ARKANSAS RIVER REGION REPORT

VOLUME III
ECONOMIC BASE

SECTION D
MINERAL AND WATER RESOURCES

PART 1 - MINERALS
CHAPTER 4

Prepared by

Industrial Research and Extension Center
College of Business Administration
University of Arkansas
Little Rock

and

Arkansas Geological Commission
Little Rock

for

Arkansas Planning Commission

August, 1966

This report was financed by the State of Arkansas and an Urban Planning Grant from the Housing and Home Finance Agency under the provisions of Section 701 of the Housing Act of 1954 as amended.

TABLE OF CONTENTS

H. E. Risser, Mineral Economist

LIST OF FIGURES

LIST OF TABLES

CHAPTER 4

POTENTIAL EFFECTS OF THE ARKANSAS RIVER DEVELOPMENT ON THE ARKANSAS RIVER REGION MINERAL INDUSTRY

Many of the common mineral commodities, because of their low unit value, their great bulk, and the relatively limited areas in which they occur, carry transportation costs equal to or greater than the initial value of the commodity at the source. For this reason, the mineral deposit nearest the point of consumption usually enjoys a considerable competitive advantage over minerals of similar grade or quality from more distant sources. The advantage of proximity to market can be offset, however, when cheaper means of transportation are available to the more distant resources. The pipeline movement of liquid fuels, for example, and the barge movement of stone, gravel and coal are less expensive than movement of the same commodities by rail.

With completion of the work now under way, low-cost river transportation will be available for products from the central part of Arkansas. The Arkansas River will become a part of the extensive Mississippi River System and will be tied to the Ohio River, the Illinois Waterway, and the Gulf Coast and Gulf Intracoastal Systems. This water network and the water distances from the mouth of the Arkansas River to various port cities are shown in Figure 4.01.

Barge transportation on inland waterways has long been recognized as one of the most economical means available for large scale movement of bulk materials. Manufactured and semi-finished products also are moved by barge, but it is the bulk commodities that are most adaptable to such movement. Some of the bulk mineral commodities moving on the Mississippi River are shown in Table 4.01.

Although, as with any type of transportation, the cost will vary according to conditions, the frequently quoted cost for barge freight is three to four mills per ton mile. Dr. Joseph Hartley, in a study of Ohio River barging costs, estimated the cost of barge movement of coal on that river at four mills per ton mile, compared to about 11 mills per ton mile for rail movement of the same commodity.[1] One of the important factors influencing the ton-mile cost is the distance traveled. Figure 4.02, showing barging costs estimated by the Federal Power Survey, demonstrates the effect of distance on costs.

Although the ton-mile cost for moving a given commodity may be approximated, there is no figure generally applicable. Rates vary according to location, distance and commodity moved, as shown in Table 4.02. In Table 4.03 are shown the direction and cost of shipment of minerals from Arkansas by rail.

Truck transportation costs, on a per-ton mile basis, are several times those for rail and barge, normally ranging from 3 to 5 cents per ton-mile when an empty back haul is involved.

The installation of "unit trains" for trainload shipments of coal and other commodities has led to the establishment of some rail rates about half those quoted above, or approximately 4 to 7 mills, depending on whether the rolling stock is owned by the shipper or by the railroad.

For a realistic comparison of rail and river transportation, the disadvantages as well as the advantages of barge transportation must be recognized and considered. River shipments travel at a slower rate of speed and, because

---

[1]Joseph R. Hartley, The Economic Effects of Ohio River Navigation (Bloomington, Indiana: School of Business, University of Indiana, 1959).

frequently they must follow a more circuitous route, they may travel a greater distance to reach their destination. Furthermore, except where the producing mine or plant and the consumer's location are both on the waterway, additional handling or transfer costs may be involved. Typical transfer costs are on the order of 15 cents per ton.

The potential effects of the availability of river transportation on markets for Arkansas minerals will stem primarily from a lowering of shipping costs that will make Arkansas minerals more competitive with the same mineral commodities occurring in other regions, or from making commodities from Arkansas available at points where they are now too expensive to utilize. Another potential benefit from cheaper transportation is a lowering of the costs of importing, from other regions, materials that may be processed inside the State, perhaps in conjunction with indigenous minerals.

While the availability of low-cost barge rates is perhaps the most important result of river improvement, the effect of these rates on the cost of other competitive forms of transportation also can be very significant. Regardless of the reason, any increased mineral industry activity based on improved transportation will result in increased employment and economic activity.

In the following sections, each of the major Arkansas mineral commodities will be analyzed individually in relation to the potential effects of the waterway. The geographic location of the major consuming industries with respect to the waterway, and the relative location and resource positions of the other areas that can supply the mineral requirements will be examined.

Coal

The decline in coal production in Arkansas was discussed in Chapter 3. This decline was largely the result of competition from low-cost natural gas available from fields within the State and adjoining states, and from easily mined low-cost coal available in the nearest states with which Arkansas coal must compete for general fuel markets.

A wide difference in coal bed thickness and productivity of workmen exists between the various states, as shown in Table 4.04. The data shown in the Table, however, represent a composite of mines of various sizes and types. In general, large and highly mechanized mines have a greater efficiency and lower cost in spite of operating in relatively thin beds. Many large mines in other states have annual outputs exceeding by several times the tonnage of the entire State of Arkansas, and are able to acquire a high productivity through use of large equipment that cannot be justified by the present market supplied by Arkansas. With expanded markets to justify greater mechanization and larger equipment it is likely that lower costs could be attained in Arkansas.

In spite of the relative disadvantage of thinness of bed, the coals of Arkansas possess certain advantages also. One of these advantages lies in their low to medium volatility which makes them suitable for coking blends and also gives them smokeless characteristics. The coals of Illinois, Indiana, West Kentucky and Missouri are high volatile coal.

A second advantage is that Arkansas coals have a higher heat value than the Illinois, Indiana and West Kentucky coals, and less coal is required to provide the same energy.

Arkansas Coal for Coke

Very few coals of the United States can be used alone for the manufacture of coke, the rare exceptions being a few of the medium volatile coals of the Nation. Nearly all of the coke now manufactured is produced from blends of low volatile and high volatile coals or, in some cases, of high and medium volatile coals, mixed in proper proportions to obtain coke of satisfactory strength. Sources of low volatile coal available for such blends are relatively few. The low volatile coal fields of southern West Virginia and northern Virginia, containing the famous Pocahontas low volatile coal beds provide such coal for a major portion of the Nation's coke ovens. It is principally with low volatile coal from this source that Arkansas coal would have to compete if it were to enter the coking coal market by way of water transportation.

In 1964, oven-coke plants of the United States used 59.2 million tons of high volatile, 11.5 million tons of medium volatile and 19.6 million tons of low volatile coal, according to the United States Bureau of Mines.[2]

Figure 4.03 shows the location of the Arkansas coal fields with respect to the waterway system. Also are shown the location of the low volatile coal fields of southern West Virginia and northern Virginia, the medium to high volatile coal of Alabama, and the coke oven plants most accessible from Arkansas by water transport.

---

[2]United States Department of the Interior, Bureau of Mines, Minerals Yearbook, 1964: Volume II, Mineral Fuels, p. 245.

The most logical targets for Arkansas coal at the present time appear to be plants at Granite City, Illinois and Houston, Texas. Plants in Chicago and Birmingham are too far by water from Arkansas, compared to the distance by rail from the eastern field, to be considered competitive at this time.

The coke ovens of the Granite City Steel Company were reported to have consumed 1,140,536 tons of coal in 1964.[3] Seventy-nine percent of this coal was high volatile Illinois coal and the remainder, amounting to almost a quarter of a million tons was low volatile coal from the southern West Virginia area indicated in Figure 4.03. It is with this eastern low volatile coal that Arkansas coal would have to compete in order to enter the coking coal market at Granite City. Research in the laboratories of the Illinois State Geological Survey has shown that Illinois high volatile coal and Arkansas low volatile coal can be blended to produce a coke that satisfactorily meets the standard tests for metallurgical use.

The distance to Granite City from southern West Virginia, via the Chesapeake and Ohio Railway is about 625 miles. The rail freight rate for shipments of 1,500 tons or more, at the beginning of 1964, was $4.49 per ton.

The distance by river to Granite City from the Arkansas coal fields is approximately 838 miles. At 3.4 mills per ton mile--the rate indicated for this distance in Figure 4.02--the cost would be $2.85 per ton. If, as some authorities estimate, the rate for movement of barge freight from Arkansas can be held to a cost of 3 mills per ton mile, the cost to Granite City would

---

[3]Keystone Coal Buyers Guide (New York: McGraw-Hill, Inc., 1965).

be $2.51 per ton. An additional handling charge of perhaps 15 cents per ton would be required at the docks at Granite City. A savings of $1.43 to $1.83 is indicated. This is approximately equivalent to the differences in the reported average values of coal, f.o.b. the mine, in each of the two regions.

The second possible target for Arkansas coking coal is Houston, Texas. The Armco Steel Corporation's coke oven plant at Houston was reported to have consumed 419,436 tons of coal in 1964.[4] Thirty-five percent of this was high volatile coal from West Virginia, 35 percent medium volatile coal from Alabama, and 30 percent low volatile from Oklahoma. Reports indicate that the coking coal entering the region from West Virginia and Alabama was shipped via waterway.[5]

Arkansas coal could not be used to replace the West Virginia high volatile coal but might, under the proper competitive conditions, be substituted for the medium and low volatile coal reported from Alabama and Oklahoma.

The medium-to-high volatile coal fields of Alabama lie 360 to 400 miles north of Mobile, Alabama, via the Warrior River. To Houston from Mobile is 561 miles. Thus, the total distance from the Alabama coal fields to Houston is about 921 to 960 miles.

The distance from the Arkansas coal fields to the Mississippi River is approximately 300 miles, and the distance from the juncture of the Arkansas

---

[4] Ibid., p. 238.

[5] U.S. Department of the Interior, Bureau of Mines, Bituminous Coal and Lignite Distribution, Calendar Year 1964, p. 15.

waterway with the Mississippi River to the port of Houston is another 920 miles, making a total of 1,220 miles.

Some low volatile coal is reported to move from eastern Oklahoma to Houston by rail.[6] In 1966, rail rates to Houston for coal moving from points on the Arkansas-Oklahoma line (Ft. Smith, Arkansas) ranged from $5.07 to $5.67 per ton. For a waterway distance of 1,220 miles to Houston from the Arkansas coal fields, estimated on the basis of 3.4 mills per ton mile, the shipping cost would be $4.11. At 3.0 mills, it would be reduced to $3.66. Thus, a savings of one to two dollars might be realized, through waterway rather than rail movement, in spite of the increased handling required.

Another possibility for some river shipments of coal is in export markets. Most low volatile coal is exported from the Appalachian fields to Europe and elsewhere. Growing coke production for steel in Japan and for Latin American countries offers some potential for Arkansas coal.

Arkansas Coal for General Fuel Use

Arkansas coals are at a comparative disadvantage in seeking general fuel markets to the west or southwest, because of the availability of natural gas and oil throughout most of the area. These fuels possess not only the advantage of greater convenience for most uses, but also of lower price. Furthermore, in those locations to the immediate west where coal still is used, the Oklahoma and Kansas coal fields have an advantage of closer proximity. These factors make it appear that any expansion of the use of Arkansas coal

[6] Keystone Coal Buyers Guide, *op. cit.*, p. 218.

in general fuel markets must be based on improved ability to compete with the low-cost coal fields lying to the east.

On the waterway system to the east, the nearest competitive coal is in the large field lying in parts of Illinois, Indiana and Kentucky, shown in Figure 4.04. At a greater distance are the fields of the Appalachian area, and the smaller fields of Missouri and Alabama. The Illinois-Indiana-West Kentucky field contains reserves estimated at more than 200 billion tons, much of which occurs in beds measuring five to eight feet in thickness. Because of the major influence that bed thickness exerts on the productivity of workmen, especially in underground mining, lower production costs normally can be expected in these coal beds than in the thin coal beds of Arkansas.

One factor helps to offset, at least to some extent, the problem of thin seam mining. The price of coal purchased by utilities and most industrial consumers is based on cost per million Btu's of delivered energy. Arkansas coal with a heat content generally in excess of 13,500 Btu's per pound has a relative advantage when compared to Illinois coal with 11,000 to 11,500 Btu's.[7] This is a factor that must be given full consideration when comparing coals from the two states, both with regard to mining and transportation costs. On an energy cost basis, Arkansas coals might be expected to compete at prices and distances roughly 15 percent greater. The cost, then, of moving a unit of energy 300 miles down the Arkansas River to its mouth would be approximately equivalent to that of moving coals of lesser heat value a distance of 260 miles.

---

[7] Ibid., pp. 329 and 341.

Numerous docks are available on the Ohio, Tennessee and Green rivers that can load coal in competition with Arkansas coal. In 1965 the nearest of these was at Joppa, Illinois, 483.5 miles above the mouth of the Arkansas Waterway. A second dock, on the Tennessee River at Paducah, Kentucky, is at a distance of 501 miles. On the Mississippi River, the nearest coal-loading dock is at Ford, Illinois, 557 miles above the Arkansas. The location of these docks is shown in Figure 4.04. Each of the three docks is a rail-to-river transfer point and coal must be transported varying distances from the coal fields to the docks. Coal loaded at Joppa must travel overland from the mining region to the dock, a distance of approximately 35 miles, at a cost equivalent to that of perhaps 100 miles by water, whereas coal from Arkansas mines should require considerable less land travel.

To the south and southeast, the nearest competitive coal is from the Alabama fields. These fields lie 520 to 560 miles from New Orleans, and 649 to 689 miles from Baton Rouge. Arkansas coal would be about 691 miles from Baton Rouge, and from a barge distance standpoint the coals would meet at about this point. Alabama and Arkansas coals are approximately equal in heat value.

From Arkansas to New Orleans by water is about 820 miles. At 3 mills per ton mile the cost to this point would be $2.46 plus handling charges. The rail cost in 1965 was $5.57 per ton (Table 4.02).

Quantities of coal are consumed by electric utilities east of Mobile, and some of the coal shipped down the Mississippi as far as Tampa, Florida, is used in this market. The balance is consumed for various other purposes.

In 1964, a total of 1,655,656 tons of coal was shipped through the section of the Mississippi River between Cairo, Illinois, and Baton Rouge.

Another 1,236,536 tons of coal shipments terminated within this Region, most of it being unloaded at Memphis.

Because of the availability of low-cost natural gas nearby, all of the power plants west of Mobile, Alabama, use this fuel. This is expected to continue to be true for the most part, though some regions where gas formerly was used exclusively in the past are gradually turning to coal because of the increased gas cost. In the West South Central Region, consisting of Arkansas, Louisiana, Oklahoma, and Texas, the average price of gas used as utility fuel has risen almost 72 per cent in the past ten years. But in 1964, this cost still averaged only 19.6 cents per million Btu's. This is equivalent to a cost of less than five dollars per ton of coal.

It appears unlikely that the decreased transportation costs resulting from the Arkansas River improvement will be sufficient to offset higher mining costs for coal for general uses in the immediate future. Even though Arkansas coal at the present time would have difficulty in competing for coal markets to the north and against natural gas to the west and south, recent developments in air pollution control bear watching. A number of years ago, Arkansas coal was highly favored in metropolitan areas because of its smokeless burning characteristics. The advantage arising from this factor was lost as natural gas rapidly replaced coal within the market area for nearly all uses. In large power plants that are using coal in other parts of the country, modern combustion equipment has largely solved the problem of smoke control. However, no economical means has yet been found for either removing the sulfur from coal or from the combustion gases to bring it within limits recently proposed by various governmental agencies.

Most of the coal lying within the Illinois-Indiana-Kentucky Region ranges from 1.6 to 3 percent or more in sulfur. The analyses of some Arkansas coals show a content of less than 1 percent sulfur. It is unlikely that much Arkansas coal will ever be mined at sufficiently low costs to actually displace the other coals to the north. Further, the reserves of Arkansas coal would be inadequate to sustain the entire coal consumption of the Midwest for more than a very short period of time. However, should rigid sulfur specifications be placed in effect, it is conceivable that quantities of Arkansas coal might be blended with other coals to lower the average sulfur analyses to acceptable limits.

In 1964, the bituminous coal industry of the United States employed 128,698 men for an average of 225 days. Annual tonnage per man was 3,783 tons. Because of the more difficult mining condition, a somewhat larger employment might be anticipated in Arkansas for a given tonnage produced. Employment also would be influenced by the type of mining, i.e., strip versus underground.

The canalization of the Arkansas River can considerably strengthen the competitive position of Arkansas coal, but the coal beds of Arkansas are considerably thinner than most of those with which they would compete and this, other things being equal, would normally make them more costly to mine. Efficient and economical mining will help to narrow the difference in cost but will require large scale mechanized mining and a steady market.

The potential for Arkansas coal at present appears greatest in the markets for low volatile coal for use in the manufacture of metallurgical coke. Expansion of demand for coal for power generation and other uses downstream also holds some promise. Should the trend toward stricter specifications on sulfur content continue, the relatively low sulfur coal of Arkansas may be favored for this reason.

Stone

Stone, considered a common material in most parts of the country, is relatively limited in availability in states of the lower Mississippi Valley and the Gulf Coast. Figure 4.05 shows counties for which stone was reported produced in 1964. Along the Gulf Coast, production of shell, used as a substitute for stone in some uses, is indicated.

Below the juncture of the Ohio and Mississippi rivers, the only county lying along the river that reported stone production was Warren County, Mississippi. Here, crushed limestone and marl were produced for use in the manufacture of cement.

Above the Ohio-Mississippi River junction, crushed stone, dimension stone and rip-rap are produced. It is with stone from this area that rip-rap and crushed stone shipped down the Arkansas Waterway is most likely to compete. The distance from the nephelen syenite and sandstone regions of Arkansas to the Mississippi River is less than 200 miles, whereas the distance from Cairo, Illinois to the same point is 450 miles.

Table 4.01 shows the combined tonnages of sand, gravel and crushed rock moving on the segment of the Mississippi River extending from Cairo, Illinois to Baton Rouge, Louisiana. Because of the scarcity of stone at the lower end, it can be assumed that little or no stone moves in an upstream direction, and that very little if any downstream movement of stone originates within the segment. Down-bound shipments, both inbound and through the segment amounting to 135,000 tons in 1964, may be assumed to be principally of stone.

Arkansas stone would have a distance advantage of 250 river miles in competing against other states for downstream markets for both rip-rap and general purpose crushed rock.

At a cost of three and one half mills per ton mile, river transportation of stone from Arkansas to New Orleans would be about $2.52 per ton. At three mills per ton mile it would be $2.16 per ton. The 1965 rate by rail was $2.77 per ton from Little Rock to New Orleans and $2.94 to Lake Charles, Louisiana.

The reduced cost of shipping by barge will considerably strengthen the competitive position of Arkansas stone and should result in a significant production increase in the future. Potential water shipments will come from replacement of stone now traveling the Mississippi River from more distant sources, stone shipments now moving to the Gulf area by rail, and the general growth in stone consumption resulting from population growth and economic expansion.

Sand and Gravel

Sand and gravel normally are so plentiful and of so low per unit value that their markets are limited to only short distances from their sources. The general exception to this is high grade special sands, generally silica, used for glassmaking and other industrial purposes.

Sand production commonly occurs along the stream valleys, where it is concentrated by stream action. Figure 4.06 shows general areas of sand production in the Arkansas Valley. Also shown on the Figure is the location of counties along the Mississippi River reporting sand and gravel production during 1964.

Table 4.01 does not designate sand and gravel separately from crushed stone, but combines them in one item (554). Of the 2.35 million tons of these products moving on the lower Mississippi River (i.e. the section between Cairo, Illinois and Baton Rouge, Louisiana) in 1964, about 2.1 million tons originated and terminated within the Region. Since there are no major sources of crushed stone near the river within this segment, it may be assumed that most of this movement was of sand and gravel.

With the numerous deposits of sand and gravel available adjacent to the Mississippi River, it appears unlikely that any significant movement of Arkansas sand and gravel will occur outside the State.

Clays

Clays of various types are widely distributed throughout the Central United States. Miscellaneous clays are used in the manufacture of brick, tile, light-weight aggregates, and other products used largely in construction. Less common types are fire clay, used in the manufacture of refractory and heavy clay products, and ball clay, used primarily in the manufacture of whiteware and floor and wall tile. In a few places throughout the Central United States, bentonite, used in drilling muds for oil well drilling, can be found.

The widespread production of clays of various types is indicated in Figure 4.07 where the clay-producing counties are shown. Because of the common occurrence of clays for the manufacture of brick, tile and other common ceramic goods, the market for these is highly competitive. As seen in this Figure, fire clays suitable for making refractory products are produced in fewer locations. Relatively few sources of production are located near the waterway system south of Missouri, which is the third most important producer in the Nation, being exceeded only by Ohio and Pennsylvania.

Table 4.01 shows that relatively minor quantities of clay products (items 540, 543, and 547) move on the lower Mississippi at present. It appears that river transportation will have limited effect on markets for general clay products from Arkansas. However, this low-cost means of transportation may enable the refractory products of Pulaski County to more readily penetrate markets unavailable to them at present.

Bauxite and Aluminum

The alumina-producing capacity of the United States in 1963 was rated at 5,459,500 short tons. (See Figure 3.04.) Of this capacity, the Hurricane Creek plant of the Reynolds Metals Company accounted for 803,000 tons and the Bauxite plant of Alcoa for 420,000 tons. The remaining 4,236,500 tons, or almost 78 percent, of the total capacity lay at points along the Gulf of Mexico, and operated entirely on imports of foreign bauxite. Alumina and aluminum plant locations are shown in Figure 4.08.

Figure 3.04 indicates that during 1963, in addition to the 1,478,000 tons of bauxite produced in Arkansas, 335,000 tons were imported into the State from British Guiana and more than 600,000 tons from Jamaica. In the past, such shipments have come by rail. The waterway will make water shipment possible, although transfer to some form of land transportation will be required. At its nearest point, the river is approximately 20 miles from the existing alumina plants. If such shipments were made, Arkansas mineral products, perhaps stone or coal, could provide return cargo to the Gulf.

The Arkansas River can also provide a water outlet for alumina and aluminum produced within the State. The alumina plants near Little Rock, Arkansas, are 200 miles nearer, by water, to the aluminum plants on the Ohio and Tennessee rivers than are the alumina plants on the lower Mississippi Waterway.

In Table 4.01 an upbound through tonnage of 423,879 tons, classified as aluminum ores, concentrates and scrap (item 617) is shown. Of this quantity, all but 4,507 tons entered the mouth of the Ohio River at Cairo. Ports along the Ohio River received 370,000 tons and those on the Tennessee River, shipments of almost 50,000 tons. Because no alumina plants are reported for this area, most of this material is assumed to be alumina destined for reduction plants.

Aluminum billets were reported shipped 937 miles from Jones Mills, Arkansas to Butler, Pennsylvania in 1965, by rail, at a rate of $18.60 per ton. Combined water and rail transportation between these same points when the Arkansas River development is completed will require 1,591 miles of barge movement from Little Rock to Pittsburgh and an estimated 100 miles by rail or highway, part of which will occur at each end of the trip.

In 1965 aluminum was shipped by barge at the following rates:

Item	From	To	Miles	Rate	Mills/ton mile
Ingots, pigs, slabs	Corpus Christi, Texas	Johnsonville, Tennessee	1,690	$8.75	5.2
"	"	Chicago, Ill.	2,071	9.45	4.6
Ingots	New Orleans, La.	Johnsonville, Tennessee	1,120	4.00	3.6

The first and second rates above included placement of the loads on flat-bed trucks at point of destination. Normal terminal charges (at Chicago) run about $1.15 per ton, which brings the actual transport cost to less than 4 mills per ton mile.

Assuming a cost of 4 mills per ton mile for water transportation, 1,591 miles from Little Rock to Pittsburgh would be $6.37. Transfer costs would add an estimated $2.30 making a total of $8.67. Thus, a margin of almost ten dollars would be available to cover two rail or highway distances of approximately 50 miles each, and the handling costs involved in this part of the transportation.

Summary

Development of the Arkansas River Waterway will provide a new low-cost means of transportation for the mineral products of the Region. As a result it will be possible to deliver these minerals at many points along the vast Inland Waterway and Intercoastal Waterway Systems at a lower cost than has hitherto been possible. The extent to which this reduction in costs will enable Arkansas minerals to expand their markets and penetrate other areas will depend in large degree upon:

1. the existence of other materials of equal quality and suitability in other locations nearer the market, and
2. the creation or development of formerly non-existent demands for minerals, based on their availability at the new lowered cost.

No large overall increase in mineral production and employment appears likely to result from the development of the Arkansas Waterway. Some segments of the mineral industry will realize direct benefits from improved competitive position for markets outside the area. Other segments will appear to receive no direct gains, but the benefits of water transportation, through the stimulation of other economic activity, will tend to stabilize them and reduce or halt declines that have been occurring. Thus, the general effect of canalization of the Arkansas River will be both directly and indirectly beneficial to the mineral industry of the State.

The availability of river transportation should improve the competitive position of Arkansas stone for markets in the lower Mississippi River area. It will likely displace a large share of the stone now moving down the Mississippi River from points above Memphis. In addition, the waterway probably either will receive part of the shipments now going by rail to the Gulf states, or result in decreased costs for rail shipment. This reduction in cost may, in some instances, lead to increased use of stone in preference to shell now being used for many purposes.

It appears unlikely that any large shipments of sand and gravel will move onto the Mississippi River from Arkansas. Most shipments of these commodities originate from deposits along the Mississippi, itself, and terminate within a short distance. Quantities of sand and gravel can be expected to move by water within Arkansas. While lower shipping costs will be attained by such movement, these shipments cannot be expected to significantly increase total production.

The Arkansas Waterway has the potential for increasing the use of Arkansas coal. It appears unlikely that shipping cost reductions provided by the waterway will enable Arkansas coal to compete in the general fuel market with more easily mined coal from Illinois, Indiana and West Kentucky. However, Arkansas coal deposits consist mostly of low-volatile coal, a relatively scarce type of coal having particular significance for coke-making. The major source of low-volatile coal currently used in coke manufacture is northern Virginia and southern West Virginia. Water transportation of Arkansas coal compared to long distance rail transportation of eastern low-volatile coals will provide a margin of savings to apply to the more difficult mining conditions in Arkansas. The nearest consuming point for coking coal located on the waterway system is Granite City, Illinois where about a quarter of a million tons of low-volatile coal is consumed each year.

Arkansas production of phosphate rock is very limited and no shipment from the State is likely. However, large quantities, both of phosphate and superphosphate move up the Mississippi past Arkansas each year. Transportation on the Arkansas River should make these available in Arkansas and Oklahoma at lower costs than currently are available by rail.

Little, if any, shipment of Arkansas bauxite can be expected on the waterway in the near future. However, availability of water transportation may have considerable future significance to the Arkansas bauxite and aluminum industry. In 1963 about a million tons of foreign bauxite was shipped by rail from ports on the Gulf of Mexico and the lower Mississippi. The Arkansas River development may provide reduced transportation costs for this movement of bauxite and help the Arkansas alumina-producing operations to maintain their competitive position within the industry. It may also provide transportation for the movement to other states of aluminum and some alumina produced within Arkansas.

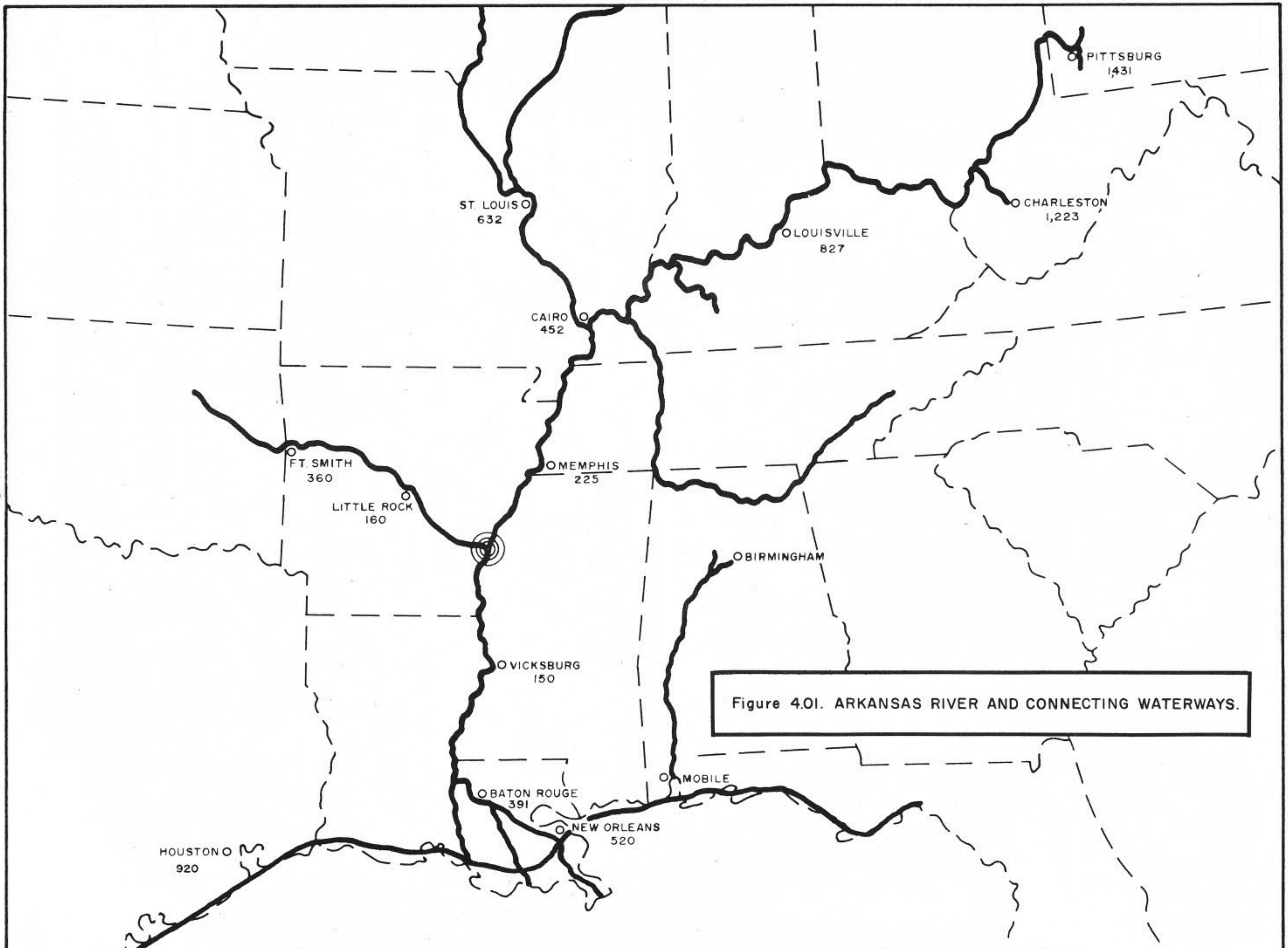
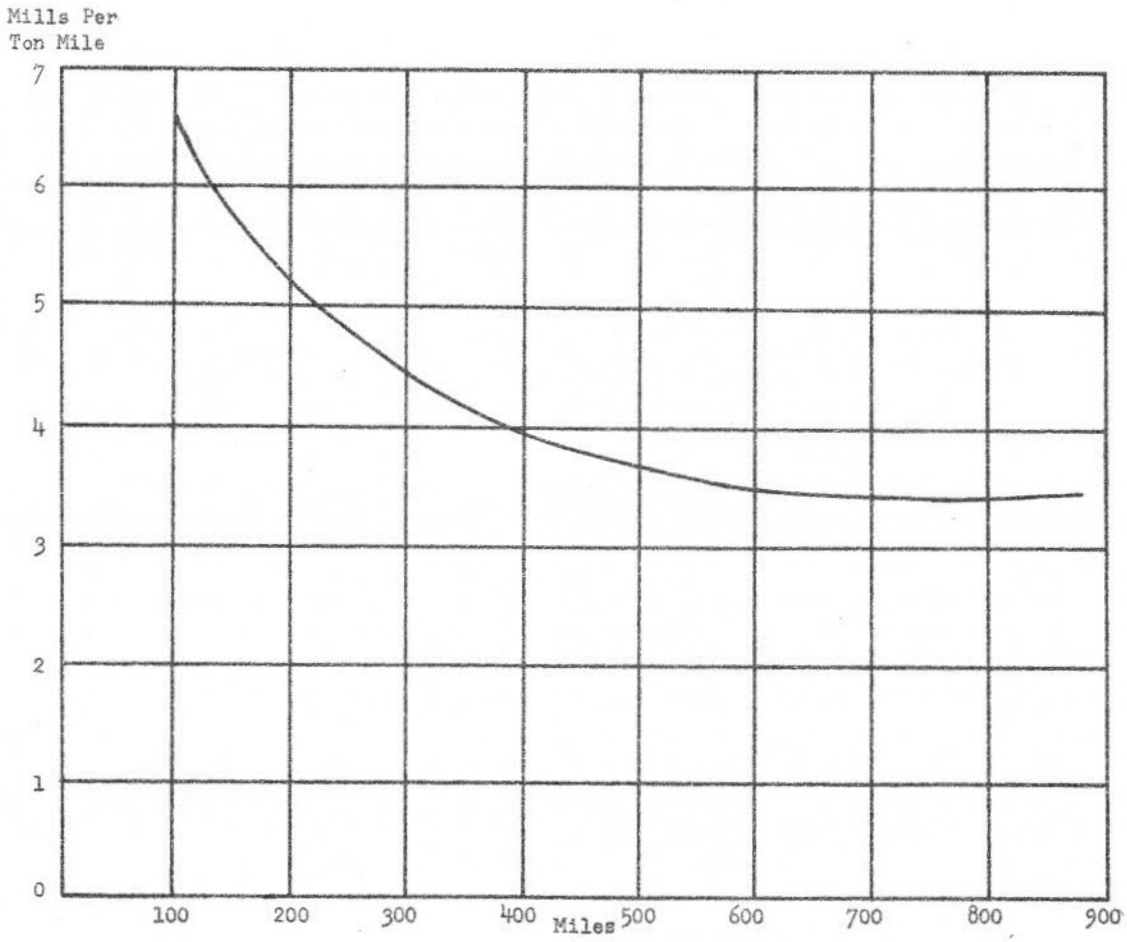


Figure 4.01. ARKANSAS RIVER AND CONNECTING WATERWAYS.

INLAND AND COASTAL WATERWAY SYSTEMS, WITH DISTANCES FROM MOUTH OF THE ARKANSAS RIVER.

FIGURE 4.02

BARGE TRANSPORTATION COSTS FOR COAL



Source: National Power Survey, Federal Power Commission--1964, Part II, p. 346.

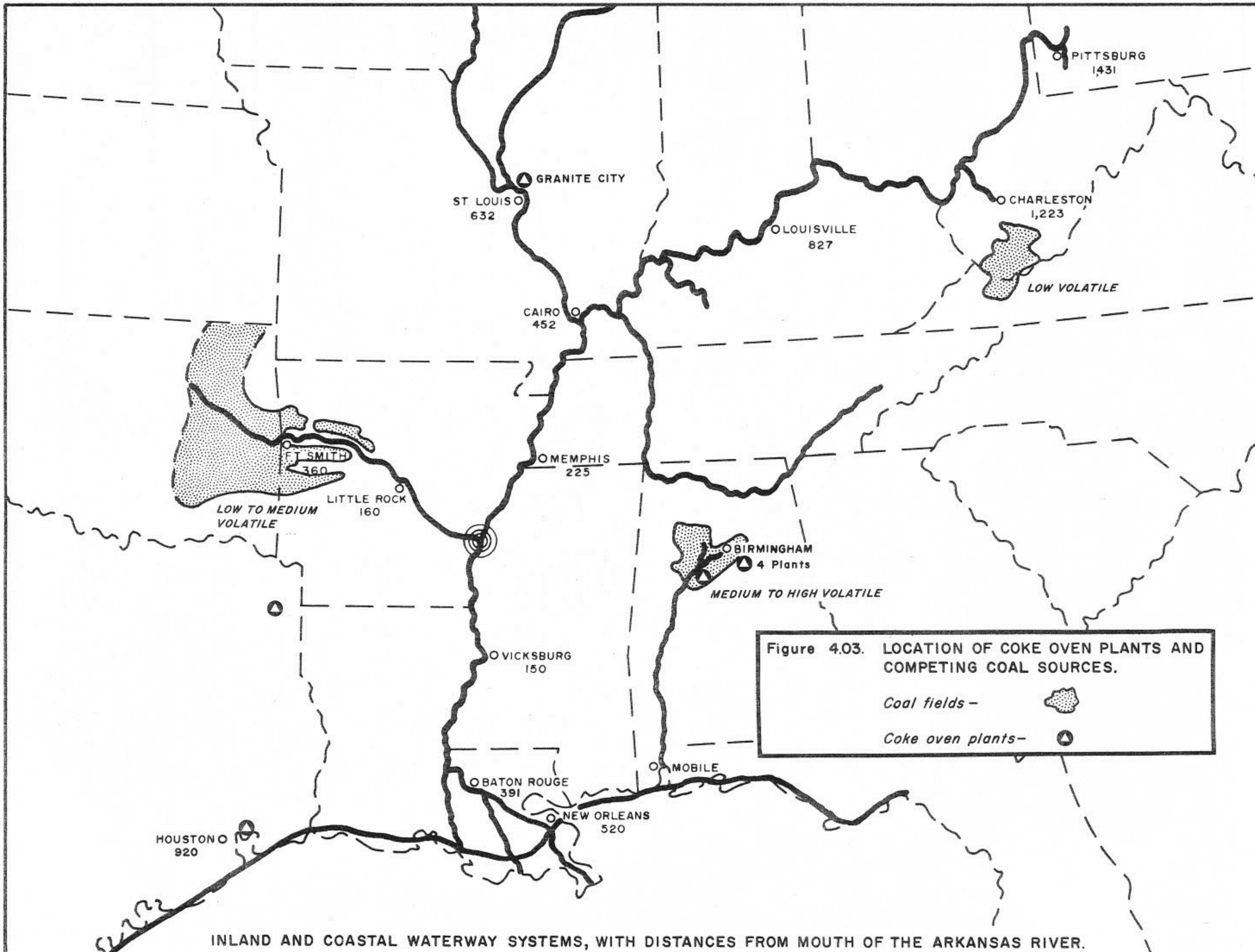


Figure 4.03. LOCATION OF COKE OVEN PLANTS AND COMPETING COAL SOURCES.

INLAND AND COASTAL WATERWAY SYSTEMS, WITH DISTANCES FROM MOUTH OF THE ARKANSAS RIVER.

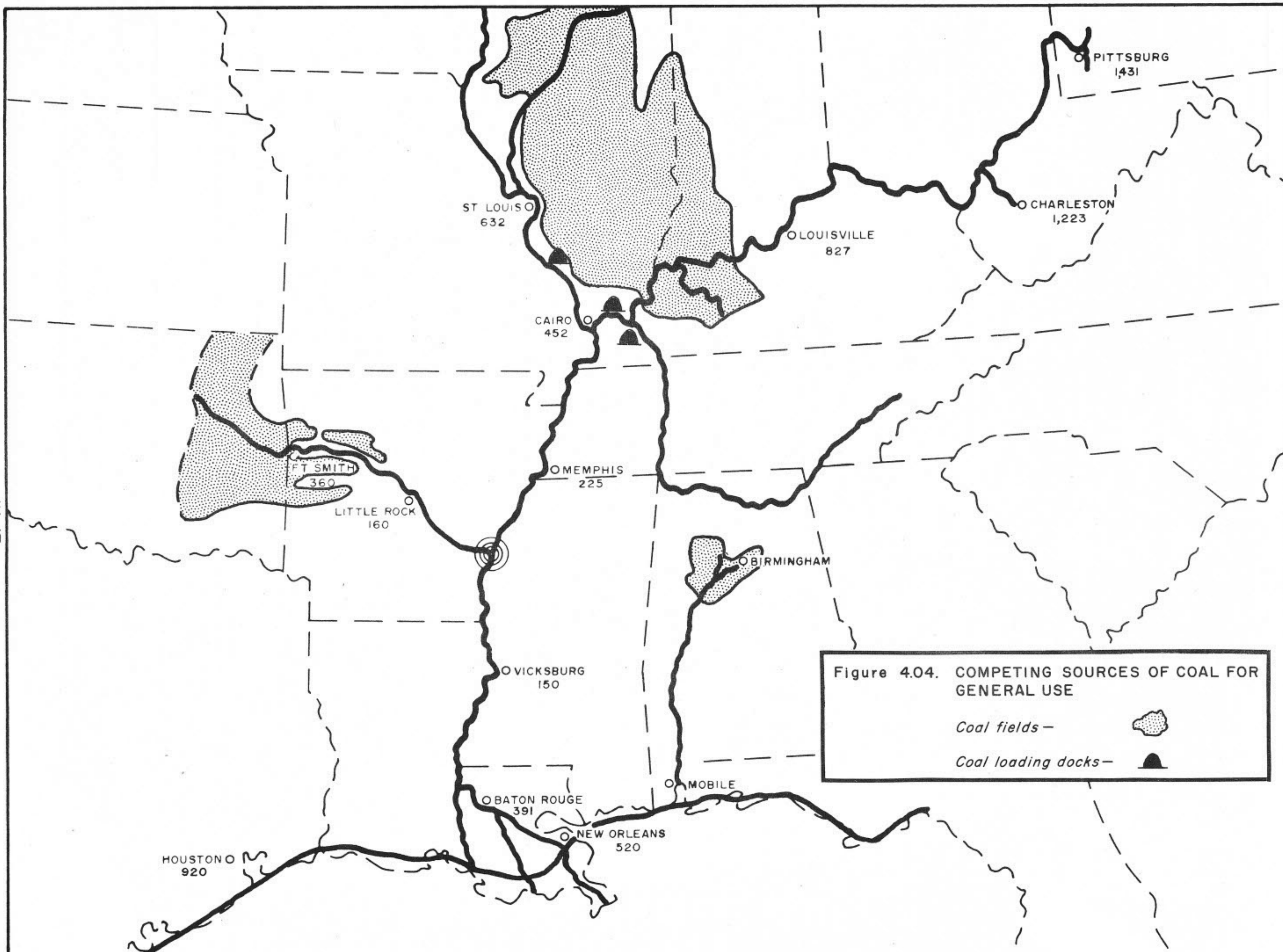


Figure 4.04. COMPETING SOURCES OF COAL FOR GENERAL USE

INLAND AND COASTAL WATERWAY SYSTEMS, WITH DISTANCES FROM MOUTH OF THE ARKANSAS RIVER.

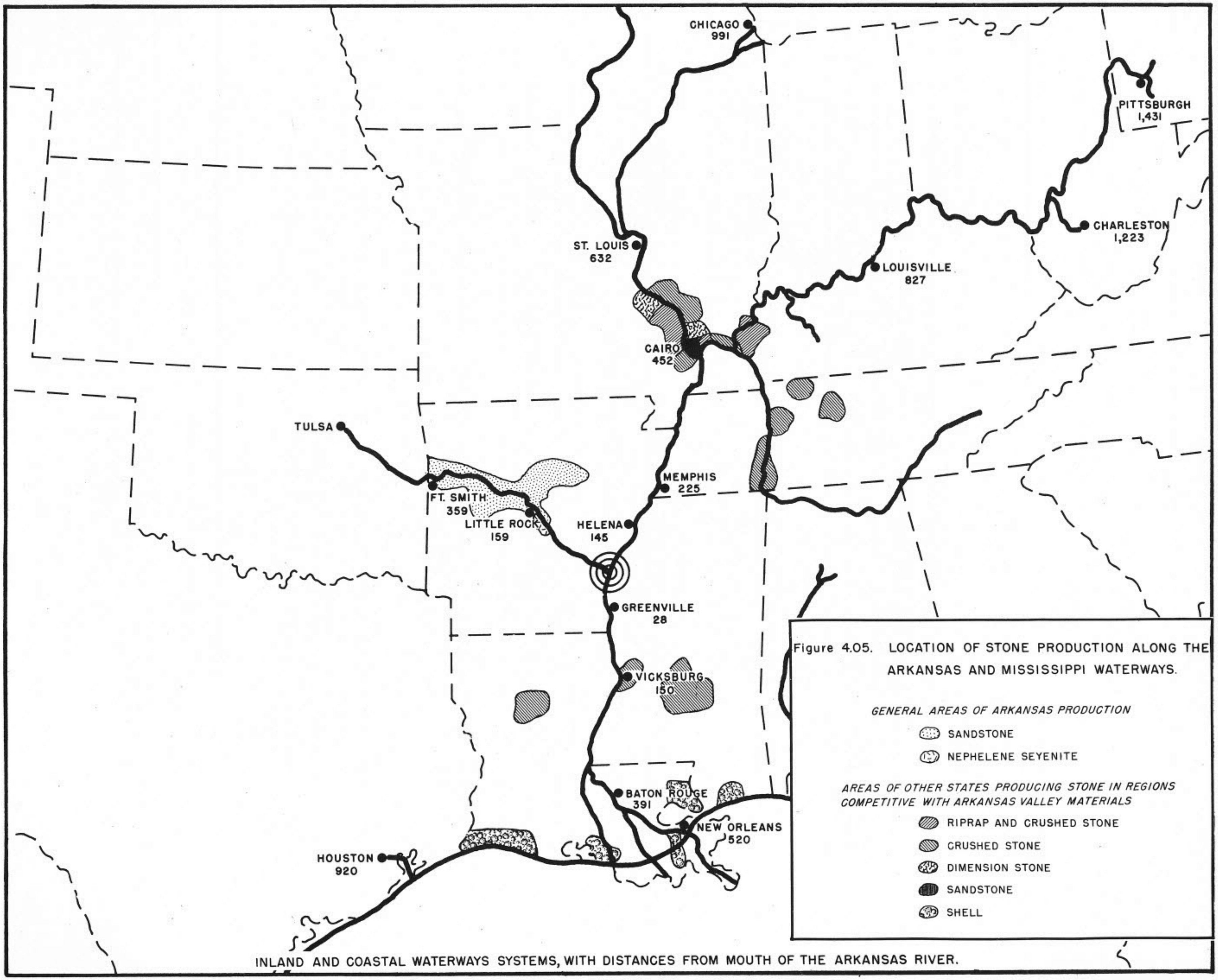


Figure 4.05. LOCATION OF STONE PRODUCTION ALONG THE ARKANSAS AND MISSISSIPPI WATERWAYS.

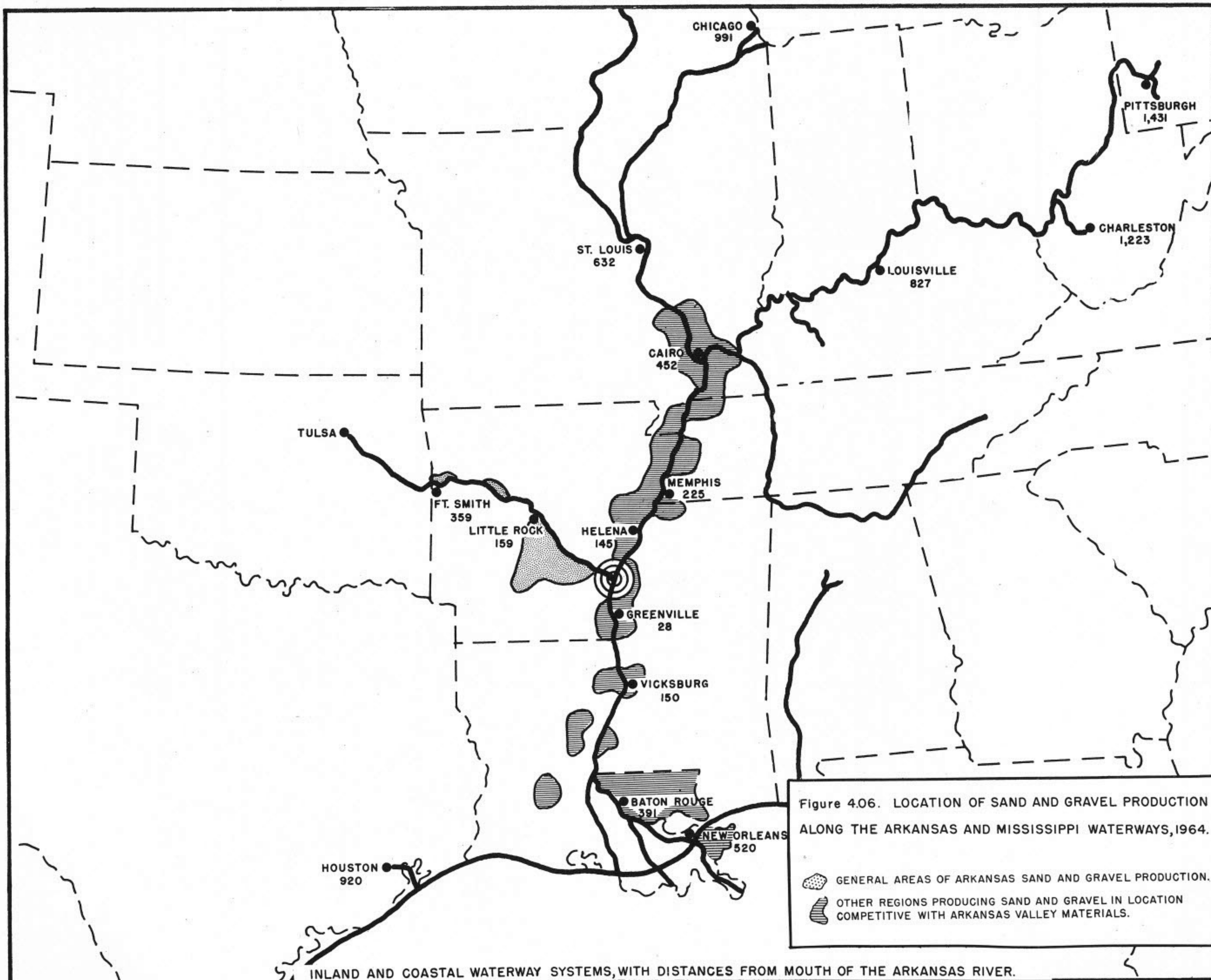


Figure 4.06. LOCATION OF SAND AND GRAVEL PRODUCTION ALONG THE ARKANSAS AND MISSISSIPPI WATERWAYS, 1964.

INLAND AND COASTAL WATERWAY SYSTEMS, WITH DISTANCES FROM MOUTH OF THE ARKANSAS RIVER.

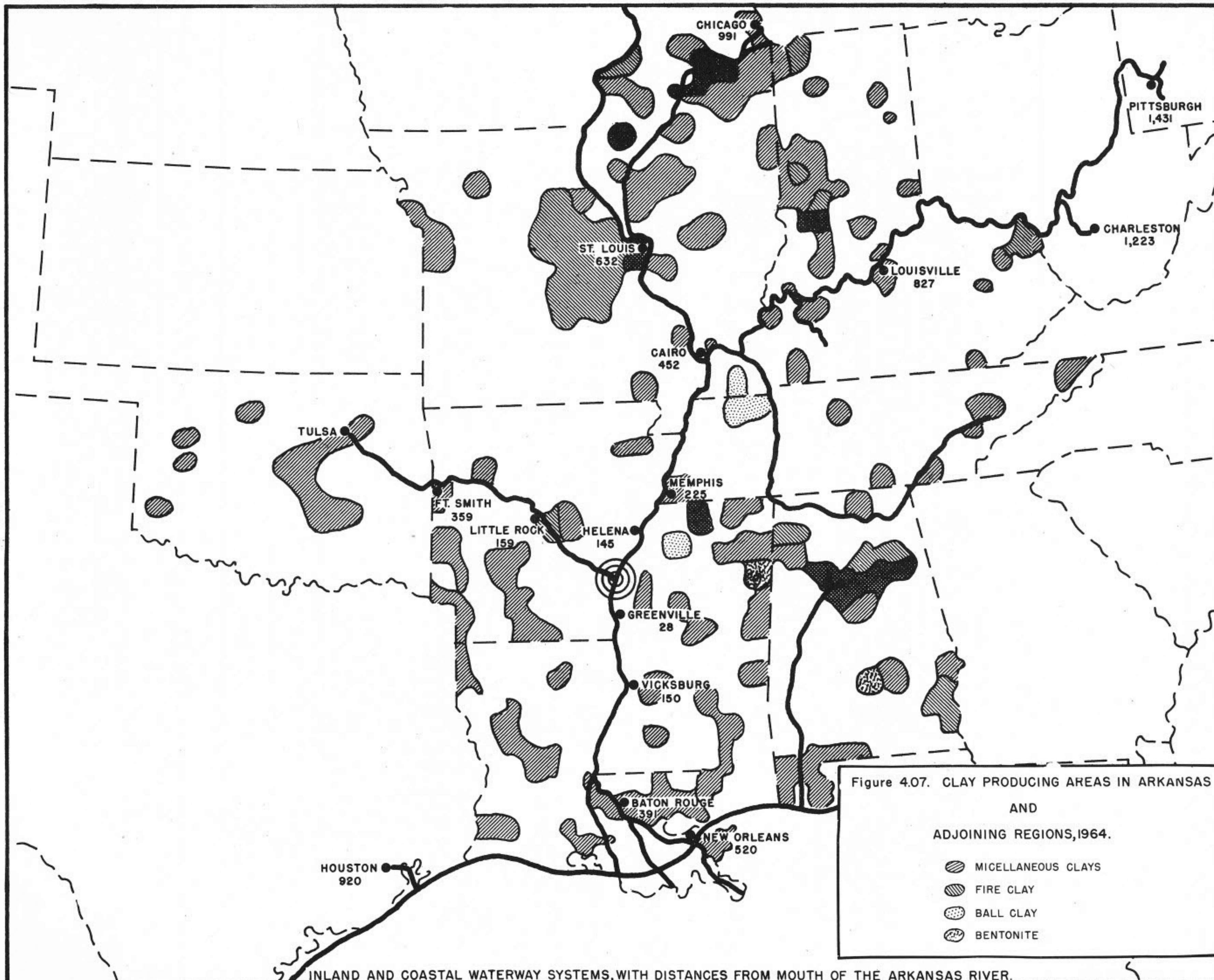


Figure 4.07. CLAY PRODUCING AREAS IN ARKANSAS AND ADJOINING REGIONS, 1964.

INLAND AND COASTAL WATERWAY SYSTEMS, WITH DISTANCES FROM MOUTH OF THE ARKANSAS RIVER.

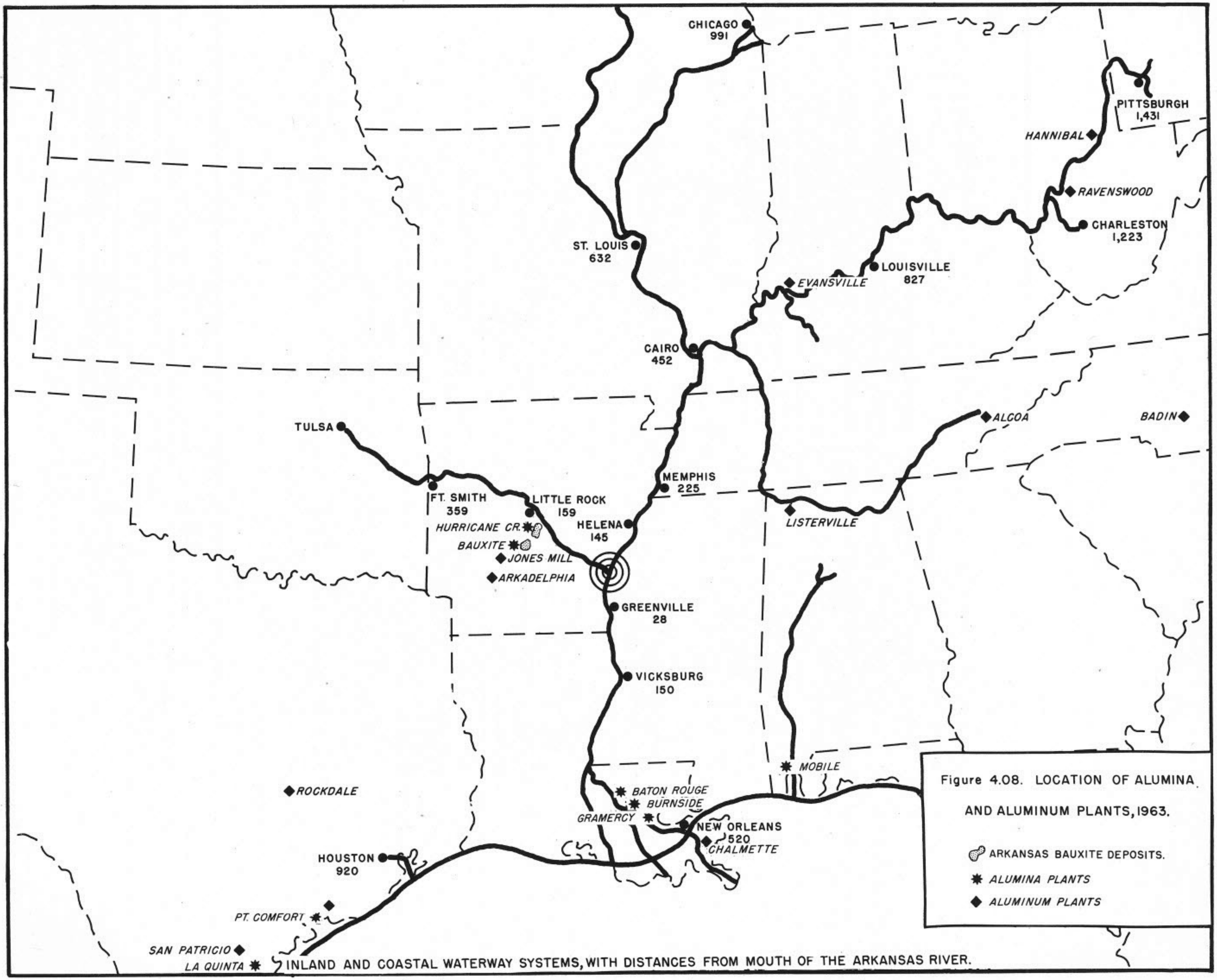


Figure 4.08. LOCATION OF ALUMINA AND ALUMINUM PLANTS, 1963.

TABLE 4.01

FREIGHT TRAFFIC, SELECTED COMMODITIES, ON THE MISSISSIPPI RIVER, FROM MOUTH OF OHIO RIVER
TO BUT NOT INCLUDING BATON ROUGE, 1964
(short tons)

Commodity	Total	Upbound	Outbound	Inbound	Through	Downbound	Outbound	Inbound	Through
			(upbound)	(upbound)	(upbound)		(downbound)	(downbound)	(downbound)
502 Bituminous coal and lignite	2,892,192							1,236,536	1,655,656
504 Coke, including petroleum coke	42,047							6,931	35,116
507 Gasoline	7,941,446	291,375	2,028,384	1,256,483	3,351,673	20,412	336,798	382,519	273,802
510 Gas oil, distillate fuel oil	1,533,929	70,533	442,815	179,604	505,279	20,220	173,229	48,590	93,659
511 Petroleum, crude	3,934,774	250,835	73,072	2,795,787	549,689	1,970	240,558	6,966	15,897
512 Jet fuel, all types	242,399	31,727	35,590	74,165	93,749			7,168	
513 Kerosene	479,689	20,498	161,800	12,387	248,361	798	31,810	3,481	554
514 Residual fuel oil	1,433,998	14,518	127,012	26,691	1,052,636	27,283	133,044	18,373	34,441
516 Petroleum asphalt	734,470			71,007	623,278		569	4,655	34,961
523 Building cement	432,507							16,530	415,977
526 Stone and mfrs, nec	14,123				1,028				13,095
540 Clays and earths	1,521				905				616
543 Brick and tile	18,339				15,796				2,543
547 Clay products, nec	649								649
551 Limestone, crushed	46,436							5,373	41,063
554 Sand, gravel, crushed rock	2,350,445	1,232,529	1,825	180	15,103	890,082	75,432	31,716	103,578
555 Nonmetallic minerals, mfrs, nec	1,645,100			37,627	1,602,167				5,306
600 Iron ore and concentrates	465,765				427,285				38,480
617 Aluminum ores, concent., scrap	423,879				423,879				
618 Aluminum metal and alloys	21,478				21,478				
852 Phosphate rock	774,440				773,990				450
854 Superphosphate	210,876				209,764				1,112

TABLE 4.02

RAIL RATES FOR SELECTED COMMODITIES ORIGINATING OR TERMINATING IN THE ARKANSAS RIVER REGION OF ARKANSAS IN 1965

Commodity	Origination	Destination	Miles	Rate[a]
Phosphate rock (minimum weight 10CM pounds)	Bartow, Florida	Fort Smith, Arkansas	1,087	820[b]
		Little Rock, Arkansas	938	785[b]
		Pine Bluff, Arkansas	932	775[b]
Potash (minimum weight 80M pounds)	Carlsbad, New Mexico	Fort Smith, Arkansas	690	1,116
		Little Rock, Arkansas	763	1,360
		Pine Bluff, Arkansas	768	1,360
Sulphur (minimum weight 100M pounds)	New Orleans, Louisiana	Fort Smith, Arkansas	572	1,055[c]
		Little Rock, Arkansas	436	1,055[c]
		Pine Bluff, Arkansas	394	1,055[c]
	Galveston, Texas	Fort Smith, Arkansas	494	1,055[c]
		Little Rock, Arkansas	436	1,055[c]
		Pine Bluff, Arkansas	417	1,055[c]
Stone, rip rap (minimum weight 100M pounds)	Little Rock, Arkansas	New Orleans, Louisiana	436	277[d]
		Lake Charles, Louisiana	371	294[d]
Aluminum billets (minimum weight 100M pounds)	Jones Mills, Arkansas[e]	Butler, Pennsylvania	937	1,860
Coal	Fort Smith, Arkansas	St. Louis, Missouri	415	428[b]
		New Orleans, Louisiana	572	557[b]
		El Paso, Texas	904	472[b]
Coal (minimum weight 120M pounds)	Fort Smith, Arkansas	Fontana, California	1,779	935[b]

[a]Cents per ton.

[b]Cents per net ton.

[c]Cents per gross ton.

[d]Short ton.

[e]Rate is based on Malvern.

Source: Data obtained from the Arkansas Industrial Development Commission and the Fort Smith Freight Traffic Bureau.

TABLE 4.03

ONE-PERCENT SAMPLE OF RAILROAD CARLOADS ORIGINATING IN THE ARKANSAS RIVER REGION

Geographic Area	Carloads	Tons	Average Tons Per Car	Ton-Miles	Revenue	Average Revenue Per Ton-Mile	Average Short-Line Haul Per Ton
				(hundreds)	(dollars)	(mills)	
			Bituminous Coal				
West North Central	5	282	56	1,033	1,252	12	366
West South Central	28	1,891	68	10,640	8,673	8	563
Oklahoma	12	792	66	2,084	2,909	14	263
Texas	15	1,031	69	8,512	5,610	7	826
Total bituminous coal	33	2,173	66	11,673	9,925	9	537
			Aluminum Ore and Concentrates				
Middle Atlantic	9	441	49	4,814	5,747	12	1,092
East North Central	18	979	54	6,830	9,069	13	698
Ohio	11	561	51	3,968	5,387	14	707
South Atlantic	6	293	49	2,994	3,373	11	1,022
East South Central	17	1,276	75	4,203	6,617	16	329
Alabama	16	1,226	77	3,825	6,130	16	312
West South Central	36	2,193	61	1,199	3,316	28	55
State, except Arkansas River Region	33	2,045	62	708	2,231	32	33
Total aluminum ore and concentrates	130	7,794	60	71,657	60,413	8	919

- continued -

TABLE 4.03
ONE-PERCENT SAMPLE OF RAILROAD CARLOADS . . . - (Continued.)

Geographic Area	Carloads	Tons	Average Tons Per Car	Ton-Miles	Revenue	Average Revenue Per Ton-Mile	Average Short-Line Haul Per Ton
				(hundreds)	(dollars)	(mills)	
Clay and Bentonite							
West North Central	9	554	62	2,517	3,113	12	454
Missouri	9	554	62	2,517	3,113	12	454
West South Central	8	413	52	817	1,234	15	198
Texas	5	251	50	565	665	12	225
Total clay and bentonite	18	1,017	57	3,937	5,107	13	387
Gravel and Sand							
West South Central	38	2,399	63	1,534	2,661	17	64
State, except Arkansas River Region	22	1,288	59	852	1,518	18	66
Arkansas River Region	14	969	69	508	860	17	52
Total sand and gravel	40	2,516	63	1,735	2,950	17	69
Stone and Rock: Broken, Ground and Crushed							
West South Central	147	9,752	66	13,006	12,135	9	133
State, except Arkansas River Region	69	4,527	66	4,061	5,512	14	90
Louisiana	D						
Texas	D						
Total stone and rock: broken, ground and crushed	150	99,319	66	13,603	12,713	9	137

D--Omitted to avoid disclosure of confidential information.

Source: Special tabulation, by U.S. Bureau of the Census, of Interstate Commerce Commission's one-percent sample of waybills.

TABLE 4.04

AVERAGE THICKNESS OF COAL MINED AND AVERAGE OUTPUT PER MAN PER DAY IN SELECTED STATES, 1960

State	Underground Mines		Strip Mines		Auger Mines		Total, All Mines	
	Thickness, Feet	Tons Per Manshift	Thickness, Feet	Tons Per Manshift	Thickness, Feet	Tons Per Manshift	Thickness, Feet	Tons Per Manshift
Alabama	4.1	7.80	2.8	14.96	2.7	26.32	3.8	8.66
Arkansas	2.6	4.24	1.8	13.38	-	-	2.0	8.39
Illinois	7.5	17.38	5.0	30.04	-	-	6.3	21.94
Indiana	5.8	11.96	4.6	29.50	-	-	5.0	20.36
Kansas	2.1	2.41	1.5	17.11	-	-	1.5	16.70
Kentucky	4.3	10.61	4.9	36.16	4.1	30.30	4.5	13.86
Missouri	3.6	3.06	2.2	11.83	-	-	2.2	10.88

Source: U.S. Department of Interior, Bureau of Mines, Minerals Yearbook, 1964: Volume II, Mineral Fuels, p. 47.