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A TRIP TO RUSSIA AND THE URAL MOUNTAINS.*

BY GEORGE F. KUNZ.

My remarks this evening will consist of a brief account of a trip made lately by myself to Southeastern Russia and the region of the Ural Mountains, a district renowned for its wealth of gold, platinum, iron, copper, chromite and precious stones. I shall confine myself, however, to a few points, such as the finding and working of precious or ornamental stones, the washing for gold and platinum, the casting of artistic iron work, and a few notes of general interest, not attempting a *résumé* of the mineral resources of this district, or the metallurgical processes, which have been fully described elsewhere by Humboldt, Rose, Murchison, Kokscharow, Ludwig, Karpinsky, Tscherneschew and a host of others.

It may safely be affirmed that few Americans have any conception of the immense extent of the resources of the Russian domain, or of the many and varied forms of industry and art which have been developed throughout its cities, towns and provinces. To some of these I shall allude briefly in this article, in connection with the mineral wealth of the Urals and the uses to which it is applied after its extraction from the earth. To obtain a more general idea of the arts and industries of this great empire, perhaps there is no work that a reader could consult with more advantage than the volume published in 1893 by the Imperial Commission in charge of the Russian Section of the World's Columbian Exposition at Chicago. This is one of the most full and able of the series of reports issued in connection with the great Fair, and though only entitled a "Catalogue of the Russian Section," it forms an octavo volume of more than 500 pages, and comprises over 1,000 titles of

* A lecture delivered before the Franklin Institute, April 20, 1898.



exhibits; while the notes in relation to a large number of them are of great value, historical, industrial and statistical.

Whoever contemplates a trip through Russia must be sure to secure a good passport. This should be *viséd* in Paris, or some European capital, before starting for Russia. From the questions put to me at these places, it soon became evident that no one of the Hebrew faith will be admitted into the realm of the Czar of all the Russias.

At the frontier the train stops for about two hours. Here, on the railroads, in the mines, on the steamers and elsewhere, I received the most courteous attention from officials and the Russians in all stations with whom I came in contact. They are exceedingly friendly to strangers.

To reach the Ural Mountains, one can go very comfortably by rail to St. Petersburg from Berlin, in thirty-two hours; or from Vienna in thirty-eight hours. From St. Petersburg the best train, leaving at eight o'clock in the evening, will take the traveler to Moscow, a distance of 366 miles, in fourteen hours, and from Moscow, 246 miles, in twelve and a half hours, to Nijni Novgorod, where, from the end of July to the middle of September, the great fair is held, at which at least \$135,000,000 change hands every year in less than six weeks' time.

From Nijni Novgorod the traveler can usually reach the Urals by way of the various daily lines of steamboats that ply on the Volga and the Kama, 894 miles to Perm—a city of 30,000 inhabitants—in three and a half to four days. But in the time of low water in summer a week or more is frequently required.

From Perm one can go by the Ural Railroad, through the heart of the Ural to Tumen, the frontier of Siberia, a distance of 463 miles, in thirty-two hours.

Another route may be taken, however, in the dry season or winter, when the traveler can go direct from Moscow, by rail, to Zlatoust, a distance of 1,059 miles, in seventy-nine hours.

It will thus be seen that one may enter and cross the Urals by two routes, the northern one from Perm and the southern one by Orenburg. These two cities lie some dis-

tance west of the mountains, Perm in about latitude 58° north, or approximately on the parallel of the Hebrides, while Orenburg is in latitude 52° , corresponding nearly to that of London. The rich mining region of the Urals lies chiefly on the eastern or Asiatic side, between these two latitudes, at which the range is traversed by railroad routes; and the principal points to which I shall have occasion to refer lie along this eastern flank of the mountains, connected



by roads that run in a general way parallel to the range, *i. e.*, north and south. The principal city, Ekaterinburg, is well toward the northern part of this line.

The journey down the Volga and up its great affluent the Kama, is strikingly like a trip on our own Mississippi; the boats are comfortable, lighted by electricity, and the fuel used is petroleum, from the oil wells of Baku, on the Caspian Sea. If the traveler goes by way of Zlatoust, the

journey from there to Ekaterinburg, 171 miles northward, can be made by tarantas, in from twenty-four to thirty-six hours.

Russia has a population of about 110,000,000, of which the Ural region contains about 5,000,000; and the largest city in the Urals (Ekaterinburg) has 34,000 inhabitants.

The area of entire Russia is somewhat over 22,000,000 square kilometers, which is one-twenty-third that of the entire globe, or one-sixth of all its visible land; and exceeds by nearly five times the area of the United States, including Alaska.

In Russia there are only about 25,000 miles of railroad, while the United States has 184,428, or more than seven times as many miles—forty-five times as many for the area. The railroads in the United States employ 823,000 men, while those of Russia employ only 35,000.

On the other hand, the standing army of Russia consists of 835,780 men and 390,000 horses; while that of the United States had, prior to the recent war with Spain, 27,390 men.

These figures show that in each country about an equal number of men are employed in the armies and railroads together, but in reversed proportions; we may further note that the subsistence of the Russian army costs at least \$50,000,000 annually, in addition to the armaments and fortifications; while the railroads of the United States made net earnings of \$369,565,000 in the year 1897.

From these data we pass naturally to the next item, that of national debts.

The debt of Russia is \$3,491,074,000; that of the United States is \$1,700,961,695. This represents over one and a half times as much per capita in Russia as in the United States; although in the latter wage-workers earn from three to five times as much per day as in Russia.

In Russia there are ten rivers over 1,000 miles long, and five of these are over 2,000 miles long.

The valleys of the Irtisch and of the Kama Rivers, with the chain of the Ural Mountains as a connecting link, have been from time immemorial the natural route open to the Asiatic migrations, whose starting point was to the east of

Lake Baikal, and which gradually spread more and more widely on their way toward the Baltic Sea. Thus it is not surprising that the soil of these regions contains hidden archæological treasures in greater abundance than any of the central provinces of European Russia. To these we will refer later.

The river courses of Russia have done much to assist in the great migrations, and naturally guided or diverted them.

At Ekaterinburg, the heart of the Urals, starts the Great Siberian Street—the road to Siberia—one of the finest broad avenues in the world. The new Siberian railroad is to go direct from Zlatoust to Vladivostok on the Pacific, a distance of 4,000 miles.

As it is now, for half the year there is no connection between the Government of Perm (to which Ekaterinburg belongs), with its 2,500,000 inhabitants, and Moscow or St. Petersburg, except by the 170-mile journey by tarantas from Ekaterinburg to Zlatoust.

This gigantic enterprise of the Trans-Siberian railway will, when completed, be the longest railroad line in the world. It extends from the Urals somewhat south of east, passing around the southern extremity of the great Lake Baikal, which lies about midway between the Urals and the Pacific; thence a little north of east till it strikes the valley of the Amoor. Crossing this stream after some distance, it turns for about 300 miles directly south to the port of Vladivostok. Portions of the road are now under construction, especially those that by uniting the great river routes of Siberia and the connecting canals, will open partial communication as soon as possible throughout the great interior, which is now so inaccessible as to render its products of little value. It is not expected that the road will be finished before the year 1904; but several thousand miles are already laid, and parts of the route are in operation. At present, although gold is worked at many points throughout Siberia, yet the vast resources of the country in products no less valuable for use, but too bulky for easy transportation, such as coal, iron and the like, are unavailable. As

soon as the Trans-Siberian railroad is completed, these resources will be opened to the world, and also a vast amount of agricultural products which the country is capable of producing, but which are now unable to reach a market. The same is true of the stock-raising capacities of many parts of Siberia, and of the immense fishing industry that exists around Lake Baikal. On the shores of this great mid-Asiatic lake are no less than 400 fishing stations, giving employment to some 30,000 men.

As a consequence of the absence of railroads, the fact is noticeable that in all Russia the roads are generally good, and the facilities for wagon traveling are better than exist anywhere in the United States.

The traveling is all done, when not on the railroad or boat, by tarantas, especially on the Government post roads. This vehicle, drawn by three running horses, is very comfortable, and one can average at least six to eight miles an hour, including the time required in the changes, which are made every twelve to eighteen miles, frequently going over ten miles an hour on the road. If the traveler contemplates a trip of some distance, or requires a long time, a good way is to buy a vehicle, put his baggage into it, and hire horses at the Government post or other stations as he travels.

The Ural Mountains form the geographical dividing line between Europe and Asia. The average altitude of the entire chain is not over 2,000 feet; an elevation of 4,000 feet is exceedingly rare, and the highest peak (near Miask) in the entire range is 5,540 feet.

The chain runs north almost in a direct line from its southern point near the Aral Sea, in latitude 46 north to latitude 65 north, then deflects to the east as far as north latitude 67, and runs to the Arctic Ocean.

The average width of the range is scarcely forty miles—only in rare instances does it attain a width of 100 miles. The entire range is embraced in the Governments of Tobolsk, Perm and Orenburg.

The various inhabitants of the Ural district are as follows: In the northern part, in the Government of Perm, with 2,700,000 inhabitants, are what are called the Great

Russians; south of this, in the Government of Orenburg, with a population of 1,300,000, there is a tract of land inhabited by the Bashkirs, a Mohammedan sect, who live in villages, and are an industrious, peaceful people. South of and bordering on these, for the purpose of keeping peace between the other peoples just named, and also for maintaining the power of the Czars, are the famous Cossacks, who separate the Bashkirs from the Khirges, and interspersed through here are also Tartars.

The Khirges are a rude, nomadic people, who raise immense herds of cattle, sheep and horses, which they sell or trade to the inhabitants of Perm, Orenburg and the Volga district.

There has just appeared a work of great value relating to the geology and mineralogy of the Ural region, viz.: the collection of guide-books prepared by the Russian committee for the series of scientific excursions in connection with the seventh meeting of the International Geological Congress, which was held during the past summer in St. Petersburg.* This volume consists of thirty-four monographs by leading Russian geologists, treating of the different portions of country to be visited or traversed by these excursion parties. These papers are accompanied by maps, illustrations, bibliographies, etc., and have been prepared with the utmost care and pains, and strictly brought up to date in their accounts. Five of these monographs relate to the mining region of the Eastern Urals—the same that was visited by the present writer.

This remarkable and indeed monumental work is one that reflects great honor upon the geologists who prepared its various parts, and it shows very strikingly the liberal and princely manner in which the Government and the scientific men of Russia plan and carry out such courtesies. The whole forms an octavo of over 500 pages, beautifully printed, and bound in a spring cover, so that each local

* Guide des Excursions du VII^e Congrès Géologique International, avec 39 planches, nombreuses figures, cartes locales et une carte géologique de la Russie d'Europe à l'échelle de 1:300,000. St. Petersburg: 1897. Imprimerie de M. Stassulewitsch, Wassili Ostrow 5, ligne 28.

monograph could be taken out and used separately during the portion of the journey with which it is concerned. The translation, chiefly into French and in some cases into German, is excellent; and the whole is a noble gift to the geologists from other lands who attended the Congress.

These excursions, which were planned to visit all the districts of Russia most interesting to the mineralogist and geologist, were arranged on a scale truly imperial in liberality. By special order of the Czar, all the members who took part were provided with first-class transportation, free of expense, over the railroad and steamer routes selected, to points as distant as the Eastern Urals, the Caucasus, the Crimea, the oil deposits of the Black and Caspian Seas, etc. An example of the faithfulness with which this pledge was carried out, may be cited in the following instance: It was found at a late date in the arrangements, that there were no first-class cars on the road between Tiflis and Batoum on the Black Sea, over which one of the parties was to travel; and the Government immediately sent five cars to that remote section, at a cost of \$600 each, solely for the use of the excursion.

In speaking of the mines of the Ural Mountains, it is well to observe that this term is employed in a very general sense, somewhat as the name Alleghany is with us. The Urals, in fact, comprise several ranges, of which the easternmost is the one specially referred to here. This eastern range is frequently designated as the Ilmen Mountains, though, in fact, this term is rather too limited. The richest mining districts are indeed in the Ilmen Mountains; but the same line of elevations, geologically and geographically, continues, with some interruptions and under various local names, for a long way parallel to the main Urals at a distance of from twenty to forty miles east. In a general way, therefore, it holds somewhat the same relation to the Urals proper, as the Blue Ridge does to the main line of the Alleghanies, and in the same manner bears different names in different parts of its course.

The principal rocks of the Ural region are metamorphic-

chloritic and talcose schists, serpentine, quartzite, coarse granite, gneiss, limestone and dolomite.

The mineral statistics for 1892 show that, as compared with Russia, the United States produces ten times the pig-iron, twenty-three times as much coal, twenty-three times as much copper, fifty times as much silver, six times as much quicksilver, 200 times as much lead and five-sevenths as much petroleum; whereas Russia produces nearly all the platinum and three times as much manganese; also, three-fourths as much gold.

A brief history of the origin of the greatest mining estate in the Urals, Nijni Tagilsk, may prove interesting.

When Peter the Great visited Tula in 1710, he brought with him a revolver which had been presented to him by an English nobleman.

This having gotten out of order, he inquired of the Governor of Tula if he had any one among his many skilled metal workers—for which the Government of Tula has always been noted—who could repair it.

The Governor immediately replied that one Demidoff, a young smith, undoubtedly possessed the requisite skill. Demidoff was then called, and assured the Emperor that he could put the revolver in perfect order. Peter the Great left it with him, and came again in about ten months. Demidoff handed him a revolver, which he, the Czar, examined carefully and seemed pleased with it, and complimented him on the good repair. He then showed him another one which was not quite as good; but this was the original one, he having made a new weapon better than the old. His expertness pleased the Czar, who then gave him and his heirs Nijni Tagilsk as long as it should be used as a mining estate.

Demidoff struck roads through an impenetrable forest, so true in direction and location, that all attempts to make better lines have failed, and his original roads are used to this day.

So expert was Demidoff as a smith that it is commonly said that he was able to put hoofs on, and had harnessed, a pair of fleas.

The celebrated mining locality of Nijni Tagilsk com-

prises really several separate mines. There are in the first place, six important mines of magnetic iron ore, which surround and penetrate the famous iron mountain, known as Mount Wyssokaia (or in Russian, Wissokaiagora), a somewhat isolated hill of porphyry 2,000 feet long, 1,500 feet wide, and 250 feet high. Of these mines, Nijni Tagilsk is the first and the most noted, the six together dividing up the approximately circular hill in something like irregular sectors. The ore taken out is used in the great iron works of the adjacent town of Tagil, which were founded by the original head of the Demidoff family, just now referred to. A little distance southward, close to the base of the mountain, is the celebrated copper mine of Mednoroudiansk, from which nearly all the malachite used in the world has come, a circumstance that has made this locality famous. It is unfortunate that the name Nijni Tagilsk, which really belongs to the adjacent iron mine, should have become so identified with the malachite, in mineralogical books and collections, that the error can probably never be corrected. The occurrence of the ores is peculiar and interesting; the iron is in beds and seams closely involved among the porphyritic rocks, in such a manner that Professor Tschernitschew, the eminent authority who has described these mines for the recent Congress of Geologists, regards them as of simultaneous formation with the igneous rocks in which they occur. The copper mine forms an ellipse 1,800 feet long and 290 feet broad, and the ores occur in ferruginous clay, apparently formed by an alteration of beds of tufa or breccia derived from the porphyries and other adjacent rocks, and included between upturned beds of Devonian limestone.

In 1835, an enormous mass of malachite was struck in mining at Nijni Tagilsk, at a depth of over 200 feet, and beneath the bed of a small stream, known as the Roudianka. This great mass or block, when disengaged from the surrounding rock, measured some 17 feet by 8, with a thickness sloping from about 6 feet at one end to a little over 1 foot at the other. Its total weight, including portions cut off in extricating it, was estimated at 65,000 kilograms. The block was surrounded and partly penetrated

by iron and manganese ores; but large portions of it were compact malachite, of reniform structure, beautifully varied with light and dark green. The inflow of water rendered it difficult to determine what lay below the mass; but it was thought that perhaps this was only the upper portion of a more extensive body of malachite. The largest mass previously found was in the Gournichef mine, and weighed 1,789 kilograms.

The copper deposit at this locality is attached to the magnetic iron mountain Labaschka, which is 3,000 feet long, 1,000 feet wide and 100 feet high. The Wissokaia gora is covered to a depth of 30 feet with loam—the upper layer is reniform limonite, then other forms of limonite, coarsely and finely granular, gradually changing into a compact magnetite, flanked on one side with compact crystalline limestone, containing silurian fossils, notably *pentamerus*, and on the other side with diabase.

The magnetite of the Labaschka is so highly magnetic, that all the tools brought in contact with it change to magnets. No ore poorer than 60 per cent. of iron is ever used, or any that is at all impure. From this ore is made the famous Russian sheet-iron, and there is enough in sight here for a hundred years to come.

A little farther to the northeast of Wyssokaia is another and loftier hill, belonging to the Government, known as Mount Blagodot. Here again occur extensive mines of magnetic iron, associated in the same intimate manner with masses of porphyritic rock, which have been forced out among limestones of Lower Devonian age.

* On the entire estate of Nijni Tagilsk (30,000 inhabitants) and Neviansk Savod (16,000) there is not a single mile of railroad. Everything is hauled by horses; and when one inquires why, he is informed that the mines were granted to the original Demidoff, on the condition that he should employ every person in the entire domain. Hence the

* I must also express my sincere thanks to Prince Demidoff, who, in response to the letters that I had to him, arranged that his engineers, Grammatakoff and Hamilton, not only afforded me every opportunity, but the horses and men to guide me over this marvelous and unique estate.

caravans, which consist of from five to forty wagons in summer, or sleds in winter, are constantly seen crawling along the roads to the railroads. Strange to say, a rigid eight-hour law exists in the Urals. No one is allowed to employ a man more than eight hours for a day's labor. It is customary for them to begin work at six in the morning and to stop at six in the evening. One hour is allowed for breakfast, from eight to nine; two hours for dinner, from twelve to two, and one hour for supper, from four to five.

The results accomplished with primitive appliances are in striking contrast to the modern methods used in the United States, notably in Minnesota, where in one day 4,000 tons of ore are raised by one steam-shovel, railroaded to lake docks and sold over 1,100 miles distant at a profit of \$2.85 a ton.

An interesting social custom at Nijni Tagilsk is, that many of the people use visiting cards, made at the Demidoff works, out of Russian sheet-iron; this rolled to the thinness of paper, is even more flexible than a thin plate of mica.

The auriferous deposits of the Urals are, as usual, of two kinds, which have been called by Karpinsky primary and secondary. In the former, gold is found either in quartzose vein-stuff, or interspersed through the mass of crystalline rocks, such as diorite and serpentine; while the secondary deposits are auriferous sands, either immediately overlying the primitive deposits, or transported and re-arranged at some distance from the point of origin.

The primary gold deposits of the Urals are very numerous, four groups of them being actually worked, namely, those of Berezowsk and Gora Blagodat, those of the district of Miask, those of the Bashkir territory and in that of the Orenburg Cossacks.

The Berezowsk deposits, which are the only ones that have been systematically developed to any extent, are included in an area of about twenty-two square miles, in which the prevailing rocks are schists penetrated by numerous veins or dykes of a fine-grained granitic rock containing pyrites and known as beresite, which vary in thickness from

3 meters to 40 and upward, and in many cases extend beyond the limits of the mining region. These beresite dykes are traversed by numerous fissures filled with quartz, forming veins varying in thickness from about 10 to 70 millimeters, or on an average 30 millimeters, having a general east and west course, often uniting into groups, but never becoming parallel to the enclosing dyke. Sometimes, but rarely, they pass from the beresite into the neighboring schistose rocks. The vein-stuff as well as the rock, where most auriferous, is rusted from the decomposition of the pyrites. The best mines yield from 1 to $1\frac{1}{4}$ ounces per ton, 10 grams (about 7 pennyweights) being considered the lowest workable limit. The pyrite is often much richer than the quartz, in some instances averaging up to 6 or 7 ounces per ton. Below the level of decomposition of the pyrites into gossan, or, as they are locally called, krassiks, the gold appears to be entirely contained in the sulphides.

The secondary auriferous deposits, although called sands, are almost entirely clays, pure or somewhat sandy, and enclosing rolled masses and blocks of many different rocks. They are found throughout the whole Ural region, over a length of more than 500 miles, filling the valleys and forming marshy plains on both slopes of the chain, the larger development, however, being on the eastern side. They form placers of elongated shape, closely conforming to the course of the valleys and ravines in which they occur, and evidently but little removed from the rocks whence they have been derived. In many cases they have not been transported at all, but are merely the decomposed and washed surface portion of auriferous veins beneath; and the gold-bearing sands can be traced almost directly downward into crumbling gold quartz. At other times they have been transported somewhat, and the gold is richest in a band or line which seems to mark the course of the strongest part of the current. Where there are outcrops crossing the bed, or where the surface (as usually when it is limestone) is irregularly worn or fissured, there the gold accumulates as by a natural riffling process, and the beds are exceptionally rich. From this circumstance has arisen an

idea that the placers are richest where the rock is limestone; but this is only accidental, and the actual richness depends mainly upon the immediate proximity of the greenstone and talcose and chloritic schists in which the veins occur.

The placer deposits are believed to be very local, and geologically very late; they are all post-tertiary, some of them even recent. The older ones contain remains of quaternary animals, such as rhinoceros and mammoth, the later ones in some cases have yielded objects of human handiwork.

The auriferous beds or placers vary in thickness from about $1\frac{1}{2}$ to $3\frac{1}{2}$ feet, in breadth from 60 or 150 feet, and exceptionally 300 feet, and in length from 60 or 80 feet to 1,500, the direction being generally parallel to that of the chain. The most extensive deposits are those of Balbuk, $2\frac{3}{4}$ miles long, and Stolbuk, $3\frac{3}{4}$ miles. The sterile covering or overlying layer is usually less than 13 feet thick, although exceptional deposits have been found at 60 and even 130 feet below the surface. The overlying mass very frequently contains peat bogs. The amount of gold found varies from 12 to 39 grains per ton of sand, although occasionally it is double or even four times the latter amount.

The gold varies much in size, as usually in such deposits. The largest nugget obtained, from the Tzarévo-Alexandrovsky placer, near Miask, weighed 36 kilograms.

In the Kotchkar district placer mining dates from 1844, on the small rivers known as the Kaminka and Sanarka. These beds yielded also valuable gems, topaz, beryl, amethyst, euclase, ruby, etc., and became celebrated therefor. After some twenty years or more the yield of gold began to diminish, and vein mining was taken up. This has now become the principal method of exploitation since about 1868, and the placers are quite subordinate. The annual yield in the Kotchkar district is now about 1,600 to 1,800 kilograms of gold, of which the vein-working furnishes 1,300 to 1,400. The total production in the district since 1844 to the present year is stated to be about 47,000 kilograms, of which 25,000 have come from the placers and 22,000 from the rock.

Not only in the region just mentioned, but widely throughout the Urals, many minerals are found with the gold in these alluvial deposits, especially magnetic iron sand, with ilmenite and chromite, much garnet, also zircon, beryl and other gems, occasionally diamonds, though none of any consequence, and platinum, of great importance. Diamonds are also found in gold placers on the west side of the Urals, in the valley of the Poloudenka River and its tributary, the Adolphe, at a point somewhat north of the Ural railroad, some 240 miles east of the city of Perm.

The platinum of the Urals is nearly all found on the eastern side of the range. It has not yet been obtained commercially except in alluvial deposits, in which it is always associated with gold. Sometimes the latter predominates, and the platinum may not exceed 1 per cent. of the product of gold; while, on the other hand, gold may be almost absent; and the deposits in which this condition prevails, although less abundant, are those of most value.

These are confined to the districts of Nijni Tagilsk, Gora Blagodat and Biseik. The first of these localities extends for about twenty-five miles to the south of the village; and judging from the associated minerals, such as olivine and chromite, the deposits appear to be derived from the débris of a mass of serpentine known as Mount Solvaiska or the White Mountain. The platinum is found in grains and nuggets; the largest of the latter known, weighing about 320 ounces, is in the Imperial Museum at Vienna. The yield varies from 39 to 195 grains per ton. The richest deposits, those of the Martian River, are from 13 to 16 feet thick, and are covered by 60 to 70 feet of overlying material, chiefly clay. The conditions of occurrence in the other localities are similar, except at Gora Blagodat, where the bed-rock of the alluvium is limestone, but outcrops of porphyry and serpentine are found in the vicinity.

In the platinum sands and gravels are occasionally found masses of the metal associated with and occurring in chromite; and as in the platinum gravels serpentine is always found associated with an abundance of chromite, it seems

evident that the source of the platinum must be in serpentine, originally a peridotite.

The first discovery of this metal in the Urals was made in 1824, and from that time till now, the richest yield has been along the valleys of the Martian and Tchaouch Rivers, and of the River Isa, in the neighboring district of Nijni Tourinsk. Thus far it has only been mined from the placers, but the theoretical conclusion previously referred to, that its source is really in the serpentine rocks, which had come to be generally adopted of late by the Russian geologists, has now been fully established. The first actual discovery of platinum in the rock was made accidentally in 1892, by a workman, in the Martian River district. The locality was subsequently examined and reported upon by Professor Inostranzew, with full confirmation of the occurrence of platinum *in situ* in the serpentine.

This rock, however, is itself a secondary one, resulting from the alteration of others, usually of the massive eruptive rock, termed peridotite, which occurs largely in this eastern part of the Ural system. Professor Tschernitschew, in a recent memoir on the region, traces all the serpentines of the Urals to the alteration of peridotites and diallage rocks, and holds that this process was accompanied with the separation of the chromic-iron, which plays so important a part in many of the serpentines, both there and elsewhere, and with the precipitation throughout the rock of both platinum and gold.

The gold deposits are partly the property of the crown or its lessees, and partly of private individuals; but in the latter case there is often a reservation of minerals which are subjected to royal rents. The rate paid by the crown lessees is from $8\frac{1}{2}$ to 20 per cent., in addition to which a 3 per cent. tax is levied on all gold produced in any of the mines, the entire output being compulsorily salable to the Government.

The whole gold product of the Urals and Siberia is sent to the imperial assay office at Ekaterinburg, where it is melted and cast into bars, the assay of which forms the basis of final settlement between the Government and the miners.

Platinum working, on the contrary, is free from all taxation, and as the Government monopoly of refining, which was kept up for a time, has been abandoned, the product is mostly placed on the London and Paris markets, and there controlled by one or two individuals.

In working the alluvial gold deposits, two methods are followed. In the first, the plant and apparatus are provided by the ground owner, who hires labor and directs the operations either personally or by deputy; while in the second, a system of tribute is followed, the ground being let to free laborers or starateli, who provide everything necessary for working, and deliver the product at a fixed rate to the proprietor. This price may vary, according to the difficulty of working, from \$9 to \$10.50 per ounce; but in all cases the prime cost in the proprietary workings is higher than in those of the free laborers, who are able to handle, with a profit, material with but from 8 to 10 grains of gold per ton. Platinum sands are considered poor when containing less than 45 grains of the metal per ton, and rich when above 180 grains. The lowest profitable limit seems to be about 39 grains.

*The platinum workings of Avorinski are at present the most important of that class. The deposits, from 13 to 16 feet thick, lie upon a conglomerate of serpentine, and are covered by nearly 80 feet of barren material; they extend for about one-and-a-half miles, with a breadth varying from 70 to 250 feet.

At Avorinski the average yield is about 87 grains of platinum minerals per ton; but in places it goes up to twenty, thirty or even fifty times as much. The working is entirely subterranean, but open, small pits 70 to 80 feet apart being sunk to the deposit, and the material, drawn to the surface by windlasses, is washed in the ordinary Siberian frame at the mouth of the pit. About 400 hands are employed, the work going on night and day.

The crude platinum contains about 1 part in 4,000 of

*The illustrations taken at the time by the author are reproduced in the volume on Mining, 11th U. S. Census, 1890.

gold, which is separated by amalgamation and washing with water in large capsules. The final product contains 90 per cent. of platinum.

Besides the platinum found from Gora Blagodat, not far from the Isa River, to Nijni Tagilsk, a distance of over fifty miles, it occurs also near Miask, more than 100 miles further south. But here, only about 1,200 ounces are obtained annually, while the yield of the entire Urals is about 55,000 ounces.

The platinum district of Isa River and its tributaries is worked by the Government, and by a number of private owners jointly with the Government. The platinum is whiter than that of any other district; whereas that from the Demidoff estate in the Martian Range, farther south, has always a rusty appearance.

PRICES PAID FOR PLATINUM WIRE.

	Per Ounce.
1883	\$7 35
1884	7 80
1885	7 75
1886	
1887	7 80
1888	7 65
1889	8 50
1890	12 95
August, 1890	17 00
December, 1890	17 00
January, 1891	16 85
February and March, 1891	14 00
April and May, 1891	13 00
June, 1891	12 00
August, 1891	12 50
September, 1891	11 00
October, 1891	10 20
November, 1891	9 80
December, 1891	9 40
December, 1894	11 00
May, 1895	10 40
May, 1896	12 40
May, 1897	14 00
July, 1898	14 40

Leaving now the mining of the precious metals, we turn to the iron industry of the Urals, which presents some feat-

ures of special interest. We have already noted the smallness of the iron product of Russia as compared with that of the United States (8,623,127 long tons in 1896, and 9,652,680 long tons in 1897), and assigned as the cause, the lack of transportation facilities. But the Russian iron-work, notwithstanding, is well deserving of attention.

At Zlatoust, formerly the terminus of the Orenburg Railroad, in the very heart of the Urals, there is a Government armory, where many of the firearms, swords and other weapons used in the Russian army are made. In addition to the arms, some remarkable specimens of cisselier or chisel work, repoussé work and etching of iron and steel are executed here in great perfection, principally in the ornamentation of table knives, daggers, swords and quaint oriental weapons. This etching and ornamenting of iron-work is also done by a number of local masters throughout the district. Some remarkable examples were presented to Sir Roderick Murchison, and are on exhibition now in the Royal School of Mines in London.

From these armory works at Zlatoust there was sent to the Columbian Exposition at Chicago a remarkable display of iron and steel products, comprising over 150 articles illustrating the skill and taste of the Russian ironworkers. Among these were weapons of all kinds—swords, sabres, hunting knives, etc.—some forged, others cast, many damasked, all elegantly ornamented and mounted; then a series of table knives and fruit knives, the blades decorated with designs in blue or gold, fruit knives gilded, nickel-plated, etc., the handles of wild-goat's-horn, ivory, ebony, malachite, jasper, all elaborately wrought and ornamented, and a number of miscellaneous articles of *vertu*, all designed and manufactured at this remote spot, the very name of which is scarcely known to most of our people.

At Kasli, 130 versts south of Ekaterinburg, and about the same distance north of Zlatoust, are situated the Kasli Iron Works, remarkable for their fine artistic castings.

It may be of interest to mention that these Kasli Iron Works daily cast kettles, or gypsy or caravan cook pots, to the extent of 32,400 pounds. These are of remarkable thin-

ness, weighing less than 30 pounds each, although more than 3 feet in diameter. They also make lavabos, or laving dishes, used by the Mohammedans in their religious ablutions, which they are supposed to perform every day. These are hauled by horses to Troitzk, about 150 miles, where they are purchased by the Khirghes, Persians, Turkomans, natives of Siberia and other oriental countries, who carry them away on camels, and who use up the product of these works, amounting to 550 tons a year.

The engineer, Karpinsky, whom I had the pleasure of meeting after visiting the works, had the courtesy and generosity to present our United States National Museum with a large series of these articles.

At Troitzk, in Orenburg, in the steppes east of the Urals, a great fair is held every May, when thousands of camels are brought to that city (which is the beginning of the Orient in every sense of the word) bringing Eastern products and returning loaded with these pots. Camels with one hump carry two loads of ten poods each—720 pounds. These camels sell as high as \$125, whereas a camel with two humps, which is only able to carry one load of ten poods—360 pounds—sells for only \$60 to \$75.

An important economic mineral of this region is chrysotile, a fibrous serpentine, often called asbestos, and sold as such. It is extensively worked near Baschenova, twenty miles off the Siberian road, near the old emerald mines. Over 1,000 men and women are employed here, who generally come some distance from the surrounding country, and must obtain leave of absence from the chief of police of their district—their papers requiring a number of revisions during a year—as unrestricted migration is not permitted in Russia. The working is all done by stripping the serpentine in layers of 4 to 5 feet deep.

While visiting the Petrokamenski Savod, Government of Perm, my attention was called to a new discovery of chrysotile on the Wuoluij River, seven or eight miles west of Petrokamenski Savod, which is likely to be of great importance. It is found loose in the soil, as well as attached to the serpentine. Part of the material found here consists

of masses in which the fibres are over five inches in length, of remarkable purity and strength. From the fact that this locality is at so great a distance, 120 miles, from Baschenova, there is every reason to believe that this useful industrial mineral, which is commercially used for many of the purposes of asbestos, may exist in large quantities in the Ural Mountains.

In 1891, in the Revdat district of Revdenski, a series of nickel ores occurring in serpentine was found, resembling in many respects the minerals found at Riddle, Douglas County, Ore. To one of these dubious silicates the name of Karatskoffite has been given.

Immense tracts of peat or turf exist throughout the Urals. Should the use of this become general, an opportunity would be afforded for the regrowth of the forests for which this region was so remarkable less than half a century ago. Wherever the original growth of pine has been removed, the second growth is always one of birch, the bark of which is extensively used throughout the Urals for milk-pails and other utensils. The peasants have also begun to use turf instead of wood as fuel; and the Syssersk Iron Works began to use it only a few years ago, for the smelting of iron. These turf deposits were described and their extent remarked on by Ludwig, as early as 1846.

In addition to the cutting down of the forests for fuel, may be mentioned the ravages made on these pine woods by a bombycid moth (*Bombyx piniperda*). For a distance of over three miles a little south from Vavlamova, Government of Perm, these insects have killed every pine tree on both sides of the road. Strange to say, the birch trees are not injured, but every pine has been destroyed, with the exception of a few trees that were isolated in a group of birches, suggesting that a border of birch trees would prevent the ravages of this destructive insect.

About nineteen-twentieths of all the buildings in Russia are of wood, and these are entirely destroyed by fire once in fourteen years. These fires are often very disastrous. In May, 1890, for example, a fire at Neviansk Savod destroyed 1,800 houses, and thirty-eight persons lost their lives, either

by fire or by drowning in the lake whither they were driven by the flames. In June of the same year, at Kanova, a village ten miles from Neviansk, more than fifty houses were destroyed.

In the south of Orenburg, in the Bashkir country, where trees are scarce, one can always be sure that a wood or grove marks the site of a graveyard, in which, if uninformed, one might camp for a day without knowing what it really was, as only an angular stone, from 1 to 3 feet high, is placed on the spot to mark a grave. These rocks project in all positions, and rarely, if ever, does one of them bear an inscription.

My friend, Mr. H. Templeton Ellicott, an English mining engineer, who had rendered the Bashkirs many services and won their favor, was offered the highest honor that a Bashkir can offer a Christian—the privilege of having his body interred in a Bashkir graveyard at his death. Mr. Ellicott, up to the present time, has not accepted the honor.

South of the Bashkir country and near Kushva, in a district over ten miles long, an immense amount of mining for gold is carried on, frequently in a very primitive manner, by the peasants, who either work alone or have a very small force of men digging out the alluvial gravel from a depth of 6 to 20 feet.

I was especially struck with the curious homes of these people. The entrance to some was below the surface of the ground, the roof projecting only from 2 to 4 feet above the ground, the small window running from the ground to the roof, and the steps going down inside of the house.

But, in addition to their metallic wealth, the Ural Mountains have for nearly two centuries been noted for their remarkable productions of gem-like minerals and gems that, for beauty and quantity, have given this region a foremost place in the mineralogical collections of the world.

In particular, the magnificent emeralds, alexandrites, phenacites, gigantic beryls, topazes, tourmalines, green garnets, amethysts, and the great variety of jaspers of all colors, are among those of the greatest interest.

Catherine I, wife of Peter the Great, who named Ekaterinburg in her honor, first paid attention to the development

of the precious-stone industry in the Urals; and two of the amethyst mines near Mursinka are to this day called Taljan, a corruption of Italian, she having sent two Italian lapidaries to this region for the purpose of developing the gem resources, founding the lapidary works and establishing an industry which gives employment to at least 1,000 people in this remote region at the present time.

The chief gem districts of the Urals are all within one hundred miles of Ekaterinburg, some eight or ten miles apart. In this limited territory there are over 100 mines or localities where minerals and gem stones of more or less value and great variety are extracted. The rocks comprise a number of kinds of granites, gneisses and related types, some of them quite peculiar, and are seamed and penetrated with granitic veins and dikes, giving evidence of great disturbance and frequent igneous intrusion. Among the more valuable gem minerals here found are sapphire corundum, in some cases of beautiful blue, occurring in a peculiar rock composed of corundum and orthoclase feldspar; topaz crystals, in cavities in true granite veins, with rich green amazon-stone and quartz crystals—a combination suggestive of some of our own Colorado localities; zircon, beryl, phenacite, and a host of other interesting minerals less familiar but sometimes very beautiful as specimens or ornamental stones, or valuable for economic uses in the arts.

The occurrence of the diamond in the Urals has for a long time been questioned. In a collection at Nijni Tagilsk I saw a small white crystal weighing $\frac{1}{8}$ of a carat, a twinned hexoctahedron, which was pronounced phenacite by a local mineralogist, who had taken its specific gravity; but which is, as the writer identified, a small opalescent white diamond, similar to those found at the Bagogem mine in Brazil. It was found in a small brook, near the village of Kalstchi. The existence of pyrope garnets here, and their frequent finding, seems to sustain the theory of their origin, although some of the Russians are quite sure that the Russian who found the diamonds for Humboldt had really deceived him.

The admirable volume on the "Genesis of the Diamond,"

Sapphire

by the late H. Carvill Lewis, edited by Prof. J. T. Bonney, and the review of the same in *Science*, by the author, G. F. Kunz, fully discuss this subject, and in the Report of the United States Geological Survey, 1896.

At Kornilowog, and near the village of Chitanka, in the washing for gold, transparent corundum is found in the form of sapphires of pale blue color, also yellow, and rubies, light red, sometimes streaked with blue, resembling the Ceylonese rather than the Burmese, and green sapphires associated with fine ruby-red pyrope garnets, blue chalcodony, transparent zircon, quartz, etc. A ruby or sapphire worth \$100 is of exceedingly rare occurrence, although many are found that sell for from 1 to 20 roubles each.

The emeralds, alexandrites and phenacites of the Urals are all from one small region, on the right bank of the Bolchoi Reft, a little north of Takowaja, fifty-one miles northeast of Ekaterinburg and quite apart from the other localities in Perm.

The emerald mines consist of four large groups of mines and a number of smaller workings; starting a little north of Takowaja, running north and west a distance of some seventeen wersts, or ten miles.

The Troitzk mine is about the central one of the group; the excavations are 1,000 feet in length and 200 feet in width, with shaft holes, wheels, etc., as the evidences of deep, extensive workings. These mines were operated by Pavlevsky, and also under the crown.

The Lubinsky mine, also a crown working, is two wersts north of Takowaja; the rock here is principally mica schist interspersed with actinolite and talcose schist. At the Krasnobolskaia, ten wersts south of Troitzk mine, the old shafts, drifts and workings indicate a vast amount of labor formerly carried on. This is the locality that has furnished the alexandrites and phenacites, as well as emeralds.

The Marienski emerald mines, seven wersts (five miles) north of Troitzk, are marked by several workings over 200 feet in diameter.

Among the associated minerals I observed quartz, feldspar, mica schist and chlorophane.

1898
60
ca 1838

This is the chlorophane mentioned by Pallas, so highly phosphorescent and sensitive, that it emitted light by the heat of the hand.

These mines were systematically operated fifty or sixty years ago, at an annual rental to the Government of 60,000 roubles (\$45,000)—a charge which finally led to their abandonment, because the mining did not pay at so high a rental. Fine roads were laid to the great Siberian Street, twenty-one miles distant, and mining was conducted on an immense scale; for a distance of some ten miles along the course of the emerald veins, in a line running northeast and southwest, shafts were sunk and tunnels were driven in the talcose schist and mica slate in which were found the fine gems. Strange to say, although now these mines have not been worked for over forty years, and are carefully guarded by the imperial woodkeepers, we see from them to this day single gems for sale in Ekaterinburg, some of them valued at \$300 each. It is hard to believe that these are from the original workings of the mine. Possibly they are sold by peasants, who have found them in re-working the old dumps, or who secretly work the mines when they are not watched.

Here also was first found the mineral phenacite, which received its name from *phenos*, meaning deceiver, and *lithos*, a stone, because it was long mistaken for white topaz. It is one of the most brilliant white gems known, but lacks the play of color possessed by the diamond. It was formerly found in connection with alexandrite, a chrome-green variety of chrysoberyl, which exhibits the property of changing from a green by daylight to a columbine or raspberry-red by artificial light. It was named alexandrite in honor of the Czar, Alexander II, by Nordenskiöld, in 1842, who discovered it in the then famous emerald mines at Takowaja.

The alexandrites when cut as gems weigh from $\frac{1}{8}$ of a carat up to (very rarely) 5 carats each, though crystals and groups of crystals weighing 20 pounds have been found, so rare is it to obtain perfect pieces even in the large crystals.

About seventy-five localities (see map prepared by P. Kalugin, of Neviansk Savod) in the Government of Perm,

furnish gems or gem minerals. These are at present the property of the Czar, and are worked irregularly by the peasants, when their crops do not require attention.

Little has been done in any of the workings in the way of systematic mining, the method consisting generally in stripping off the rock, or simply following a vein with the use of as little timbering or pillar-building as possible. None of these mines show any great amount of work done; and from what I ascertained on my recent trip, the rights to mine may be offered for sale at a prohibitory figure, as was the case with the emerald mines, resulting in a complete suspension of the search for these minerals, whose finding, working into gems, and sale, furnished a livelihood to fully 1,000 peasants and lapidaries.

Here have been found marvellous crystals of transparent aquamarine, notably the one found on November 19 (December 1), 1828. This is a dark asparagus-green crystal, weighing $6\frac{1}{2}$ pounds, brilliantly transparent, doubly terminated and beautifully marked with etched planes. It was acquired by the museum of the Imperial Mining Institute of St. Petersburg, and was then valued at 43,000 roubles, equalling at the present time \$23,000.

At Lewaschinagorka, one mile east of Alabashka, there was found in 1888 a fine yellow crystal of beryl, 5 inches in length and weighing 8 ounces, of a beautiful golden color. Another beryl was found in the mountain of Zolotonah, near the village of Ujakova. This measured 5 inches in length, 2 inches in the widest part and $2\frac{1}{10}$ in its narrowest. It is doubly terminated, with a basal plane at one end, and with pyramidal faces at the other. It is a beautiful sea-green color and showing at the face the pyramid, a slightly fibrous structure is developed.

It weighs $436\frac{1}{2}$ grams, almost 1 pound avoirdupois. Both these beryls are now in the remarkable collection of Russian minerals belonging to Harvard University.

Lewaschinagorka is about a mile east of Alabashka, in the Biserk (district) Alaraensky. A working, irregular in shape, 1,000 feet long and 40 to 50 feet deep, and 50 to 60 feet wide has been made here. It was at this locality

Same
as
described
by
Rose

that the writer obtained the large yellow beryl crystal, now in the Garland Collection at Harvard University, was found. The rock here is pegmatite.

Black tourmaline occurs, plentifully interspersed in the orthoclase of all the gem-bearing veins of this district.

Beautiful blue, sea-green and white and sherry-colored topazes, generally transparent, are found at Alabashka and adjoining localities in Perm, some crystals weighing from a few ounces to 4 pounds each, notably a 4-pound one now in Harvard University, in the collection before referred to. There was a great yield in 1880 to 1882, producing many hundreds of crystals absolutely transparent and furnishing gems weighing over an ounce each, at Alabashka, which is situated on a small river of the same name. A number of excavations here have been made varying from 50 to 500 feet in length.

The famous red tourmalines—rubellites—formerly obtained from Chitanka and now from Sarapulka, and one or two other localities, are the most magnificent ever found as crystals, although they rarely afford gems.

At Sarapulka, in the Bizerk of Rejscheski, there are two localities, about 100 feet apart, on the side of a hill, which is one of a number, none of them higher than 100 feet, in a beautiful fertile rolling country. One of these mines was opened over a century ago; the other in 1841. At this place the excavations are now 150 feet wide, and at a depth of 30 feet a shaft is sunk in one of them. Numerous small workings are about it.

Perhaps the most magnificent gems from the Urals are the wonderful royal purple amethysts, changing to red by artificial light, that are found at about forty localities in the Government of Perm. For intensity of color and perfection of quality, and one might say majestic beauty, these rival almost any other colored gem. A series of them was exhibited at the World's Fair at Paris, in 1889, five of which were presented to the Czarina by the peasant who found them. Two of these measured nearly 2 inches across, and are royal purple by day, changing to rich red wine-color by artificial light, as do nearly all the Uralian amethysts.

topaz

1798

Besides the purple quartz, or amethyst, other colored varieties of quartz occur, and mention may be made of the smoky shades, which may be altered by heat to rich deep yellow, forming the so-called quartz topazes.

M. Kleiner* says that the miners in the Government of Perm found that crystals of quartz and smoky quartz when taken from the ground and exposed to the air frequently became filled with rents, flaws and turbidity; but that if, immediately upon finding, the crystals were packed in damp sand or other material, and then put in a box and allowed to remain for one or more years in the cellars of their houses—which in the Urals are very warm—their color would not change as it did if exposed at once to the air. This is probably due to the fact that the crystals contain large quantities of liquid carbonic acid, and that at the temperature at which they are taken out, generally in spring or winter, the cavities would explode; whereas, by covering with sand, the same temperature they were found in was preserved.

Kleiner also states that to impart to the smoky quartz a golden yellow color, the peasants would put them in a loaf of bread and then bake them in the oven. When the color was not sufficiently changed, they were baked three or four times. He remarks, however, that the crystals often exploded before they changed color, which fact would substantiate the view that they exploded through the agency of the presence of carbonic acid gas that produced the turbid marking and rents on exposure to the low temperatures.

One of the most beautiful of all gems, and one that was not known two decades ago, is the demantoid (green garnet), or "Uralian emerald," erroneously extensively sold as olive, found at Poldnewaja, near Syssersk, in the Government of Orenburg.

This form of garnet varies from yellowish-green to a most intense emerald-green, and possesses a high power of refracting light, showing a distinct fire like the diamond or zircon, so much so that in the evening it has almost the appearance of a green diamond. It is found as rounded nodules in a

* Mineralogisches Verein Russland, St. Petersburg, 1842.

curious serpentine-like rock, and also as loose grains in the gold washings, selling in small gems (the most desired) for almost the price of diamonds of the same size.

The rare mineralogical deep blue gem, euclase, has been found for the past forty years in the gold washings on the River Sanarka, associated with cyanite, for which it was at first mistaken. In 1889 superb sapphire-blue euclases, one a crystal $7\frac{1}{2}$ centimeters long, were found here, one of which was cut into a gem of 4 carats, and sold for over \$500.

Passing now from gems and precious stones to the ornamental stones for which Russia is justly celebrated, we note particularly rhodonite, malachite, jasper and lapis lazuli. The malachite of Nijni Tagilsk has been already referred to, and the use of this beautiful material in works of art is a peculiarly marked feature in the palaces and cathedrals of Russia, and in the Russian exhibits in all the great international expositions.

Lapis lazuli is found not so much in the Urals as farther east, in Siberia, in the neighborhood of Lake Baikal. From this far-off region has been brought the material used for veneering the celebrated lapis lazuli columns in the cathedral of St. Isaac's at St. Petersburg, and for many other elegant works of art in the imperial palaces.

Another of the most beautiful ornamental stones—labradorite or opalescent feldspar—is found at a locality in the Government of Kiev, where works for cutting it were founded in 1849 by the proprietor of the estate on which it occurred. This establishment was represented at the World's Fair by a number of articles. The yearly product is estimated at some \$26,000, all made by handwork.

Rhodonite (silicate of manganese), in greater quantity and of finer color than anywhere else in the world, is found in the Ural Mountains, in the village of Sedelnikowja, thirteen miles southwest from Ekaterinburg, and at Malazidelinki, some eight miles farther. Its color varies from the richest deep warm pink to a reddish brown. Chemically, it is composed of silica and manganese; and it is almost always associated with pyrolusite and psilomelane, black oxides of manganese, which mark and streak the stone, frequently

adding greatly to its beauty. Its hardness is nearly 6.5, about that of the harder varieties of feldspar and of jade, although not so tough as the latter.

Nearly all the rhodonite of commerce is brought from this Russian locality, where it is found by the ton.

Pieces of fine pink color without the black streaks of oxide of manganese are exceptionally rare, so much so that when the late Empress of Russia, who was very fond of it, ordered, it is said, a piece cut the size and shape of an egg, that was to be free from all blemishes or black streaks, over one ton was cut for this purpose without obtaining enough for the desired piece.

Nowhere else in the world is jasper so abundant, and found in such endless varieties of color; it is obtained principally in the Government of Orenburg. One of the most highly prized colors is a rich gray-green; and also red, mottled with yellow and green, which form an endless series of combinations. It also is found in beautiful colors in the Guberline Mountains, near the city of Werchne Uralsk, 100 miles south of Zlatoust. A superb green jasper is obtained from the River Achtuba and from the River Ohra.

The jasper found in the Kalkansky Mountains, ninety-five miles from the city of Ohrsk, in the Urals, is of a gray to a grayish-green color, with a very fine-grained texture, and is an ideal substance for lapidary work. The most delicate touch of the wheel or graver is perceptible. The stone admits of a high polish, but the texture is so fine that a dull or mat surface is equally beautiful. It may be likened to a rich gray putty, on which the slightest touch of a razor-edge remains as a true impression. The contrasts between the polished and dull surfaces afford opportunity for very beautiful effects. This is one of the most highly prized of Russian ornamental stones.

I was present when a dish of Kalkansky jasper was presented by the city of Tscheliabinsk, in the Government of Orenburg, to the Czarevitch, on the second of August, 1891, at a reception given him at Troitzk (the first city out of the steppes), on his return from the great trip across Siberia.

This dish, which was 18 inches in diameter, represented a fluted platter, entirely covered with grape leaves, most of which were arranged or laid on so as to have the under or pale side up. At the edges, however, the leaves were turned up and over, so that in looking down on the dish the leaves all around the edge showed their bright upper side to a height of 2 inches, thus forming a border. The outer and upper edges, as well as the veinings on all the leaves, were polished, while the lower side of the leaves that was visible was dull. The grayish-green color of the Kalkansky jasper when unpolished exactly simulates the dull tint of a grape leaf. Several men were steadily employed for one whole year on this dish alone.

With this was also a small salt-cellar, similarly made of grape leaves, the stems of the leaves serving for feet, to carry out the ancient custom of presenting royalty with bread and salt on entering a city.

The Russian Czars have taken pains to develop the industries connected with these valuable and beautiful materials, and have founded great establishments for cutting and polishing ornamental stones, at which a kind and amount of work has been produced, that is not equalled in the world. Chief among these are the Peterhoff Lapidary Works, at St. Petersburg, the immense establishment at Ekaterinburg, in the Urals, and the lapidary works at Koliwan, in Siberia.

Of these great Government workshops and their products, it is fitting that some account should be given here.

Many small and choice objects, as well as fine mosaic work of hard stone rivalling anything ever produced elsewhere, are made at the Peterhoff Lapidary building, established by Catherine II in 1775; situated between the new and old Peterhoff palaces, about forty minutes' ride from St. Petersburg. It is a three-story building with palatial interior decorations. The central hall is 150 feet square, and the entire building is an example of imperial magnificence. One is surprised to find marble staircases, marble floors, fine high ceilings, and the most elaborate machinery for stone-work. One floor is entirely filled with glass cases

not
mentioned
by Rose

containing stones to be worked up in the building. Here are expended annually 40,000 rubles, with sixty-four permanent and eleven temporary workmen.

The lapidary work of the Ural materials is all executed either at the Imperial Lapidary Works, at Ekaterinburg, or in the vicinity by the lapidary-masters, as they are termed, who employ the workmen or apprentices, each having his own peculiar style. The product of these latter is sold to the dealers at Ekaterinburg, who visit the Nijni Novgorod, Moscow and Ekaterinburg fairs.

The Czars have always manifested great interest in these lapidary works; and at Ekaterinburg is still on exhibition, preserved in a glass case, the cutting-tool used by the Emperor Alexander I, who worked here more or less, and became quite an expert lapidary.

A training-school connected with these works was started in 1877. At present there are fifty-five boys as pupils, who draw and design for nine months in the year, from nine to eleven o'clock, have one hour for recreation, and then model till two o'clock. The graduates have the option, either of remaining as lapidaries in the Government works, or of becoming master-workmen on their own account.

The lapidary works at Ekaterinburg, founded in 1765, and at Kolivan, in the heart of Siberia, in 1787, are so situated that they have command of an immense water-power by which they are run. These works are on a large scale, so that enormous masses of hard stone can be as readily worked as marble is throughout Europe. Those at Kolivan, in the Government of Tomsk, deal chiefly with stones from the Altai Mountains.

Many of the machines are of a primitive character, and have not been changed during the past century. But the facilities for sawing and for drilling of large columns, for ornamenting or for lightening large masses of stone, for channeling, grooving, polishing, etc., are ingenious, and are manipulated with the greatest skill. The annual product of these two establishments amounts to some \$35,000, and is entirely for Government use, either in the palaces and public buildings, or for imperial gifts.

The various forms of lapidary work may be divided into three classes. First, the manufacture of vases, dishes and paperweights, often of large size, but invariably made of jasper, rhodonite, malachite, lapis lazuli, aventurine or the like. When the objects are of malachite or lapis lazuli, the body is made of slate or other readily-worked stone and then veneered with a thin coating of these more precious substances. Jewel-caskets, seals and small charms are made either plain or fluted, or are ornamented with leaves, scroll-work or other devices; also seals and cameo-work, such as animals and busts of prominent persons, as the reigning Czar, Turgenieff, etc.

Second, the manufacture of objects of a peculiar kind of mosaic work, somewhat in the Florentine style, and yet very different, made of such stones as perfectly simulate berries, fruits, leaves or flowers.

The unique feature which distinguishes this work is that while mosaics, properly so called, are flat and inlaid, here the objects are represented in their actual form and size. The favorite designs are fruit-groups, which are so accurately matched in color and carved in form that they are exact reproductions in stone of the real fruits, resting upon a dish or pedestal of jasper or black marble. Thus, for raspberries, rhodonite of dark pink color is used; for red or black cherries, a peculiar-colored sard and black onyx; for white currants, rock-crystal spheres, slightly smoky, which are cut hollow in the center, and the inner parts are so engraved as to simulate perfectly the seeds. The leaves are generally made of noble serpentine. For grapes, a peculiar-colored sard, black onyx or dark purple amethyst is used; black onyx for blackberries, and a yellow jasper for mulberries; and these fruits are generally massed on pieces of jasper, or placed on jasper dishes, and are marvellous for their exactness as to the color, lustre and form of the natural fruit.

Third, the cutting of faceted stones for jewelry, such as aquamarine, sapphire, ruby, topaz and quartz of various colors, and the royal amethyst from Chitanka and Mursinka.

The Ekaterinburg Lapidary Works at present employ

seventy-five men, receiving 25 roubles per month each (\$12.50), and ten boys at from 2 to 10 roubles each per month (\$1 to \$5). Forty thousand roubles are annually expended here.

In 1830 there were 150 men employed. All the designs for these works are made at Peterhoff. A wax model, the exact size of the object, is made by expert modellers and then handed to the lapidaries to copy. The original designs are returned to St. Petersburg, to remain secret in the cabinet of the Czar.

In August, 1891, there were at least 36,000 poods, or over 1,000,000 pounds, of rhodonite, jaspers of various colors, jade and other allied hard stones, at the Ekaterinburg Works. One single block of rhodonite weighed 1,500 poods, or 54,000 pounds. A mass of Kalkansky jasper weighed 500 poods (18,000 pounds). These may seem immense blocks of stone, but in 1869 a mass of rhodonite was brought to the Ekaterinburg Works weighing 2,850 poods (102,600 pounds). It was transported on immense sledges made of iron and wood, and was drawn by ninety horses, or, more strictly speaking, by thirty troikas tied together, one after the other. These were driven by more than fifty men, who shrieked, whistled, swore and beat the horses, and an entire week was required to transport the stone from the mine at the town of Sedelnikowja, about fourteen miles southwest, to Ekaterinburg, a rate of about two miles a day.

It is only on reaching the finishing-room of the great lapidary works that one realizes the imperial grandeur of what is accomplished here. A pair of magnificent Kalkansky jasper vases and pedestals, measuring six feet in height, occupied the time of half a dozen or more men for six whole years.

In 1840 there was finished a large elliptical jasper vase, now in the Winter Palace at St. Petersburg. It is one meter in diameter, and required just twenty-five years to complete. Time seems to be no object; there is no haste. Everything goes to the Czar, either for the adornment of his palaces or as imperial gifts; and whatever is not up to the standard is sold. The two imperial lapidary works are run at a cost of

80,000 to 100,000 roubles annually, paid from the private revenue of the Emperor.

One of the most remarkable pieces of lapidary work ever attempted is the sarcophagus of rhodonite now in process of making for the widow of the late Czar, Alexander II. The block weighs 800 poods, or 28,800 pounds. This may require at least ten years more to complete. A monument of green jasper was also made for her, which was brought from the Altai Mountains in Siberia.

These establishments have made Russia famous for wonderful objects of this kind, nearly all of which are of imperial character. Among the more notable of these may be mentioned the two vases of Siberian aventurine (oriental sunstone), a quartz containing brilliant spangles of mica, one of which was presented to Sir Roderick Murchison, and is now at the Royal School of Mines, in London, and the other to Alexander von Humboldt, and now in the Mineralogical Museum of the University of Berlin, in recognition of the services done by these two eminent scientists in their travels in the Urals.

Dishes, mantels, tables and other objects made of lapis lazuli and of malachite, are to be seen in the Louvre, at Petit Trianon, and at the royal palaces throughout Europe; and the celebrated columns veneered with lapis lazuli and malachite, over twenty feet high, at St. Isaac's Cathedral, and the immense dishes at the Ermitage and other palaces in St. Petersburg.

The Alexander Column was designed by Montferrand, in 1834, at the command of Emperor Nicolas I. This column, of polished red granite from Finland, is 82½ feet high, 13 feet 3 inches in diameter, and rests on a polished block of red Finland granite, 26½ feet square. It is surmounted by a bronze angel 13 feet high, holding a cross 10 feet high, and crushing a serpent underfoot.

In the porticoes of St. Isaac's Cathedral are over forty-eight polished columns of red Finland granite, 56 feet high and 6'6 feet in diameter, resting on immense steps of polished granite, each of a single piece.

The west entrance of the Ermitage is supported by eight

pilasters, against each of which leans a dark-gray granite polished figure from Sserdobol. Each pilaster is 19·8 feet high, supporting the roof. These are only a suggestion to the wonderful interior,—one hundred and twenty columns, all of which are of marble, granite, jasper or other costly material.

On the Anitschkow Bridge over the Fontanka Canal, St. Petersburg, are four colossal bronze horses after the models of Baron Klodt, of St. Petersburg.

From a careful examination of the Russian gem minerals, namely, amethyst, ruby, sapphire, beryl, tourmaline, colored topaz, chrysoberyl, alexandrite, etc., it is my conviction that they suggest an identity of occurrence in the crystalline rocks with those of Ceylon, Japan and Madagascar, and of Oxford County, Maine.

The finest collections of Russian minerals are in the Imperial Mining School, in the Imperial Academy of Science, and the Kotchubey Collection in St. Petersburg, the Kokscharow Collection in the British Museum, the Duke of Leuchtenberg Collection in the Mineralogisches Institute at Munich; and, in the United States, in the collections of Harvard College, Cambridge, Mass., the Field Columbian Museum, Chicago, that of Mr. Clarence S. Bement, and the late W. S. Vaux and Mr. George Vaux, of Philadelphia; also in the American Museum of Natural History, and the School of Mines Collection, New York, and in the National Museum at Washington, D. C.

Finally, a few words may be said as to recent archæological investigations in the Ural region, a great district about which there is yet much to learn; and, although its mines and minerals have been studied so well as to make the memoirs upon them classics for the entire world, the archæology and anthropology are not so thoroughly known.

The low water in the Ural region during the summers of 1890 and 1891 afforded an unusual opportunity of examining the lake and river bottoms of this district. This was improved by the Uralian archæologist, Prof. C. Clerc, my esteemed friend and adviser, who accompanied and guided me on my trip with untiring devotion and courtesy, who

has done much to advance the sciences in the Ural Mountains, and to whom I would here express my sincere thanks. His explorations resulted in the finding of some 60,000 objects in flint, jasper and other stones, some of them evidently of high antiquity. The study of these will probably give us valuable data as to the history of the region from an early date to the present time.

On the crest of a small hill, a couple of miles east of Ekaterinburg, are some very curious and interesting prehistoric localities, known as the Kamennya-palatki, or Stone Tents. These are elevated masses of the stratified granitic rock composing the hill, which have in some manner resisted weathering more than the rest, and now stand out on the summit like low towers or beehive-shaped huts. Their general form, and the strongly-marked horizontal layers of the weathered granite composing them, give them the aspect of half-ruined structures built by man. A few years ago a person seeking for gold or treasure discovered at the base of these "Stone Tents" some remains of ornamented pottery; this led to careful examination by archæologists; and there have since been obtained, beneath, around and on the top of them, many interesting objects, indicating that these singular natural formations were a favorite resort of men in prehistoric times. Dr. Clerc, who has written and published largely in regard to them, suggests that they may have been used partly as places of sacrifice and partly as lookouts or watch-towers. He even inclines to the belief that man has aided nature somewhat in shaping them into their peculiar forms. The objects found include ornamented pottery, stone implements, a rock-crystal bead and fragments of bones. The further discovery of a small bronze arrow-head in the vicinity, associated with remains otherwise similar, leads M. Clerc, with M. Malakhoff and others, to assign the whole to the close of the neolithic period, when bronze, although known, was still rare and valuable. Other similar natural structures, some of larger size, occur at several points in this region, and have yielded similar traces of having been long frequented for some purpose by prehistoric men.

