STATISTICAL SUPPLEMENT

OF THE

ENGINEERING AND MINING JOURNAL.

THE MINERAL INDUSTRY,

ITS

STATISTICS, TECHNOLOGY AND TRADE,

IN THE

UNITED STATES AND OTHER COUNTRIES

TO THE END OF

1896.

VOL. V.

EDITED BY

RICHARD P. ROTHWELL,

Editor of the Engineering and Mining Journal; Ex-President American Institute of Mining Engineers; Member American Society of Civil Engineers; Fellow Royal Statistical Society, London, Etc., Etc., Etc.

NEW YORK AND LONDON:

THE SCIENTIFIC PUBLISHING COMPANY.

1897.

R

PREFACE.

In presenting the fifth volume of this work we gratefully acknowledge the enthusiastic reception which the previous volumes have met with and the many testimonials of warm approval and commendation which have been accorded to them. The following extracts from the preface to Volume I. outline the objects in view when this stupendous undertaking was inaugurated, and the pages of the volumes themselves testify how far these aims have already been attained:

"This volume is a result of the development of the annual statistical numbers of the *Engineering and Mining Journal*, and owes its existence to the appreciation with which these statistics have been received by business men, by experts, and by others interested in the mineral industry throughout the world.

"The modern newspaper has made promptness in furnishing information not only familiar, but indispensable to the man of affairs, and accurate and timely statistics have now become absolutely necessary for the intelligent direction of industry, trade, and legislation. The collection of such statistics in an industry which extends over the face of the entire globe is, however, a work so vast and difficult that it has hitherto been considered impossible except through the unlimited resources of governments; and as the machinery of government is not adapted to the rapid attainment of results, the statistics of the mineral industry have been so tardily collected and published in all countries that their value has been greatly impaired. . . . For many years the *Engineering and Mining Journal*, as the leading representative of this great industry, has accumulated vast stores of statistical information relating to it and has greatly improved the machinery for the collection of these statistics. . . .

"The universal appreciation of the work done by the *Engineering and Mining Journal* called for its extension, and consequently in this initial volume there are given, for the first time, the statistics of substantially all the minerals and metals produced in the United States and in many other countries for the full year 1892, and often from the earliest times. This series of annual volumes it is intended shall, in due time, cover the entire mineral industry of the world, giving its statistics, its technology, and its trade, each succeeding volume not repeating

the data given in previous issues, but supplementing them, and carrying forward the current history of the industry almost to the day of publication. Unaided by any governmental powers to enforce the making of returns, we have relied for success solely upon personal courtesy and confidence and upon the intelligent appreciation of the value of the work to the industry at large, and this great volume is the monument we have erected to the courtesy of those whose prompt and willing co-operation has alone rendered its success possible. Long experience in this kind of work has fully demonstrated the fact that men are in general more willing to give important and correct information to the private individual who can be held responsible for its proper use than to the more or less impersonal 'government.' It is indeed extremely rare that any producer neglects or refuses to give full, truthful, and satisfactory replies to our requests for information. . . .

"Accuracy should always be the first care of the statistician, but it is scarcely less important to the business man that the information should be promptly furnished. Belated statistics are ancient history, of little practical value in the active affairs of an industry, or as a guide for legislation affecting it. . . . Subjects which are uppermost in the business world naturally demand the greatest attention in this industrial work. . . .

"Much attention has been devoted to the subject of cost of production. The itemization of cost is the first essential step in securing economy in producing any article, and the history of every country and of every industry has shown that prosperity, whether national, industrial, or individual, is, in a general way, inversely proportional to the cost of supplying the rest of the world with what one produces. The great economies which command the markets for products are due, not to reductions in wages, but to increased knowledge and intelligence, and are accompanied by higher remuneration and a betterment of the condition of those engaged in the industry. . . .

"It is the object of the *Engineering and Mining Journal* to give in detail, and of this supplemental volume of the *Journal* to summarize, the facts which show how such results are accomplished; to photograph, as it were, from time to time, the condition of the several departments of the mineral industry in various parts of the world, placing within the reach of all the information that intelligence can apply to the reduction of cost in producing and marketing the useful minerals and metals and in promoting the welfare of those engaged in this industry. In every country this information will enable those who legislate for and those who administer this industry to do so with an intelligent appreciation of the conditions affecting it in its every department, and, widely disseminated, will promote the national prosperity.

"It is with the very greatest regret that we have been obliged in this work to use other than the metric system of weights and measures, which are now legalized in nearly every civilized country and should be universally adopted. The necessity of conforming to custom and popular prejudice in a work so expensive as this explains the use here of that nightmare of weights and measures which, as a relic of barbarism, survives and is used in all English-speaking countries as 'the English system.' We have, however, where possible, reduced the number of varieties of measures as used in the publications of the United States Govern-

ment. All foreign statistics are given in this work in metric weights, and the United States products are given in the metric system as well as in the customary weights. . . .

"The advertising pages of this book will well repay the careful perusal and study of every reader who wishes to be well informed upon the present condition of the mineral industry. They give an admirable and practical insight into the present state of the mining and metallurgical arts, for in them nearly every manufacturer or dealer of note in this country advertises the machines, appliances, and processes which are now in vogue, or which it is sought to introduce, while the names and qualifications of the most eminent members of the engineering professions indicate the importance and directions of modern mining and metallurgy. These advertising pages are no less important to those who desire a clear knowledge of the means by which this country has come to be far the most important producer of minerals and metals, than to him who wishes to know where to get that full and reliable information concerning the values of properties, machinery, processes, and products which should precede the investment of capital."

Had any doubt existed as to the utility and even absolute need of such a work as this, it would have been quickly dispelled by the prompt and enthusiastic recognition of its value and the unstinted and unanimous words of praise which welcomed in every part of the world the first volume of THE MINERAL INDUSTRY, ITS STATISTICS, TECHNOLOGY AND TRADE. It is not too much to say that probably no other technical book was ever so universally praised, as is shown in the brief extracts given on another page from some of the thousands of letters received, and doubtless never before was a technical book sold in so large numbers within so short a time. These results are extremely gratifying not alone from a business standpoint, but chiefly because they constitute a flattering evidence of the value of the work as a whole, and of the ability of the many specialists who contributed to its pages.

This success has increased the obligation we are under to the great captains of the industry throughout the world who have, with uniform courtesy and unlimited confidence, furnished the data which alone have permitted the compilation and prompt publication of these valuable statistical volumes.

From the very first the amount of useful material grew so rapidly with the plans for the work that it quickly became evident that the book must become larger and more costly than anticipated. The original object has, however, been kept in view of placing it within the reach of all.

The importance of collecting in this volume, as far as possible, the existing statistics of production, imports, exports, and consumption of the various minerals and metals in every country, and the large space devoted to this and to the description of the best existing practice in the chief departments of metallurgy and chemical technology, have crowded over into the current issues of the *Engineering and Mining Journal* and into succeeding volumes of this book much valuable information, and retarded the issue of this book beyond the date at which it is expected future volumes will appear.

The data collected in the five volumes present already a good foundation on which to commence an intelligent study of the industry and of the conditions

which affect it, and we earnestly invite the co-operation in this work of all who possess further facts which may be of use in it.

This introduction may be appropriately ended with the following closing paragraph of the preface to the first volume:

"No one can appreciate more fully than the statistician himself the limits and shortcomings which are inseparable from all statistical work of this character. As further facts come to light and a higher degree of accuracy rewards our continuous efforts to render these volumes trustworthy, corrections will be made in the statistics should errors of importance be found. He is but a dishonest statistician who retains known important erroneous statements in order that the public, in its ignorance, may believe, from the absence of corrections, that his figures are accurate. Readers of this book are therefore earnestly requested to notify its editor of any errors or omissions which may be found in it, in order that corrections may be made in subsequent volumes, and suggestions which may render future volumes more valuable will be gratefully received."

RICHARD P. ROTHWELL.

GEMS AND PRECIOUS STONES.

THE mining of gems and precious stones has not yet become an important industry in the United States, the production in 1896 amounting to only about $200,000 in value. The more part of this was in sapphire and ruby from Montana, and turquoise from New Mexico. In the former State several claims in the vicinity of Phillipsburg were worked in 1896, and a considerable output is reported from them. Sapphire and ruby mining is also being carried on in North Carolina, mention of which will be found under the caption "Sapphire."

In New Mexico the American Turquoise Company has been exploiting mines 15 miles south of Santa Fé, and some fine specimens of turquoise are reported to have been found at Hatchita in the southern part of Grant County, while the mines in the Burro Mountains, a short distance south of Silver City, have been exploited somewhat extensively.

AMBER.

THE production of amber in Germany in 1895 was about 440 tons, or nearly 100 tons more than in the previous year. By far the larger part of this is put out by the two mines of Palmnicken and Kraxtepellen, belonging to the firm of Stantien & Becker, while the smaller part is obtained by dredging and searching the shore of the Baltic Sea. The industry employs about 1200 persons.

The occurrence and production of amber in Burma is described in the article on that country in a subsequent part of this book.

DIAMONDS.

DIAMONDS are obtained from Kimberley, Jagersfontein, and the Bloemhof district, in South Africa; from Brazil, and from India. By far the more part come from Kimberley, where the mines are owned by the De Beers Consolidated Company, which controls prices by regulating its output to the demand of the market.

The production of Jagersfontein, which is situated in the Orange Free State about 80 miles from Kimberley, in 1896 was 218,886 carats, valued at £382,780.

In the Bloemhof district, South African Republic, diamonds are obtained from the gravel of the Vaal River. The production in 1895 was 2469 carats, valued at £4938. The production of diamonds in Cape Colony, practically the whole being from Kimberley, was 2,507,408 carats, valued at £3,013,578, in 1894, and 3,622,344 carats, valued at £4,775,016, in 1895.

De Beers Consolidated Mines, Limited, continues to be one of the most remarkable enterprises in the world. The dividend paid for the year ending June 30,

1896, was at the rate of 40% per annum, as compared with 25% per annum di buted for 1894–5, a balance of £329,357 being carried forward to the credi 1896–7. The diamonds sold in the year ending June 30, 1896, realized £3,165, while the working expenses were £1,452,528. The working expenses inclu £60,225 for depreciation of machinery and plant, and £206,754 for inte upon the company's debentures. The profit of £1,712,854 was increased £2,019,087 by £100,817 received from rents and dividends on sundry inv ments, £82,231 representing profits on the realization of investments, £7 derived from miscellaneous revenue, and £116,001 from the balance brought ward from 1894–5. The dividend declared for 1895–6 absorbed £1,579, £92,539 was invested in consols on reserve-funds account, £17,609 was applie repayment of expenses incurred in certain debenture-conversion operations, £329,357 was carried forward, as already indicated. The average yield of monds per load of "blue" handled by the company in 1895–6 from De Beers Kimberley was 0.91 carat. The average value of each carat of diamonds ra was 26s. 9d., so that the average value of each load of "blue" was 24s. 4½d. increased price was obtained for diamonds in 1895–6, and the directors antici that this rise will be maintained. The quantity of "blue" and lumps on floors at the close of June, 1896, was 3,674,357 loads, as compared with 3,452 loads at the close of June, 1895. The company commenced working the pre mine (Wesselton) in 1896–7, the lessee's contract having expired. Includin reserves, its debenture capital, and its share capital, the company at the clos June, 1896, possessed resources to the aggregate amount of £10,207,704.

India, which was once famous for its diamonds, now produces very few. cording to the official statistics the output was 210¾ carats, valued at 16,251 ru in 1894, and 215 carats, valued at 19,506 rupees, in 1895.

There are no statistics of the production of diamonds in Brazil, and the much difference of opinion as to the future of the industry in that country an those who have had experience there. Some hold that it is still in its inf and will become important when more scientific methods are introduced, w others assert that the best ground has been worked over already. The important fields that have been exploited are in the Serra das Lavras Dia tinas and the Serra da Sincora at the headwaters of the Paraguassu River, in deep pools of which diamantiferous gravel is raised by divers. Recently American imported diving-suits for carrying on this work. On the S Itaraça, near Salobre in the southern part of Bahia, there are important dep which furnish very fine stones and are now being worked. Associated with Brazilian gems is a good deal of boart and carbonado, reference to which is m under the caption "Abrasives," in the first part of this volume.

Diamonds have recently been found in British Guiana on the Himara Mazaruni and Potaro rivers. Some of these deposits may be profitably work

The Kimberley mines were described by William Crookes in the *Imperial I tute Journal*, January, 1897. See also "Diamonds, Where they Occur, and to Search for Them," by Melville Atwood, *Engineering and Mining Jour* August 15, 1896.

* D. E. Headley, *Engineering and Mining Journal*, Aug. 22, 1896.

SAPPHIRE.

By CHARLES N. JENKS.

SAPPHIRE, sometimes called telesia, is the hardest of gems next to the diamond; it crystallizes in the rhombohedral division of the hexagonal system, the six-sided doubly terminated prism being the most common form. Its sp. gr. varies from 3.907 to 4.16, with a mean of about 4, and it stands at 9 in Mohs' scale of hardness. The composition of the mineral varies somewhat as well as the hardness and specific gravity. The question of specific gravity will be referred to later.

The sapphire is unacted upon by acids and is infusible before the blowpipe, but if finely pulverized is soluble in fused borax and partially soluble in potash. With steel it strikes fire, but not so readily as some of the silicates. By collision it becomes luminous, the light varying with the color of the stone, in some instances purple, in others a deep cherry-red. Its diaphaneity varies from transparent to translucent. Sapphire exhibits a great variety of colors, and nine gems are designated according to this difference, namely: Oriental sapphire, ruby, emerald, asteria, topaz, amethyst, chatoyant, girasol, and white or colorless sapphire.* The index of refraction of sapphire is 1.76, and this high figure accounts for its great brilliancy.

The blue or Oriental sapphire is the true jeweler's sapphire; its color is generally attributed to protoxide of iron, or possibly to uranium. When of a carmine-red or pigeon-blood color the gem is called Oriental ruby, and when deep green (not too dark), Oriental emerald. The coloring material for both the ruby and emerald is thought (almost certainly) to be chromium oxide. If the gem is violet, it is called Oriental amethyst; if yellow or reddish yellow, Oriental topaz. These and other shades are thought to be produced by different proportions of oxide of iron.

The Oriental emerald and ruby are the most valuable of all gems, the emerald taking precedence on account of its extreme rarity. The emerald of commerce is not, however, to be confounded with the corundum or true Oriental emerald. Stones bearing this name obtained from Peru and Bogota are largely silica, and are comparatively soft and lacking in the brilliancy which is the distinguishing feature of the corundum emerald. This is also true of the hiddenite or lithia emerald. Both these so-called emeralds stand only at 7 in the scale of hardness and are of a lower and variable specific gravity. Of the true Oriental emeralds there are only a few in existence and these are of enormous value. A ruby of the finest pigeon-blood color, free from flaws, is worth per carat, when over one carat in size, several times more than a diamond of the first water. But the true ruby should not be confounded with the spinel ruby, which is an inferior and entirely different gem.

Among the foreign localities where the Oriental corundum gems are found may be mentioned India, Ceylon, China, Armenia, Siberia and Bohemia. Burma, Siam, and Ceylon yield the finest rubies. The Mogok district, which covers an area of about 100 sq. miles in Upper Burma, about 70 miles from Mandalay, has for

* The use of the terms topaz and amethyst to designate varieties of the sapphire or ruby is licensed by Dana, but on this account they should not be confounded with the minerals topaz and amethyst proper, and when applied to the ruby should be qualified by the adjective "Oriental." In any case it is bad nomenclature.—ED.

ages supplied the finest blue and red sapphires. The Ceylon stones are ne
value. The Siam ruby is usually light red in color and dull in luster; whil
sapphire is of a dark, dull blue without the luminous silken gloss which i
distinctive mark of the Burma and Ceylon stones.

According to Streeter the original matrix of these stones was probably cr
line limestone, the disintegration of which has distributed them along the
sides and valleys where they are found. The credit of the first discove
corundum gems *in situ* belongs to Col. Charles W. Jenks of Boston, who ea
1872, while mining for commercial corundum at Corundum Hill, in M
County, N. C., at a depth of 10 to 75 ft., found Oriental sapphire and
crystals imbedded in the chlorites and vermiculites between two walls of ol
rock. This discovery was followed by a further find of the corundum ge
the alluvial gravel at one or more points below the veins; and later at L
Creek, Raybun County, Ga., sapphire and ruby crystals were also found by
Jenks *in situ* and in the placer below.

About 100 true gems of Oriental sapphire, ruby, and emerald were
out by Col. Jenks at this time and by the writer, who, under the direction
father, superintended the washing. A few of these crystals brought good
as gems, being pronounced by experts equal in color and brilliancy to any Or
stones of the same size. Some of the finest specimens were never cut, but
eagerly purchased by the British Museum and foreign collectors; also b
leading American colleges and collectors, including Tiffany & Co. of New
The writer remembers one specimen which he saw picked from the wash-bo
mass of blue sapphire semi-transparent (a fragment of a large crystal) and
the size of a turkey's egg. This had one perfect termination, of a pure pi
blood color, which at the extreme end was without flaw or fracture, perfectly
parent. This specimen was sold in London to an English collector for $250

Mr. George F. Kunz, the distinguished gem expert, says of one of these cr
discovered at this time: "At the Jenks mine was found probably one of th
known specimens of emerald-green sapphire (Oriental emerald). It is the
parent part of a crystal 4 by 2 by 1½ in., from which several gems could b
that would together furnish from 80 to 100 carats of very fine almost em
green gems (not too dark as the Siamese are), the largest possibly fully 20
in weight. As this gem is one of the rarest known, it makes this specimen
valuable one."

Only about three months was spent by Col. Jenks in actual washing for
The financial panic of 1872–3 suddenly closed the mines, and in consequen
the death of his partner in the enterprise the property went into litigation
after being tied up for a number of years it passed out of his control.
this time the corundum gems have been picked up at intervals at the sam
at different points within the gem-bearing area of North Carolina and Ge
but no more systematic washing was done until early in 1896, when a New
syndicate, The American Prospecting and Mining Company, began placer m
at one or more points in Macon County, N. C., a short distance from Coru
Hill. This work is still in progress, but the success in finding gems can
learned. At three other points in Macon and Jackson counties small c
of good color and brilliancy have been found *in situ* within the past year.

Among the other localities where sapphires are found in considerable number may be mentioned the deposits near Helena, Mont., where a large number of small "gem gravel" sapphires are found in the bars on the bed of the Missouri River and in some of its tributaries. These stones when cut possess a peculiar and beautiful metallic luster, but on account of their uniformly pale color do not rank with the gems from the Orient. The Sapphire and Ruby Company of Montana, Limited, which was organized in London some years ago to work these deposits and had a paid-in capital of $2,500,000, has never been financially successful for this reason. Sapphires are also found in Southern Colorado, Arizona, and near Santa Fé, where they are associated with garnets and peridotes, and are often found in the sands on and near the countless anthills. Those that the writer has seen in and from these localities are generally of a better color than the Montana stones, having also a wider range of color, with some remarkably fine specimens of red and blue. A few sapphires have been found at Vernon, N. J., but they were generally opaque and unfit for gems.

The corundum gem deposits of North Carolina and Georgia are of much greater extent than any similar single deposit of the Eastern Hemisphere. They are known to occur in Macon, Jackson, and Transylvania Counties in North Carolina, and in Raybun County, Ga., at intervals through a territory 40 miles in length by 15 in extreme width and comprising about 500 sq. miles. The deposits or sources of supply are at an average altitude of 3500 ft., or only a little less than the Burma fields, which average about 4000 ft. The placer occurrences are almost precisely identical with some of the most famous of the foreign washings, the geological as well as the topographical conditions being much the same.

A series of exhaustive tests made by the writer show an average of the crystals of both localities to be structurally alike, and the mean hardness (9) and specific gravity (4) are the same. An analysis of both the sapphire and the ruby from three different localities in North Carolina and Georgia also gave almost identical results with those from Burma, Siam, and Ceylon. An average of three analyses of the blue sapphire of India and one of North Carolina compare as follows:

	Hardness.	Alumina.	Magnetic Oxide of Iron.	Lime.	Silica.	Loss in Decomposition.
Blue sapphire of India.....	9	97.87	1.29	0.2	0.28	0.54
Blue sapphire of North Carolina.	9	98.06	1.38	.....	0.23	0.33

Acids do not act upon the sapphire from either localities, and both remain unaltered before the blowpipe. The fracture of the sapphire of India, Montana, North Carolina, and Georgia is identical. Their hardness varies somewhat in different localities, that of the North Carolina blue being apparently a trifle more (Corundum Hill, N. C., Cullasegee, N. C., Sapphire, N. C.) than the blue sapphire of Siam and Ceylon and about the same as that of Burma, Bactria, and Montana crystals. These are all a little harder than the red (ruby) and other colors from the same and different localities. This may be due to a greater proportion of silica in the ruby, an average of six analyses showing about 2.67% more than the average of the six analyses of the blue sapphire before referred to. Mr. Chenevix's analysis of the ruby of India, which has been widely quoted,

is: Alumina 90%, magnetic oxide of iron 1.2%, silica 5.25%; loss of 1.8% in de position. Prof. J. Lawrence Smith's analysis of the ruby of India was: Alu 97.32%, magnetic oxide of iron 1.09%, silica 1.21%.

A peculiarity of the North Carolina crystals that does not seem to occur where is that in the same specimen may occur all the colors characteristic of of the nine corundum gems. The writer has seen in one large semi-transp crystal the Oriental sapphire, ruby, emerald, topaz, amethyst, and col sapphire. No locality in the world has thus far produced such magnificent ca specimens of corundum as the fields of North Carolina.

The North Carolina deposits have the most favorable gangue for a perfect formation, consisting in many instances almost entirely of the chlorites and vermiculites, and when they are systematically washed there is no reason they may not prove of equal importance with those of the Orient. It is a although it will be disputed by the trade, that several hundreds of car corundum gems, mostly of an inferior quality (the reason for this being that are mostly surface specimens), are annually obtained by the natives of N Carolina, by strolling prospectors and others within this gem area, but wi systematic mining. These are handled principally through local dealers i rough or sold to curio collectors, and their identity is in most cases lost.

In the opinion of the writer, who has carefully studied the several Ame localities, the reasons why sapphires have not been found in Montana in g abundance, of better color, and no more than three or four carats in weigh that in the eruptive dike carrying the crystals they are very scattering and small in size. Occasional fine specimens have been and will be found, but n commercial quantity. These same reasons apply to all other localities I visited in the United States, with the single exception of the few deposit limited area in Georgia and of the large gem area in North Carolina. The l sapphire crystal ever found in either hemisphere was taken from the Jenks (Corundum Hill) in 1872 at the time of the first work. It weighed 312 and was both red and blue, ruby and sapphire, in color. It is now in the Sh collection at Amherst College, Mass.

Sapphires, rubies, and emeralds, highly crystallized and of brilliant luster, been artificially produced by Deville, Feil, Frémy, and others, and are desc at length by Kunz, Miers, and other authorities on gems. These are, hov small in size, rarely exceeding $\frac{1}{3}$ carat in weight, and are consequently especial value, as genuine stones of this size may be purchased by the pound. artificial product is readily detected by the expert, as it is more brittle and brilliant, and under a magnifying glass the cavities (which occur in both n and artificial stones) in the artificial stone are of a cloudy appearance and gl in shape, while in the true Oriental stone they are angular or crystalline. are only a few of the more common tests, the spectroscope, polariscope, and d scope revealing other differences. In detecting readily any spurious or so- corundum gems from the true Oriental stone several methods are emp by experts. One is by determination of the specific gravity of the spec Another is by use of the Roentgen rays; the true sapphire is, like flesh, parent to the rays, but their imitations are, like bones, opaque to them.

THE SAPPHIRE (RUBY) MINES OF BURMA.*

BY T. TRAFFORD WYNNE.

THE principal ruby-producing district of Burma is the country near Mogok, which is situated 90 miles north of Mandalay. Kyatpyin is the present headquarters of the Ruby Mines Company, and a 15-mile circle around this place would contain nearly all the mines now being worked.

Geological.—The country rock is usually a very hard gneiss, varying to granite, or a soft micaceous schist. Large hill masses of calc-spar are met with which have evidently been forced by some upheaval through the gneissic formation. These masses, of which the hill called Pingudoung, near Kyatpyin, is the most prominent example, contain fissures and caves usually filled with "byon." This "byon," in which the rubies are usually found, varies from a somewhat tenacious clay with small, rounded quartz and other pebbles to a fine gravel almost like river sand. In color it may be from dark red to light yellow.

The great bulk of the "byon" is found as an alluvial deposit in valleys which show these characteristics, viz., a more or less shallow basin, closed at the lower end by a barrier of hard rock, and with a stream flowing through it. The "byon" having presumably been brought down by the denudation of the hills above into these basins, the rock barriers have acted as riffles, and, while allowing the lighter mud to flow over, have held up the heavier ruby-bearing ground. Those valleys also contain a varying quantity of calc-spar in huge boulders to small pebbles, and the greater the quantity of this the better seems to be the quality of the "byon."

Rubies are also found in some places with the calc-spar matrix, but the stones are imperfectly formed and full of flaws; and even if they were of any value, no method of extracting them from the matrix without injury has yet been discovered; hence no attempt is now being made to work these mines.

Exploitation.—After various failures the English company finally decided to sink a pumping pit at the lower end of the Tagoungnandine valley, and to use the available water-power to drive part of the machinery. A 4-ft. Pelton wheel was erected at a point about three-quarters of a mile below the rock-barrier, at the lower end of the valley, where 100 ft. of effective head of water was available, and the power was transmitted by means of wire ropes to the pumps. A 4-in. centrifugal was found sufficient to drain the excavation to a depth of 50 ft. during the dry weather, a 6-in. being required during the rains.

A third valley was opened up in a different manner. In order to save the heavy pumping costs, the valley being quite waterlogged and under water for several months in the year, it was decided to drive a tunnel through the rock barrier at the lower end, and so drain the valley to a depth of 40 ft. A tunnel 10 ft. by 10 ft. was driven for a length of 500 ft., the entrance being in a ravine, where a good tip for the spoil, as well as a site for the washing plant, was obtained. The washer erected there is driven by water-power, and the present cost of excavating, hauling, washing, and sorting is only 0.55 Rs. per load of 15 cu. ft. Unfortunately this plan is not feasible at Mogok, at least not for the large valley, as the length of tunnel required would make the cost prohibitive.

All these valley deposits are worked in the same manner. When the ground

* From a paper read before the Institution of Mining and Metallurgy (London), Jan. 20, 1897.

has been drained, either by pumps or drainage tunnel, the surface soil is stri
off, and tipped to waste, the byon being loaded into trucks, and either run thr
the tunnel, or wound up an incline and run to the washer. On arrival at
washer, it is tipped on a grizzly to remove all large stones, and is then fed in
revolving trommel, covered with 1-in.-square wire mesh, all the byon pa
through this mesh going directly to the pans, while what is discharged through
end of the trommel, principally stones and lumps of barren clay, is remove
further treatment. The washing pans used are either of the Whitmore & Bi
or Davy Paxman type, both giving equally satisfactory results, the quantity
ing through each pan before it is necessary to wash out varying from 3000 to
cu. ft., according to the nature of the byon, as when much clay is found with
byon the washing is very much more difficult than when it is sandy nature.

The concentrated byon left in the pan, about 70 to 80 cu. ft., is run in
locked receptacle, from which it is fed to classifying trommels, in which
washed in a strong stream of water, to remove all the sand. The different
are then picked over by specially selected sorters, and all valuable stone
removed; or the deposit may be again treated in a pulsator, which still fu
reduces the quantity, and then it is passed to the sorters.

TURQUOISE.

TURQUOISE, which is a hydrous phosphate of aluminum, is derived chiefly
Persia, where it occurs in seams as wide as 6 mm., or in irregular patches i
brecciated portions of a porphyritic trachyte and the surrounding clay-slate,
Nishâpûr in the northern part of the kingdom. The mines are situated o
southern slope of Mt. Ali-Mirsa, northwest of the village of Madèn, at an elev
of 5000 to 6000 ft. The Reish mine is the only one worked vigorously at pr
This is opened to a depth of about 90 ft. The turquoise-bearing rock is h
in sheepskin bags, and the waste sorted out at the surface. The good stone is
sent to Meshed, where it is dressed, cut, and packed for export.

Since the Abdur Rezai mine caved in, turquoise of perfect color is very
found, though in all probability the hill contains considerable good stone.
Reish mine furnishes stones of good shape, but their color soon fades. Acco
to a recent report of the British vice-consul at Meshed, although good stone
rare, there is an abundance of imperfect ones, which are eagerly bought, sin
Orientals prize them, and the poorest persons like to possess one in a ring, e
it is green and spotted. Some of the stones now found look excellent at firs
the color soon fades, a green tinge develops, or white spots appear. Some
spots can only be detected at first with the aid of a magnifying-glass, but g
ally become larger, and finally spread across the stone. The color of most
turquoise can be temporarily revived by dampness. In Meshed no one
dream of buying a turquoise without having it in his possession for some

Besides the Nishâpûr mines turquoise is found in the Megara Valley,
from the Karkaralinsk (Kirghiz Steppes), Semipalatinsk, Siberia; in the
Tube Mountains in Turkestan, 50 versts from Samarkand, where it occurs in
onite, etc., in seams in a silicious clay-slate, which were worked at some unk
time in the past.