DIAMOND-BEARING PERIDOTITE IN PIKE COUNTY, ARKANSAS.

By Hugh D. Miser and Clarence S. Ross.

LOCATION OF THE AREA.

Peridotite is exposed in four places near Murfreesboro, Pike County, in southwestern Arkansas, and at three of these places diamonds have been obtained. (See fig. 65.) The exposure that

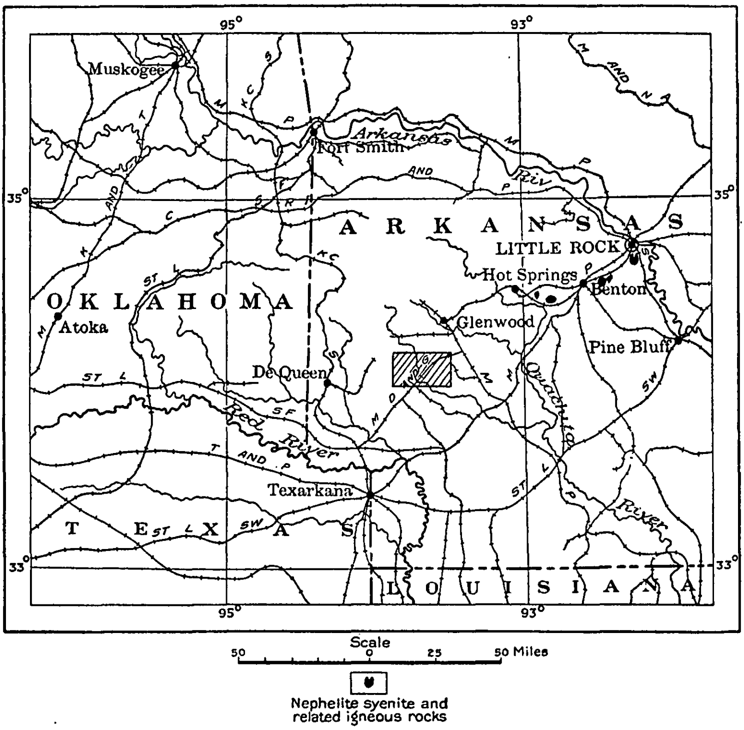


FIGURE 65.—Map of parts of Arkansas, Oklahoma, and adjacent States, showing the area (shaded rectangle) that contains the diamond-bearing peridotite of Pike County, Ark.

was first discovered, which has been known to geologists since 1842, lies 2½ miles south-southeast of Murfreesboro, near the confluence of Prairie Creek with Little Missouri River, and is here called the Prairie Creek area. (See Pl. VIII.) Diamonds were discovered in this area in 1906, and several thousand of them, ranging in weight from a small fraction of a carat to 20¼ carats, have since been produced. The mines in this area are the Ozark, Mauney, and Arkansas. All the other exposures of peridotite occur within an area of 1 square mile about 2 miles northeast of the Prairie Creek area and 3 miles S. 75° E. of Murfreesboro. Two of these exposures are here named the Kimberlite and American areas, from the Kimberlite and American mines, which are in them; they are in sec. 14, T. 8 S., R. 25 W. A third exposure, known as the Black Lick area, is at and near the Black Lick, in the northwest corner of sec. 23, T. 8 S., R. 25 W. The Kimberlite and American areas have been prospected on a small scale for diamonds, and each has produced a small number. The Black Lick area has been prospected less than any of the others and has thus far produced no diamonds.

INVESTIGATION AND ACKNOWLEDGMENTS.

The field investigation of the peridotite areas for this report was made by Mr. Miser in 1912 and 1916 in connection with detailed studies in the De Queen and Caddo Gap quadrangles. The data on the Kimberlite, American, and Black Lick areas of peridotite were published in 1913[1] and with some modifications are republished here.

The specimens collected by Mr. Miser have been studied microscopically by Mr. Ross, who has written large parts of the descriptions of the different areas of peridotite.

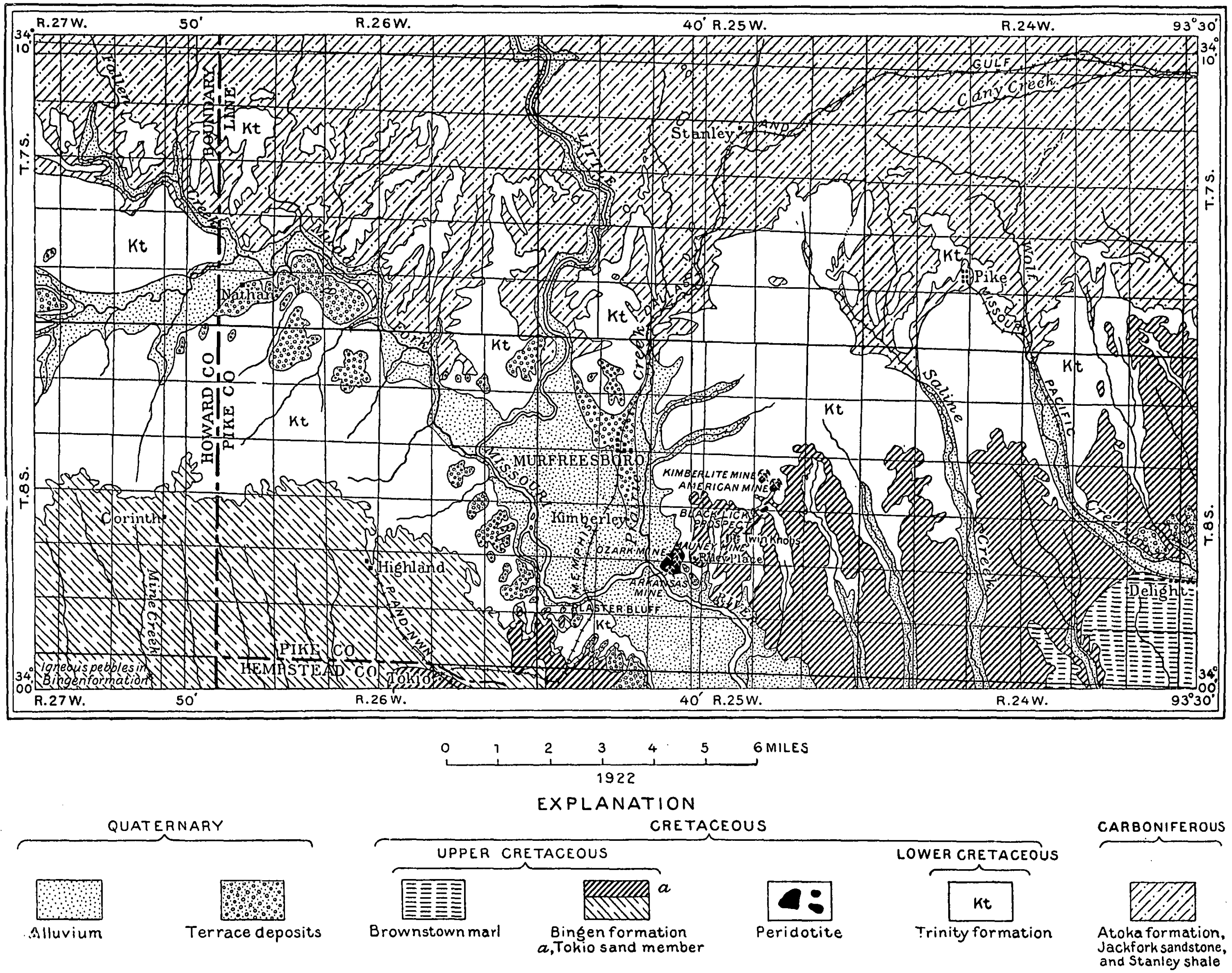
The Prairie Creek area has been more extensively developed than the others and has thus far yielded practically all the diamonds that have been obtained in the region. It is therefore described in greater detail than the other areas of peridotite, and a more detailed map has been made of it than of the other areas.

The preparation of the topographic map of the Prairie Creek area (Pl. IX) was greatly facilitated by the use of a map that had been made by John T. Fuller, formerly consulting engineer of the Arkansas Diamond Co. By running a line of levels Fuller tied the elevations of his map with the elevation of the United States Geological Survey bench mark stamped "H. S. 367" in the east wall of the courthouse at Murfreesboro. His sketching of the contours was found to be so accurate that large portions of his map were transferred with minor alterations to the base prepared by Mr. Miser.

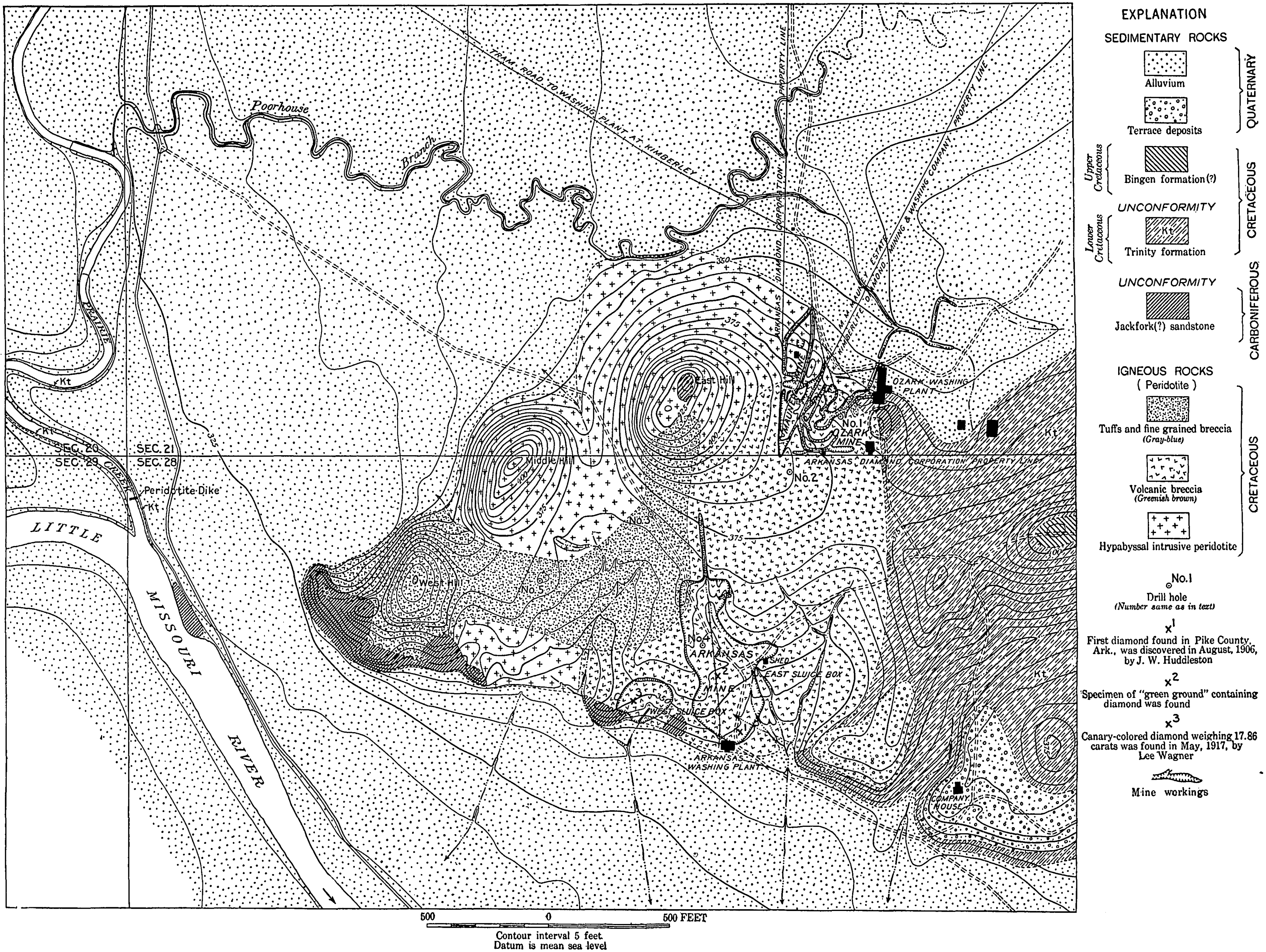
The data on the sedimentary rocks of the region were obtained during field work by A. H. Purdue, assisted by Mr. Miser, in 1908 and 1911 and during field work by Mr. Miser in 1912 and 1916. R. D. Mesler rendered valuable assistance in 1912.

The writers are under obligation to the officials of the companies for permission to enter and examine their properties. Among the persons to whom special acknowledgments are due for courtesies and

[1] Miser, H. D., New areas of diamond-bearing peridotite in Arkansas: U. S. Geol. Survey Bull. 540, pp. 534–546, 1914 (Bull. 540–U, 1913).



GEOLOGIC MAP OF PARTS OF PIKE, HOWARD, AND HEMPSTEAD COUNTIES, IN SOUTHWESTERN ARKANSAS.



GEOLOGIC MAP OF THE PRAIRIE CREEK AREA OF PERIDOTITE IN T. 8 S., R. 25 W., 2½ MILES SOUTH-SOUTHEAST OF MURFREESBORO, PIKE COUNTY, ARK.

Surveyed with plane table in 1916 by H. D. Miser.

for information are S. W. Reyburn, president, C. S. Stifft, vice president, L. J. Wagner, watchman, and John Peay, of the Arkansas Diamond Co.; A. Q. Millar and H. A. Millar, of the Kimberlite Diamond Mining & Washing Co.; and Walter Mauney, of Murfreesboro, Ark.

The collection of diamonds owned by Col. Washington A. Roebling has been kindly loaned by him to the Survey, so that a photograph of the collection could be made for use in this report. (See Pl. XV, *A*.)

W. T. Schaller, mineralogist, of the United States Geological Survey, has made mineral determinations and has supplied notes on the forms of the diamonds in the Roebling collection pictured in Plate XV, *A*. E. S. Larsen has given valuable advice and assistance during the microscopic study of the peridotite.

The present report does not give a complete and comprehensive description of the diamond deposits, because no examination of the mine workings has been made since 1917, partly owing to the refusal of the officials of the Arkansas Diamond Corporation to permit an examination of the Arkansas mine in 1921; because the complete figures of production of diamonds are not obtainable from the operating companies; because practically no information regarding the recovery of diamonds per load of diamond-bearing material has been furnished by the companies; and because a detailed study of the crystal forms of a large representative collection of the diamonds has not been made by a mineralogist. The report consists mainly of a presentation of the available information on the diamond-bearing area and a comparison of it with the diamond fields in South Africa.

BIBLIOGRAPHY.

A list of papers treating of the peridotite and diamonds of Pike County, Ark., and the more noteworthy papers on the geology of the region is given below.

1842.

Powell, W. B., Geological report upon the Fourche Cove and its immediate vicinity, p. 6, footnote. Mentions the Prairie Creek area of peridotite in a vague way and connects it genetically with the Fourche Mountain, Bauxite, and Magnet Cove igneous areas.

1846.

Shepard, C. U., On three new mineral species from Arkansas, and the discovery of the diamond in North Carolina: Am. Jour. Sci., 2d ser., vol. 2, footnote on p. 253. A hand specimen of the peridotite from the Prairie Creek area, which was sent to Shepard by Rev. E. R. Beadle, was described in the following words: "From same region [Little Missouri, Pike County] (sec. 27, T. 8 S., R. 25 W.). A trachytic porphyry. It has the dry, harsh feel and emits the peculiar odor (when moistened) of the European trachytes. It is said by Mr. Beadle to be as recent as the Tertiary."

1860.

OWEN, D. D., Second report of a geological reconnaissance of the middle and southern counties of Arkansas, made during the years 1859 and 1860, p. 32. The peridotite of the Prairie Creek occurrence is mentioned but not described in detail. It is simply spoken of as a "porphyritic greenstone" and a "trachytic rock."

1888.

HILL, R. T., The Neozoic geology of southwestern Arkansas: Arkansas Geol. Survey Ann. Rept. for 1888, vol. 2. Includes a description of the Cretaceous and Quaternary rocks of Pike County, Ark.

1889.

BRANNER, J. C., and BRACKETT, R. N., The peridotite of Pike County, Ark.: Am. Jour. Sci., 3d ser., vol. 38, pp. 50–59; Am. Assoc. Adv. Sci. Proc., vol. 37, pp. 188–189 (abstract). This is the first detailed report on the Prairie Creek area of peridotite. Part I, by Branner, describes the relations of the igneous to the sedimentary rocks and is illustrated by a colored geologic map, which was the only geologic map of the occurrence that had been made when the present investigation was begun. He states that "the peridotite is a simple injection which took place about the close of the Cretaceous through and between the Paleozoic strata and penetrating the lower Cretaceous beds." His guarded reference to the possibility of the presence of diamonds follows: "Inasmuch as it has been suggested that the South African diamonds may have been generated by the metamorphism of the carbon in the carbonaceous shales penetrated by peridotite, it should be added that no such phenomenon is suggested by observations at this locality upon these rocks." Part II, by Brackett, gives a microscopic description of the peridotite and compares it with the peridotites at Syracuse, N. Y., and in Elliott County, Ky.

1891.

WILLIAMS, J. F., The igneous rocks of Arkansas: Arkansas Geol. Survey Ann. Rept. for 1890, vol. 2, pp. 377–391. The preceding paper by Branner and Brackett was copied, with some changes and additions, including a chemical analysis of the peridotite.

1906.

VEATCH, A. C., Geology and underground water resources of northern Louisiana and southern Arkansas: U. S. Geol. Survey Prof. Paper 46. Area described includes Pike County, Ark.

1907.

KUNZ, G. F., and WASHINGTON, H. S., Note on the forms of Arkansas diamonds: Am. Jour. Sci., 4th ser., vol. 24, pp. 275–276. The statement is made that the diamonds of Pike County, Ark., are found in a "peridotite stock." The forms, color, and size of the first 140 diamonds found at the Arkansas mine are described. A summary of part of the paper is given on page 319 of this report.

SCHNEIDER, P. F., A preliminary report on the Arkansas diamond field, 16 pp., Arkansas Bur. Mines, Manuf., and Agr. Describes briefly the Prairie Creek area of peridotite, including its history, topography, the peridotite, the associated rocks, metamorphism, the diamonds, and the mining of the diamonds. Points out that Pike County, Ark., is "the first American locality in which diamonds have unquestionably been traced to their rocky matrix of peculiar kimberlite."

1908.

SCHNEIDER, P. F., A unique collection of peridotite: Science, new ser., vol. 28, pp. 92–93. Describes a collection containing specimens of "the peculiar peridotite breccia" from Arkansas, Kentucky, and New York. Says that the peridotites from the different localities are so similar that it is almost impossible to distinguish them. Also discusses the general question of the origin of diamonds.

PURDUE, A. H., A new discovery of peridotite in Arkansas: Econ. Geology, vol. 3, pp. 525–528. The peridotite at the American mine is briefly described.

KUNZ, G. F., and WASHINGTON, H. S., Diamonds in Arkansas: Am. Inst. Min. Eng. Bimonthly Bull. 20, pp. 187–194, 1908; Am. Inst. Min. Eng. Trans., vol. 39, pp. 169–176, 1909. Describes the occurrence of peridotite on Prairie Creek. The subjects discussed are the diamonds, the peridotite, the relations of the peridotite to the adjacent sedimentary rocks, and mining conditions. The opinions are expressed that the rock in which the diamonds are found is "a vitreous peridotite, forming a stock or volcanic neck," and that "the rock is evidently an igneous intrusive, which welled up in comparative quiet and solidified not far from the surface."

KUNZ, G. F., and WASHINGTON, H. S., On the peridotite of Pike County, Ark., and the occurrence of the diamonds therein: New York Acad. Sci. Annals, vol. 18, p. 350. A description of a paper that was presented before the New York Academy of Sciences.

1909.

FULLER, J. T., Diamond mine in Pike County, Ark.: Eng. and Min. Jour., vol. 87, pp. 152–155, 616–617. The first article describes the diamond-bearing peridotite and the associated rocks of the Prairie Creek area of peridotite, gives table showing weights and colors of the first 75 diamonds found in the Arkansas field, and gives early history of the Arkansas mine. The second article discusses some questions in Branner's article cited below.

BRANNER, J. C., Some facts and corrections regarding the diamond region of Arkansas: Eng. and Min. Jour., vol. 87, pp. 371–372. Gives some facts of historical interest in connection with the discovery of diamonds in Arkansas. He says: "The peridotite was not only recognized [at the time of the field examination in the late eighties] as the kind of rock in which diamonds occur in South Africa, but I spent many hours on my hands and knees looking for diamonds in the gullies and over the bare surfaces of the decomposed rocks." He says he referred to the diamond question in a guarded manner in his earlier report because he did not feel warranted in starting a fresh mining excitement, especially as there was then raging in west-central Arkansas "one of the wildest and most uncontrollable mining excitements that ever broke forth in any part of this country." He adds: "After the excitement in Arkansas had subsided I made the statement on various occasions that it was possible that there might be diamonds in this peridotite area."

MILLAR, A. Q., The Arkansas diamond fields: Min. and Sci. Press, vol. 99, p. 534. Describes the distribution of the peridotite in Pike County, Ark.; gives the number and weight of the recovered diamonds; discusses the relations and diamond content of the "hardebank," "black ground," "yellow ground," "green ground," and "blue ground"; and states that these materials can be duplicated by like materials from South Africa. He expresses the opinion that "the 'blue ground' is the matrix and carrier of the diamonds from depth in Arkansas as in Africa and the accompanying areas of 'hardebank' no doubt will in time prove to be 'horses.' "

HARRIS, G. D., Magnetic rocks: Science, new ser., vol. 29, p. 384. A note on the peridotite in Arkansas, so interesting that all of it is quoted: "While in southern Arkansas recently, studying the northern outcrops of the oil-bearing horizons of Louisiana, I took occasion to ascertain whether the peridotite eruptives about Murfreesboro, Ark., were as magnetic as similar rocks in central New York. They prove to be so; hence it seems that if a somewhat detailed magnetic survey of the region thereabout were made the tens of thousands of dollars now expended in worthless options might practically all be saved. Naturally in searching for diamonds the first information desired is the whereabouts of the volcanic necks bearing the diamond dirt. Though these are covered by plateau gravel or alluvial sands and clays they can be detected as readily as the dikes in central New York can be located, though under many feet of glacial till."

McCOURT, W. E., Diamonds in Arkansas: St. Louis Acad. Sci. Trans., vol. 18, pp. lix–lx; Science, new ser., vol. 30, p. 127. Abstract of an illustrated lecture given May 17, 1909. Gives a brief description of the diamond region in Pike County, Ark.

FULLER, J. T., Arkansas diamond fields in 1909: Eng. and Min. Jour., vol. 89, pp. 767–768. Describes development at the diamond mines in 1909.

1911.

FULLER, J. T., Arkansas diamond field in 1910: Eng. and Min. Jour., vol. 91, pp. 6, 164. Describes diamond-mining operations in 1910.

1912.

GLENN, L. C., Arkansas diamond-bearing peridotite (abstract with discussion by A. H. Purdue): Geol. Soc. America Bull., vol. 23, p. 726; Science, new ser., vol. 35, p. 312. Glenn believes there was a circulation of thermal waters about the margin of the Prairie Creek area of peridotite. He describes the water-laid deposit, consisting of disintegrated peridotite, sand, and chert pebbles, on the Riley place. He says: "Indications of the age of this material narrow down the period within which the extrusion of the peridotite must have occurred." This deposit is considered by Mr. Miser to be at the base of the Tokio sand member of the Bingen formation (Upper Cretaceous). Purdue in discussing Glenn's paper says: "It appears to establish the age of the peridotites as post-Lower Cretaceous and pre-Upper Cretaceous."

FULLER, J. T., The Arkansas diamond field: Eng. and Min. Jour., vol. 93, p. 6. Describes the small amount of diamond mining that was done in 1911.

1913.

FULLER, J. T., Diamond mining in Arkansas: Eng. and Min. Jour., vol. 95, p. 75. Describes diamond-mining operations in 1912.

1914.

MISER, H. D., New areas of diamond-bearing peridotite in Arkansas: U. S. Geol. Survey Bull. 540, pp. 534–546. The Kimberlite, American, and Black Lick areas of peridotite are described. The age of the peridotite is discussed. Its intrusion is stated to have been after the deposition of the Trinity formation (Lower Cretaceous) and before the deposition of the Bingen formation (Upper Cretaceous).

FULLER, J. T., Arkansas diamond field in 1913: Eng. and Min. Jour., vol. 97, p. 52. Describes diamond-mining operations in 1913.

1919.

MISER, H. D., and PURDUE, A. H., Asphalt deposits and oil conditions in southwestern Arkansas: U. S. Geol. Survey Bull. 691, pp. 271–292. Contains a description of the Trinity formation (Lower Cretaceous) and other rocks in Pike County, Ark.; describes the asphalt deposits in Pike County; and discusses the structure of the rocks and the possibility of the discovery of oil.

MISER, H. D., and PURDUE, A. H., Gravel deposits of the Caddo Gap and De Queen quadrangles, Ark.: U. S. Geol. Survey Bull. 690, pp. 15–29. The gravel deposits of Lower Cretaceous, Upper Cretaceous, and Quaternary age near Murfreesboro and in other parts of Pike County are described.

1920.

REYBURN, S. W., and ZIMMERMAN, S. H., Diamonds in Arkansas: Eng. and Min. Jour., vol. 109, No. 17, pp. 983–986, Apr. 24. Reyburn, the president of the Arkansas Diamond Corporation, and Zimmerman, the engineer in charge of the Arkansas mine, give abstracts and quotations from different geologic reports on the Prairie Creek area of peridotite and especially give information about the Arkansas mine, which is owned and operated by this corporation. They give the history of the mine, state that it has produced more than 2,000 diamonds, and describe the washing plant that was erected in 1920 to make further tests on the value of the property.

1907–1920.

THE MINERAL INDUSTRY for 1907 and subsequent years; and UNITED STATES GEOLOGICAL SURVEY MINERAL RESOURCES OF THE UNITED STATES for 1906 and subsequent years. Give partial statistics of production of diamonds in Arkansas, brief descriptions of the diamonds and the diamond-bearing peridotite, and short accounts of the operations of the companies.

HISTORY.

The first diamonds found near Murfreesboro, and also the first found in Arkansas, were picked up on the Prairie Creek area of peridotite on August 1, 1906, by John W. Huddleston, the owner of most of the area. He showed them to Horace Bemis, of Prescott, Ark., who, suspecting that they were diamonds, took one to the Mermod, Jaccard & King Jewelry Co., of St. Louis, for identification. A little later one or more stones were sent to Charles S. Stifft, jeweler, of Little Rock, Ark., for identification, who in turn submitted them to George F. Kunz, a gem expert, of New York City. After the stones had been identified as diamonds Mr. Stifft, A. D. Cohn, and S. W. Reyburn, of Little Rock, and J. C. Pinnix, of Murfreesboro, secured an option on the Huddleston property and later organized the Arkansas Diamond Co., which purchased the property.

The discovery of the diamonds by Huddleston caused prospectors to search for other areas of peridotite. To the present time three others, the Kimberlite, American, and Black Lick areas, have been discovered; and diamonds have been found on all except the one last named.

After the Arkansas Diamond Co. had purchased the Huddleston property it cleared the timber from much of the property and put down numerous pits and a few drill holes to determine the extent and depth of the soft, decomposed peridotite that could be treated for the recovery of diamonds. It then began mining and washing the diamond-bearing peridotite. The mine thus opened is called the Arkansas mine. (See Pl. IX.) In May, 1908, the company erected a small diamond-washing plant at the southern edge of the outcrop of peridotite, and in August, 1909, it remodeled the plant. The remodeled plant consisted of a revolving sizing screen, an 8-foot rotary washing pan, a Harz jig, and a 20-horsepower boiler and engine. It was operated from time to time until 1912, but since then it has been operated very little. Its location is shown on the map (Pl. IX), which was made in 1916. Water for the plant was piped from Little Missouri River, about a quarter of a mile to the southwest. In 1919 the company was reorganized as the Arkansas Diamond Corporation of Virginia, with an authorized capital of $10,000,000, and in 1920 it erected a larger washing plant near the earlier one, in order to make further tests of the value of the property. The new plant, which has been in operation much or all of the time since its erection, is said by S. W. Reyburn and S. H. Zimmerman [2] to contain a No. 3 gyratory crusher, an 8-foot Hardinge tube mill, a rotary drier, two washing pans, jigs, and a grease table. Most of the diamonds that have been produced by the Arkansas mine have been recovered in the washing plants, but many have been picked up by chance on the surface or have been recovered in sluice troughs through which the soft, decomposed peridotite was washed during hydraulic mining. The mine openings on the property of this company consist of trenches and cuts which, when last examined, in December, 1917, did not exceed 10 feet in depth and covered an aggregate area of several acres.

The Mauney mine, in the northeastern part of the Prairie Creek area of peridotite, was opened by M. M. Mauney, who worked it on a small scale for a number of years prior to 1912. (See Pl. IX.) In that year the Kimberlite Diamond Mining & Washing Co., which had obtained a long-term lease on the mine, began the erection of a washing plant on the west bank of Prairie Creek at the village of Kimberley, and this plant was completed in 1913. Both the plant and the mine were operated by this company much of the time until January 13, 1919, when the plant was destroyed by fire. The earth or decomposed peridotite was mined by hand and hauled in tram cars a distance of 4,300 feet to the plant, where it was fed through a revolving screen and into a 10-foot diamond concentrating

[2] Reyburn, S. W., and Zimmerman, S. H., Diamonds in Arkansas: Eng. and Min. Jour., vol. 109, pp. 983-986, 1920.

pan of the pattern used in South Africa. The concentrates were further screened and then treated in jigs, and the final concentrates were examined on metal-covered tables in a well-lighted room. After this examination the concentrates were run over a grease table. Oversize material from the first screening was subjected to further weathering; the undersize material from the jigs was placed in a large pile for future treatment; and the tailings were conveyed by flume to Prairie Creek. A constant and sufficient water supply was obtained by pumping water from the creek and from two wells 170 feet deep at the plant. The Mauney mine has not been operated since 1919, and the washing plant at Kimberley, to which the diamond-bearing material was hauled for the recovery of the diamonds, has not been rebuilt.

The Ozark mine, in the northeast part of the Prairie Creek area of peridotite, was first worked by the Ozark Diamond Mines Corporation in 1912 or a short time before. (See Pls. IX and XI, *B*.) In 1912 the company constructed a washing plant near the mine and operated it for a few months beginning late in the year and ending early in 1913. The plant was equipped with a stationary boiler and engine, a trommel separator, a log washer, sizing screens, jigs, a jaw crusher, and a grease table. Mr. Warren, the superintendent at the time the plant was in operation, estimated that about 5,000 loads, each containing 16 cubic feet of decomposed peridotite, which was obtained from an open cut 300 feet long, 15 to 35 feet across, and 8 to 20 feet deep, were washed in the plant and in sluice boxes. This material is said to have yielded between 800 and 900 diamonds. About 1,000 loads of gumbo and gravel from the Bingen formation on the Riley tract, about half a mile northeast of the plant, were washed, but no diamonds were found in this material. (See Pl. VIII.) Water for the plant was piped from a point near the mouth of Prairie Creek, a little more than half a mile to the west.

The Ozark mine and the washing plant were sold in December, 1914, by a receiver of the Ozark Diamond Mines Corporation, to the Kimberlite Diamond Mining & Washing Co. The mine was operated by the latter company until January, 1919, when the washing plant at the Ozark mine and also the washing plant at Kimberley were destroyed by fire. The decomposed peridotite that was mined between 1914 and 1919 was not treated in the Ozark plant but was hauled in tram cars to the plant at Kimberley. The mine has not been operated since 1919, and the Ozark plant has not been rebuilt.

The Kimberlite mine, in the SW. ¼ NW. ¼ sec. 14, T. 8 S., R. 25 W., is owned by the Kimberlite Diamond Mining & Washing Co., which has made a number of shallow trenches and pits and has sunk a few drill holes in order to determine the depth and area of the soft decomposed peridotite. (See Pls. XIV and XV, *B*.) The company has not done any washing for diamonds at this locality, but it reports that several diamonds of good quality, the largest of which weighed 4 carats, were picked up on the surface.

The American mine, in the NE. ¼ SW. ¼ sec. 14, T. 8 S., R. 25 W., is on land belonging to T. E. Flournoy, who purchased the property in 1914 through receivers from the American Diamond Mining Co., which in turn late in 1908 had succeeded the Pike County Diamond Mining Co. Several pits, cuts, trenches, drill holes, a shaft, and a tunnel have been made to determine the depth and area of the soft, decomposed peridotite, and the two companies mentioned did a little washing for diamonds by means of crudely constructed devices. (See Pl. XIV.) Thus far 24 diamonds are reported to have been found. One of these, a white stone, is said to have weighed $3\frac{11}{16}$ carats. Reece Lamb, of the American Diamond Mining Co., says that one of the miners for this company discovered a diamond in hard peridotite taken from the shaft (see Pl. XIV), but that the miner, who did not realize the importance of the discovery, immediately removed the diamond from the rock.

The Black Lick area of peridotite, in sec. 23, T. 8 S., R. 25 W., formerly owned by the Grayson-McLeod Lumber Co., has not been prospected except by three shallow pits, which have been sunk into the soft, decomposed peridotite. (See Pl. XIV.) So far as known none of the decomposed peridotite from this locality has been washed and no diamonds have been found.

The Bingen formation has been prospected for diamonds at a locality near the head of Mine Creek, on the southern border of the Caddo Gap quadrangle, 3 miles south of Corinth and 10 miles west-southwest of Murfreesboro. (See Pl. VIII.) The strata exposed in the bed and banks of the creek at this locality consist of a greenish arkosic sand containing lenses of gravel, which is made up of pebbles of fourchite, tinguaite, syenite, quartzite, novaculite, millstone grit, and other kinds of rocks. Some people have supposed that a part of the material in the strata at this locality was derived from peridotite. That a very small amount of it was so derived is likely, but if any peridotite is present it has been decomposed so much that it can not be recognized. Some men who have done prospecting here in recent years report the discovery of five small diamonds, which have been presented to the American Museum of Natural History.

GEOGRAPHY.

The areas of peridotite here described are in the Gulf Coastal Plain, only a few miles south of its northern margin, beyond which is the Ouachita Mountain region. The Ouachita region, which is 50 to 60 miles wide, extends from Little Rock, Ark., to Atoka, Okla., a distance of 200 miles. It contains numerous nearly eastward-trending ridges, several intermontane basins, and a dissected piedmont plateau 15 miles wide, which lies along its southern border in Arkansas and adjoins the Coastal Plain. This plateau, known as the Athens Plateau, is lowest on the south, ranging from about 750 to 1,100 feet above sea level, and the valleys of the larger streams that trench it are about 350 feet deep.

The part of the Coastal Plain embraced in the area shown on the map (Pl. VIII) is an east-west belt 7 to 10 miles wide. Its surface, which is gently undulating, consists of shallow valleys, of rather wide alluvial bottoms, of remnants of terraces along the larger streams, and of irregular hilly interstream areas. This belt in the vicinity of Murfreesboro is crossed in a southeast direction by Little Missouri River, which has cut a shallow valley that contains a flat alluvial floor or "first bottom" from about 1½ to 2 miles wide. The largest of the numerous small streams that enter the Little Missouri in the vicinity of the peridotite areas is Prairie Creek, which enters it just west of the Prairie Creek area of peridotite. These smaller streams have flats whose size is proportional to that of the streams. Most of the alluvial tracts are between 300 and 350 feet above sea level.

The country to the east and west of the Little Missouri contains low irregular hills, which culminate in elevations of 650 feet or more as the Athens Plateau, a few miles north of Murfreesboro, is approached and in elevations of 600 to 700 feet above sea level in two dissected southward-sloping plateau-like areas (cuestas) south of the latitude of Murfreesboro, one east of the Little Missouri and the other west of it. The villages of Highland and Corinth are on the plateau west of Little Missouri River. The plateau that is east of the Little Missouri has been so deeply channeled by southward-flowing streams that in reality it consists of north-south ridges. The Kimberlite, American, and Black Lick areas of peridotite are on the north edge of this plateau. The Prairie Creek area adjoins the bottom lands of Little Missouri River and Prairie Creek; more than half of its border is formed by bottom land.

The area is not densely populated, though all parts of it are inhabited. The rural population is sparse, except in the level or gently rolling upland and valley areas, where most of the tillable land occurs. The largest town is Murfreesboro, the county seat of Pike County. Other towns include Delight, Pike, Tokio, and Highland, all of which are on railroads.

The Prescott & Northwestern Railroad enters the area at Tokio and extends as far as Highland. The Memphis, Dallas & Gulf Railroad also enters the area at Tokio and runs northeastward through Murfreesboro. A branch of the Missouri Pacific Railroad enters the area at Delight and extends to the northwest as far as Pike.

Public and secondary roads reach all parts of the area, but only a few are maintained in good condition.

GEOLOGY.

GENERAL FEATURES.

The rocks of the area shown on the map (Pl. VIII) and of adjoining parts of the Gulf Coastal Plain and the Ouachita Mountain region are all of sedimentary origin except four bodies of diamond-bearing peridotite near Murfreesboro. Those in the Ouachita region are of Paleozoic and Quaternary age. The Paleozoic rocks, which range from Cambrian to Carboniferous, consist mainly of shale, sandstone, novaculite, and chert and have an aggregate thickness in west-central Arkansas of 26,000 feet. They have been subjected to intense folding, so that the beds stand at high angles. Most of the folds trend eastward. The rocks along the northern border of the area here described are shales and sandstones of Carboniferous age. In that part of the area stream gravels and silts of Quaternary age occur only as narrow strips or small patches along some of the streams.

The sedimentary rocks of the part of the area that lies in the Coastal Plain are of Lower Cretaceous, Upper Cretaceous, and Quaternary age. The Lower Cretaceous series is represented by the Trinity formation, the Upper Cretaceous series by the Bingen and Brownstown formations, and the Quaternary system by extensive terrace and alluvial deposits.

TRINITY FORMATION.

The Trinity formation is exposed in a belt a few miles wide, extending from a point near Delight westward across Pike County and thence into Howard County. It has a thickness of over 600 feet at a locality 2 miles north of Center Point, which is a few miles west of the area shown on the map (Pl. VIII), and probably has a like thickness near Corinth, but it becomes thinner toward the east and is only about 70 feet thick north of Delight. It consists predominantly of clay but includes beds of sand, gravel, and limestone. The limestone contains fossil oysters and other shells and occurs in two beds, the Dierks limestone lentil and the De Queen limestone member, both of which are exposed in narrow belts.

The De Queen limestone, the higher of the two beds, is near the middle of the formation. It ranges in thickness from a feather edge to 72 feet and its outcrop extends from Plaster Bluff, near Murfreesboro, westward through De Queen. It is not present east of Plaster Bluff.

The Dierks limestone at some places is 50 feet above the base of the formation and at others is probably 200 feet above the base. Its thickness ranges from a feather edge to 40 feet. Its outcrop extends from a locality about 2 miles north of Delight westward, past the mouth of Muddy Fork and thence beyond the border of the area shown on the map (Pl. VIII).

The gravel occurs as a bed as much as 100 feet thick at the base of the formation. It is called the Pike gravel member and is exposed in an almost continuous though irregular belt along the north edge of the outcrop of the formation.

These three lentils and members and the interbedded sands and clays of the Trinity have a southward dip of about 100 feet to the mile. Although the Trinity thus occupies a nearly horizontal position, it rests upon the truncated upturned edges of steeply dipping shales and sandstones of Carboniferous age, which, however, form a smooth floor that has only minor irregularities and undulations. A pronounced unconformity therefore occurs at the base of the Trinity.

The gravel mentioned above is composed mostly of pebbles of novaculite. It is widely distributed and constitutes a very large supply of good road material. Gypsum occurs in the De Queen limstone member and has been prospected in a small way near Plaster Bluff. Limestone in this member and in the Dierks limestone lentil would be suitable for rough building stone, but neither of these contains limestone pure enough for making lime.

BINGEN FORMATION.

The Bingen formation received its name from the village of Bingen, Hempstead County, a few miles southwest of Tokio. It crops out in a narrow belt along the south side of the area shown on the map (Pl. VIII). The formation ranges in thickness from about 100 feet in the eastern part of its outcrop to 350 feet in the western part. It is composed of sand, clay, and gravel, and near Tokio and farther east it contains beds to which the name Tokio sand member has been applied. This member, which is at the top of the formation, is in fact the only part of the formation exposed east of Little Missouri River and is the only part that contains beds of quartz sand.

The gravel in the Bingen occurs in several beds. The southward-sloping plateau on which Highland and Corinth are located owes its preservation and prominence to these gravels. The thickest and also the most widely distributed bed, which is as much as 60 feet thick in places, is at the base. These different deposits of gravel resemble one another as well as those of the Trinity formation and are well adapted for road making. They are composed of partly rounded to well-rounded pebbles, most of them of novaculite and an inch or less in diameter. The other kinds of pebbles include various types of igneous rocks that are similar to some of the crystalline rocks of Arkansas or identical with them. These pebbles are found in the basal part of the formation from the vicinity of Murfreesboro westward.

A greenish cross-bedded arkosic sand composed of kaolinized feldspar and a less amount of other minerals is widely distributed west and northwest of Tokio and Highland.

Besides the sand just described the formation contains red, light-colored, and dark clays and quartz sand. The beds of light-colored clay reach a thickness of 5 to 6 feet and comprise plastic ball clay and nonplastic kaolin. A 5-foot bed of kaolin in the NE. ¼ SE. ¼ sec. 24, T. 8 S., R. 25 W., is a fuller's earth. Some of the clays contain fossil plants.

BROWNSTOWN MARL.

The Brownstown marl is the surface formation in a small area near Delight, where it is probably 100 feet or more thick. It is a blue or gray calcareous clay containing many fossil oysters and is characterized by the presence of the large oyster *Exogyra ponderosa*, whence it has sometimes been called the "*Exogyra ponderosa* marl." The soil derived from the formation, when not mixed with surficial deposits, is black and waxy, but the subsoil is yellow.

TERRACE DEPOSITS.

The terrace deposits are in general unassorted mixtures of small and large pebbles and sand and are in most places overlain by a loam producing a good soil. The pebbles are local in origin, having been derived directly from the rocks of the Ouachita Mountains and indirectly from the same source through the gravel beds of Cretaceous age in the area here described. They are mostly pebbles of novaculite, which are partly to well rounded, and they range in size from minute pebbles to cobbles a foot in diameter. A few pebbles are sandstone and quartz.

The terrace gravels so closely resemble those of Cretaceous age that in places it is difficult or apparently impossible to distinguish them. In such places the altitude of the gravel deposit, the character of the surface, and the assortment and size of the pebbles have to be considered in determining their age. These deposits range from a thin mantle to deposits 50 feet or more thick, but in most places they are 15 to 20 feet thick. As a rule the largest patches contain pebbles and cobbles at the base and sand or loam at the top, and the smallest patches contain only pebbles and cobbles.

These deposits are found chiefly along Little Missouri River. They occupy benches at heights that range from 35 to 150 feet above this and other streams. Some deposits are in places strewn along the slopes between the different benches.

ALLUVIUM.

The larger and most of the smaller streams flow in flat-bottomed valleys and are bordered by flood plains that as a rule are widest in the Coastal Plain, where the rocks are largely unconsolidated and soft, and narrowest in the Ouachita Mountain region, where the rocks are hard. Although pebbles and cobbles make up a large part of this filling, the surface is usually covered with rich loam and sand, and most of it makes good farm land. These pebbles and cobbles have been derived from the erosion of the outcropping edges of the other gravel deposits of the region, though some of them have been carried by the streams from the Ouachita Mountain region. Accordingly they do not differ, except in their distribution and lack of assortment, from the other gravels already described. Little is known of the thickness of the alluvium, but it is probably less than 25 feet at most places.

PERIDOTITE.

PRAIRIE CREEK AREA.

LOCATION AND TOPOGRAPHY.

The area of peridotite on Prairie Creek is roughly triangular in outline and comprises about 73 acres. It lies in T. 8 S., R. 25 W., the southern part of it in sec. 28 and the northern part in sec. 21. (See Pl. IX.) The surface is gently rolling and has an altitude of 340 to 380 feet except along its northwest margin, where three knobs or hills, known as West, Middle, and East hills, rise to altitudes of 401, 420, and 441 feet, respectively. The area is joined on the southeast by rolling country, but along other parts of its margin it is joined by the low, nearly level valley floor of Little Missouri River and some of its tributaries. The surface of most of the valley floor is between 315 and 340 feet above sea level, though near the Ozark mine it attains an elevation of a little over 355 feet. Little Missouri River runs southeastward past the west end of the peridotite exposure. Prairie Creek enters the Little Missouri from the north about 800 feet west of the west end of the exposure. Poorhouse Branch, a small perennial stream with an exceedingly crooked course, runs west past the north side of the exposure and enters Prairie Creek.

ROCKS ASSOCIATED WITH THE PERIDOTITE.

The peridotite is joined along most of its east side by clays and sands of the Trinity formation and on its north and west sides and much of its south side by alluvium. However, no exposures show the peridotite in contact with the Trinity except at the northeast end of the large northeastward-trending cut of the Ozark mine. The clay at the contact with the peridotite at that locality has been changed by metamorphism to fairly hard gray clay, though it can be scratched with a knife, and the sand has been changed to a moderately hard bluish-gray sandstone.

The alluvium is between 10 and 15 feet thick at and near the mouth of Prairie Creek. Very little is known regarding its thickness elsewhere, but it is probably less than 25 feet at most places. The alluvium is composed of pebbles and cobbles of novaculite and of a gray to yellow sandy surficial loam, though much of the soil adjacent to the peridotite is a black clay that has been washed from the peridotite area. The alluvium not only conceals the Trinity formation but also conceals some peridotite along the margins of the exposure of the peridotite and possibly many dikes that radiate away from the exposure. On Prairie Creek near its mouth, where the alluvium has been eroded, sand of the Trinity formation is exposed at three places and a peridotite dike at one place.

Numerous boulders of Carboniferous sandstone occur in the bank of Little Missouri River just below the mouth of Prairie Creek and, although they are not in place, they are probably near the parent ledges. Boulders of peridotite also occur at the same locality. Their source is not known, but they were probably derived from one or more dikes that are now concealed.

A small part of the east border of the exposure of peridotite and a greater part of its south and southwest borders are joined by exposures of sandstone of Carboniferous age, which may be the Jackfork sandstone. The sandstone is massive, gray, greenish gray, and brown, and some has been changed to a hard, compact quartzite. The sandstone that is exposed just east of the Ozark mine strikes north-northwestward and dips 40° E., and the sandstone on the West Hill dips 26° SW. On the West Hill it protrudes as rough massive ledges from which huge boulders break away. These ledges and boulders afford good hiding places for numerous rattlesnakes and other snakes. A mass of fine-grained gray quartzite about 100 feet long and 50 feet wide occurs on the crest of East Hill; it was perhaps derived from the Jackfork sandstone and was included in the peridotite magma while the magma worked its way toward the surface.

Terrace gravels rest upon the Carboniferous sandstone in a very small area on the west point of the West Hill, and similar gravels that are overlain by clay rest upon the Trinity formation southeast of the Arkansas mine. These terrace deposits are from 350 to 370 feet above sea level and have the same elevation as the long north-south terrace on which the towns of Murfreesboro and Kimberley are built. The gravels consist of well-rounded pebbles and cobbles of variegated novaculite. A well at the "company house" (see Pl. IX) has revealed 10 feet of gravel overlain by 10 feet of clay. These gravels are remnants of deposits laid down by the Little Missouri when its channel and flood plain were at the same elevation as that of the gravel occurrences.

The black soil overlying the peridotite at the Ozark, Mauney, and Arkansas mines contains numerous pebbles of novaculite to a depth of 1 to 2 feet. The greatest elevations at which the pebbles in the soil occur are nearly the same as the elevation of the terrace gravels mentioned above. The elevation of these pebbles suggests that they have been derived from a terrace deposit that was laid down on the peridotite. If they were so derived, Little Missouri River must have once flowed across the southeast part of the exposure of peridotite.

A bed of conglomerate about a foot thick and several feet of sandy loam cap a low hill on the east edge of the area shown on the map and are apparently the basal part of the Tokio sand member of the Bingen formation.

CHARACTER OF THE PERIDOTITE.

GENERAL FEATURES.

Although the exposure of peridotite near Prairie Creek covers, as previously stated, an area of 73 acres, the exposures of the hard, unweathered rock do not cover more than 12 acres. One of the largest exposures extends west-northwestward from the Mauney mine to Poorhouse Branch. (See Pl. X, *A*.) Another is on the Middle Hill, where the peridotite is revealed as protruding masses and boulders on the slopes and crest. Another exposure, covering about an acre, is 600 feet southeast of the crest of the West Hill, and very small exposures occur in the Arkansas mine.

Elsewhere the peridotite has been weathered to a soft earth and to a fairly soft rock. The depth of the weathered peridotite has not been fully determined, though it has been shown by pits and drill holes to be at least 205 feet. The depth of drill hole No. 1 (well on Ozark mine) is 80 feet, that of No. 2 is 79 feet, that of No. 3 is 180 feet, that of No. 4 is 100 feet, and that of No. 5 is 205 feet. (See Pl. IX.) The bulk of the rock obtained from the drill holes is said to have been soft enough to be washed when it was removed from the drill holes. The harder parts of the rock cores were saved, but when Mr. Miser saw them in 1916 most of the material in them had disintegrated into soft earth and small rock fragments.

The weathered peridotite shows many shades of green, blue, and yellow, and the different materials, according to their color, are known by the miners as "green ground," "blue ground," and "yellow ground." The soft earth at the surface is black from the presence of organic matter and is thus known as black ground. It is waxy like gumbo and is as much as 4½ feet thick, though it is usually only about 1 foot thick. At places fully half of the black ground is composed of well-rounded pebbles of novaculite and angular fragments of sandstone and quartzite. The black color or the texture of the soil or the vegetation on the Prairie Creek and other areas of peridotite appear to be favorable for the development of the minute red spiders known as "chiggers," for these areas are inhabited during the summer by millions of these pests, which burrow into the skin of people and make small sores. The surrounding areas that have gray and yellow soils and that perhaps carry a somewhat different kind of vegetation do not have so many chiggers.

The peridotite appears to be divisible into three rather distinct types. One is a massive hypabyssal intrusive rock; another is a volcanic breccia that is almost identical with the first in mineral composition and is probably the pyroclastic equivalent of that rock; and the third comprises volcanic tuff and fine-grained breccia. The distribution of these types is shown in Plate IX, which is a map of the Prairie Creek area of peridotite. The first two types are nearly black when fresh and weather to a dark dirty olive-green, but the third type is light blue. These different types are described below.

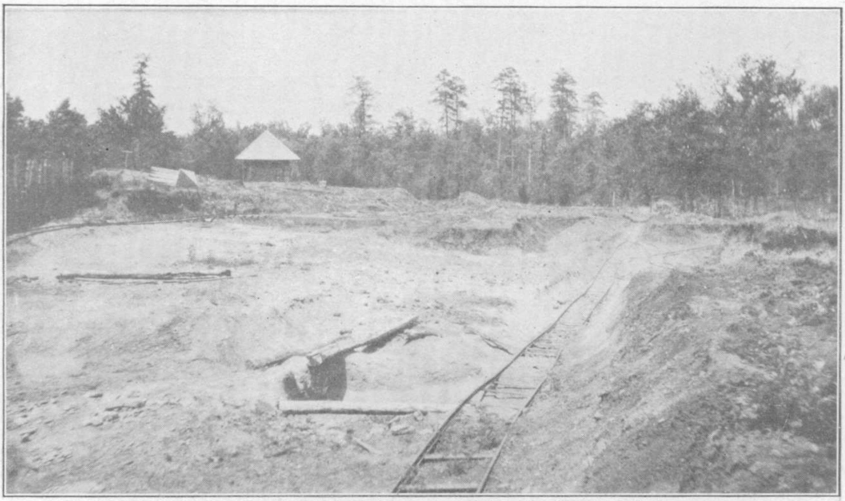
HYPABYSSAL INTRUSIVE PERIDOTITE.

The hypabyssal intrusive peridotite is the surface rock in two areas. One of these areas extends from the northern part of the Ozark mine across the northern part of the Mauney mine and thence westward and southwestward beyond the Middle Hill. (See Pl. IX.) The other area is between the Arkansas mine and the West Hill. The hard unaltered rock is exposed over much of these areas. The largest exposures of such rock are on the Middle Hill, on the northeast slope of the East Hill between Poorhouse Branch and the Mauney mine, and at a locality 600 feet southeast of the crest of the West Hill. The large size of these exposures is very conspicuous in comparison with the few and small exposures of the unaltered breccias and tuffs.

The intrusive peridotite is very similar in appearance to the associated volcanic breccia and is no doubt its hypabyssal equivalent. The specific gravity of the rock from the Middle Hill ranges from 2.728 to 2.651 and that of the same type of rock from the northeast base of the East Hill is 2.317.[3] Different occurrences of the intrusive type differ very little in color and mineral composition. Fresh surfaces show a very dense porphyritic rock, which is dull black, greenish black, or brownish black. The fresh rock is hard and exceedingly tough and for this reason is called "hardebank" by the miners. The weathered surfaces are in many places extremely ragged and pitted, and their color is a dull grayish green. Olivine forms the only phenocrysts of appreciable size in the rock. The color is nearly white when the olivine is unaltered, but the aggregates of secondary minerals derived from them are commonly nearly black. The greenish or brownish-black groundmass is fine grained and has a dull surface on fresh fracture. A very few grains of chromite have been observed with the unaided eye.

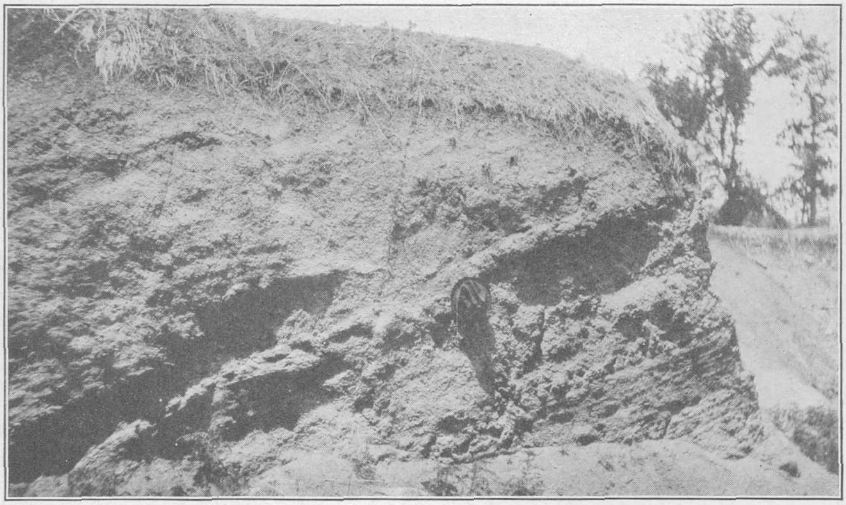
[3] Branner, J. C., and Brackett, R. N., The peridotite of Pike County, Ark.: Am. Jour. Sci., 3d ser., vol. 38, p. 56, 1889.

A. EXPOSURES OF THE HYPABYSSAL INTRUSIVE PERIDOTITE ("HARDEBANK") IN THE NORTHERN PART OF THE MAUNEY MINE, NEAR MURFREESBORO, ARK.



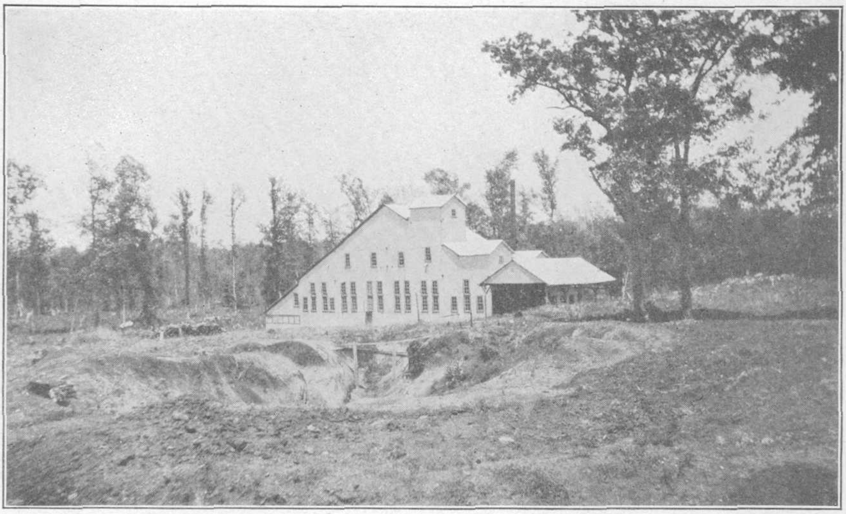
B. VIEW LOOKING NORTH ACROSS THE LARGE OPEN CUT OF THE MAUNEY MINE, NEAR MURFREESBORO, ARK.

The large cut is in "yellow ground" and "green ground" derived from volcanic breccia. There are outcrops of hypabyssal intrusive peridotite ("hardebank") near the building in the distance.



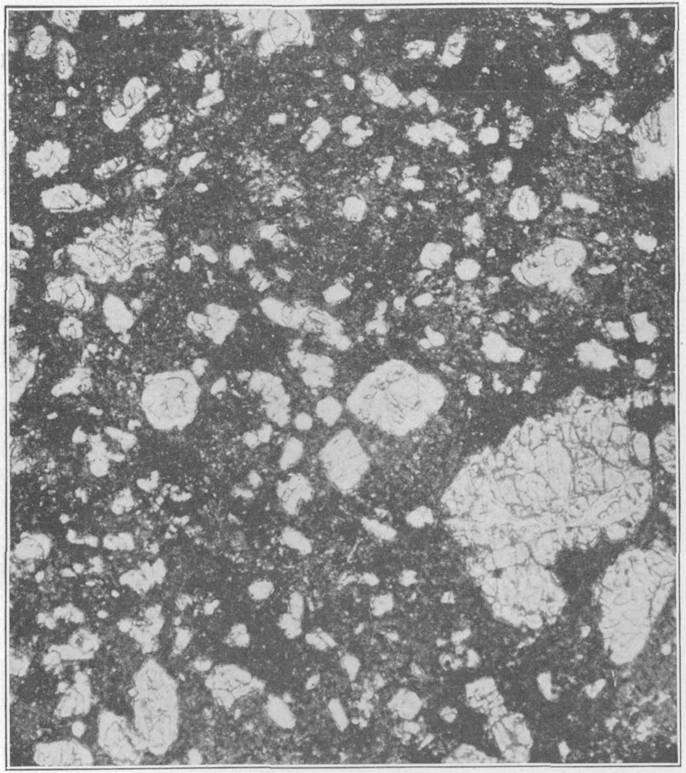
A. ALTERED VOLCANIC BRECCIA ("BLUE GROUND") IN CUT OF OZARK MINE, NEAR MURFREESBORO, PIKE COUNTY, ARK.

The bedding dips about 30° W.



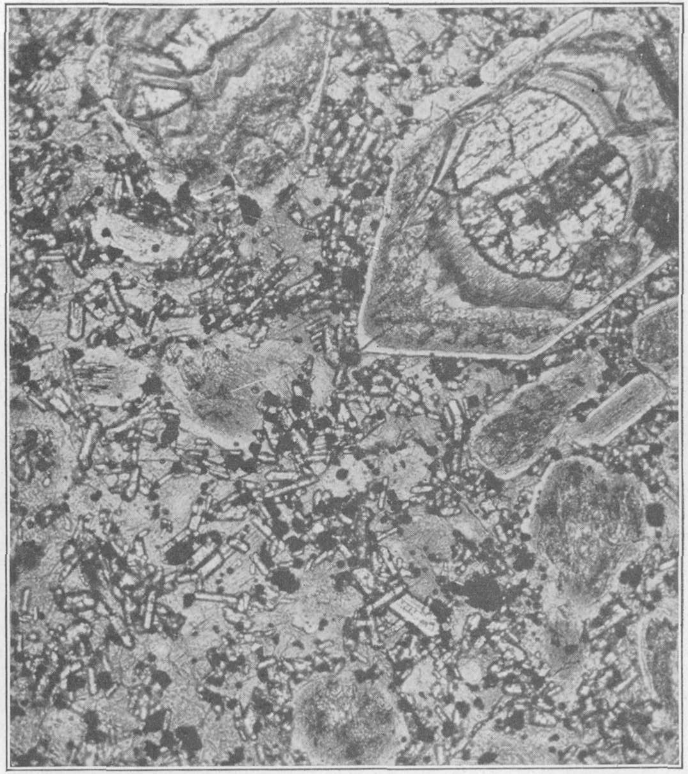
B. OZARK MINE AND WASHING PLANT NEAR MURFREESBORO, ARK., LOOKING NORTHEAST.

The Cut is largely in "blue ground" and "yellow ground" that have been derived from volcanic breccia. Picture taken in 1916; since that time the plant has been destroyed by fire.



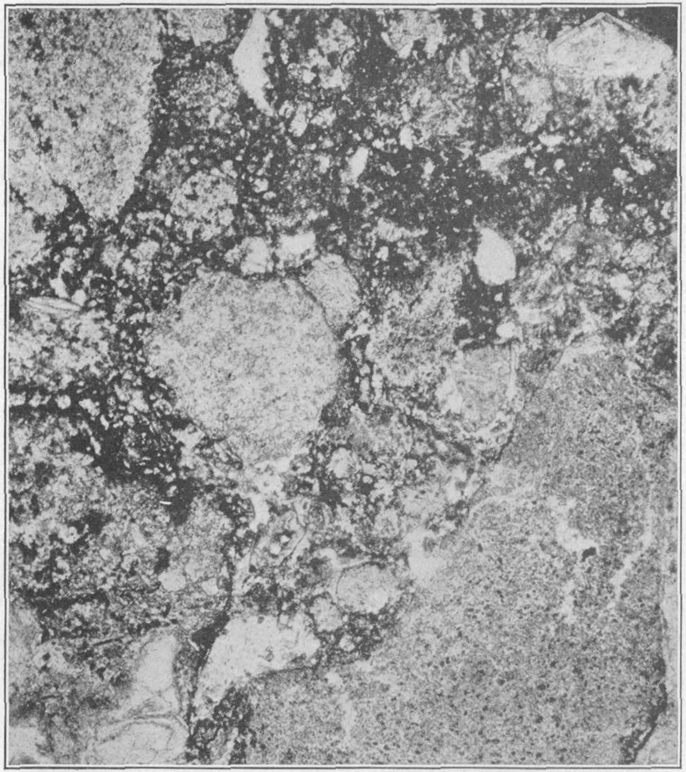
A. PHOTOMICROGRAPH OF NEARLY FRESH HYPABYSSAL INTRUSIVE PERIDOTITE ("HARDEBANK"), PRAIRIE CREEK AREA OF PERIDOTITE, NEAR MURFREESBORO, ARK.

Large phenocrysts of olivine show partial alteration to serpentine. Dark-gray groundmass is fine-grained aggregate of phlogopite, augite, and magnetite. Enlarged 15 diameters.



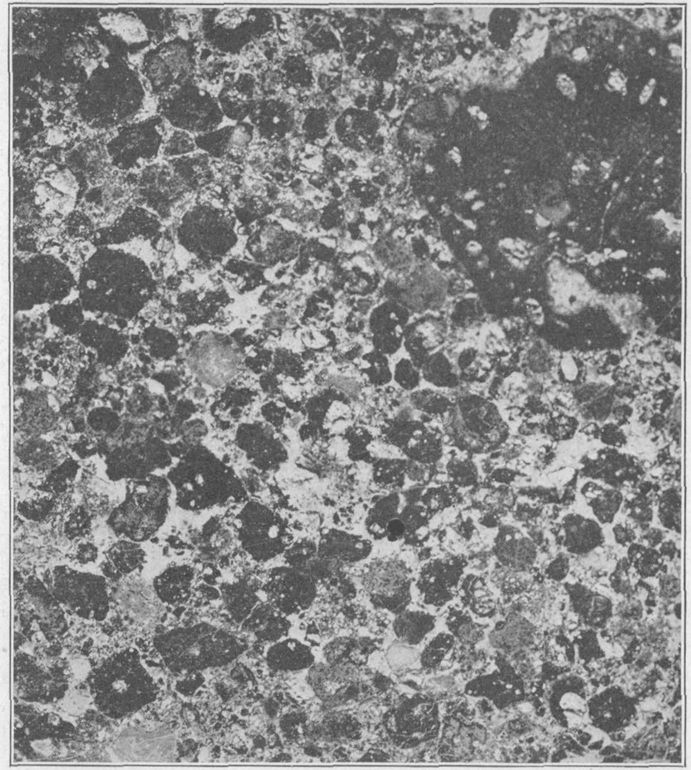
B. PHOTOMICROGRAPH OF HYPABYSSAL INTRUSIVE PERIDOTITE ("HARDEBANK") FROM SUMMIT OF MIDDLE HILL, PRAIRIE CREEK AREA OF PERIDOTITE, MURFREESBORO, ARK.

Phenocrysts of olivine partly altered to serpentine. Groundmass is phlogopite containing small prisms of augite and black grains of magnetite and perovskite. Enlarged 50 diameters.



A. PHOTOMICROGRAPH OF BLUE-GRAY TUFF FROM DRILL HOLE NO. 3 NEAR ARKANSAS MINE, NEAR MURFREESBORO, ARK.

Large fragments are metamorphosed shale. Crystal in upper right corner is phlogopite. Groundmass is an aggregate of alteration minerals. Enlarged 15 diameters.



B. PHOTOGRAPH OF POLISHED SURFACE OF VOLCANIC BRECCIA "BLUE GROUND" FROM SOUTHERN PART OF MAUNEY MINE NEAR MURFREESBORO, ARK.

Composed of angular fragments of altered peridotite. Large dark fragment contains phenocrysts of altered olivine in serpentine groundmass. Natural size.

The microscope shows that the rocks are composed essentially of olivine phenocrysts in a groundmass of pale red-brown mica. (See Pl. XII, *A*, *B*.) The mineral composition of a typical specimen is as follows:

Mode of hypabyssal intrusive peridotite.

Augite	6
Olivine	11
Serpentine derived from olivine	24
Phlogopite	56
Perovskite	1
Magnetite	2
	100

In some specimens the alteration of the olivine to serpentine is almost complete, but in many of the larger phenocrysts alteration has occurred only along the borders and cracks. Many of the phenocrysts have a fine euhedral outline, even if they have been completely altered to serpentine, but others have a rounded outline. The fresh olivine has the indices $\alpha = 1.658$, $\beta = 1.674$, $\gamma = 1.971$, indicating that it is low in FeO and contains approximately 10 per cent of Fe_2SiO_4. Most of the areas of olivine and serpentine are surrounded by a narrow reaction rim of the brown mica phlogopite, which, unlike the rest of the phlogopite, contains no poikilitic inclusions. In thin sections the serpentine is colorless or pale yellow and commonly contains minute inclusions of secondary magnetite which developed during the alteration of the olivine.

The most abundant mineral of the groundmass is phlogopite, which occurs in fine-grained aggregates, in large anhedral crystals, and as narrow reaction rims around olivine grains. Most of the phlogopite is poikilitic and incloses the other minerals of the groundmass. The color in thin sections is usually very pale yellow to reddish brown, but some grains are rose-pink in the direction of maximum absorption. Most of the phlogopite is unaltered, but that of the fine-grained aggregate of the groundmass is in places pale green through partial alteration to chlorite.

Light-colored augite is found in most of the rocks of this type, and where best developed it occurs in euhedral needles from 0.05 to 0.15 millimeter in length. In other specimens it forms very small irregular grains. Small black crystals of magnetite and rounded or octahedral crystals of yellow perovskite are abundant accessories.

An analysis that has been published by J. F. Williams was probably made on a sample obtained from the hypabyssal rock. The analysis is given in the table appearing on page 316.

Several distinct types of inclusions have been noted in the intrusive peridotites. One type forms subangular areas composed of very fine-grained serpentine that may represent altered inclusions of limestone. These inclusions are as much as 3 inches in their longest, dimension and are composed mostly of very fine grained serpentine, which is greenish brown to nearly black in the hand specimen and is surrounded on its outer border by thin layers of light-green coarser-grained serpentine. In thin section both varieties are nearly colorless. The best exposures of these inclusions are in the north part of the Mauney mine and on the Middle Hill.

Many small fragments of shale are present, and these have become dull green through the development of minute crystals of chlorite. No large fragments of black shale like those in the breccia were observed. Another kind of inclusion appears to have been originally a very coarse-grained igneous rock composed largely of hypersthene. The original minerals have been completely altered, and the rock is now composed of serpentine and secondary amphiboles and pyroxenes. The amphibole is rose-purple, pleochroic, manganese-bearing tremolite, and the green pleochroic pyroxene is intermediate between aegirite-augite and diopside.

A few small diamonds are said to have been recovered from the soft, decomposed material derived from the intrusive type of peridotite.

VOLCANIC BRECCIA.

The volcanic breccia is a pyroclastic rock similar to the hypabyssal intrusive peridotite and closely associated with it. It is the surface rock over a fairly large area extending from the southern parts of the Ozark and Mauney mines southward to the Arkansas mine and beyond. It has produced most of the diamonds from the three mines mentioned. Although the distribution of the breccia is shown on the accompanying map (Pl. IX), the boundary line that represents the contact between it and the intrusive peridotite is not accurately located because there are comparatively few exposures of unaltered rock. When further exposures are made during mining operations the breccia may be found to have a larger or smaller surface distribution than is shown on the map.

The breccia at the surface is weathered and has changed to clay and soft rock except in three or four small areas near the shed on the Arkansas mine, where slightly weathered rock is exposed. The rock in these areas is a very firmly cemented, tough pyroclastic rock. An examination of the least weathered specimens of it shows that it is composed of fragments of rock that vary greatly in texture, some of the fragments being porphyritic peridotite and others being completely aphanitic. The original olivine phenocrysts are now light-colored aggregates of serpentine, a few of which contain cores of fresh olivine. A few flakes of dark mica can usually be recognized in the hand specimen. The microscope shows that the rock differs little from the hypabyssal phases. Phenocrysts of olivine partly altered to serpentine are abundant, and a few small phenocrysts of phlogopite are present. The groundmass is composed of a fine-grained aggregate of phlogopite, augite, magnetite, and perovskite. The inclusions of shale are much altered and are now composed largely of very small grains of quartz and augite or chlorite.

Some of the altered breccia is clay but some is fairly hard rock. A small quantity of the clay is yellow and is known as "yellow ground," but the soft rock and most of the clay are a dirty green and are known as "blue ground" or "green ground." (See Pls. X, *B*, and XI.) Most of the "blue ground" or "green ground" as revealed in gullies is a fairly hard breccia, though the hard rock softens on long exposure so that it can be washed for the recovery of the diamonds. The "blue ground" shows bedding at a few places, the best exposure being near the southwest end of the large northeastward-trending cut of the Ozark mine. At this place the bedding dips about 30° W. and the different layers show not only a difference in color but also a difference in the size of the rock fragments composing the breccia. (See Pl. XI, *A*.) Another exposure is near the apex of the Mauney mine, where the bedding apparently strikes S. 30° E. and dips 20°–30° SW. The "blue ground" in the gullies between the Arkansas washing plant and the shed shows differently colored layers which strike east and dip 50° or more toward the north. The difference in the color of the layers is due to the occurrence of large grains of altered olivine in certain layers, whereas other layers contain only small grains of altered olivine. Some specimens only a few inches long show this variation in texture and color.

The "blue ground" is composed largely of angular and subangular fragments of igneous rock but contains many irregular fragments of shale, clay, and sandstone. Most of the fragments are less than an inch in length, though some were observed that are 15 inches in length.

The fragments of shale and sandstone have been derived from rocks of Carboniferous or earlier age, and most or all of them have probably been carried upward hundreds or thousands of feet above their source. The shale is gray, olive-green, or black and is fairly hard, though it can be easily scratched with a knife. One fragment of shale was observed that contained black carbonaceous pieces of plants or wood. Metamorphism has affected the shale very little if any. In fact, specimens of it can be duplicated by specimens from the Carboniferous shales that are exposed in the Ouachita Mountain region, to the north.

The fragments of clay were obviously derived from beds of clay in the Trinity formation. One inclusion of sandstone observed in the Arkansas mine is greenish gray, fine grained, and hard but is far from being a quartzite.

The fragments of igneous rock in the "blue ground" reach a maximum size of about 6 centimeters and average less than 2 centimeters in diameter, but some layers consist entirely of fine material a few millimeters in diameter. (See Pl. XIII, *B*.) The olivine in the "blue ground" has completely disappeared but is represented by light-colored areas, the largest of which are 1 centimeter in diameter. The individual fragments of rock and their difference in texture can be easily recognized. The fine-grained material now forms a friable granular rock in which weathered serpentine is the only recognizable mineral. An analysis of the "green ground" from the Arkansas mine is given in the table of analyses on page 316.

A number of minerals that are rarely observed in hand specimens or in thin sections of the volcanic breccia are obtained as concentrates by washing the soft, decomposed rock for the recovery of the diamonds. These minerals are hematite, limonite, barite, colorless quartz, amethyst quartz, magnetite, schorlomite (or melanite), chromite, almandite, pyrope, pyrite, diopside, and epidote. The quantity of each mineral here named differs somewhat from place to place, but in general the most abundant have been named first and the least abundant last. All the minerals mentioned occur in larger quantities than the diamonds, with the possible exception of the diopside and epidote.

The barite, colorless quartz, and amethyst quartz form veins in the peridotite and are therefore described under the heading "Veins in the peridotite." (See pp. 302–303.) The magnetite occurs in irregular and octahedral grains as much as 10 millimeters in their longest dimension, and some of it, like the barite and quartz, is present in veins in the peridotite. The hematite and limonite occur in irregular and rounded grains as much as 10 millimeters in their longest dimension, but some grains have the forms of crystals of pyrite from which they have been derived. Some of the hematite and limonite, however, has been derived from magnetite. The chromite is present as irregular black grains which attain a maximum length of 8 millimeters. A mineral that is either melanite or schorlomite is apparently more abundant than the chromite; the grains of it are irregular in shape and are as much as 7 millimeters in their longest dimension. The almandite is dark red and occurs in irregular grains the largest of which are 6 millimeters in length. Crystals of it are very rare. The pyrope is present in about the same quantity as the almandite; its grains are pale red to hyacinth-red, are irregular in shape, and attain a maximum length of 4 millimeters. The epidote and diopside occur as brown and green prismatic grains, which attain a maximum length of about 3 millimeters.

The diamonds from the volcanic breccia as well as the few diamonds from the hypabyssal intrusive peridotite are described on pages 316–321.

TUFFS AND FINE-GRAINED BRECCIAS.

Tuffs and injection breccias of dikelike form comprise a group of pyroclastic rocks that appear to have had a somewhat different history from the volcanic breccia. They are exposed in a large area, extending from the West Hill eastward to the Arkansas mine and thence northward nearly to the crest of the East Hill, and also in two small areas—one in the Ozark mine and the other in a gully in the northeast part of the Arkansas mine. They have been penetrated by drill holes Nos. 3 and 5 to depths of 180 and 205 feet, respectively, without being passed through. The boundaries of the areas of exposure as represented on the map (Pl. IX) are somewhat indefinite on account of the small number of rock outcrops.

The only locality in which these rocks are exposed in contact with the volcanic breccia is in the large northeastward-trending cut of the Ozark mine. The northernmost exposures of a blue rock (tuff or fine-grained breccia) in this cut show it to be in contact with "yellow ground," which is probably derived from hypabyssal intrusive peridotite. The contact is distinct and dips about 70° NW.

These rocks as they are revealed at the surface are light bluish gray and are fairly hard, though at most places the hard rock has been concealed by soft blue earth. The black soil ("black ground"), which is so characteristic of the areas of the hypabyssal peridotite and volcanic breccia, is present only in parts of the areas of the tuffs.

The blue-gray tuff varies greatly in texture. Some specimens are composed of fragments that average less than 1 millimeter in diameter and have an even-grained lithoidal appearance; others contain similar material that incloses fragments as much as 10 millimeters in diameter; and still others are made up largely of such fragments with only a little fine-grained matrix between them. Reddish-brown phlogopite occurs in fine fresh flakes, commonly 1 millimeter or less in diameter, though a few attain 3 millimeters in diameter. Many small white or pale-yellow areas are occupied by serpentine, probably derived from olivine.

The microscope shows that the most abundant mineral of the rock is a pale blue-green chlorite that is secondary to an older mineral, or more probably to the very fine grained aggregate that formed the groundmass of the original rock. In some specimens these chloritic grains are angular in outline and are formed of radial aggregates with a small amount of fine-grained phlogopite which remains unaltered. This feature suggests that the original rock was an olivine-mica peridotite like the hypabyssal rock and the volcanic breccia. Accessory minerals in the tuff are magnetite, secondary calcite, and fine-grained opaque aggregates. Fragments of shale are abundant in the tuffs in many places, and fine-grained fragments of sandstone are less abundant. (See Pl. XIII, *A*.) The smaller inclusions have developed some chlorite, but the larger ones are not greatly metamorphosed, and most of them are only slightly indurated.

The alteration of the light-colored blue-gray volcanic tuff is much more complete than the alteration of the hypabyssal rocks and the volcanic breccias, and so the original composition of the tuff is very much more problematical, but there is no reason to suspect any great difference in the mineral composition of the original tuffs, the hypabyssal rocks, and the volcanic breccias. It is evident, however, that the later history of the tuffs is different from that of the other rocks of igneous origin. The tuffs contain much chlorite, whereas the other rocks contain little or none of that mineral. It is very probable that this different type of alteration is the result of different conditions at the time of extrusion.

The injection breccias of dikelike form are similar in all ways to the tuffs and in the hand specimen are almost indistinguishable from them. Breccia of this sort is exposed as a dike in a gully in the northern part of the Arkansas mine. (See Pl. IX.) The dike is about 10 feet wide and trends northeastward. The contacts with the "blue ground" of the volcanic breccia on either side of the dike are concealed by loose surficial material, and the dike can not be followed more than 25 or 30 feet.

Associated with the purely pyroclastic tuffs and grading into them are green-gray rocks that resemble these tuffs and that can not be sharply separated from them. These rocks contain variable proportions of material that is not derived from the peridotites. Quartz is much the most abundant foreign mineral, but alkalic feldspars are not uncommon. The quartz shows enlargement, but well-rounded cores are present in many of the grains, leaving no doubt that the quartz had a sedimentary origin. Thus it seems clear that parts of the tuff beds were reworked with the admixture of quartz derived from near-by sands and sandstones. A quartz-bearing tuff is exposed on the crest and north end of the West Hill, where it protrudes as hard, rough boulders whose distribution and shape suggest that the rock is in beds that have a northerly strike and a dip of 90°. Numerous claylike inclusions as much as half an inch in their longest dimension are present.

No diamonds, so far as known, have been obtained from the tuffs and fine-grained breccias.

VEINS IN THE PERIDOTITE.

Veins composed of quartz and barite cut the volcanic breccia in the Ozark mine, and the fragments of quartz on the surface at the Arkansas mine indicate that such veins are also present there.

These veins are rare and attain a thickness of not more than 2 inches. The barite occurs as crystals next to the breccia, and the quartz surrounds and incloses these crystals, showing that the barite was deposited in fissures in the peridotite earlier than the quartz. Some of the quartz, especially that next to the breccia, is chalcedony, but much of it is massive, and some occurs as crystals lining cavities in the veins. These crystals range from a small fraction of an inch to 2 inches in their longest dimension, and many of them are clear and transparent, though most of them are milky. Much of the massive quartz and many of the crystals have a pale amethyst color. In the Arkansas mine the amethyst is most abundant near the west sluice trough.

Veins consisting of barite and altered serpentine and small crystals of magnetite were observed in the hypabyssal peridotite at the Mauney mine. They are as much as 2 inches thick. One vein of barite a quarter of an inch thick was observed in the altered volcanic breccia in the Arkansas mine. The barite in these veins and the loose fragments of it observed at different places in the mines are blue, white, and colorless. Some of it occurs in tabular crystals and sheaf-like aggregates of crystals.

A pocket of vein material is present at the contact of the weathered hypabyssal peridotite with the tuff in the north side of the large northeastward-trending cut of the Ozark mine. The pocket has a maximum dimension of 2 feet and consists of white coarse-grained calcite and a tough cream-colored mineral known as paligorskite, which is a hydrous silicate of aluminum and magnesium.

A few veins of a buff leather-like mineral less than half an inch thick occur in the altered volcanic breccia in the Arkansas mine. The mineral, which has been determined to be paligorskite, contains a small quantity of calcium that may be due to the presence of tremolite.

DIKE NEAR MOUTH OF PRAIRIE CREEK.

The dike represented on the map (Pl. IX) near the mouth of Prairie Creek was exposed 30 years ago on the left bank of Little Missouri River just below the mouth of this creek, but since then the Little Missouri has shifted its channel to the south, so that the exposure is now in the bed of the creek. In 1916 the creek, though low, was muddy with tailings from the washing plant of the Kimberlite Diamond Mining & Washing Co. The dike was therefore not visible, but its location was pointed out to Mr. Miser by Lee Wagner. A pit was then dug at the water's edge until the dike was reached. The part of the dike thus exposed is 170 feet south by east from the northwest corner of sec. 28. It is there about 8 inches wide, and the rock has altered to a soft yellow earth in which yellow mica and numerous inclusions are conspicuous. The dike is described by Branner[4] as follows:

Where Prairie Creek enters the Little Missouri, a dike of peridotite not more than 10 inches wide stands out for 50 feet across the mouth of the former stream, and on the left bank of the river this dike is seen to penetrate the soft sandstones of the lower Cretaceous. Where the Cretaceous has been cut away by post-Tertiary erosion and covered with the waterworn débris, the dike is also cut off even with the eroded Cretaceous surface and covered with débris. At the line of contact between the dike and the Cretaceous sandstone the most careful microscopic examination does not reveal the slightest trace of metamorphism. The original material injected into this crevice is so thoroughly filled with the débris of the beds through which it has passed—shales, sandstones, and quartz pebbles—that their included fragments form about two-thirds of the dike as it now stands. Even the soft inclusions from the Cretaceous are unaffected.

The igneous material in the dike no doubt cooled rapidly, and the magmatic gases quickly escaped, so that conditions within the dike were not favorable for extensive alteration of the included fragments.

Specimens of the fairly hard rock collected in 1900 by J. A. Taff were examined by the writers. The igneous portion that cements the inclusions is yellowish brown in color and is composed of a groundmass weathered to compact yellow clay and of crystals of brown phlogopite as much as 2 millimeters in length. Owing to the advanced stage of weathering no other minerals can be recognized.

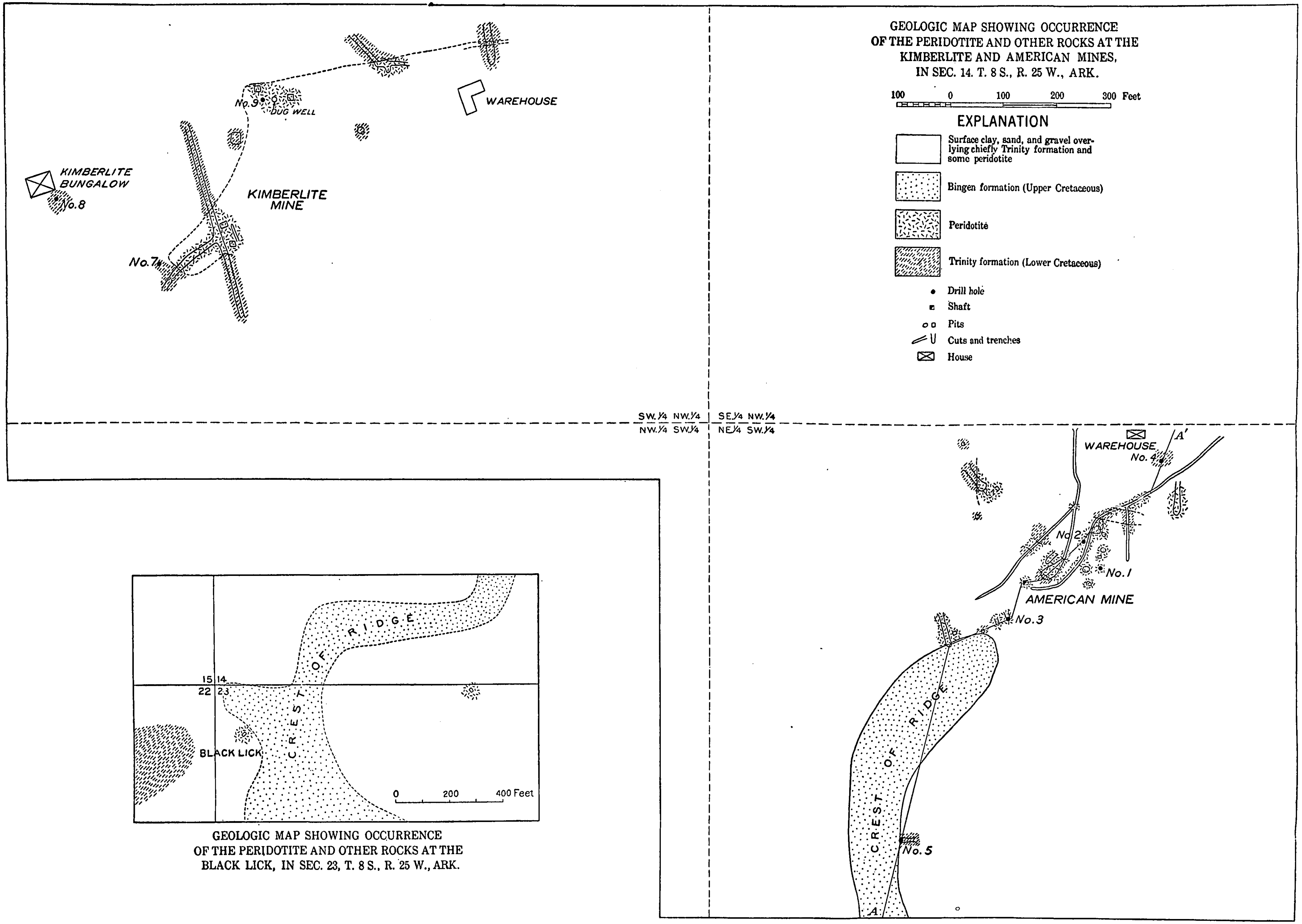
PERIDOTITE ON LITTLE MISSOURI RIVER BELOW THE MOUTH OF PRAIRIE CREEK.

Several boulders of hard unweathered peridotite occur in a gravel bar within an area about 250 feet long up and down stream and 100 feet or less wide, on the left bank of Little Missouri River just below the mouth of Prairie Creek. (See Pl. IX). Besides these boulders of peridotite there are many of sandstone, some of which are several feet in their longest dimensions. They are not waterworn and thus could not have been carried far by Little Missouri River. They are probably not far from their place of origin. Some of the boulders of peridotite are lying loose on the surface, but most of them are embedded in the stream gravels. One of the largest protrudes 18 inches above the gravels; its exposed part is 3½ feet long and 2½ feet wide. Certainly not all these boulders are in place, but those that are not in place can not be far removed from what is probably one or more dikes at this locality.

KIMBERLITE AREA.

The Kimberlite mine is in an area of peridotite in a cleared tract on the crest of a low hill in the SW. ¼ NW. ¼ sec. 14, T. 8 S., R. 25 W. The map (Pl. XIV) shows by patterns only the observed

[4] Branner, J. C., and Brackett, R. N., The peridotite of Pike County, Ark.: Am. Jour. Sci., 3d ser., vol. 38, pp. 52-54, 1889.



GEOLOGIC MAP SHOWING OCCURRENCE OF THE PERIDOTITE AND OTHER ROCKS AT THE BLACK LICK, IN SEC. 23, T. 8 S., R. 25 W., ARK.

MAPS SHOWING THE DISTRIBUTION OF THE PERIDOTITE AT THE AMERICAN AND KIMBERLITE MINES AND AT THE BLACK LICK, IN T. 8 S., R. 25 W., PIKE COUNTY, ARK.

and reported occurrences of the rocks. The peridotite is not revealed in natural exposures but is concealed by yellow to red surficial clay, a few inches to a few feet thick, derived largely from the weathering of the Trinity formation, which at the surface at this locality consists of yellow, red, and brown clays. The peridotite was revealed nowhere at the different times of visit, except in pits and trenches from a few feet to 15 feet deep and in a dug well 22 feet deep. It is reported in drill hole No. 7 at a depth not known to the authors, in a well (drill hole No. 8) at a depth of 90 feet from the surface, and in drill hole No. 9 from the surface to a depth of 50 feet. The dike that is exposed in the trench farthest east on this property (fig. 66) is probably an eastward continuation of the larger mass of peridotite to the west. The apparent form of the intrusion, to judge from present exposures, is that of a crescent-shaped dike, which strikes northeastward and which has a length of at least 700 feet and a width of possibly 100 feet at the surface, but further prospecting to the east and southeast may prove extensions of the peridotite in these directions. In 1912 and 1916, when the area was visited, the contact of the peridotite with the clay of the Trinity formation was exposed in six different places, in all of which it is distinct. At all these places the contacts dip at a high angle from the horizontal. The exposures indicate that the clay of the Trinity was metamorphosed to a vitrified clay for a distance of a few feet from the contact at the time of the intrusion of the peridotite, but since then the metamorphosed clay has weathered so much that it is now only a little harder and lighter in color than the clay that was not metamorphosed. Many inclusions of black shale, derived from the Paleozoic shales beneath, occur in both the fresh and the disintegrated peridotite, and some of them reach 2 inches in diameter. They were baked by heat from the peridotite at the time of its intrusion, and though they are much weathered near the surface, they are still harder than the ordinary black shales that are widely exposed in the Ouachita Mountains, to the north. Veins of white barite and of a tough yellow mineral known as paligorskite cut both the fresh and the altered peridotite.

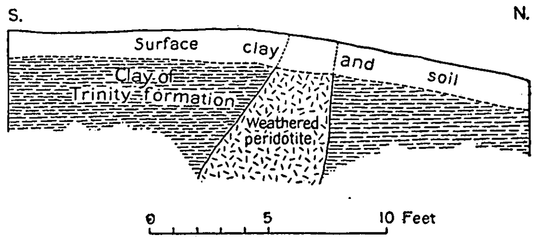


FIGURE 66.—Section of dike of weathered peridotite cutting the clay of the Trinity formation at the Kimberlite mine, Pike County, Ark. The dike is revealed in the exposure that is farthest east at the mine.

The hard unaltered peridotite, known locally as "hardebank," occurs as two small patches a few feet across in the southwestward-trending trench at the west boundary of the mass, and it was encountered in the well (drill hole No. 8) near the Kimberlite bungalow. Elsewhere it has disintegrated to a soft green and yellow earth. (See Pl. XV, *B*.) Its maximum depth is not known, though it exceeds 50 feet, as that is the greatest thickness of the peridotite penetrated, except at the Kimberlite bungalow, where the peridotite was encountered after passing through 90 feet of clay and sand of the Trinity formation. The unaltered rock is dense, tough, porphyritic, and dark greenish black and is apparently similar to the hypabyssal intrusive type of peridotite found in a part of the Prairie Creek area. The hand specimen reveals numerous phenocrysts of more or less altered yellowish-green olivine as much as 9 millimeters in their longest dimension in a dense brownish-black groundmass.

The olivine crystals are in part bounded by their crystal faces; they make up 20 to 25 per cent of the rock and have been more or less altered to serpentine around their outer borders and along the large irregular cracks. Where they have been entirely altered to serpentine their original outlines still remain distinct. The groundmass consists of augite, phlogopite, perovskite, and magnetite embedded in a colorless submicroscopic base. The augite is present as very small colorless laths. The perovskite is yellow and occurs as numerous small individual grains scattered throughout the rock. The phlogopite poikilitically incloses patches of other minerals, and its brown color gives the rock its brownish cast.

AMERICAN AREA.

The area of peridotite on which the American mine has been opened is on a steep wooded northerly slope at the northeast end of a ridge in the NE. ¼ SW. ¼ sec. 14, T. 8 S., R. 25 W. The ridge at this locality is between 550 and 600 feet above sea level and rises about 100 feet above a wet-weather branch that is just east of the house shown on the map (Pl. XIV). The ridge is capped by the Tokio sand member of the Bingen formation, which consists of about 15 feet of interbedded clay and gravel and of a basal layer of conglomerate, 12 to 15 inches thick, which is composed of pebbles of novaculite cemented together by brown iron oxide. The Bingen is underlain by the Trinity formation, represented here by clay, and by the peridotite, which has been intruded upward into the Trinity.

Most of the peridotite has been deeply weathered, and only a few small fragments of it were found on the surface before prospecting was begun. The Trinity and the peridotite are concealed by red and yellow surficial clays in which there are numerous pebbles and some fragments of conglomerate. The surficial clay on the lower half of the hill slope is black, and for this reason it has been given the name "black ground."

At the time of examination the peridotite was exposed in shallow pits, trenches, and cuts, not over a few feet deep, and in a shaft and a tunnel. Its superficial portion has disintegrated to a soft greenish earth, locally known as "green ground," whose more weathered portions have in turn changed to a yellowish earth called "yellow ground." Hard rock is exposed at the surface at a number of places near the center of the area of peridotite shown on the map (Pl. XIV), the exposures consisting, as previously stated, of a few fragments of rock protruding through the surface clay. Hard rock was reached in the shaft after passing through 32 feet of "yellow ground" and "green ground" and was then penetrated to a depth of 16 feet. It is said to have been reached in the bottom of drill holes Nos. 1, 2, and 3 after they had passed through about 30 feet of earth derived from the peridotite. "Green ground" is reported to have been reached in drill hole No. 4 below 10 feet of clay belonging to the Trinity formation, in drill hole No. 5 below 30 feet of clay belonging to the Trinity, and in other shallow drill holes between No. 4 and the tunnel.

The relation of the peridotite to the sedimentary rocks is represented in the accompanying section (fig. 67), which shows that the peridotite penetrates the Trinity formation but does not penetrate the Bingen formation. The only noticeable effect of metamorphism is that the clay of the Trinity has in places been semivitrified to a hard gray stone for a distance of 2 feet away from its contact with the peridotite.

The shape and full extent of the mass of peridotite are not known because of the small number of exposures. Wide dikes extend outward from the main mass, or else the main mass of rock in passing upward through the Trinity has included rather large bodies of this formation. Probably both of these conditions exist. The disintegrated rock exposed at the surface at the time of examination occurs within an area of 2½ acres, but, including that which was penetrated in drill holes Nos. 4 and 5, it occurs at and near the surface of a much larger area.

The hard peridotite and most of the altered peridotite contain numerous small angular inclusions of black shale, which was derived from the Paleozoic shales through which the peridotite was intruded. These inclusions are present in most of the altered rock. Some pieces of clay from the Trinity, the largest of them 6 inches in diameter, a few fragments of sandstone, and some well-rounded pebbles of quartz were observed in the altered rock.

The peridotite, even where hard, is so much altered that a microscopic study is not very satisfactory, but it is apparently the same as

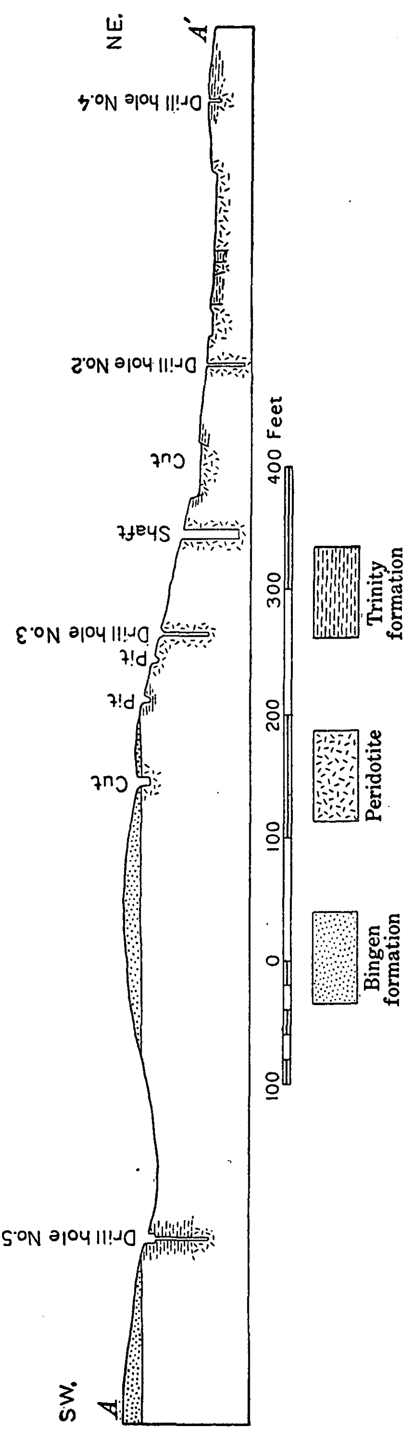


FIGURE 67.—Structure section through the American mine, Pike County, Ark., along line *A–A'*, Plate XIV, illustrating the relations of the peridotite to the Trinity and Bingen formations.

the volcanic breccia of the area near Prairie Creek. The olivine has completely altered to a serpentinous mineral, which fills sharply defined, well-preserved cavities. Magnetite, phlogopite, perovskite (?), augite (?), and the colorless submicroscopic base were recognized, and the relation of these minerals to one another is apparently the same as in the peridotite of other areas. Some of the loose wash found in the bottom of the northeastward-trending gully south of the house shown on the map (Pl. XIV) was panned by Mr. Miser, and the concentrates thus obtained consisted of pebbles of novaculite, white barite, chromite, magnetite, hematite, and a very small number of grains of red garnet.

BLACK LICK AREA.

The Black Lick area of peridotite is near the crest of a crooked ridge, about 550 feet above sea level, in sec. 23, T. 8 S., R. 25 W. (See Pl. XIV.) The ridge is capped by the basal part of the Tokio sand member of the Bingen formation, which here consists of 30 feet of gravel and a basal layer of conglomerate composed of pebbles of novaculite cemented together by brown iron oxide. The Trinity formation and the peridotite, which has penetrated the Trinity, underlie the Bingen.

The Black Lick is on the upper part of the gentle west slope of the ridge. The occurrence of a black soil at this locality led someone to make a very small pit in search of peridotite, and in this pit a yellowish-green earth was poorly exposed. In 1912 Mr. Miser deepened this pit to 7 feet and made another pit 6 feet deep 900 feet farther east. Since 1912 the first pit has been enlarged and another pit has been made 90 feet southwest of it. All three pits reveal altered peridotite, and they comprise the only exposures of such rock in the vicinity. The only exposures of the Trinity, which is represented here by clay, are down the slope west of the pits at the Black Lick, the nearest exposure being about 150 feet west of the westernmost pit. The extent of the peridotite in this vicinity is not known, but it is probable that the disintegrated rock exposed in the pits is comprised in a single area. From the relations of the peridotite to the Bingen it will be necessary for pits or drill holes on the crest of the ridge to pass through the Bingen before the peridotite is reached.

The peridotite exposed in the two pits at the Black Lick has disintegrated to a soft yellowish-green earth, which still retains indications that the original unaltered rock was a porphyritic volcanic breccia. It contains a few inclusions of clay from the Trinity formation and is free from quartz sand. A great many angular fragments of sandstone are scattered over the surface near the pit. This sandstone is gray and fine grained and has green spots, being in these respects not unlike the Paleozoic sandstone in and about the mass of peridotite near Prairie Creek. It is not impossible that the fragments were hauled there, but as this seems improbable it is likely that they were included in the peridotite as it passed upward through the Paleozoic sandstones, which lie buried possibly at a considerable depth beneath the surface. A small piece of chalcedonic quartz like that in the Prairie Creek area was found on the surface. The black soil referred to above, known locally as "black ground," covers possibly 3 or 4 acres to the west and south of the pits, and a good deal of it probably was derived from peridotite. Concentrates obtained by Mr. Miser by panning several pounds of disintegrated peridotite taken from one of the pits include a few minute grains of magnetite.

The pit that is 900 feet east of the Black Lick is in a timbered area which is comparatively level over several acres. The surface material consists of a black gumbo soil mixed with some waterworn gravel and is 2½ feet thick. Below this material yellowish-green earth, derived from peridotite, was penetrated to a depth of 3½ feet. Although the material has so disintegrated that microscopic study is impossible, the texture is clearly porphyritic, the phenocrysts being serpentinous pseudomorphs after olivine, whose outlines are in many places sharply defined and well preserved.

RELATION OF THE PERIDOTITE TO THE OTHER IGNEOUS ROCKS OF ARKANSAS.

The peridotite in Pike County, as has been pointed out by J. F. Williams,[5] is of the same age or nearly the same age as the other igneous rocks of Arkansas. The igneous rocks in the other parts of the State consist of nephelite syenite, pulaskite, and related types of intrusive rocks and occur in four small separate areas in the eastern part of the Ouachita Mountain region and in the northwest border of the Gulf Coastal Plain. One of these areas is in the Fourche Mountain region, near Little Rock, Pulaski County; a second is near Bauxite, Saline County; a third is at Magnet Cove, Hot Spring County; and a fourth is at Potash Sulphur Springs, Garland County. In addition hundreds of dikes of igneous rock are scattered here and there over much of the east half of the Ouachita Mountain region. Concerning these dikes Williams[6] says:

> Outside of these four typical regions there are many dikes of igneous rock, which, as far as their petrographic characteristics are concerned, might be associated as well with one group [region] as with another and which are, as a matter of fact, probably directly connected with none of them, although formed from the same magma from which they all derived their material.

The rocks in the dikes include tinguaite, fourchite, ouachitite, and monchiquite. Of these the monchiquite is more closely related in composition to the peridotite in Pike County than any other, for it is composed mainly of altered olivine and augite and at some places contains much biotite.

AGE OF THE PERIDOTITE.

The peridotite of each of the different occurrences is similar, and although the rocks of the different occurrences are not connected at the surface the similarity of the material makes it seem very probable that they are of common origin and are connected beneath the surface. The three types of peridotite were apparently formed by three distinct volcanic outbursts, but they are so closely related that they probably mark successive stages in a single period of volcanic activity. The evidence so far obtained indicates the following igneous history of the region:

First, the hypabyssal peridotite was intruded into the Carboniferous and Lower Cretaceous rocks. Volcanic explosions then took place, which broke up into small fragments not only much of the hypabyssal

[5] Williams, J. F., The igneous rocks of Arkansas: Arkansas Geol. Survey Ann. Rept. for 1890, vol. 2, p. 391, 1891.

[6] Op. cit., pp. 2-3.

peridotite but also some of the shales and sandstones of Carboniferous age. In the area of peridotite near Prairie Creek the fragments were apparently ejected into the air and then deposited in inclined layers which, in hardening, have formed a breccia. The layers dip 30° W. in the Ozark mine, 20°–30° SW. at the apex of the Mauney mine, and 50° or more toward the north near the south side of the Arkansas mine. (See Pl. XI, *A*.) This arrangement of the dips, in pointing toward the center of the exposure of peridotite near Prairie Creek, strongly suggests that the vent or vents from which the fragments were ejected were near the center of the area and also suggests that the fragments were deposited within the crater of a volcano. The dips of about 30° in the Ozark and Mauney mines represent nearly the angle at which fragments would rest on a slope, but the high dip of 50° or more toward the north in the Arkansas mine is much greater than the angle at which fragments would repose. This high angle may be due to a settling of the breccia or of the underlying lava in the crater.

A second group of explosions probably formed the tuffs and closely associated fine-grained breccias of the area near Prairie Creek. The distribution of these rocks and their relation to the hypabyssal peridotite and to the volcanic breccia apparently indicate that they are younger than those rocks. Northwest of the Arkansas mine they were penetrated by drill holes Nos. 3 and 5 to depths of 180 and 205 feet, respectively, and in the northern part of this mine and in the Ozark mine they occur as dikelike bodies which apparently cut the volcanic breccia. (See Pl. IX.) The apparently vertical dip of the tuff on the West Hill may be due to settling of the tuff or the underlying lava.

The peridotite is younger than the Trinity formation, which is of Lower Cretaceous age, as is shown by the high dip of the contacts between the peridotite and the nearly horizontal beds of the Trinity, by the metamorphism of the clay of the Trinity adjacent to its contact with the peridotite, and by the occurrence in the peridotite of fragments of clay and pebbles derived from the Trinity. (See figs. 66 and 67.)

The peridotite is probably of the same age as the Tokio sand member of the Bingen formation (Upper Cretaceous), though it may be older. This is shown by the fact that the lower beds of the Bingen on the Riley place and on the Twin Knobs, near Murfreesboro, contain altered grains of serpentine and fragments of peridotite. Although these grains and fragments were water-laid, they may have been ejected as fragmental material from one or more near-by vents instead of being washed by streams from exposures of peridotite. That the peridotite is not younger than the Bingen is shown by the fact that the Bingen rests upon the peridotite at the American mine and at the Black Lick. (See Pl. XIV and fig. 67.)

This evidence is corroborated by the occurrence of pebbles of tinguaite, fourchite, and syenite near the base of the Bingen at localities near Corinth and Centerpoint. Most of the pebbles of tinguaite and fourchite found there are identical in character with intrusive rocks of these types that are exposed farther northeastward, near the central part of Arkansas, and the syenite does not differ greatly from the pulaskite near Little Rock. However, as the distance from the rocks under discussion to the nearest exposure of similar rocks toward the northeast is about 60 miles, the igneous pebbles in the Bingen were probably derived from near-by areas of igneous rocks that are now concealed by Upper Cretaceous sediments. The igneous rocks near the center of the State and the peridotite near Murfreesboro are all thought to be connected genetically, and the intrusion of the peridotite, as stated by J. F. Williams,[7] took place at nearly the same time as that of the other igneous rocks of the State.

The foregoing evidence clearly indicates that the peridotite is younger than the Trinity formation, of Lower Cretaceous age, and is not younger than the Bingen formation, of Upper Cretaceous age. The volcanic activity that produced the peridotite may have accompanied diastrophic movements at the close of the Lower Cretaceous epoch, but it more probably accompanied the downwarping of the Mississippi embayment early in the Upper Cretaceous epoch. As already pointed out by J. C. Branner,[8] the igneous rocks of Arkansas occur near and parallel to the old Cretaceous-Tertiary shore line, which extended northeastward across the State. He believed that this shore line was affected by faulting or other weakness and that the igneous rocks of Arkansas had some possible connection with this line of disturbance.

COMPARISON OF THE DIAMOND-BEARING ROCKS OF ARKANSAS WITH THOSE OF SOUTH AFRICA.

PIPES OF KIMBERLITE IN SOUTH AFRICA.

The peridotite of Arkansas is generally believed to be similar in character and mode of occurrence to that of South Africa, but the exact points of similarity have not been recorded. For purposes of comparison brief extracts and abstracts from the excellent work by Wagner are given below.

> The pipes [in South Africa] represent deeply eroded, funnel-shaped volcanic necks of the Marr type, which appear to have been formed by the violent explosive liberation at the earth's surface of highly compressed vapors and gases, emanating from a

[7] Williams, J. F., Igneous rocks of Arkansas: Arkansas Geol. Survey Ann. Rept. for 1890, vol. 2, p. 391, 1891.

[8] Branner, J. C., The former extension of the Appalachians across Mississippi, Louisiana, and Texas; Am. Jour. Sci., 4th ser., vol. 4, p. 365, 1897.

deep-seated ultrabasic magma. They are occupied as a rule by nonvolcanic detritus derived from the shattering and comminution of the rocks pierced by the explosions, by fragmentary material derived from trituration of kimberlite, and at greater depths by solid plugs of the later rock.[9]

Dealing first with the relationship of pipes to fissures, we have learned that the magma in its ascent appears invariably to have been guided to within a greater or less distance of the original surface by planes of structural weakness in the earth's crust. * * * The earliest eruptions appear to have been in the nature of mighty explosions, which resulted in blowing out of funnel-shaped apertures. The bulk of the material forcibly ejected during these outbursts no doubt fell back into the vents, which at one stage of their history may thus have been more or less completely occupied by nonvolcanic detritus. The relief of pressure occasioned by these earlier explosions must be assumed to have led to the ascent of the magma into the pipes, where it appears, as a rule, to have given rise, by successive eruptions, to a number of distinct columns of kimberlite and kimberlite tuff.[10]

MATERIAL IN THE VENTS IN SOUTH AFRICA.

The material that occupies the vents Wagner describes as follows:

It has been pointed out that in so far as the pipe filling is concerned, the rocks pierced by the explosions, the kimberlite magma, and the atmosphere have all contributed.[11]

We may divide, following the precedent of Du Toit, the foreign matter of the pipes into three principal groups—rock fragments derived from the adjacent pipe walls; xenoliths of rock, which have been brought up from below; masses of rock, which to attain the position in which we now find them must have fallen into the pipes from above.[12]

The pipe rock proper consists of kimberlite and of material derived from its brecciation, comminution, and decomposition.[13]

The microscope reveals the fact that among the products comprehended under the general term of blue ground three main varieties may be distinguished. These are true kimberlite tuff or kimberlite breccia, injection breccia, and decomposed kimberlite. * * * As greater depths are attained in the mines the products we have hitherto been dealing with, as one would naturally expect, are replaced in increasing measure by "hardebank," or kimberlite, the parent rock, to the trituration and decomposition of which they owe their origin.[14]

DIKES AND SILLS IN SOUTH AFRICA.

Wagner notes the presence of dikes and sills in South Africa as follows:

In 1905 Harger directed attention to the widespread distribution of such dikes or "fissures" of kimberlite, as he termed them, and to their frequent association with pipes and large bodies of kimberlite. The dikes have themselves in many instances been found to contain diamonds.[15] * * *

Kimberlite is also known to occur in the form of transgressive sheets or sills not visibly connected with dikes.[16]

---

[9] Wagner, P. A., The diamond fields of southern Africa, p. 5, 1914.
[10] Op. cit., p. 41.
[11] Op. cit., p. 18.
[12] Op. cit., p. 20.
[13] Op. cit., p. 24.
[14] Op. cit., pp. 27–28.
[15] Op. cit., p. 42.
[16] Op. cit., p. 45.

PETROGRAPHY OF THE KIMBERLITE IN SOUTH AFRICA.

Wagner describes the kimberlite of South Africa as follows:

The true character of the rock which forms the matrix of the diamond in South Africa was first recognized in the year 1886 by Prof. Henry Carvill Lewis, who, after careful microscopic investigation, pronounced the hard blue ground or "hardebank" exposed in depth in the Kimberley mines to be a serpentinized "porphyritic volcanic peridotite of basaltic structure." * * *

More recent investigations have definitely established the existence of two distinct varieties of kimberlite, which, notwithstanding the fact that they are clearly of closely cognate origin and linked up by many intermediate types, differ both in composition and in structure. These are (1) a basaltic variety, poor in mica, the kimberlite of Carvill Lewis; and (2) a lamprophyric variety, rich in mica.

In kimberlite of the first type one usually finds olivine in large and small individuals, together with occasional phenocrysts of phlogopite and isolated grains of ilmenite, enstatite, pyrope, and diopside embedded in a groundmass of secondary minerals, rich in perovskite, apatite, chromite, and iron ores. Phlogopite never enters largely into the composition of this groundmass, and in many instances the mineral does not recur in distinct groundmass generation. Olivine generally forms from 50 to 75 per cent of the rock, while phlogopite is rarely present to the extent of more than 3 or 4 per cent. * * *

In kimberlite of the second type one finds the same porphyritic elements as before, in a holocrystalline or hypocrystalline groundmass, of which phlogopite is the dominant constituent. The groundmass minerals comprise phlogopite, olivine, apatite, perovskite, chromite, and iron ores, while augite may or may not be present. Phlogopite may form as much as 50 per cent of the rock. * * * The structure of the rock is again very peculiar but approximates to that of the basic lamprophyre. The micaceous kimberlites present a close analogy to the alnoites. * * *

Basaltic kimberlite is equally common in dikes, sills, and true volcanic pipes. The micaceous rock, on the other hand, attains its typical development when occurring in dikes and sills, or in the enlargements of such massive bodies, though pipes of micaceous kimberlite are also known.[17]

The micas of the micaceous kimberlites are described by Wagner as follows:

A very interesting feature in connection with the mica is its pleochroism. As a rule, the absorption is normal, so that $Z \lesseqgtr Y > X$. On the other hand, the pleochroism is not infrequently seen to be abnormal, and the absorption scheme becomes $X > Y \gtreqless Z$.

Normal and abnormal mica are frequently visible in the same section, and in many instances the two varieties are seen to be zonally intergrown, a core of the normal variety being commonly inclosed by a shell of the abnormal variety.[18]

SIMILARITY OF THE DIAMOND-BEARING ROCKS OF ARKANSAS TO THOSE OF SOUTH AFRICA.

The quotations given above, which outline very briefly the type of eruption and describe the diamond-bearing rocks of South Africa, serve as a basis for comparison with the diamond-bearing rocks of Arkansas. In South Africa work has proceeded to great depths (3,601 feet in the Kimberley mine), and the geology and relationships are known in considerable detail, whereas in Arkansas the surface

---

[17] Op. cit., pp. 78-80.

[18] Op. cit., p. 58.

of the ground has only been scratched. Nevertheless, many points of similarity are evident.

The violence of the volcanic explosions by which the South African vents were produced and the extent to which the kimberlite and country rock were shattered and mixed together in the vents has been emphasized. In Arkansas there was evidently marked shattering of the peridotite, and the explosive violence has brought to the surface Paleozoic rocks that lay far beneath the surface. Injection breccias composed of shattered country rock mixed with a small proportion of volcanic material and having the characteristics of dikes have been identified in both areas.

In many of the South African vents recurrring volcanic activity produced compound pipes formed of slightly different rocks and even bearing diamonds of dissimilar character. Petrographic studies have shown that in Arkansas there are at least three types of rock, only one of which carries diamonds in considerable amounts.

In South Africa a notable though not the richest group of diamond-bearing rocks is a porphyritic kimberlite with micaceous groundmass and lamprophyric habit. The Arkansas peridotite, which is in reality kimberlite, is strikingly similar in composition and habit to the micaceous kimberlite of lamprophyric habit of South Africa. These similarities can be well emphasized by tabulating their principal characteristics.

Characteristics of kimberlites of Arkansas and South Africa.

Kimberlite (peridotite) of Arkansas.	Micaceous kimberlite of South Africa.
Phenocrysts:	Phenocrysts:
40 to 50 per cent olivine.	50 to 75 per cent olivine.
Olivine low in FeO.	Olivine low in FeO.
A little phlogopite.	A little phlogopite.
Pyrope, almandite, and melanite.	Pyrope.
Groundmass:	Groundmass:
50 to 60 per cent phlogopite.	As much as 50 per cent phlogopite.
Important accessory minerals:	Important accessory minerals:
Augite, perovskite, chromite, and iron ores.	Augite, perovskite, chromite, and iron ores.
Habit:	Habit:
Lamprophyric.	Lamprophyric.

This table shows that the rocks of the two regions are nearly identical and differ only in slight variations in proportions of minerals. The large amount of development work in South Africa has brought to light many rare minerals which are not yet known in Arkansas and which are not listed in the table.

A very interesting similarity in minerals is found in the micas of the kimberlites in the two regions. In both South Africa and Arkansas the most abundant mica is a reddish-brown, normally pleochroic phlogopite, with here and there a peculiar mica showing abnormal pleochroism. In both rocks this abnormally pleochroic mica is of a later generation and forms zones around the olivine and normal mica. (See p. 297 and Pl. XII, *B*.)

The chemical similarity of the kimberlites in Arkansas and South Africa is shown by the following analyses of the two rocks:

Analyses of kimberlites of Arkansas and South Africa.

	1	2	3	4		1	2	3	4
SiO_2	38.78	47.92	35.49	31.80	H_2O+	7.85	9.49	6.69	5.59
Al_2O_3	6.85	5.69	3.42	3.41	H_2O-	1.95	......	.47	.63
Fe_2O_3	8.83	5.99	6.37	5.19	TiO_2	.89	2.71	1.65	1.40
FeO	1.99	.84	3.02	3.48	P_2O_5	......	......	.63	1.49
CaO	3.88	3.16	5.12	10.04	CO_2	.14	.49	3.03	7.65
MgO	26.34	21.82	30.98	24.69					
Na_2O	.78	.29	.20	.29		100.84	99.83	99.68	99.98
K_2O	2.56	1.43	2.61	4.32					

1. Peridotite (probably hypabyssal) from Prairie Creek area, Ark. R. N. Brackett, analyst.
2. Volcanic breccia ("green ground") from Prairie Creek area, Ark. H. S. Washington, analyst.
3. Kimberlite, Lion Hill dike, South Africa. P. A. Wagner, analyst.
4. Highly micaceous kimberlite from the peripheral portion of the Lion Hill dike, South Africa. M. Dettrich, analyst.

The kimberlite of Arkansas and the micaceous kimberlite of South Africa are very similar in chemical composition. The most conspicuous similarity is the low content of sodium and the high content of potassium, and this is reflected in the large proportion of mica that they contain. Another feature common to both rocks is the proportion of iron, which is small for peridotites. A corollary to this feature is the high magnesium content of both rocks, which has resulted in the formation of olivine high in magnesium and low in iron and in the development of light-colored phlogopite. Both rocks have undergone the same type of alteration, probably as a result of their similar mineral composition. Thus it is evident that the diamond-bearing rocks of Arkansas and the diamond-bearing micaceous peridotite of South Africa are nearly identical. Their chemical composition is similar and the modes of the rocks in the two regions are so much alike that the minerals developed are practically identical. The essential minerals are the same, varying but slightly in proportion, and even the accessory minerals are similar.

DIAMONDS.

OCCURRENCE.

Nearly all the diamonds from Arkansas have been found within the exposures of the peridotite in the areas near Prairie Creek and at the Kimberlite and American mines, though a very few diamonds have been found along streams where they have been washed from these areas, and five diamonds are reported to have been found at a locality on Mine Creek, 3 miles south of Corinth. The mines that have produced diamonds are the American, Kimberlite, Mauney, Ozark, and Arkansas. The diamonds at these mines have been found not only on and near the surface but at depths of as much as 20 feet. How much deeper the diamonds extend is not known, but the depth is probably much greater than that to which mining can be carried.

Only one specimen of decomposed peridotite in which a diamond was embedded has been examined by Mr. Miser. This specimen was obtained in 1907 from weathered peridotite breccia several feet below the surface in the Arkansas mine. It was examined earlier by G. F. Kunz and H. S. Washington,[19] who have made the following statement regarding it: "Our careful examination * * * leaves no doubt that the diamond is actually in place in the rock and was not inserted in the specimen. Consequently it constitutes a definite proof that the peridotite is the source of the diamonds."

The yield of diamonds in carats per load of diamond-bearing material differs at different places in the mines and also at different depths, but this yield, as it has been determined by the great amount of work that has been done by the mining companies, is known only in part by the writers. Figures giving the yield are not available for publication. A few conclusions which seem to be supported by the available facts are here presented.

Most of the diamonds from the Arkansas, Ozark, and Mauney mines have been obtained within the area or areas in which the volcanic breccia is exposed. The areal distribution of the breccia at the surface of these mines is shown on the map (Pl. IX). Austin Q. Millar states that the soft, decomposed peridotite overlying the "hardebank" (hypabyssal intrusive peridotite) in the north part of the Mauney mine is nearly or entirely barren of diamonds, and he also states that the soft blue, somewhat banded earth (altered peridotite tuff) that covers a small area on the Ozark mine is barren of diamonds.

The diamonds, wherever they are present, have probably been concentrated on and near the surface by weathering and erosion. The great amount of erosion that the peridotite has undergone has removed much of the clay and other minerals with a low specific gravity from the outcrop of the peridotite, leaving perhaps most of the diamonds and other heavier minerals. The heavier minerals thus concentrated are in the black ground. The panning of samples of black ground and of the underlying green and blue grounds by Mr. Miser shows that the quantity of heavier minerals to the cubic foot in the black ground is many times that in the underlying material.

[19] Kunz, G. F., and Washington, H. S., Diamonds in Arkansas: Am. Inst. Min. Eng. Trans., vol. 39, p. 173, 1909.

The supposition that there has been a surficial concentration of diamonds is also apparently supported by the results of washing done by the Ozark Diamond Mines Corporation, which obtained a larger yield of diamonds from surface material than from the underlying disintegrated rock. Hard rains, however, wash some of the heavier minerals away from the outcrop. Mr. Miser found grains of chromite, garnet, and barite along a stream as far as 300 or 400 feet south of the Arkansas mine, and these minerals are said to have been found as far as half a mile south of the mine. The presence of these minerals indicates very strongly that some diamonds have been washed by streams away from the peridotite exposures, but thus far only a few diamonds have been found among the sands and gravels along the streams below the exposures of peridotite.

The Bingen formation on the Riley place, half a mile northeast of the Ozark mine, contains pebbles of peridotite and grains of altered serpentine which were washed from an exposure of peridotite or were ejected as fragmental material from volcanic vents. The Ozark Diamond Mines Corporation washed 1,000 loads, each containing 16 cubic feet of material, from the Bingen at that locality but found no diamonds.

PRODUCTION.

The number of diamonds that have been found near Murfreesboro, Ark., since their discovery in 1906 is only partly known, for the mining companies have withheld from publication the complete figures of production. So far as the authors know, however, at least 5,300 diamonds have been obtained.

The Arkansas mine, which has been worked by the Arkansas Diamond Co. and its successor, the Arkansas Diamond Corporation, had produced about 3,000 diamonds by the end of 1920;[20] it was worked in 1921, but the production in that year is not known.

The Ozark mine is reported to have yielded 800 or 900 diamonds in 1912 or 1913, when it was worked by the Ozark Diamond Mines Corporation. It was worked by the Kimberlite Diamond Mining & Washing Co. from 1914 to January, 1919, but the statistics of production for that period are not available.

The Mauney mine produced 1,500 diamonds from 1913 to April, 1915, when it was worked by the Kimberlite Diamond & Washing Co., but the number of diamonds that were found by M. M. Mauney before 1913 and the number found by the company after April, 1915, are not known to the authors.

The American mine is reported to have produced 24 diamonds, and the Kimberlite mine several diamonds.

[20] Kunz, G. F., Eng. and Min. Jour., vol. 103, p. 160, 1921.

Most of the diamonds from the mines near Murfreesboro have been held by the mining companies, though some uncut stones have been sold. The first cut stones were offered for sale in 1921 by Tiffany & Co., of New York City, and by the Chas. S. Stifft Co., of Little Rock, Ark.

CHARACTER.

The diamonds that have been found range in weight from a very small fraction of a carat to many carats. Some are so small that 250 of them would be required to weigh 1 carat. The largest diamond which was found in the Arkansas mine in September, 1921, weighed 20¼ carats, and one weighing 17.86 carats (see Pl. XV, *A*) was found in the Arkansas mine in May, 1917. The average weight of the 3,000 diamonds that had been produced by the Arkansas mine at the end of 1920 was about 0.4 carat,[21] but the average weight of the entire production of all the mines is probably between 0.3 and 0.4 carat.

Most of the diamonds are white, brown, or yellow. According to Kunz and Washington,[22] there is a large proportion of white stones, for the most part of a high grade in color, brilliancy, and freedom from flaws. They also say that many stones are as fine as any that have been found elsewhere and that some of the yellow ones are of exceptional quality and color. Kunz [23] also makes the following statement in describing several yellow, brown, and white stones from the Arkansas mine: "These are absolutely perfect and are equal to the finest stones found at the Jagersfontein mine, or that were ever found in India."

The forms of most of the diamonds have not been studied, but the following paragraph, abstracted from a paper by Kunz and Washington,[24] summarizes briefly the forms of the first 140 diamonds that were found:

> The most common forms are distorted hexoctahedrons—most of them elongated but others flattened—with much rounded faces. There are a few regular and undistorted octahedrons that show slightly rounded faces, though in most of these the center is flat. Many of the edges are replaced by dodecahedrons, and some of them are further rounded by trigonal trisoctahedrons, with hexoctahedrons near the apices. No cubes were seen, and tetrahexahedral and dodecahedral forms seem to be rare, except as they replace octahedral edges and angles.

---

[21] Kunz, G. F., Eng. and Min. Jour., vol. 103, p. 160, 1921.

[22] Kunz, G. F., and Washington, H. S., Diamonds in Arkansas: Am. Inst. Min. Eng. Trans., vol. 39, pp. 173-174, 1909.

[23] Kunz, G. F., Precious stones: The mineral industry during 1918, vol. 27, pp. 621-622, 1919.

[24] Kunz, G. F., and Washington, H. S., Note on the forms of Arkansas diamonds: Am. Jour. Sci., 4th ser, vol. 24, pp. 275-276, 1907.

The diamonds shown in Plate XV, *A*, are all crystals and are described by W. T. Schaller as follows:

Weight, size, and color of diamonds from the Arkansas mine, Pike County, Ark.

No.	Weight (carats).	Maximum dimensions (millimeters).			Color.
		Length.	Width.	Thickness.	
1	11.21	24½	15	5½	Slightly smoky or brownish.
2	6.83	13½	13	5	Colorless.
3	3.30	11	7	4	Colorless.
4	2.77	14½	5½	3½	Brownish.
5	17.86	17	14	12	Yellow.
6	4.40	16	9	4	Colorless.
7	1.19	6	5	4	Yellow.
8	.91	6½	4	3½	Yellow.
9	2.50	11½	9	5	Colorless.
10	1.40	11½	6½	2½	Colorless.

The crystals seem to be rounded and distorted hexoctahedrons; the bounding faces are not typical crystal faces but are end forms toward which the curved faces tend.

Crystal No. 1: Probably a flattened and distorted octahedron or hexoctahedron with possibly additional forms. Several of the rounded faces have parallel octahedral-like "etch hills" or "ridges" on them.

Crystals Nos. 2 and 3: Probably distorted flattened hexoctahedrons.

Crystal No. 4: Elongated crystal with ends not complete; a different phase of distortion.

Crystal No. 5: Very little distorted; essentially a rounded octahedron, the octahedral faces being replaced by the rounded faces of a hexoctahedron. Shows several solution "pits," one quite deep, in the position of the cube.

Crystal No. 6: Suggestion of a flattened octahedral twin but may be only a distorted form like the others.

Crystals Nos. 7 and 8: Like crystal No. 5.

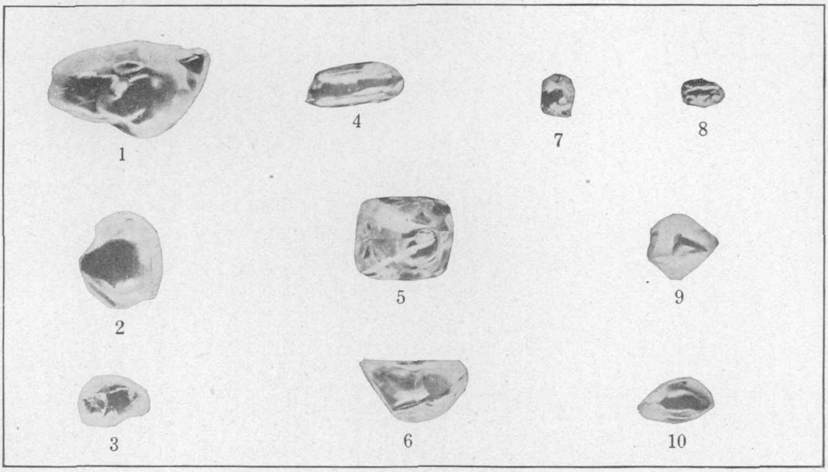
Crystals Nos. 9 and 10: Rounded, flattened, and distorted hexoctahedrons.

The following statement regarding the diamonds from the Mauney and Ozark mines was furnished in 1921 by Austin Q. Millar, of the Kimberlite Diamond Mining & Washing Co.

From a careful examination of several thousand diamonds the percentages of yield of the various grades of the mine run are: White stones, 40; yellow, 22; brown, 37; true bort, 1. The gem material of the yellow, the deep canary, is most magnificent, and the mahogany shade of the brown is equally desirable. The white gem material is matchless for purity, and about 10 per cent of the stones classed as white are of this grade.

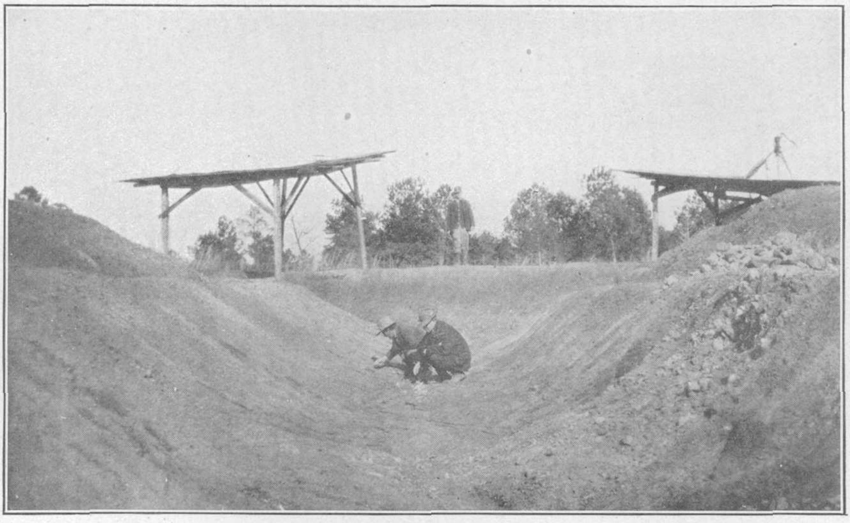
Because of the high luster in their rough state, a parcel of Pike County diamonds are unmatchable by a like parcel of the African stones. This quality is largely due to their extreme hardness, and as a consequence the greater brilliancy of the finished gem is the result. In both hardness and size the mine-run stones are best comparable to the Brazilian diamonds.

Their crystallographic characteristics are distinct. As the larger proportion of the recoveries belong to the more complex forms of the isometric system, the trisoctahedron and hexoctahedron predominate more than the octahedron or dodecahedron. Rarely are crystals recovered that present sharp, angular faces, the characteristic rounded (convexed) surfaces greatly predominating. The true bort is translucent with a radial structure and occurs in rounded forms.



A. DIAMONDS FROM THE ARKANSAS MINE, PIKE COUNTY, ARK. NATURAL SIZE.

The diamonds shown in the picture are owned by Col. Washington A. Roebling, Trenton, N. J. They are crystals, with the following weights: No. 1, 11.21 carats; No. 2, 6.83 carats; No. 3, 3.30 carats; No. 4, 2.77 carats; No. 5, 17.86 carats; No 6, 4.40 carats; No. 7, 1.19 carats; No. 8, 0.91 carat; No. 9, 2.50 carats; and No. 10, 1.40 carats. Other information concerning the crystals is given on pages 319 and 320.



B. TRENCHES ON THE KIMBERLITE MINE, NEAR MURFREESBORO, ARK.

The trenches are in a soft green and yellow earth derived from peridotite, though in the foreground there is a small area of hard unaltered peridotite (hypabyssal intrusive peridotite). Photograph by Howard A. Millar.

Stones have been found with a blue or pink tinge, and occasionally a "frosted" or etched white is noticeable in the recoveries.

Fragments and fractures were much more noticeable when mining was being done in surface material; but at slight depth in the undisturbed volcanic ground these features were almost entirely absent.

MINING AND TREATMENT OF DIAMOND-BEARING MATERIAL.

Probably several hundred diamonds have been picked up by miners from the surface of the peridotite areas, especially the Prairie Creek area, but most of the diamonds have been obtained by washing the diamond-bearing material. Different methods of mining and washing have been employed, in part because of the diverse character of the diamond-bearing material, which differs not only from one locality to another but also at different depths.

Much of the decomposed peridotite, including the surficial black soil called "black ground" and also a large part of the underlying "blue ground," "yellow ground," and "green ground," is soft enough to be washed for the recovery of the diamonds without being crushed or weathered first. Most of the black ground is very sticky, like gumbo, when it is wet, so that it disintegrates with some difficulty in the washing plants. Experiments are said to show that when thoroughly dried and then washed it absorbs water rapidly, swells, and finally slacks to a thin mud. Much of the diamond-bearing material, especially that of some of the "blue ground" and "green ground," is fairly hard and requires crushing, exposure to weathering, or other treatment for the recovery of diamonds. The unaltered peridotite, called "hardebank," and the unaltered peridotite breccia are so hard and tough that they probably can not be treated in any way for the extraction of diamonds except by crushing, which would doubtless fracture some of the diamonds. The areal extent and depth of the soft, decomposed peridotite and of the hard, unaltered rock are described on pages 295, 304–310.

All the mining has been done in shallow open cuts. Hydraulic mining has been used to a small degree, but most of the mining has been done by hand and by means of plows and scrapers. In the hydraulic mining the water carried the disintegrated diamond-bearing material through a sluice trough from which the concentrates were removed and then jigged by hand in small sieves. After the jigged concentrates were placed on smooth sheets of metal they were carefully searched for diamonds.

Most of the material that has been mined, however, has been hauled in tram cars, with a capacity of 16 cubic feet each, to the washing plants.

The fairly hard peridotite is crushed in the new plant of the Arkansas Diamond Corporation, and after being crushed it is treated in the washing plants like the softer material.

A log washer was used for a short time in the Ozark washing plant, but it did not prove to be a success on account of the stickiness of the black ground that was washed in it.

Washing pans of the type common in the South African diamond fields have been successfully used. Such a pan is circular, has a flat bottom, and rests in a horizontal position. At its center there is a vertical revolving shaft to which radiating arms are attached. On these arms there are metal teeth that revolve in the pan and thus stir the diamond-bearing material that is fed into the pan. During this stirring the diamonds and associated heavy minerals gradually settle to the bottom of the pan while the clay and other light minerals rise to the surface and flow out of the pan near its center. The concentrates thus obtained in the bottom of the pan are then sized and next jigged. The jigged concentrates are carefully searched for diamonds on metal-covered tables or are washed by water over a table which is covered with a thick film of grease and which is shaken rapidly from side to side by an eccentric. While the concentrates are washed across the table, the grease sticks to the diamonds and holds them, whereas it does not stick to the other minerals, most of which are therefore washed off the table. The grease with its content of diamonds and other minerals is removed from the tables from time to time. The diamonds are then freed from the grease by converting it into soap or by putting it into boiling water.

CONCENTRATE MINERALS ASSOCIATED WITH THE DIAMONDS.

A number of minerals besides diamonds are concentrated during the treatment of diamond-bearing material. These include hematite, limonite, barite, colorless quartz, amethyst quartz, magnetite, pyrope, almandite, schorlormite (or melanite), chromite, pyrite, diopside, and epidote. The quantity of each mineral differs somewhat from place to place, but in general the most abundant have been named first and the least abundant last. A few specimens of amethyst quartz that have been found were of gem quality, and some of them have been cut for use in jewelry. A small number of pebbles of the dense chalcedonic varicolored novaculite that are found on the surface at the diamond mines have also been cut for this use.