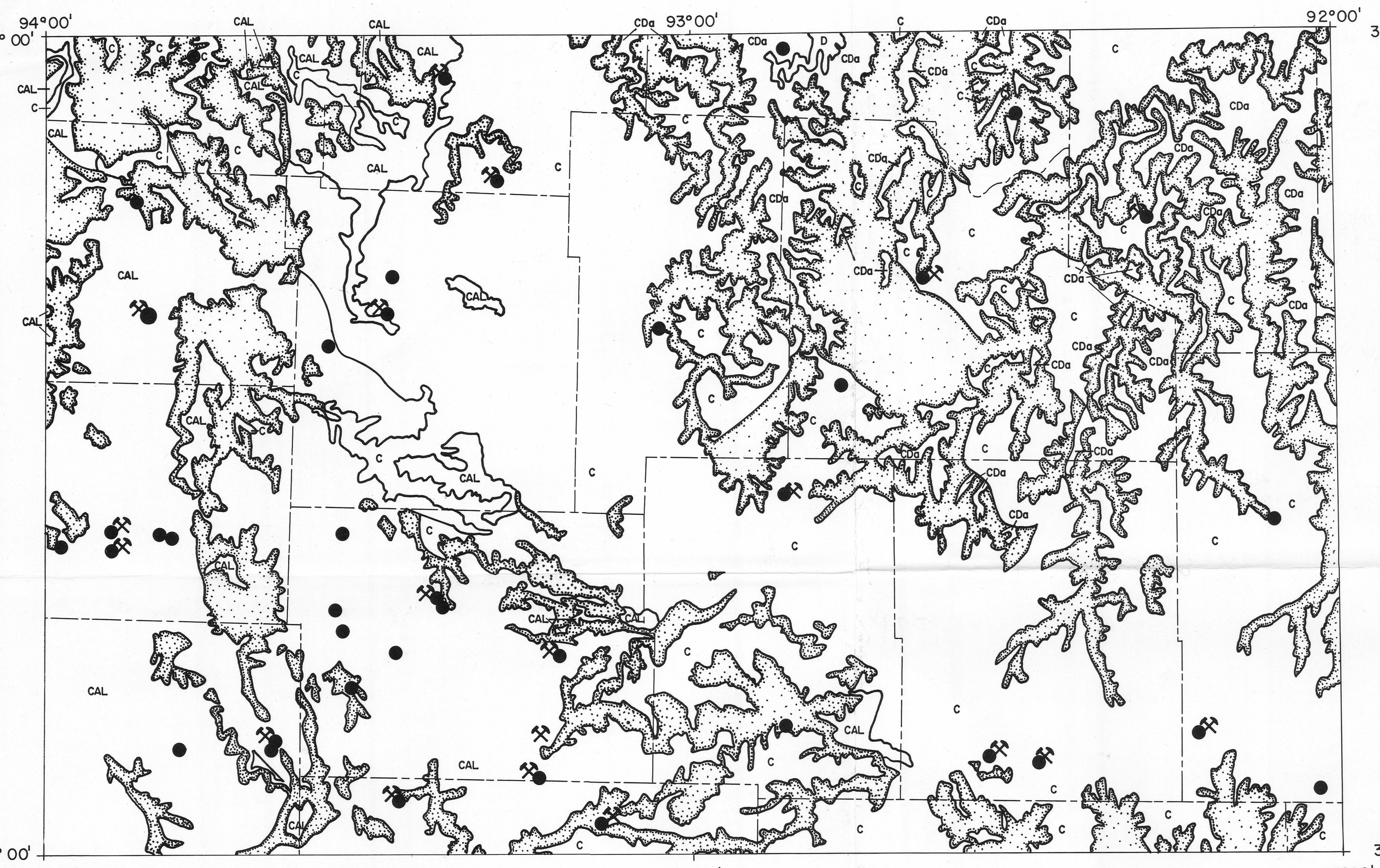
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE MISSOURI DEPARTMENT OF NATURAL RESOURCES, DIVISION OF GEOLOGY AND LAND SURVEY

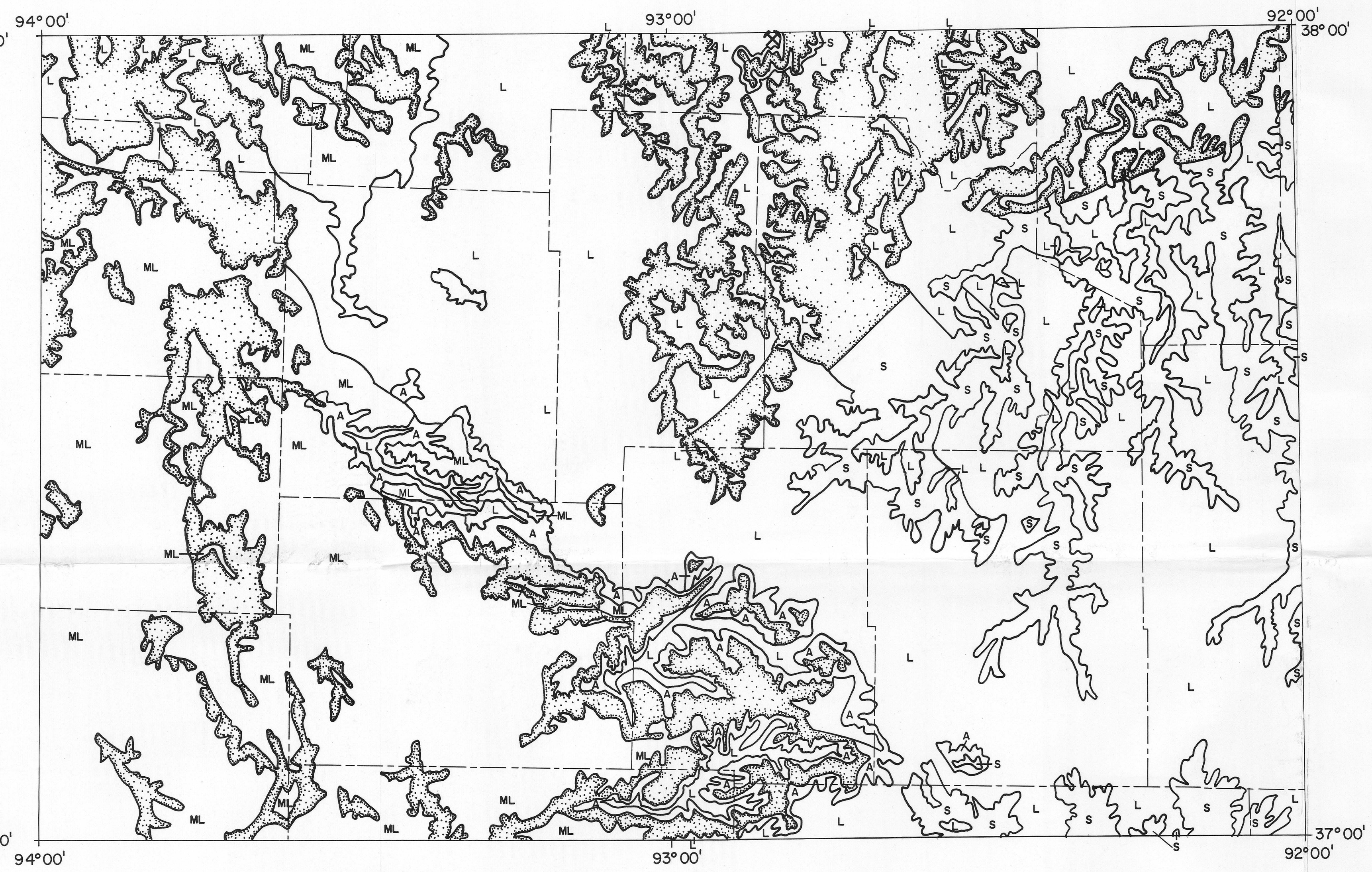
MISCELLANEOUS FIELD STUDIES
MAP MF-1830-F
FOLIO OF THE SPRINGFIELD 1° X 2° QUADRANGLE, MISSOURI



EXPLANATION

- L Areas of known resources of high-purity limestone
- A Areas of known resources of high-specification aggregate
- C Areas of known resources of commercial limestone and dolomite
- D Areas of known resources of high-purity dolomite
- a Areas of hypothetical resources of high-specification aggregate
- Areas with little or no commercial potential
- Sample sites
- Crushed stone operation

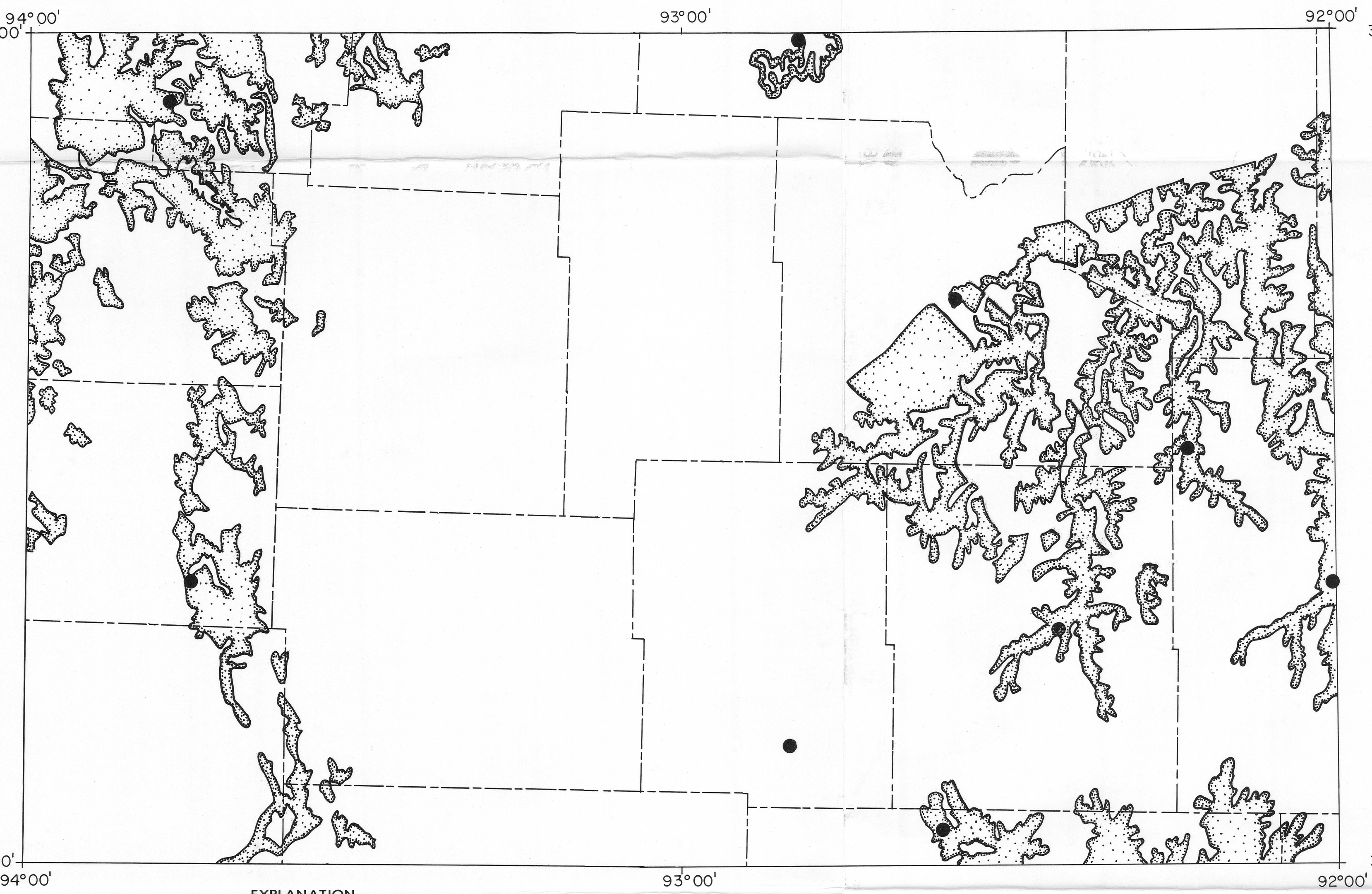
MAP A. CRUSHED STONE RESOURCES



EXPLANATION

- M Areas of known resources of marble
- A Areas of known resources of siltstone
- L Areas of known resources of carbonate building stone
- S Areas of known resources of sandstone building stone
- Areas with little potential for commercial dimension stone production.
- Dimension stone operation

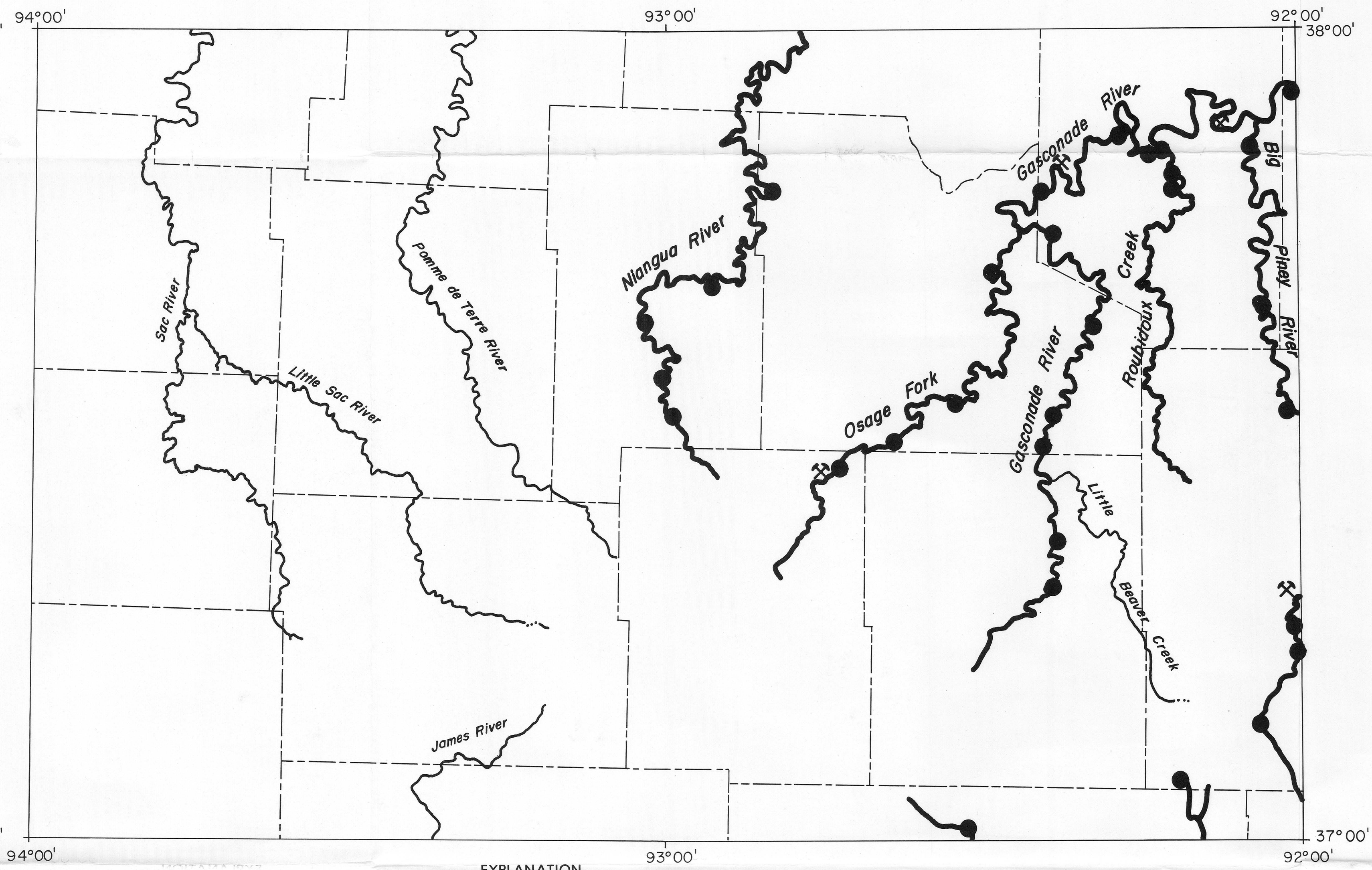
MAP B. DIMENSION STONE RESOURCES



EXPLANATION

- Areas of hypothetical resources of industrial sand
- Sample sites

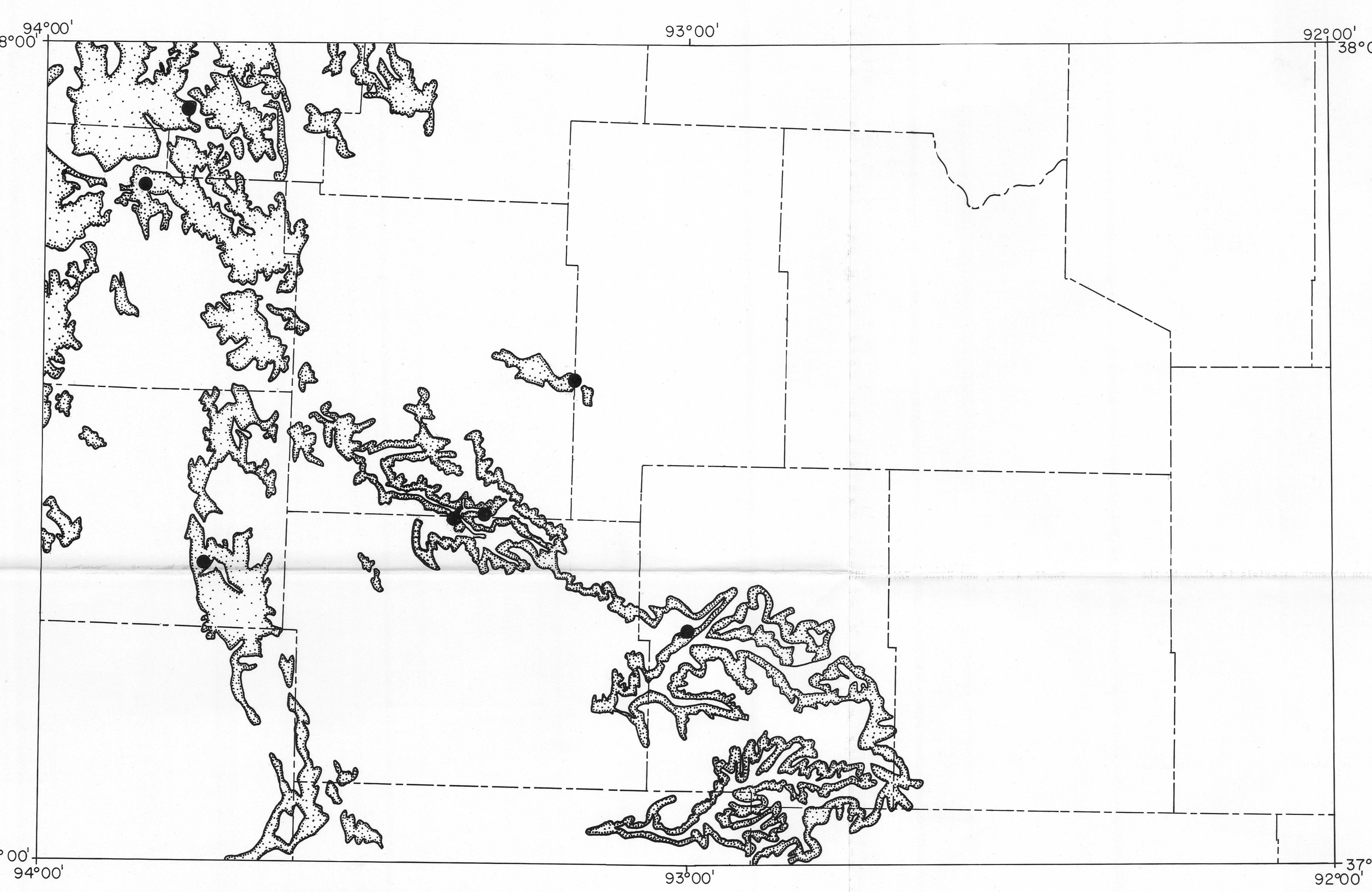
MAP C. INDUSTRIAL SAND RESOURCES



EXPLANATION

- Areas of known resources of construction sand and gravel
- Sample sites
- Major streams
- Construction sand and gravel operation

MAP D. CONSTRUCTION SAND AND GRAVEL RESOURCES



EXPLANATION

- Areas of hypothetical resources of structural clay and shale
- Sample sites

MAP E. CLAY AND SHALE RESOURCES

SCALE 1:500 000

CONTOUR INTERVAL FEET
DATUM IS MEAN SEA LEVEL

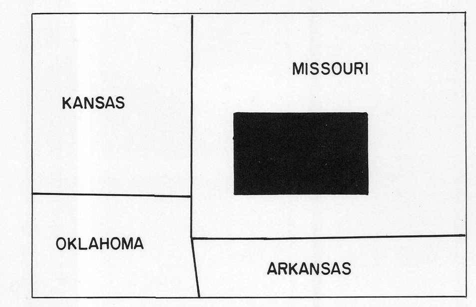
Table 1.--Chemical and physical properties of carbonate rock units having potential for crushed stone production

[SpG, Specific gravity; Abs, absorption; LA, resistance to abrasion and impact in Los Angeles testing machine (ASTM C-313-81)]

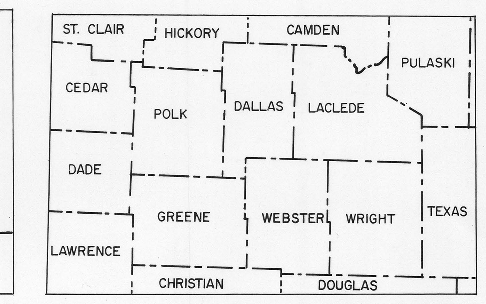
Geologic unit	Number of samples	CaO	MgO	SiO_2	Al_2O_3	Fe_2O_3	MnO	Na_2O	K_2O	LOI	SpG	Abs	LA
		Chemical analysis (in percent)								Physical properties			
Warsaw Formation	22	52.58	0.65	2.82	0.37	0.35	0.04	0.06	0.15	42.02	2.59	1.27	46.33
Burlington and Keokuk Limestones	79	52.78	0.89	2.23	0.38	0.25	0.04	0.03	0.08	42.69	2.64	0.76	36.97
Reeds Spring Formation	2	19.24	0.545	62.09	0.32	2.60	0.03	0.04	0.09	14.8	2.42	3.55	23.27
Pierson Limestone	3	45.07	2.65	8.19	1.47	0.60	0.09	0.02	0.44	39.73	2.65	1.02	27.18
Sedalia Formation	6	25.25	11.91	22.24	1.41	1.85	0.01	0.10	0.60	37.90	NA	NA	NA
Compton Limestone	3	51.66	0.53	4.64	0.92	0.60	0.05	0.02	0.30	40.51	2.66	0.70	30.19
Jefferson City and Cotter Dolomites	23	27.04	8.20	9.00	1.31	0.50	0.03	0.08	0.61	43.00	2.55	3.17	36.44
Gasconade Dolomite	13	29.36	20.40	2.39	0.53	0.25	0.02	0.02	0.14	NA	2.64	1.61	32.3
Eminence Dolomite	4	31.01	20.72	0.54	0.39	0.26	0.03	0.01	0.02	NA	NA	NA	NA

Table 2.--Chemical and physical properties of hypothetical industrial sand resources

Geologic formation	Number of samples	SiO_2	Fe_2O_3	Al_2O_3	MnO	CaO	MgO	K_2O	Na_2O	LOI	20	40	60	80	100
		Chemical analysis (in percent)									Cumulative percent retained U.S. Standard Sieve				
Warner Formation	2	94.37	1.09	1.80	0.02	0.07	0.14	0.65	0.05	1.14	-	7.9	56.2	79.0	84.8
Pennsylvanian channel sands	2	97.46	0.63	0.63	0.01	0.07	0.06	0.29	0.04	0.53	-	19.5	57.4	82.2	89.1
Swan Creek Sandstone Member of Cotter Dolomite	2	98.79	0.14	0.13	0.02	0.06	0.02	0.23	0.16	0.22	-	0.3	17.8	55.3	77.9
Roubidoux Formation	12	97.73	0.36	0.48	0.02	0.07	0.04	0.15	0.05	0.50	0.2	22.1	64.3	86.6	93.2
Gunter Sandstone Member of Gasconade Dolomite	2	99.18	0.18	0.09	0.01	0.05	0.02	0.12	0.13	0.19	0.5	23.2	58.2	86.3	93.5



INDEX MAP OF SPRINGFIELD 1°x 2° QUADRANGLE



INDEX OF COUNTIES

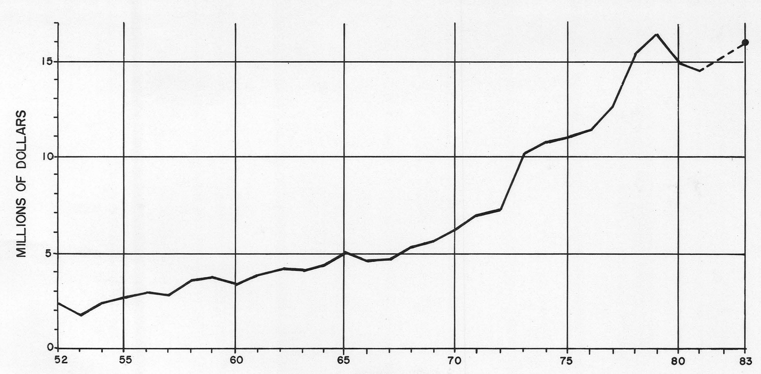


Figure 1.—Annual value of industrial mineral production (1952-1983)

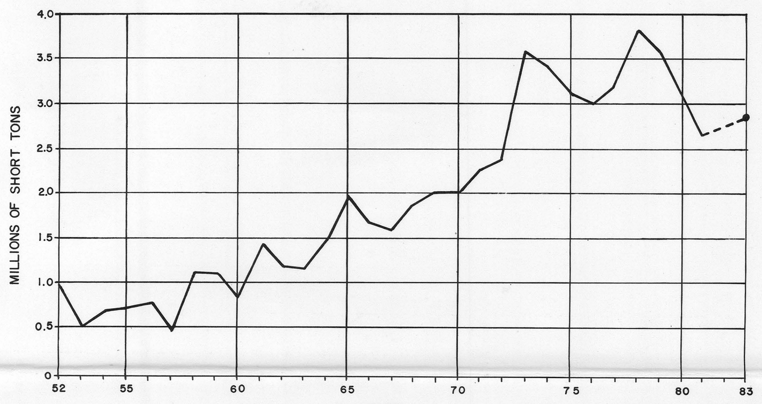


Figure 2.— Annual production of stone (1952-1983)

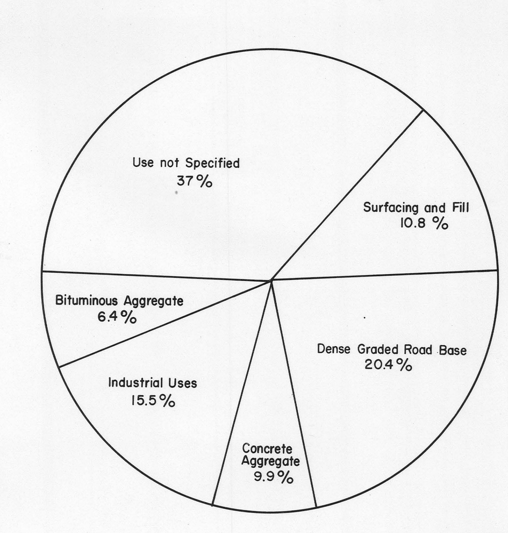


Figure 3.— Stone production by use—1983

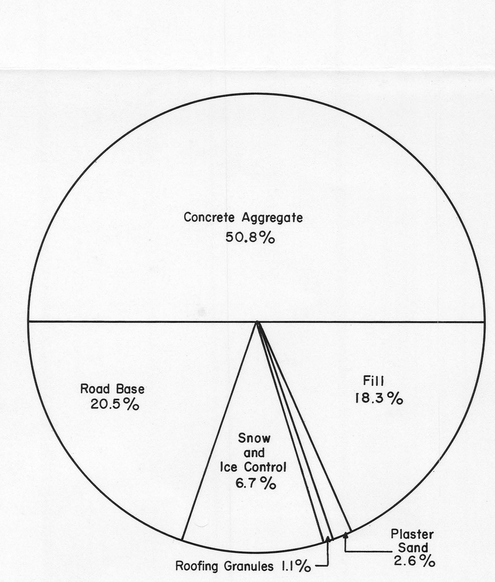


Figure 4.—Construction sand and gravel production by use—1984

FOLIO NOTE

This map is part of a folio of maps of the Springfield $1^{\circ}x2^{\circ}$ quadrangle, Missouri, prepared under the Conterminous United States Mineral Assessment Program. Other publications in this folio to date include U.S. Geological Survey Miscellaneous Field Studies Maps MF-1830-A through -E and Missouri Geological Survey Open-file Report OFR-85-42-MR.

DISCUSSION

The industrial mineral resources of the Springfield $1^{\circ}x2^{\circ}$ quadrangle are crushed stone, dimension stone, industrial sand, construction sand and gravel, and clay and shale. Of these, only crushed stone and construction sand and gravel are currently of economic importance; industrial sand, clay, and shale are judged to be hypothetical resources. Lime, a product manufactured from high-purity limestone, is produced in the quadrangle but is considered together with other crushed-stone products. Barite occurs in the quadrangle but is considered in a separate report (Wharton, 1987) because of its association with lead and zinc resources. All current mineral production in the Springfield quadrangle is from industrial minerals; the value of this production during 1983 was approximately $16 million. Figure 1 shows production values for the period 1952 through 1983.

Stratigraphic units present in the quadrangle are given in the LIST OF STRATIGRAPHIC UNITS.

CRUSHED STONE

Crushed stone is the most valuable mineral commodity produced in the quadrangle. In 1983, the latest year for which complete data are available, 2.8 million tons were produced; production was reported from 20 sites representing every county in the quadrangle. The major use during that period was for aggregate. Figure 2 shows annual stone production in the quadrangle from 1952 through 1983; figure 3 shows stone production by use during 1983.

To evaluate the stone resource potential of the quadrangle, samples were collected from 42 sites. Major-element chemical analyses and common aggregate tests were run on each sample (Rueff, 1985; Rueff and Hayes, 1985). These data, combined with knowledge of past and present usage, provided a basis for classifying the stone resources of the quadrangle into the five categories listed below. Map A shows the distribution of these resources. Units suitable for more than one category of use are shown by a combination of letters--for example, a rock unit that is a known resource of high-purity limestone (L), of high-specification aggregate (A), and of commercial limestone or dolomite (C), is labeled CAL. Categories of crushed-stone resources are:

L - Known resources of high-purity limestone. For the purposes of this report, high-purity limestone consists of formations that contain minable sections of limestone with a minimum $CaCO_3$ content of 95 percent (CaO 53 percent). Resources meeting this criterion are in the Warsaw Formation and Burlington and Keokuk Limestones.

A - Known resources of high-specification aggregate. This is an arbitrary category that designates stone meeting standard specifications of the Missouri Highway and Transportation Department and other agencies for aggregate to be used in portland cement. Resources meeting this criterion are in the Warsaw Formation and Burlington and Keokuk Limestones.

C - Known resources of commercial limestone and dolomite. This category includes rock units in the high-purity limestone and high-specification aggregate categories and those suitable for less stringent aggregate and agline use. Resources are in the Warsaw and Sedalia Formations, the Burlington, Keokuk, Pierson, and Compton Limestones, and the Jefferson City, Cotter, and Gasconade Dolomites. Resources of commercial limestone and dolomite are large and widespread in the quadrangle.

D - Known resources of high-purity dolomite. Resources in this category consist of dolomite formations that contain minable sections of dolomite with a $MgCO_3$ content of 40 percent or greater (MgO 19 percent). Resources are in the upper unit of the Gasconade Dolomite and in the Eminence Dolomite.

a - Hypothetical resources of high-specification aggregate. This category consists of formations that may contain sections of stone meeting the standards for high-specification aggregate as defined earlier. The upper unit of the Gasconade Dolomite is the only unit in this category.

Large areas of the Springfield $1^{\circ}x2^{\circ}$ quadrangle are underlain by formations having little or no commercial value as crushed stone; they are indicated on Map A by the stipple pattern. Areas in this category are those underlain by the Pennsylvanian formations and the Elsey, Reeds Spring, and Roubidoux Formations, and areas near complex structural features.

Table 1 contains data on the average chemical and physical properties of rock units judged to have commercial potential for crushed-stone production. For detailed information on the structure, lithology, and distribution of geologic units mapped in the quadrangle refer to Middendorf and others (1987).

DIMENSION STONE

Dimension-stone resources are considered separately from crushed-stone resources, though they include many of the same formations. Although these resources are large and diverse they have little economic value. The generalized dimension-stone resource map, Map B, shows the distribution of the following categories of dimension-stone resources:

M - Known resources of marble. For purposes of this report and by commercial definition, marble is any carbonate rock that can be polished. Resources are in the Warsaw Formation and the Burlington and Keokuk Limestones. A quarry that produced rough blocks of Warsaw limestone for finishing outside the area of the quadrangle has been closed since the 1960's.

A - Known resources of siltstone. Resources are present in the Northview Formation where that unit is a durable, calcite-cemented siltstone. Siltstone from the Northview is commonly used in construction of fireplaces and for decorative purposes where an earthy, dark-colored stone is desired. It is often used with dark or black mortar.

L - Known resources of carbonate building stone. This category includes carbonate rock units with past or present use as building, rubble, or flagging stone. The rock is often used as roughly shaped blocks. Resources with extensive past production are in the Warsaw Formation, Burlington and Keokuk Limestones, and the Jefferson City, Cotter, and Gasconade Dolomites. Minor resources are in the Pierson and Compton Limestones and Sedalia Formation.

S - Known resources of sandstone building stone. This category includes those units with past or present use as building, rubble, or flagging stone. Resources are in the Roubidoux Formation and in the Gunter Sandstone Member of the Gasconade Dolomite. These sandstones have been extensively used in southern Missouri for houses, fireplaces, patios, and decorative trim.

Units with little potential for commercial dimension-stone production include the Pennsylvanian formations, the Elsey and Reeds Spring Formations, and the Eminence Dolomite.

INDUSTRIAL SAND

The resource potential for industrial sand (silica) in the Springfield quadrangle is hypothetical. Distribution of such materials is shown by the stipple pattern on Map C. Units considered as possible sources of industrial sand are the Warner Formation, undifferentiated channel sandstones in the Cherokee Group, the Swan Creek Member of the Cotter Dolomite, the Roubidoux Formation, and the Gunter Sandstone Member of the Gasconade Dolomite. Table 2 provides average chemical and grain-size data. These sandstones are believed suitable for no more than the lowest industrial-use specification without extensive beneficiation; no past or present use for any industrial purpose is known. Major drawbacks are chemical impurities, improper grain sizes, irregular shapes, and a high degree of cementation.

CONSTRUCTION SAND AND GRAVEL

Construction sand and gravel resources, although not widespread in the Springfield quadrangle, are locally important as aggregate for ready-mix concrete. During 1984, the latest year for which complete data are available, production of nearly 200,000 short tons was reported. Figure 4 shows the use of construction sand and gravel during 1984. Samples were collected from 31 sites and evaluated for size gradation.

The best resources are in the northeast part of the quadrangle along the Big Piney River, Roubidoux Creek, and the Osage Fork and Gasconade Rivers. Lesser resources are included along the Niangua River and in small streams at the southern margin of the quadrangle. Streams in the western part of the quadrangle contain mostly chert gravel with very little sand of suitable quality. Streams with major resource potential are shown on Map D.

CLAY AND SHALE

The Springfield quadrangle contains no known high-quality structural clay and shale resources. Firing tests to determine ceramic potential were made by the U.S. Bureau of Mines on thirteen samples from the Rowe, Riverton, and Northview Formations (Rueff, 1986). None of the tested samples were suitable as solid-source structural clay products. Samples from the Rowe shale appeared to have some potential; those from the Northview were mostly unsuitable. Even samples classified as suitable had short firing ranges, followed by abrupt vitrification. If blended with other materials, however, some of these shales might prove usable. Because of the foregoing inadequacies, the resources of clays and shales in the Springfield quadrangle are considered hypothetical. Their distribution is shown on Map E.

SUMMARY

The production of industrial minerals is the only mineral industry currently active in the Springfield quadrangle and the only one active within the last 20 years.

Of the industrial minerals present, only crushed stone and one of its products, manufactured lime, are currently of major economic importance. Limestone units in the Warsaw Formation and Burlington and Keokuk Limestones contain thick sections of stone suitable for the manufacture of cement, lime, and specialty limestone products. Future development of these resources will depend on demand and prospective investment. Construction sand and gravel are produced from streams in the northeastern part of the quadrangle; however, they are of lesser economic importance.

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LIST OF STRATIGRAPHIC UNITS

Cherokee Group (Pennsylvanian-Desmoinesian)
  Undifferentiated channel sandstone
  Rowe Formation
  Warner Formation
Riverton Formation (Pennsylvanian-Atokan)
Warsaw Formation (Mississippian-Meramecian)
Keokuk Limestone (Mississippian-Osagean)
Burlington Limestone (Mississippian-Osagean)
Elsey Formation (Mississippian-Osagean)
Reeds Spring Formation (Mississippian-Osagean)
Pierson Limestone (Mississippian-Osagean)
Northview Formation (Mississippian-Kinderhookian)
Sedalia Formation (Mississippian-Kinderhookian)
Compton Limestone (Mississippian-Kinderhookian)
Bachelor Formation (Mississippian-Kinderhookian)
Cotter Dolomite (Ordovician-Canadian)
Swan Creek Sandstone Member of Cotter Dolomite (Ordovician-Canadian)
Jefferson City Dolomite (Ordovician-Canadian)
Roubidoux Formation (Ordovician-Canadian)
Gasconade Dolomite (Ordovician-Canadian)
Gunter Sandstone Member of Gasconade Dolomite (Ordovician-Canadian)
Eminence Dolomite (Upper Cambrian

INDUSTRIAL MINERAL RESOURCES OF THE SPRINGFIELD 1° X 2° QUADRANGLE, MISSOURI

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1987

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