ABRASIVE MATERIALS.

BUHRSTONES.

The nearest approach to the hard French buhrstones is a stone occurring on an eminence known as Little Butte, in the Owen's River valley, Inyo county, California. It is hard, brecciated, and very much like the best French stone. The quantity has not been ascertained, but appears to be considerable. Although none of this material has been mined there is little doubt of its value for milling purposes, and it will probably be used in the future. In Ulster county, New York, the so-called Esopus stone has gained a definite footing as a substitute for buhrstone, for millstones for grinding chemicals and other materials except wheat. The production of this stone in 1885 is estimated at a value of $90,000. This, together with a less important production of Cocalico stone in Lancaster county, Pennsylvania, is the only domestic material used for millstones. The total value of all domestic millstones did not exceed $100,000 in 1885. The French millstones are seldom imported as such, but the stone is shipped in comparatively small pieces which are then dressed to a uniform size and carefully fitted together, making one millstone of the ordinary form. There is a continued decrease in the imports, due to the use of the roller process in flour mills.

Buhrstones and millstones imported and entered for consumption in the United States, 1868 to 1885, inclusive.

Fiscal years ending June 30—	Rough.	Made into millstones.	Total.	Fiscal years ending June 30—	Rough.	Made into millstones.	Total.
1868	$74,224	.....	$74,224	1877	$60,857	$23,068	$83,925
1869	57,942	$2,419	60,361	1878	87,679	1,928	89,607
1870	58,601	2,297	60,898	1879	101,484	5,088	106,572
1871	35,406	3,698	39,104	1880	120,441	4,631	125,072
1872	69,062	5,967	75,029	1881	100,417	3,495	103,912
1873	60,463	8,115	68,578	1882	103,287	747	104,034
1874	36,540	43,170	79,710	1883	73,413	272	73,685
1875	48,068	66,991	115,059	1884	45,837	263	46,100
1876	37,759	46,328	84,087	1885	35,022	455	35,477

GRINDSTONES.

The most noteworthy change in the grindstone industry during the year 1885 was the consolidation of the large producers in Ohio into the Cleveland Stone Company, which now furnishes nearly all the stone quarried in the State. The value of the total production may be estimated at $500,000, at an average value of $8 to $11 per ton.

Imports.—The importation of grindstones is given below.

Grindstones imported and entered for consumption in the United States, 1868 to 1885, inclusive.

Fiscal years ending June 30—	Finished.		Unfinished or rough.		Total value.
	Quantity.	Value.	Quantity.	Value.	
	Long tons.		*Long tons.*		
1868	.....	$25,640	.....	$35,215	$60,855
1869	.....	15,878	.....	99,715	115,593
1870	.....	29,161	.....	96,444	125,605
1871	385	43,781	3,957.15	60,935	104,716
1872	1,202	13,453	10,774.80	100,494	113,947
1873	1,437	17,033	8,376.84	94,900	111,933
1874	1,443	18,485	7,721.44	87,525	106,010
1875	1,373	17,642	7,656.17	90,172	107,814
1876	1,681	20,262	6,079.34	69,927	90,189
1877	1,245	18,546	4,979.75	58,575	77,121
1878	1,463	21,688	3,669.41	46,441	68,129
1879	1,603	24,904	4,584.16	52,343	77,247
1880	1,573	24,375	4,578.59	51,899	76,274
1881	2,064	30,288	5,044.71	56,840	87,128
1882	1,705	30,286	5,945.61	66,939	97,225
1883	1,755	28,055	6,945.63	77,797	105,852
1884	.....	.....	.....	.....	86,286
1885	.....	.....	.....	.....	50,579

CORUNDUM.

Emery and corundum are found in many localities described in former reports, but all the emery used is imported, principally from Turkey, and the production of corundum is limited to the deposits at Corundum hill, North Carolina, and at Laurel creek, Georgia, as described in the last report. The production has not been reported. The mines are both operated by the Hampden Emery Company, of Chester, Massachusetts.

Foreign sources.—An interesting description of the corundum deposits in Asia Minor is contained in the report of Mr. W. E. Stevens, consul at Smyrna, abstracted below:

"Emery stone is found in nearly all parts of Asia Minor, and not unfrequently in the remote and almost inaccessible regions of the interior, where the natural obstacles are too great to offer any inducement to the miner. The principal mines are confined to the districts of Thyra and Aidin, situated to the southward from Smyrna, and not far distant from the line of the Ottoman railway. These are known as: The Tchavus, within one hour's ride from the town of Thyra, owned by Mr. Frederick Charnaud; the Hassan Tchaouslar, owned by Mr. Jackson; the Aladjali Tchiflik and Kourchak, owned by Mrs. Abbot; the Halka or Saladin, owned by Mr. Frederick Charnaud; the Akdere, owned by Mr. Glyka, and the Gurnush Dogh, owned by Mrs. Abbot. There is another mine near Milassa, the stone from which is brought for shipment to a place on the coast called Kuluk, near the gulf of Mendalia. It is either shipped direct from that place to foreign markets or brought to Smyrna in small sailing craft for reshipment.

"When well picked and free from unsound ore and waste, the emery from the Charnaud, Jackson, and Abbot mines is of good and nearly

equal quality. The Glyka or Akdere stone is not as much sought after, while that excavated near Milassa, the larger part of which finds purchasers in the United States, is of inferior quality, the grain being smooth and a great deal of magnetic iron entering into its composition.

"The amount of stone annually shipped from Smyrna to Great Britain, the United States, France, Germany, and Belgium aggregates about 7,000 tons, the relative quantity consumed in each country being in the order named. In the matter of quality, manufacturers in France and Germany are extremely particular; they will have none but thoroughly picked stone, and willingly pay the highest prices to obtain it. In France, especially, Naxos emery, considered to be the best in the world, is used to the almost complete exclusion of all other kinds. In Great Britain, also, purchasers are particular as to quality; but in the United States, especially within a few years past, importers have encouraged the shipment of inferior or uncleaned stone, because of its lower price. Good clean lump emery stone can be contracted for here on board ships at $19.50 to $20.70 per ton of 2,240 pounds, and the same quality, but in smaller pieces, say 1¼ to 1½ inches, at $3.65 per ton less than these figures.

"The rates of freight for emery stone shipped in bulk by steamers to the ports of the north of France, the Netherlands, and Germany are from $3.90 to $4.38 per ton; to London, $2.33 to $2.92; to Liverpool, $3.90 to $4.87; to New York or Boston the freight is $1.22 to $2.44 per ton. Sailing ships with cargoes of licorice root require ballast, and so the stone is readily taken at almost a nominal freight.

"The customs duty is only 16 cents per ton, but as 'backsheesh' is indispensable in all dealings with Turkish customs officials, this charge is equivalent to 25 cents. The quay dues are 4 cents per ton. The Turkish Government levies a duty or royalty of $3.21 on every ton of emery shipped. In addition, the grantee must pay a tax of 2½ cents per acre on the area of land ceded him by his firman.

"The mines are opened by wells and galleries, and the stone is obtained in most instances by blasting, gunpowder and dynamite being freely used to extract it from between blocks of marble or masses of granite. The overseers and principal workmen at the mines are Italians, who are paid 82 cents per diem; the native workmen are paid only about half as much. In some cases the mining is attended with difficulty and expense. At the Jackson mine, for example, the stone is procured from a great depth, and is covered with water, necessitating the employment of a steam pump. At Kourchak, not even blasting is required, the emery being dug up from the red argillaceous earth wherewith it is mixed. The coating of the stone varies with the color of the earth or rock in which it is found—from red to brown, gray, or white; and, as a rule, no correct judgment of the quality can be formed from its outward appearance. But the grain must be closely examined. This should be hard, bright, and coarse, resembling gunpowder, and varying in hue from reddish black to dark bluish gray. The grain must be tested before one

can certainly know its abrading power, which it has been ascertained does not solely depend upon the amount of alumina it contains, but also upon the particular way in which the particles have been placed by nature. In the Tchaous concession, near Thyra, a great deal of the emery is not mined, owing to the presence of mica in the grain.

"The emery is picked daily at the mines as fast as it is extracted, in some instances not one-half the quantity being selected. It is then conveyed by camels to the nearest railway station and from thence to Smyrna, where it is generally picked again previous to shipment. When the mines are situated on heights inaccessible to camels, the ore is brought down to the plain by donkeys. If the pieces are too large to be carried by camels, they are brought to the station in carts drawn by buffaloes. But these very large pieces are broken at the mines with sledge hammers, after having been subjected to the action of fire to facilitate their breaking. The railway rates are rather high; from Thyra to Smyrna, for instance, a distance of 60 miles, the charge is equal to $3.36 per ton; and from Cosbonnar, the railway station from which the greater part of the ore is brought, and distant 41 miles from Smyrna, the rate is $2.20.

"The mines are worked upon the strength of concessions, termed 'firmans,' granted by the Imperial Government for a period usually of ninety-nine years, or in cases where the emery has been found on 'nacouf' property, *i. e.*, belonging to the Turkish religious institutions, by special permit of the department at Constantinople which administers the 'nacouf' estates, and exacts payment to them of so much per kintol. A 'firman,' or concession, during the period it is in force, can be sold, transferred, and transmitted by inheritance, like other property in Turkey, provided due notice be given to the department of mines at Constantinople, and authorization formally obtained. The obtainment of a 'firman' is at all times attended with difficulties, loss of time, and expense. According to by-laws on mines, the formalities to be accomplished appear very simple and the cost of the concession reasonable, but an applicant soon finds all this to be a delusion. Its obtainment is at present still harder and more tedious to Europeans, owing to the reigning Sultan being averse to granting concessions to subjects of foreign Governments, although the grantee would always be amenable to Turkish law in all matters having reference to his concession. The difficulty can, however, be avoided by making the demand in the name of an Ottoman subject, and it would facilitate things all the more if he be, besides, a Mussulman. At all events, it is almost absolutely necessary that the demand of a foreigner be made at least jointly with an Ottoman subject, so that the latter's name may be also inserted in the firman presented for imperial sanction.

"*Naxos emery.*—The emery in the island of Naxos is farmed or let out by lease to firms or private individuals by the Greek Government for periods of twelve consecutive years. Sealed tenders are sent in by

persons wishing to compete, and the contract is allotted to the highest bidder. The party who obtains the monopoly for twelve years has to deposit forthwith in the National Bank of Greece $19,300, to remain there as a guarantee for the fulfillment of his engagements during the whole period. He has to bind himself to take a minimum of 1,650 tons annually, at $42.50 per ton put free on board at Naxos, for the emery just as it is excavated, without selection.

"The lessee is free to take double or triple the quantity if he wishes but is obliged to take at least 1,650 tons. Formerly the price was higher and the minimum quantity fixed larger, but the contractors lost money. The lowest price at which Naxos emery could then be had from them was $48.70 per ton put free on board at Syra.

"The greater part of the emery has to be brought to the neighboring island of Syra, in sailing vessels, at the contractor's expense, where it is reshipped. Steamers or large vessels cannot load at Naxos, except during the fine season, owing to the absence of shelter, which renders the operation dangerous The contract of the present lessees, a Greek firm of Syra, has still about seven years to run. They will not sell to any one free on board, as their predecessors did, but have agencies and stocks in the principal markets of Europe and the United States."

Emery imported and entered for consumption in the United States, 1867 to 1885, inclusive.

Fiscal years ending June 30—	Grains.		Ore or rock.		Pulverized or ground.		Powdered.	Total.
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.		
	Pounds.		*Tons.*		*Pounds.*			
1867	.....	.....	428	$14,373	924,431	$38,131	.....	$52,504
1868	.....	.....	85	4,531	834,286	33,549	.....	38,080
1869	.....	.....	964	35,205	924,161	42,711	.....	77,916
1870	.....	.....	742	25,335	644,380	29,531	.....	54,866
1871	.....	.....	615	15,870	613,624	28,941	.....	44,811
1872	.....	.....	1,641	41,321	804,977	36,103	.....	77,424
1873	610,117	$29,706	755	26,065	343,828	15,041	107	70,919
1874	331,580	16,216	1,281	43,886	69,890	2,167	97	62,366
1875	487,725	23,345	961	31,972	85,853	2,990	20	58,327
1876	385,246	18,999	1,395	40,027	77,382	2,533	94	61,653
1877	343,697	16,615	852	21,964	96,351	3,603	.....	42,182
1878	334,291	16,359	1,475	38,454	65,068	1,754	34	56,601
1879	496,633	24,456	2,478	58,065	133,556	4,985	.....	87,506
1880	411,340	20,066	3,400	76,481	223,855	9,202	145	105,894
1881	454,790	22,101	2,884	67,781	177,174	7,497	53	97,432
1882	520,214	25,314	2,765	69,432	117,008	3,708	241	98,695
1883	474,105	22,767	2,447	59,282	93,010	3,172	269	85,490
1884	143,267	5,802	4,145	121,719	513,161	21,181	(a)	.....
1885	228,329	9,886	2,445	55,368	194,314	8,789	(a)	.....

a Not specified.

Exports of manufactured emery.

Fiscal years ending June 30—	Value.	Fiscal years ending June 30—	Value.
1878	$1,608	1882	$813
1879	1,265	1883	1,857
1880	1,312	1884	3,565
1881	1,242	1885	19,232

INFUSORIAL EARTH.

The deposit of infusorial earth, locally known as "tripoli," on the Patuxent river, near Dunkirk, in Calvert county, Maryland, was referred to in the last report. Operations for mining this deposit upon an extended scale were begun in September, 1885, but the output was not over 250 tons before the close of navigation ended shipments for the year. It was shipped principally to New York for use as a nonconductor and also as a polishing powder. There is no record of work on the deposits near Richmond, Virginia, nor on those near Virginia City, Nevada, during 1885.

PUMICE STONE.

There was little change in the slight production of pumice stone near Lake Merced, a few miles from San Francisco, California. The production did not exceed 70 tons. The greater part of the pumice stone used for polishing wood surfaces, etc., is imported, according to the following table:

Pumice stone imported and entered for consumption in the United States, 1871 to 1885, inclusive.

Fiscal years ending June 30—	Value.	Fiscal years ending June 30—	Value.
1871	$6,448	1879	$12,892
1872	12,796	1880	15,520
1873	9,264	1881	19,052
1874	22,899	1882	29,370
1875	8,726	1883	50,634
1876	9,122	1884	26,667
1877	11,556	1885	14,147
1878	12,343		

NOVACULITE.

By George M. Turner.

The word novaculite (from *novacula*, a razor), according to its present use, is applied to a class of siliceous rocks which are valuable because of their grit or sharpening qualities as whetstones. This peculiar sharpening quality is due in some cases to crystalline silica, in others, according to a German writer, to small crystals of garnet or rutile.

Occurrence.—The principal source of the novaculite produced in this country at present, is the region embraced by Hot Spring and Garland counties, Arkansas. It is also quarried in Grafton county, New Hampshire, and in Orange county, Indiana. Quarries are reported in Onondaga county, New York, but no reliable information concerning them has been obtained.

Arkansas.—Although the main source of the Arkansas novaculite is in Hot Spring and Garland counties, a few deposits are found in Mont-

gomery and Saline counties. The best oilstone comes almost entirely from Garland county. A tract of land about 50 miles long by 20 miles wide will include the area from which the oilstone is taken. Two varieties of novaculite are quarried here, and are commercially known under the names of "Washita" oilstone and "Arkansas" oilstone. The former is used by carpenters and wood workmen in general, while the latter is particularly adapted for the use of watchmakers, dentists, and surgeons.

The "Arkansas" stone is a very compact, bluish white, semi-translucent rock of uniform color and structure. The best "Washita" is less compact than the "Arkansas" stone, pure white and opaque. They are both composed of nearly pure, very fine-grained quartz, and differ from each other only in that the grains of quartz are finer and the spaces between them much smaller in the "Arkansas" than in the "Washita" stone. Both kinds are found in narrow leads from 5 to 15 feet wide, running northeast and southwest on the north side of the mountains of the Ozark range, and lying between walls of a very similar character. Some of these leads are less than a mile long, while others are several miles in length. The quality of the stone in the same lead often varies considerably as the quarrying progresses. Perfect whetstones of even grit, uniform in crystallization, and free from all impurities are found in only a few places, which are nearly always less than 100 feet in length, and are called pockets. The novaculite has been very much cracked and broken up by natural forces. The workable rock is often rendered worthless by the presence of vitreous lumps of quartz, which sometimes appear in the midst of the best producing rock, so that nearly one half of the rock taken out of the quarries goes into the waste pile. The hot springs occurring in the immediate neighborhood of the oilstone region probably play an important part in the deposition of silica in the form of novaculite. The structure of the Arkansas rock, from its appearance under the microscope, is similar to that of marble. The crystals in forming have so run into each other as to prevent the natural crystalline faces from appearing, but have left minute cavities between the quartz grains. Up to the present time no thorough investigation has been made as to how the silica came into solution and was deposited as novaculite. There are also no data which lead us to suspect that it was deposited in a different manner from the silica of the hot-spring region of the Yellowstone Park, which region has been carefully studied and described by Hayden in his report on the "Geological Survey of the Territories."

New Hampshire.—Although whetstone schists occur, according to Hitchcock's "Geology of New Hampshire," at Piermont, Lisbon, and Littleton, in Grafton county; Tamworth, Carroll county; and Connecticut Lake, Coos county, only the deposits in Littleton and Lisbon are worked. The novaculite taken from these quarries is known in the

market as "chocolate" stone. It is very different, both in composition and structure, from the novaculite found in Arkansas. It is an argillitic mica schist of a dark gray color. Under the microscope were discernible: silica in the form of small quartz crystals; a substance which appeared black and could not be recognized by the microscope alone; minute crystals of garnet scattered through the whole mass; small plates of mica; and a few crystals of rutile. All the minute quartz crystals have their corresponding axes running parallel to each other. This arrangement, together with the mica present, gives to the rock its schistose structure and characteristic appearance. The small garnets present probably give to the rock its peculiar power for use as a whetstone. On a partial chemical analysis of the rock the substance which appeared black under the microscope proved to be a compound of manganese (probably one of the higher oxides) together with a small amount of iron.

Indiana.—Owing to the reticence of the firms with whom correspondence was undertaken concerning the so called "Hindostan" stone of Indiana, no reliable statements could be obtained from them. The only information upon which dependence can be placed is the account given of this whetstone in the Geological Report of Indiana for 1875, by E. T. Cox, the State geologist. The quarries are located near French Lick, Orange county. The rock is described as being of schistose structure, evenly stratified, and capable of being split with great ease. A large number of fossils of great beauty and size have been found in this rock; among them are beautifully preserved leaves and what appear to be crustacean tracks. There are also some fine dendrites. The stone quarried is of even texture and fine grained. The two forms under which it is placed on the market are the "Hindostan," which is white in color, and a buff variety known as the "Orange" stone. The novaculite of this locality, as determined by the fossils in the rocks, is said to be of the same geological horizon as the novaculite of Arkansas.

Production and prices.—About 500,000 pounds of the "Washita" and 30,000 pounds of the "Arkansas" stone in the rough are quarried and sold annually. The sound Washita is shaped into blocks of from 100 to 2,500 pounds, and shipped to the various whetstone factories throughout the country. The "Arkansas" stone is found in small pieces—sometimes as small as 2 pounds—and is packed in barrels for shipment. The stones are cut by means of saws. This method of preparing the stone for market is very slow, and hence the cost of the finished stone becomes greatly increased over that of the uncut. A gang of saws which will cut from 12 to 15 inches a day in marble will cut only about 4 inches of Washita and three-quarters of an inch of "Arkansas" stone. The rough Washita sells at the quarry at from 1 to 3 cents per pound, and the uncut "Arkansas" from 4 to 6 cents per pound. The latest price list of three combined firms (J. J. Sutton, of Hot Springs, Arkansas;

George Chase, of New York; and F. E. Dishman, of New Albany, Indiana) is as follows for the Washita stone:

Price list of Washita stone in 1885.

Grades.	Cents per pound.
Washita stone:	
No. 1 (extra)	25
No. 1	20
No. 2	16
Washita slips:	
No. 1 (extra)	50
No. 1	40

No. 1 is taken as their standard stone. "Arkansas" stone sells at from $1.25 to $2 per pound, according to the size of the piece. The great difference in price between crude and finished stone is due to the cost of preparing it for market.

The quarry of the "chocolate" stone has been, until quite recently, developed mainly for local use, so that only about 15,000 pounds of the stone are now annually taken from the quarry. The method of preparing this novaculite for market is practically the same as in case of the Washita and "Arkansas" stones. The stone is cut with iron blades by the use of sand and then finished on iron wheels with sand. This stone, not being as hard as the Washita and "Arkansas" stones, the cost of manufacture is much less. The estimated cost of preparing the "chocolate" stone for market is about 10 cents per pound.

Use.—Until quite recently the use of novaculite was confined to the sharpening of edged tools. Of late it has come into use for grinding, reducing, and finishing. It has invaded the limits of the grindstone, emery, rottenstone, tripoli powder, and has reached almost to rouge. It is cut and dressed in many different forms for varying purposes. In any hardware store it may be found in various shapes under the name of slips, adapted for sharpening tools of all forms. In dentists' supply stores it may be found in a number of cylindrical, circular, and ovoid forms, sufficiently small to be used between the teeth in dental work. In the manufacture and finishing of metals, novaculite is also used for truing turned and planed surfaces of iron and brass, slowly grinding down the imperfections left by the finish file and corundum wheel. Some varieties have also been used to a certain extent in the powdered form in place of emery.