STATE OF ARKANSAS
ARKANSAS GEOLOGICAL SURVEY
GEORGE C. BRANNER
STATE GEOLOGIST

INFORMATION CIRCULAR 3

BLACK MARBLES OF NORTHERN ARKANSAS

FIELD WORK BY BRYAN PARKS
TEXT BY BRYAN PARKS AND J. M. HANSEL

WITH A SECTION ON THEIR ECONOMIC POSSIBILITIES

BY
E. E. BONEWITS

LITTLE ROCK
1932

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Based on a reconnaissance survey

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LETTER OF TRANSMITTAL

ARKANSAS GEOLOGICAL SURVEY

Little Rock, Arkansas

October 8, 1932

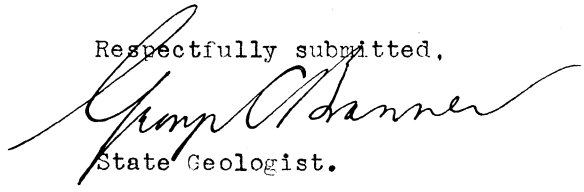
Hon. Harvey Parnell,
Governor, State of Arkansas,
Little Rock, Arkansas.

Sir:

I have the honor to submit herewith the report "Black Marbles of Northern Arkansas," which contains a section on the economic possibilities of the marble. The field work on this report is by Bryan Parks, and the text is by Bryan Parks and J. M. Hansell. The economic section is by E. E. Bonewits.

The black marble deposits described are exposed for over 200 miles in Independence, Cleburne, Stone, and Searcy counties. They are the only deposits of true black marble known to occur in the United States. With the exception of the Arkansas product, all the true black marble utilized in this country is imported from Belgium. As the Arkansas product has a distinct price advantage in the central part of the United States over the Belgium product, it is highly probable that the Arkansas black marble industry will eventually develop into one of considerably more importance than it is at present. This report is an attempt to call attention to the distribution and quality of the stone, the prevailing markets, and the possibilities for developing the industry.

Respectfully submitted,



State Geologist.

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PART I

BLACK MARBLES OF NORTHERN ARKANSAS

By Bryan Parks and J. M. Hansell

ABSTRACT

Black limestone, known commercially as black marble, has been known to occur in north Arkansas since 1858, but, due principally to inadequate transportation facilities, early attempts to utilize the deposits were unprofitable. Since 1926, however, the construction of good highways and a bridge across White River at Batesville has encouraged extensive leasing, and 16 prospect black marble quarries have been opened between Oil Trough, Independence County, and Marshall, Searcy County. The marble has been used for decorating the interiors of at least seven public buildings and has been specified for use in several buildings now under construction. Since July, 1930, 47 car loads of marble blocks and terrazzo have been shipped.

The black marble occurs as flat-lying beds of dark gray-black limestone in the Fayetteville and Pitkin formations of Mississippian age, which outcrop along the north slope of the Boston Mountain escarpment. Immediately south of White River the thickness of the individual marble beds ranges from a feather edge to about four feet. The beds outcrop for a distance of from 200 to 225 miles between Oil Trough and Marshall which are 68 miles apart on an air line. Black marble occurs in the upper one-third to one-half of the Fayetteville formation, and principally in the basal 30 to 40 feet of the Pitkin formation.

Both the Fayetteville and Pitkin formations contain large quantities of very fine-grained, even-textured and uniformly shaded black marble which, as a type, is termed "Arkansas Black" marble. Judging by present day demand, it is estimated that there are sufficient quantities of accessible black marble in these formations to supply the entire demand of the United States for a great many years.

In addition to the black marble, several shades of dark-gray, coarse-textured marble are present in large quantities in the Pitkin formation. These gray, coarse-textured marbles are called, as a type, "Arkansas Fossil."

Three quarries are now operating in the Fayetteville formation and one in the Pitkin formation.

INTRODUCTION

Several varieties of commercial marbles are widely distributed in northern Arkansas, but the quarrying of black marble, dating principally from 1928, marks a new development in the quarrying industry of this state. Because of the scarcity of geological information concerning the region where the black marble occurs, a preliminary survey of the region was made to determine the character and extent of the deposits. This report contains the result of this investigation and is accompanied by a map showing the approximate outcrop of the black marble-bearing formations and the locations of the quarries in these formations.

Field work upon which this report is based was done by Bryan Parks, who also prepared the original manuscript. The final manuscript was prepared from the original manuscript by J. M. Hansell, who also contributed sections on physical and chemical tests and quarrying factors.

ACKNOWLEDGMENTS

The writers wish to express their appreciation to George C. Branner, State Geologist, for aid in organizing and editing this report; and to W. R. Spencer, Professor of Civil Engineering of the University of Arkansas, and Van Trump Testing Laboratory, of Little Rock, Arkansas, for making strength tests of the black marble. They also wish to acknowledge the assistance and information supplied by George J. Terry, of the Batesville Black Marble Company, Batesville, Arkansas, Bert W. Brown, of the American Black Marble Company, Leslie, Arkansas, and S. O. Denton, of Denton & Waldo, Leslie, Arkansas.

HISTORY OF DEVELOPMENT

The occurrence of black marble in northern Arkansas south of White River was known to the early settlers in that region. In 1859, D. D. Owen 1/ mentioned examining polished black marble from the vicinity of Oil Trough, Independence County.

In 1879, a wagon load of black marble was quarried on a ridge three miles southwest of Oil Trough near the present site of Ellison's quarry. This was hauled to White River and shipped by water to Louisville, Kentucky, for finishing. This was the first recorded shipment of black marble from Arkansas.

About 1890, three wagon loads of black marble were quarried two miles northeast of Leslie, Searcy County, on the Clements farm. This was hauled over the mountains to Plumerville, which was then the nearest rail shipping point, and is reported to have been shipped to Kansas City, Missouri.

In 1890, Hopkins 2/ mentioned the occurrence of two beds of black marble in Independence County, but did not discuss the deposits in detail.

No rail transportation is available in the highland region immediately south of White River in Independence, Stone, and Searcy counties where the deposits occur. The Missouri and North Arkansas Railway which, in general, follows the course of Little Red River, was completed from Leslie to Helena in 1909 and crosses the deposits in Searcy County near Leslie.

Until 1928, the roads in the black marble area were not easily passable for heavy traffic. These conditions, and the fact that there were no bridges across White River, made hauling marble by motor truck or wagon too costly for profitable quarry operation. In the past three or four years, modern gravel highways and a bridge across White River at Batesville have been constructed, allowing easy access to the area.

As a result of these improvements and an increased commercial demand for dark-colored stone, interest has been revived in the development of the black marble industry, particularly in the vicinity of Batesville and Leslie. Land favorable for quarry sites has been leased and 16 quarry prospects have been opened.

The Batesville Black Marble Company, Batesville, Arkansas, has been a pioneer in the recent development and has 1,000 acres under lease. This company has opened three small quarries and has shipped to date (June 15, 1932) 15 car loads of blocks and 16 car loads of terrazzo. It also operates a 40-ton crushing plant for making four sizes of terrazzo and has a marble yard and loading switch at Batesville. The American Black Marble Company, Kansas City, Missouri, has leased 537 acres of land and has prospected in the vicinity of Mountain View, Stone County. Denton & Waldo, Leslie,

1/ Owen, D. D., A geological reconnaissance survey of northern Arkansas counties: Arkansas Geol. Survey First Rept., p. 35, 1858.
2/ Hopkins, T. C., Marbles and other limestones: Arkansas Geol. Survey Ann. Rept. pp. 354-355, 1890.

Arkansas, have leased 1,000 acres in the vicinity of Leslie, and are operating a quarry on the Missouri and North Arkansas Railway one-fourth of a mile east of Leslie and a 20-ton terrazzo plant at Leslie. Six car loads of blocks and five car loads of terrazzo have been shipped from this quarry to date. Anderson & McMein, Kansas City, Missouri, have opened a quarry on Bagley Creek, one mile north of Leslie, and have shipped part of a car load and one truck load of blocks to Kansas City for testing. Anderson & Brown, Kansas City, Missouri, have opened a quarry on the north slope of Cow Mountain, five miles west of Mountain View, and have shipped one car load of blocks. It is reported that the Devonian Marble Company, Batesville, Arkansas, shipped five car loads of blocks before it ceased operations.

DESCRIPTION OF THE REGION

Location and Accessibility

The black marble beds of northern Arkansas outcrop south of White River in a narrow zone, usually less than two miles wide, extending along the north slope of the Boston Mountain escarpment from near Oil Trough, in T. 12 N., R. 5 W., to a few miles south of Marshall, in T. 14 N., R. 16 W. This escarpment extends from the Gulf Coastal Plain in southeast Independence County, west through the region of black marble occurrence in Independence, Stone, and Searcy counties, and thence across Newton, Madison, and Washington counties. The U. S. Geological Survey topographic maps of the Batesville, Mountain View, and Marshall quadrangles show the topography of the black marble area. Batesville, in the eastern part of the area, Mountain View, in the central part, and Marshall and Leslie, in the western part, are the most important towns near the black marble outcrops.

The railroads nearest the black marble outcrops are the Missouri Pacific (White River branch), which closely follows the north side of White River from Batesville to Cotter, Baxter County, and the Missouri and North Arkansas, which crosses the black marble outcrops near Leslie and Marshall, Searcy County. Good gravel roads now connect the black marble area with shipping points on these railroads. State Highway 14 from Batesville to Mountain View and State Highway 66 from Mountain View to Leslie run more or less parallel to the black marble outcrop. The latter highway is unsurfaced for over half of the distance between Mountain View and Leslie. State Highways 11 from Batesville, 25 from Locust Grove, 9 from Mountain View, and U. S. Highway 65 from Marshall through Leslie, all cross the black marble region.

Topography and Drainage

The most prominent topographic feature in the black marble region is the Boston Mountain escarpment which rises abruptly to elevations of from 700 to 1,000 feet above the rolling lowland to the north. The maximum relief of the area is 1,650 feet. This is measured from the approximate elevation of 250 feet above sea level on White River in T. 12 N., R. 5 W., and a like elevation of 1,900 feet on Henderson Knob in T. 14 N., R. 15 W. The Boston Mountain escarpment appears as a low mountain wall of sharp relief, winding along the south boundary of White River drainage basin. Erosion across the dip of the sedimentary beds which form the escarpment has exposed alternating hard and soft strata and has produced a bench and bluff type of topography. From the base of the escarpment north to White River the land is usually flat with a few low, rounded hills. Southward from the top of the escarpment, the country is mostly rough and broken, but without strong relief. Streams which drain the north slope of the escarpment and the adjacent flats flow into White River. The largest of these streams have cut numerous reentrants, locally called coves, which in some cases extend as much as six miles south into the highlands. South of the escarpment the drainage is, for the most part, southward into Little Red River and its tributaries.

GEOLOGY

Stratigraphic Section of the Black Marble Region

The formations which outcrop in the black marble region are all sedimentary deposits of Carboniferous age, belonging to both the Mississippian and Pennsylvanian series. The Mississippian is represented by sandstone, shale, and limestone, and the Pennsylvanian mainly by sandstone and shale. The black marble is obtained only from two formations belonging to the Mississippian, the Fayetteville and Pitkin formations which, because of topographic irregularities, have outcrop lengths of from 200 to 225 miles in the linear distance of 68 miles between Oil Trough and Marshall. (See Pl. I.) The formations which outcrop in the black marble region are shown in the order of their relative ages in Figure 1, and are briefly described in the geologic column given below. Descriptions of the other formations in the area, in addition to those in the geologic column, are given by Croneis 3/.

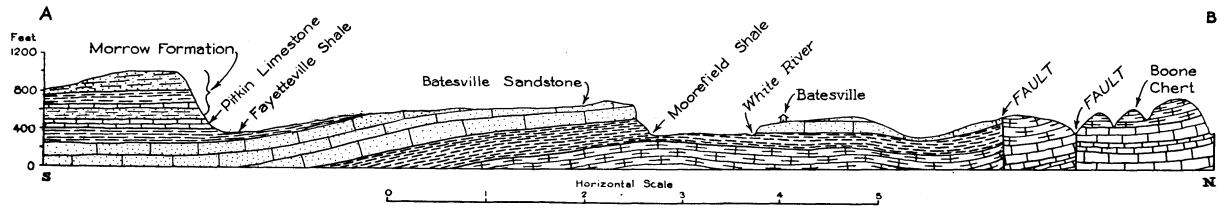


Figure 1. - North-south section through Batesville, Arkansas, showing the structure and formations of the black marble area. (After Purdue.) Note: Morrow formation is now usually referred to as Morrow group. The Atoka may occupy a portion of the upper part of the formation.

Geologic Formations Present in the Black Marble Region

System	Series	Formation	Thickness in feet	Description	Character of Outcrop and Distribution
CARBONIFEROUS	Pennsylvanian	Basal Atoka (Winslow formation)		Thick-bedded, brownish-gray, medium-grained sandstone, grading upward to thin-bedded sandstones and shales that constitute the major portion of the Atoka. Thickness varies because of ersion on crest of escarpment.	Forms bluffs from 30 to 40 feet high marking the upper rim of the Boston Mountain escarpment.
		- - - - - -	- - - - - -	- - - - - UNCONFORMITY - - - - - -	- - - - - - - - - - - -
		Hale formation and Bloyd shale undifferentiated*	30-200	Dominantly shale in area being described. At places contains limestone lentils and calcareous layers.	Forms steep slopes between upper limestone of Pitkin formation and the overlying Atoka sandstone.
		- - - - - -	- - - - - -	- - - - - UNCONFORMITY - - - - - -	- - - - - - - - - - - -
	Miss.	Pitkin	225-300	Consists of relatively thick limestone beds separated by beds of shale from a fraction of an inch to 30 feet thick. Limestone varies in color from light-gray to dark-gray and	Limestone forms precipitous bluffs and shale steep slopes along north slope of Boston Mountain escarpment.

3/ Croneis, Carey, The geology of the Arkansas Paleozoic area: Arkansas Geol. Survey Bull. 3, pp. 51-91, 1930.

Geologic Formations Present in the Black Marble Region (cont.)

System	Series	Formation	Thickness in feet	Description	Character of Outcrop and Distribution
CARBONIFEROUS	Mississippian	Pitkin (cont.)		black. Texture finely crystalline to coarsely crystalline. Fossils abundant in almost all beds. Characteristic fossil screwlike bryozoan (Archimedes). Oolitic limestone occurs near base in Denton & Waldo quarry at Leslie.	
				-UNCONFORMITY ?	
		Fayetteville	200-350	Black fissile shale. Contains from one to two zones of black limestone in the upper portion varying from 4 feet to a maximum of 140 feet south of Marshall.	Outcrops along the base and lower slope of the Boston Mountain escarpment, forming low, rounded hills, spurs and shale benches.
		Batesville sandstone	50-225	Medium-grained, buff to brown and gray sandstone. When freshly exposed in cuts appears to be thick-bedded. On weathered surface is flaggy and thin-bedded.	Forms comparatively broad sandstone flats extending north from the base of the Boston Mountain escarpment.
		Moorefield shale	30-300	Black fissile shale closely resembling the Fayetteville shale. Dark-gray, sandy limestone occurs in the middle portion of the formation. Also contains thin beds of sandstone.	Outcrop area is generally narrow and occurs in stream valleys cut through the Batesville sandstone north of the base of the Boston Mountain escarpment.

* Dr. Croneis 4/ states, in regard to the Hale formation: "Near Jamestown ..... the beds are at least 200 feet thick, but it is not known whether all the beds exposed at that place belong to the Hale or whether some of them belong to the overlying Bloyd formation. Most of these beds in the Batesville district, however, belong to the Hale formation." In a communication dated September 12, 1932, Dr. Croneis indicates that this latter statement may be subject to revision after detailed stratigraphic and paleontologic studies have been made of the region. Mr. Parks is inclined to believe that the Hale formation is absent in the black marble region but that the Bloyd is present. Because these formations have not been identified with certainty, the above method of tabulation has been used.

Structure

The sedimentary beds of the black marble area lie upon the southern flank of the Ozark Uplift and have a regional dip of approximately three degrees to the southwest. Local variations in the regional dip are produced by a few minor folds with dips of from one to nine degrees, and by normal faults with displacements seldom exceeding 100 feet. One normal fault of unusual length (the Jamestown fault) strikes northwest from the southeast corner of T. 12 N., R. 6 W., to the southwest corner of T. 13 N., R. 7 W. This fault has not been mapped in detail but it may have a displacement exceeding 100 feet.

4/ Croneis, Carey, Op. cit., p. 77

The formations of the black marble region all become lower in elevation from west to east. The elevation of the Fayetteville formation decreases toward the east from approximately 1,400 feet above sea level south of Marshall, Searcy County, to 400 feet in the southeast corner of T. 12 N., R. 5 W., in Independence County. This is a difference in elevation of 1,000 feet over a distance of 68 miles, or an average southeastward slope of from 14 to 16 feet per mile between the above-mentioned points. This may be taken as representative of the eastward slope of all of the formations of the area. The decrease in elevation may be due either to the small normal faults of the region which, in the aggregate, can produce a total downthrow of approximately 1,000 feet, or erosion may have exposed the formations at points progressively farther down the dip, and hence at lower elevations, to the east.

Occurrence and Description of Black Marble

The black marble of Arkansas is called marble in a commercial sense only. The various beds of dark limestone from which the black marble is obtained have not suffered the pressure or heat effects which eliminate pore space and water and produce the coarse crystallization of true marble. It is the commercial practice, however, to apply the name marble to all limestones which take a high polish. It is in this sense that the term is used in this report.

As previously stated, the source of the Arkansas black marble is the dark-gray limestone of the Fayetteville and Pitkin formations. These formations and the marbles occurring in them are described below.

Fayetteville Formation

General Description

The Fayetteville formation in the region described in this report is a black, fissile shale containing, in its upper portion, beds of dark, slightly bituminous limestone interbedded with the shale. The formation is commonly about 200 feet thick but, south of Marshall, it attains a maximum thickness, in the area described, of 350 feet. This formation is well exposed on the steep slopes and benches at the base of the Boston Mountain escarpment and on the outlying hills. Recent road construction in the region, and the still more recent search for quarry sites in the upper portion of the formation, have exposed sections which otherwise could not have been observed.

The Fayetteville conformably overlies the Batesville sandstone and is itself overlain by the Pitkin formation. The Pitkin apparently rests disconformably upon the Fayetteville in northwestern Arkansas, but no evidence of this relation between the two formations was noted in the black marble region. The Fayetteville formation can be distinguished in the field from the Moorefield shale, which it closely resembles, by its occurrence at higher relative elevations. The Fayetteville also occurs on the steep slopes of the Boston Mountain escarpment whereas the Moorefield shale outcrops below this escarpment. The Batesville sandstone separates the Fayetteville from the Moorefield formation.

Occurrence of Black Marble

The black marble of the Fayetteville formation is obtained from dark limestones interbedded with the shale in the upper portion of the formation. The maximum thickness of the dark limestone horizon noted was in a road cut on U. S. Highway 65 south of Marshall. The Fayetteville formation there has a thickness of 350 feet and the upper 140 feet (the upper one-third of the formation) contains the limestones. South of Mountain View the Fayetteville formation has a thickness of 170 feet, of which only the upper 25 feet contains dark limestone. At this place, the limestone horizon occupies the upper one-seventh of the formation. Other comparative thicknesses between the calcareous portion of the formation and the underlying shale have not been obtained. It is believed, however, that the maximum thickness of the zone in which

the dark limestone occurs will range between one-third and one-half of the total thickness of the formation. The limits of the proportion of limestone to shale in the limestone-bearing horizons have not been estimated.

The individual limestone beds range in thickness from two inches to four feet. This greater thickness, however, is exceptional and the usual thickness of the individual beds is from two to 18 inches. Gradations from the shale through shaly limestone to the more massive and purer limestone are often noted. Some of the shale beds separating the limestone are from one-half to one inch thick, others are from three to 12 inches thick, and still others are from 20 to 60 inches thick. Occasionally, thicknesses of from four to 30 feet of shale have been observed between two dark limestone members. It is the general rule that the greater the number and thickness of limestone beds, the thinner the separating shale beds.

The limestone occurs in discontinuous beds which may have a rather limited lateral extent. This conclusion is based on the fact that there is a wide range in the thicknesses of the limestone in various sections examined, and also from the variation of the proportion of limestone to shale in these sections. Thus, a section at the same relative position in the formation as another several hundred feet distant may contain not only thinner limestone beds, but also only half, or even a lesser proportion, of limestone to shale.

Outcrop Description of Black Marble

The limestones of the Fayetteville formation have a color range through various shades of gray and brownish-gray to shades bordering on true black. When exposed to the weather in outcrop, or as talus, the surface of these dark limestones changes to a light gray or light brownish-gray color. The thickness of this weathered surface is usually one-eighth to one-thirty-second of an inch, but it occasionally exceeds this. Organic material is reported in chemical analyses of the limestone and crude petroleum has been found in small cavities in the rock. Freshly broken fragments have a characteristic fetid, bituminous odor. It is therefore assumed that the dark color of the limestone is due to the presence of bituminous material.

The limestone beds range in texture from coarsely crystalline to fine-grained. The coarsely crystalline phases appear to be made up largely of fossil fragments but fossils are rare in the very fine-grained phases. The purity of the limestones cannot be determined by appearance alone, and this is especially the case in the very fine-grained varieties. Gradations can sometimes be traced from shale through shaly limestone to the fine-grained phases of the limestone. With the more coarsely crystalline phases, however, there appears to be little, or no, gradation into shale. It therefore appears that the fine-grained phases contain more shaly or clay mineral impurities than do the more coarsely crystalline phases. Small cubes of pyrite are sometimes seen in the limestone. Occasionally fossils are completely replaced by pyrite.

Jointing in the limestone of the Fayetteville formation varies. Joints may be abundant locally, not only in sets at right angles to each other, but also in sets at angles to these, whereas elsewhere only the two sets at right angles to each other may be present, and these may be more widely spaced. Some joints are open, others from extreme thinness to more than one-eighth of an inch in width are filled with calcite, and still others are incipient or closed, and are not noticeable until an attempt is made to quarry the limestone.

Pitkin Formation

General Description

The Pitkin is a thick-bedded, fossiliferous limestone containing some interbedded shale in both its lower and upper portions. The formation is the youngest member of the Mississippian series in northern Arkansas and has a maximum thickness of 300 feet

in the Boston Mountain escarpment south of Locust Grove, Independence County. South of Mountain View, Stone County, the thickness is 270 feet. The average thickness for the region under discussion, however, is probably between 225 and 275 feet. The Pitkin rests with apparent conformity upon the Fayetteville formation, but it may be separated by a disconformity from the overlying Pennsylvanian series. Outcrops of the Pitkin occur commonly as precipitous faces or on steep slopes above the relatively more gentle slopes formed by the underlying Fayetteville formation.

Occurrence of Black Marble

The dark-gray to black limestones (black marble) of the Pitkin occur throughout the formation but there is one main horizon of occurrence. This is in the basal 30 to 40 feet of the formation. On Brock Mountain, south of Locust Grove, a black marble horizon occurs in the upper 40 feet of the formation but this may be only a local occurrence. In addition to the dark-gray limestones, the formation contains limestones of lighter shades of gray and brown. Most of the limestones occur in massive beds from 18 inches to four feet in thickness, but both thicker and thinner beds occur at some points. Black fissile shale is interbedded with the limestone in subordinate amounts. This shale, like the limestones of the Fayetteville formation, occurs in discontinuous beds. At one exposure, several shale beds, from a fraction of an inch to a few feet thick, may be found separating limestone members, whereas at a second exposure, one-fourth to one mile distant, the shale may occur in beds from 10 to 30 feet thick. In addition, the number of shale beds, whether thick or thin, is not the same in different exposures and does not occur at the same horizons at different points.

Outcrop Description of Black Marble

The colors of the limestones of the Pitkin formation range from light-gray, through dark-grays and browns, to nearly black. Weathered surfaces are usually a lighter gray or brown than the fresh rock. The film of weathered material is usually from one-eighth to one-thirty-second of an inch thick beneath which fresh, unaltered rock occurs. Analyses show that the Pitkin limestones contain organic material and freshly broken fragments have a fetid, bituminous odor. The dark color of these limestones, like the Fayetteville formation, is ascribed to the bituminous material that they contain.

There is considerable variation in the character of the rock of the Pitkin formation. Beds range from fine to coarsely crystalline, and from shale through sandy limestone to limestone of high purity. As compared to the Fayetteville formation, the limestones of the Pitkin are the more coarsely crystalline. Practically all of the beds contain some fragments of fossils and many appear to be made up almost entirely of organic remains. The screwlike bryozoan (Archimedes) is almost invariably found in the limestone and is its most characteristic fossil. There are a few very dark colored beds which are fine-grained and even-textured, but these are not as common as in the Fayetteville. Occasionally thin-bedded phases of the limestones are quite sandy and, in the Denton & Waldo quarry at Leslie, two brownish-gray beds near the base of the formation are oolitic. No gradation from shale to limestone has been noted in the Pitkin formation but calcareous shales are known which may represent such gradations. Pyrite occasionally is found as minute cubes or completely replacing fossils.

The massive limestones of the Pitkin formation are usually not as highly jointed as the thin-bedded limestones of the Fayetteville formation. Two sets of joints approximately at right angles to each other are common and sometimes other sets occur at angles to these. Some of the joints are open, others are closed and not apparent in the rock until quarried, and still others are filled with calcite.

CHARACTERISTICS OF THE BLACK MARBLE

Fayetteville Formation

Character of Polished Stone

The limestone of the Fayetteville formation desired for use as black marble is the darkest, fine-grained, uniformly-textured type of limestone. When polished, this type of limestone produces a marble having a surface of uniform color, unmarred by flashing or off-color crystal faces, and a shade which is classed commercially as jet black. This black marble cannot be differentiated from the imported "Belgian Black" marble and the name "Arkansas Black" has been assigned to marbles of this type from the Arkansas region. The lighter shades of gray limestone often have a brownish cast on a polished surface and some of the dark limestones, when polished, have a spotty or streaked appearance which is unnoticeable before the rock is polished. Usually, when slabs are cut from the limestone blocks parallel to the bedding planes and polished on this surface, brownish streaks do not appear.

Chemical Characteristics

Analyses of five samples of limestone (black marble) from the Fayetteville formation, are given in Table 1.

Table 1. - Chemical Analyses of Black Marble from the Fayetteville Formation

W. F. Manglesdorf, Analyst

December 3, 1930

	1	2	3	4	5	Average
Silica (SiO_2)	14.38	21.95	14.30	11.86	14.16	15.33
Alumina (Al_2O_3)	2.55	2.02	1.45	0.98	2.25	2.05
Iron oxide (Fe_2O_3)	0.76	1.20	0.96	1.12	1.44	1.09
Manganese oxide (MnO)	0.15	0.20	1.24	0.10	0.22	0.18
Calcium oxide (CaO)	44.02	37.70	44.10	45.96	43.78	43.11
Magnesium oxide (MgO)	1.01	1.95	0.97	0.73	0.97	1.13
Phosphate as P_2O_5	0.09	0.10	0.12	0.08	0.21	0.12
Sulphur (S)	0.18	0.33	0.18	0.04	0.24	0.19
Loss on ignition	36.68	34.15	36.75	37.40	36.36	36.27
	99.82	99.60	99.07	99.27	99.63	99.47
As calcium carbonate	78.56	67.44	78.71	82.03	78.14	76.98
As magnesium carbonate	2.12	4.09	2.02	1.53	2.02	2.35

All samples show small amounts of organic matter.

1. From quarry in Fayetteville formation on Stone Creek in SW.¼ NW.¼ sec. 17, T. 12 N., R. 5 W.
2. From quarry in Fayetteville formation at northeast corner NW.¼ NW.¼ sec. 10, T. 12 N., R. 7 W.
3. From quarry in Fayetteville formation on Swaim lease, E.½ SW.¼ sec. 22, T. 13 N., R. 7 W.
4. From quarry in Fayetteville formation on Joe Bell property, NW.¼ NW.¼ sec. 6, T. 14 N., R. 11 W.
5. From quarry in Fayetteville formation on Clemens property, NW.¼ sec. 22, T. 14 N., R. 15 W.

In each of the above analyses the calcium oxide and magnesium oxide have been recalculated into terms of calcium carbonate and magnesium carbonate. The small percentages of magnesium carbonate indicate that the limestones are not dolomitic. The range in silica content (from 11.86 to 21.95 per cent) and calcium oxide content (from 37.70 to 45.96 per cent) indicates that the limestones are impure and somewhat siliceous. It is probable that the alumina is combined with some of the silica and forms clay minerals, and that the remainder of the silica is present as fine quartz sand or chert. As would be expected, those analyses showing the highest silica content have the lowest calcium carbonate content. The variation in magnesium carbonate content, however, appears to have no definite relation to any one of the other constituents. Sulphur combined with iron forms the detrimental iron sulphide, pyrite. If, however, the small percentage of sulphur shown in the analyses were combined with iron, only very small amounts of pyrite can be present.

Small amounts of organic matter, probably bituminous material, are reported in all analyses and probably cause the dark color of the fresh and polished rock.

Physical Characteristics

Three sets of physical tests (see footnotes a, b, and c) have been made upon selected blocks of "Arkansas Black" marble from the Fayetteville formation. The results of these tests are given in Tables 2 and 3, and one is shown graphically in Plate II. All specimens were supplied by the Batesville Black Marble Company. Specimens 1 and 2 came from the quarry on the Williams lease in the SW.¼ SE.¼ sec. 8, T. 12 N., R. 6 W. The location from which specimen 3 was obtained is unknown.

Table 2. - Strength Tests "Arkansas Black" Marble

Spec. No.	Size of block	Modulus of Elasticity* (lbs. per sq. in.) 0-3100	3100-8000	8000-up	Ultimate strength (lbs.per sq.in.)	Size of block	Modulus of rupture** (Beam method) (lbs. per sq. in.)
a/ 1	6"x6"x6"	5,050,000	6,600,000	5,930,000	20,500	a/4"x5"x18"	1980
a/ 2	6"x6"x6"	5,830,000	6,900,000	-	19,380	-	-
c/ 3	3.35" x 2.99" x 0.57"	-	-	-	15,580	c/5.75" x 2.03" x 0.756"	5910

* The modulus of elasticity is the force required to deform a unit mass a unit distance. It is sometimes defined as that force required to stretch a rod one square inch in section to double its length.

** The modulus of rupture is the tension in pounds per square inch causing rupture. In case of a beam supported at both ends with the force applied to the center, the unit-rupturing force would be measured in the outermost part of the side opposite to that on which the force is applied.

Table 3. - Durability Tests "Arkansas Black" Marble

Spec. No.	Specific gravity	Absorption (per cent)	Weight of stone (per cubic foot)	Heat effect	Effect of alternate freezing and thawing
b/ 1 & 2	2.671	0.8	166.6 lbs.	1800° F. for 3 hours produced complete disintegration.	5 alternations produced loss of 0.8 per cent in weight.
c/ 3	-	0.24	-	-	-

a/ Tests made for the Arkansas Geological Survey by Rex L. Brown, Urbana, Illinois, March 11, 1932. The description of these tests follows:

> "Two 6-inch cubes were received. These cubes were numbered 1 and 2 respectively. A 3,000,000 pound Southwark Emery hydraulic testing machine was used. The 1,000,000 pound gage was used throughout the test. The extensometer was of the usual averaging type with a gage length of 4 inches, using an Ames dial, reading directly to 0.0001 inch. Sheet aluminum 0.01 inch thick was placed between the specimen and the heads of the machine to distribute the load of the specimen. A spherical bearing block, which is a part of the machine, was used.
>
> "In testing, the machine was turned on and, at uniform increments of strain, the load on the machine was read. The increment of strain used on specimen No. 2 was 0.000025, and on specimen 1 was 0.000062 inch per inch. The application of load was continuous through the strain measuring part of the test. The rate of application of load was such that readings of strain and load could be observed and recorded. The load on the specimen was increased at a rate of about 50,000 pounds per minute. When the load on the specimen reached a point where it seemed unwise to continue the reading further, the machine was stopped and the extensometer removed. This was done without disturbing the specimen. The specimen was then loaded to failure at a faster rate of application of load."

The plotted data are shown in Plate II.

b/ Tests made by the Engineering Department of the University of Arkansas, Fayetteville, Arkansas, under the direction of Professor W. R. Spencer, were reported in a communication dated March 31, 1932. In the modulus of rupture test, the span between supports was 16 inches in length.

c/ Tests made by Van Trump Testing Laboratory, Little Rock, Arkansas, August 3, 1932. Notes on the tests were as follows:

> "Samples, as received in the laboratory, were polished on one face....Two specimens of the "Arkansas Black"....were tested and the results obtained above are the average of the two tests..... Compressive pressures were applied on the bed; that is, on the smallest dimension of the block.
>
> "Modulus of Rupture - $\frac{1.5 \times \text{Rupt. Load} \times \text{Span}}{\text{Width} \times (\text{Thickness})^2}$
>
> "The absorption test was made as follows: Tests were made by first drying samples to constant weight at 220° F., then placing them in distilled water at room temperature, bringing the water to a boil and then boiling specimen for five hours. Specimens were allowed to cool in the water, dried quickly with a towel and weighed. After absorption tests, none of the specimens showed signs of deterioration."

In general, the results of the above laboratory tests, although not complete in every detail, show that the strength of the Fayetteville black marble is greater than the average strength of marble and is far in excess of most demands made upon a stone for interior trim. The fact that no acid tests have been made makes it impossible to predict the permanency of color or the durability of the polished black marble when exposed to the weather over a long period of years. For most interior trim, where wet gasses are not usually present, the color will probably be permanent.

Pitkin Formation

Character of Polished Stone

The limestones of the Pitkin formation yield several varieties of gray and black marble, but no marble with a fineness of texture or an evenness of color comparable to that obtained from the Fayetteville has yet been produced, although it is probable that the fine-grained black limestone will produce a black marble of the type termed "Arkansas Black." One black, finely-crystalline marble occurs, however, which has a very pleasing appearance, although containing a few scattered fragments of fossils. In addition to this, several shades of gray marble are produced which have textures of varying coarseness. The coarsely-crystalline gray marbles from this formation, which are being utilized, closely resemble the marbles marketed under the trade names of "York Fossil" and "French Gray." Marbles of this character are herein termed "Arkansas Fossil." Some of the gray marbles have a splotchy appearance, due to uneven coloring and texture, some have whorls of either light or dark material in a contrasting background, and some are of a uniform texture and shade except for an occasional coarse calcite crystal representing a fragment of a fossil. The Pitkin black marble, closely resembling "Arkansas Black," is reported to be more difficult to polish than "Arkansas Black" but, when polished, it has a higher gloss than the Fayetteville stone.

Chemical Characteristics

Analyses of five samples of limestone (black marble) from the Pitkin formation, are given in Table 4.

Table 4. - Chemical Analyses of Black Marble from the Pitkin Formation

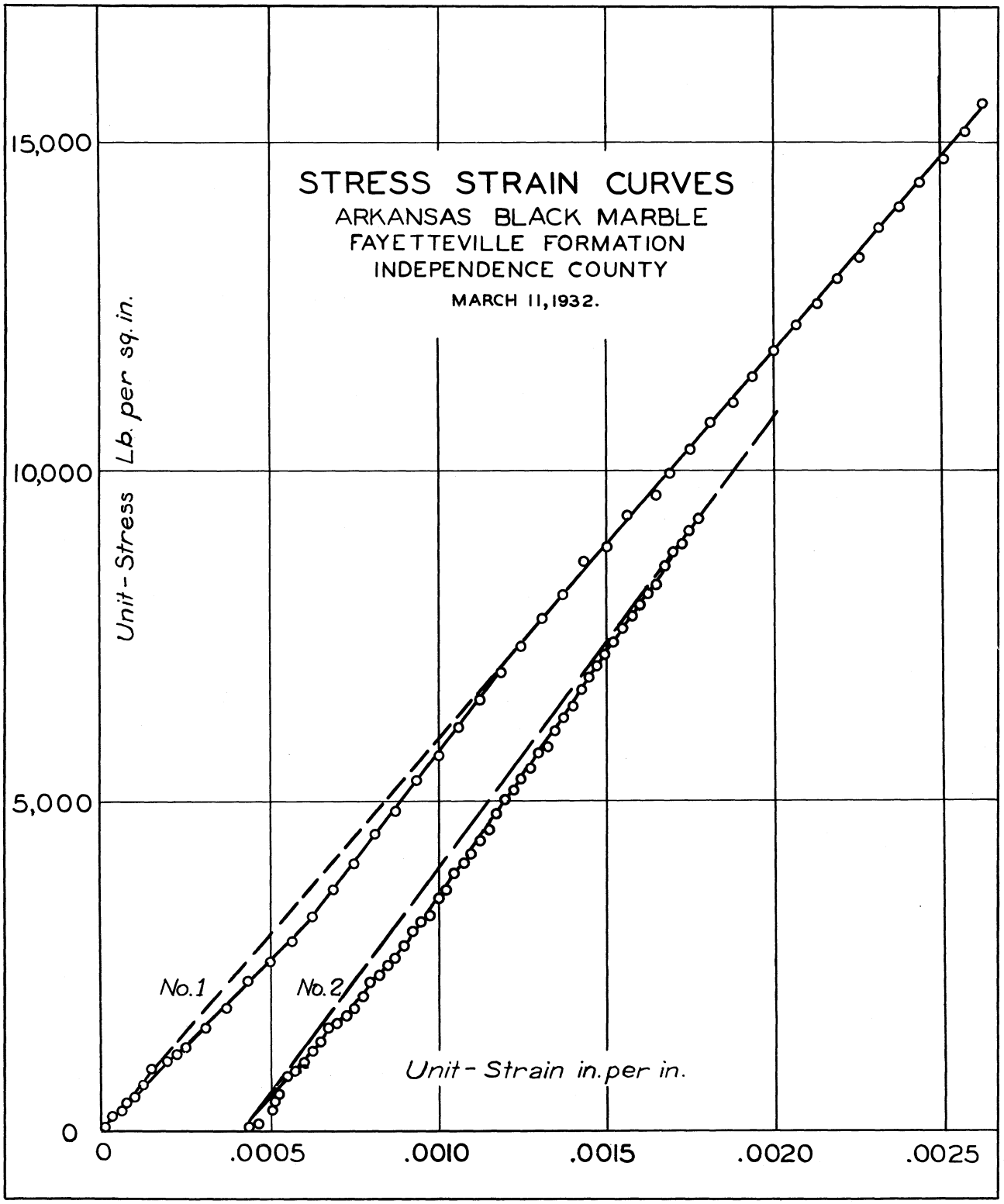
W. F. Manglesdorf, Analyst

July 8, 1932

	1	2	3	4	5	Average
Silica (SiO_2)	3.32	9.05	2.88	3.14	10.96	5.87
Alumina (Al_2O_3)	0.60	0.30	0.34	0.50	0.35	0.42
Iron oxide (Fe_2O_3)	0.86	0.88	1.12	0.80	1.60	1.05
Manganese oxide (MnO)	0.24	0.39	0.21	0.24	0.85	0.39
Calcium oxide (CaO)	51.02	48.30	52.00	52.02	43.88	49.44
Magnesium oxide (MgO)	1.63	1.19	0.90	0.94	2.92	1.52
Phosphate as P_2O_5	0.07	0.47	0.51	0.43	0.06	0.31
Sulphur (S)	0.19	0.21	0.16	0.13	0.28	0.19
Loss on ignition	42.02	39.00	41.60	41.90	39.05	40.71
	99.95	99.79	99.72	99.90	99.95	99.90
As calcium carbonate	91.06	86.20	92.80	92.84	78.31	88.24
As magnesium carbonate	3.42	2.50	2.18	1.97	6.11	3.24

A small amount of organic matter was reported in Analysis 1.

1. From upper black limestone in Pitkin formation on Brock Mountain, one-half mile southwest of Locust Grove, in sec. 33, T. 13 N., R. 7 W.
2. Black limestone from basal 30 to 40 feet of Pitkin formation exposed along State Highway 11, one mile south of Caney Creek, in NW.¼ NE.¼ sec. 23, T. 12 N., R. 6 W.
3. Black limestone from basal part of Pitkin formation exposed along State Highway 25, one mile southwest of Locust Grove, in SE.¼ NE.¼ sec. 32, T. 13 N., R. 7 W.
4. Black limestone from basal part of Pitkin formation exposed along State Highway



STRESS STRAIN CURVES OF ARKANSAS BLACK MARBLE FROM THE FAYETTEVILLE FORMATION, INDEPENDENCE COUNTY.

25, one mile southwest of Locust Grove, in NE.¼ SE.¼ sec. 32, T. 13 N., R. 7 W.
5. Black limestone from basal part of Pitkin formation in Denton & Waldo quarry, one-fourth of a mile east of Leslie, in SW.¼ NW.¼ sec. 26, T. 14 N., R. 15 W.

The above analyses show that the Pitkin limestone from which black marble is obtained is low in silica and high in calcium carbonate. Alumina and iron are also low. The conclusion to be drawn from these analyses is that the limestones are relatively pure and contain very small amounts of clay and siliceous impurities. Specimen 5 is an exception to this and more closely resembles the less pure Fayetteville stone in composition.

Very small percentages of sulphur are present and, if these were combined with iron to form iron sulphide, or pyrite, this mineral would be present in the rock in negligible amounts. A small amount of organic material, which probably causes the dark color of the rock, is reported in one of the analyses.

Physical Characteristics

No physical tests have been made upon the fine-grained black marble from the Pitkin formation but one set of physical tests has been made upon selected blocks of the coarsely-crystalline dark marble, called "Arkansas Fossil." These tests are set forth in the following table:

Table 5. - Strength and Durability Tests "Arkansas Fossil" Marble

Location	Size of block	Ultimate strength (lbs.per sq.in.)	Size of block	Modulus of rupture (lbs. per sq. in.)	Absorption
1/Denton & Waldo quarry SW NW sec.26-14N-15W	3.31" x 2.89" x 0.531"	14,286	3.25" x 1.98" x 0.551	1760	0.52 per cent

1/ Tests made by Van Trump Testing Laboratory, Little Rock, Arkansas. (See footnote c, Tables 2 and 3.)

Because only the one set of tests has been made upon the Pitkin limestone, it is inadvisable to draw any conclusions as to the strength and durability of the stone. It appears from the strength tests, however, that the strength of the stone is adequate and compares favorably with that of other marbles.

COMPARISON OF MARBLES FROM THE FAYETTEVILLE AND PITKIN FORMATIONS

Large quantities of fine-grained, even-textured black marble occur in both the Fayetteville and Pitkin formations and, to all appearances, the black marble from one formation is like that from the other. In the present early period of development of the black marble industry, black marble is being quarried only from the Fayetteville formation. This type of stone, termed "Arkansas Black," is of uniform shade and is non-granular and non-crystalline when polished. In all probability, the darkest black marble from the Pitkin formation would produce a stone which could not be distinguished from that now produced from the Fayetteville. In addition to the black marble, the Pitkin formation contains large quantities of grayish and brownish, coarsely-crystalline marbles. Several varieties of dark-gray, coarsely-crystalline marbles are being produced, some of uniform shade and texture, and others having mottled or whorled effects, due to uneven shade and texture. These coarsely-textured gray marbles, at present grouped under the one trade name "Arkansas Fossil," take a brighter polish than the fine-grained "Arkansas Black" marbles.

It appears that the size of the blocks which can be obtained from the Fayetteville formation will average smaller than those from the Pitkin formation. Blocks of thickness adequate for commercial use can be obtained from either formation, but the thin-bedded Fayetteville is more highly jointed than the more massive-bedded Pitkin formation. Consequently, it is more difficult to obtain large blocks from the Fayetteville than from the Pitkin.

Chemical analyses show that the black marbles from the Fayetteville formation contain greater percentages of silica and alumina and smaller percentages of calcium carbonate than the black marbles from the Pitkin formation. In other words, the black marbles from the Fayetteville formation contain more clay and siliceous impurities than those from the Pitkin formation. None of the marbles analyzed is dolomitic and the small amounts of sulphur present indicate that only negligible amounts of detrimental iron sulphide can be present in the specimens analyzed. The marbles from both formations owe their dark color to the organic material present.

Little comparison can be made between the physical characteristics of the black marbles from the two formations because tests in both cases are incomplete, and only one set of samples from the Pitkin has been tested, as compared to three sets from the Fayetteville formation. The material at hand, however, would indicate that the Pitkin marble has less compressive strength on the bedding and also a lower modulus of rupture than the marble from the Fayetteville formation.

COMPARISON OF ARKANSAS BLACK AND ARKANSAS FOSSIL MARBLES WITH COMPETITIVE MARBLES

As mentioned previously, the appearance of the black marble from the Fayetteville formation, termed "Arkansas Black," differs in no respect from the imported "Belgian Black" marble. Likewise, the marbles being produced from the Pitkin formation, termed "Arkansas Fossil," closely resemble the dark marbles known under the trade names of "French Gray" and "York Fossil." Comparative physical tests have been made by the Van Trump Testing Laboratory, Little Rock, Arkansas, upon specimens obtained from commercial blocks of "Belgian Black" and "Arkansas Black," and "York Fossil" and "Arkansas Fossil" marbles. The blocks from which samples of "Belgian Black" and "Arkansas Black" were obtained were both of No. 2 grade, and those from which the "York Fossil" and "Arkansas Fossil" were obtained were unclassified as to grade. (See footnote c, Tables 2 and 3.) The tests on these blocks are tabulated below:

Table 6. - Compressive Strength Tests

Name of marble	Length (inches)	Width (inches)	Thickness (inches)	Total load (pounds)	Pounds per square inch
"Belgian Black"	3.31	2.04	0.579	33,000	17,223
"Arkansas Black"	3.35	2.99	0.570	29,750	15,580
"York Fossil"	6.03	2.06	0.512	42,000	13,605
"Arkansas Fossil"	3.31	2.89	0.531	25,000	14,286

(One specimen each of "Belgian Black" and "York Fossil" were tested. Two specimens of the "Arkansas Black" and "Arkansas Fossil" were tested and the results reported are the average of the two tests.)

Table 7. - Flexure Tests

Name of marble	Rupt. load (pounds)	Span (inches)	Width (inches)	Thickness (inches)	Modulus of rupture
"Belgian Black"	355	5.75	2.02	0.583	5670
"Arkansas Black"	625	5.75	2.03	0.756	5910
"York Fossil"	210	5.75	2.04	0.527	4070
"Arkansas Fossil"	170	3.25	1.98	0.551	1760

Table 8. - Absorption Tests

Name of marble	Absorption (per cent)
"Belgian Black"	Trace
"Arkansas Black"	0.24
"York Fossil"	Trace
"Arkansas Fossil"	0.52

The above tests, although incomplete in several details, indicate that the physical characters of the "Belgian Black" and "Arkansas Black" marbles, as well as the appearance, are approximately the same. Both the "Belgian Black" and the "Arkansas Black" have much higher compressive and flexural strengths than either the "York Fossil" or the "Arkansas Fossil." In comparing the "York Fossil" and "Arkansas Fossil" marbles, it will be noted that their compressive strengths are approximately the same, but that the "Arkansas Fossil" is only 40 per cent as strong as the "York Fossil" in the flexure tests.

COMMERCIAL USE

The Arkansas black marble is used mainly as an interior trim in buildings where a black stone is desired. The unfinished stone is also crushed for terrazzo. Physical tests of the marble indicate that it has strength and durability far in excess of commercial requirements, both as a trim and as terrazzo. According to the Batesville Black Marble Company, the following is a partial list of public buildings in which Arkansas black marble has been used: Waldorf-Astoria Hotel, New York City; Drake Hotel, St. Paul, Minnesota; Court House, Lincoln, Nebraska; Ben McGehee Hotel, Little Rock, Arkansas; Arkadelphia High School, Arkadelphia, Arkansas; and Barnett Hotel, Batesville, Arkansas. Several car loads of marble have been shipped to dealers in Oklahoma City and some shipments have been made to Kansas City.

Arkansas black marble has been specified for use in the following public buildings: Post Office Building, Fort Worth, Texas; Federal Building, Little Rock, Arkansas; Federal Building, Texarkana, Arkansas-Texas; Post Office Building, Kansas City, Missouri; Post Office Building, Baton Rouge, Louisiana; and Army and Navy Hospital, Hot Springs, Arkansas.

AVAILABLE SUPPLIES

Practically unlimited amounts of black marble occur in the 200 to 225 miles of outcrop of the Fayetteville and Pitkin formations in the area included in this report. Not all of the black marble can be quarried economically, but, judging by the present consumption, it is believed that quantities sufficient to supply the entire demand of the United States for a long period of years can be economically obtained. The gray, coarsely-crystalline marbles from the Pitkin formation also occur in practically unlimited amounts and present a large potential supply of several varieties of this type of marble.

FACTORS AFFECTING QUARRYING

In quarrying the dark limestones of either the Pitkin or Fayetteville formations, the following factors should be borne in mind:

(1) A limestone, having a thickness, purity, texture and color satisfactory for use as commercial black marble, in either the Fayetteville or Pitkin formation at one location, cannot, with certainty, be expected to occur elsewhere at the same relative position in the formation. This is due to the fact that the lenticular character of the limestone beds does not permit continuity laterally for great distances.

(2) The discontinuity of the limestone, with corresponding variation in the thickness of the interbedded shale, means that, within certain restricted vertical sections of the limestone zones, there are no marker horizons within the formations which can serve to guide exploration for quarry sites. This holds especially for the upper part of the Fayetteville formation where the black marble is not in regularly continuous beds. In the Pitkin, there is one main zone of black marble occurrence (in the lower 30 to 40 feet) but black marble beds may be found elsewhere in the formation. The gray and brownish-gray, coarsely-crystalline marbles are widely distributed in the Pitkin formation, but a search for a definite type of marble might disclose the same difficulties that are presented with respect to the black marbles; that is, discontinuity and variation in texture and thickness.

(3) The size and shape of the limestone blocks which may be obtained from a quarry are controlled by the joint pattern. Hence, if there are two sets of joints present at approximately right angles to each other, and if these are widely spaced, large rectangular blocks can be obtained. On the other hand, if the two sets of joints are closely spaced so that blocks obtainable are small, or if there are other sets of joints causing irregular, many-sided, or triangular blocks to break out, merchantable rock may be difficult to obtain. Locally, in the Fayetteville formation, joints are so abundant and so closely spaced that the limestone cannot be quarried in large blocks. The same may also hold for the Pitkin but it appears that less difficulty will be experienced from joints in quarrying this formation than the Fayetteville formation. Areas where joints are abundant and closely spaced have usually been affected by local faulting or folding, and, hence, such disturbed areas should be avoided.

(4) Calcite filling in joints with a width of one-eighth of an inch, or more, is usually objectionable. The calcite forms light-colored lines which detract from the harmony of the otherwise uniformly colored stone and also represent lines of weakness along which the block may break.

(5) Pyrite in any noticeable amount is objectionable. If stone containing pyrite is used where there is an opportunity for oxidation, rusty, brown iron oxide is formed. The original pyrite crystals may become soft, brown spots or eventually cavities, marring the surface of the polished stone. In addition, streaks of iron oxide and a general brownish staining of the rock surrounding the pyrite grains may occur. Acid produced in the oxidation of the pyrite may also serve to weaken the stone.

(6) An overburden of excessive thickness will make quarrying costs high. No definition of an excessively thick overburden can be made because influencing factors will vary from place to place. In part, however, it depends upon the quantity and quality of marble which occurs beneath it.

(7) Ease of access and a short haul for the quarried blocks are usually essential in the selection of a quarry site. There is less chance for breakage of blocks in handling and production costs are lower.

DESCRIPTION OF QUARRY SITES

QUARRY 1 (Ellison Quarry)

Location: E.½ NE.¼ sec. 35, T. 12 N., R. 5 W., 3 miles southwest of Oil Trough, Independence County, on crest of hill overlooking White River bottoms.

Accessibility: The quarry is about one-third of a mile southwest of the gravel road connecting Oil Trough and Salado, but there is no road into the quarry. This quarry is about 10 miles west of the main line of the Missouri Pacific Railroad at Newport.

Formation: Fayetteville formation.

Stratigraphy: The beds exposed in the quarry and along the slope of the hill are shown in the vertical section in Figure 2. The lower limestone bed (Bed B) is dark-gray, both coarsely and finely-crystalline, and has a jagged fracture. The second bed (Bed A) is a black, finely-crystalline, even-textured limestone which occurs about 15 feet below the top of the Fayetteville formation.

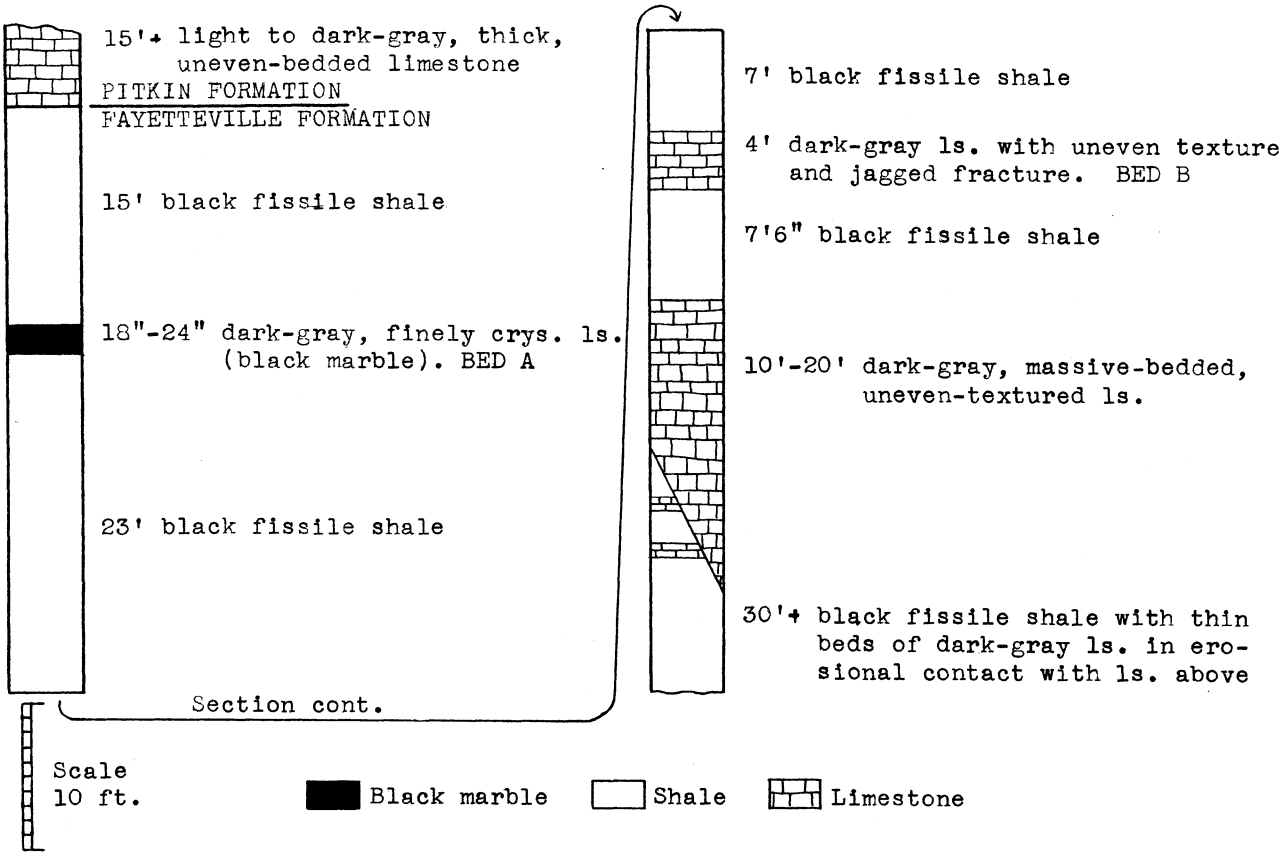


Figure 2. - Vertical section of upper part of the Fayetteville formation exposed at Quarry 1.

Structure: Horizontally bedded. Joints are present in two sets crossing at approximately right angles to each other, causing the marble to break out in almost square blocks. A small fault, having a displacement of about 24 inches, cuts through the limestone almost the length of the quarry.

Development: The quarry is 130 feet long, 30 feet wide, and 3 feet deep, and was opened in 1930 by Luther Ellison, of Oil Trough. A shale overburden of from 2 to 4 feet has been removed, exposing a bed of black limestone ranging from 18 to 24 inches thick. No marble has been shipped from this quarry and no work has been done for more than a year.

Commercial considerations: This limestone would probably make a good quality marble as polished specimens show it to be even-textured and of a uniform black color. The first black marble shipped from the district (in 1879) was obtained from near this quarry.

QUARRY 2 (Stone Creek Quarry)

Location: SW.¼ NW.¼ sec. 17, T. 12 N., R. 5 W., on Stone Creek about 2 miles southeast of Salado postoffice, Independence County, on the steep northwest slope of a hill.

Accessibility: The quarry is located on the improved Batesville-Salado-Oil Trough county road.

Formation: Fayetteville formation.

Stratigraphy: The beds exposed in the quarry are shown in the vertical section in Figure 3. The limestone in this quarry is black, finely-crystalline, and even-textured, closely resembling that described in Quarry 1.

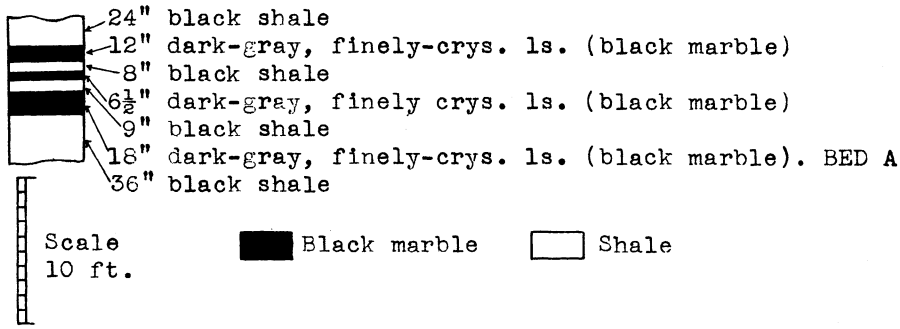


Figure 3. - Vertical section of the Fayetteville formation exposed at Quarry 2.

Structure: Strike N. 60° W., dip 7° SW. Joints occur in sets almost at right angles to each other.

Development: The quarry is 30 feet long, 20 feet wide, and 3 feet deep, and was opened in the summer of 1930 and soon after abandoned. The limestone bed (Bed A) which was uncovered is 18 inches thick. Several large blocks were loosened from this bed, the largest measuring 6 feet long, 18 inches wide, and 15 inches thick, after the shaly material was trimmed off.

Commercial considerations: The limestone would probably make a good quality black marble as it is even-textured and of a uniform color. This location does not seem to be a favorable site for a quarry because of the relatively steep dip of the beds and the proximity to faulting, which may increase the number of joints.

QUARRY 3 (Powers Creek Quarry)

Location:	SE.¼ sec. 35, T. 12 N., R. 6 W., on east side of highway south of Powers Creek and on south slope of hill.
Accessibility:	Quarry is on State Highway 11 about 4 miles south of Caney Creek.
Formation:	Pitkin limestone.
Stratigraphy:	Massive limestones and interbedded shale are exposed on the hillside and in two quarry openings. The upper quarry is in the top part of the formation and the lower quarry is near the base. A bed of hard, dark-gray to black limestone occurs a few feet above the lower quarry site.
Structure:	No structural details noted.
Development:	Both quarries were opened to supply road surfacing material.
Commercial considerations:	No attempt has been made to utilize any of the stone for black marble purposes.

QUARRY 4 (McHue Quarry)

Location:	SE.¼ SE.¼ sec. 8, T. 12 N., R. 6 W., about one mile south of McHue postoffice, Independence County, on a low hill near the head of a small valley.
Accessibility:	The quarry is two miles from State Highway 11 and can be reached by following a county road for 1½ miles and an unimproved road for one-half of a mile.
Formation:	Fayetteville formation.
Stratigraphy:	The exposed beds of black limestone are shown in the vertical section in Figure 4. The limestone (Bed A) is even-textured.

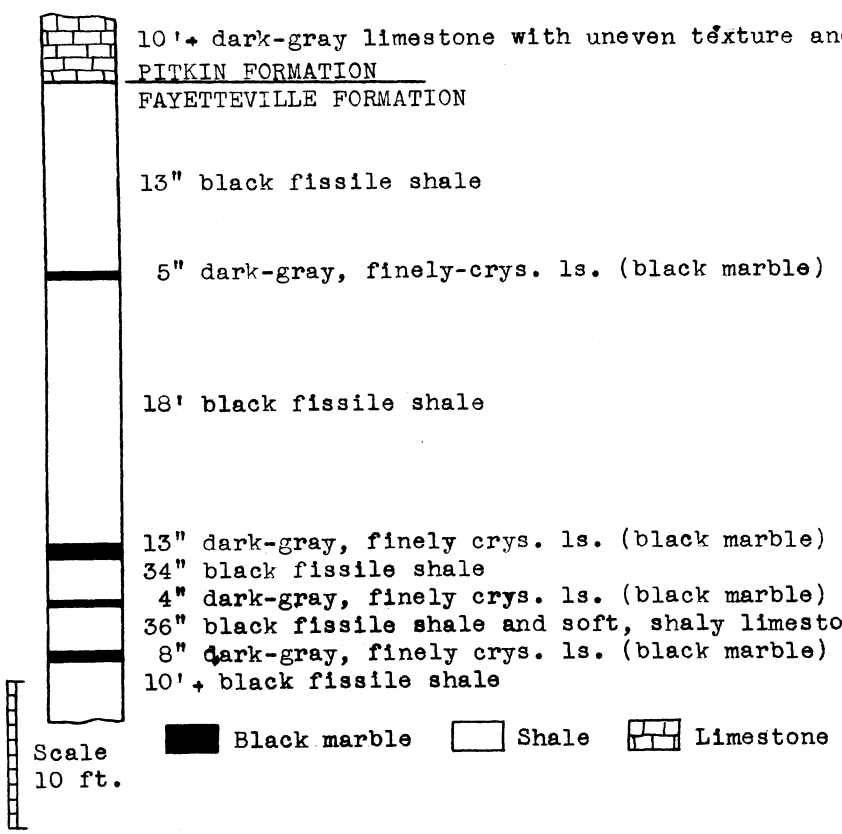


Figure 4. - Vertical section of upper part of the Fayetteville formation exposed at Quarry 4.

A. View of Batesville Black Marble Company's quarry, in the Fayetteville formation, one mile south of McHue, in the SE. ¼ SE. ¼ sec. 8, T. 12 N., R. 6 W.

B. A block of black marble, 10'x4' x8", from the Fayetteville formation, ready for shipment at the Batesville Black Marble Company's yard, Batesville.

C. Blocks of black marble from the Fayetteville formation, at the Batesville Black Marble Company's yard, Batesville.

Structure: Flat-lying beds with joints principally in one direction.
Development: The quarry is 56 feet long, 34 feet wide, and 4 feet deep. (See Pl. III) It was opened in July, 1930, by the Batesville Black Marble Company, and has been operated irregularly. About 4 feet of shale overburden has been removed. A few blocks 10 feet long, 4 feet wide, and 8 inches thick have been taken from the quarry, and some carefully selected blocks have been shipped, but only upon demand for blocks of extra large size.
Commercial considerations: When polished, the marble has a light-brownish tint and is often spotty and streaked, and care must be used to select blocks which have the uniform color desired.

QUARRY 5 (Jamestown Quarry)

Location: NE.¼ SE.¼ sec. 2, T. 12 N., R. 7 W., at the west edge of Jamestown, Independence County, along creek bluff below church.
Accessibility: The quarry is on the Jamestown road, 3 or 4 miles south of State Highway 25.
Formation: Fayetteville formation.
Stratigraphy: The black limestone beds exposed in the bluff above the stream bed are shown in the vertical section in Figure 5. The beds range from 6 to 15 inches in thickness.

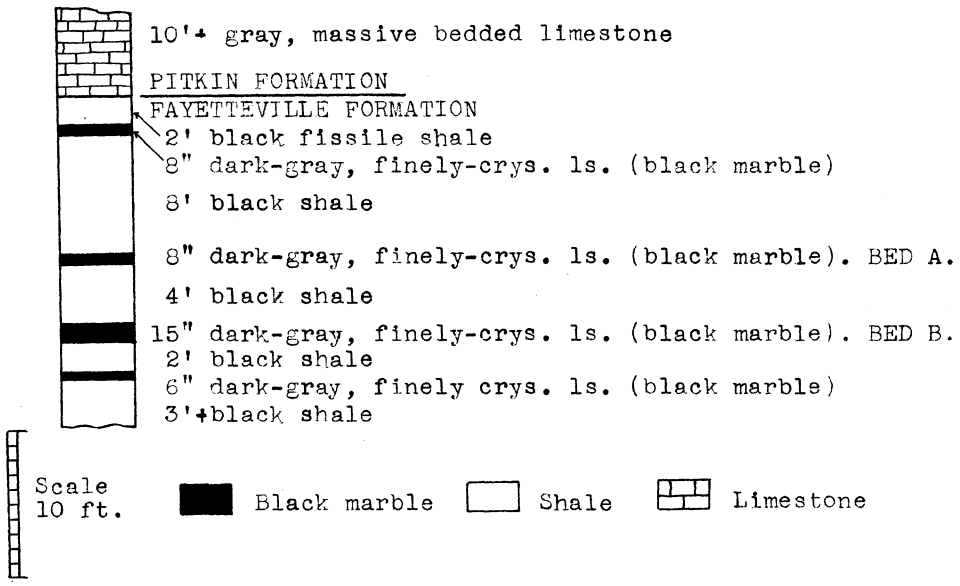


Figure 5. - Vertical section of the top of the Fayetteville formation at Quarry 5.

Structure: Strike E-W, dip 9° S. Joints are abundant and are probably in part due to the deformation which produced the dip of 9°.
Development: No quarry opening has been made at this location. Stone has been obtained by removing blocks from the face of the creek bluff. Work was begun here in July, 1930, by the Devonian Marble Company, of Batesville, Arkansas. Approximately two car loads of black marble were quarried and shipped and the quarry abandoned. The beds which were quarried (Beds A and B) are indicated in Figure 5.

Commercial considerations: Because of the increase in overburden in the direction of dip, quarrying costs here would be excessively high. In addition, the abundant joints make it difficult to obtain large blocks.

QUARRY 6 (Devonian Marble Company Quarry)

Location: Northeast corner NW.¼ NW.¼ sec. 10, T. 12 N., R. 7 W., about 2½ miles southwest of Jamestown, Independence County, near the head of a north-sloping depression.

Accessibility: The quarry can be reached by following a very poor, unimproved road from Jamestown.

Formation: Fayetteville formation.

Stratigraphy: The black limestone beds exposed in the quarry are shown in the vertical section in Figure 6. The black marble was obtained from several beds near the top of the Fayetteville formation. The limestone quarried is fine-textured, and of a uniform shade of black.

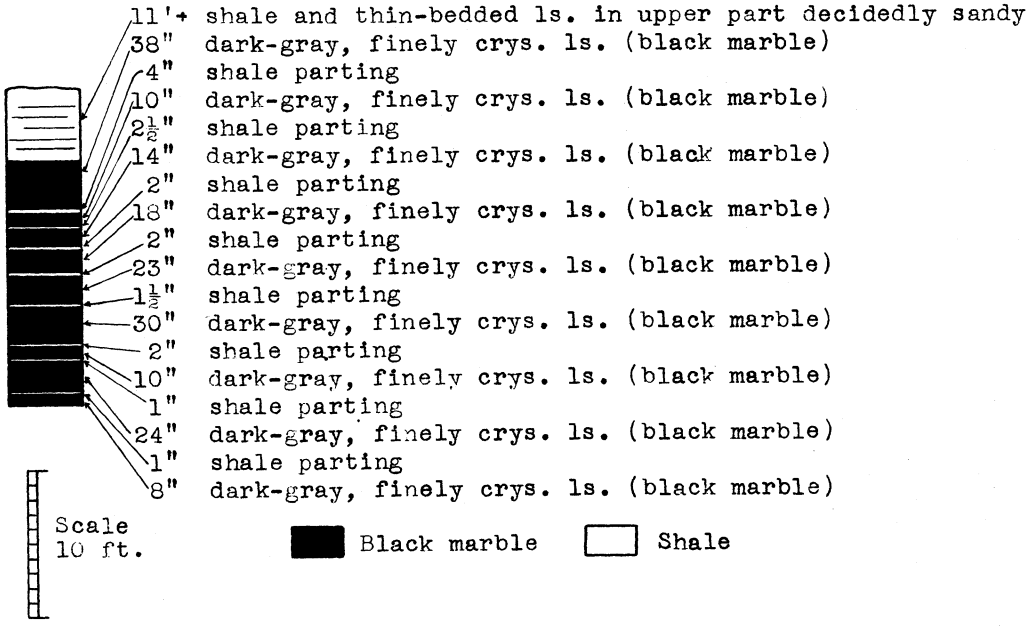


Figure 6. - Vertical section of the Fayetteville formation exposed at Quarry 6.

Structure: Horizontally bedded.

Development: The quarry is about 36 feet long, 27 feet wide, and 16 feet deep, and was opened in the summer of 1930 by the Devonian Marble Company. A small steam shovel was used to remove overburden and waste rock. Three car loads are reported to have been shipped to Canada. The quarry was abandoned in 1930.

Commercial considerations: The even-textured, uniformly-colored limestones exposed in the quarry face are apparently suitable for use as black marble. It was reported that this marble is harder to polish than the marble from the black limestones lower in the Fayetteville formation. Blocks from 4 to 5 feet long can be obtained from this quarry.

QUARRY 7 (Williamson Quarry)

Location: E.½ SE.¼ sec. 27, T. 13 N., R. 7 W., about 1 mile northeast of Locust Grove postoffice, Independence County, near the top of a low, rounded hill.

Accessibility: The quarry is on an unimproved road about three-fourths of a mile south of State Highway 25.

Formation: Fayetteville formation.

Stratigraphy: The black limestone beds exposed in the quarry are shown in the two vertical sections in Figure 7. The hill on which the quarry is located is made up mainly of shale of the Fayetteville formation. The limestone that is being quarried (Bed A) is even-textured and of a uniform grayish-black color. Calcite veins occur in the limestone but they are usually less than one-twentieth of an inch wide.

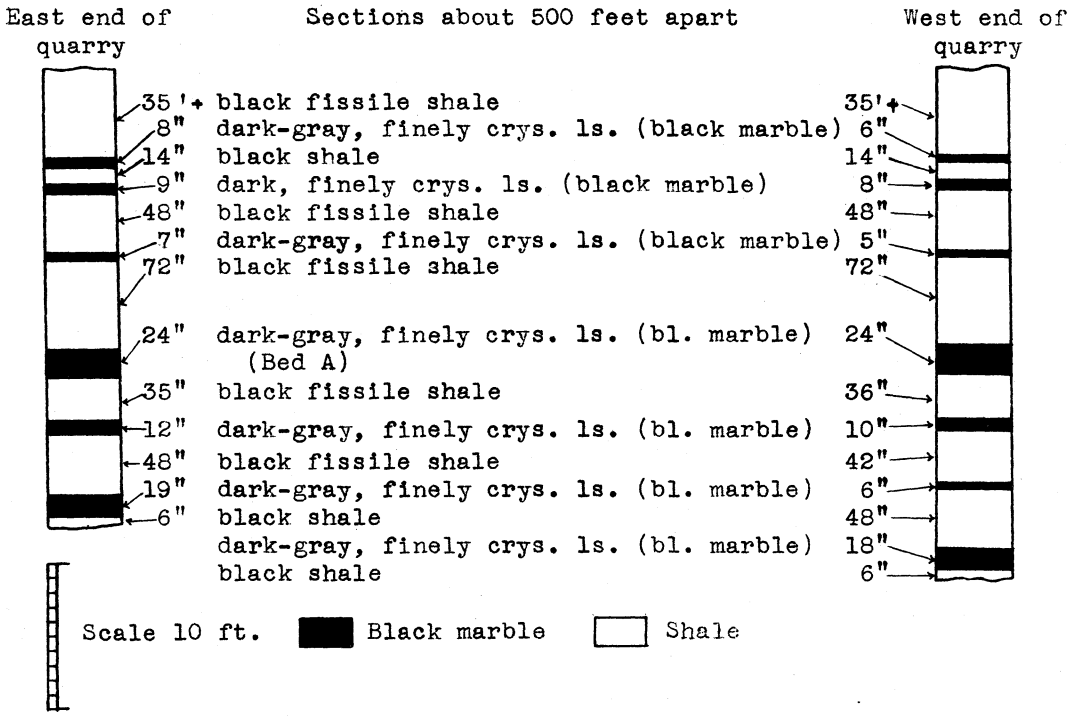


Figure 7. - Vertical section of upper part of the Fayetteville formation exposed at Quarry 7.

Structure: Strike N. 60° W., dip 2° SW. Two sets of fractures occur, causing the limestone to break into square and rectangular blocks.

Development: The quarry is about 150 feet long, 35 feet wide, and 20 feet deep. This quarry, sometimes called the Williamson Quarry, was opened in the summer of 1930, by the Batesville Black Marble Company, and has been operated more or less continuously since. The bed that is being worked (Bed A) measured 24 inches thick, but, when the shaly limestone is trimmed off, it is about 18 inches thick. Three blocks lying in the quarry marked for shipment had the following measured dimensions:

(1) 36 inches long, 30 inches wide, 23 inches thick.
(2) 40 inches long, 30 inches wide, 22 inches thick.
(3) 38 inches long, 38 inches wide, 22 inches thick.

Commercial considerations: Most of the black marble that has been shipped from the Batesville district has been obtained from this quarry. The limestone is of even texture and uniform black color. The chief problem with this quarry has been to secure blocks of size sufficient for commercial use.

QUARRY 8 (Locust Grove Quarry)

Location: Southeast corner SE.¼ sec. 27, T. 13 N., R. 7 W., one mile northeast of Locust Grove postoffice, Independence County. Located in a saddle on the same hill as Quarry 7.

Accessibility: The quarry is on State Highway 25.

Formation: Fayetteville formation.

Stratigraphy: The limestone beds occur in the upper part of the Fayetteville formation and are about the same in thickness and quality as those in Quarry 7.

Structure: Strike N. 40° W., dip 3½° SW. The dip increases rapidly along the edge of the hill to the east. A maximum dip of 8° was observed. Joints are more closely spaced than in Quarry 7.

Development: The quarry is 43 feet long, 20 feet wide, and has a face of 8 feet cut into the hill. It was opened in the summer of 1930 by the Batesville Black Marble Company in an attempt to find a quarry site on the highway.

Commercial considerations: The relatively steep dip and highly jointed condition of the beds make this location an unfavorable site for a quarry.

QUARRY 9 (Swaim Quarry)

Location: E.½ SW.¼ sec. 22, T. 13 N., R. 7 W., 1½ miles northeast of Locust Grove postoffice, Independence County, on a low spur at the northeast end of Dean Mountain.

Accessibility: The quarry is on an unimproved road about one-half of a mile west of State Highway 25.

Formation: Fayetteville formation.

Stratigraphy: The black limestone beds exposed are shown in the two vertical sections in Figure 8. Heavy layers of shaly limestone cover the two thickest limestone beds (Beds A and B). Both limestones are even-textured and have a uniform dark grayish-black color. The limestones are highly jointed and are also cut by many calcite veins, some of which are as much as one-tenth of an inch wide.

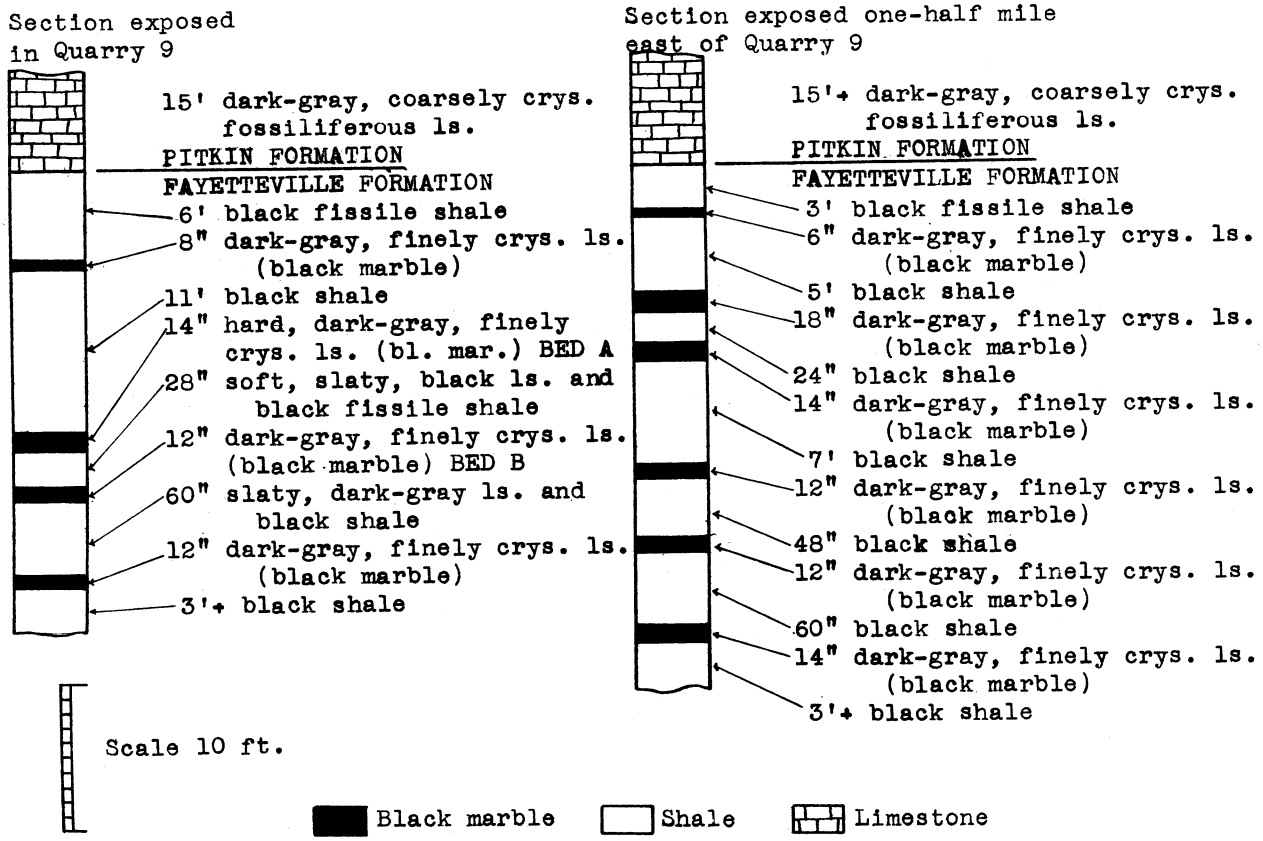


Figure 8. - Vertical sections of upper part of the Fayetteville formation exposed in the south end of Dean Mountain.

Structure: Strike N. 60° E, dip $2\frac{1}{2}$° NW., but at the west end of the quarry the strike is N. 40° E., and the dip has increased to 7° NW. Three prominent sets of joints occur which cause the limestone to break into angular blocks.

Development: The quarry is 400 feet long, 32 feet wide, and from 4 to 20 feet deep. It was opened in the summer of 1930 by the Devonian Marble Company and was later taken over by the Batesville Black Marble Company which extended the opening made by the Devonian Marble Company eastward along the edge of the hill. An overburden of from 2 to 10 feet of shale has been removed. A block that had been split by a diagonal crack measured 60 inches long, 47 inches wide, and 36 inches thick. With the shaly limestone trimmed off, this block would be about 24 inches thick. No car load shipments have been made from this quarry but a large number of choice blocks and a quantity of terrazzo material have been obtained.

Commercial considerations: The even texture and uniform color of the stone make it suitable for use as black marble. Due to the three prominent sets of joints, rough handling often causes a rectangular or square block to break diagonally, thus forming two three-cornered pieces which are unfit for commercial use because of excessive waste when square blocks are cut.

QUARRY 10 (Bickles Cove Quarry)

Location: NW.¼ sec. 26, T. 14 N., R. 10 W., near the head of Bickles Cove, 8 miles southeast of Mountain View, Stone County, on the southwest slope of a steep hill, slightly above creek level.

Accessibility: It is necessary to haul blocks northwest for 2 miles over an unimproved road and for 4 miles over a graded dirt road to reach State Highway 14.

Formation: Fayetteville formation.

Stratigraphy: A vertical section of the limestone exposed at this locality is shown in Figure 9. The limestone occurs about 30 feet below the top of the Fayetteville formation. The uncovered limestone (Bed A), including the shaly limestone, is 22 inches thick. The stone has an even texture and a uniform grayish-black color.

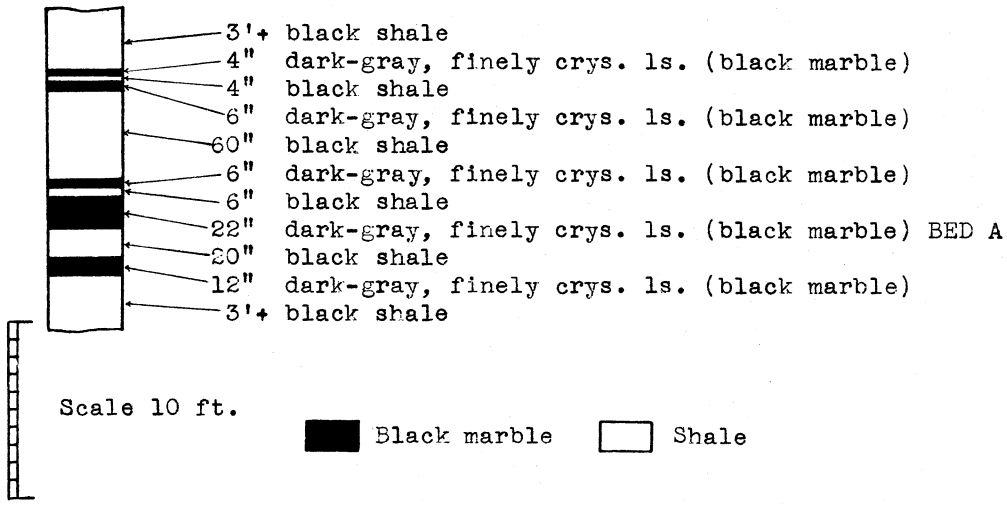


Figure 9. - Vertical section of limestone zone in the Fayetteville formation exposed at Quarry 10.

Structure: Horizontally bedded.

Development: The quarry is 30 feet long, 13 feet wide, and from 2 to 3 feet deep, and was opened in January, 1932, by the American Black Marble Company. An overburden of about 3 feet of shale has been removed.

Commercial considerations: The even-textured, uniformly colored stone quarried appears suitable for use as black marble, but no stone from this quarry has been utilized.

QUARRY 11 (Killen Quarry)

Location: SE.¼ sec. 9, T. 14 N., R. 11 W., about 3 miles west of Mountain View, Stone County, near the head of a small stream on the northeast slope of a hill.

Formation: Fayetteville formation.

Stratigraphy: Vertical sections of the beds exposed at this locality are shown in Figures 10 and 11. Two black limestone beds (Beds A and B) are exposed in the quarry. (See Fig. 11.) The lower bed (Bed B) is 23 inches thick and the upper bed (Bed A) is 20 inches thick. These beds are even-textured and have a uniform grayish-black color.

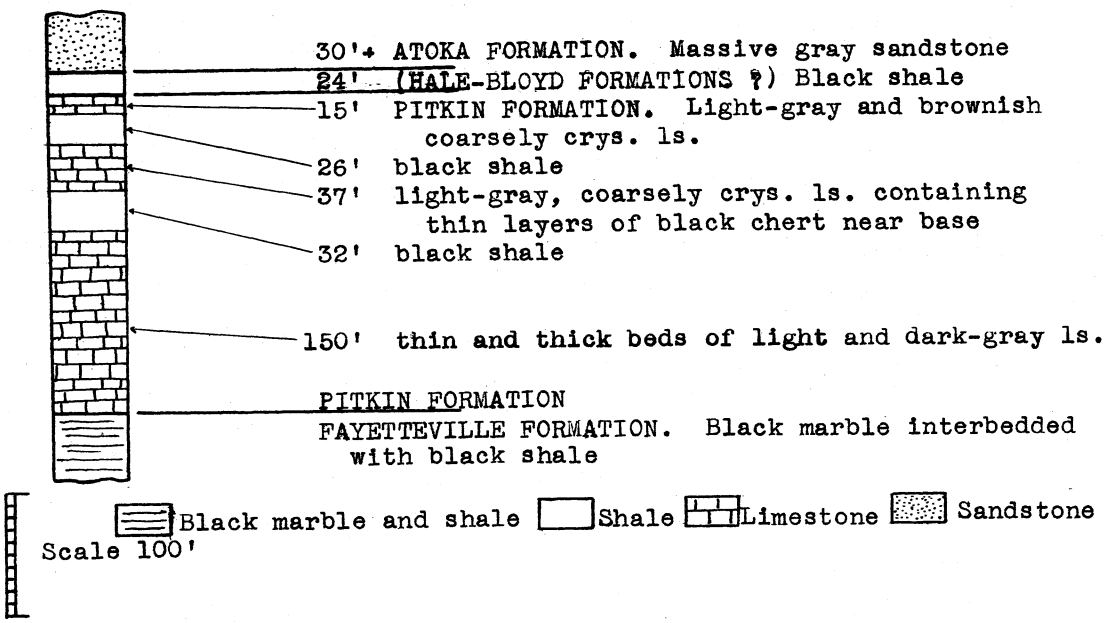


Figure 10. - Vertical section of the Pitkin formation exposed in stream bed on north slope of Blue Mountain near Quarry 11.

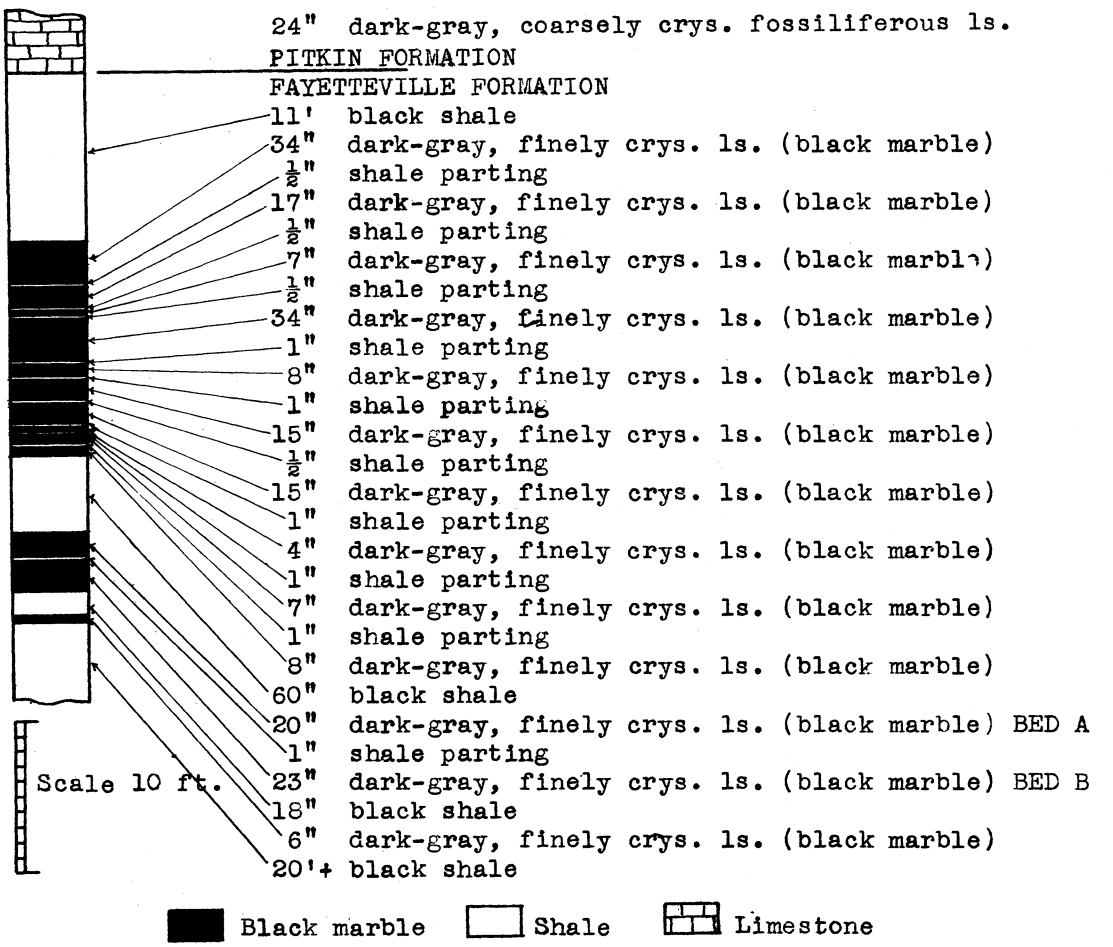


Figure 11. - Vertical section in upper part of the Fayetteville formation exposed at Quarry 11.

Structure: Strike N. 75° W., dip 3° SW.

Development: The quarry is 52 feet long, 18 feet wide, and 4 feet deep, and was opened in January, 1932, by the American Black Marble Company on the Killen farm. No black marble has been shipped from this quarry.

Commercial considerations: The even-textured, uniformly colored stone appears to be satisfactory for use as black marble. In addition, blocks 4 to 6 feet long can be obtained here.

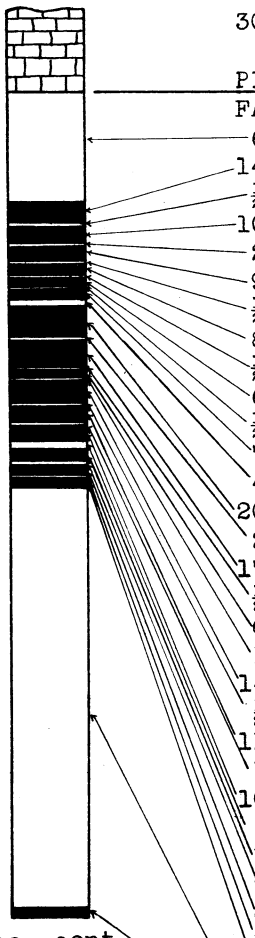
QUARRY 12 (Story Quarry)

Location: NE.¼ sec. 8, T. 14 N., R. 11 W., 4 miles west of Mountain View, Stone County, on a steep slope near the head of a hollow between two shale spurs on Blue Mountain, near the top of the east spur.

Accessibility: The quarry is about one-half of a mile south of State Highway 66, and can be reached only by a trail.

Formation: Fayetteville formation.

Stratigraphy: A vertical section of the beds exposed at this location is shown in Figure 12. The limestone bed is near the top of a black limestone zone about 6 feet thick thick, and belongs to the lower of two black limestone zones which occur at this location.



30'+both light and dark gray, fine and coarsely crys. ls., uneven-bedded and possessing a jagged fracture.
PITKIN FORMATION
FAYETTEVILLE FORMATION
6' black shale
14" dark-gray, finely crys. fossiliferous ls. (bl. marble)
½" shale parting
10" dark-gray, finely crys. ls. (black marble)
2" shale parting
9" dark-gray, finely crys. ls. (black marble)
½" shale parting
8" dark-gray, finely crys. ls. (black marble)
½" shale parting
6" dark-gray, finely crys. ls. (black marble)
½" shale parting
7" dark-gray, finely crys. ls. (black marble)
4" shale parting
20" dark-gray, finely crys. ls. (black marble)
2" shale parting
17" dark-gray, finely crys. ls. (black marble)
½" shale parting
6" dark-gray, finely crys. ls. (black marble)
1" shale parting
14" dark-gray, finely crys. ls. (black marble)
½" shale parting
11" dark-gray, finely crys. ls. (black marble)
1" shale parting
10" dark-gray, finely crys. ls. (black marble)
5" black shale with thin beds of black chert
7" dark-gray, finely crys. ls. (black marble)
2" shale parting
6" dark-gray, finely crys. ls. (black marble)
1" shale parting
7" dark-gray, finely crys. ls. (black marble)
23' black shale
8" dark-gray, finely crys. ls. (black marble)

Sec. cont. on p. 31.

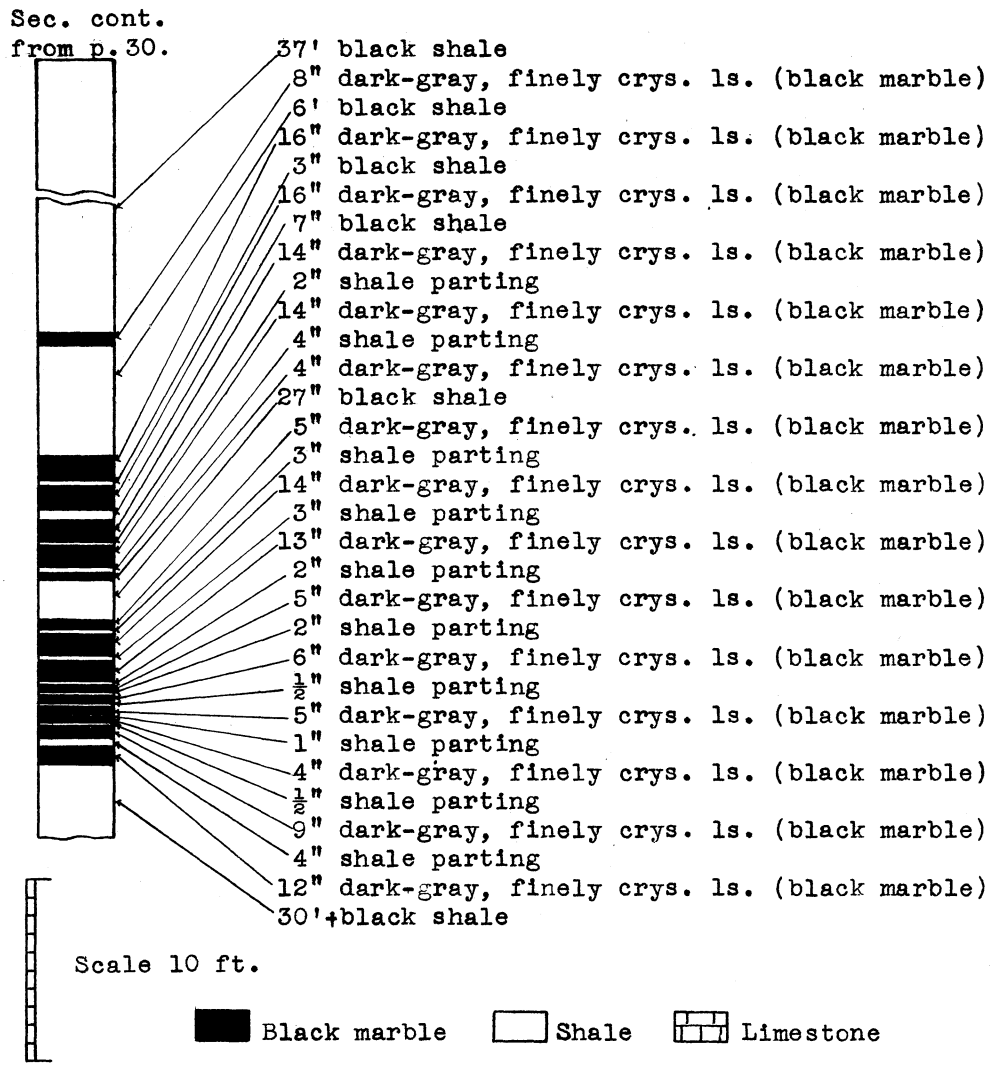


Figure 12. - Vertical section in upper part of the Fayetteville formation exposed in stream bed and in Quarry 12.

Structure: Horizontally bedded. The limestone bed exposed in this quarry is highly jointed.

Development: The quarry is 115 feet long, 15 feet wide, and 10 feet deep, and was opened in September, 1931, by Anderson & McMein, of Kansas City, Missouri, on the Story farm. An overburden of 10 feet of shale has been removed. No marble has been shipped from the quarry.

Commercial developments: The stone exposed here has a slightly brownish shade and is more coarsely textured than stone used from other quarries for black marble. Jointing may offer difficulty in obtaining large blocks.

QUARRY 13 (Bell Quarry)

Location: NW.¼ NW.¼ sec. 6, T. 14 N., R. 11 W., 5 miles west of Mountain View, Stone County, on the steep north slope of Cow Mountain.

Accessibility: The quarry is about one-fourth of a mile south of State Highway 66. It can be reached by an unimproved road.

Formation: Fayetteville formation.

Stratigraphy: The limestone beds of the upper part of the Fayetteville are shown in the vertical section in Figure 13. Two beds (Beds A and B), occurring about 75 feet below the top of the formation, have been quarried. The thickness of these beds is 28 and 16 inches respectively. These thicknesses include some shaly limestone. Most of the beds exposed have a streaked, brownish appearance. Calcite veins also occur in the limestone.

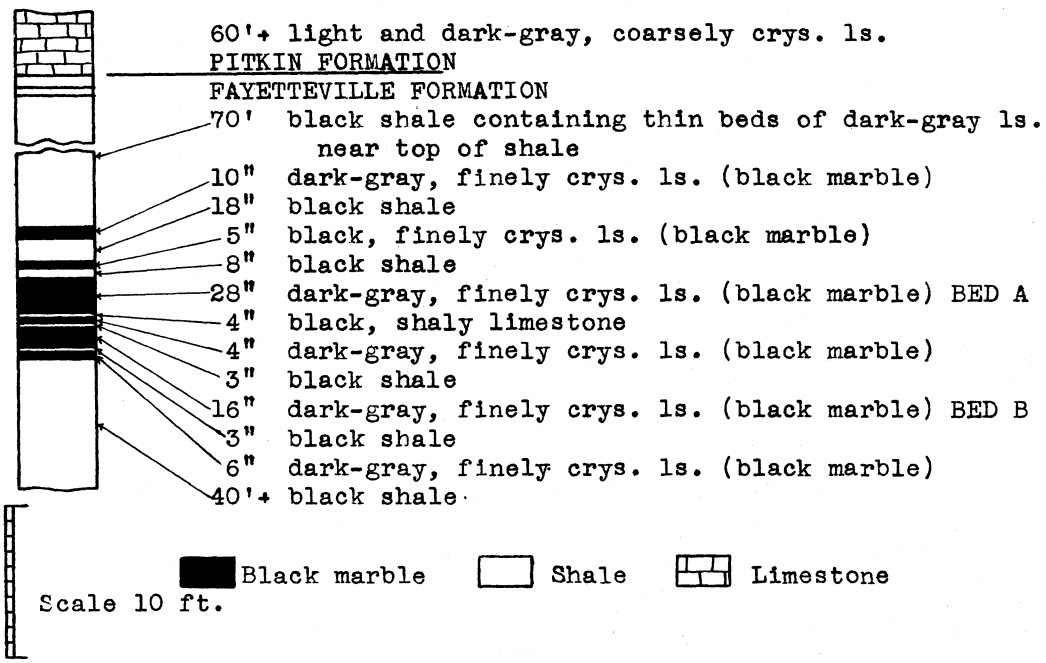


Figure 13. - Vertical section of upper part of Fayetteville formation exposed at Quarry 13.

Structure: The beds are horizontal and somewhat jointed.

Development: The quarry is about 40 feet long, 22 feet wide, and 17 feet deep and was opened on the Joe Bell property in the summer of 1930, by Brown & Anderson, Kansas City, Missouri. A car load of marble from this quarry was shipped to Kansas City, Missouri.

Commercial considerations: According to one report, the stone had an uneven, splotchy color and the texture was coarser than is desired for use as black marble.

QUARRY 14 (Clemens Quarry)

Location: NW.¼ sec. 22, T. 14 N., R. 15 W., 1½ miles northwest of Leslie, Searcy County, in the bed of Trace Creek.

Accessibility: The site where the marble was obtained is on a county road about 1½ miles northwest of Leslie.

Formation: Fayetteville formation.

Stratigraphy: Black limestone occurs in beds 4 to 8 inches thick in the upper part of the Fayetteville formation. The texture of the limestone is rather coarse but it is of an exceptionally dark color.

Structure: Horizontally bedded.

Development: The limestone quarried here has been removed from the bed of Trace Creek. It is reported that marble was shipped from this property as early as 1890. This quarry is on the Clemens property and is not at present in operation.

Commercial considerations: There has been no work done here for 40 years. The creek bed is a poor location for a quarry.

QUARRY 15 (Anderson & McMein Quarry)

Location: SW.¼ sec. 23, T. 14 N., R. 15 W., one-half of a mile north of Leslie, Searcy County, on the side of a hill about 30 feet above the bed of a small stream tributary to Bagley Creek.

Accessibility: The quarry is on a trail about one-fourth of a mile east of a county road.

Formation: Fayetteville formation.

Stratigraphy: The vertical sections (Figs 14 and 15) show the beds of both the Fayetteville and Pitkin at this location. The beds that are being quarried (Beds A and B, Fig. 14) occur about 30 feet below the top of the Fayetteville above a thick, unevenly bedded gray limestone. These beds have a fine, even texture and a very dark grayish-black color. Calcite veins are present but are not abundant nor of unusual width. Up the stream bed from the quarry, black limestones of apparently good quality are exposed. A ledge of black limestone in the stream bed (about 3 feet below the base of the Pitkin) was measured and found to be 30 feet long, 20 feet wide, and 10 inches thick. This ledge is in one solid block and is not broken by joints. A vertical section of the beds and the formations outcropping in the stream are shown in Figure 15.

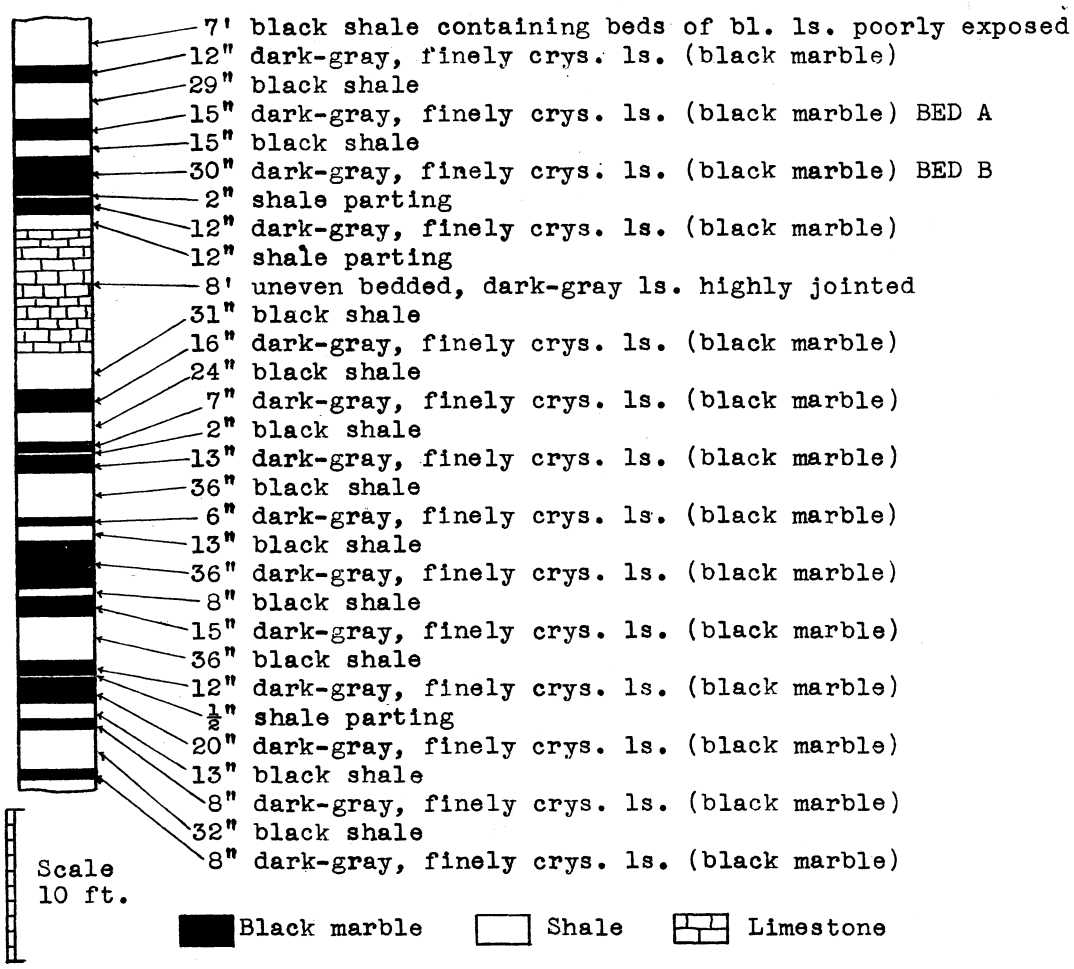


Figure 14. - Vertical section of upper part of the Fayetteville formation exposed at Quarry 15.

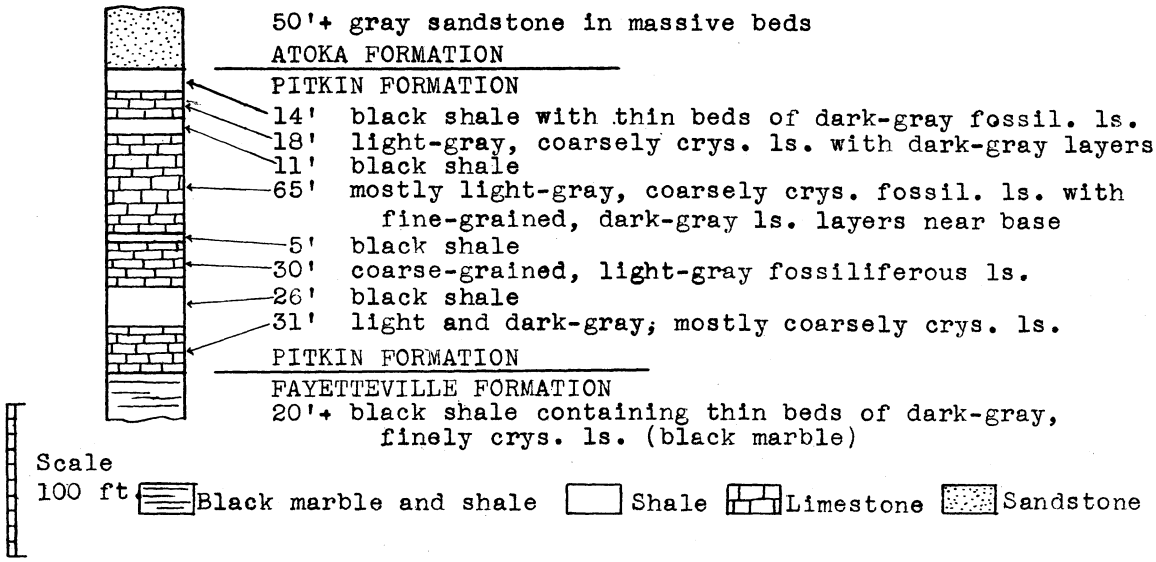


Figure 15. - Vertical section of formations exposed in creek bed up stream from Quarry 15.

Structure: Horizontally bedded. Jointing is principally in one direction.

Development: The quarry is 50 feet long, 24 feet wide, and from 13 to 14 feet deep, and was opened in January, 1932, by Anderson & McMein, of Kansas City, Missouri. One truck load of marble was shipped from this quarry to Kansas City in February, 1932. Part of a car load of marble was quarried from the lower black limestones exposed in the stream bed below the quarry but, according to reports, for unknown reasons, the marble did not meet the standard desired. Four individual blocks that have been separated from beds in the quarry had the following dimensions:

(1) 12 feet long, small end 19 inches wide and 12 inches thick, large end 29 inches wide and 12 inches thick.
(2) 14 feet long, 24 inches wide, 18 inches thick.
(3) 9 feet long, 54 inches wide, 12 inches thick.
(4) 12 feet long, 30 inches wide, 12 inches thick.

Commercial considerations: The limestone exposed is even-textured and of a uniform grayish-black color, and apparently is suitable for use as black marble. Large blocks can be obtained at this location.

QUARRY 16 (Denton Quarry)

Location: SW.¼ NW.¼ sec. 26, T. 14 N., R. 15 W., one-fourth of a mile east of Leslie, Searcy County, on a hillside above Cove Creek, about 30 feet above the Missouri and North Arkansas Railway.

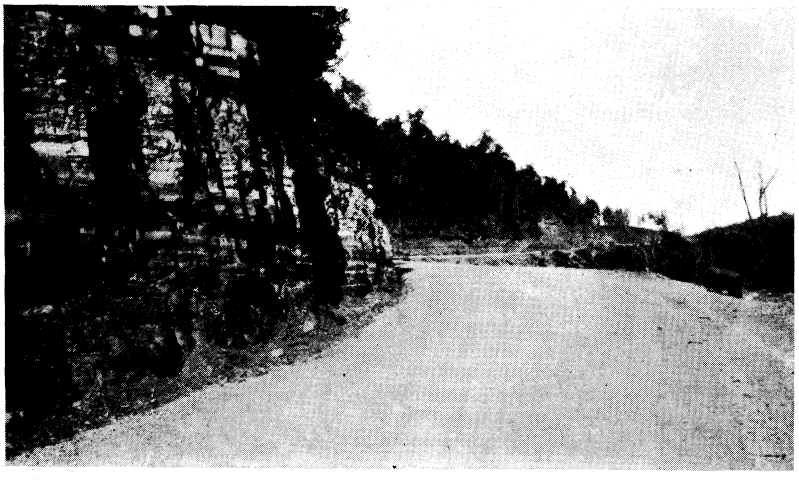
Accessibility: The quarry is on the Missouri and North Arkansas Railway. U. S. Highway 65 parallels the railroad on the south side of Cove Creek.

Formation: Pitkin formation.

Stratigraphy: The limestones exposed in the quarry and on the side of the hill are the dark-gray, fossiliferous limestones of the lower part of the Pitkin formation and are shown in Figure 16. (See also Pl. IV, A and B.) The beds range from 11 to 72 inches in thickness. Colors are generally a lighter shade of gray than the limestones of the Fayetteville and textures are generally coarser, although there are exceptions to these statements. Two dark, brownish-gray beds of oolitic limestones were observed in the quarry face. These oolitic beds are near the base of the formation and are highly fossiliferous.

A. View of quarry opened by S. O. Denton, in the Pitkin formation, one-fourth of a mile east of Leslie, in the SW. ¼ NW. ¼ sec. 26, T. 14 N., R. 15 W.

B. Dark-gray, fossiliferous limestone layers of the Pitkin formation exposed at the quarry opened by S. O. Denton, one-fourth of a mile east of Leslie, in the SW. ¼ NW. ¼ sec. 26, T. 14 N., R. 15 W.



C. Part of a 140-foot zone of dark-gray limestone (black marble) and interbedded black shale in upper part of the Fayetteville formation, one mile south of Marshall, in the NE. ¼ sec. 6, T. 14 N., R. 15 W.

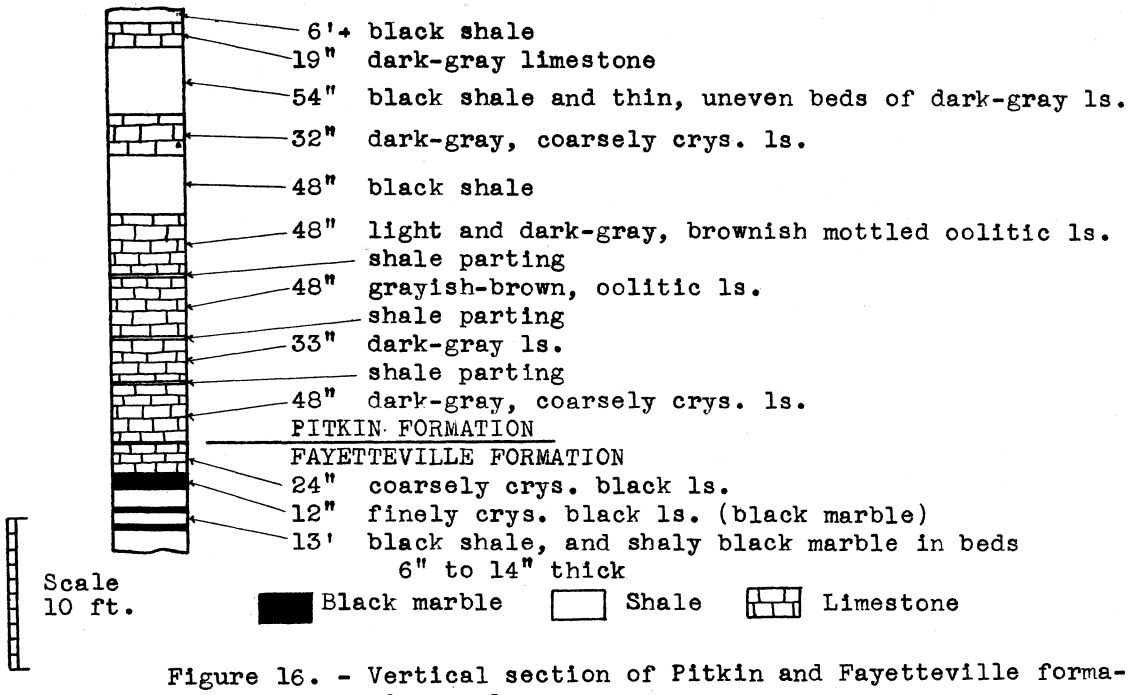


Figure 16. - Vertical section of Pitkin and Fayetteville formations exposed at Quarry 16.

Structure: Horizontally bedded.

Development: The quarry is 80 feet long, 30 feet wide, and a face of 30 feet is exposed. It was opened in the spring of 1931 by S. O. Denton, of Leslie, Arkansas. Up to June 17, 1932, 6 car loads of blocks and 5 car loads of terrazzo had been shipped from this quarry.

Commercial considerations: Quarry is now operated by Denton & Waldo. Several varieties of grayish-black and brownish-black, coarse-textured marbles can be obtained from this quarry.

QUARRY 17 (Quarry site)

Location: NE.$\frac{1}{4}$ sec. 6, T. 14 N., R. 15 W., one mile south of Marshall, Searcy County.

Accessibility: On U. S. Highway 65.

Formation: Fayetteville formation.

Stratigraphy: A road cut (see Pl. IV,C) offering a potential quarry site on U. S. Highway 65, has almost completely exposed the black limestone in the upper part of the Fayetteville shale, which here reaches the maximum thickness observed in the entire black marble region. A total thickness of 140 feet of interbedded black limestones and shales was measured. A detailed section, measured from the top to the bottom of the black limestone zone, follows:

5" black limestone, coarse grained
40" black shale
2$\frac{1}{2}$" black limestone
30" black shale
3$\frac{1}{2}$" concretionary layers black limestone
15" black shale
3" concretionary layers black limestone
50" black shale
4" concretionary black limestone
8" black shale
8$\frac{1}{2}$" black limestone, smooth-textured

23" black shale
11' black limestone, uneven bedded, hackly fracture
4" black shale
3" black limestone
22" black shale
12" black limestone, smooth texture
10" black shale
34" black limestone, has a 4" soft streak 10" from base
6" black shale
12" black limestone, uneven concretionary bed
20" black shale
12" concretionary bed black limestone
23" black shale
10" concretionary black limestone
10" black shale
14" concretionary black limestone
16' black shale
4" black limestone, coarse-grained
23" black shale
5" black limestone, smooth texture
14" black shale
3" black limestone, coarse-grained
2" black shale
3" black limestone, coarse-grained
19" black shale
7" black limestone
8" black shale
4" concretionary black limestone
10" black shale
9" black limestone, smooth texture
15" black shale
6" black limestone
30" black shale
5" black limestone
7" black shale
4" black limestone
8" black shale
7" black limestone
14" black shale
6" black limestone, smooth texture
23" black shale
7" black limestone, smooth texture
22" black shale
5" black limestone
4" black shale
5" black limestone
17" black shale
7" black limestone
12" black shale
7" black limestone
25" black shale
10" black limestone
35" black shale
12" black limestone
13" black shale
8' black limestone, coarse uneven-bedded with thin shale seams
10" covered interval, mostly shale

Development: None.

Commercial considerations: Potential quarry site. Not all of the beds exposed would be commercially suitable for use as black marble and, in addition, the overburden is generally thick.

PART II

ECONOMIC VALUE OF BLACK MARBLES OF NORTHERN ARKANSAS

By E. E. Bonewits

ABSTRACT

The only active competitor of Arkansas true black marble in the United States is Belgian black marble. In marketing this stone, Arkansas quarrymen have a price advantable over Belgian dealers in 21 states and can probably compete successfully in other states. Arkansas gray or "fossil" marble, known commercially as "black marble," is, in this country, in competition with Vermont, New York, and Texas marbles.

It is essential that producers of Arkansas black marble be prepared to meet trade practices now in use in order to compete successfully with dealers in Belgian black marble. This applies particularly to the preparation of the blocks, to furnishing marble dealers and manufacturers with full information concerning Arkansas black marble, and, if required, to furnishing dealers with Arkansas marble on consignment.

There is undoubtedly an opportunity for an increase in the sale of Arkansas black marble terrazzo, and the Arkansas product has a considerable price advantage at the present time throughout the United States. It is estimated that Arkansas black marble blocks, valued at over $200,000, can be successfully marketed at the present time.

INTRODUCTION

The term "black marble," as used by the marble trade, includes marbles varying in color from jet black to gray. The gray type of marble is often referred to as "fossil," particularly when it carries fragments of light-gray fossils.

During the middle of the 19th century, black marble was used in the United States rather extensively as an interior trim in building construction. After that time, its use declined until about 1926, when the demand increased. About a year ago its use declined again because of decreased building construction. The demand for black marble, however, has since been maintained in proportion to the construction which has taken place. The use of black marble for table tops, pedestals, novelties, mantle pieces, tiles, etc., has not changed greatly in the last fifty years.

In practically all of the Federal buildings constructed in the last few years, and particularly in those buildings built to relieve unemployment, black marble has been specified for use in some part of the structure. The Federal government stipulates that marble in government buildings shall be of domestic origin, other considerations being equal. This provision and the tariff on foreign marbles have given a decided advantage to domestic producers and manufacturers.

Since 1926, several black marble deposits in north-central Arkansas have been developed and products from them placed on the market.

Information concerning the production and uses of black marble is incomplete. Statistics relative to marble production are compiled by the U. S. Bureau of Census, but all of the marbles are grouped together and no segregation of black marble has been made. In addition, no complete list of marble manufacturing plants in the United States is available. The Federal Census of Manufactures lists the number of stone manufacturing plants by states, but this number includes not only plants manufacturing marble, but also those manufacturing granite, slate and other stones.

Most of the information in this report has been obtained by correspondence and personal interviews with quarry operators, marble manufacturers, tile setters, and makers of terrazzo.

Black marble chips used in the construction of terrazzo pavement are produced from Arkansas black marble, and this paper, therefore, includes a study of the preparation and the marketing of this material.

SOURCES OF COMMERCIAL BLACK MARBLE

Foreign

Belgium

Belgium is the chief producer of black marble. A description of the Belgian black marble industry is given in a report by the American Consul, Brussels, Belgium, dated June 5, 1928, from which the following paragraphs are taken:

> "Belgian black marbles are especially well known in the United States where important quantities are exported yearly. Perfect examples are difficult to obtain owing to the presence of bug-holes and a tendency of the marble to break off along the many cleavage planes during the cutting. The principal quarries are situated at Mazy near Namur. Black marble deposits are at a considerable depth which renders exploitation of the quarries particularly expensive. Black marble, like the red varieties, is generally found in Frasnien rock formations. The deposits in the Namur district have a length of approximately 7 miles. Although rich in different grades, the black spotless variety known as number one quality is extremely rare at the present time. It is supposed that considerable quantities of the grade are still in place in the Mazy quarries but they are at such depth that to reach them a large quantity of inferior or worthless black marble must be removed.
>
> "American buyers generally specify the first quality of black marble but prices ordinarily quoted usually hold for second or third quality. The inferior grades have usually a reddish tint and are slightly shot with white. The first quality Belgian black is a handsome marble with a very fine structure and is particularly suitable for sculptural work. The inferior grades generally have a coarser structure, do not take a high finish, and are as a rule employed for marble pavements. The Mazy quarry is one of the few in a position to furnish limited quantities of the superior grade, while all supplies from the quarries located around Dinant, Bossieres, and Denee are now largely furnishing number two and number three qualities."

Domestic

The only true black marbles now known are obtained from Arkansas and Belgium. So-called black marbles have been produced in the United States in Vermont, New York, and Texas, but they are gray in color and not a true black. Brief descriptions of these marbles are given below:

Vermont

Black marble is quarried in the United States principally from the Chazt limestone on Isle La Motte. This marble has a black groundmass shot with fragments of crinoids. When viewed from a distance, the polished surface appears to be gray. It is sold under the trade names of "French Gray" and "York Fossil." There is also produced in the Champlain district a spotted or pied variety of black marble, marketed under the names of "Champlain" and "Swanton Black."

New York

For a number of years a black marble was quarried near Glen Falls, from the black Trenton limestone. This marble was sold under the trade name of "Glen Falls Black." C. A. Hartnagle, Assistant State Geologist of New York, advised the writer on July 1, 1932, that quarries near Glen Falls were not being operated and that he understood the owners did not expect to reopen them.

The Chazy limestone south of Plattsburg provides a black marble containing pinkish crinoids, which is also known as "York Fossil." This stone is similar in appearance to the "York Fossil" or "French Gray" produced in Vermont.

Texas

The U. S. Bureau of Mines reports production of black marble, known as "Numidian Shell," by the Marble Mountain Company, Marfa, Texas. This marble has a black groundmass containing gray, irregular whorls from one-half to three-quarters of an inch in diameter.

Arkansas

Black marbles obtained from the Arkansas deposits are described in the first section of this report. The true black variety, known as "Arkansas Black," is so similar to the "Belgian Black" that it is difficult to distinguish one from the other. The "Arkansas Fossil" variety, which is a gray marble, cannot easily be distinguished from the "French Gray" and "York Fossil" varieties of Vermont and New York. Both the "Arkansas Black" and "Arkansas Fossil" marbles take a high, enduring polish.

MARKETING OF BLACK MARBLES IN THE UNITED STATES

Marketing of Belgian Black Marble

Markets

Area of consumption

Belgian black marble is marketed throughout the entire United States.

Sales

According to the statistics of the U. S. Census of Manufactures, the sales of marble for interior construction in the United States in 1929 amounted to $35,307,244. If we assume that 3 per cent of this consisted of black marble sales, then the value of these sales in the United States in 1929 was $1,059,217. The value of marble used in table tops and miscellaneous ornamental articles sold in the United States in 1929 was $1,596,736. Assuming 10 per cent of this amount to be black marble, the value of that used for ornamental purposes was $159,673. The estimated total value of black marble used in the United States in 1929 was $1,218,890. The greater part of this was imported from Belgium. (See also section on "Marketing of Arkansas Black Marble.")

Methods of distribution

Distribution of Belgian black marble in this country is made through importers, dealers and marble manufacturers*.

* The term "marble manufacturer," as herein used, applies to any firm that processes marble after it has been sawed into slabs, and is not merely a selling or distributing organization or setting contractor.

A communication from the Brussels (Belgium) office of the U. S. Bureau of Foreign and Domestic Commerce, issued in February, 1931, is as follows:

> "Belgian marble quarries are almost all in the hands of the Societe Anonyme de Merbes Sprimont. This firm is represented in the States by the Consolidated Marble Corporation, 10th Street and Allegheny Avenue, Philadelphia, Pennsylvania."

The first link in the chain of distribution of Belgian black marble in the United States is the importer. The principal importers are located in New York, but their cargoes of black marble blocks or slabs may be delivered at any port.

Most of the importers not only import foreign marbles other than black marbles, but also act as wholesalers and sales agents for domestic marbles, including the black variety. A small number of the importers operate quarries.

It is customary for importers to advise the marble manufacturers concerning the blocks they have on hand by means of circulars, called "stock sheets." These list the marble blocks by name and grade and give the block number, the three dimensions, and the contents in cubic feet. Frequently these circulars are sent to the marble manufacturers before the blocks reach the United States, in which case the circular so states, usually giving the name of the vessel carrying the shipment, the port and the date of arrival.

Most marble manufacturers not having sawing plants purchase sawed stone through dealers having such plants. These dealers also assist the manufacturer in arranging prices and deliveries. A partial list of marble dealers and manufacturers is given on pages 53 to 55. Most of the names were obtained from the National Association of Marble Dealers. Although it is possible that some names have been omitted, the list is sufficiently complete for use in opening negotiations.

The operators of sawing plants are often dealers. When it is possible to substitute a marble, or when a second choice is permitted manufacturers, dealers often control the selection of the kind of marble used to fill orders. In addition, the opinions of the dealers are usually respected by architects who often follow the dealers' suggestions in the choice of marble.

When plants are equipped for sawing, it is customary for dealers to place a selection of blocks at the large marble sawing plants on consignment. In this way, manufacturers who do not have sawing plants may place their orders for blocks and, at the same time, contract with the consignee plant for sawing. This is done to facilitate distribution and the practice applies to all marbles. The table on page 43, which shows the number of manufacturing plants in the various states, may be used as a guide in determining to what extent the field has been covered in making trade connections.

The stock sheets sent out by wholesalers do not quote prices. To obtain a quotation, the marble manufacturer indicates his selection of blocks and asks for quotations. He is then advised whether or not the blocks he has selected are available, and if they are, is quoted a price f.o.b. the port of entry; or, if the blocks selected have been consigned to some marble yard, the price is quoted f.o.b. that point.

The Belgian people are on the alert for business and are quick to adopt new methods to compete for business in America. The Belgian consuls at the principal ports of entry are very active. In February, 1932, the Belgian consul at New Orleans sent out letters to various consumers inviting inquiries regarding commodities and materials which the Belgian industries had to sell, and which included black marble. A response to this letter requesting information concerning black marble brought forth quotations from the Societé Marbriere de l'Entre-Sambre & Meuse, Yves-Gomezee, Belgium, a producing and manufacturing association. Full details as to grade, size, cubic contents of

blocks and slabs were given, and prices per cubic foot and per square foot, c.i.f. (cost, insurance, freight) were quoted. Quotations were also received from A. Etienne, Mazy, Belgium, an independent producer and manufacturer. Another association quoting prices is the Société Anonyme Belge des Marbres, Pierres et Granits, Brussels. This indicates that Belgian black marble may be obtained in this country through channels other than the Consolidated Marble Corporation of Philadelphia referred to on page

Size and preparation of blocks

In 25 or more stock sheets and quotations, extending over the period 1928-1932 inclusive, no blocks were listed weighing as much as 5 tons. The Société Marbriere de l'Entre-Sambre & Meuse quotation of May 6, 1932, specifically limits the maximum weight of each block to 5 tons. The A. Etienne quotation does not limit the weight per block but limits the minimum order to 10 tons. The lowest prices quoted are on blocks up to 5 feet in length. The price is increased for lengths falling between five feet and six feet, six inches, and again for lengths over six feet, six inches. Black marble blocks are thinner than other marble blocks. The thinnest block on which price quotations were obtained was 5 inches; the narrowest, 12 inches; and the shortest, 20 inches. The smallest, by volume, was 3.4 cubic feet. The largest dimensions listed in the quotations were: length, 12 feet; width, 4 feet, 10 inches; and thickness, 2 feet, 6 inches. The largest block had a volume of 53.3 cubic feet.

Imported Belgian black marble blocks are either squared by sawing or scabbled (dressed with a pointed tool), or they are sawed on the ends and sides and scabbled on the top and bottoms. The preparation of the blocks is practically perfect and they may be used with little or no waste.

Tariff

The American quotations on Belgian black marble blocks are f.o.b. the ports, marble yards, or plants, or c.i.f., the ports of entry. In any case, the tariff or import duty is included in the cost. This duty is provided for in the Tariff Act of 1922, as follows:

> "Par. 232. Marble, breccia, and onyx, in blocks, rough or squared only, 65¢ per cu. foot; marble, breccia, and onyx, sawed or dressed, over two inches in thickness, $1.00 per cubic foot; slabs and paving tiles of marble, breccia, or onyx, containing not less than four superficial inches, if not more than one inch in thickness, 8¢ per superficial foot; if more than one inch and not more than one and one-half inches in thickness, 10¢ per superficial foot; if more than one and one-half inches and not more than two inches in thickness, 13¢ per superficial foot; if rubbed in whole or in part, 3¢ per superficial foot in addition; Mosaic cubes of marble, breccia, or onyx, not exceeding two cubic inches in size, if loose, one-fourth of one cent per pound and twenty per centum advalorem; if attached to paper or other material, 5¢ per superficial foot and thirty-five per centum advalorem.
>
> "Par. 233. Marble, breccia, onyx, alabaster, and jet, wholly or partly manufactured into monuments, benches, vases, and other articles, and articles of which these substances or any of them is the component material of chief value, and all articles composed wholly or in chief value of agate, rock crystal, or other semi-precious stone, except such as are cut into shapes and in forms fitting them expressly for use in the construction of jewelry, not specially provided for, fifty per centum advalorem."

Prices

One authority states that the average price for the last ten years of "Belgian

Black" in blocks at United States ports was $1.75 per cubic foot, not including the tariff of 65 cents per cubic foot.

The latest (August 1, 1932) quotation for delivery from Belgium, c.i.f. and tariff, New Orleans, is as follows:

Belgian Black Marble

No. 2:

6½ feet long and less	$2.55 per cu. ft.
More than 6½ feet long	2.80 " " "

No. 3:

6½ feet long and less	2.10 " " "
More than 6½ feet long	2.35 " " "

The price of No. 2 Belgian Black marble slabs one inch thick and one foot square, sawn from No. 2 blocks, c.i.f. New Orleans, is 41 cents per slab; and No. 3, same dimensions, 33 cents.

All of the price quotations obtained were on second and third grade marbles. Some importers quote on "selected" or "choice" blocks, but these refer to second grade. The difference between second and third grade blocks is that the third grade blocks are smaller in one or two dimensions, may contain thin, straight white calcite joints which do not impair the soundness, and may have small, white spots and a reddish tint.

Marketing of Arkansas Black Marble

Markets

Area of potential consumption

Belgian black marble has a price advantage over Arkansas black marble on the Atlantic and Pacific seaboard states and in the states immediately east of the Pacific Coast. Until adjustments in marketing conditions extend these limits, the economic marketing area for Arkansas black marble will be confined largely to those states lying between the Appalachians and the Rocky Mountains.

Operations in the area

The number of plants which manufacture marble, granite, slate and other stone products in the 21 states lying between the Appalachians and the Rocky Mountains as given in the Census of Manufactures for 1925, 1927, and 1929, is shown below:

	1925	1927	1929
Alabama	18	16	19
Arkansas	9	8	10
Colorado	15	16	18
Illinois	157	121	110
Indiana	80	60	59
Iowa	21	19	18
Kansas	24	14	13
Kentucky	28	23	22
Louisiana	8	8	10
Michigan	60	45	44
Minnesota	56	52	65

	1925	1927	1929
Mississippi	8	7	5
Missouri	70	48	50
Nebraska	18	12	11
North Dakota	5	1	1
Ohio	96	66	75
Oklahoma	23	15	16
South Dakota	4	4	3
Tennessee	36	38	31
Texas	83	62	61
Wisconsin	74	55	51
Total for area under consideration	893	690	692
Total for United States	2,356	1,978	1,881

This total includes only the plants that reported sales exceeding $5,000 for the years shown. No segregation of plants as to kind of product manufactured is possible from the data available, but it is estimated that 10 per cent of the numbers given are marble manufacturing plants.

Sales

The value of interior marble sold by marble manufacturing plants in the United States, as given by the Census of Manufactures, for the year 1929, was $35,307,244. The value for the states within the area between the Appalachians and the Rocky Mountains, including the values in eight states not within the area (Oregon, Utah, Georgia, North Carolina, Virginia, Delaware, Maine, and Maryland), is given below:

Illinois	$ 1,634,710	
Minnesota	938,210	
Michigan	671,785	
Missouri	1,999,271	
Ohio	1,028,157	
Tennessee	5,388,943	
Texas	516,621	
Indiana, Iowa, Kansas, Nebraska, and Wisconsin	1,268,770	
Colorado, Oregon and Utah	396,448	
Alabama, Georgia, Louisiana, North Carolina, and Virginia	1,403,709	
Arkansas, Delaware, Kentucky, Maine, Maryland, and Oklahoma	1,735,990	
Total for states in Arkansas marketing area (including eight states not in area)		$16,982,614
Total for states outside Arkansas marketing area (excluding New York and eight states)	9,356,791	
New York	8,967,839	
Total for states outside Arkansas marketing area (less eight states)		18,324,630
Total for United States		$35,307,244

It will be noted from the above that the value of the sales in New York State alone for the year 1929 was 25 per cent of the total for the United States.

It is difficult to say what part of the sales values given above is represented by black marble values. Various estimates have been furnished on the proportion of black marble used to the total of other marbles in interior building construction. The proportion is as high as 100 per cent in some instances, while in others it may be as low as a fraction of one per cent, or none at all.

It is estimated that the proportion of the value of black marble to that of other marbles used in interior building construction in the past seven years, has not exceeded 3 per cent. Assuming this is the correct percentage, the value of black marble sold in the United States during 1929, based on the above figures, was $1,059,217; and for the Arkansas marketing area, which includes the eight states referred to above not in the area, was $509,478. It is estimated that the value of black marble used in these eight states was $26,000. The value of black marble used in interior construction in the Arkansas marketing area proper in 1929 is, therefore, estimated to be $483,478.

In addition to the sales value of interior marble for 1929, the value of sales of marble for table tops and other ornamental and miscellaneous uses, including pedestals, for the entire United States, amounted to approximately $1,596,736. Figures which are available for states within the Arkansas marketing area, but which also include California, Massachusetts, New Hampshire, New Jersey, Pennsylvania, Vermont, Delaware, Georgia, Maryland, North Carolina, are given below:

Marble Table Tops

Illinois	$ 105,241	
California, Kansas, Louisiana, Massachusetts, Minnesota, Missouri, Nebraska, New Hampshire, New Jersey, Ohio, Pennsylvania, Vermont, and Wisconsin	38,963	
Total for Arkansas area (including ten states not in area)		144,204
New York		349,043
Total for United States		$ 493,247

Other Marble for Ornamental and Miscellaneous Uses, including Pedestals

Illinois, Kansas, Michigan, Minnesota, Missouri, and Wisconsin	$ 144,232	
California, Delaware, Georgia, Louisiana, Maryland, New Jersey, North Carolina, Ohio, Pennsylvania, Vermont, and Virginia	201,322	
Total for Arkansas marketing area (including ten states not in area)		345,554
New York		757,935
Total for United States		$1,103,489

It will be noted from the above that the value of the sales in New York State alone, for the year 1929, was 71 per cent of the total for the United States for marble table tops, and 69 per cent for other marble for ornamental and miscellaneous uses.

It is impossible to determine exactly what percentage of the sales of table tops and miscellaneous marbles were black marble sales. Assuming 10 per cent to be the approximate amount, the aggregate value for the two classes in the United States would be $159,673. It is estimated that the black marble value used in the Arkansas marketing area, which includes values for ten states not in the area, was $48,976; the estimated sales of black marble used for table tops and miscellaneous purposes in the ten states not in the Arkansas marketing area proper was $22,976; and the estimated sales for black marble for these uses for the Arkansas marketing area proper was, therefore, $26,000.

From the above, it may be assumed that the total value for 1929 of all black marble sold in the United States was $1,218,890, and that the total value for the same period of black marble sold in the most favorable Arkansas marketing area was $509,478.

If we further assume that 40 per cent of this value could have been produced by Arkansas quarrymen, then the total amount which could have been paid to these operators in 1929 for black marble blocks produced for the Arkansas marketing area would not have exceeded $203,791. This figure is useful for estimating the maximum yearly amount of sales of Arkansas black marble for several years to come. The figure, it should be noted, does not take into consideration the value of terrazzo.

If producers are to increase this figure, it will be necessary for them to sell outside the area of the states included in the above tabulation. The value of sales in the 27 states outside of the most favorable Arkansas marketing area in 1929 amounted to $18,324,630, 69 per cent of this being in the State of New York. That Arkansas black marble can be sold in this outlying area, through judicious marketing connections, has been demonstrated by shipments to New York City.

Size and preparation of blocks

The size of Arkansas black marble blocks compares well with those of the Belgian black marble blocks. Blocks measuring 8 feet by 5 feet by 8 inches have been shipped from Arkansas. The maximum thickness of blocks shipped to date is 32 inches. The shippers have been governed largely by the natural shape in which the blocks were taken from the ledge.

Prices

The maximum price which may be charged for Arkansas black marble will be controlled to a considerable degree by the Belgian black marble prices in this country. The price of Belgian black marble will, of course, vary from place to place in the United States, depending on the freight rates from the ports at which Belgian shipments are received. The maximum price of blocks, which, in the early part of 1932, could have been charged for Arkansas black marble blocks at New Orleans would be the price of Belgian blocks at New Orleans, less the cost of freight from quarries in northern Arkansas to New Orleans. An estimate of the maximum price which could have been charged for Arkansas marbles in 1932 is set forth in the following:

Comparative price of Arkansas black marble and Belgian black marble

Grade	Length	Price of Belgian blocks at New Orleans (per cu. ft.)	Freight from north Arkansas to New Orleans (per cu. ft.)	Est. maximum price of Arkansas blocks, f.o.b. cars north Arkansas, to compete with Belgian black (per cu. ft.)
No. 2	6½ feet long and less	$2.55	$0.80	$1.75
" 2	More than 6½ feet long	2.80	0.80	2.00
" 3	6½ feet long and less	2.10	0.80	1.30
" 3	More than 6½ feet long	2.35	0.80	1.55

The port of New Orleans was selected for comparison as it is the nearest port to the Arkansas marble deposits, although practically the same prices prevail at other gulf ports.

The average price of blocks, f.o.b. Batesville, has been about $2.50 per cubic foot, the maximum price being $4.00.

Slabs one inch thick, sawn in Belgium, are landed c.i.f. and tariff New Orleans. Ten slabs, one inch thick and one foot square (amounting to ten square feet), is the maximum which can be obtained from one cubic foot. Slabs from No. 2 blocks are quoted

at 41 cents per square foot; from No. 3 blocks, at 33 cents.

The charge for sawing one cubic foot into slabs at New Orleans is $1.25. Charges are higher in some localities, reaching $1.75 in New York. The charge for sawing black marble is usually slightly higher than for sawing other marbles.

If the blocks are to be shipped from ports by rail, the drayage charges from wharf to railroad terminal sometimes amounts to as much as 15 cents per cubic foot.

To estimate the maximum price which can be charged for blocks, f.o.b. north Arkansas, to meet the Belgian price for slabs at New Orleans, the sum of the per cubic foot freight charge from north Arkansas to New Orleans ($0.80) and the New Orleans sawing charge ($1.25), which is a total of $2.05, is deducted from the cost at New Orleans of ten square feet of Belgian slabs.

	No. 2	No. 3
Price of 10 square feet of Belgian slabs at New Orleans	$4.10	$3.30
Less freight and sawing charge	2.05	2.05
Estimated maximum block price, f.o.b. north Arkansas to meet Belgian slab price at New Orleans	$2.05	$1.25

TERRAZZO

Description and uses

Terrazzo consists of small chips or pieces of stone (usually marble or limestone) 3/32 to 7/16 of an inch in diameter, which are made by crushing and screening.

Terrazzo pavement is made by imbedding stone chips in Portland cement mortar, and is used principally in corridors, courts, rotundas, and lobbies.

The chips are prepared in four sizes and mixed in the desired proportion. For contrast, chips of two or more colors are used, with various backgrounds.

Terrazzo pavement is laid by skilled men, not every tile setter being skilled in assembling and finishing it. Terrazzo pavement specifications, as drawn by the architect, usually accompany the specifications for interior marble and tile, and the marble and tile contractor usually bids on the terrazzo paving along with the marble and tile work. If the successful bidder is not equipped, or does not have skilled terrazzo workmen, he sublets the terrazzo paving work to others who are equipped and who understand the technique. For this reason, practically all of the large marble manufacturers carry in stock a supply of terrazzo pavement chips of various colors, which usually include gray, red, pink, green, white, yellow, and black. Many of these chips are made from foreign marbles and are shipped into this country as crushed stone chips, or they are made in this country from the waste and cull stock from imported marbles.

Crushed black marble is used in the construction of terrazzo pavement because of its high contrast with lighter colored marbles. Black marble, which has been crushed and screened for this purpose, is furnished by the trade in the following four sizes:

No. 0, passing 3/16" screen, retained on 3/32" screen.
No. 1, passing 1/4" screen, retained on 3/16" screen.
No. 2, passing 3/8" screen, retained on 1/4" screen.
No. 3, passing 7/16" screen, retained on 3/8" screen.

Methods of distribution

Black marble chips, sometimes called Granito, are, for the most part, shipped into this country by the Belgian black marble producers and are marketed in much the same way as are their black marble blocks. Some of the distributors of the various marbles used in terrazzo pavement do not distribute block marble and some of the importers of Belgian black marble blocks do not distribute terrazzo.

Prices and competition

Wholesalers and manufacturers of chips send out price lists from time to time, giving price quotations on various kinds of chips. The prices are usually based on a per net ton of 2,000 pounds, in 100-pound bags. The price quoted is the same for each size of stone, whether it be on one or more sizes. Although a large tonnage of Belgian black marble blocks and Belgian black terrazzo reaches this country in the holds of ships as ballast, at a freight rate as low as 25 cents per ton, the price of Belgian black terrazzo has been maintained at a comparatively high figure.

Belgian

The price quoted by dealers on Belgian black chips in bags at the various ports is approximately $20 per ton. The following quotation, issued in February, 1932, is from the Brussels, Belgium, Office of the U. S. Bureau of Domestic and Foreign Commerce:

> "Marble chips may be purchased direct in Belgium from the Société Anonyme de Merbes Sprimont (Usines de la Buissier) Le Buissier, Hainaut, Belgium. This firm's quotations as of the above date were as follows: Black Belgian marble chips, Nos. 0, 1, 2, and 3 for the price of $6.40 per ton."

To the above price must be added all the charges making up a c.i.f. (cost, insurance, freight) price at American ports in order to estimate the delivered price at such ports. When it is considered that the lowest quoted price on chips from the more common domestic marbles, such as the grays, is $6.00 per ton, it is apparent that the price of Belgian black chips is well maintained.

Arkansas

Arkansas producers of black chips for terrazzo pavement have held the price, f.o.b. their plants, at about $11.00 per ton. The difference in price between the Belgian black and the Arkansas chips is a measure of the distance, in terms of freight rates, to which the Arkansas plants can ship their product at a profit. This suggests a potential market for Arkansas black marble chips in the states of the United States between the Appalachians and the Rocky Mountains. The Belgian black marble people are, however, keen competitors and it is to be expected that they will not surrender their practical monopoly of this business to the Arkansas plants without strong resistance.

Terrazzo from domestic black marbles outside of Arkansas will not offer serious competition for the reason that these chips do not polish a jet black and show light spots which detract from the contrast desired.

In the preparation of chips, about 50 per cent of the material is lost in the fine limestone fragments and dust produced. As the manufacturing costs are applied to all stone put through the plants, with only 50 per cent recovery in chips, the price of $6.00 per ton appears to be about the cheapest figure at which chips can be manufactured and sold at a profit in this country. It sometimes is possible to dispose of the "fines" and dressed material (3/32 of an inch in diameter and less) for shingle surfacing and fertilizer filler, in which case the cost of chips is slightly less.

RECOMMENDATIONS FOR MARKETING

Black Marble

Trade names

Arkansas producers of black, fossil, and gray types of marbles, all of which, according to trade practice, come under the head of "black marbles," should, first of all, adopt trade names for the various kinds of dark or black marbles they produce. These names should be similar to those that have long been in use and are familiar to the trade. They should also be suggestive of location and character. For instance, the name "Black Ark Fossil" has been proposed to designate a variety that resembles the "York Fossil." This name not only suggests the color and location, but its character as well. Names in use are "Arkansas Black," "Arkansas Fossil," and "Arkansas Gray."

Distribution

Arkansas producers should follow the methods of distribution and marketing now used in this country for both domestic and imported black marbles. Distributors of these marbles are so well established that it is necessary to obtain their cooperation in marketing. Unless this procedure is followed, a much longer period of time will be required to bring about the extensive use of Arkansas black marble. Full information, which will be of interest to marble manufacturers and their customers, regarding "Arkansas Black" marble should be furnished them.

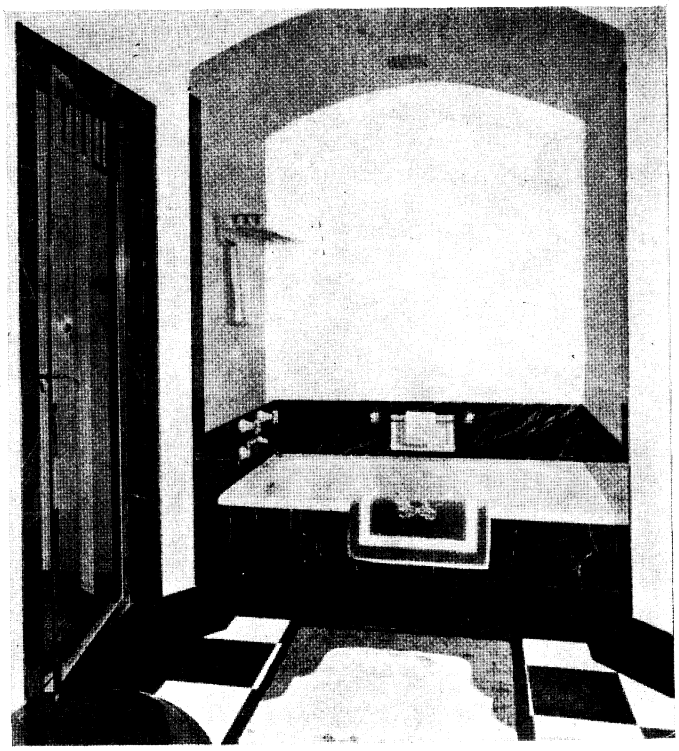
Negotiations should be entered into between Arkansas producers and marble dealers regarding the handling of Arkansas blocks on the same basis as other black marbles. If the dealers usually receive Belgian Black, or other black marbles, on consignment at their yards without investment in the blocks so consigned, then Arkansas producers should adopt the same practice.

As the architect who designs a building specifies the marble which is to be used, the names and addresses of all practicing architects should be obtained and suitable literature should be sent to them from time to time, in order to inform them of the Arkansas marble. The architect cannot be expected to specify something with which he is not acquainted.

Preparation of blocks

The preparation of "Belgian Blocks" for the market has been described. A purchaser of a Belgian block knows that he will be able to use the entire block without loss. The marble manufacturer cannot be expected to purchase "Arkansas Black" blocks if he has to lose a large percentage of them as waste. Even though due allowance be made for waste in the measurement of the block and for freight on the waste material, the purchaser is not fully compensated for the cost of handling the waste.

The question of correct measurement of marble blocks has always been a matter of contention. Arkansas producers should square their blocks either by sawing the ends and sides by scabbling or by dressing them with a point and hammer. Selling the blocks with the natural top and bottom surface does not offer a serious objection if the blocks have been squared. If the blocks are squared, there can be no question as to length and width, and allowance can be made for the sawbacks which can be taken off with little additional sawing expense, and can often be utilized. Those Arkansas producers not now squaring their blocks should make arrangements to do so, as this is a vital factor in marketing. They should also consider the installation of scabbling machines for dressing top and bottom surfaces.



A. Arkansas black marble used in the floor of a bathroom in the new Waldorf-Astoria Hotel, New York City.

B. Arkansas black marble installation in Lincoln County Courthouse, North Platte, Nebraska.

Terrazzo

The business of manufacturing and marketing terrazzo is so closely associated with the marble industry that the same recommendations for the Arkansas black marble block industry apply to it.

Arkansas producers of terrazzo should strive to place their product with present distributors. In order to do this, it will be necessary to offer lower prices than are being paid for Belgian black chips. The distributor will then be in a position to furnish Arkansas chips when Belgian chips are not specified.

As an instance of this, the sale of Belgian black chips by a large distributor in a north-central state during 1930 represented 95 per cent of his volume, the remaining 5 per cent being Vermont chips. He began distributing Arkansas black marble chips in 1931, and the ratio of sales for that year was 67 per cent Arkansas black chips and 33 per cent Belgian black chips. The switch to Arkansas chips not only meant giving his customers a product of equal utility but afforded a saving to them of from $2 to $6 per ton. No doubt a part of this saving was passed on to the owners of the buildings in which the terrazzo was placed. Thus, it will not only be profitable to the Arkansas producers of black terrazzo to have the good will of the distributors who handle their product, but it will also be profitable to the distributors as well, and will, in most instances, afford a substantial saving to purchasers of terrazzo floors.

CONCLUSIONS

Black marble

With due consideration to all the factors of marketing and ordinary efficiency in quarrying operations, it appears probable that Arkansas producers of black marble can compete with other producers of black marble, both domestic and foreign, in practically the entire United States, and will have a distinct price advantage in the 21 states lying between the Appalachians and the Rocky Mountains.

Terrazzo

It is evident that the business of producing black marble chips in Arkansas is one that will assist greatly in the development of black marble deposits within the state, and will provide a source of income to the marble producers during the early years of the industry while the use of the marble is being established. The margin between cost and sales price is such that a sufficiently low price can be offered to distributors to cause them to handle the product.

DEVELOPMENTS

The following companies have undertaken the development of black marble in Arkansas, to June 15, 1932:

AMERICAN BLACK MARBLE COMPANY

Office address: 1804 Grand Avenue, Kansas City, Missouri.
Officers: Bert V. Brown, President.
Location of quarries: NW.¼ sec. 26, T. 14 N., R. 10 W., Stone County (Quarry 10)
SE.¼ sec. 9, T. 14 N., R. 11 W., Stone County (Quarry 11)
Number of acres under lease: 537.
Production: none.
Remarks: Not in operation.

ANDERSON & McMEIN

Office address: Kansas City, Missouri.
Location of quarries: NE.¼ sec. 8, T. 14 N., R. 11 W., Stone County (Quarry 12)
SW.¼ sec. 23, T. 14 N., R. 15 W., Searcy County (Quarry 15)
Production: one truck load and part of one car load of blocks.
Remarks: Not in operation.

BATESVILLE BLACK MARBLE COMPANY

Office address: Gem Theater Building, Batesville, Arkansas.
Incorporated: August 19, 1930, State of Arkansas.
Capitalization: $15,000, 750 shares common stock, no par value.
Officers: T. L. Thogmartin, President, O. K. Thogmartin, Vice President,
George J. Terry, Secretary-Treasurer.
Location of quarries: SE.¼ SE.¼ sec. 8, T. 12 N., R. 6 W. (Quarry 4)
E.½ SE.¼ sec. 27, T. 13 N., R. 7 W. (Quarry 7)
SE.¼ sec. 27, T. 13 N., R. 7 W. (Quarry 8)
E.½ SW.¼ sec. 22, T. 13 N., R. 7 W. (Quarry 9)
All in Independence County.
Number of acres under lease: 1,000.
Production: 15 car loads of blocks, 16 car loads of terrazzo.
Remarks: In operation.

BROWN & ANDERSON

Office address: Kansas City, Missouri.
Location of quarry: NW.¼ NW.¼ sec. 6, T. 14 N., R. 11 W., Stone County (Quarry 13)
Production: One car load of blocks.
Remarks: Not in operation.

DENTON & WALDO

Office address: Leslie, Arkansas.
Officers: S. O. Denton and V. H. Waldo.
Location of quarry: SW.¼ NW.¼ sec. 26, T. 14 N., R. 15 W., Searcy County
(Quarry 16)
Number of acres under lease: 1,000.
Production: 6 car loads of blocks, 5 car loads of terrazzo.
Remarks: In operation.

DEVONIAN MARBLE COMPANY

Office address: 322 Euclid Avenue, Cleveland, Ohio.
Arkansas address: Batesville, Arkansas.
Incorporated: July 9, 1930, State of Delaware.
Capitalization: $33,181.79.
Officers: Paul H. Bradley, President.
Location of quarries: NE.¼ SE.¼ sec. 2, T. 12 N., R. 7 W. (Quarry 5)
NW.¼ NW.¼ sec. 10, T. 12 N., R. 7 W. (Quarry 6)
Both in Independence County.
Production: 5 car loads of blocks.
Remarks: Out of business.

List of Marble Importers, Dealers and Manufacturers in the United States

City and State	Company
Atlanta, Ga.	Reeves Marble Co.
Baltimore, Md.	Hilgartner Marble Co.
Baltimore, Md.	Jos. B. Dunn & Sons, Inc.
Birmingham, Ala.	Alabama Marble Co.
Boston, Mass.	Troy Bros. & Co.
Boston, Mass.	United American Soda Fountain Co.
Brooklyn, N. Y.	Atlantic Marble Co., Inc.
Brooklyn, N. Y.	Bensonhurst Marble Works, Inc.
Brooklyn, N. Y.	Brooklyn Marble Co., Inc.
Brooklyn, N. Y.	Equity Marble Co., Inc.
Brooklyn, N. Y.	Grand Marble Works, Inc.
Brooklyn, N. Y.	Reiley Marble Works
Brooklyn, N. Y.	South Brooklyn Marble Co.
Buffalo, N. Y.	Geo. W. Maltby & Son Co.
Buffalo, N. Y.	Robert K. Glass & Co., Inc.
Carthage, Mo.	Arnosti Marble Co.
Carthage, Mo.	Carthage Marble Corp.
Carthage, Mo.	Lautz Missouri Marble Co.
Chicago, Ill.	American Marble Mill Co.
Chicago, Ill.	Black & Gold Marble Co.
Chicago, Ill.	Chicago Art Marble Co.
Chicago, Ill.	Corley-Meservey Marble Co.
Chicago, Ill.	Davia Bros. Marble Co.
Chicago, Ill.	Enterprise Marble Co.
Chicago, Ill.	Flavin Marble Mill
Chicago, Ill.	Frank P. Bauer Marble Co.
Chicago, Ill.	Henry Marble Co.
Chicago, Ill.	Jas. B. Clow & Sons Co.
Chicago, Ill.	M. Keating & Sons Co.
Chicago, Ill.	Peerling Marble Co.
Chicago, Ill.	Standard Mosaic Tile Co.
Chicago, Ill.	McCue Marble Co.
Chicago, Ill.	Liquid Carbonic Corp.
Cicero, Ill.	National Mosaic Tile Co.
Cincinnati, Ohio	Cincinnati Marble Co.
Cleveland, Ohio	Allen Marble Co.
Cleveland, Ohio	Empire Marble Co.
Cleveland, Ohio	Haworth Marble Co.
Cleveland, Ohio	Interior Marble & Tile Co.
Cleveland, Ohio	Prospect Marble & Tile Co.
Cleveland, Ohio	Roy-Cliff Marble Co.
Cleveland, Ohio	The Norcross Marble Co.
Columbus, Ohio	Wege Marble & Tile Co.
Dallas, Texas	Vermont Marble Co. of Texas
Dallas, Texas	Georgia Marble Co. of Texas
Dallas, Texas	Southwest Marble Co.
Denver, Colo.	McElhinney Tile & Marble Co.
Denver, Colo.	Denver Mantel & Tile Co.
Des Moines, Iowa	Des Moines Marble & Mantel Co.
Des Moines, Iowa	Rowat Cut Stone Co.
Detroit, Mich.	Christa-Batchelder Marble Co.
Detroit, Mich.	Detroit Marble Co.
Detroit, Mich.	Northern Marble Corp.
Detroit, Mich.	Wolverine Marble Co.
East Cambridge, Mass.	Johnson Marble Co.

City and State	Company
Fort Worth, Texas	Good Marble & Tile Co.
Houston, Texas	Salt Lake Marble & Supply Co.
Indianapolis, Ind.	F. E. Gates Marble & Tile Co.
Joliet, Ill.	Adam Gorth & Co.
Kansas City, Mo.	Kansas City Marble & Tile Co.
Kansas City, Mo.	Phenix Marble Co.
Kansas City, Mo.	Sutermeister Stone Co.
Kasota, Minn.	Babcock & Willcox
Kasota, Minn.	Breen Stone & Marble Co.
Knoxville, Tenn.	Candoro Marble Co.
Knoxville, Tenn.	Gray Eagle Marble Co.
Knoxville, Tenn.	Gray Knox Marble Co.
Knoxville, Tenn.	John J. Craig Co.
Knoxville, Tenn.	Ross & Republic Marble Co.
Knoxville, Tenn.	Tennessee Producers Marble Co.
Knoxville, Tenn.	Columbia Marble Co.
Knoxville, Tenn.	Andres Stone & Marble Co.
Little Rock, Ark.	Southwestern Marble & Tile Co.
Long Island City, N. Y.	Clarendon Marble Co.
Los Angeles, Calif.	Hilgarten Marble Co.
Los Angeles, Calif.	Musto Keenan Co.
Louisville, Ky.	Peter & Burghard Stone Co.
Mankato, Minn.	T. R. Coughlan Co.
Marble, Colo.	Yule Colorado Marble Co.
Memphis, Tenn.	Central Mosaic & Tile Co.
Milwaukee, Wis.	Andres Stone & Marble Co.
Milwaukee, Wis.	Arnosti Marble Co.
Milwaukee, Wis.	Breidster Marble Co.
Milwaukee, Wis.	McClymont Marble Co.
Minneapolis, Minn.	Twin City Tile & Marble Co.
Minneapolis, Minn.	Northwestern Marble & Tile Co.
Newark, N. J.	Geo. Brown & Co.
Newark, N. J.	Columbia Marble Works, Inc.
Newark, N. J.	Henry R. Isenberg Co., Inc.
Newark, N. J.	R. Young & Son
New Orleans, La.	Albert Weiblen Marble & Granite Co.
New York, N. Y.	Aetna Marble Co.
New York, N. Y.	Antonio Biggi, Inc.
New York, N. Y.	Atlas Architectural Marble Works
New York, N. Y.	Borgia Bros. Co.
New York, N. Y.	Williams Bradley & Son
New York, N. Y.	Calano & Co., Inc.
New York, N. Y.	Cullo & Son Marble Co., Inc.
New York, N. Y.	John J. Deery Co.
New York, N. Y.	F. DeBellegarde, Inc.
New York, N. Y.	Friedman Marble & Salt Works, Inc.
New York, N. Y.	Charles M. Gray Marble & Slate Co.
New York, N. Y.	C. D. Jackson & Co., Inc.
New York, N. Y.	Jerome A. Jackson
New York, N. Y.	Majestic Marble Crafts, Inc.
New York, N. Y.	McGowan & Connelly Co.
New York, N. Y.	McGowan Marble Co., Inc.
New York, N. Y.	McGraty & Sons
New York, N. Y.	McLaury Marble Corp.
New York, N. Y.	Marchettia Marble Co., Inc.
New York, N. Y.	Miller-Druck Co.
New York, N. Y.	Pisana Bros., Inc.
New York, N. Y.	Reese-Volckmann

City and State	Company
New York, N. Y.	Schackt-Williams Marble Co.
New York, N. Y.	P. M. & W. Schlichter, Inc.
New York, N. Y.	Scolaro Marble Co., Inc.
New York, N. Y.	Sheridan & Milko, Inc.
New York, N. Y.	Schuttleworth Co.
New York, N. Y.	Alexander Thompson & Son
New York, N. Y.	Tompkins-Kiel Marble Co.
New York, N. Y.	Villano Brothers
New York, N. Y.	Voska, Foelsch & Sidlo, Inc.
New York, N. Y.	Yorkville Marble Co.
Oklahoma City, Okla.	Taylor Marble & Tile Co.
Omaha, Neb.	Sunderland Bros. Co.
Peoria, Ill.	Peoria Stone & Marble Works
Pittsburgh, Pa.	American Marble Co.
Pittsburgh, Pa.	Charles C. Guenther Marble Co.
Pittsburgh, Pa.	Iron City Marble Co.
Pittsburgh, Pa.	Pennsylvania Marble & Mosaic Co.
Proctor, Vermont	Vermont Marble Co.
St. Louis, Mo.	Bradbury Marble Co.
St. Louis, Mo.	Interstate Stone & Marble Works
St. Louis, Mo.	Shaw Marble & Tile Co.
St. Louis, Mo.	Union Marble & Tile Co.
St. Louis, Mo.	Weis & Jennett Marble Co.
St. Louis, Mo.	Fitze Marble & Tile Co.
St. Louis, Mo.	Guidicy Marble, Terrazzo & Tile Co.
San Francisco, Calif.	American Marble Co.
St. Paul, Minn.	Drake Marble Co.
Tate, Georgia	Georgia Marble Co.
Wichita, Kan.	Hawkins Marble & Tile Co.
Wilkinsburg, Pa.	United States Marble Co.
Winchester, Mass.	Puffer Manufacturing Co.