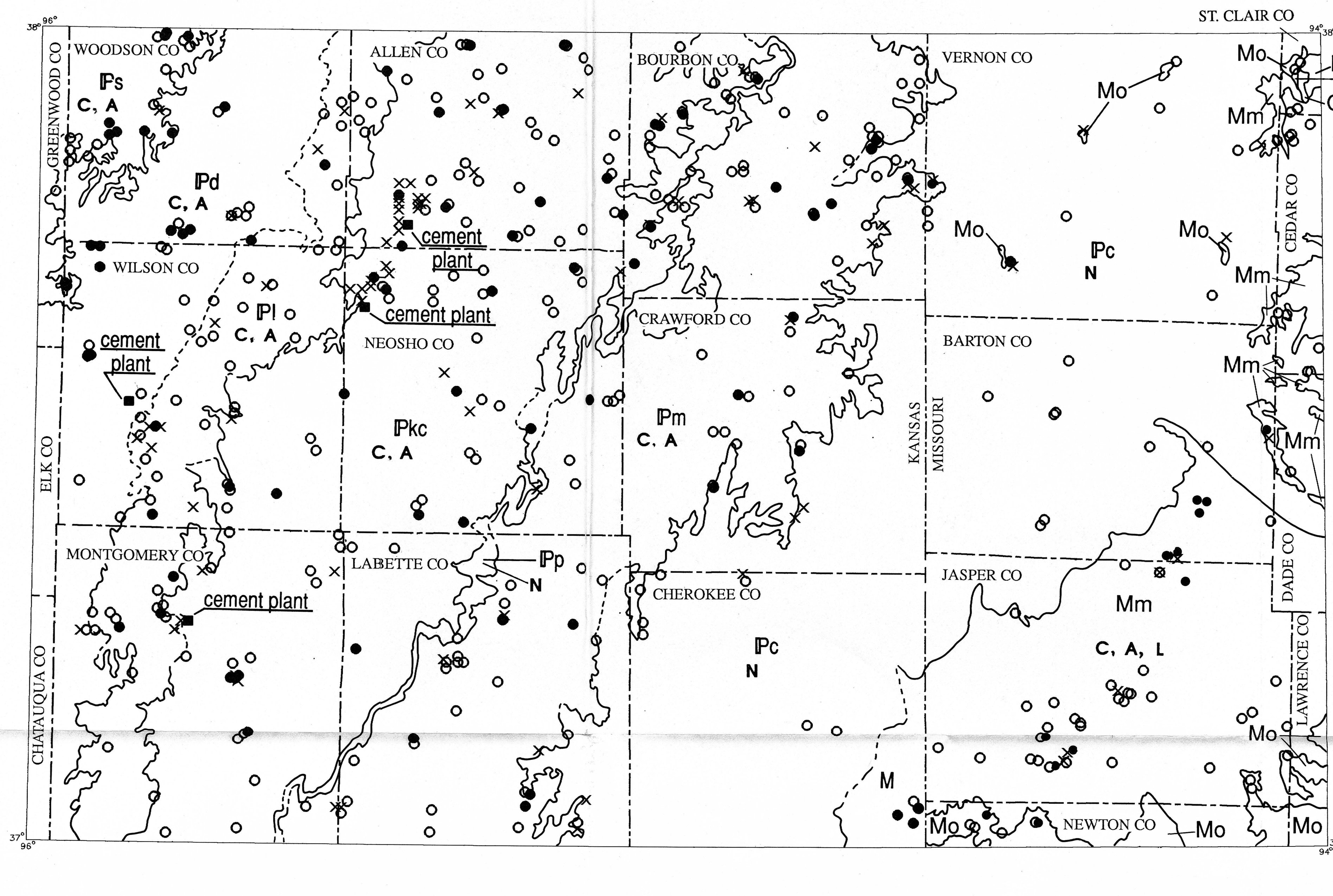
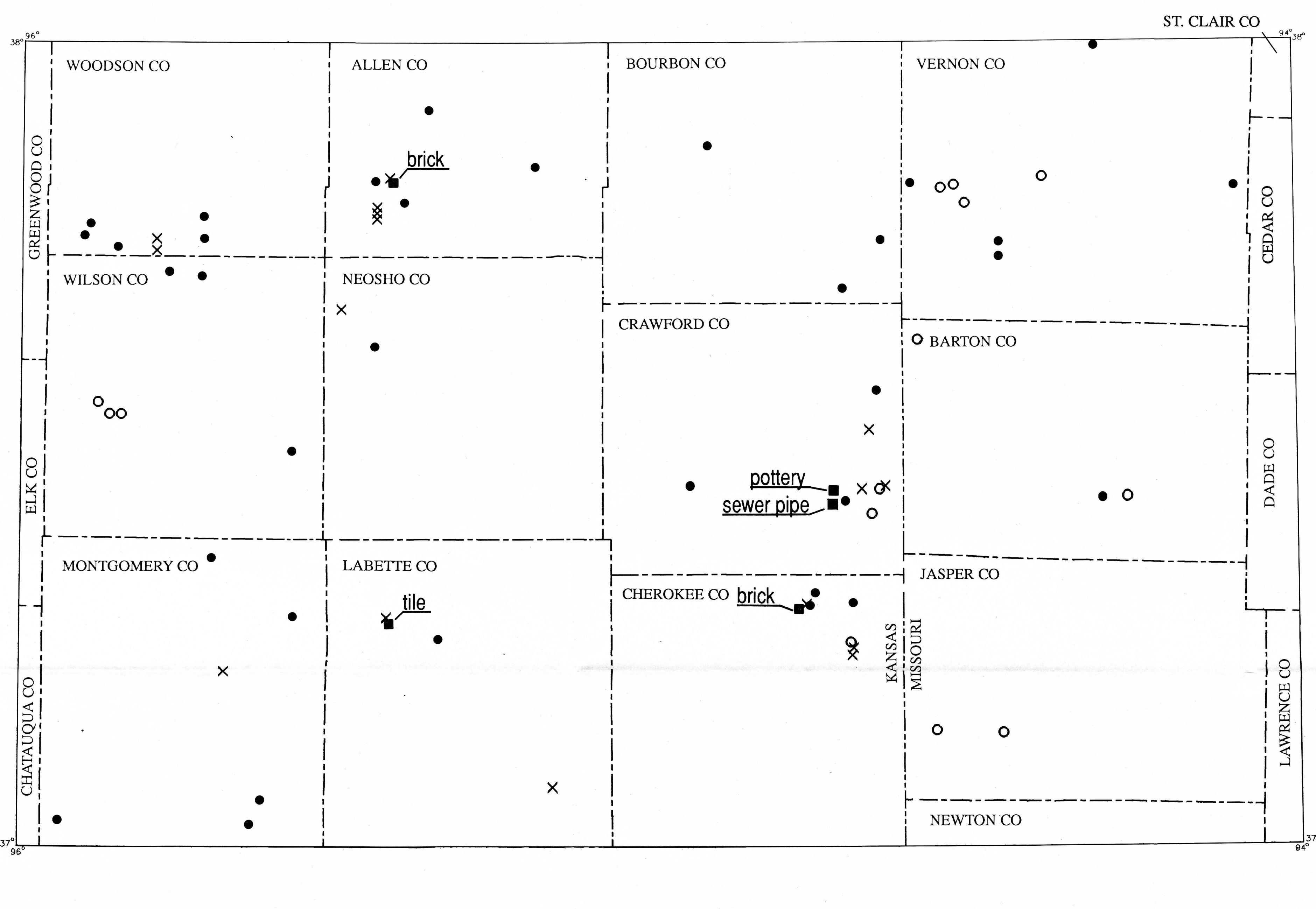
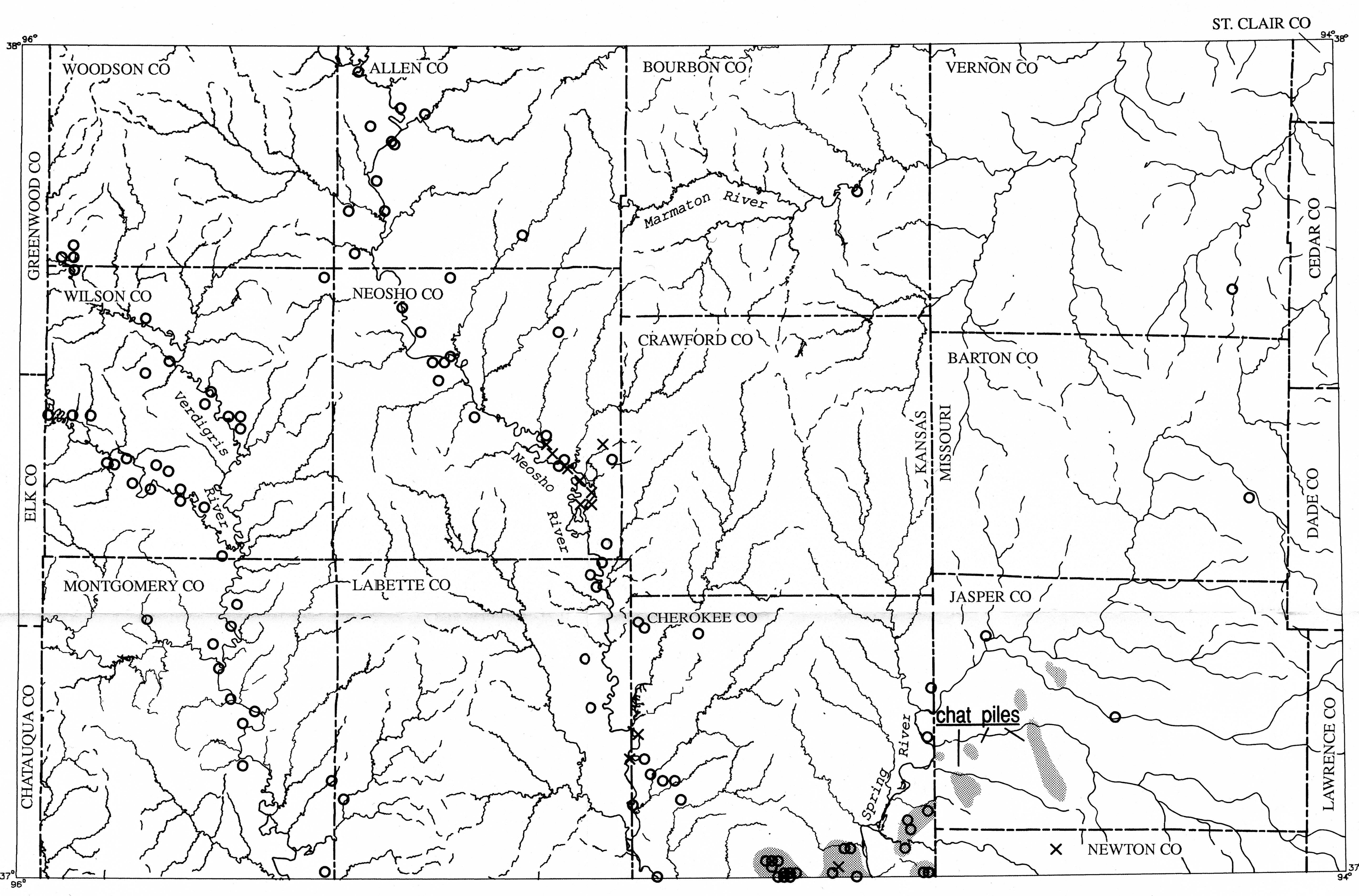


MAP *A*. CRUSHED STONE RESOURCES



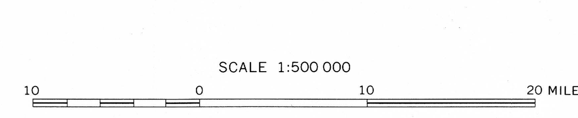
MAP *B*. CLAY AND SHALE RESOURCES

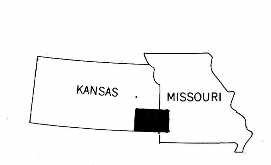


Base from Kansas Geological Survey

Compiled in 1989
Maps made by GIMMAP at the Kansas Geological Survey
Manuscript approved for publication July 25, 1991

MAP *C*. SAND AND GRAVEL RESOURCES





QUADRANGLE LOCATION

MAPS SHOWING INDUSTRIAL MINERAL RESOURCES OF THE JOPLIN 1° X 2° QUADRANGLE, KANSAS AND MISSOURI

By

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1991

EXPLANATION

PENNSYLVANIAN SYSTEM

- IPs — **Shawnee Group**
- IPd — **Douglas Group**
- IPl — **Lansing Group**
- IPkc — **Kansas City Group**
- IPp — **Pleasanton Group**
- IPm — **Marmaton Group**
- IPc — **Cherokee Group**

MISSISSIPPIAN SYSTEM

- M — **Mississippian System, undivided**--Shown west of Kansas-Missouri State Line
- Mm — **Meramecian Series (Salem and Warsaw Formations)**
- Mo — **Osagean Series (Keokuk and Burlington Limestones)**
- Mk — **Kinderhookian Series (Sedalia Formation and Compton Limestone)**

ORDOVICIAN SYSTEM

- Ojc — **Canadian Series (Cotter and Jefferson City Dolomites)**
- —— **Contact**--Dashed where approximately located
- × **Active quarry**
- ○ **Inactive quarry**
- ● **Sample Site**
- ■ **Plant location**
- **Resources**--Symbol applies to area coextensive with map unit
- A — **High-specification aggregate**
- L — **High-purity limestone**
- C — **Commercial limestone and dolomite**
- N — **Formations having little or no commercial value**

FOLIO NOTE

This map is part of a folio of maps of the Joplin 1°X2° quadrangle, Kansas and Missouri, prepared under the Conterminous United States Mineral Assessment Program (CUSMAP). Other publications in this folio to date include U.S. Geological Survey Miscellaneous Field Studies Map MF-2125-A (Erickson and others, 1990). Additional maps showing various geologic aspects of the Joplin quadrangle will be published as U.S. Geological Survey Miscellaneous Field Studies Maps bearing this same serial number with different letter suffixes (MF-2125-C, -D, and so on).

SUMMARY

The industrial mineral resources of the Joplin 1°X2° quadrangle are crushed stone, dimension stone, clay and shale, construction sand and gravel (including chat, or chert-rich tailings from metal mines), and asphaltic sandstone. At present only crushed stone, clay and shale, and construction sand and gravel are of economic importance; the remainder are considered hypothetical resources. The value of industrial mineral production during 1987, the most recent year of complete data as supplied by the U.S. Bureau of Mines, was nearly $25,600,000. In terms of finished products such as cement and brick, the value is several times that amount. Figure 1 shows the annual value of industrial mineral production within the quadrangle from 1960 through 1987.

CRUSHED STONE

Crushed stone is the most valuable industrial mineral commodity produced in the quadrangle, and in 1987 reported production approached 6.5 million tons. Production was from more than 50 sites and from all counties within the quadrangle. Annual production of crushed stone by tonnage for the period 1960 through 1987 is shown in figure 2. The major use for crushed stone is cement production. There are four cement plants in the western part of the quadrangle, and their production accounts for about one-third of the quadrangle's stone consumption, as shown in figure 3.

To evaluate the stone resources within the quadrangle, nearly 200 samples were collected from more than 100 sites. Each sample was analyzed for major element composition, and many samples were analyzed for physical properties. These data, accompanied by past and present usage, provided a basis for classifying the stone resources of the quadrangle:

Resources of high-specification aggregate.--This is an arbitrary category that designates stone meeting standard specifications of the Missouri and Kansas Highway and Transportation Departments and other agencies, for aggregate to be used in portland cement. Minable resources meeting this criterion are present in the Higginsville Member of Fort Scott Limestone, Salem and Warsaw Formations, and Burlington Limestone.

Resources of high-purity limestone.--For the purposes of this report, high-purity limestone consists of formations that contain a minable section of limestone having a minimum $CaCO_3$ content of 95 percent. Resources meeting this criterion are present in the Salem and Warsaw Formations, undifferentiated Warsaw Formation and Keokuk Limestone, and Burlington Limestone.

Resources of commercial limestone and dolomite.--This category includes rock units in the high-specification aggregate and high-purity limestone categories along with those suitable for less stringent aggregate and aglime use. Resources meeting this criterion are present in the Lawrence, Stanton, Plattsburg, Iola, Drum, Dennis, Swope, Altamont, and Pawnee Formations, Higginsville and Blackjack Creek Members of the Fort Scott Limestone, Salem and Warsaw Formations, undifferentiated Warsaw Formation and Keokuk Limestone, Burlington Limestone, Sedalia Formation, Compton Limestone, and Jefferson City and Cotter Dolomites.

Resources of chert.--This category includes localized areas where bedrock has been completely silicified. Units commonly affected are the Reeds Spring and Elsey Formations and the lower part of the Burlington. This category is restricted to the extreme south-central part of the quadrangle. It is not shown on the map because limestone minable reserves are mostly in the subsurface.

Map A shows the distribution of these resources as well as the locations of active and abandoned quarries and sample sites. In many cases, one sample site represents more than one sample from a given geological formation or member. Also, more than one member was sampled at many of the sites.

Table 1 consists of data on the average chemical analyses of carbonate rock units judged to have commercial potential for crushed stone production. Publications containing detailed information from which table 1 is derived as well as detailed information on the structure, lithology, and distribution of geologic units mapped are listed in "Sources of Data."

DIMENSION STONE

Dimension stone resources are considered separately from crushed stone resources even though they include many of the same formations. Although these resources are large and diverse and have had substantial past production, they have little present economic value. The following categories of dimension stone resources are present in the quadrangle.

Resources of marble.--For the purposes of this report and by commercial definition marble is defined as any carbonate rock that will take a polish. The Carthage area was the center of marble production in Missouri for many years, but there is no present production. Resources are present in the Salem and Warsaw Formations and Burlington Limestone.

Resources of sandstone building stone.--This category includes units with past or present use as building, rubble, or flagging stone. Resources are in the lower part of the Cherokee Group (Krebs Formation in Kansas), the Bandera Quarry Sandstone Member of the Bandera Formation in the Marmaton Group, and Pennsylvanian-age channel sandstones.

Resources of carbonate building stone.--This category includes carbonate rock units with past or present use as building, rubble, or flagging stone. Most resources are of Mississippian age and are in the Salem and Warsaw Formations and Burlington and Compton Limestones; the minor resources are in Jefferson City and Cotter Dolomites of Ordovician age.

CLAY AND SHALE

Clay and shale resources of the quadrangle are large and relatively widespread; however, current production is limited to the central and western parts of the quadrangle. From 1985 to 1987 seven counties in Kansas annually produced about 400,000 tons valued at more than $2.0 million for a variety of uses, including cement, brick, sewer pipe, tile, pottery, and animal feed supplement. Cement plants utilize Upper Pennsylvanian shales while practically all ceramic products are made from Middle Pennsylvanian clays, especially the underclays in the Krebs Formation of the Cherokee Group. The area has a long history of ceramic products, and near the turn of the century, when gas was abundant and inexpensive, large numbers of brick plants and many pottery operations existed, notably in the south-central part of the quadrangle.

In a recent testing program, 22 samples were collected from the shales of the Little Osage, Excello, Riverton, Cabaniss, Rowe, Drywood, and Bluejacket Formations. Of those samples evaluated for structural clay products manufacture, 17 were considered suitable, 4 were marginally suitable, and 1 was unsuitable. When evaluated for expanded lightweight aggregate manufacture, 8 were considered suitable, 1 was marginally suitable, and 13 were unsuitable.

Map B shows the present and past locations of clay pits in the quadrangle as well as sites of samples for which chemical composition and ceramic properties have been determined. A sample site symbol may represent more than one sample. Because so many zones of clay have been tested, test results are not included in this paper but can be obtained from the respective Kansas and Missouri authors. Figure 4 shows the annual clay and shale production in the quadrangle from 1960 through 1987.

SAND AND GRAVEL

Readily available construction sand and gravel resources in the Joplin quadrangle are neither large nor of high quality. Areas underlain by Mississippian bedrock in the southeastern part of the quadrangle contain stream alluvium composed mostly of chert gravel with only minor amounts of quartz sand. In areas underlain by Pennsylvanian sedimentary rocks, the alluvial deposits consist mostly of fine quartz sand, silt, and clay, generally lacking in material for coarse aggregate. Deposits of terrace gravels mixed with red clay occur at several sites in the northeastern part of the quadrangle. Present production of construction sand and gravel from all sources is minor. The industry peaked between 1976 and 1979, when annual production levels in the quadrangle averaged nearly 1 million tons. At present, production is confined to the Neosho River system and the chat piles in southeastern Kansas and southwestern Missouri, as shown on map C.

The resource potential for industrial (silica) sand in the Joplin quadrangle is small; however, a locally important industry does exist processing mine-mill tailings (chats). Chats are the result of the gravity separation methods used at the now-inactive mines of the Tri-State zinc-lead district. They are composed mostly of chert with small amounts of limestone. Larger sizes of the chats are processed and used for railroad ballast, road aggregates, and aggregate in asphaltic and portland cement concrete. Smaller sizes have been used for abrasives, roofing granules, and pipe coatings. Reserves of chat, as estimated in 1983, were 10 million tons present on 1,000 acres in three counties. Since the U.S. Bureau of Mines classifies chat piles as construction sand and gravel, production locations are shown on map C along with present and past conventional sand and gravel operations. Total annual production within the quadrangle between 1960 and 1987 is shown in figure 4.

In addition to the tailings a very hypothetical resource for industrial sand exists in the sandstones of the lower part of the Cherokee Group (Krebs Formation in Kansas) and also in the Pennsylvanian channel sandstones. No past or present usage of these sandstones for industrial purposes is known.

ASPHALTIC SANDSTONE

The Joplin quadrangle has large resources of sandstone saturated with a naphthene-paraffin-based, high-viscosity petroleum. Commonly referred to as "tar sands," these sandstones represent a resource for both petroleum production and as a paving material. For paving use, common practice has been to crush and size the sandstone and add additional asphalt as a binder. Even with additional asphalt the material is suitable only for applications bearing light loads and is inferior to designed mixes. Several sites in Barton and Vernon counties have operated in the recent past producing this material for paving use, but there is no present production.

Large areas of the quadrangle are underlain by formations that have little or no commercial value. Areas in this category include those underlain by the Pleasanton and Cherokee Groups along with the Riverton, Elsey, Reeds Spring, and Northview Formations. At one time, some sandstone was quarried from the Cherokee Group.

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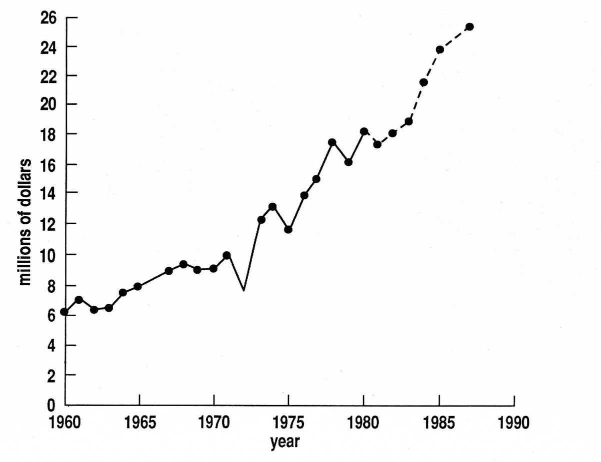

Figure 1. Annual value of industrial mineral production for 1960-1987; values estimated for 1981, 1983, and 1985.

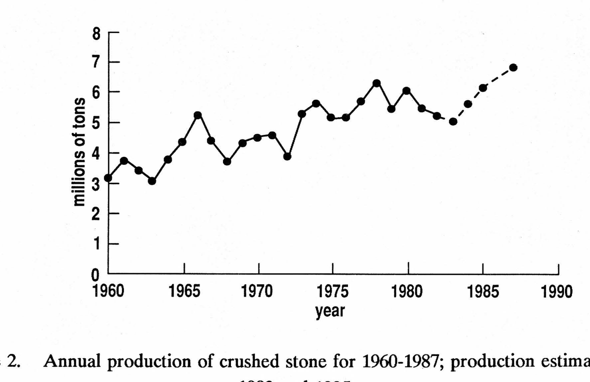

Figure 2. Annual production of crushed stone for 1960-1987; production estimated for 1983 and 1985.

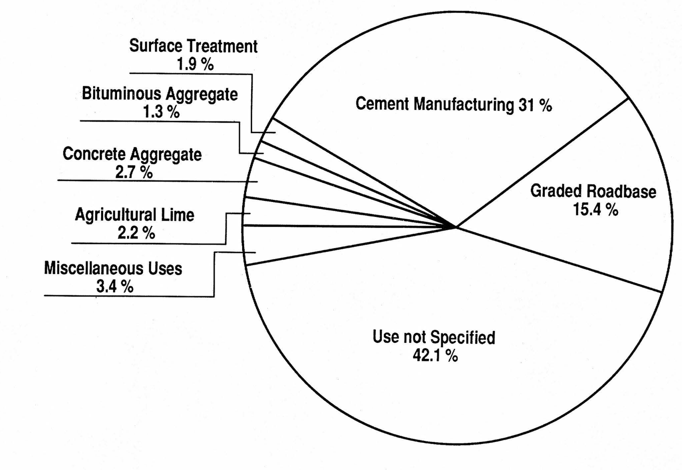

Figure 3. Stone consumption by use for 1987.

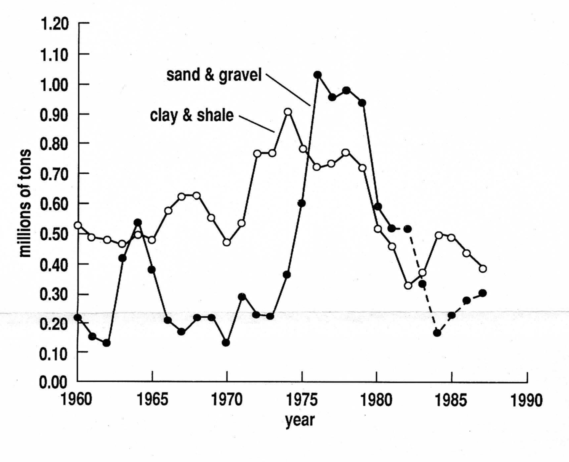

Figure 4. Annual production of clay and shale, and sand and gravel for 1960-1987; production estimated for 1982, 1984, and 1986.

Table 1. *Chemical analyses of selected carbonate rock units in the Joplin 1°X2° quadrangle*

[NA, not applicable; no grab samples are included, only composite samples]

Age	Group	Formation	Limestone Member	Samples	Chemical analysis (in percent)								
					CaO	MgO	SiO_2	Al_2O_3	Fe_2O_3	Na_2O	K_2O	LOI	Calc. $CaCO_2$
Pennsyl-vanian	Shawnee	Oread	Kereford	2	39.54	0.35	24.60	1.09	2.02	0.04	0.03	31.90	70.49
			Plattsmouth	3	47.24	0.91	6.95	2.53	2.71	0.21	0.21	38.94	84.18
			Leavenworth	3	50.50	1.58	2.62	0.89	1.63	0.02	0.09	41.76	89.85
			Toronto	5	48.83	1.33	5.35	1.21	2.59	0.04	0.10	40.17	87.05
	Douglas	Lawrence	Haskell	5	50.72	0.99	4.03	1.21	1.61	0.09	0.07	41.11	90.35
	Lansing	Stanton	Stoner	5	51.20	1.26	3.63	1.09	1.04	NA	NA	41.49	91.31
			Captain Creek	3	52.30	0.73	2.52	0.76	0.99	NA	NA	42.01	93.31
		Plattsburg	Spring Hill	3	51.65	1.18	3.28	1.14	0.83	0.06	0.22	41.52	92.07
	Kansas City	Iola	Raytown	9	51.43	1.59	2.32	0.78	1.22	0.03	0.05	42.18	92.08
		Drum	Corbin City/Dewey	7	52.27	0.82	2.82	0.83	1.02	NA	NA	41.93	93.14
		Dennis	Winterset	9	51.53	0.83	4.84	0.50	0.61	0.02	0.07	41.30	91.98
		Swope	Bethany Falls	5	52.54	0.84	2.77	0.48	1.12	0.04	0.05	42.07	93.69
	Marmaton	Lenapah	Idenbro	2	50.78	0.72	3.44	1.65	0.92	NA	NA	41.55	90.73
		Altamont	Worland	4	52.52	0.78	3.04	0.62	1.06	NA	NA	41.82	93.62
		Pawnee	Laberdie	8	51.99	1.19	3.33	0.54	0.81	NA	NA	41.93	92.61
		Fort Scott Limestone	Higginsville Member	15	47.52	2.60	7.16	0.92	1.20	NA	NA	40.22	84.73
Missis-sippian		Salem		7	53.10	0.27	0.72	0.19	0.21	0.02	0.08	43.39	94.62
		Warsaw		49	52.33	0.46	3.89	0.25	0.36	0.05	0.11	41.77	93.25
		Warsaw/Keokuk Limestone (undifferentiated)		7	54.64	0.30	0.60	0.12	0.13	NA	NA	43.56	97.33
		Keokuk/Burlington Limestone		19	52.11	0.20	5.12	0.19	0.42	0.04	0.07	41.15	92.86
	Chouteau	Sedalia/Compton Limestone		6	26.08	11.93	23.24	1.50	1.71	0.10	0.64	34.16	46.47
Ordovician		Cotter/Jefferson City Dolomites		15	27.66	18.53	8.78	1.10	0.42	0.03	0.49	42.30	49.29

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