplements as they are issued struck off, that they may be accessible to all who have copies of the mineralogy.

2. *The Mining and Metallurgy of Gold and Silver;* by J. Arthur Phillips, Mining Engineer. London, E. & J. N. Spon, 48 Charing Cross, 1867. 8vo, pp. 532.—This treatise of Mr. Phillips supplies a want long felt in the literature of the mining and metallurgy of the precious metals. The author has enjoyed unusual advantages for the task he has taken in hand, and has produced a volume which contains a great amount of valuable information, and exhibits fairly the present state of knowledge, both theoretical and practical, relating to the subjects discussed. He first describes the principal gold and silver-producing districts, accompanied by such statistical information as could be obtained respecting their yield and importance; and follows this with an account of the methods employed for extracting ores, and lastly with a description of the apparatus and methods made use of for their mechanical and metallurgical treatment.

The author states "that recent observations and experience appear to lead to three important conclusions. First, that the most productive gold bearing rocks are by no means exclusively confined to the Silurian period; secondly, that aqueous agencies have been, and still are, actively at work in the formation of mineral deposits; and, thirdly, that gold ledges are not more liable than ordinary metalliferous veins to become impoverished in depth."

The account of gold mining embraces several important topics not before discussed in a competent manner in any systematic work accessible to English readers. This is especially true of the peculiarly American system of hydraulic washing, now of cardinal importance in California and Australia, and likely to remain for generations a steady industry, proportioned in importance to the great extent of the deep-lying placers. The account of vein mining is accompanied by a full description of the best approved methods adopted in the most prosperous mines both in California, Brazil and Australia, accompanied with detailed drawings and plates. A particularly interesting account of the Morro Velho mines (commonly called San Juan d'El Rey) and of the methods of

treatment of its ores is given in the chapters on South America (Vth and Xth chapters). These mines are of special metallurgical interest as well from the peculiar character and great amount of the ore operated on, as for the methods of extracting the gold adopted, the carefulness of the management being such that the whole data needed to present a complete exhibit of all the operations of mining and metallurgy are collated and exhibited in the most precise form.*

The ore treated at *Morro Velho* mines is chiefly a mixture of magnetic, arsenical and common iron pyrites, freely disseminated in a quartzose gangue. Calcite, dolomite, brown spar, and, very rarely, copper pyrites are present in the vein. The composition of what is called "pure ore" may be taken at about 43 per cent silica, and 57 per cent pyritous matter. Of these minerals, arsenical pyrites is usually the most auriferous, although it does not occur in large quantities. Pure specimens of this substance afford, by assay, from four to six ounces of gold per ton, and wherever crystals of this mineral make their appearance the yield of the precious metal is large. Cubical pyrites is of more frequent occurrence, but is far less rich in gold, yielding at best but about an ounce and a half of gold per ton by assay. Magnetic pyrites, the most abundant sulphid, is very slightly auriferous, pure specimens yielding but about four dwt. per ton. Branches of clay slate are often found in the principal veins, and this rock, under such circumstances, commonly affords, by assay, from five to seven and a half dwt. of gold per ton. Quartz without any admixture of sulphids has never been found to be auriferous in these veins, and it is a remarkable fact, stated on the authority of Mr. Hockin, managing director of the Company, that the smallest speck of gold is rarely seen, previous to concentration, in any of the ores from this mine. In some parts the vein is cavernous, and less close in its texture than in others; but where drusy cavities are frequent, the yield of gold diminishes; the most productive matrix for gold is a compact mixture of quartz and pyrites with varying quantities of slate. The great metalliferous deposit called the Cachoeira, Bahu, and Quebra Panella, is one continuous, very irregular vein, varying in width from seven to seventy feet, and at one point reaching one hundred feet. The average thickness at the present depth 176 fathoms (1056 feet) perpendicular on the Cachoeira and 165 fathoms on the Bahu, is 19 feet; the sloping space extends over 807 square fathoms. The enclosing rock is a clay slate of tolerably uniform texture. The mineral is brought to the surface on tram ways placed on the slope of the vein, about 45°, in tubs ("kibbles") containing about a ton each. The ore is freed by hand from unproductive slate and is then reduced to fine powder by wet stamping. All the machinery is moved by water power. The pulverised ore, issuing from the stamp coffers through finely perforated copper grates, passes over bullock skins and then lower down over woolen cloths (blan-

* The last accounts which have reached us are information of the almost total destruction of these remarkable mines by a disastrous fire, rendering active operations impossible for a long time to come.

kets) placed on inclined tables. The skins are washed out in vats every hour and the blankets at longer intervals. No mercury is used in the batteries under the stamps, amalgamation being restricted to the concentrated sands from the skins, &c., which are subsequently treated in barrels.

The following table shows the quantity of rock raised and stamped, the amounts of gold produced, and annual net profits made since 1848. This company employs upward of 2,400 hands, from 120 to 130 of whom are Europeans. The nnmber of stampheads at work, is 135 for reducing the ore in the first instance and 56 for restamping residual sand with quartz and slate; arrastres are also used for repulverising the residual sand with good effect.

Years.	1849.	1850.	1851.	1852.	1853.	1854.	1855.	1856.	1857.
Stone raised, tons,	67,336	67,106	79,810	82,642	85,698	86,048	87,297	89,877	86,407
Stone & ore stamped, tons,	69,004	64,313	81,629	81,236	86,866	86,433	86,848	87,424	84,325
Gold produced, lbs. Troy,	2,583	2,517	3,057	3,326	3,623	3,464	3,325	2,992	2,539
Net profits, £ stg.	38,136	35,880	51,586	55,391	49,273	44,740	34,466	23,233	787

Years.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.
Stone raised, tons,	88,901	88,968	91,361	96,612	90,896	84,758	65,435	78,880
Stone & ore stamp'd, tons,	87,270	82,880	74,528	71,902	67,508	65,697	62,147	59,607
Gold produced, lbs. Troy,	2,733	3,294	3,974	5,051	5,182	4,713	2,852	4,153
Net profit, £ stg.	8,545	38,058	60,460	96,769	87,531	63,285	*	30,438

* Loss, £14,629.

This amount of work was done by 135 stamps striking an average of 55·84 blows per minute (the stamp when new weighing with the lifters, &c., 640 lbs.), for 356·27 days per year, crushing 167·65 tons of stuff per day, or 2,683 lbs. per day per head.

The total value of the precious metals extracted to close of 1865 has been £2,902,480

The total quantity of mineral raised ..... 1,769,050 tons

The average yield of ore ..... 4·333 oitavas per ton, or as nearly as possible, half an ounce Troy, value about 32*s.* 6*d.** The ores have on the whole been poor, but the yield tolerably uniform. If the labor had been paid for at California rates of wages the result would have been disastrous. The use of water power and cheap native labor have made the adventure extremely satisfactory. The yield for 1866 exceeded £100,000 net profit.

The details of the processes developed at these extensive mines and mills are of the greatest practical value to all persons engaged in like operations, but are out of place here. A few general results alone must suffice.

Of 1000 parts of ore stamped at Morro Velho, the relative proportions of slimes and fine sand are found to be thus:

Passing a sieve of 10,000 holes per square inch, 88 to 95 per cent

Not passing a sieve of 2,500 holes, " " 0·28 " 0·50 per cent

The stamping is thus seen to be extremely fine.

The auriferous material issuing from the stamping mills is associated with gold in three different states, viz:

* An oitava is 2 dwt. 7·343 grains Troy, or 8·67425 oitavas = 1 oz. Troy.

1st. Free gold capable of concentration by washing.
2nd. Free gold in a lamellar form liable to be carried off by suspension in water.
3d. Mechanically combined, gold enclosed in particles of pyrites, but capable of being liberated by further grinding.

The system of concentration adopted at Morro Velho mines, is extremely simple, cheap and economical, consisting of a series of inclined tables or boards 18 inches in width, falling about one inch in a foot, and covered with bullock skins tanned with the hair on, for about 30 feet and followed by other inclines covered by baize or blankets. These inclined sluices are called *strakes.* The following table gives many important details relating to this system as employed at Morro Velho mines:—

Name of Stamps.	No. of Heads.	No. of strakes	Length of strakes	Width of strakes.	Area of strakes, squ're ft.	Squ're ft per ton of ore stamp'd.	Tons ore passing in 24 hours.	No. of skins on strakes	No. of baizes on strakes	Quant'y of head sands pr day.
			ft. in.	ft. in.						cub. ft.
Lyon, ...	30	36	31 10	1 6	1,719	46·83	36·73	288	210	20·00
Cotesw'rth	12	13	30 6	1 4½	545	32·21	16·92	104	65	5·50
Susannah,	9	8	27 0	1 6	324	29·61	10·94	48	48	2·75
Herring,--	24	29	35 0	1 6	1,232	35·64	34·56	228	174	18·00
Powles, --	36	42	33 7	1 3½	1,821	27·55	66·10	336	252	28·47
Addison, -	24	30	31 10	1 5	1,352	38·04	35·54	240	170	17·00
	135	158			6,993		200·79	1244	910	91·72

By this system, about 67 per cent of the gold originally present in the ore is obtained in a highly concentrated state, whilst 33 per cent which escapes is in two distinct forms: 1st, light free gold; 2d, gold enclosed in coarser particles of pyrites.

The first which has been laminated to a great extent by the action of the stamps, exposes too great an amount of surface in proportion to its weight to be saved by any known method and floats off with the slimes. Its quantity is believed to be about 10 per cent of the original amount of gold in the ore. The second is fine gold entangled in pyrites the larger part of which is saved by regrinding and by a subsequent system of *strakes.*

The system of amalgamation of the concentrated ores at Morro Velho is described in detail with careful drawings. It depends essentially on the use of revolving barrels containing 16 cubic feet, or one and a half tons of wet sand, with 60 lbs. mercury and a sufficient quantity of clean water to give the necessary degree of fluidity to enable the globlules of quicksilver formed to become properly incorporated without causing them to become sufficiently mobile to admit of the settling of the mercury and amalgam at the bottom. The barrels are then caused to revolve from 30 to 36 hours, when their contents are discharged into a washing apparatus to separate the slimes from the quicksilver and amalgam, a process which cannot be well explained without a diagram. The loss of mercury in this process on an average of the last three years has been 2·923 oz. per ton of ore stamped. The average cost of extracting the mineral from the mine and its reduction, including every expense of general management, etc., for the last ten years has been 25*s.* per

ton; out of which the cost of stamping alone has been 2*s.* 10*d.* per ton. The average value of the ores stamped is determined by assays of samples of pulp from the batteries; this last is on the authority of Mr. Attwood to the writer, and is not quoted from our author.

The account of the Australian gold mines contains much valuable information not elsewhere accessible in a compact or connected form, but our space limits our extracts to the following interesting tabular exhibit of the approximate yield, and in lbs. Troy of the principal gold-producing countries at the commencement of the present century, and for the years 1850, 1860 and 1865. The return for California and the neighboring States and territories for 1865, is probably somewhat under the truth, since it is exceedingly difficult to obtain the precise yields of Idaho, Montana, Colorado and some other outlying districts. After each absolute sum is given, its relative weight, in comparison with the grand total, produced throughout the world:—

Table showing approximate production of the principal gold fields of the world.

	1800.		1850.		1860.		1865.	
	lbs. troy.	Ratio per cent.	lbs. troy	Ratio per ct.	lbs. troy.	Ratio per ct.	lbs. troy.	Ratio per ct.
Russian Empire,	1,440	2·7	65.600	19·0	66,000	11.3	69,500	12·4
Austrian Empire, and rest of Europe,	3,500	6·5	5,600	1·6	5,500	1·0	5,500	1·0
			100	----	350	----	375	----
Southern Asia,	10,000	18·5	25,000	7·3	25,300	4·3	25,000	4·5
Africa,	600	1·2	4,000	1·1	4,000	0·7	4,000	0·7
Chilé,	7,500	13·8						
Bolivia,	1,600	3·0						
Peru,	2,400	4·4						
New Granada,	12,600	23·4 *	34,000	9·9	34,000	6·9	34,000	6·1
Brazil,	10,000	18·5						
Mexico,	4,300	8·0						
California & neighboring States and Territories,	------	-----	208,000	60·2	187,000	31·9	210,000	37·6
Rest of United St'tes,	------	-----	2,950	0·9	1,020	0·2	140	
Nova Scotia,	------	-----	------	----	------	----	2,072	0·4
British Columbia,	------	-----	------	----	20,000	3·4	11,600	2·1
Australia,	------	-----	------	----	217,500	37 0	156,000	27·9
New Zealand,	------	-----	------	----	25,000	4·3	41,400	7·4
	53,940	100	345,250	100	585,000	100	559,587	100

The portion of Mr. Phillips's book devoted to silver offers probably more matter which is new to English readers than the part we have already considered, although as regards the methods of metallurgical treatment its aim is simply to present a fair exhibition of the existing state of the arts therewith connected. The chapters devoted to the silver regions of Nevada and the new mechanical methods of treatment of ores which the experiences of the mines on the Comstock lode have evoked, will be read by all interested in such subjects, with satisfaction and instruction. We must

* The yields of these several States varies considerably from year to year, but the aggregate produce is believed to remain tolerably constant.

reserve for another notice what we have to say on this branch of the subject.

The following table offers an interesting comparison with that already quoted respecting the product of gold. It gives the approximate yield in pounds troy, of the principal silver-producing countries of the world, at the commencement of the present century, and for the years 1850 and 1865. In cases where the returns for the year indicated could not be obtained, the produce for the nearest year for which they could be obtained has been substituted. The quoted produce of the various European countries and of the United States of America may be taken in each instance as a sufficient approximation, but the figures relating to Mexico, Central America and South America, must be regarded as estimates only. A large proportion of the precious metals produced in these countries is annually exported without passing through the hands of government officers, and consequently the most reliable information that can be procured is but little to be depended on. No systematic investigations have been made in Mexico by competent persons, since the date of the writings of Duport and Chevalier.

Table showing the approximate yield of the principal silver-producing countries.

	1800.		1850.		1865.	
	lbs. troy,	Ratio per ct.	lbs. troy.	Ratio per ct,	lbs. troy.	Ratio per ct.
Russian Empire,	58,150	2·5	60,000	2·1	58,000	1·5
Scandinavia,			20,400	0·7	15,000	0·4
Great Britain,			48,500	1·7	60,500	1·5
Hartz,			31,500	1·1	28,000	0·6
Prussia,			21,200	0·7	68,000	1·7
Saxony,			63,600	2·2	80,000	2·0
Other German States,	141,000	6·0	2,500	0·1	2,500	
Austria,			87,000	3·1	92,000	2·2
France,			5,000	0·2	18,000	0·4
Italy,			------	---	* 25,000	0·6
Spain,			125,000	4·4	110,000	2·8
Australia, New Zealand, British Columbia, Nova Scotia,	--------	----	10,000	0·4	9,500	0·2
Chili,	18,300	0·8	238,000	8·4	299,000	7·3
Bolivia,	271,300	11·6	130,000	4·6	136,000	3·3
Peru,	401,850	17·2	303,150	10·7	299,000	7·4
New Granada,	5,000	0·2	13,000	0·5	15,000	0·4
Brazil,	1,200	---	675	---	1,500	0·4
Mexico,	1,440,500	61·7	1,650,000	58·4	1,700,000	42·3
United States,	--------	----	17,400	0·7	1,000,000	25·0
Total,	2.337,300	100	2,827,425	100	4,017,000	100

We cannot close this notice without thanking Mr. Phillips for the very able manner in which he has performed the task he has undertaken, and for bringing together in so readable and well designed a form, so much information of permanent value upon the subjects of which he treats. The book is beautifully printed and illustrated, the only regret being that these very excellencies should place it beyond the reach of a large class of readers. B. S.

* Obtained from the island of Sardinia, where it is found associated with galena.

3. *New Geological Maps and Chart.*—Prof. JAMES HALL is engaged upon a geological Map of the United States, which he informs us, will be essentially a continuation of the large map of the Canadian Survey, soon to be published. The Northern States will in fact be printed from the same plates, and the portions south and west will be continued by Prof. Hall on the same scale.

We understand also that Prof. O. C. Marsh, of Yale College, has in preparation a pocket geological map of the United States, designed for general use among students of geology. This map is intended to be a companion to Dana's Manual of Geology, and it will be issued by the same publishers.

A Geological Atlas of North America is also in course of preparation under the direction of Prof. C. H. Hitchcock, of New York. It will contain a series of maps of the different States and Territories, as well as of the British Provinces, and will soon be published in New York.

Prof. A. Winchell, of Ann Arbor, has, moreover, in progress a Geological Chart, designed to illustrate the more prominent facts of geology, which will doubtless prove of great value to teachers and students of the science.

4. *New borate from Mine Hill, Franklin, Sussex Co., New Jersey—Sussexite;* by G. J. BRUSH.—A new asbestiform borate has been found at Franklin, which I propose to describe in the next number of this Journal. The specimens were obtained at the locality by Mr. Wm. G. Mixter, of the Sheffield Laboratory.

III. BOTANY AND ZOOLOGY.

1. *The Variation of Animals and Plants under Domestication;* by CHARLES DARWIN, M.A., F.R.S., &c. American edition. 2 vols. 1868. (Orange Judd & Co., New York).—In his "Origin of Species" the author promised to give us some of the details of the changes produced in animals and plants by Man's selection, and this promise is redeemed in the work before us. The first volume is devoted to a consideration of breeds and varieties of various domestic animals and plants; the second relates to the variability of species in nature, the inheritance, crossing, hybridism, methodical selection, &c., the whole concluding with certain hypotheses and speculations.

The first volume will perhaps be most prized by naturalists, as it treats mostly of unquestioned facts concerning varieties, their characteristics, history, &c., but so arranged that they continually suggest and support the author's theory.

The second volume, it seems to us, will be most valued by practical breeders of animals and cultivators of plants, men whose professions have made them familiar with the class of facts recorded in the first. We will not at this time consider the author's well known views respecting species, and their origin, as the hypotheses and speculations referred to can hardly be discussed, or even explained, within the narrow limits of the present notice. As