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TRIPOLI DEPOSITS OF OKLAHOMA.

BY

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NORMAN.
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TRIPOLI DEPOSITS IN OKLAHOMA.

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TRIPOLI DEPOSITS OF OKLAHOMA.

INTRODUCTION.

This report deals with the deposits of tripoli occurring in northeastern Oklahoma, chiefly in Ottawa county. A brief discussion is also given of the deposits adjacent, in the vicinity of Seneca, Missouri. The geology and occurrence of the deposits, the methods of preparation of the marketed material, and the number and location of the firms engaged in the industry are also among the subjects treated. Tripoli has been put to but little use and the demand for the material is slight. Consequently few companies are engaged in the quarrying and manufacturing of it, and only a few of the known deposits are being worked.

The investigations carried on by the writer were limited to the various openings and beds where the material is now being, or has been, quarried, although a few of the outlying deposits which are known to exist are mentioned and their location shown on the maps.

The field and office work has been entirely individual, the former consisting of an examination of the various quarries and outcrops where good exposures could be had, and the latter including, beside the writing of the report, some experimental work on the manufactured products.

Prior to this report, nothing has been published concerning the Oklahoma tripoli except very brief mention of it in some of the publications of the Oklahoma Geological Survey. Various articles and papers have been printed, describing the deposits in Missouri, but as these deposits are at present less important than those now being worked in Oklahoma, the need for the present report is obvious.

The writer acknowledges the assistance of the superintendents of the various firms in supplying statistics and other data, and the many courtesies extended to him while visiting the manufacturing plants.

Columnar sections of the MISSISSIPPIAN ROCKS in northeastern Oklahoma.

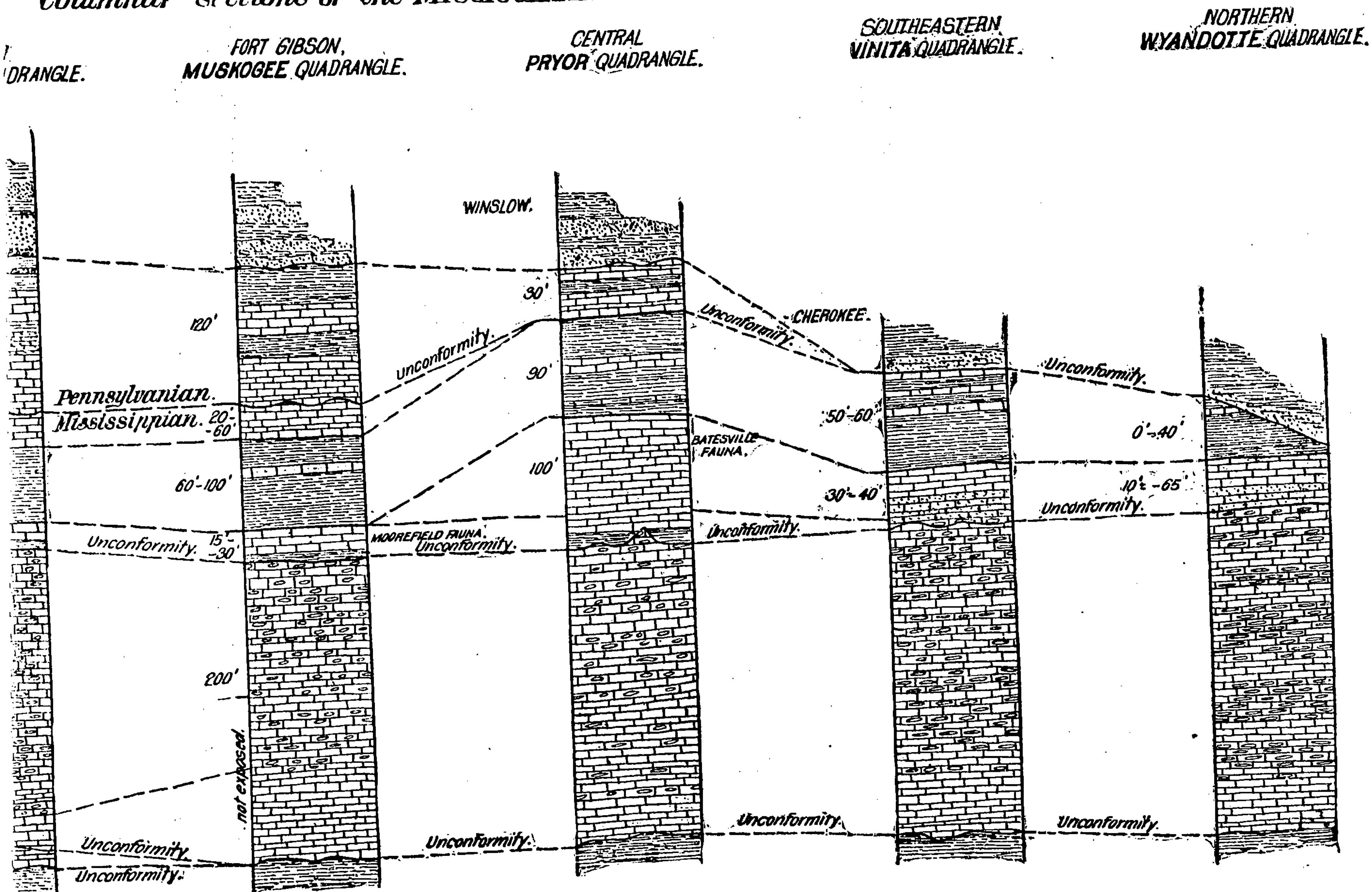


PLATE I.

Columnar sections of the MISSISSIPPIAN ROCKS in northeastern Oklahoma.

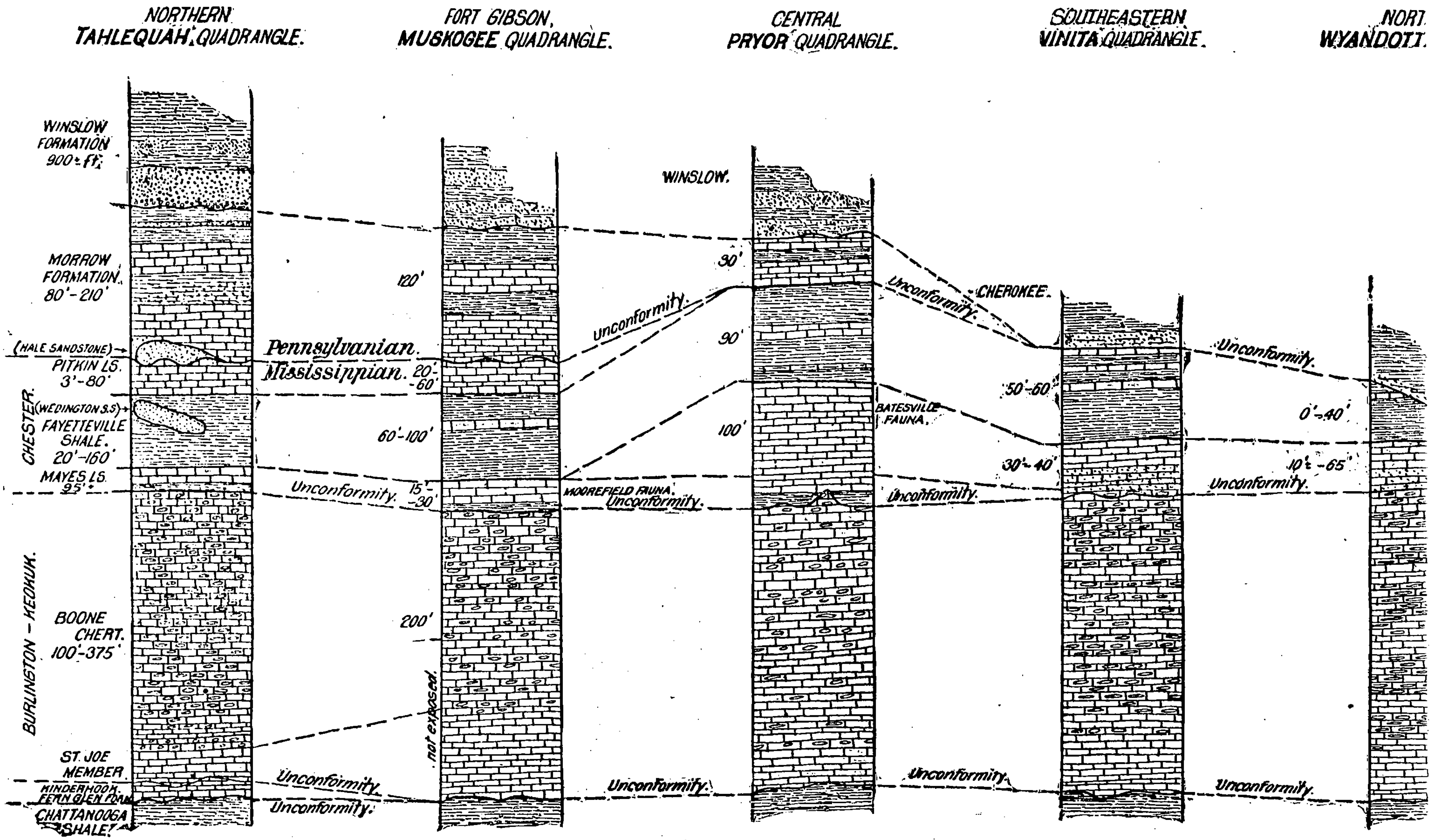


PLATE I.

LOCATION OF DEPOSITS.

Tripoli is known to occur in disconnected and widely scattered deposits of greater or lesser value over an area of approximately 500 square miles in the general region about Wyandotte, Oklahoma. The most important localities where deposits have been worked and proved of value are (1) about three miles south of Racine, Mo., (2) about one and one-half miles north of Seneca, Mo., partly in Oklahoma and partly in Missouri, and (3) about two miles north of Peoria, Oklahoma. Some of the smaller deposits are found near Fairland and Grove, Okla., and near Neosho, Mo., and there are numerous other small deposits scattered about in the general region.

PHYSIOGRAPHY.

The topography of the tripoli region varies considerably from a rolling prairie with a relief of 50 feet, as west of Neosho and Spring rivers, to a maturely dissected plateau with canyons and sharp divides, as east of Neosho and Spring rivers. About Fairland and Miami the county is almost a featureless plain, but south of Wyandotte it is extremely rough, and locally the relief is as much as 250 feet. The elevation of the land rises here from 750 feet to 1,100 feet in a distance of three miles, and is in a stage of early maturity in its physiographic development. High prairies occupy certain areas between the maturely dissected regions to the east of the Neosho-Spring river valleys, and these are the divides between the major streams and the lands not yet reached by the erosive action of the streams. Jackson, Burkhart, Swars, and Cowskin prairies are the principal ones and have an elevation of from 900 to 1,160 feet above sea level. The drainage is southwest through Spring and Neosho rivers, which unite near Wyandotte.

STRATIGRAPHY.

BOONE FORMATION.

GENERAL STATEMENT.

The tripoli deposits are found within the Boone formation entirely. This formation consists of a series of alternating limestones and cherts having an average thickness of 350 feet. (See Plate I). The Boone is Mississipian in age and represents

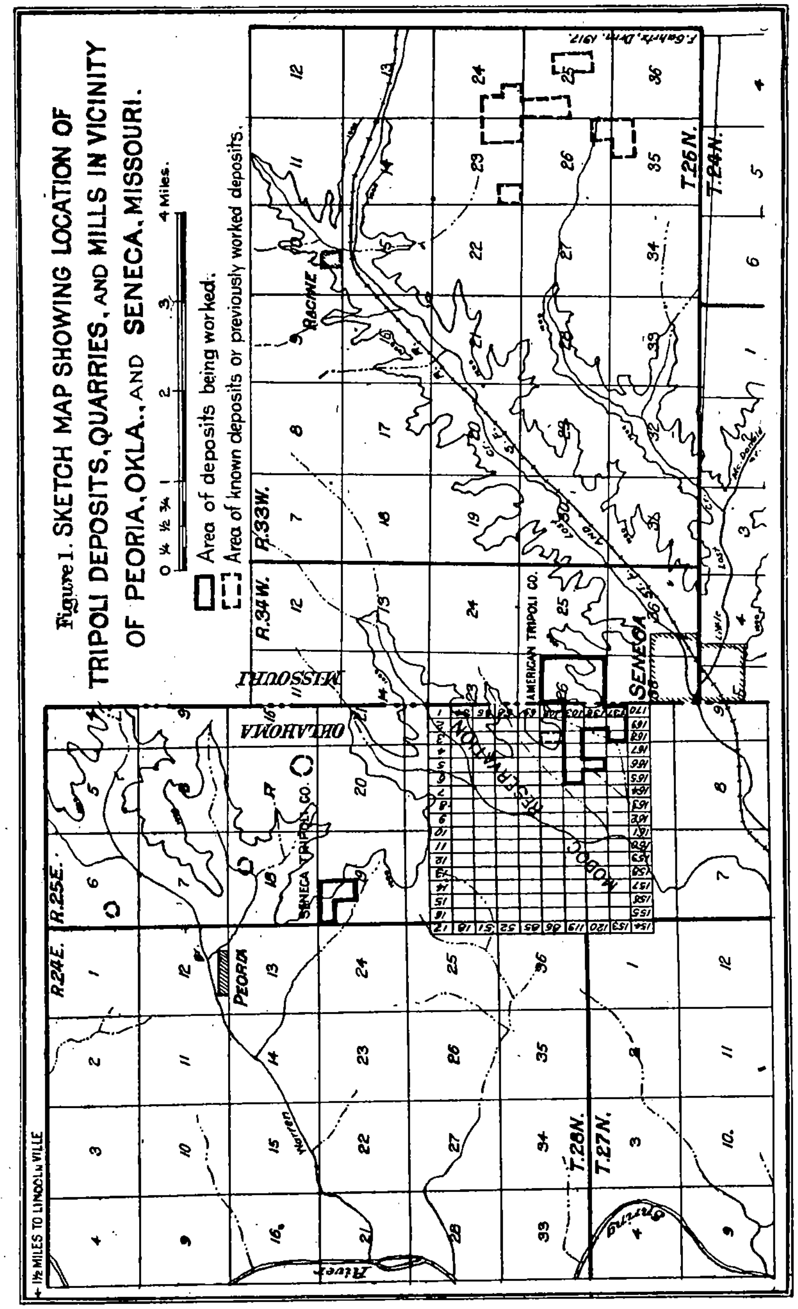


Figure 1. SKETCH MAP SHOWING LOCATION OF TRIPOLI DEPOSITS, QUARRIES, AND MILLS IN VICINITY OF PEORIA, OKLA., AND SENECA, MISSOURI.

the Kinderhookian, Burlington, Keokuk, and basal Warsaw stages of other regions.* There is no stratum in the immediate neighborhood of the deposits which can definitely be used as a horizon marker. However, in the region of Joplin there are two horizons in the Boone which can readily be distinguished. These are the Grand Falls chert and the Short Creek oolite.

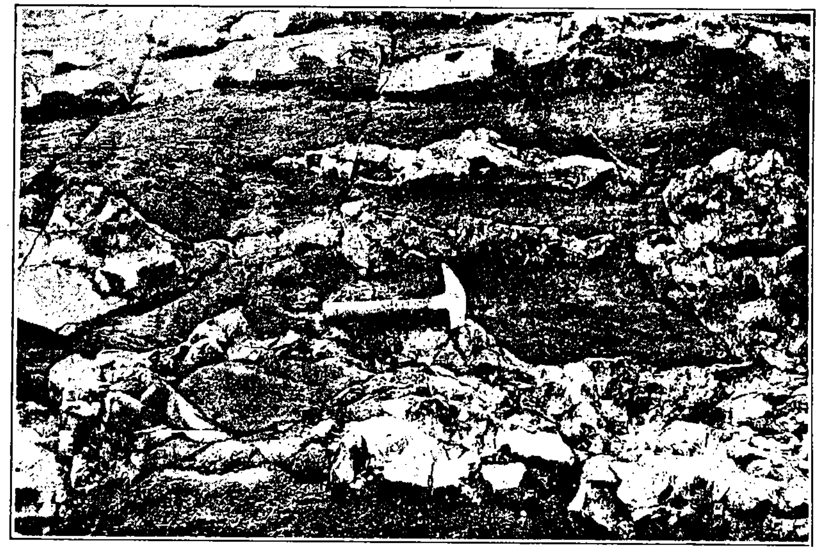
PLATE II

BOONE LIMESTONE WITH INCLUDED CHERT NODULES, NEAR SENECA, MISSOURI.

At Peoria the Grand Falls chert outcrops on the banks of Warren branch. The Short Creek oolite is found at Peoria as small fragments imbedded with other chert fragments in a matrix

*According to Geo. H. Girty (U. S. Geol. Survey Bull. 595, p. 15, 1915) the Boone includes no Warsaw whatever, but represents Kinderhook, Burlington, and Keokuk only.

PLATE III



A. CLOSE VIEW OF BOONE LIMESTONE WITH INCLUDED CHERT NODULES.

B. EXPOSURE OF LINCOLNVILLE CHERT, JUST NORTHWEST OF PEORIA, OKLAHOMA.

of black flint forming a breccia. This breccia marks the unconformity between the Boone and the overlying Chester formation.

The Lincolnville chert becomes a constant horizon in the region about Peoria and Lincolnville.

GRAND FALLS CHERT.

The Grand Falls chert has not been traced into northeastern Oklahoma except in the vicinity of Peoria as above stated. This is probably due to a change in the character of the material. This chert represents the lowest horizon of commercial lead and zinc deposits in southern Missouri. It has a thickness of from 30 to 55 feet.

SHORT CREEK OOLITE.

The Short Creek oolite is occasionally found outcropping in parts of the county and in drill holes throughout the county, but it does not appear to be everywhere present. It lies 100 feet above the Grand Falls chert horizon, and about the same distance from the top of the formations. It is an oolitic member from 8 to 10 feet in thickness.

In the Joplin area the Short Creek member is a thin and very persistent bed of oolitic limestone, generally forming a single, massive, homogeneous layer from $1\frac{1}{2}$ feet to 8 feet in thickness. In the Miami area it shows a very great variation in thickness, and at many places can not be found. The individual oolites are round, very regular in size, and are usually of a whitish or grayish, and sometimes brownish color, which distinguishes them from the oolites of the Chester formation, which are oblong, variable in size, and have black centers. The name of "fish egg" lime, applied by drillers, well describes the appearance of the oolite. In places this member has been altered to chert, through which process the characteristics of the rock are generally preserved. In some localities, however, the alteration has changed the rock so that it cannot be recognized. On Warren Branch, about one mile below Peoria, an outcrop of this silicified oolite may be seen.

Another interesting feature of the Short Creek oolite in the Miami field, is its occurrence as angular fragments in basal breccias. Almost always the fragments of oolite are in the matrix jasperoid or black flint, as at Peoria. These fragments also occur in the matrix of black chert, as at the United States

mines at Tar River, or in the matrix of limestone, as at the Lake mines just west of Miami. When fragmental the oolite is altered to chert.

The presence of the Short Creek oolite in some localities may be accounted for in three ways. First, the bed may have become thin and actually pinched out. Secondly, it may have changed in character so as not to be recognizable. Or, thirdly, it may have been continuous over a part of the area and was later removed by erosion and solution.

Good exposures of oolite may be seen on the east bank of Spring River, about one-half mile below the mouth of Five Mile Creek. The bed here is 10 feet thick and is found a few feet below the Lincolnville chert member. At the mouth of Five Mile Creek the bed dips into Spring River. Southward, it rises until the Short Creek member is 80 feet above the river. The bed gradually dips downward again. Here the oolitic limestone weathers into slabs which break off and slump down the hillside.

At Peoria the oolite was found only as fragmental breccia. Two miles South of Lincolnville it is found on the East bank of Spring River, while at Lincolnville the oolite is found at a depth of about 90 feet. North of Pawpaw, drilling shows the Short Creek member at 160 feet. At Tar River, in the United States mine, fragments were found between depths of 216 and 270 feet below the surface, while in places two miles west it is found at a depth of 296 feet. At Afton the Short Creek oolite was found at a depth of 10 feet, and has also been found in several drill holes between Afton and Miami.

LINCOLNVILLE CHERT MEMBER.

In the region about Peoria and Lincolnville, Oklahoma, a persistent chert member is found, which, because of its geographic occurrence, has been called the Lincolnville chert. This chert member can be seen to best advantage along Spring River and its tributaries east of Lincolnville.

The Lincolnville chert when unaltered is splintery and very compact. It is white to gray in color, and often has a vitreous to greasy luster. Exposed surfaces do not crumble or soften, but become slick and lustrous. Fragments buried beneath the soil show evidence of leaching and take on a chalky appearance and are known to miners as "cotton flint." The Lincolnville chert member can be followed almost continuously from the mouth of Warren Branch eastward past Peoria. At Lincolnville it constitutes the sheet ground horizon.

The Lincolnville chert member occurs in the upper Boone, a few feet above the Short Creek oolite horizon. The oolite was found just below it in several places along Spring River and also at Peoria.

TRIPOLI AS A ROCK.

CHARACTERISTICS.

Tripoli is a light, homogenous, minutely porous rock which can be scratched with the fingernail and crumbled in the hand, and yet, owing to the hardness of the particles of which it is composed, it will scratch steel. When magnified 800 diameters the tripoli appears granular. Hovey* found the grains very minute, by far the most of them being not over .01 mm. (0.0004 inch) in diameter, though occasionally grains measure .03 mm. across. These particles are double refracting and are probably chalcedony.

PROPERTIES.

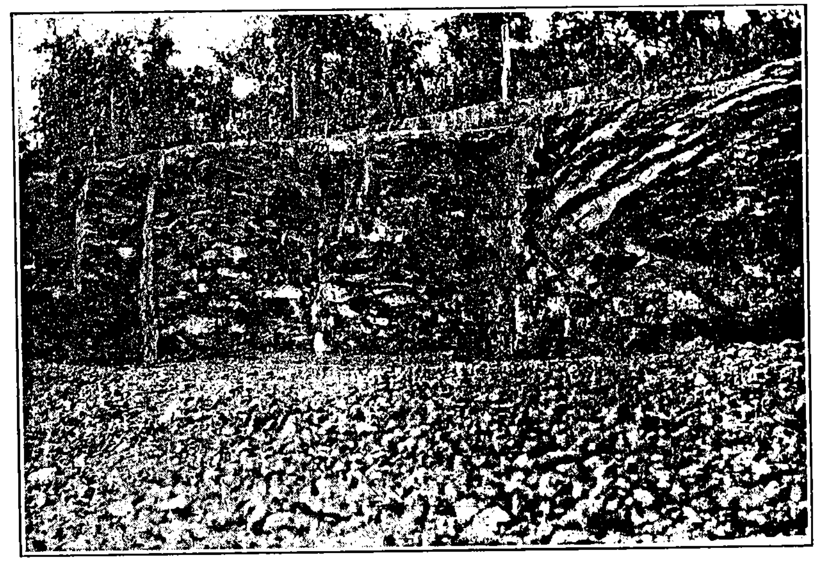
The rock is highly absorbent, due to the extreme condition of porosity. A dry piece of tripoli four inches in diameter will absorb one-third its weight of water in about five minutes, in which time it will become completely saturated. In ordinary room atmosphere it will lose this moisture in three days. A large quantity of water when poured on the surface of the tripoli will immediately disappear within, showing its presence only by a damp appearance of the surface. The fracture is very rough and uneven, showing no tendency to break along any definite lines.

COLOR.

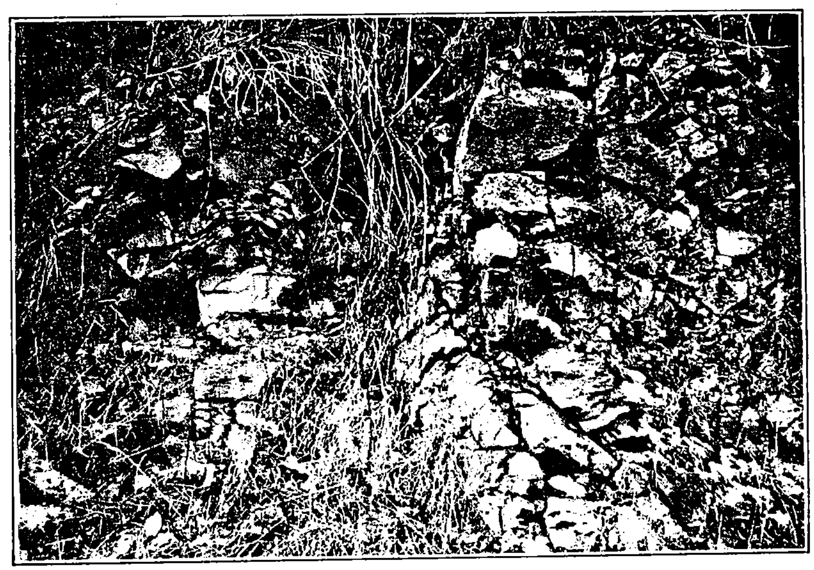
The color of pure tripoli is snow white. Iron stain, causing the rock to be red or pinkish, is extremely common, and is often in the nature of banding, which may be very delicate and may take on the appearance of bedding. The bands, although parallel, will curve in all directions. (See Plate X). At times many irregular black blotches and sometimes black veinlets run through the rock. These are caused by the presence of manganese.

As already mentioned, the rock is homogeneous. Samples taken from the top, the middle, and the bottom of a 12-foot

*Sci. Am. Supply, July 28, 1894, p. 15487.



A. SHOWING CONCENTRIC FRACTURE AND VERTICAL JOINTS IN QUARRY OF AMERICAN TRIPOLI COMPANY.



B. CONCENTRIC FRACTURING BOUNDED BY VERTICAL JOINTINGS. NOTE CHARACTER OF THE FRACTURE.

bed, and samples taken at intervals for several hundred feet along the face will all be so much alike that it is impossible to tell from which place they came. This homogeneity applies to texture, structure, and composition, but the coloration varies.

CHEMICAL COMPOSITION.

The chemical composition of tripoli is shown by the following analyses:

Analysis of tripoli from deposits near Seneca, Missouri.

NAME	Formula	1	2	3
Silica	SiO_2	98.28	98.10	98.10
Alumina	Al_2O_3	.17	.24	.24
Iron Oxide	Fe_2O_3	.53	.27	.27
Lime	CaO	Trace	.18	.33
Potash	K_2O	.17		
Soda	Na_2O	.27	.23	.23
Ignition		.5	1.16	1.17
Organic Matter			.008	
		99.92	100.188	100.34

1. By R. N. Brackett, Rept. Arkansas Geol. Survey for 1892, vol. 5, p. 207.
2. By W. H. Seaman, Sci. Am. Supp., July 28, 1894, p. 15487.
3. Missouri Geol. Survey, vol. 7, 1894, p. 731.

NOTE.—For those not familiar with chemistry, chert and flint are almost pure silica (SiO_2). Quartz, or rock crystal, is pure silica, and common glass is almost all silica.

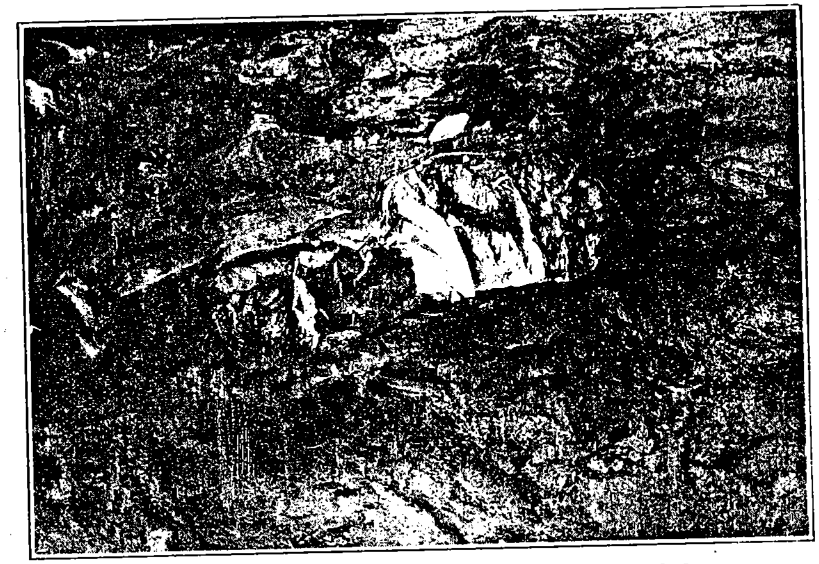
FRACTURING.

The homogeneity of the beds has been emphasized. This is only in texture and composition. They differ from place to place in the amount and nature of fracturing and in color. The fracturing is of two varieties: First, a largely concentric, concretionary-like type, which, to use a local phrase, "peels off like the layers of an onion"; second, a vertical fracturing, the fractures being sometimes open and filled with red clay. The concentric fractures may be extensive for 10 or 12 feet, or they may be only a couple of feet in diameter. The seams in the concentric fractures are never open or filled with clay, nor do they even show a staining. This condition would seem to point to a somewhat recent origin, at least more recent than the vertical fractures which are stained with iron and filled with red clay. The individual concentric breaks do not extend entirely around the center, but always disappear after passing around the sides of the centers. This type of fracturing may not form a circle. In fact, more often the shape of the concentric breaks is that of

an elipsoid, the lesser axis being vertical. The distance between the fractures, that is, the thickness of the concentric layers, is generally about 2 or 3 inches. This type of fracturing is extraordinary and its cause is problematical. It is resultant from some condition within the rock mass—conditions of texture or depositional structure—and not from external forces such as exfoliation or folding.

The vertical fractures are extensive through the beds of tripoli, but can not be traced farther. Very often sets of these fractures or joints occur which are parallel, the direction varying slightly with the locality, but in a general northeast-southwest

PLATE V



A. NODULES OF CHERT WITHIN A BED OF TRIPOLI.

and northwest-southeast direction. Such an occurrence, taken together with the fact that some of them have been opened and later filled with fine-grained red clay, would indicate that they were generated early, perhaps at a time before alteration had started. The vertical joints never cut across the concentric fracturing. On the contrary, there is a tendency for the concentric fracturing to be confined to blocks which are bounded by vertical jointing. Inclined seams and sometimes horizontal seams also occur.

CHERT NODULES.

Chert within the massive beds of tripoli is not common; however, nodules do occasionally occur. Locally they may be abundant enough to cause the abandonment of a quarry. Often, when present, there is a gradation from the chert to the tripoli so uniform that no dividing line can be drawn. The "balls" of chert are irregular in shape and strung out in horizontal alignment. Another interesting feature is the presence of the so-called "eggs." (See Plate VC). Within the mass of homogeneous tripoli, spherical and elipsoidal balls of tripoli occur, which, when encountered, easily break loose from the rock, but are, in themselves, very compact and firm. Their appearance suggests that the silica which was once a nodule of chert has been altered to tripoli.

BEDDING.

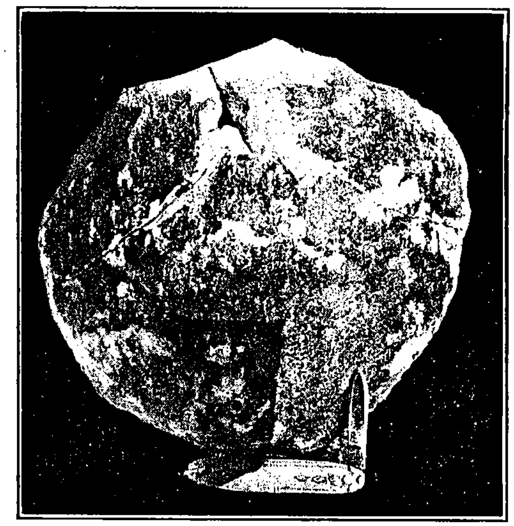
There is no trace of stratification in most of the quarries. Two miles south of Peoria in a pit in which a face of tripoli had been exposed for some time, there appeared a slight differential weathering in the tripoli in horizontal lines. It was extremely suggestive of bedding. A horizon which had weathered to a depth of about a quarter of an inch could be followed for several rods. In the "rotten" tripoli above the massive beds there was a horizontal alignment of chert nodules very similar to the manner in which chert is found in the ordinary Boone limestone. The rotten material above the beds showed that it was at one time stratified.

FOSSILS.

No fossil remains of any kind have been found in the tripoli beds. Fossils have been found in the decomposing chert just above and also below the beds. The change of the chert to tripoli, provided this has actually taken place, seems to have destroyed all trace of fossils.

Another substance sometimes mistaken for tripoli is a homogeneous, siliceous clay. It is hard when dry, but very soft and even plastic when wet. A simple test for tripoli is to dip the sample in water and note the rapidity with which it takes up water, and also the effect upon its hardness. Tripoli will absorb the water as fast as poured on and is not softened by the wetting.

B. CHERT NODULE WITHIN TRIPOLI, GRADING INTO TRIPOLI.



C. "EGG." A NODULE OF TRIPOLI WITHIN SOLID TRIPOLI. THESE FIRM BALLS CAN BE PICKED OUT FROM THE TRIPOLI BEDS.

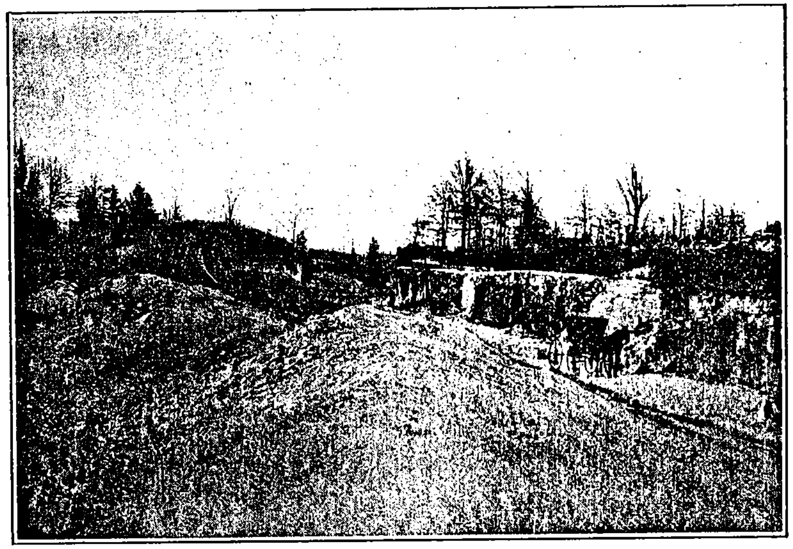
ORIGIN.

The most common explanation for the origin of tripoli is that it has resulted from the decomposition of chert. Siebenthal* suggests that such is not the case, but that the beds of tripoli come from the leaching out of the lime from the siliceous limestone above described. It would seem that if the tripoli is formed by the leaching of lime from a siliceous limestone that somewhere there would be remnants of this limestone left and the tripoli would be found in contact with siliceous limestone. Nowhere have these conditions been observed. It also seems, since the siliceous limestone is found in valleys, that tripoli would somewhere be found in the valleys, but such occurrence is not known.

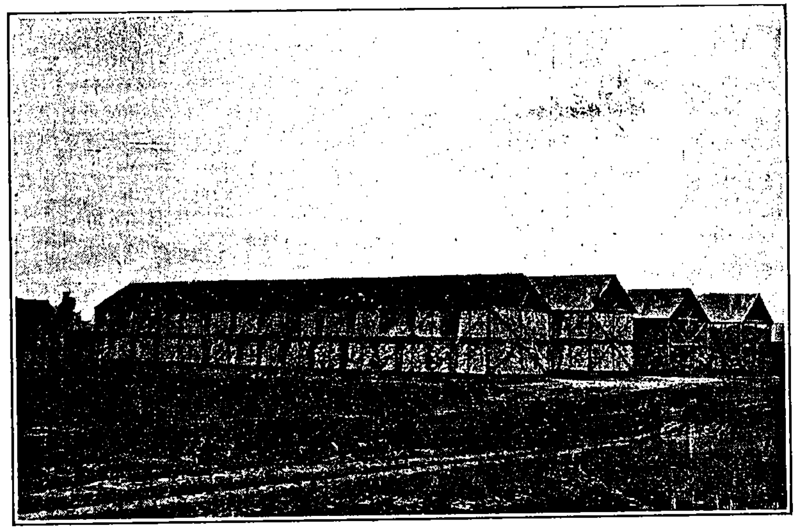
Everywhere chert is found grading into tripoli, the gradation generally being so gradual that no line can be drawn between the two rocks. Everywhere the tripo i is found associated with chert. Nowhere is any kind of material associated with the deposits other than the red clay and chert. The writer believes that the beds of tripoli are the result of weathering on thick, homogeneous beds of chert. The layer of weathered material (red clay and chert fragments) both above and below the beds, together with its occurrence at the top of broad, flat-topped hills, certainly points to extreme conditions of weathering, while the sharp lines of contact of the tripoli beds with the material above and below, and the homogeneous, persistent, unstained nature of the beds themselves point toward a very resistant and also homogeneous, persistent layer from which the tripoli has been altered.

The question now arises, is there any persistent bed of chert in the locality that might, if put under the proper conditions, alter into beds of tripoli such as are found? Two miles north of the deposits of the Seneca Tripoli Company is a persistent chert bed having about the same thickness as the tripoli beds and occurring at approximately the same geologic horizon. This bed is discussed elsewhere in this report as the Lincolnville chert. (See Plate III). The Lincolnville chert member of the Boone is locally a persistent horizon about 15 to 20 feet thick. It is homogeneous in nature, has a bedded structure, and is barren of fossils. It shows rather sharp contact lines with the

*Siebenthal, C. E., U. S. Geol. Survey Bull. 340, p. 432, 1907.



A. QUARRY OF AMERICAN TRIPOLI COMPANY, IN OKLAHOMA, ONE MILE NORTH OF SENECA, MISSOURI.



B. DRYING SHEDS OF AMERICAN TRIPOLI COMPANY, ONE MILE NORTH OF SENECA, MISSOURI.

limestone beds above and below. It would seem, therefore, that this persistent bed of chert is the layer which has been altered to tripoli.

TRIPOLI ARROW HEADS AND TOMAHAWKS.

In a collection of Indian relics owned by Dr. Barnard of Seneca, Missouri, are several Indian arrow heads, spear heads, and Indian axes which are composed of tripoli. They were found buried beneath a few feet of soil not far from Seneca. The tripoli of these relics is quite similar to the tripoli of the deposits. Some people believe that these were made by the Indians from tripoli as ornaments, since they could have been of no practical value. Several of the arrow heads, however, show a very decided concoidal fracture, which is so characteristic of chert. They also show smooth surfaces and very sharp edges—sharper than could easily have been broken from tripoli. That these surfaces and sharp edges were not caused by polishing or grinding, but are concoidal fractures, suggests very strongly that these Indian relics have been altered from chert into tripoli, and gives almost conclusive proof of the origin of the commercial deposits.

RELATION TO SURFACE.

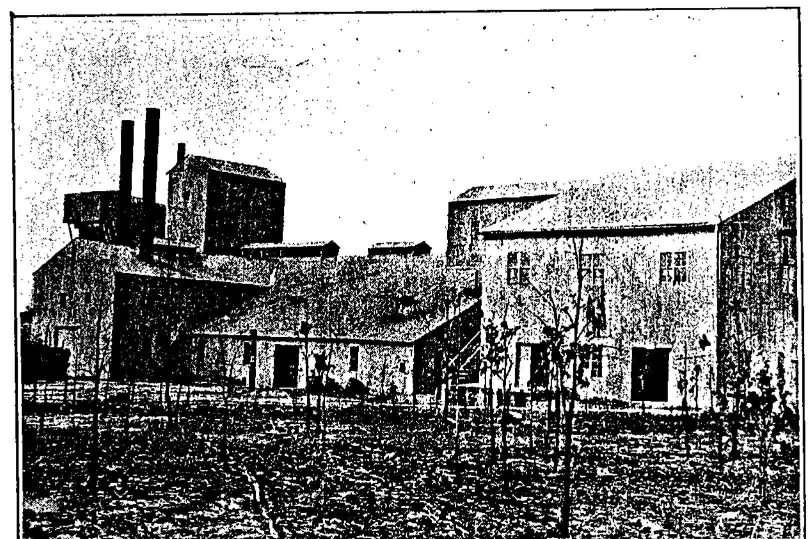
GENERAL STATEMENT.

Everywhere the deposits of tripoli are near the surface. No deposit is known to have more than 12 feet of overburden, and in most cases not more than 4 to 6 feet. (See Plate ---). The deposits never occur on low land nor in valleys, but always on broad, flat-topped hills, which may be as much as a mile across. The deposits are always horizontal and upon approaching the slope of the hill they pinch out and grade into the soil so that there is never an outcrop of tripoli unless some stream has been unsually active in recent cutting. The tripoli does not necessarily occur on the very highest hills.

DESCRIPTION OF DEPOSITS AND RELATION TO OLDER ROCKS.

The thickness of a bed of tripoli will vary from a couple of feet to perhaps 20 feet. Two miles south of Peoria, Okla., a pit was sunk through 18 feet of good tripoli. One and one-half miles northwest of Seneca, Mo., there is a bed 15 feet thick. These beds lie below 4 to 10 feet of overburden which is composed of "rotten" tripoli, with many irregular fragments of tripoli and chert, and, at the surface, ordinary red clay soil.

A. QUARRY OF SENECA TRIPOLI COMPANY, TWO MILES SOUTH OF PEORIA.



B. MILL OF SENECA TRIPOLI COMPANY, LOOKING NORTHWEST, TWO MILES SOUTH OF PEORIA.

The red clay grades into the "rotten" tripoli, but there is always a very sharp line of contact between the good tripoli and the disintegrated material. Elongated chert nodules often are found lying along this contact line, the outer part of the nodule being tripoli and the inner part chert. Such a condition is true of the nodules and fragments within the rotten overburden.

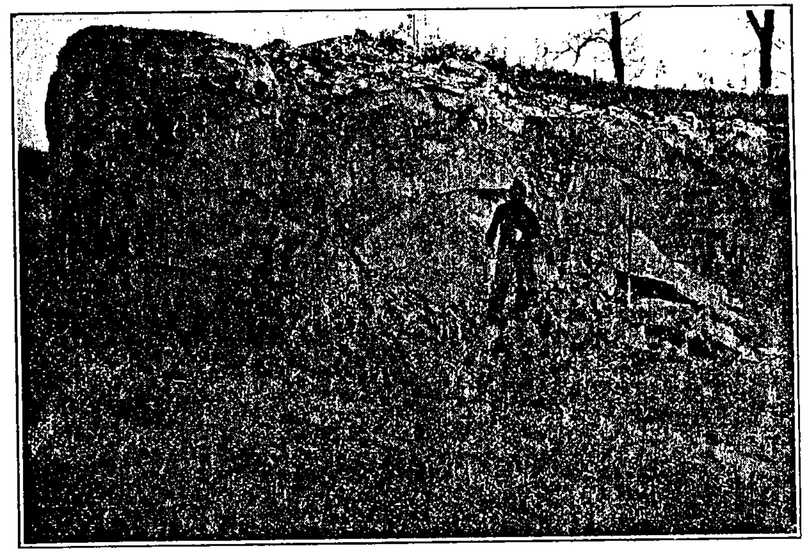
It was noticeable that the fragments in the lower part of the clay were wholly or partly turned to tripoli, while those near the surface were chert. The tripoli which resulted from the decomposition of these chert fragments was not of a fine-grained, homogeneous nature like that of the main body, but was coarse-grained, generally iron-stained, and resembling somewhat the "cotton flint," excepting that it was much softer and could be cut or scraped with a knife. There seemed to be a gradation from the soft, decomposed pieces upward to the undecomposed fragments of chert at the surface. The clay matrix to these fragments is deep red in color and very fine-grained and plastic. Locally it is known as "ochre." The decayed material just above the beds is coarse-grained, deeply iron-stained, very loose, and full of nodules of chert varying in size from a fraction of an inch to a foot or more in diameter.

RELATION TO SUBSURFACE.

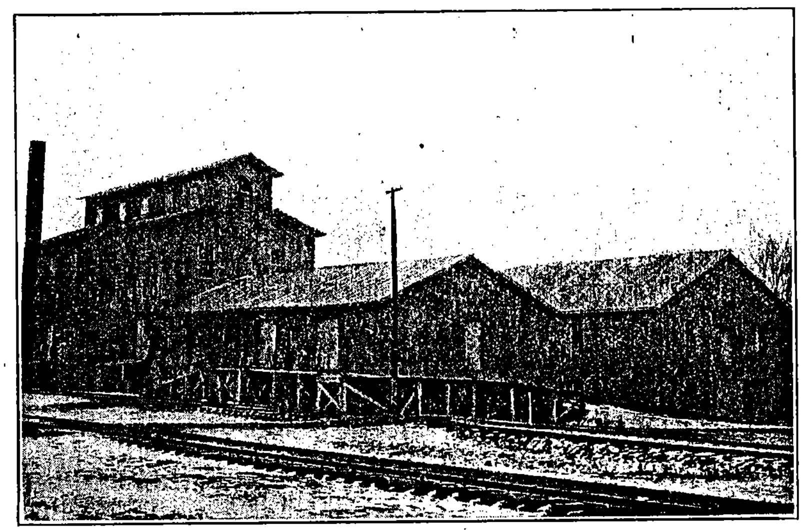
Since there are no outcrops of tripoli, and since no pits were found which had gone below the beds, the writer was unable to find out definitely about the condition of the ground below the beds. From reliable descriptions it appears that nowhere is solid rock found directly below the beds. It would seem that there is a foot or two of rotten tripoli with chert nodules and fragments and then several feet of red clay filled with many fragments of greatly decomposed chert intervening between the tripoli deposits and the solid rock beneath. When solid rock is reached a number of feet below the beds it is the characteristic cherty limestone of the Boone formation.

ROCKS RESEMBLING TRIPOLI.

Occurring throughout the district, and in fact almost every place where the Boone formation outcrops, a white, porous, light-weight, siliceous limestone is present, which greatly resembles pure tripoli. It resembles tripoli so much that many who are not familiar with the rocks cannot tell them apart.



A. QUARRY OF AMERICAN TRIPOLI COMPANY, SHOWING CHARACTER OF ROCK AND NEARNESS TO SURFACE.



B. FLOURING MILL OF AMERICAN TRIPOLI COMPANY, SENECA, MISSOURI.

Deposits of such siliceous limestones usually occur in the heads of valleys where there has been or is a spring. The siliceous material grades into dense limestone upon being followed into the hill. The known deposits are usually very small, being only a few feet in extent. However, large deposits have been reported. This limestone is of no value either as a filtering agent or as an abrasive when ground into flour. Filters made of it work very well for a short time, but soon crumble.

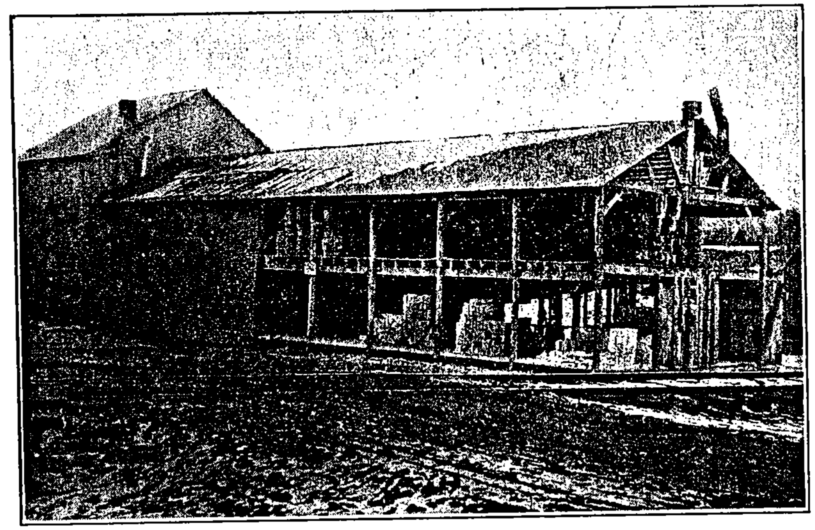
PROCESS OF MANUFACTURE.

QUARRYING.

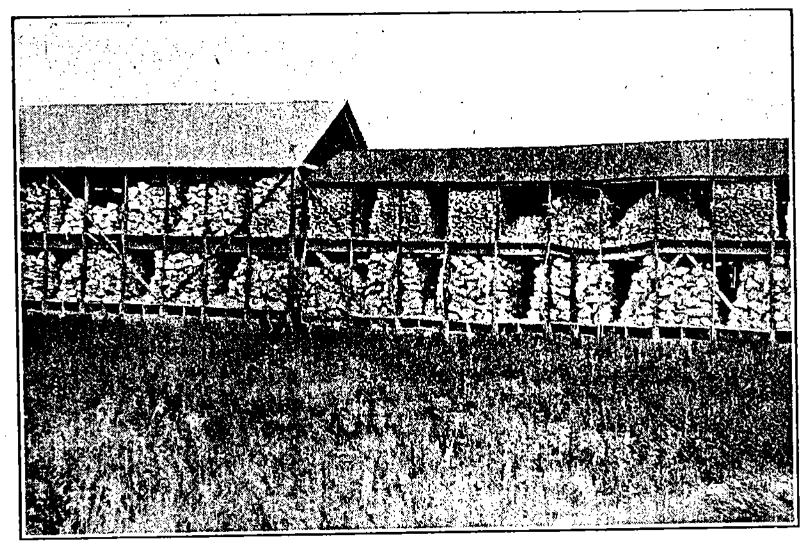
The deposits of tripoli which are being quarried for commercial purposes are covered with from 4 to 6 feet of waste. This overburden is scraped away with ordinary scrapers. If the quarry be large the overburden may be piled in the center of the quarry, where the tripoli has been removed. When so placed it requires no second moving, as might be the case if merely piled on the surface a short distance from the opening of the quarry. After the tripoli is uncovered for a distance of several feet from the opening, vertical holes are drilled by an ordinary 2-inch screw auger. These holes are 4 to 8 feet from the opening and may be spaced a rod apart. A small charge of blasting powder, amounting usually to about two quarts, is used to loosen the rock. The charge does not shatter the tripoli but heaves it upward and outward. Often blocks several feet in diameter remain unbroken and need to be further broken by means of hand picks. The loose rock is shoveled into cars or wagons by means of ordinary scoops.

DRYING AND MILLING.

After leaving the quarry the process of preparation differs somewhat in the different mills. The American Tripoli company hauls the "green" rock direct from the quarry to the drying sheds, where it is placed loosely in stacks about 3 x 4 x 8 feet. The rock remains in these sheds in the open air for from three to four months, by which time it has become dry enough to be taken to the mill and ground to flour. One advantage of this method of drying in sheds is that the only expense attached to the process is the handling. The American Tripoli Company first runs the rock through a rotary crusher which breaks it into pieces of about one inch, and it is then passed to a buhrmill



A. FILTER MILL OF SENECA TRIPOLI COMPANY, SENECA, MO., SHOWING STORAGE OF ROUGH BLOCKS READY TO BE FINISHED INTO FILTERS.



B. DRYING SHEDS OF SENECA TRIPOLI COMPANY.

where the rock is ground into flour. Upon leaving the buhrmill the flour is separated on reels, quite similar to the manner in which wheat flour is separated. The size of the mesh used varies from 50 to 200 — the 200 mesh being that used in ordinary trade. The flour is sacked in 200-pound bags and is then ready for shipment to the consumer.

The Seneca Tripoli Company has a slightly different method of procedure. From the quarry the rock is hoisted over an inclined tramway direct to the mill. The "green" rock then goes to a 4-inch gyratory crusher which breaks it into pieces of about one inch in diameter. From the gyratory the rock goes to the dryer. This is a cylindrical tube about 12 feet in diameter and about 35 feet long. It is arranged into longitudinal compartments so that heat from a furnace will enter one end, pass the entire length of the tube, and return through another compartment to the smoke stack. There is still a third compartment through which the material to be dried passes. The drying rock is caused to move forward through the tube by the tube being inclined and rotated. It takes a piece of rock about one hour to pass from one end of the dryer to the other. In this time it has lost its moisture. One advantage of this process is that the rock is handled but once; also, dry rock can be had at any time. From the dryer the tripoli is passed through a hammer mill which breaks it into pieces about one-fourth of an inch in diameter, and thence it goes to a tube mill to be ground to flour. The coarseness of the flour is regulated somewhat by the speed with which it is passed through the tube mill. From the tube mill the flour is passed over a "scalping reel," where the various meshes of flour are obtained. It is then sacked in 200-pound bags and is ready for the market.

FINISHED PRODUCTS.

FLOUR.

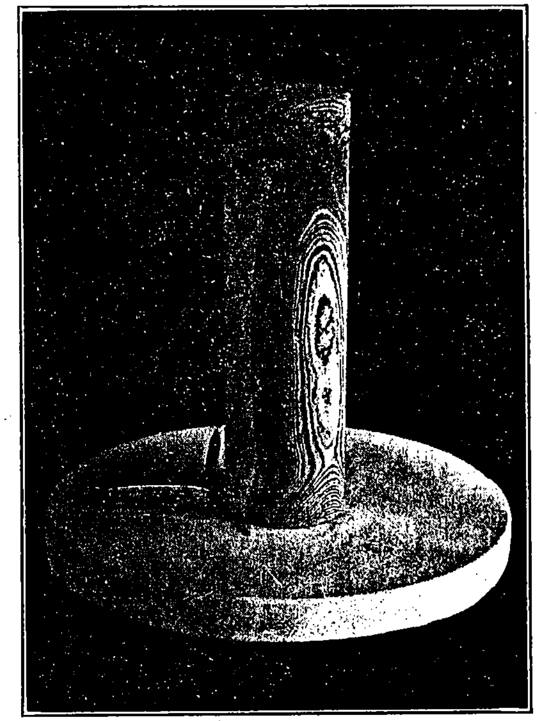
Two grades of flour are generally marketed, depending on the degree of fineness, as the O. G. (once ground) and the D. G. (double ground). The former is about 100-mesh, and the latter is about 200-mesh. The D. G. grade will pass through No. 14 silk bolting cloth. Various shades of colors are produced and go under the names of "white," 'cream," and "rose." Such shades are obtained by varying the amount of iron-stained

tripoli in the process of manufacture. Any shade of flour from white to rose may be procured.

FILTERS.

The manufacture of filters is far less important than the production of tripoli flour. Filter production is less important now than it was a few years ago. The reason for this is the

PLATE X.



CYLINDRICAL AND DISK FILTERS. THE MARKINGS ARE DUE TO COLOR BANDS FROM IRON STAIN.

installation of improved water systems throughout the cities of the United States. Not all tripoli is suited for filters. Very uniform rock which is free from cracks, "sand pits," and other imperfections must be picked out. Iron stain occurs in some rock, and, while it has no effect in the filtering capacity of the rock, is objectionable to some consumers. (Plate X). Fractures and cracks are usually the most serious drawbacks. Certain quarries are found which contain better filter stones than others, and these may be set aside for filtering purposes only.

In quarrying filter rock particular care must be exercised so as not to break the rock into small pieces. Black powder is not used. Often unslaked lime is placed into drill holes and the holes plugged. The slaking of the lime, due to the absorption

PLATE XI

A. QUARRY OF AMERICAN TRIPOLI COMPANY IN OKLAHOMA, SHOWING THICKNESS OF OVERBURDEN, THICKNESS OF TRIPOLI, AND MANNER OF QUARRYING.

of moisture from the ground, causes the lime to expand, thus breaking off large blocks without shattering them. The most common method of breaking out filter rock is the "plug and feather" method, such as is applied in other quarries. Series of holes are drilled and two specially shaped wedges are placed in each hole, the small ends downward. By driving in the wedges with a hammer the rock is broken out in large blocks.

After being taken to the mill these irregular blocks are sawed to dimension by circular steel saws which have special

adjustable teeth. After being first sawed roughly to dimension the stones are finished on revolving carborundum wheels, or are "turned" to exact dimension on a lathe. Filters are made in all shapes and sizes, from flat disks 12 inches in diameter and 1 inch in thickness, to cylinders 6 inches in diameter and

PLATE XI

B. QUARRY OF SENECA TRIPOLI COMPANY, SHOWING CONTACT LINE OF "GOOD" AND "ROTTEN" TRIPOLI; ALSO SHOWING GRADATION INTO SOIL.

8 inches long. The cylinders generally have a hole bored entirely through them and the water is made to pass through the sides of the cylinder and out of the hole. Filters are always made to order, the particular size and shape being designated at the

time the order is placed. When put into use, water may be passed through the filters indefinitely without the filtering ability being affected.

PRODUCTION.

According to Siebenthal* the production has increased from less than 200 tons of tripoli flour in 1888 to 1,000 tons in 1893; 1,375 tons in 1894; and 4,000 to 5,000 tons per year in the succeeding years to 1907. During the year of 1916 approximately 9,000 tons of flour were shipped. The present (1917) price of tripoli flour f. o. b. Seneca, Mo., is from $6 to $8 per ton. It is estimated that in 1906 six hundred tons of rough rock were worked into filter stones. Since then the production of filters has gradually decreased. A unit price can not be placed on the individual filter stones, as the price varies with the size, shape, and amount of work done on each stone. Perhaps an average price for a cylinder 3" x 6" would be from 15 to 20 cents. Total figures upon the value of the entire production of tripoli of Oklahoma could not be procured, but from reliable estimates for the year 1916 they would not be far from $90,000. Between 30 and 40 per cent of the flour is exported.

USES OF TRIPOLI.

Tripoli is used largely for filters and as abrasive powders or flour. As mentioned, filters are made in various shapes and sizes. The ord nary house filter has a capacity of about 400 gallons per hour, but by arranging the filters in series or batteries almost any desired capacity may be obtained. The larger portion of any suspended matter in water will be removed upon passing through filters. Since pathogenic germs infesting waters are largely attached to suspended matter, it follows that these germs would also be removed. It is said that bacteriological examination of water before and after its passage through tripoli demonstrates the sterilizing efficiency of the stone.

Tripoli flour is used for abrasive work, such as polishing, burnishing, and buffing. In this capacity it is mixed as an ingredient into various scouring soaps and metal polishes. A large amount of tripoli is consumed by foundries, where it is

*Siebenthal, C. E., Tripoli deposits near Seneca, Mo., Bull. U. S. Geol. Survey 340, p. 435, 1907.

used as parting for molds. Tripoli flour serves as the most important constituent of the parting and when put on the molds causes the casting to leave the mold with a smooth surface.

There are many other materials against which tripoli must compete as an abrasive. Among these are corundum, emery, abrasive garnet, diatomaceous earth, volcanic ash, pumice ,feldspar, and silica (quartz). The production of these other abrasives is vastly more important than the production of tripoli. Tripoli is used only where a very even and very fine abrasive is wanted. It is interesting to note that the demand for tripoli amounts to about 8,000 or 10,000 tons per year, while the combined output of the mills, if running full capacity, would amount to about 25,000 tons per year.

INDUSTRIES.

The American Tripoli Company was the first to do active work in the production of tripoli, having commenced operations as early as 1887. The land controlled by this company lies one mile North of Seneca, Mo., partly in Oklahoma and partly in Missouri. Deposits of tripoli occur on both sides of the state line, but the main deposit now being worked is on the Oklahoma side. The drying sheds belonging to this company are located close to the quarries. The mill is located at Seneca, Mo., and was constructed in 1907. It is equipped with machinery adequate to turn out 30 tons of tripoli flour per ten hour day. The filter works are established in connection with the flouring mill.

The Seneca Tripoli Company is the only other firm operating in Oklahoma. (See Plates VII and IX). The mill is situated on 120 acres of land two miles south of Peoria, and most of this land is underlaid with tripoli. The rock is hoisted direct from the quarries to the mill, where it is prepared for market. Machinery is installed for the manufacture of filters, but the principal product of the mill is the tripoli flour. The capacity of the mill is about 50 tons of finished product per ten hour day. This company also has a small filter mill just south of Racine, Mo., where a fine-grained tripoli which is more suited to filter making is quarried.

There are one or two smaller companies which ship some tripoli from the neighborhood of Racine, Mo., but their output is negligible.