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IDENTIFICATION AND ASSESSMENT OF ASBESTOS EMISSIONS FROM INCIDENTAL SOURCES OF ASBESTOS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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IDENTIFICATION AND ASSESSMENT OF ASBESTOS EMISSIONS FROM INCIDENTAL SOURCES OF ASBESTOS

by

R. J. Kuryvial, R.A. Wood, and R.E. Barrett

Battelle, Columbus Laboratories
505 King Avenue,
Columbus, Ohio 43201

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EPA Project Officer: D.K. Oestreich

Control Systems Laboratory
National Environmental Research Center
Research Triangle Park, North Carolina 27711

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OBJECTIVE

The objective of this task is threefold:

1. To identify mining operations that involve ore or gangue containing asbestos as an accessor mineral.
2. To estimate emissions to the air of asbestos from sources identified above.
3. To collect and analyze ambient air samples in the vicinity of the two sources identified above that have the probable most serious environmental consequence.

Each of these objectives parallels one of the first three subtasks as identified in EPA Task Order 24 dated October 19, 1973.

APPROACH

Battelle-Columbus' approach to identifying ore and gangue mining operations that utilize material containing asbestos as an accessory mineral was to assemble and review available geological literature. One of the prime literature sources to be utilized in this task was information obtained from state geologists. Other information sources included Federal sources and miscellaneous published literature. This information was assembled and reviewed to identify mining areas where the ore is known to contain significant amounts of asbestos.

Once the areas where ore contains significant quantities of asbestos were identified, Battelle proceeded to identify and quantify the type and scale of mining operations being conducted in those areas.

Sixteen specific large-scale mining operations were identified and treated on an individual basis. For the 16 specific large-scale mining operations, the following were estimated or determined

- annual volume of ore handled
- asbestos content of ore
- type of operations conducted
- type of air pollution-control equipment
- population distribution within vicinity of the source.

Using this data, and with the concurrence of the Project Officer, two sources of the "most probable serious environmental consequence" were selected. Short-term sampling and analysis programs were conducted to better quantify emissions from the two sources having most probable serious environmental consequence. These sampling programs involved ambient high-volume sampling of air in the vicinity of the mining operations. Analyses of the ambient air samples for asbestos were conducted by Battelle-Columbus.

SUMMARY AND CONCLUSIONS

The literature indicated that asbestos is present as an accessory mineral in significant quantity in ores mined in many areas of the United States and much mining activity occurs in these areas. The limited sampling and analysis done during this study did not support the hypotheses that a health hazard exists. A health hazard is defined as the exposure of populations to significant asbestos concentrations in the air. Based on the very limited sampling conducted for this program, it was found that persons living in the vicinity of two large mining operations working asbestos-containing ore were not exposed to asbestos concentrations above those frequently encountered in ambient air. The maximum concentration determined was 0.009 $\mu g/m^3$ (based on 24-hour sample), whereas concentrations of 0.001 to 0.01 have been encountered by Battelle-Columbus in other ambient sampling programs.

There is little question that the sampling and analytical work conducted under this study was extremely limited in scope and resources. Because of the serious health aspects of asbestos as an air pollutant, it is recommended that a much broader sampling and analysis program be conducted to establish if there is a problem and the extent of the problem.

BACKGROUND INFORMATION

Asbestiform Minerals of Interest

The term asbestos is a general name given to a number of minerals having a fibrous form and is more related to the economic uses of the material character.* The fibrous mineral phases which are of primary concern in this study are listed in Table 1. Each of these phases can exhibit acicular-shaped grains. All except chrysotile belong to a family of silicate minerals which are termed amphiboles. Chrysotile belongs to the serpentine group of minerals, which includes the nonfibrous polymorph phase antigorite.

Compositionally, the amphiboles are hydrous silicates of magnesium, iron, calcium, sodium, and aluminum which in general crystallize in the acicular form of fibrous crystals. Each member of the amphibole family has in common the crystallographic property of excellent prismatic cleavage, in which the cleavage surface make characteristic angles of 56 degrees and 124 degrees to each other. It is this cleavage which causes the mineral to fragment into fibers. This property distinguishes the amphibole group from all other minerals and is also the property which causes the amphiboles to fracture into the long, needlelike fibers observed during the mining and processing of amphibole-bearing ores.

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* A glossary of terms is included on pages 40 through 42.

The amphiboles are generally considered in terms of five series. These are (1) anthophyllite-gedrite, (2) cummingtonite-grunerite, (3) tremolite-actinolite, (4) hornblende, and (5) soda amphibole. In the anthophyllite series magnesium predominates over iron, while aluminum can substitute for silicon and magnesium in the structure up to the limit shown in gedrite. In the cummingtonite series, the ratio Fe:(Fe + Mg) ranges from 1 to about 0.4. The iron-rich varieties of cummingtonite are termed grunerite. Amosite is another name for fibrous grunerite. Here there is some ambiguity in nomenclature as to the point where cummingtonite is sufficiently iron rich to be called grunerite or when grunerite is sufficiently fibrous to be termed amosite. The tremolite-actinolite series contains essential calcium in the structure. Tremolite refers to the magnesium-rich variety and actinolite to the iron-rich variety.

TABLE 1. PRINCIPAL ASBESTIFORM MINERAL PHASES

Chrysotile	$Mg_3\ [Si_2O_5]\ (OH)_4$
Anthophyllite	$(Mg,\ Fe^{+2})_7\ [Si_8O_{22}]\ (OH,F)_2$; (Mg > Fe)
Gedrite	$(Mg,\ Fe^{+2})_5\ Al_2\ [Si_6Al_2O_{22}]\ (OH,F)_2$
Cummingtonite	$(Mg,\ Fe^{+2})_7\ [Si_8O_{22}]\ (OH)_2$; (Fe > Mg)
Grunerite	$(Fe^{+2},\ Mg)_7\ [Si_8O_{22}]\ (OH)_2$; (Fe >> Mg)
Tremolite	$Ca_2\ (Mg)_5\ [Si_8O_{22}]\ (OH)_2$
Actinolite	$Ca_2\ (Fe^{+2},\ Mg)_5\ [Si_8O_{22}]\ (OH)_2$
Glaucophane	$Na_2\ (Mg_3Al_2)\ [Si_8O_{22}]\ (OH)_2$
Riebeckite	$Na_2\ (Fe_3^{+2})\ [Si_8O_{22}]\ (OH)_2$

Hornblende, $NaCa_2$ (Mg, Fe, Al), $[(Si, Al)_8 O_{22}](OH)_2$, has a wide range of chemical compositions and a correspondingly wide range of physical properties. Hornblende, though nearly ubiquitos in occurrence, is seldom seen in a fibrous form and for this reason will not be dealt with at any length in this study. The principal members of the soda amphiboles are the magnesium-rich variety glaucophase and the iron-rich variety riebeckite. Crocidolite is the term generally given to the fibrous form of riebeckite.

Geologic Occurrence of Asbestiform Phases

To quantitatively assess the magnitude of fugitive asbestos emissions in the mining industry, a necessary first step is to determine how large a segment of the industry has asbestos as a gangue constituent in the ore. In general, only the larger mining companies have detailed knowledge of gangue mineralogy and, of these, only the more classic examples of ore bodies are reported in the literature. Because of this scarcity of data, it is necessary to predict the mining areas which are most likely to have gangue asbestos from the geologic settings of the areas. This is possible because chrysotile and the amphiboles occur only under specific types of geologic conditions in the earth crust. Knowing geographically where these favorable settings occur and the coincidence of mining activity within these areas is a first step in assessing the magnitude of the fugitive asbestos in the industry.

The geologic settings where the asbestiform phases given in Table A occur are discussed below.

Chrysotile. Chrysotile asbestos is the fibrous polymorph of the metamorphic mineral termed serpentine. Serpentine is really a group of secondary minerals resulting from the alteration of magnesium-bearing minerals, such as olivine (the most common source), enstatite, hornblende, tremolite, and augite.

Serpentinite is the name applied to rock units which consist almost entirely of minerals of the serpentine group, all of which are to be ascribed to late- or post-magmatic hydrothermal alteration of pyroxen and olivine in the igneous rocks pyroxenite, peridotite, and dunite. Most serpentinites are composed chiefly of the flaky serpentine mineral antigorite. Antigorite forms when the rock is subjected to stresses, while fibrous chrysotite is formed in unstressed rocks. All serpentinites are soft and massive and are usually found in veins with any fibers perpendicular to the walls of the veins.

The ultramafic (magnesium-iron rich) igneous rocks which lead to the formation of chrysotile can occur as extensive peridotite and serpentinite belts or as small intrusive plutons. A swarm of small ultramafic bodies extend for 1600 miles along the Appalachian Mountains from the Saint Lawrence estuary to North Carolina. Several hundred individual lenses, rarely exceeding 100 yards, occur in North Carolina alone. Similar swarms of ultramafic sills, sheets, and plugs of serpentinized peridotite, which invade the Franciscan sedimentary rocks, occur in the coast range of California and Oregon. Figure 1 shows the geographic location of these serpentinite belts. It is now recognized that serpentinite belts and related rocks follow the flanks of most of the great mountain chains and island arcs.

Anthophyllite-Gedrite. Anthophyllite and gedrite occur in a wide range of rocks of igneous and metamorphic origin. Anthophyllite is commonly developed, often with an asbestiform habit, during the regional metamorphism of ultramafic (Mg-Fe rich) rocks. In these cases it is associated with talc in anthophyllite-talc schists. Other modes include its occurrence as rims surrounding orthopyroxenes subjected to metamorphic activity, and as a hornfels constituent within the metamorphic aureoles of intermediate intrusive. Anthophyllite is also characteristic of siliceous magnesium marbles and many schistose rocks.

Anthophyllite is found in numerous small bodies in the Piedmont Province of the southeastern U.S., especially in North Carolina and Georgia. It also is known to occur in other localities of Pennsylvania and Montana.

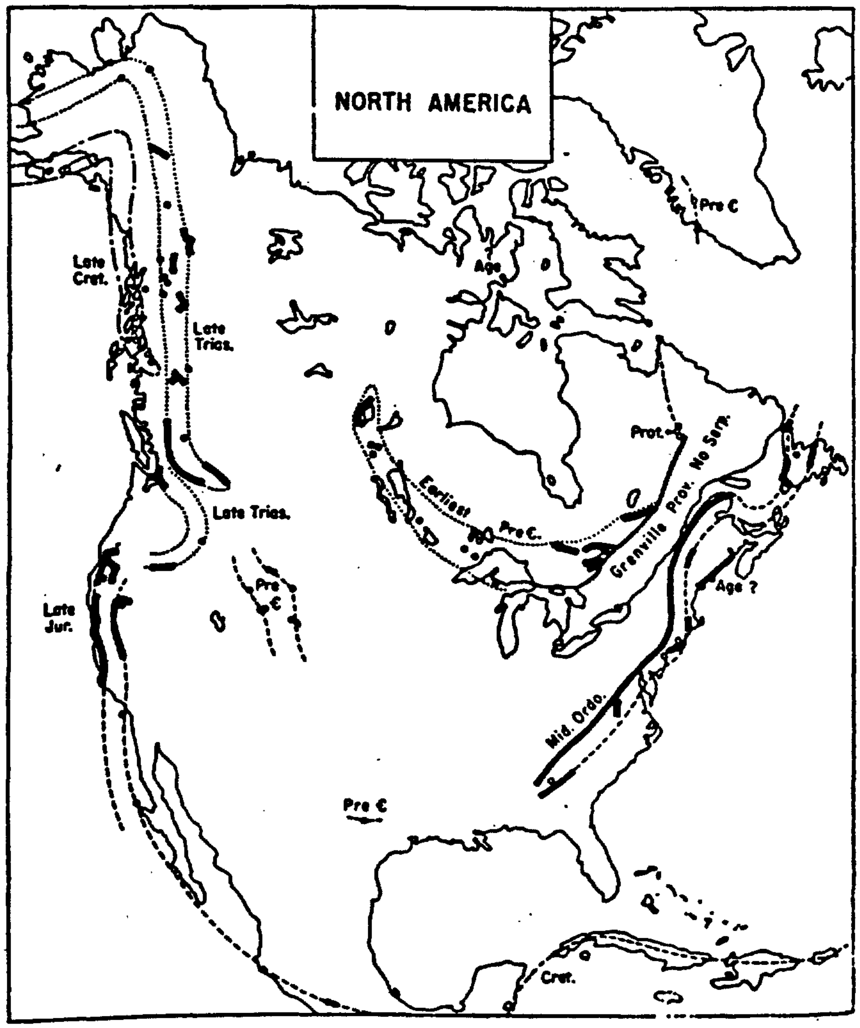

FIGURE 1. SERPENTINITE BELTS OF NORTH AMERICA

(After H. H. Hess, Geol. Soc. Am. Spec., Paper 62)

Cummingtonite-Grunerite. Cummingtonite and grunerite are virtually confined to metamorphic rocks and are probably the least abundant of the amphiboles. Members of this series generally occur in metamorphased iron formations, but may also occur in middle grades of metamorphased mafic igneous rocks.

Cummingtonite is a characteristic mineral in schists at the Homestake Mine in South Dakota and is a characteristic mineral of hornfels at several localities in California. Grunerite is a characteristic mineral of metamorphased iron-rich siliceous sediments and is very prominent in some of the iron ores of the Lake Superior region, notably the magnetite ores of the Upper Peninsula of Michigan.

Tremolite-Actinolite. Tremolite and actinolite are essentially metamorphic minerals and occur in contact metamorphic deposits, in schists and gneisses, and in metamorphic limestones. They are also found as a replacement of pyroxene in igneous rocks. Tremolite is probably the most common fibrous amphibole and is most characteristic of metamorphased dolomitic limestone, while actinolite occurs in rocks richer in iron.

Tremolite can occur in calcium-rich gneisses. These rocks frequently consist of two or three mineral combinations as diopside-tremolite or diopside-phlogophite-tremolite, or grossularite-diopside-wollastonite. The calcium-rich gneisses generally result from the contact and regional metamorphism of limestones and dolomites containing large amounts of sand and clay. In some cases the injection of limestones and dolomite by granitic material may result in the development of calcium gneisses. Examples of calcium-rich gneisses are reported from the North Conway quadrangle of the White Mountains, New Hampshire, and in the Littleton-Moosilauke and Mount Washington areas, New Hampshire.

Marbles often contain tremolite and are formed either by contact or regional metamorphism of carbonate rocks. Usually tremolite occurs in marbles subjected to higher temperatures of formation. Although marbles are composed chiefly of carbonate minerals, minor and variable silicates as accessories are always present. In magnesium limestone there is a large development of tremolite and olivine. Silicates and other accessories may be concentrated in thin streaks or bands or in granular to radial aggregates. Olivine may alter to chrysotile and form a network of veinlets.

Tremolite and actinolite may also occur in skarns. These are rocks occurring in the lime-silicate zone at the junction between marbles and plutonic rocks. Often these rocks will be nearly monomineralic in tremolite.

Actinolite commonly occurs in certain low-grade schists. In many cases it is the chief constituent of green-colored schists and greenstones. Schists of low-grade metamorphism are mostly confined to the outer and upper zones of areas affected by regional metamorphism. Actinolite and tremolite can also occur in greenschists, which are formed by low-grade regional metamorphism from mafic and ultramafic igneous rocks. Frequently the actinolite of such rocks has had its origin in the pyroxene contained in the igneous rocks from which the metamorphic type has been derived. Actinolite sometimes occurs in parallel intergrowths with hornblende, or in crystals sharply rimmed by hornblende.

The asbestos form of actinolite has been found in the metamorphic rocks in various states along the Appalachian Mountains. Occurrences are at Bare Hills, Maryland, Franklin, New Jersey, Delaware, and Chester counties, Pennsylvania, Chester, Massachusetts, and Windham, Vermont.

Glaucophane-Riebeckite. Glaucophane and members of this sodic variety of amphiboles are not very common and largely confined to low- and medium-grade metamorphic rocks, as schists and gneisses. Glaucophane-bearing rocks are usually located in folded geosynclinal terrains and are commonly associated with greenschists and epidote amphibolites.

In the Coast Range of California and elsewhere, glaucophane schists, occur in localized areas together with narrow layers or sills of serpentinite within the sedimentary formations. The Coast Range formation is an altered series of typical geosynclinal sedimentary rocks. Outcrops of glaucophane schists within the formation are generally irregular and discontinuous. Glaucophane schists are metamorphically derived from rocks of diverse composition, such as basalts, diabase, calcareous sedimentary rocks, graywacke, sandstone, and iron-rich chert.

Riebeckite is found both in metamorphic and igneous rocks. In the latter it occurs especially in soda-rich granites, rhyolites, granitic pegmalites, syenites, nepheline syenites, and trachytes. Riebeckite is found in a few low-grade regionally metamorphased schist and has been reported in rocks of the Green River oil shale formation of northeast Utah. The transformation of riebeckite to fibrous crocidolite is thought to result from the instability of the massive riebeckite during periods of shearing stress. Crocidolite has been noted in metamorphased iron formation.

Geographic Distribution of Areas Likely to Contain Asbestiform Minerals

The geologic environments or settings in which asbestiform minerals tend to occur were discussed above for each mineral subgroup of interest. It is apparent from the discussion that chrysotile and the amphiboles occur only in metamorphic and igneous rock terrains or in weathered sediments in close proximity to these rock types. This fact narrows considerably the geographic areas of the U.S. which need be of concern in a fugitive asbestos study. Areas underlain largely by sedimentary rocks, as sandstone, shale, and limestone, are very unlikely to have asbestiform occurrences and thus any mining activity taking place within these areas should not be considered suspect. Mining activity carried out within metamorphic or igneous rock terrains, however, should be considered as potential sources of fugitive asbestos until the ore has been mineralogically examined. Of the two types of terrains, metamorphic rocks appear to be much more likely sources of asbestos than igneous rocks. For this reason, mining sites within metamorphic rock terrains should receive greatest attention in determining fugitive asbestos emissions.

Probably 30 to 40 percent of the continental U.S. is immediately underlain by metamorphic or igneous rock types. Within these areas the original sedimentary-type rocks have generally either been intruded by molten igneous rocks or have been compressed and buckled by large-scale crustal movements. When molten igneous rock is emplaced within sedimentary rock, the high temperatures and solutions produced convert or metamorphose the normal mineralogy of the sedimentary rock to another assemblage of minerals, ones often containing asbestiform phases. The igneous rock itself, depending on composition and other environmental factors, may also crystallize asbestiform phases directly or may later alter to asbestiform phases.

Sedimentary rocks which have been deeply buried within the crust or which have been subjected to high compressional forces within the crust are often converted to metamorphic rocks. Here the original mineralogy is converted to a secondary mineral assemblage, the nature of which depends on rock chemistry, temperature, and pressure.

To the first approximation, those areas of the U.S. which contain igneous or metamorphic rocks are fairly well known. Figure 2 shows the geographic distribution of these areas and compiles information gathered from the various literature sources reviewed in this study. In the eastern states, the large northeast trending area containing igneous and metamorphic rocks corresponds with the Appalachian Mountain Province. In the western states, these areas also correspond with areas of large-scale crustal movement which resulted in igneous intrusions and mountain building. Figure 2 shows specific localities where high concentrations of asbestiform phases have been observed in the underlying bedrock. These sites correspond perfectly with the igneous-metamorphic terrains shown in Figure 3.

Areas of the U.S. containing igneous and metamorphic rocks are dealt with in some detail in Appendix A. Here there is a state-by-state treatment of suspect areas and a discussion of mining activity within those areas.

Figure 4 shows the population density of the U.S., by county, as of 1970. A comparison of this figure with Figure 3 indicates those portions of the U.S. having a high population density and also having a high potential for fugitive asbestos emissions. The most critical areas appear to be in eastern Pennsylvania, southeastern New York, southwestern Connecticut, the San Francisco area, and the Los Angeles area. Fortunately, there is little in the way of heavy mining in these areas. Most mining is confined to small underground mines or small quarries.

In most cases areas containing igneous or metamorphic rock which do support heavy mining activity tend to be sparsely populated.

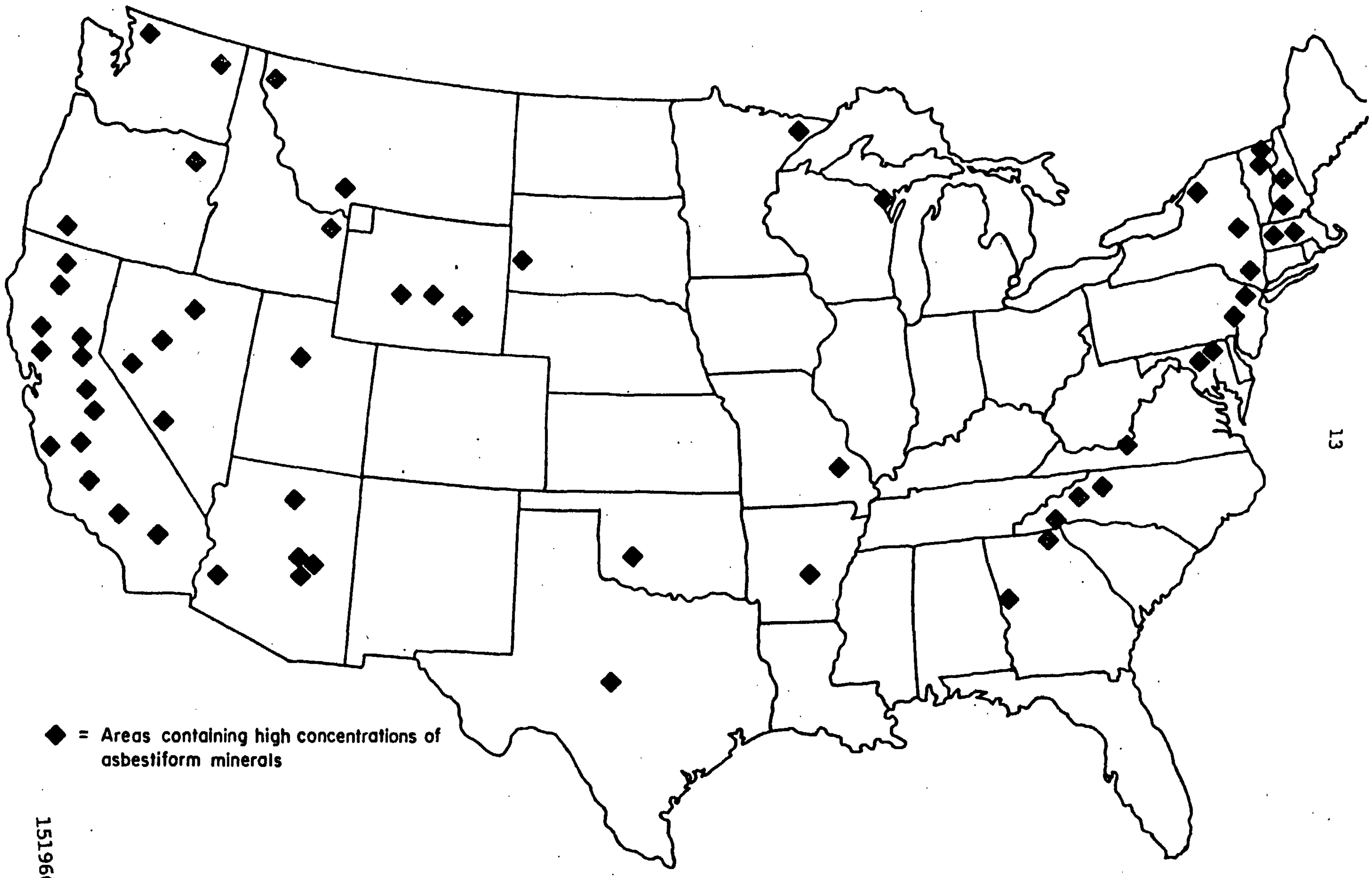

FIGURE 2 . SPECIFIC SITES CONTAINING HIGH CONCENTRATIONS OF ASBESTIFORM PHASES

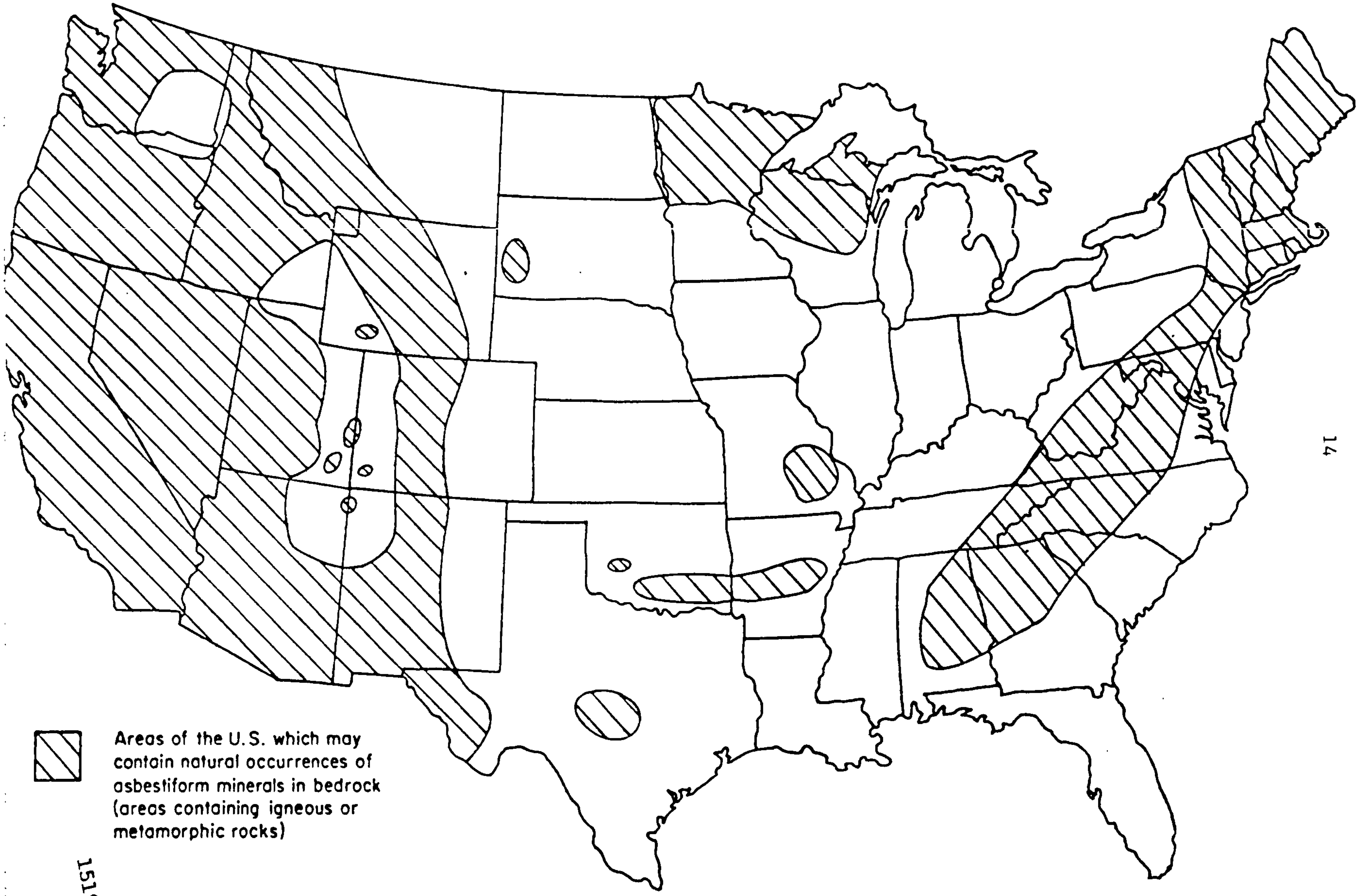

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FIGURE 3 . GEOGRAPHIC DISTRIBUTION OF IGNEOUS-METAMORPHIC ROCK TERRAINS

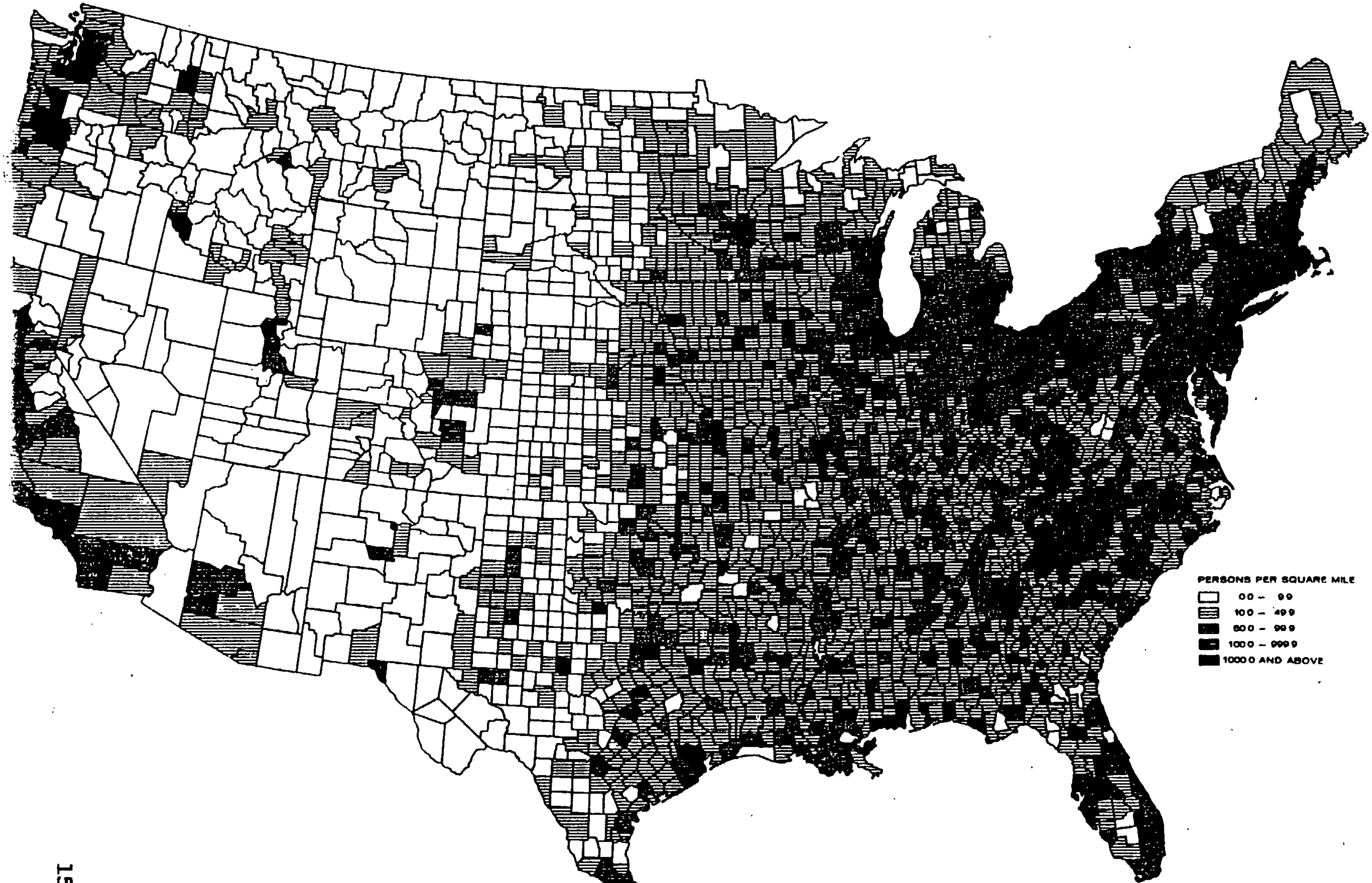

FIGURE 4. THE UNITED STATES - 1970 POPULATION DENSITY BY COUNTY

APPROACH AND RESULTS

Occurrence of Asbestiform Minerals in Ores

An attempt was made in this study to mineralogically characterize as many ore bodies as possible within the given time framework. This was done by contacting state and federal geologic agency personnel, by reviewing agency publications, and by reviewing appropriate mining journals for mention of asbestiform occurrences. In general, most available literature deals only with the ores minerals and their occurrences throughout the deposits. Table 2 gives those mining districts or mines reviewed and lists whether or not references were found to indicate the presence of asbestos in the ore.* Of the 58 mining localities cited, 16 were indicated to have some form of asbestiform minerals present as gangue in the ore. Each of these is within the igneous-metamorphic suspect areas given in Figure 3.

The 42 localities for which there was no indication of the occurrence of asbestiform minerals are not excluded as possible sources of asbestiform minerals. However, they were excluded from further consideration due to lack of specific information showing the occurrence of asbestiform minerals.

A discussion of the 16 localities where asbestiform minerals are known to occur follows.

Menominee District, Central Dickinson County, Michigan, The Groveland Mine. Iron ore occurs in a long, narrow syncline containing metamorphased sedimentary formations. The sedimentary sequence dips steeply and is in unconformable or fault contact with granite or with foliated granitic gneiss that contains layers of amphibolite. It is moderately coarse grained, consisting mainly of hematite, magnetite, quartz, tremolite-actinolite, cummingtonite, diopside, garnet, and carbonate.

* Possible asbestos emission sources considered in this study generally were limited to large mining districts. Small mining operations (quarry sand and gravel operations, etc.) in possible areas of asbestiform minerals were not considered in detail.

TABLE 2 . SPECIFIC MINING DISTRICTS INVESTIGATED

In 16 out of 58 mining districts asbestiform phases known to be present

No.	Mining District and State	Asbestiform Phases Known To Be Present in Ore: Yes	No
1	Birmingham Iron Ore District, Alabama	X	
2	Monument Valley Uranium Area, Arizona-Utah		X
3	Banner Copper-Silver-Lead-Zinc Mining District, Arizona	X	
4	Iron King Gold-Base Metal Mine, Arizona		X
5	Mineral Park Copper-Molybdenum District, Arizona		X
6	Magma Copper Mine, Arizona		X
7	Bagdad Copper Mine, Arizona		X
8	Bishop Tungsten District, California		X
9	Cordera Mercury Mine, Opalite Mining District, California	X	
10	New Idria Mercury Mining District, California	X	
11	Climax Molybdenite Mine, Colorado		X
12	Gilman Base Metal District, Colorado		X
13	Leadville Base Metal-Precious Metal District, Colorado		X
14	Colorado Plateau Region Uranium-Vanadium Deposits		X
15	Grants Region Uranium Deposits, Colorado		X
16	Uravan Uranium-Vanadium Mineral Belt, Colorado		X
17	Coeur d'Alene Base Metal District, Idaho		X
18	Illinois-Kentucky Fluorite-Zinc-Lead Mining District		X
19	Northern Michigan Native Copper Deposits		X
20	Marquette Iron Ore District, Michigan	X	
21	Menomince Iron Ore District, Michigan	X	
22	Southeast Missouri Lead District		X
23	Pea Ridge Iron Ore Body, Missouri		X
24	Tri-State Lead-Zinc Deposits of Missouri, Kansas, and Oklahoma		X
25	Butte Copper Mine, Montana		X
26	Carlin Gold Mine, Nevada		X
27	Eureka Mining District, Nevada		X
28	Mountain City Copper Mine, Nevada		X
29	Pioche District, Nevada		X
30	Gabbo Magnesite-Brucite Deposit, Nevada	X	
31	Central Base Metal Mining District, New Mexico	X	
32	Questa Molybdenum Mine, New Mexico		X
33	Balmat-Edwards District Zinc Deposits, New York	X	
34	Benson Mines Iron Ore Deposit, St. Lawrence, New York		X
35	Sanford Lake Titanium Ores, New York		X
36	Nickel Mountain Mine, Oregon		X
37	Cornwall Iron Ore Deposit, Pennsylvania	X	
38	Friedensville Zinc Mine, Lehigh County, Pennsylvania		X
39	Grace Mine Magnetite Deposit, Berks County, Pennsylvania	X	

TABLE 2 . (Cont)

No.	Mining District and State	Asbestiform Phases Present in Ore: Yes	No
40	Black Hills Uranium Deposits, South Dakota		X
41	Homestake Gold Mine, South Dakota	X	
42	Ducktown Copper-Lead-Zinc District, Tennessee	X	
43	Mascot-Jefferson City Zinc District, Tennessee		X
44	Lisbon Valley Area Uranium Deposits, Utah		X
45	Bingham Copper District, Utah	X	
46	East Tintic Copper Mining District, Utah		X
47	Iron Springs Iron Ore District, Utah		X
48	Marysvale Uranium Mine, Utah		X
49	Main Tintic Mining District, Utah		X
50	Park City Gold Mining District, Utah		X
51	Spor Mountain Beryllium District, Utah		X
52	Austinville-Ivanhoe Lead-Zinc District, Virginia		X
53	Metaline Lead-Zinc District, Washington		X
54	Republic Gold Mining District, Washington		X
55	Van Stone Lead-Zinc Mine Area, Washington	X	
56	Powder River Basin Uranium Deposits, Wyoming		X
57	Shirley Basin Uranium Deposits, Wyoming		X
58	Atlantic City Iron Ore District, Wyoming	X	

Central Mining District, Grant County, New Mexico. Here limestone, dolomite, shale, and sandstone units are faulted and intruded by sills, laccoliths, plugs, stocks, and dikes, and in part covered by volcanic breccia. Around the margins of one stock the folded limestone and dolomite was massively replaced by tabular bodies of magnetite and sphalerite. Gangue minerals identified are quartz, serpentine, magnesite, idocrase, augite, wollastonite, talc, tremolite, biotite, actinolite, epidole, and hedenbergite.

Van Stone Mine Area, Stevens County, Washington. The Van Stone Mine occurs along a steeply S-shaped fold lying between an igneous intrusive on the west and a fault on the southwest. The host rocks are dolomites. Jasperoid and tremolite are common alteration minerals. The ore minerals, galena, jamesonite, and sphalerite, occur in bunches intergrown with tremolite and jasperiod.

New Idria Mercury Mining Deposit, California. This is a hydrothermal deposit of cannabar, pyrite, and marcasite occurring in country rock of sandstone, shales, greywackes, and serpentinites. The ore is in veins and stockworks that fill late fractures in the country rock.

Bishop Tungsten District, Inyo County, California. Country rock around deposit consists of a series of tightly folded metasedimentary and metavolcanic rock remnants surrounded by exposed plutons ranging in composition from hornblende gabbro to alaskite. The ore bodies of the Bishop district consist of scheelite-bearing tactite formed by the replacement of calcareous rock along the contact with an acidic granitic intrusive. The Pine Creek mine is located along a quartz monzonite contact with a large marble bed. A large breccia zone exits near, and partly in, some northern portion of the ore body. This zone is generally avoided during mining. Included with the breccias are small porous masses consisting of stilbite, clinozosite, actinolite, phlogopite, and calcite.

Cornwall Iron Ore Deposit (Bethlehem Steel Corporation), Pennsylvania. The ore consists of magnetite, pyrite, chalcopyrite, and hematite, in order of abundance. The major gangue minerals associated are actinolite and chlorite. Actinolite is almost universally associated with the magnetite ore. It occurs in slender prisms or needles. The deposit is a limestone replacement above a diabase sheet. Thermal metamorphism of carbonate-bearing country rocks largely to calc-silicates, is ubiquitous. The associated magnetite-actinolite mineralization replaces all earlier

Grace Mine Magnetite Deposit, Berks County, Pennsylvania. Here magnetite is the major ore mineral; pyrite and chalcopyrite are accessories. Serpentine, talc, and chlorite are the major gangue minerals, tremolite is present locally. Typically the ore consists of magnetite in a matrix of serpentine. The ore has replaced a Cambrian limestone lens isolated between a diabase footwall and a sedimentary rock hanging wall.

Atlantic City Iron Ore District, Fremont County, Wyoming. A sedimentary iron-formation, similar to the Lake Superior taconites, occurs in the northern part of the district. Quartz and magnetite make up 90 percent of the rock, while amphibole (grunerite or actinolite), chlorite, and garnet are sparingly present. The iron formation is very fine grained.

Ducktown District Base Metal Deposits, Tennessee. Here massive sulfide ore bodies occur in highly folded metamorphic and sedimentary rock. The ore deposits are tabular bodies that have been extensively folded. The deposits are composed principally of pyrrhotite, pyrite, chalcopyrite, sphalerite, and magnetite. Gangue minerals are quartz, calcite, actinolite, tremolite, hornblende, garnet, and mica. Lenses are about 100 ft in width and generally conformable with enclosing graywacke and schist.

Iron Mountain Mine, Missouri. The ore minerals occur principally as open-space fillings in fractured and brecciated andesite porphyry. The enclosing rocks consist of a series of dacite, rhyolite, and andesite flows. All the ore is in the andesite. One of the two main ore bodies is crudely dome shaped, the other shaped like an elongated lense. Hematite is the main ore mineral, magnetite is subordinate. Important gangue minerals are andradite, quartz, calcite, actinolite, apatite, epidote, and chlorite.

Homestake Gold Mine, South Dakota. The Homestake Mine ore body occurs as a pipe-like replacement of an iron-magnesium carbonate rock unit along zones of cross-folding. Minerals present include pyrrhotite, pyrite, arsenopyrite, ankerite, cummingtonite, sideroplesite, biotite, garnet, albite, calcite, sericite, fluorite, galena, sphalerite, chalcopyrite, hematite, and gypsum.

Balmat-Edwards Lead-Zinc District, New York. The ores consist of sulfides, predominately sphalerite, pyrite, and accessory galena. The gangue is dolomitic crystalline limestone, highly silicated, so that the principal gangue minerals are diopside, tremolite, quartz, serpentine, and talc. Ore deposits are contained within marbles of the Precambrian Grenville series. The district lies within the northeast-striking belt of Grenville lowlands and is underlain largely by highly deformed Precambrian metasediments. Tremolite occurs as a tremolite schist.

Banner Mining District, Christmas Mine, Arizona. The deposit was formed by the intrusion of igneous rocks into folded and faulted sedimentary rocks. Contact metamorphism and hydrothermal alteration resulted in the deposition of ore minerals and also in the formation of amphibole phases. The ore deposit occurs in the form of veins and veinlet pipes, irregular massive replacements, and bedded replacements. Some clays, serpentine, and chlorite, resulting from hydrothermal alteration, are present near the intrusive contact. Within a replacement ore body of a limestone series, the gangue minerals are garnet, marble, clays, chlorite, diopside, and tremolite. In the deeper levels of the Christmas mine limestones and dolomites are extensively replaced by anhydrite and antigorite. These alteration products are interbedded with layers and lenses of other gangue minerals which include chondrodite, diopside, tremolite, actinolite, sericite, and chlorite.

Selection of Sources for Field Sampling

In an effort to identify the two sites for the ambient sampling program (those sites showing the greatest environmental impact), available information was tabulated in Table 3. This information included estimated production rates, asbestos content of ore and asbestos type, and population distribution near the plant. An effort has been made to learn more about operations and control equipment at the 16 sites listed in Table 3 by contacting local air pollution authorities. Summaries of what was learned in these contacts is tabulated under "Comments" in Table 3.

Considering the potential asbestos emissions and the population within the vicinity of the plant, the list of sites most attractive for sampling were

(1) Cornwall Mine, Cornwall, Pa. (if operating)

(2) Grace Mine, Berks County, Pa.

(3) Charman Plant, Adams Co., Pa.

(4) Balmat-Edwards, St. Lawrence Co., N.Y.

It was subsequently confirmed that the Cornwall Mine was not operating at this time.

On March 7 the Project Officer met with Battelle-Columbus staff to discuss the above data on candidate sampling sites and to choose two sites for the field sampling program. The Grace Mine and the Charman Plant were selected as the two sites to be sampled.

Field Sampling at Two Sites

Sampling was conducted at the Grace Mine between March 16 and 21, 1974, and at the Charman Plant between March 25 and 29, 1974. Samples were collected at six sampling stations for each of several 24-hour periods at each mine site. Sampling stations were selected to surround the mining site with the largest number of stations in the prevailing downwind direction. All stations were between 0.5 and 2.0 miles from the plant site.

TABLE 3. SPECIFIC SITES HAVING POSSIBLE ASBESTOS EMISSIONS

ential Site	Activity	Estimated Production	Estimated Asbestos Content of Ore	Population in Vicinity: Co. Average p/sq. mi.	Population in Vicinity: Nearby Cities (within 15 min)		
ace Mine ethlehem Steel Corp. rks Co., Pa	Iron ore mine, underground	1,740,000 tpy ore	5% (serpentine-tremolite)	>250	Reading Pottstown Birdsboro Adamstown Terre Hill New Holland Coatesville Phoenixville	93,000 26,000 3,000 1,000 1,000 3,000 13,000 14,000	No fugitive dust problem but a continuing particulate problem with benefaction and upgrading operation. They have cyclone collectors, but these are inadequate. The emissions from the material piles are estimated to be small compared to stack emissions.
ersen Plant F Corp, Indus. Prod. Div, ams Co., Pa	Roofing granules open pit	100,000 to 1,000,000 tpy	5% (metabasalt)	50-250	Waynesboro Hagerstown, Md Gettysburg	10,000 36,000 8,000	An extensive operation in a remote area. Putting in wet sprays for their crushing and screening operations and install a baghouse for their drying operations. They have a dust problem now, but are working on it.
tlantic City District .S. Steel Corp remont Co., Wy	Iron ore open pit	1,550,000 tpy ore	5% (grunerite-actinolite)	< 10	Atlantic City South Pass City	< 500 <1000	They do crushing at the site throughout the year. There is no record of control equipment. No complaints had been lodged against the company.
opperhill Operations ities Service Co opperhill, Tenn.	Iron sulfide copper sulfide zinc sulfide	10,000 to 100,000 tpy underground	10% (actinolite-tremolite) (dust wet scrubbed)	10-50	Ducktown Copperhill McCaysville, Ga Blue Ridge, Ga	740 630 1,800 1,400	This is an underground mine with primary crushing done underground. When ore arrives at surface for additional crushing and processing, it is dampened and the moisture is retained throughout the processing
The Homestake Mine omestake Mining Co awrence Co., S. D.	Gold mine underground	2,000,000 tpy	10% (cummingtonite)	10-50	Lead Deadwood Spearfish Sturgis	6,200 3,000 3,700 4,600	
almat-Edwards District St. Joseph Lead Co. t. Lawrence Co., N.Y.	Lead-zinc mine underground	600,000 tpy	25% (tremolite-serpentine)	10-50	Gouverneur Balmat Emeryville Fowler	5,000 < 1,000 < 1,000 < 1,000	St. Joseph Lead is not considered to be a problem as there have been no complaints. The operation is mostly inside with no open piles. They have cyclones and baghouses and are upgrading their controls.
hristmas Mine Inspiration Consol. Copper Co. ila Co., Ariz.	Porphry Co. Mine, open pit	1,800,000 tpy	10% (tremolite-actinolite)	< 10	Globe Miami Superior	6,300 3,300 4,900	Personal observations during a visit to the site included observations of a light haze over the open pit copper mine, a large tailings pile which could be a dust problem in windy weather and the visible emissions from the tall smelter stack.
Iron Mountain Mine The Hanna Mining Co. ron Co., Mo.	Iron ore underground	1,900,000 tpy	5% (actinolite)	10-50	Ironton Bismark Iron Mtn Graniteville	1,300 1,200 300 400	The law says that water scrubbers should be placed where possible (e.g., on crushers) to reduce dust, but they are not always working. Two uncontrolled sources of dust are the stockpile and a mountain of waste material. Some of the latter is returned to the mine.

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TABLE 3. (Continued)

Potential Site	Activity	Estimated Production	Estimated Asbestos Content of Ore	Population in Vicinity: Co. Average p/sq. mi.	Population in Vicinity: Nearby Cities (within 15 min)	Comment
Mountain Pass Area Molybdenum Corp of Am San Bernadino, Cal	Rare earths deposit, open pit	400,000 tpy	1% (crocidolite)	50-250	Mountain Pass <1,000 Ivanpah <1,000 Moore <1,000 Nipton <1,000	They consider the dust from this operation to be well controlled. It is near the highway to Las Vegas and there are no complaints. High wi[n]ds at all months of the year are the principal problems for keeping down the dust in this desert area. The county requires water sprays on the crushing operations. There are also several baghouses at this plant.
Idria Mine New Idria Mining & Chem. Co. San Benito Co., Cal	Mercury deposit underround and open pit	100,000 tpy	(15%) (serpentine)	10-50	Idria 250 Hernandes ? Panache ?	This mine is no longer operating.
Bishop Tungsten District Pine Creek Mine Union Carbide Corp Inyo Co., Cal	Tungsten Mine, underground	500,000-1,000,000 tpy	0.5% (actinolite)	< 10	Bishop 3,000	This operation has cyclone scrubbers and there is not much dust. This probably is due to the ore being wet when it comes from the mine and remaining that way during processing.
New Almaden District New Idria Mining and Chem. Co. Santa Clara Co., Cal	Mercury deposit	< 100,000 tpy	5% (serpentine)	>250	San Jose 310,000 Campbell 23,000 Saratoga 15,000 Los Gatos 9,000 Morgan Hill 4,000	This mine is now operating at only a low capacity.
Crushed Marble Quarry Universal Marble Products Corp Westchester Co. N.Y.	Crushed marble	?	2% (tremolite)	>250	Ossining 21,000 Tarrytown 11,000 White Plains 50,000 Peekskill 19,000 Norwalk, Conn 80,000 Stamford, Conn 110,000 Darien, Conn 18,000	Neither the state nor the county knew of a quarry at this site. They identified that Universal Marble Products Corp. had facility in Thornwood, but they had not identified it as an air pollution problem.
Marble Quarry Vermont Marble Co Portland Co., Vt	Marble Quarry	?	2% (tremolite)	50-250	Proctor 2,000 Rutland 18,000 Brandon 1,700 W. Rutland 2,000	Vermont Marble has three plants in this area producing a number of products including crushing to make marble chips. Although considered a dusty operation in the past, they have put on control equipment. More fugitive dust is generated by loading operations, emptying baghouses , and movement over unpaved roads than from winds blowing dust from the piles.
Frostbite Mine Windsor Minerals, Inc. Windsor Co., Vt	Talc mine, open pit	100,000-500,000 tpy	5% (tremolite)	10-50	Windsor 3,200 Springfield 6,200 Lebanon, N.H. 9,300 Claremont, N.H. 13,500	There are two plants here in a rural area. There is a scrubber and they are putting in a baghouse. It is not considered to be much of a problem.
Cornwall Mine Cornwall, Pa Lebanon, Co.	Iron mine, open pit		5-10%			All operations have been discontinued at this site.

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The sampling technique used was to collect ambient samples on Millipore filters. An appropriate pump and dry-gas meter was used to generate and measure the flow. Sample volumes were from about 40 to 50 m^3 per day.

Sampling Networks. Figures 5 and 6 are segments of topographic maps showing the sampling network location in the vicinity of the Grace Mine and the Charman open-pit plant, respectively. The six sampling sites at each location are indicated by solid black circles, and their approximate location was as follows

Figures 7 through 15 are photographs of most of the sampling sites. Figure 16 shows the Charman Plant.

Grace Mine (Figure 5):

A. Roof of Volunteer Friendship Fire Company on East Main Street in Morgantown, 1 mile SSW of mine

B. Private property, 16 feet above ground level, 2-3/4 miles E of mine

C. Roof of Twin Rivers High School maintenance garage, 1-1/2 miles ESE of mine

D. American Legion Post No. 537, 16 feet above ground level, 1-3/4 miles ENE of mine

E. Private property, 16 feet above ground level, 3/4 mile NE of mine

F. Private property, 16 feet above ground level, 2-1/2 miles NE of mine.

Charman Plant (Figure 6):

G. Private property, 16 feet above ground level, 1-1/2 miles SSE of plant

H. Private property, 16 feet above ground level, 1-3/8 miles ESE of plant

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I. Private property, garage roof, 1/4 mile SE of plant

J. Private property, garage roof, 1/2 mile WSW of plant

K. Private property, 16 feet above ground level, 1 mile SW of plant

L. Private property, 16 feet above ground level, 5/8 mile NE of plant.

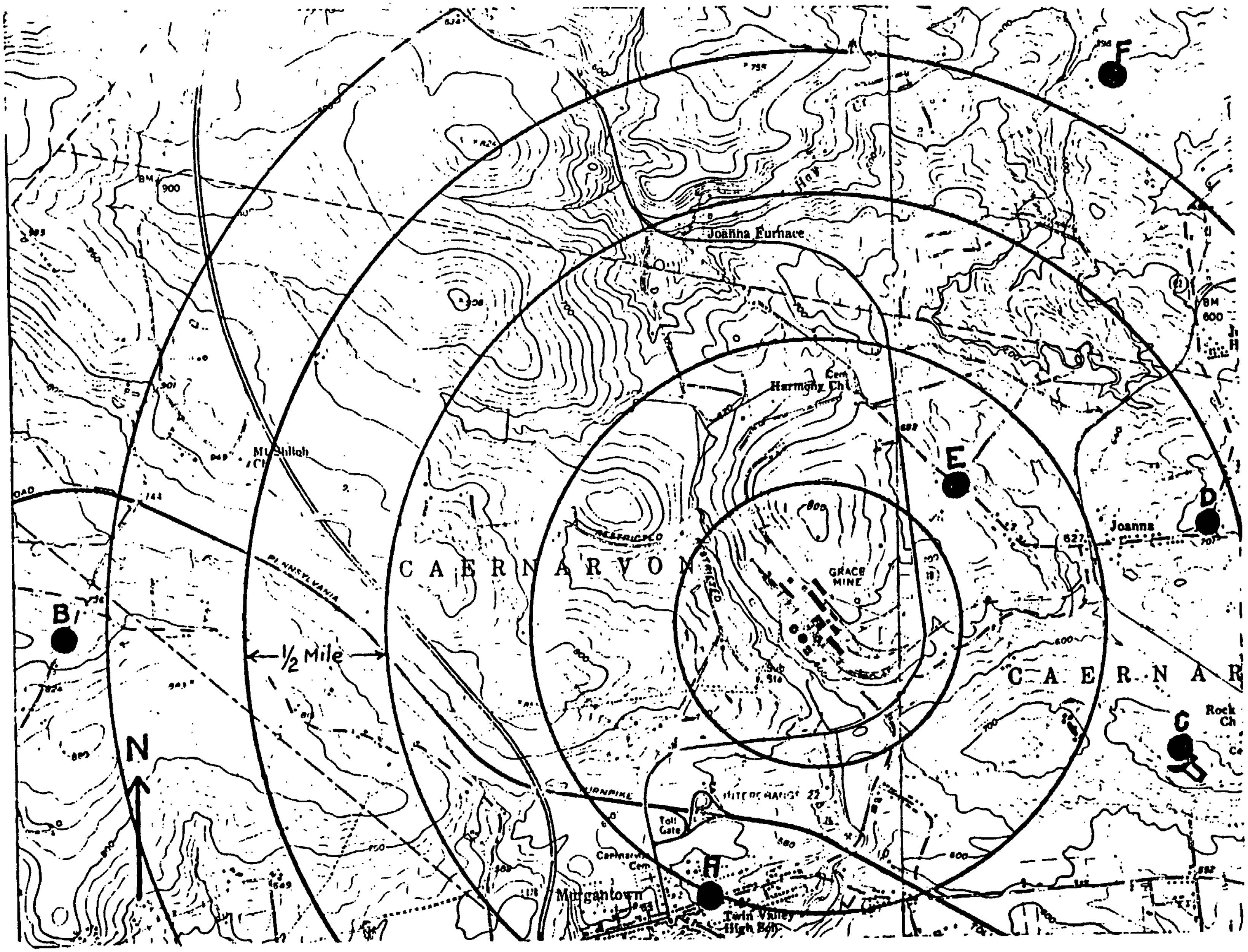

FIGURE 5. ASBESTOS SAMPLING NETWORK LOCATIONS - GRACE MINE

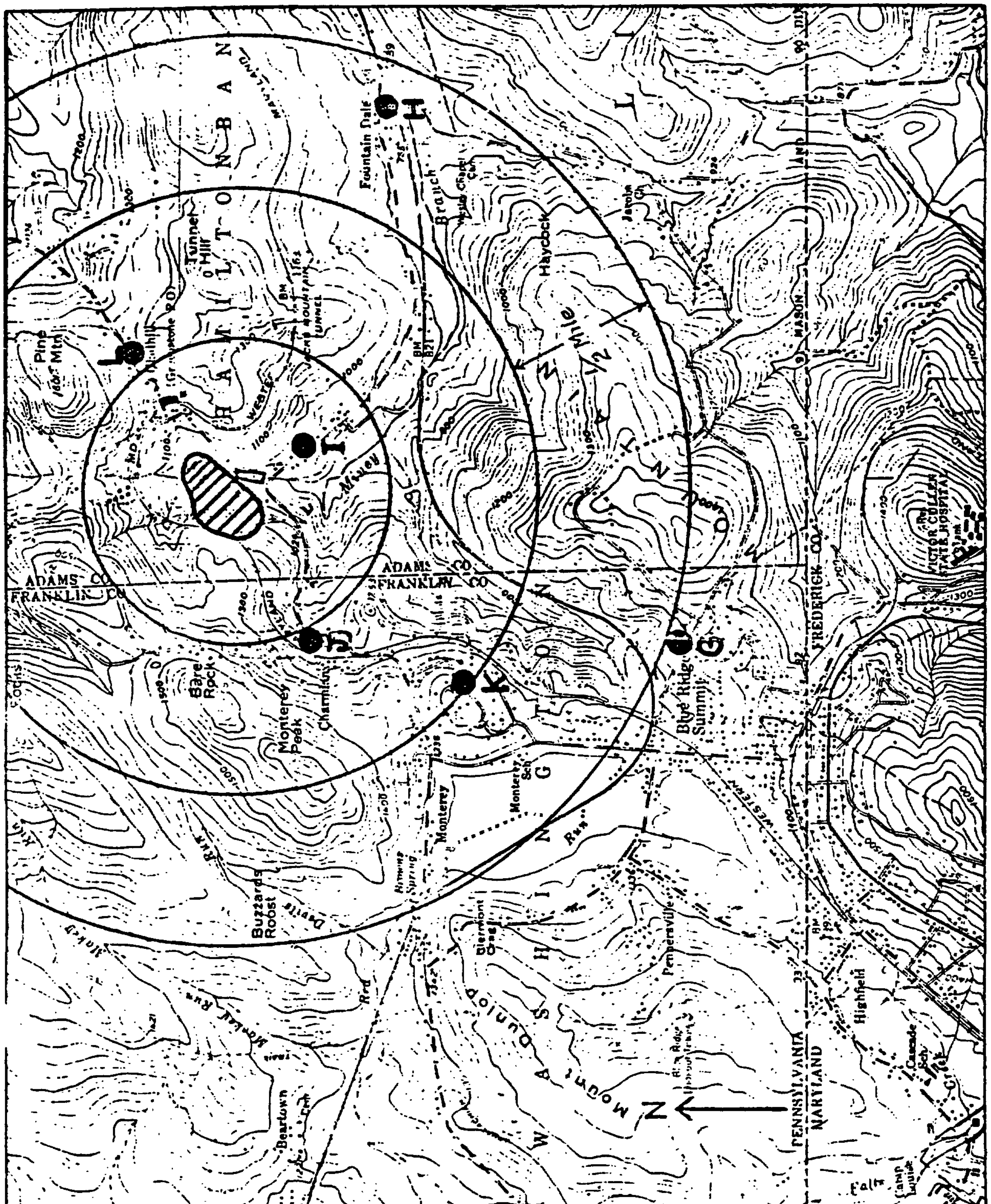

FIGURE 6. ASBESTOS SAMPLING NETWORK LOCATIONS - CHARMAN PLANT

Sampling Procedure. Filter samples were taken concurrently at the six strategically located sites in the vicinity of each source. The particulate samplers, shown schematically in Figure 17, were made up special for this program. Each sampler contained a 1/4-hp carbon vane Gast pump and a dry-gas meter with appropriate valves to provide a desired sampling rate of approximately 1.7 m^3/hr. The equipment was housed within a plywood shelter for protection. The filter holder was mounted on a rod 16 feet above the shelter. Particulate was collected on 47 mm Millipore filters with a pore size of 0.8 μ (Cat. No. AAWP-04700).

Sampling and Meteorological Data. Field sampling for asbestos was initiated at the Grace Mine location on March 16, 1974, and continued through March 21, 1974. The nonitoring period at the second location (Charman Plant) was March 25 through March 29, 1974. A total of 50 samples were obtained from the two locations. Table 4 lists the samples collected and the air volumes sampled for each sample.

A meteorological station was located near each source to record wind speed and direction and temperature during the monitoring period. The station at the Grace Mine facility was located at Site C, 1-1/2 miles ESE of the mine. The station at the Charman Plant was located at Site L, 5/8 mil NE of the plant. Weather information obtained at Sites C and L is summarized in Table 5 and 6, respectively.

Analysis of Samples. The exposed filters from the Grace Mine were examined optically to select those filters with the largest quantity of asbestos fibers. This examination revealed that large quantities of fibrous material had been collected but the fiber size was too small to permit identification of asbestos. Several filters with the highest fiber content were selected for transmission electron microscopy (TEM) analyses.* The TEM analyses showed that most of the fibrous material collected on the filters was organic and that asbestos levels were less than 0.01 μg/m^3. Ambient samples from areas not expected to contain significant asbestos

* Henry, W. M., Heffelfinger, R. E., Melton, C. W., and Kiefer, D. L., "Development of a Rapid Survey of Sampling and Analysis for Asbestos in Ambient Air", Final Report on EPA Contract CPA-22-69-110,

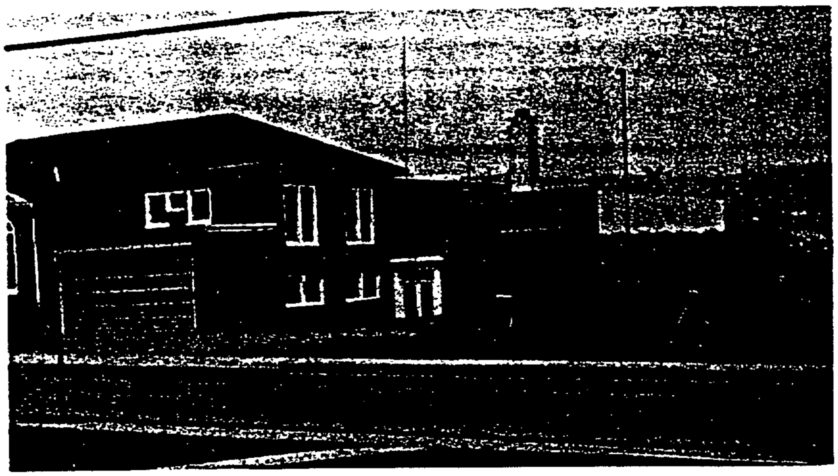

FIGURE 7. SAMPLING SITE "A" (SAMPLER LOCATED AT "X" ON ROOF)

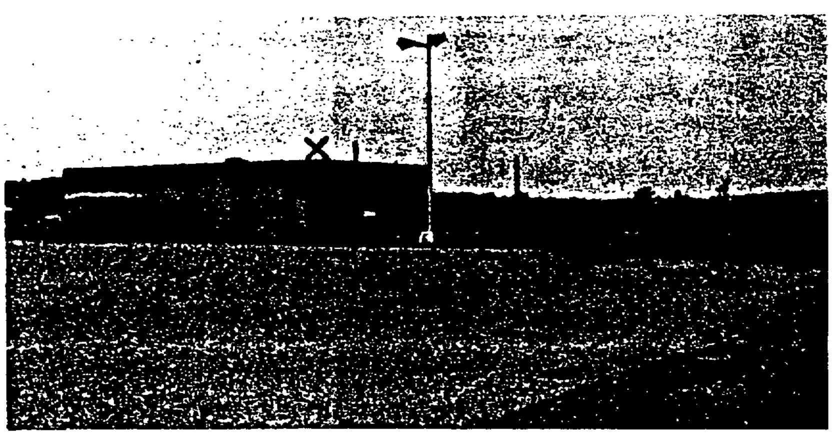

FIGURE 8. SAMPLING SITE "C" (SAMPLER LOCATED AT "X" ON ROOF)

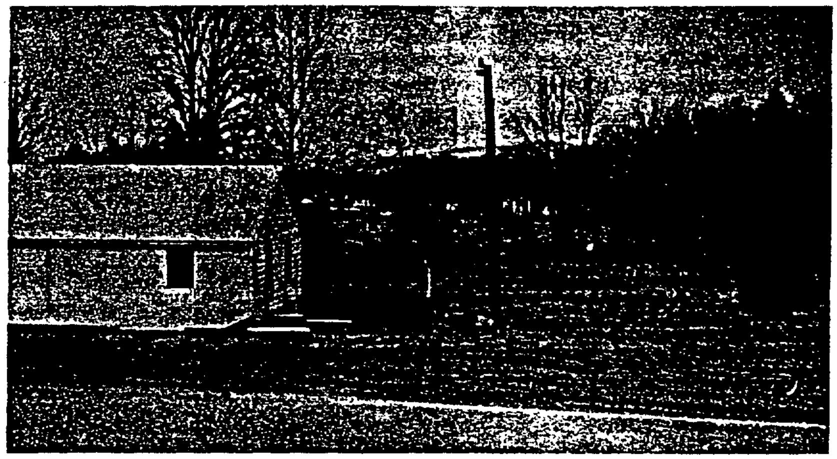

FIGURE 9. SAMPLING SITE "D" (SAMPLER LOCATED AT "X")

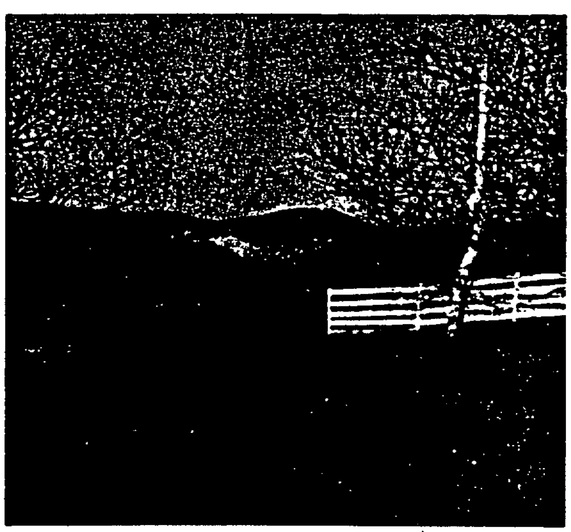

FIGURE 10. SAMPLER AT SITE "G"

FIGURE 11. SAMPLER AT SITE "H"

FIGURE 12. SAMPLER AT SITE "I"

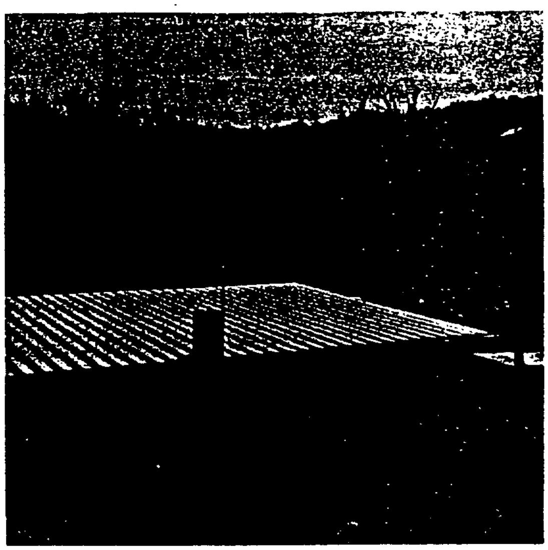

FIGURE 13. SAMPLER AT SITE "J"

FIGURE 14. SAMPLER AT SITE "K"

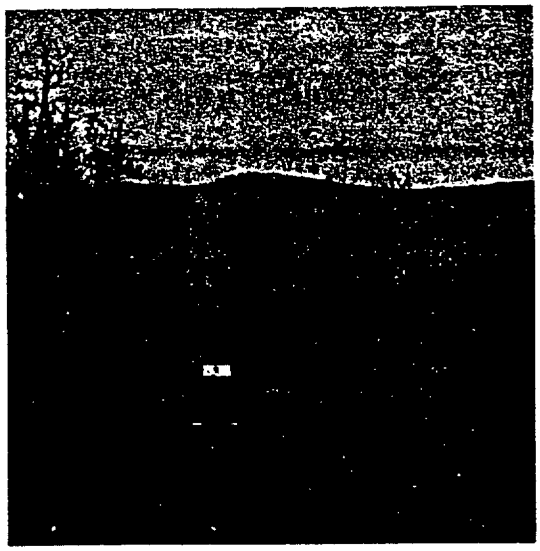

FIGURE 15. SAMPLER AT SITE "L"

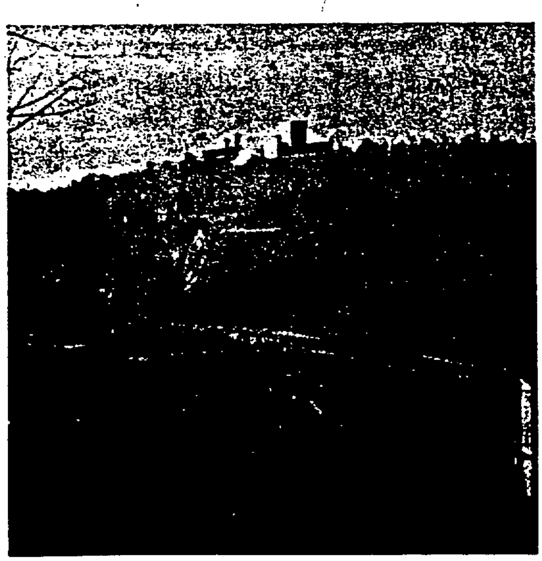

FIGURE 16. CHARMAN PLANT

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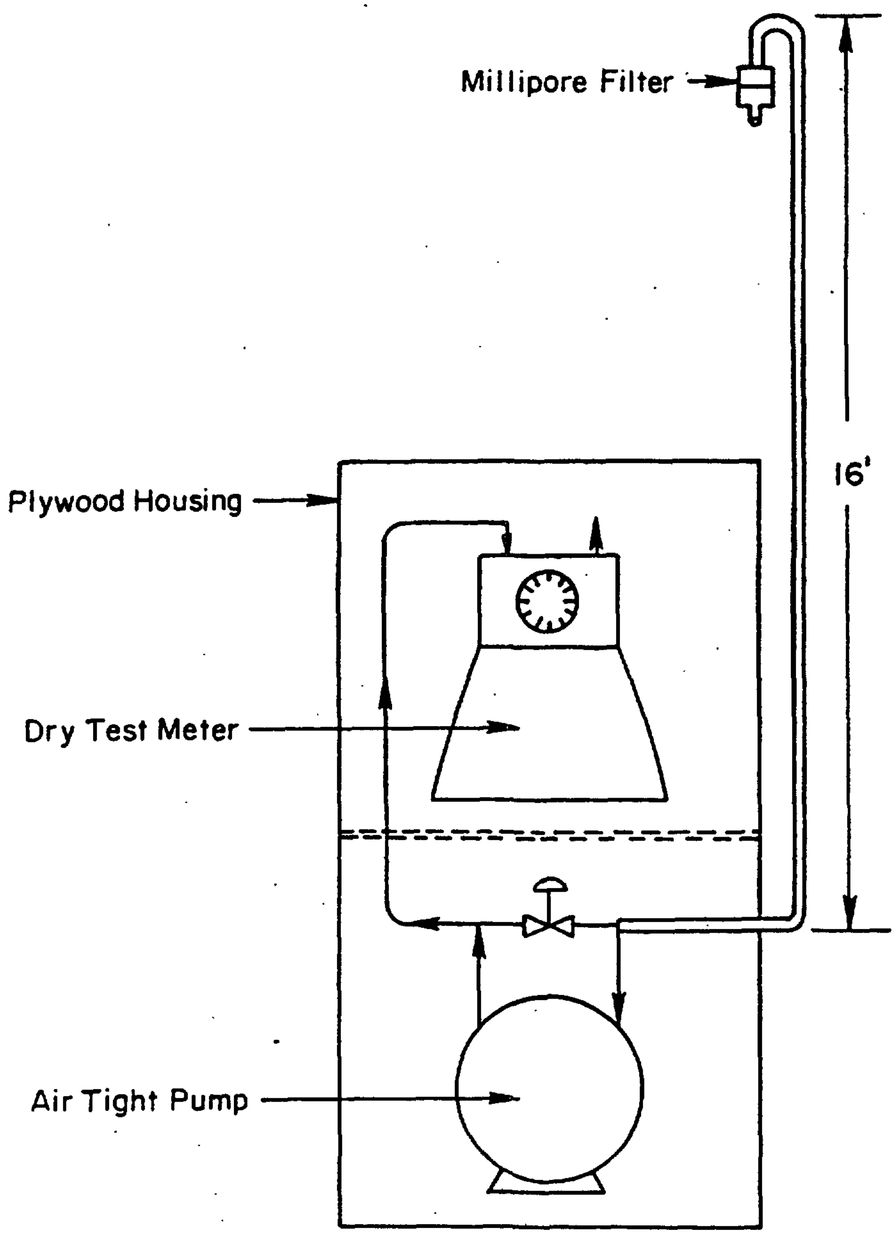

FIGURE 17. SAMPLING RIG

TABLE 4. FILTER DESIGNATION AND AIR SAMPLE VOLUMES

Sampling Period Date	Time	Sampling Sites A	B	C	D	E	F
3/14/74	2:00 p.m.	1	2	3	4	--	--
3/15	4:30 p.m.	64.34	59.13	38.69	42.97	--	--
3/15	4:00 p.m.	7	8	9	10	5	6
3/16	5:15 p.m.	50.41	42.74	--(b)	--(b)	--(b)	--(b)
3/18	11:00 a.m.	13	(c)	15	16	11	12
3/19	9:15 a.m.	46.37		38.41	37.60	36.41	34.85
3/19	9:45 a.m.	19	14	21	22	17	18
3/20	9:15 a.m.	48.34	39.62	38.92	41.55	37.70	38.78
3/20	9:30 a.m.	23	20	25	26	27	(c)
3/21	9:45 a.m.	48.08	40.09	--(b)	43.33	--(b)	
		G	H	I	J	K	L
3/25	10:15 a.m.	24	29	30	31	32	33
3/26	10:00 a.m.	59.72	44.80	46.52	46.64	41.42	41.86
3/26	10:15 a.m.	34	35	36	37	38	39
3/27	8:30 a.m.	42.79	39.68	44.43	44.10	40.14	39.30
3/27	8:45 a.m.	40	41	42	43	44	45
3/28	8:00 a.m.	43.72	43.74	44.58	44.58	41.92	38.77
3/28	8:45 a.m.	46	47	48	49	50	51
3/29	8:00 a.m.	44.39	46.37	43.67	46.04	42.07	43.87

(a) Top number in each entry is filter designation; bottom number is air volume sampled in m^3.

(b) Flow stopped due to moisture increasing pressure drop.

(c) Pump failed, no sample.

TABLE 5. METEOROLOGICAL OBSERVATIONS
(Grace Mine - Site C)

Sampling Period Date	Time	Wind	Temperature High	Low	Precipitation
3/14/74 3/15/74	5:00 p.m. 4:00 p.m.	5:00 p.m. - 12:00 noon, 5-10 mph from the NW 12:00 midnight - 4:00 p.m., calm (< 2 mph) from the SW	50	23	None
3/15/74 3/16/74	4:30 p.m. 4:00 p.m.	4:30 p.m. - 7:30 p.m., 8-10 mph from the S 8:00 p.m. - 4:00 p.m., 10-15 mph from the SSE	50	38	None. Heavy (steady downpour) 2:00-9:00 p.m.
3/18/74 3/19/74	11:00 a.m. 9:00 a.m.	11:00 a.m. - 11:00 p.m., 15-20 mph from the W 12:00 midnight - 9:00 a.m., 2-5 mph from the SW	47	32	None
3/19/74 3/20/74	9:00 a.m. 8:30 a.m.	9:00 a.m. - 12:30 p.m., 3-10 mph from the SW 1:00 p.m. - 12:00 midnight, 7-10 mph from the NW 12:30 a.m. - 9:00 a.m., 3-5 mph from the N	52	29	Light snow flurries
3/20/74 3/21/74	8:30 a.m. 11:00 a.m.	9:00 a.m. - 2:00 p.m., 5-10 mph from the N 3:00 p.m. - 12:00 midnight, 3-5 mph from the SSE 1:00 a.m. - 11:00 a.m., 3-10 mph from the E	49	30	None. Heavy (steady downpour)7:00 to 11:00am

TABLE 6. METEOROLOGICAL OBSERVATIONS
(Charman Plant - Site L)

Sampling Period Date		Time	Wind	Temperature High	Temperature Low	Precipitation
3/25/74	to	11:30 a.m.	12:00 noon to 12:00 midnight, calm (< 2 mph)	36	16	None
3/26/74		11:30 a.m.	12:00 midnight to 11:00 a.m., 2 mph, from W			
3/26/74	to	11:30 a.m.		57	26	None
3/27/74		10:00 a.m.	3-10 mph, from W			
3/27/74	to	10:00 a.m.	10:00 a.m. to 7:00 p.m., 3-5 mph, from W	53	30	None
3/28/74		9:00 a.m.	9:00 p.m. to 9:00 a.m., 2-5 mph, from E			
3/28/74	to	9:00 a.m.				
3/29/74		9:00 a.m.	2-5 mph, from E	50	32	Trace

generally have asbestos levels of 0.001 to 0.01 $\mu g/m^3$*. Hence, these samples showed no excessive asbestos emissions in the vicinity of the plant.

Because the presence of large quantities of organic fibers precluded optical screening of filters, five additional filters (some from each plant site) were selected for TEM analysis based on the sampling site location and wind direction. These filters also showed asbestos concentrations below 0.01 $\mu g/m^3$. The asbestos concentration in the** air around the Grace Mine was in the range of 0.006 to 0.010 $\mu g/m^3$; concentrations around the Charman Plant were lower, 0.0002 to 0.0012 $\mu g/m^3$.

Hence, based on this very limited sampling program, it does not appear that substantial populations surrounding mining sites where asbestos is present as an accessory mineral are exposed to significant asbestos concentrations in air.

Results of the analyses are tabulated in Table 7.

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* Based on Battelle-Columbus' analyses of samples from the National Air Sampling Network on EPA Contract 68-02-0230, Task 14.

** The precipitation encountered during sampling near the Grace Mine may have reduced emissions from ore piles at the plant, but should not have significantly influenced emissions from stacks or plant sources. Thus, the precipitation probably had no major influence on ambient asbestos levels.

TABLE 7. ANALYSES OF FIELD SAMPLES

Sample Filter No.	Asbestos on Filter, μg/filter	Air Volume Sampled, m^3	Asbestos Present in Air, μg/m^3
Selection Based on Optical Examination of Filters:			
3	0.36	38.69	0.00930
12	0.286	34.85	0.00821
Selection Based on Meteorological Data:			
19	0.31	48.34	0.00641
21	0.27	38.92	0.00694
39	0.01	39.30	0.00025
49	0.01	46.04	0.00022
50	0.05	42.07	0.00119

GLOSSARY

Alaskite	A plutonic rock consisting of orthoclase, microcline, and subordinate quartz, with few or no mafic constituents
Albite	Member of the plagioclase mineral series. Composition is $NaAlSi_3O_8$.
Amosite	Fibrous form of grunerite, an amphibole.
Andesite	A volcanic rock composed essentially of andesite and one or more mafic constituents.
Ankerite	A ferroan variety of dolomite, $CaCO_3 \cdot (Mg,Fe,Mn)CO_3$.
Antigorite	A lamellar variety of serpentine, $Mg_6 (Si_4O_{10}) (OH)_8$.
Apatite	A mineral group ranging in composition from $Ca_5(PO_4)_3F$ to $Ca_5(PO_4)_3Cl$ to $Ca_5(PO_4)_3OH$.
Arsenopyrite	A mineral, FeAsS.
Augite	A pyroxene mineral, of composition $(Ca,Mg)(Mg,Fe,Al)(Si,Al)_2O_6$.
Basalt	A volcanic rock composed primarily of calcic plagioclase and pyroxene, with or without olivine.
Breccia	A rock made up of highly angular coarse fragments.
Chalcopyrite	A mineral, $CuFeS_2$, and important ore of copper.
Chlorite	A term used for a group of platyhydrous silicates of aluminum, ferrous iron, and magnesium which are closely related to the micas.
Crocidolite	Fibrous form of riebeckite, blue asbestos.
Dacite	The volcanic equivalent of quartz diorite. Principal minerals are plagioclase, quartz, pyroxene and/or hornblende, with minor biotite.
Diabase	A rock of basaltic composition, consisting essentially of labradorite and pyroxene, and characterized by ophitic texture.
Dike	A tabular body of igneous rock that cuts across the structure of adjacent rocks or cuts massive rocks.
Diopside	A pyroxene mineral having the composition $CaMg (Si_2O_6)$.
Dolomite	A term applied to those rocks that approximate the mineral dolomite in composition, $CaMg (CO_3)_2$.

Dunite	A peridotite consisting almost wholly of olivine and containing accessory pyroxene and chromite.
Enstatite	A pyroxene mineral with the composition $Mg_2\ (Si_2O_6)$.
Epidote	A common mineral in metamorphic rocks having a composition $Ca_2(Al,Fe)_8(SiO_4)_3(OH)$.
Gabbro	A plutonic rock consisting of calcic plagioclase and clinopyroxene, with or without orthopyroxene and olivine. Loosely used for any coarse-grained dark igneous rock.
Galena	PbS, an important ore mineral of lead.
Gneiss	A coarse-grained rock in which bands rich in granular minerals alternate with bands in which schistose minerals predominate.
Graywacke	A type of sandstone marked by large detrital quartz and feldspars set in a prominent to dominant clay matrix.
Grossularite	A member of the garnet mineral family, composition $Ca_3Al_2(SiO_4)_3$.
Hornfels	A fine-grained, nonschistose metamorphic rock resulting from contact metamorphism.
Igneous	Formed by solidification from a molten or partially molten state.
Laccolith	A concordant, intrusive body that has domed up the overlying rocks and also has a floor that is generally horizontal, but may be convex downward.
Metamorphic Rock	Includes all those rocks which have formed in the solid state in response to pronounced changes of temperature, pressure, and chemical environment below surface weathering and cementation.
Olivine	An important rock forming mineral, especially in the mafic and ultramafic rocks. Composition is $(Mg,Fe)_2 SiO_4$.
Pegmatite	Those igneous rocks of coarse grain found usually as dikes associated with large mass of plutonic rock of finer grain size.
Peridotite	A general term for essentially nonfeldspathic plutonic rocks consisting of olivine, with or without other mafic minerals.
Pyroxenite	A medium- or coarse-grained rock consisting essentially of pyroxene.

Rhyolite	The aphanitic or fine-grained equivalent of a granite.
Schist	A medium or coarse-grained metamorphic rock with sub-parallel orientation of the micaceous minerals which dominate its composition.
Sill	An intrusive body of igneous rock of approximately uniform thickness and relatively thin compared with its lateral extent, which has been emplaced parallel to the bedding or schistosity of the intruded rocks.
Sphalerite	ZnS, an important ore mineral of zinc.
Stock	A body of plutonic rock that covers less than 40 square miles, has steep contacts, and is generally discordant.
Syenite	A plutonic igneous rock consisting principally of alkalic feldspar, usually with one or more mafic minerals such as hornblende or biotite.
Tactite	A rock of complex mineralogical composition formed by contact metamorphism and metasomatism of carbonate rock.
Trachyte	A volcanic rock composed essentially of alkalic feldspar, and minor biotite, hornblende, or pyroxene.
Ultramafic	Igneous rocks containing less than 45 percent silica; containing virtually no quartz or feldspar and composed essentially of ferromagnesian silicates, metallic oxides, and sulfides.
Wollastonite	A mineral, $CaSiO_3$, commonly found in contact metamorphosed limestone.

APPENDIX A

DETAILED DISCUSSION OF OCCURRENCE OF ASBESTOS AS AN ACCESSORY MINERAL AND MINING ACTIVITY IN THESE AREAS

Alabama

The Piedmont region in the east-central part of the state of Alabama has an extensive occurrence of metamorphic rocks as outlined in Figure A-1. Within the general region of metamorphism, amphibolite zones are quite prevalent in several counties as depicted in Figure A-2, a regional map naming counties. Asbestos and talc occurrences are tabulated in Table A-1. Localities in Tallapoosa and Chambers counties have been described in detail to pinpoint selected ultramafic pods that have been altered to asbestiform minerals including anthophyllite, tremolite and actinolite. Anthophyllite was mined intermittently during the late 1960's from the large mafic complex northeast of Dadeville in Tallapoosa County as shown on Figure A-3. Talc is available from the same region (Talledega County) from the American Talc Company (Alpine, Alabama 35014).

Neatherly wrote "The mafic and ultramafic rocks of the Piedmont region represent a wide variety of distinct but related rock types which have been involved in one or more cycles of regional metamorphism, structural dislocation, and pervasion by emanations mobilized from the country rock. Four processes of alteration are recognized: (1) serpentinization, (2) steatitization, (3) amphibolization, and (4) chloritization. All these processes occurred more or less concurrently throughout the mafic-ultramafic belt; however, one mode of alteration generally predominated over the other three at a given locality. The processes of amphibolization and steatitization were most widespread. Amphibolization is the alteration of pyroxenes (enstatite, hypersthene, olivine, etc) to amphibole minerals (anthophyllite, actinolite, tremolite, hornblende, etc). The amphibole formed in the Dadeville area is the orthorhombic variety, anthophyllite, commonly from olivine. Tremolite and actinolite also are commonly associated with the ultramafic rocks in the Dadeville area having been found along the periphery of the ultramafic-mafic rock complex."

While the asbestos mineral prospects of Tallapoosa County are not now being worked, talc is currently being mined by the American Talc Company in Talladega County. Elsewhere in the counties containing the amphibolite zones, large quantities of talc and soapstone are found over wide areas, close to the surface, and are of current and long-range interest. The current mining and quarrying activities in the area are summarized in Table A-2.

TABLE A-1. THE OCCURRENCE OF ASBESTOS, TALC, AND SOAPSTONE IN ALABAMA (FROM USGS MR-17 and MR-31)

Asbestos

Tallapoosa County:

1. Dadeville area. Short-fiber amphibole asbestos associated with basic intrusive rocks. Maynard and others, 1923; Pallister, 1955. 32° 54' 85° 44'

Talc and Soapstone

Talladega County:

1. Talladega. Talc probably derived from dolomite. McMurray and Bowles, 1941. 33° 19' 86° 13'

Tallapoosa County:

2. Dadeville area. Soapstone probably associated with mafic igneous rocks. Maynard and others, 1923; Pallister, 1955. 32° 53' 85° 40'

(Localities by North Latitude and West Longitude)

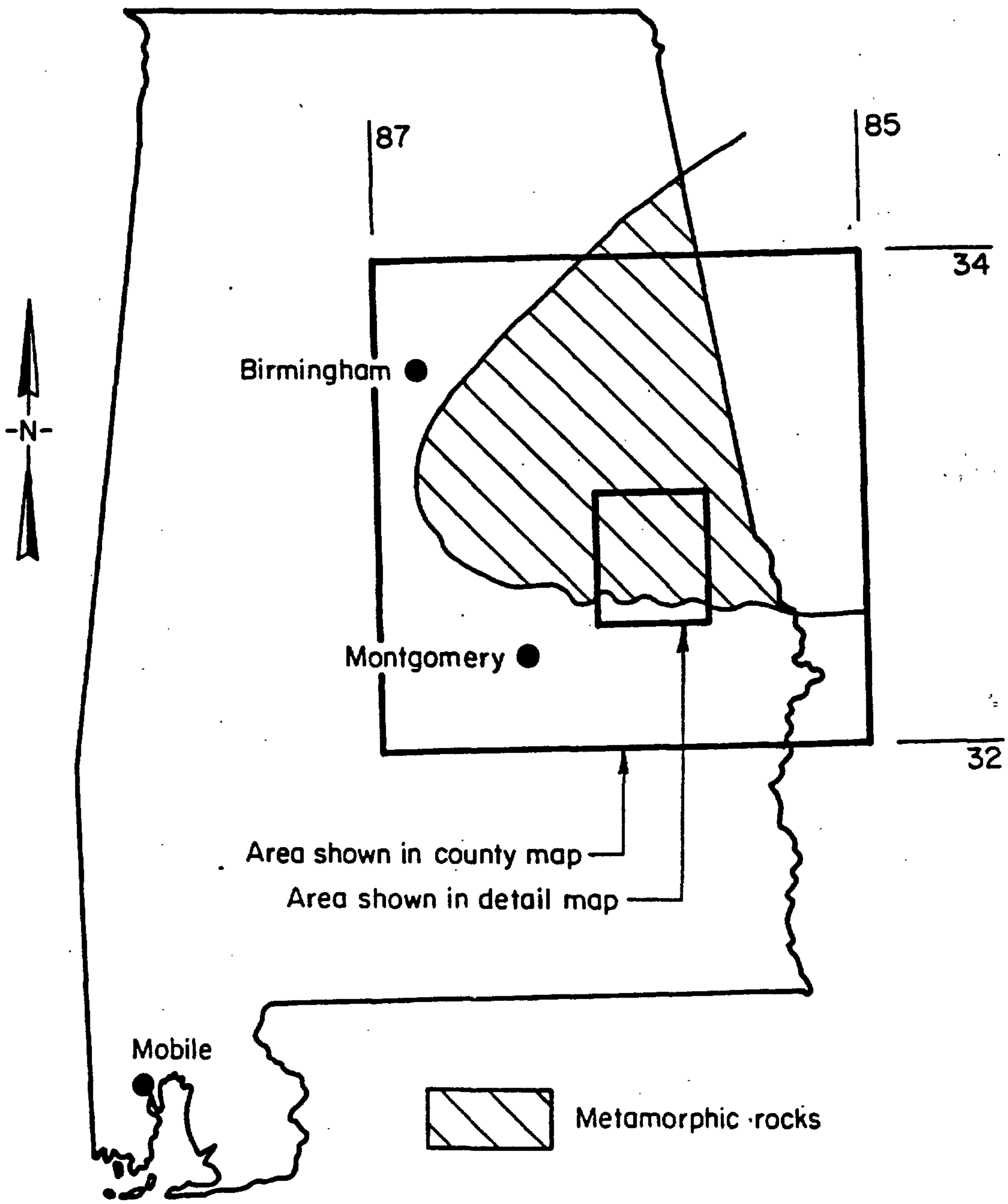

FIGURE A-1. METAMORPHIC ROCK OCCURRENCE IN ALABAMA

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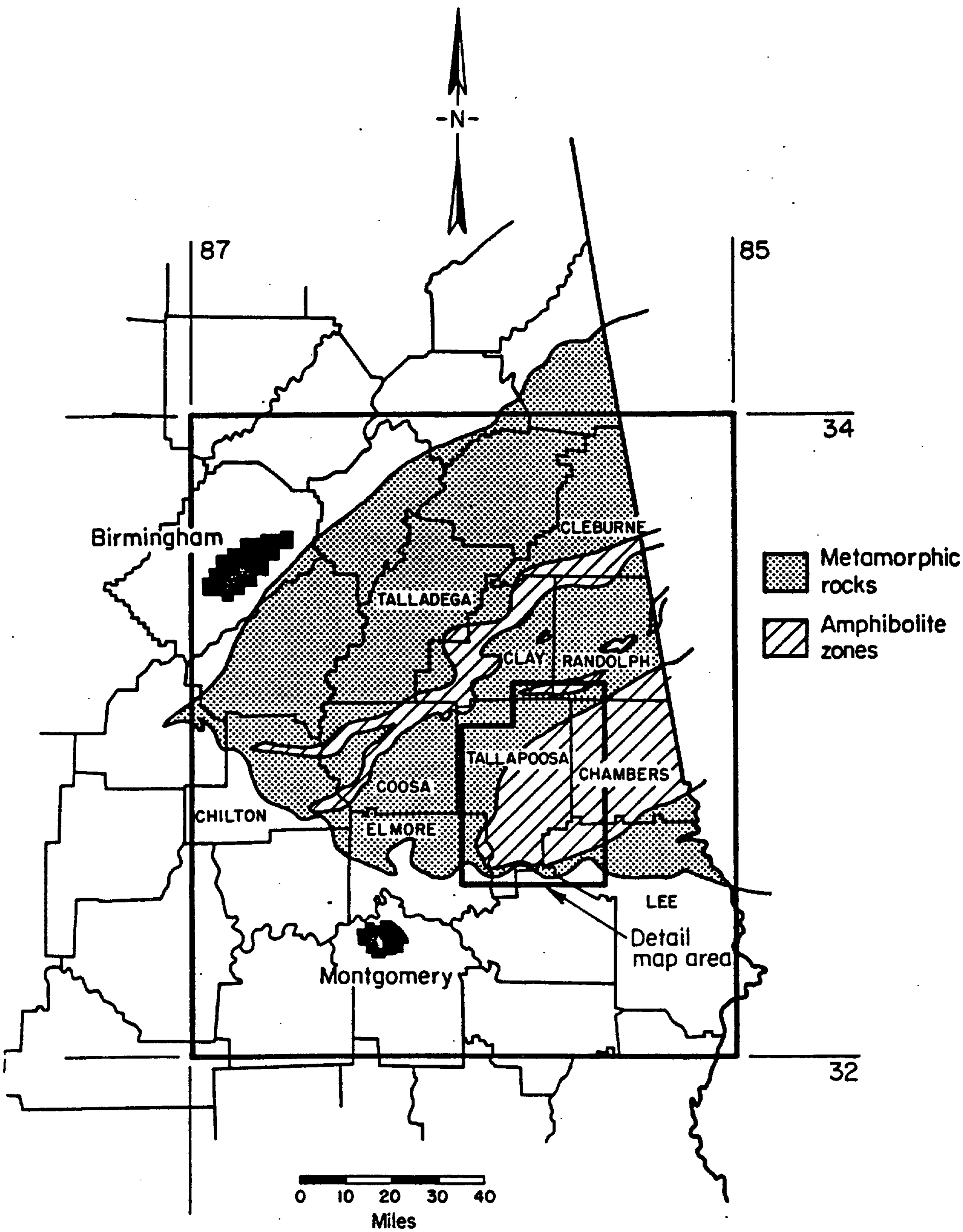

FIGURE A-2. MAP OF AREA OF ALABAMA CONTAINING METAMORPHIC ROCKS

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FIGURE A-3. Portions of Clay, Randolph, Tallapoosa, Chambers, Lee, and Elmore Counties, Alabama, showing the occurrence of Amphibolite (massive and layered) with Chlorite Schist. Gabbro, Norite, and Ultramatic Pods locally intermixed. Areas of past Anthophyllite or talc mining.

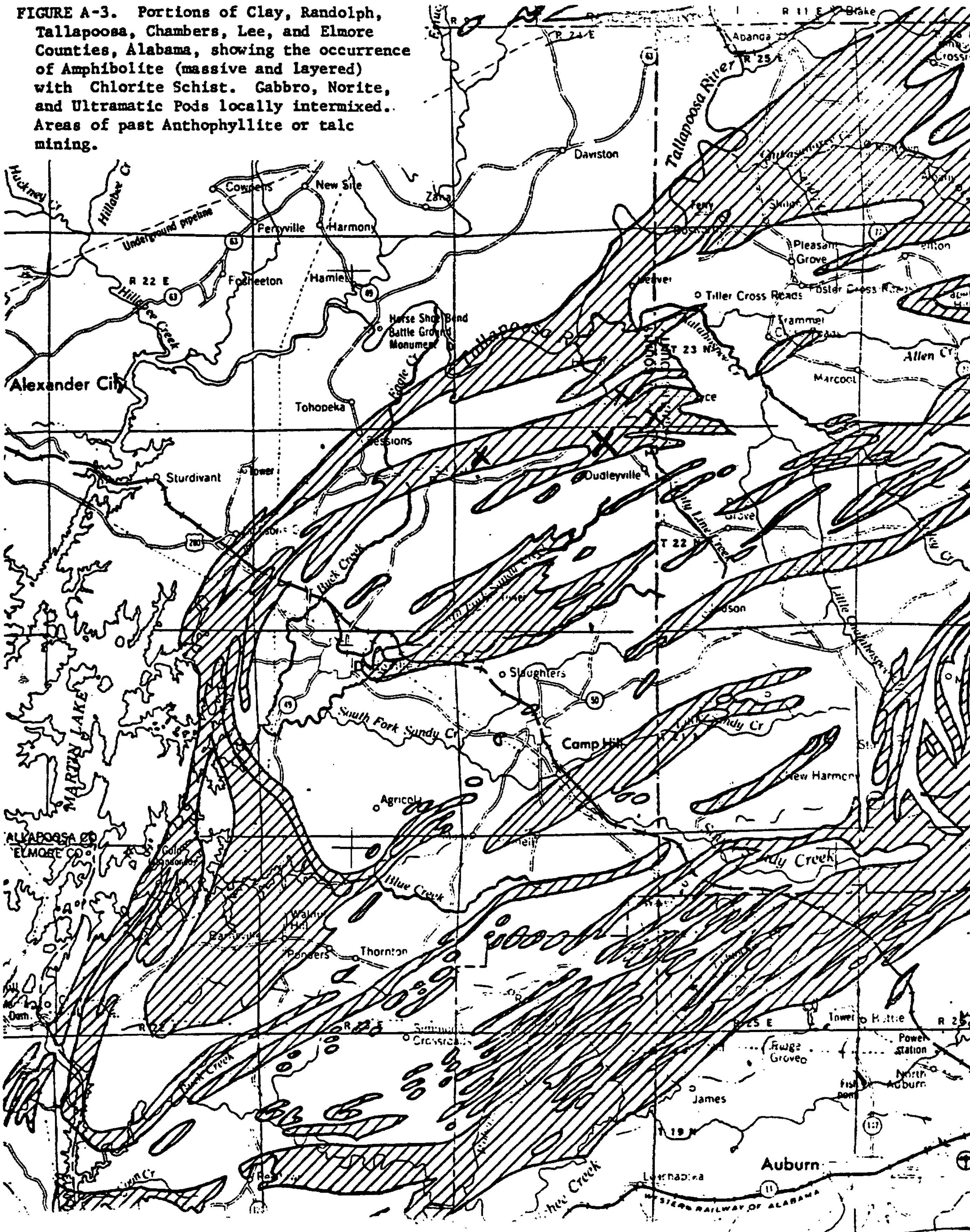

TABLE A-2. PRINCIPAL MINERAL PRODUCERS IN ALABAMA

County	Company and Address	Commodity
Chambers	----	None
Chilton	No major producer	Sand and gravel
Clay	----	None
Cleburne	No major producer	Sand and gravel
Coosa	----	None
Elmore	Jenkins Brick Company P.O. Box 91 Montgomery, Alabama 36101	Clay, sand and gravel
	Vulcan Materials Company P.O. Box 7324-A Birmingham, Alabama 35223	
Lee	No major producer	Stone
Randolph	United States Gypsum Co. 101 S. Wacker Drive Chicago, Illinois 60606	Scrap mica
Talledega	Vulcan Materials Company P.O. Box 7324-A Birmingham, Alabama 35223	Limestone, talc
	Georgia Marble Company Gantts Quarry, Alabama 35069	
	Thompson-Weinman & Company Cartersville, Georgie 30120	
	American Talc Company Alpine, Alabama 35014	
Tallapoosa	No current producer	Anthophyllite.

Source References

(1) Metamorphic Map of the Appalachians
Benjamin A. Morgan, 1972
USGS Map I-724

(2) Asbestos in the United States
A. H. Chidester and A. F. Shride, 1962
USGS Map MR-17

(3) Talc and Soapstone in the United States
A. H. Chidester and H. W. Worthington, 1962
USGS Map MR-31

(4) Talc and Anthophyllite Deposits in Tallapoosa and Chambers Counties, Alabama
Thornton L. Neathery, 1968
Bulletin 90, Geol. Surv. of Alabama

(5) Talc and Asbestos at Dadeville, Alabama
T. L. Neathery, et al, November, 1967
U.S. Bureau Mines, R.I. 7045

(6) Amphibolite Areas of the Pidemont Region (Map)
T. L. Neathery, et al, 1973
Geol. Surv. of Alabama

(7) The Mineral Industry of Alabama
H. L. Riley and W. E. Smith, 1971
U. S. Bureau of Mines Minerals Yearbook

Alaska

The major part of Alaska has been geologically investigated only in an exploratory manner. Only in the last few years has much geologic mapping been done. Figure A-4 shows a general division of Alaska. The Arctic Coastal Plain area consists mainly of sedimentary deposits, with some sedimentary rocks containing coal. The Arctic Foothills region is characterized by the presence of mafic intrusions tightly folded. The Arctic Mountains area is intruded by diabase sills with occurrences of schist, quartzite, limestone, and slate. The eastern half of the area are granitic intrusions and metamorphosed basalt. The Western Alaska region,including the Seward Peninsula and the Bering Shelf, is composed largely of volcanic rocks with some local metamorphism and cut by intrusions. The occurrence of ultramafic rocks, graywacke, argillite, and shale are all noted. The Alaska-Aleutian Province is characterized by areas of mild metamorphism with some intrusions to the eastern end along the Canadian border. The southern end along the Canadian border shows more intrusives and mafic bodies intruding the schist.

There has been a considerable amount of metamorphic and intrusive action in Alaska and, thus, the possibilities of occurrence of fiberous amphiboles is significant.

The general areas where asbestos has been reported to date are indicated in Figure 1. These specific areas are as follows:

- Hunt River
- Jade Creek; Jade Mountain
- Bismark Mountain; Skungnak River
- Cosmos Creek
- Asbestos Mountain
- Lemesurier Island
- Bear Creek.

The sand and gravel industry accounted for the largest dollar value in 1971 followed by stone, barite, uranium, platinum-group metals, gold and mercury. This excludes the fossil-fuel production. Table A-3 gives the value of mineral production for Alaska for 1971. Table A-4 gives the principal producers.

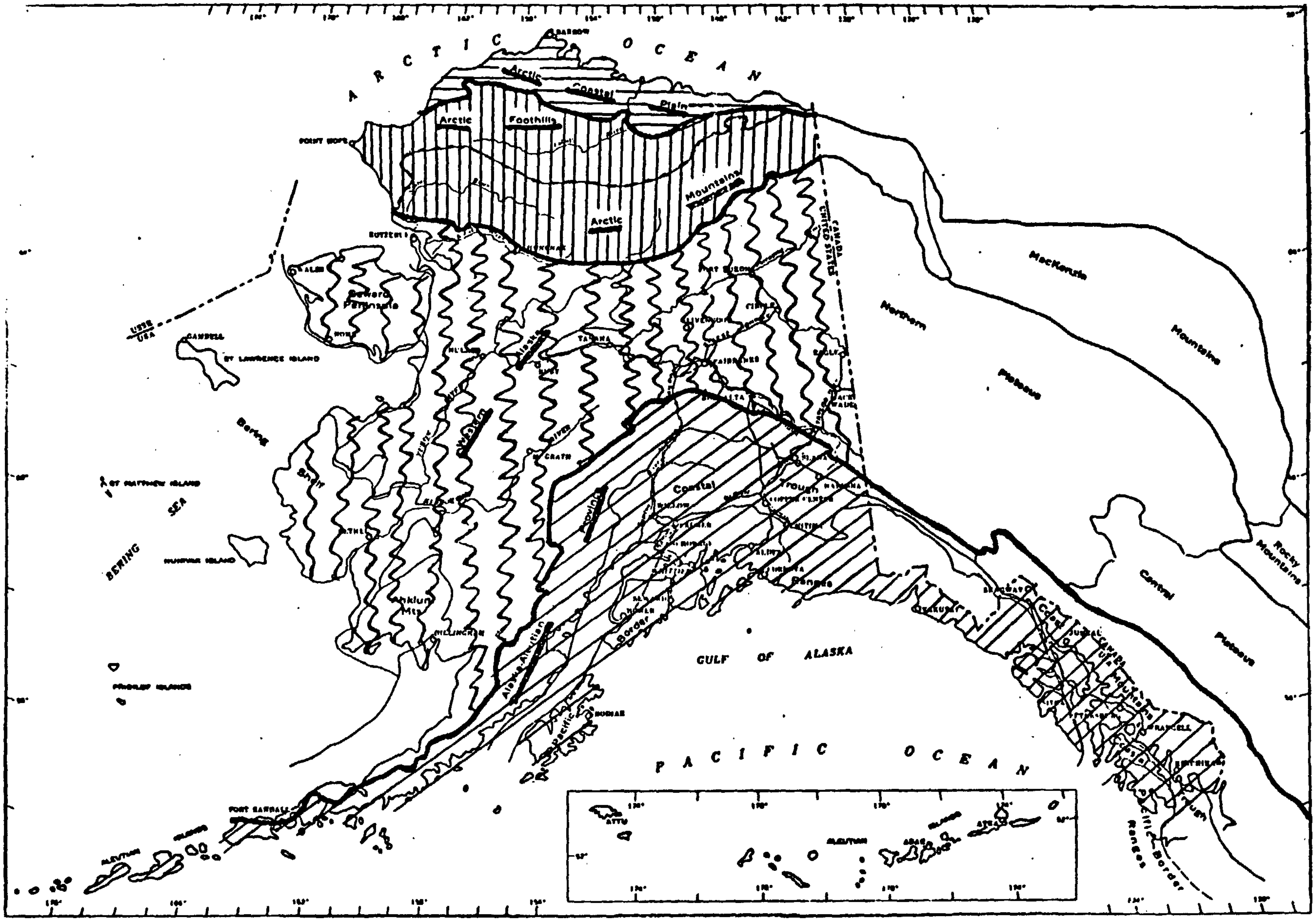

FIGURE A-4. GEOLOGICAL FEATURES OF ALASKA

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TABLE A-3. MINERAL PRODUCTION IN ALASKA[a]

Mineral	1971 Quantity	1971 Value, thousands $
Antimony ore and concentrate, short tons, antimony content	(b)	(b)
Barite, thousand short tons	102	1,075
Coal (bituminous), do	698	5,710
Gold (recoverable content of ores, etc), troy ounces	13,012	537
Natural gas, million cubic feet	121,618	28,945
Petroleum (crude), thousand 42-gallon barrels	79,494	257,562
Sand and gravel, thousand short tons	23,617	32,806
Silver (recoverable content of ores, etc), thousand troy ounces	1	1
Stone, thousand short tons	2,658	5,066
Tin, long tons	17	47
Value of items that cannot be disclosed: Gem stones, LP gases (1971), mercury, platinum-group metals, uranium (1971)	XX	2,174
Total	XX	333,923
Total 1967 constant dollars	XX	p290,112

p = Preliminary. XX = Not applicable.

(a) Production as measured by mine shipments, sales, or marketable production (including consumption by producers).

(b) No production of antimony was reported to the Bureau of Mines. However, the Alaska Department of Natural Resources reported production of 34 tons of ore valued at approximately $34,000.

TABLE A-4. PRINCIPAL MINERAL PRODUCERS IN ALASKA

Commodity	Company and Address	Region
Barite	Alaska Barite Co Anchorage, Alaska 99500	Southeastern Alaska
Coal	B & R Coal Co Healy, Alaska 99743	Yukon River
	Delta Coal Co North Pole, Alaska 99705	Do.
	Premier Coal Co Palmer, Alaska 99645	Cook Inlet-Susitna
	Usibelli Coal Mine, Inc Usibelli, Alaska 99787	Yukon River
Gold	U.S. Smelting Refining and Mining Co Fairbanks, Alaska 99701	Do.
	L. McGee Manley Hot Springs, Alaska 99756	Do.
	Ruby Mining Co Ruby, Alaska 99768	Do.
	Prince Creek Mining Co Flat, Alaska 99584	Do.
Natural gas	Amoco Production Co Anchorage, Alaska 99500	Offshore Cook Inlet
	Mobil Oil Corp do	Westside Cook Inlet
	Phillips Petroleum Co do	Kenai Peninsula, Offshore Cook Inlet
	Standard Oil Co. of California do	Kenai Peninsula, Westside Cook Inlet
	Texaco Inc do	Offshore Cook Inlet, Westside Cook Inlet
	Union Oil Co. of California do	Offshore Cook Inlet, Kenai Peninsula
	Holmes & Narver, Inc. Point Barrow, Alaska	North Slope
Petroleum-crude	Amoco Production Co Anchorage, Alaska 99500	Offshore Cook Inlet
	Atlantic Richfield Co do	Kenai Peninsula, Offshore Cook Inlet, North Slope
	BP Alaska, Inc do	North Slope

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TABLE A-4. (continued)

Commodity	Company and Address	Region
Petroleum-crude	Mobil Oil Corp do	Offshore Cook Inlet
	Shell Oil Co do	Kenai Peninsula, Offshore Cook Inlet
	Texaco Inc do	Offshore Cook Inlet
	Standard Oil Co. of California do	Kenai Peninsula
	Union Oil Co. of California do	Offshore Cook Inlet
Petroleum refining	Atlantic Richfield Co Prudhoe Bay, Alaska	North Slope
	Standard Oil Co. of California Nikiski, Alaska	Kenai Peninsula
	Tesoro-Alaskan Petroleum Corp do	Do.
Platinum-group metals	Goodnews Bay Mining Co Fairbanks, Alaska 99701	Salmon River
Sand and Gravel	Alaska Department of Highways Juneau, Alaska 99801	Various
	Alaska Department of Public Works do	Do.
	Burgess Construction Co Fairbanks, Alaska 99701	Yukon River
Stone	Alaska Department of Highways Juneau, Alaska 99801	Various
	Manson Osberg Co Seattle, Wash. 98100	Southeastern Alaska
	Moore Construction Co., Inc. Ketchikan, Alaska 99901	Do.
	U.S. Army Corps of Engineers Anchorage, Alaska 99500	Copper River, Kenai Peninsula, Southeastern Alaska
	Burgess Construction Co Fairbanks, Alaska 99701	Various
	Central Construction Co., Inc. Seattle, Wash. 98100	Northwestern Alaska

Source References

(8) The Mineral Industry of Alaska, R. B. Smith, W. C. Fackler, 1972, U.S. Bureau Mines, Minerals Yearbook.

(9) Geology of the Alaska Peninsula--Island Arc and Continental Margin (Part 1), C. A. Burk, Princeton, New Jersey, The Geological Society of America Memoir 99 (Part 1), 1965.

(10) Alaska's Mineral Resources as a Base for Industrial Development, Report to The State of Alaska by Arthur D. Little, Inc., February, 1962.

(11) Various Mineral Investigations Resources Maps by E. H. Cobb, U.S. Geological Survey, as follows:

Iron Occurrences in Alaska, Map MR-40, 1964
Antimony Occurrences in Alaska, Map MR-52, 1970
Bismuth Occurrences in Alaska, Map MR-53, 1970
Mercury Occurrences in Alaska, Map MR-54, 1970
Industrial Minerals and Construction Materials Occurrences in Alaska, Map MR-41, 1964
Lode Gold and Silver Occurrences in Alaska, Map MR-32, 1962
Antimony, Bismuth, and Mercury Occurrences in Alaska, Map MR-11, 1960
Industrial Minerals and Construction Materials Occurrences in Alaska, Map MR-41, 1964

(12) The Use of Remote Sensing in Conservation, Development, and Management of the Natural Resources of the State of Alaska, Richard H. Eakins, Jr., and Robin I. Welch, Department of Economic Development, State of Alaska, December, 1969.

(13) Economic Analysis of Fairbanks and Contiguous Area, Alaska, prepared by North Pacific Consultants, Anchorage, Alaska, Portland, Oregon, for Golden Valley Electric Association, Inc., Fairbanks, Alaska, January, 1959.

(14) Physiographic Divisions of Alaska, Geological Survey Professional Paper 482.

(15) Asbestos Air Pollution Control, IITRI Report No. C8216 for Institute for Environmental Quality, IIT Research Institute, Chicago, September, 1971.

(16) Keller, A. S. and Reiser, H. N., Geology of the Mount Katmai Area Alaska, Geological Survey Bulletin 1058-G, United States Government Printing Office, Washington (1959).

(17) Sainsbury, Geology of Lost River Mine Area, Alaska, USGS Bulletin, Plates.

(18) Rossman, D. L., Geology and Ore Deposits in the Reid Inlet Area Glacier Bay, Alaska, Mineral Resources of Alaska, Geological Survey Bulletin 1058-B, United States Government Printing Office, Washington (1959).

(19) Rossman, D. L., Geology and Ore Deposits of Northwestern Chichagof Island, Alaska, Mineral Resources of Alaska, Geological Survey Bulletin 1058-E, United States Government Printing Office, Washington (1959).

(20) Wahrhaftig, G. and Black, R. F., Quaternary and Engineering Geology in the Central Part of the Alaska Range, Geological Survey Professional Paper 293, United States Government Printing Office, Washington (1958).

Arizona

Arizona may be divided into two distinct physiographic provinces: the Colorado Plateaus Province in the north and the Basin and Range Province to the south and along the western border of the state. The northern province may be subdivided into four sections and as the province name implies, these may be characterized as plateau areas, in places much dissected. The southern Tonto Section of the northern province is transitional into the Basin and Range Province and part or all of it has been included in the southern province from time to time. The major provinces and the Tonto Section are delineated in the map figures.

The Basin and Range Province also may be subdivided into subprovinces or sections. The Mexican Highland Section in southeastern Arizona is extensively mountainous with peaks up to 9000 feet--as much as 5000 feet above adjacent valley floors. The Sonoran Desert section in southwestern Arizona has numerous mountain ranges also but these are lower and narrower than the mountains to the east and make up only about a fourth of the section area. While not as high as the eastern mountains, the southwestern mountains of Arizona are nevertheless quite rugged, rising abruptly from valley floors. The Mohave Section on the northwest border of Arizona is similar topographically to the Mexican Highland Section except that both the valley floors and mountain peaks are lower in overall elevation and the area is more desertlike.

The Basin and Range Province is notable for its numerous igneous intrusive rocks of several geologic ages. Granites and gabbros of Precambrian age and older are found. Sills and dikes of diabase are intrusive into upper Precambrian strata and a notable occurrence of these is in association with the chrysotile deposits of Gila County. Elsewhere in the Basin and Range Province, the intrusives are granite, quartz monzonite, monzonite, diorite, and diorite porphyry, and range in age from Triassic to middle Tertiary with most being of late Cretaceous and early Tertiary age. The latter intrusive activity was of prime importance in the placement of many of the state's major metal deposits. In some places older rocks surrounding Laramide (age) intrusive bodies were intensely metamorphased. To the north in the Colorado Plateaus Province, the structural disruption during the Laramide orogeny was limited to gentle warping and high-angle faulting.

The Basin and Range Province and the Tonto Section of the Colorado Plateaus is an area of extensive mineralization and the commodity of highest production here is copper. In fact, about 85 percent of Arizona's mineral production is in copper. From 45 to 50 mines, chiefly in southeastern and southcentral Arizona but also well distributed throughout the Basin and Range Province, are producers of copper and coincidentally, molybdenum, gold, silver, lead, and zinc. The general location of the copper producing mines is shown in Figure A-5 and briefly described in Table A-5. The mineral values produced by counties are given in Table A-6.

The major source of current copper production in Arizona is from deposits commonly referred to as "disseminated" or "porphyry copper" lypes which may occur in schists, silicated limestone, volcanic rocks, or even-granular granitic rocks. A feature of all such deposits is that they are spatially related to stocks, plugs, sills, or dikes of quartz-bearing porphyritic to granular intrusive rocks, variously classified as quartz diorite, granodiorite, quartz monzonite, and granite, or their porphyritic equivalents. Another common feature is alteration of the host rocks which took place during the mineralization stage. Five types of alteration are recognized: (1) propylitic, characterized by abundant lime bearing and other minerals such as calcite, epidote, chlorite, talc, and kaolinite; (2) argillic, characterized by clay minerals; (3) potassic, characterized by muscovite-biotite-K-feldspar assemblages; (4) quartz-sericite, characterized by a quartz-sericite-pyrite assemblage; and (5) lime silicate, characterized by assemblages of garnet, tremolite, epidote, diopside, etc. Much of the ore in the Pima district (20, 21, 22 on the copper occurrence map) is associated with the lime-silicate-type alteration. Lime-silicate-type alteration also may be found in several other copper producing areas. Thus, it is readily apparent that the fibrous amphiboles are fairly commonly found in association with the copper recovery activities in Arizona. Since considerable tonnages of ore are worked, about 166

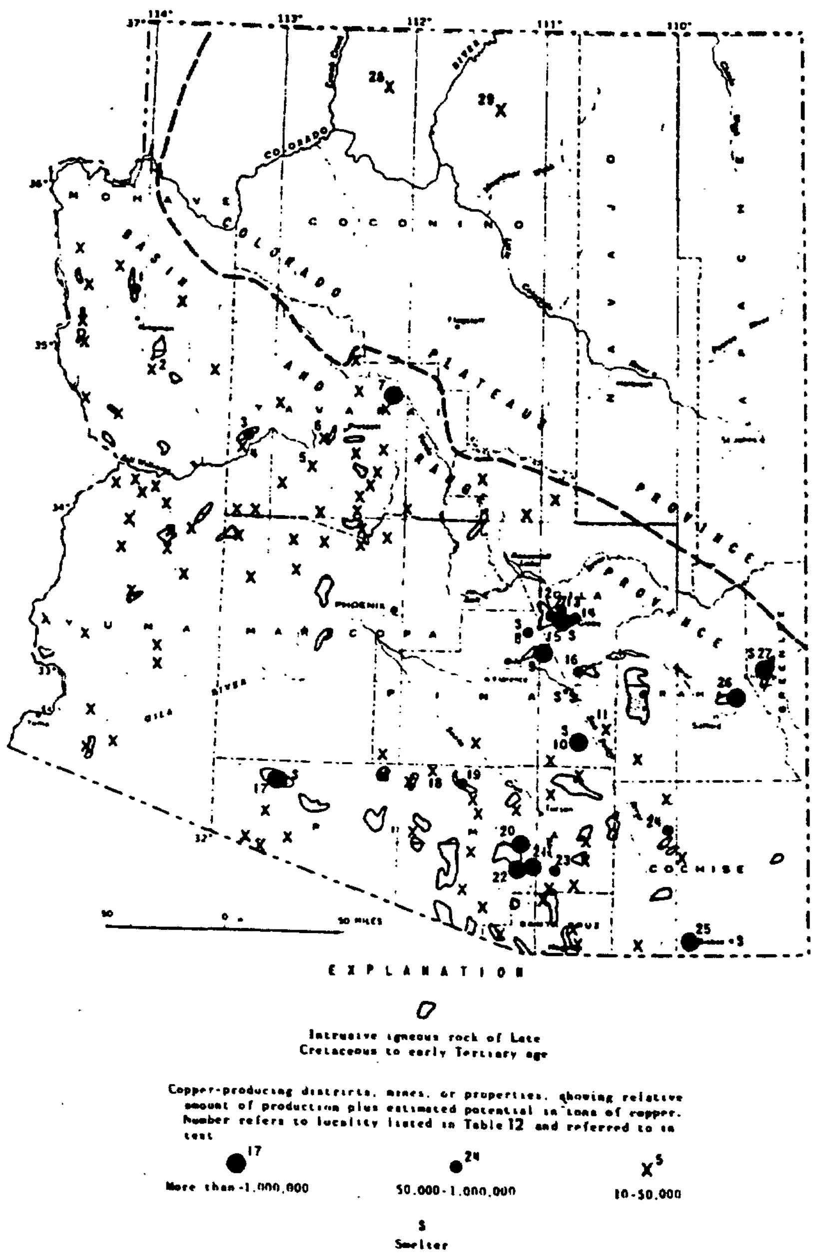

FIGURE A-5. COPPER OCCURRENCES AND PRODUCTION

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TABLE A-15. COPPER DEPOSITS IN ARIZONA

	District or area, mine or property	County	Type of deposit and mine
1	Mineral Park mine	Mohave	Disseminated in quartz monzonite. Open pit.
2	Antler mine	do.	Massive sulfide lens in metamorphic rock. Copper, zinc, and lead. Underground.
3	Bagdad mine	Yavapai	Disseminated in quartz monzonite. Open pit.
4	Old Dick-Copper Queen mines	do.	Massive sulfide lenses in metamorphic rock. Copper, zinc, and lead. Underground.
5	Zonia mine	do.	Oxide-copper lenses, largely chrysocolla, in shear zone in schist. Opencut.
6	Copper Basin area	do.	Breccia pipes containing copper and Molybdenum. Underground.
7	Jerome area United Verde mine	do.	Massive pyritic pipe; copper and some zinc. Underground and opencut.
	United Verde Extension mine		Massive-sulfide lens, largely high-grade chalcocite ore. Underground.
8	Magma mine	Pinal	Vein deposit with some replacement in limestone. Underground.
9	Ray mine	do.	Chalcocite blanket in schist and chalcopyrite in diabase. Open pit.
10	San Manuel mine	do.	Disseminated in granite and monzonite porphyry. Underground.
11	Copper Creek area	do.	Breccia pipes containing copper and molybdenum. Underground.
12	Castle Dome mine	Gila	Disseminated in quartz monzonite. Opencut.
13	Copper Cities mine	do.	Disseminated in quartz monzonite. Open pit.
14	Old Dominion mine	do.	Vein deposit with some supergene enrichment. Underground.
15	Miami-Inspiration properties	do.	
	Miami mine		Chalcocite blanket in schist and quartz monzonite. Underground.
	Inspiration mine		Same as Miami except some mixed oxide and sulfide ore. Open pit.
16	Christmas mine	do.	Limestone replacement deposits. Underground.
17	New Cornelia mine	Pima	Disseminated in quartz monzonite. Open pit.
18	Lakeshore mine	do.	Oxide-copper ore. Open pit.
19	Silver Bell mine	Pima	Disseminated chalcocite blanket. Open pits.
20	Mission mine Pima mine Banner-Anaconda mine	do.	Disseminated ore bodies in silicated limestone and altered siltstone and sandstone. Open pits.
21	Twin Buttes property	do.	Same and Mission and Pima. Stripping for open pit.
22	Esperanza mine Sierrita property	do.	Disseminated deposits with some supergene enrichment. Open pit.
23	Helvetia district	do.	Replacement deposits in silicated limestone. Underground.
24	Johnson Camp area	Cochise	Limestone replacement deposits of copper and zinc. Underground.
25	Copper Queen mine	do.	Replacement deposits in limestone. Underground.
	Lavender Pit mine		Disseminated deposit in silicified quartz porphyry and masses of breccia. Open pit.
26	Lone Star mining district	Graham	Huge low-grade disseminated deposit in volcanic rocks. No mining to date.
27	Morenci mine	Greenlee	Chalcocite blanket in granitic rock. Open pit.
28	Jacobs Lake area	Coconino	Disseminated deposits in sandstone. Opencut.
29	White Mesa District	do.	Disseminated deposits in sandstone. Opencut.

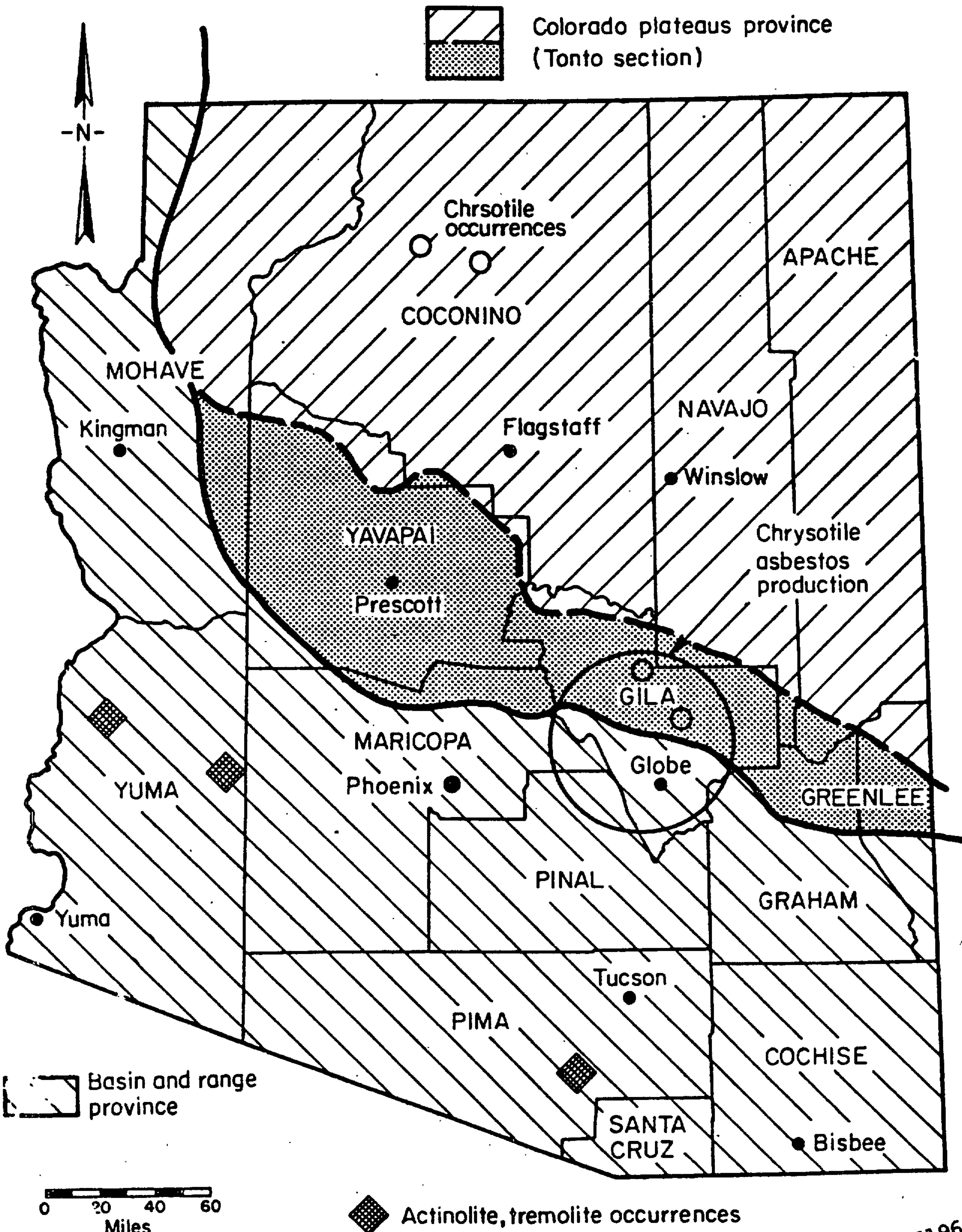
TABLE A-6. Value of mineral production in Arizona, by county

County	1970	1971	Minerals produced in 1971 in order of value
Apache	$7,231	$5,913	Petroleum, helium, clays, natural gas, pumice, iron ore, sand and gravel, stone.
Cochise	78,297	62,799	Copper, stone, lime, silver, gold, sand and gravel, fluorspar.
Coconino	2,290	666	Pumice, sand and gravel, stone.
Gila	124,653	101,614	Copper, molybdenum, asbestos, lime, stone, silver, sand and gravel, gold, fluorspar, clays.
Graham	W	W	Sand and gravel, stone, lead, zinc, copper, pumice, silver, gold.
Greenlee	151,043	119,492	Copper, silver, lime, stone, gold, sand and gravel.
Maricopa	7,258	14,420	Sand and gravel, lime, stone, clays, mica, copper, silver, gold.
Mohave	40,762	34,017	Copper, molybdenum, sand and gravel, silver, stone, feldspar, gold, tungsten, clays.
Navajo	W	W	Coal, sand and gravel, pumice, stone.
Pima	422,298	378,219	Copper, molybdenum, cement, silver, sand and gravel, gold, lime, stone, lead, clays, zinc, mica.
Pinal	285,166	211,772	Copper, molybdenum, silver, gold, sand and gravel, gypsum, lime, stone, perlite, diatomite, pyrites, lead.
Santa Cruz	W	W	Sand and gravel, stone, tungsten, copper, lead, silver, zinc.
Yavapai	41,698	46,284	Copper, cement, zinc, sand and gravel, stone, lime, molybdenum, gypsum, silver, clays, lead, gold, pumice, iron ore.
Yuma	W	W	Sand and gravel, stone, copper, silver, gold.
Undistributed[1]	6,071	5,819	
Total	1,166,767	[2]981,020	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes gem stones, sand and gravel, and stone that cannot be assigned to specific counties, and values indicated by symbol W.
[2] Data does not add to total shown because of independent rounding.

The fibrous amphibole minerals, actinolite and tremolite, are also found in potential economic concentrations (for short-fiber asbestos utilization) in Yuma and Pima Counties. The locations of these occurrences are marked on the map delineating the physiographic provinces (Figure A-6). Currently, there is no production from these amphibole asbestos deposits.

The asbestos deposits that are currently being worked are chrysotile asbestos. These are clustered in Gila County principally, as shown in Figure A-7 (chrysotile also is found in the Grand Canyon region as illustrated). The chrysotile is found to occur in the Mescal Limestone of Precambrian age and is genetically related to small dikes and extensive sills of diabase. As part of the alteration process that accompanied the diabase intrusives, the magnesia from the originally dolomitic strata migrated to combine selectively with silica of chert nodules and layers to form aggregates of tremolite, diopside, talc, and serpentine that are crudely pseudomorphic after the chert masses. The asbestos occurs as cross-fiber veins in the thin tabular serpentine


Colorado plateaus province
(Tonto section)
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Chrsotile
occurrences
APACHE
COCONINO
MOHAVE
NAVAJO
Kingman
Flagstaff
Winslow
Chrysotile
asbestos
production
YAVAPAI
Prescott
GILA
MARICOPA
Globe
YUMA
Phoenix
GREENLEE
PINAL
GRAHAM
Yuma
Tucson
PIMA
COCHISE
Basin and range
province
SANTA
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Miles
Actinolite, tremolite occurrences

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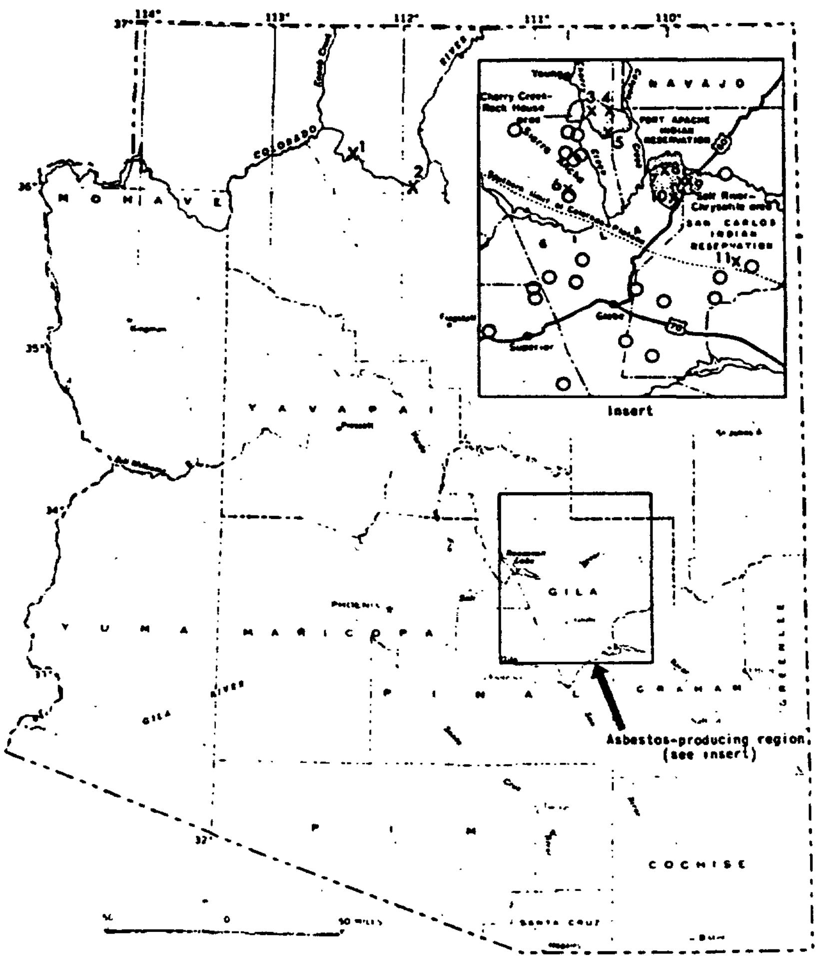

EXPLANATION

Principal area of deposits

Deposit or group of deposits outside principal areas

Deposits referred to in text and listed below

1 Bass (in Grand Canyon)
2 Hance (in Grand Canyon)
3 Wilson Creek - Walnut Creek area
4 Sloane Creek
5 Rock House
6 American Ores (Asbestos Peak)
7 Regal
8 Grandview and Ladder
9 Pinetop (Lucky Seven)
10 Chrysotile
11 Bear Canyon

FIGURE 46.—Asbestos in Arizona.

FIGURE A-7. CHRYSOTILE ASBESTOS DEPOSITS layers that comprise the bulk of most silicate zones. The copper production in the Globe (town) area is fairly extensive from several mines and may in fact be located in strata similar in occurrence to the chrysotile deposits in the area. For example, the Old Dominion vein system near Globe is in rocks of Precambrian and Paleozoic age containing appreciable masses of diabase. Among the contact-metamorphic minerals associated with the copper minerals in such deposits are serpentine, tremolite, diopside, and a little garnet. The interpretation of the mineral history in this and similar areas of copper production is that the copper sulfide mineralization was introduced after metamorphism. There is little doubt that the production of copper in the Arizona copper districts involves the working and handling of considerable asbestiform minerals.

The principal mineral producers in Arizona are tabulated in Table A-7.

TABLE A-7. PRINCIPAL MINERAL PRODUCERS IN ARIZONA

Commodity and company	Address	Type of activity	County
Asbestos: Jaquays Mining Corp.	1219 South 19th Ave. Phoenix, Ariz. 85009	Underground mine and crushing, screening, and air-separation plant.	Gila.
Cement:			
American Cement Corp., Phoenix Division.	2404 Wilshire Blvd. Los Angeles, Calif. 90057	Dry process, 3-rotary-kiln plant.	Yavapai.
Arizona Portland Cement Co., a division of California Portland Cement Co.	612 South Flower St. Los Angeles, Calif. 90017	....do....	Pima.
Clays:			
American Cement Corp., Phoenix Division.	2404 Wilshire Blvd. Los Angeles, Calif. 90057	Open pit mine	Yavapai.
Filtrol Corp.	3250 East Washington Blvd. Los Angeles, Calif. 90023	....do....	Apache.
McCarrell & Gurley	Box 1377 Gallup, N. Mex. 87301	....do....	Do.
Pheonix Brick Yard	[illegible] South 7th Ave. Phoenix, Ariz. 85007	....do....	Maricopa.
		....do....	Pima.
Tucson Pressed Brick Corp.	Box 2592 Tucson, Ariz. 85702	....do....	Do.
Copper:			
American Smelting and Refining Co.	120 Broadway New York, N.Y. 10005	3 open pit mines, 2 mills, leach dumps, and precipitation plant.	Do.
The Anaconda Company	Box 127 Sahuarita, Ariz. 85629	Open pit mine and mill	Do.
Bagdad Copper Corp.	Box 245 Bagdad, Ariz. 86321	Open pit mine, mill, leach dumps, precipitation plant, and copper powder refinery.	Yavapai.
Cyprus Mines Corp., Bruce Mine Division.	Box 457 Bagdad, Ariz. 86321	Underground mine and mill.	Do.
Duval Corp.	Box 1271 Kingman, Ariz. 86401	Open pit mine, mill, leach dumps, and precipitation plant.	Mohave.
	Box 38 Sahuarita, Ariz. 85629	....do....	Pima.
Inspiration Consolidated Copper Co.	Inspiration, Ariz. 85537	4 open pit mines, 2 mills, leach dumps and in place leaching, heap leaching, precipitation plant, rod plant rolling mill, custom smelter, electrolytic refinery.	Gila.
Kennecott Copper Corp., Ray Mines Division.	Hayden, Ariz. 85235	Open pit mine, leach dumps and in place leaching, electrowinning plant, and precipitation plant.	Pinal.
		Mill and smelter	Gila.
Magma Copper Co.:			
San Manuel Division	Box M San Manuel, Ariz. 85631	Underground mine, mill, and smelter.	Pinal.
Superior Division	Box 37 Superior, Ariz. 85273	Underground mine, mill, and custom smelter.	Do.
Phelps Dodge Corp.:			
Copper Queen Branch	Drawer K Bisbee, Ariz. 85603	Open pit mine, underground mine, mill, leach dumps and in place leaching, and precipitation plant.	Cochise.
Morenci Branch	Douglas, Ariz. 85607	Custom smelter	Do.
	Morenci, Ariz. 85540	Open pit mine, mill, leach dumps, precipitation plant, and smelter.	Greenlee.
New Cornelia Branch	Drawer 9 Ajo, Ariz. 85321	Open pit mine, mill, and smelter.	Pima.
Phelps Dodge Corp., (Big Hole Mining Co., lessee).	Box 125 Jerome, Ariz. 86331	Open pit mine, leach dumps, and precipitation plant.	Yavapai.
Pima Mining Co.	Box 7187 Tucson, Ariz. 85713	Open pit mine and mill	Pima.
Ranchers Exploration and Development Corp.	Box 6217 Albuquerque, N. Mex. 87107	Open pit mine, heap leaching, and electrowinning plant.	Gila.
Cities Service Co., Miami Copper Co. Division.	Box 100 Miami, Ariz. 85539	Open pit mine, mill, leach dumps and in place leaching, and 3 precipitation plants.	Do.
Diatomite: Arizona Gypsum Corp.	Box 6495 Phoenix, Ariz. 85005	Open pit mine and plant	Pinal.
Feldspar: International Minerals & Chemical Corp., Industrial Minerals Division.	Administration Center Old Orchard Road Skokie, Ill. 60079	....do....	Mohave.
Gold:			
Inspiration Consolidated Copper Co.	Inspiration, Ariz. 85537	*See* Copper	Gila.
Kennecott Copper Corp., Ray Mines Division.	Hayden, Ariz. 85235	....do....	Pinal.
Magma Copper Co.:			
San Manuel Division	Box M San Manuel, Ariz. 85631	....do....	Do.
Superior Division	Box 37 Superior, Ariz. 85273	....do....	Do.
Phelps Dodge Corp.:			
Copper Queen Branch	Drawer K Bisbee, Ariz. 85603	....do....	Cochise.
Morenci Branch	Morenci, Ariz. 85540	....do....	Greenlee.
New Cornelia Branch	Drawer 9 Ajo, Ariz. 85321	....do....	Pima.
Cities Service Co., Miami Copper Co. Division.	Box 100 Miami, Ariz. 85539	....do....	Gila.
Gypsum:			
Arizona Gypsum Corp.:			
Verde Division	Box 6675 Phoenix, Ariz. 85005	Open pit mine and plant	Yavapai.
Winkelman Division	....do....	....do....	Pinal.
National Gypsum Co.	325 Delaware Ave. Buffalo, N.Y. 14202	....do....	Do.

TABLE A-7. (Continued)

Commodity and company	Address	Type of activity	County
Helium:			
Kerr-McGee Corp., Gas Processing Department.	Kerr-McGee Bldg. Oklahoma City, Okla. 73102	6 wells and plant; Pinta Dome field.	Apache.
Iron ore: CF&I Steel Corp.	Box 316 Pueblo, Colo. 81002	Open pit mine	Navajo.
Lime:			
Paul Lime Plant, Inc.	Drawer T Douglas, Ariz. 85607	5 rotary-kiln plant	Cochise.
Phelps Dodge Corp., Morenci Branch.	Morenci, Ariz. 85540	1 rotary-kiln, 1 fluidized-bed-kiln plant.	Greenlee.
Mica:			
Buckeye Mica Company	Box 416 Buckeye, Ariz. 85326	Open pit mine	Maricopa.
San Antonio Mica Co.	Box 397 Ajo, Ariz. 85321	....do	Pima.
Molybdenum:			
American Smelting and Refining Co.	120 Broadway New York, N.Y. 10005	*See* Copper	Do.
The Anaconda Company	Box 127 Sahuarita, Ariz. 85629	....do	Do.
Bagdad Copper Corp.	Box 245 Bagdad, Ariz. 86321	....do	Yavapai.
Duval Corp.	Box 1271 Kingman, Ariz. 86401	....do	Mohave, Pima.
Duval Sierrita Corp.	Box 125 Sahuarita, Ariz. 85629	Open pit mine, mill, and roaster.	Pima.
Inspiration Consolidated Copper Co.	Inspiration, Ariz. 85537	Open pit mine, mill, and roaster.	Gila.
Kennecott Copper Corp., Ray Mines Division.	Hayden, Ariz. 85235	....do	Pinal.
Magma Copper Co., San Manuel Division.	Box M San Manuel, Ariz. 85631	....do	Do
Pima Mining Co.	Box 7187 Tucson, Ariz. 85713	....do	Pima.
Cities Service Co., Miami Copper Co. Division.	Box 100 Miami, Ariz. 85539	....do	Gila.
Natural gas and petroleum:			
Humble Oil & Refining Co.	2000 Classen Center-North Oklahoma City, Okla. 73106	Crude oil and natural gas wells; East Boundary Butte field.	Apache.
Kerr-McGee Corp.	Kerr-McGee Bldg. Oklahoma City, Okla. 73102	Crude oil and natural gas wells; Dinch bi Keyah field.	Do.
Perlite:			
Supreme Perlite, Inc.	321 So. 27th Ave. Phoenix, Ariz. 85009	Open pit mine	Maricopa.
Pumice:			
Apache County Highway Department.	Box 428 St. Johns, Ariz. 85936	....do	Apache.
Atchison Topeka & Santa Fe Railway Co.	Winslow, Ariz. 86047	Open pit mine and plant	Coconino.
Superlite Bldrs. Supply, Inc.	5201 North 7th St. Phoenix, Ariz. 85014	Open pit mine	Do.
Pyrites: Magma Copper Co., Superior Division.	Box 37 Superior, Ariz. 85273	*See* Copper	Pinal.
Sand and gravel (commercial):			
Arizona Sand & Rock Co.	Box 20067 Phoenix, Ariz. 85036	2 pit and plants	Maricopa.
Tucson Sand & Soil, Inc.	2430 West Curtis St. Tucson, Ariz. 85705	Pit and plant	Pima.
Union Rock & Materials Corp., Bentson Contracting Co.	2800 South Central Ave. Phoenix, Ariz. 85040	3 pits and plants	Maricopa.
United Metro Materials & Concrete Co., Inc.	Box 13309 Phoenix, Ariz. 85002	5 pits and plants 2 pits and plants Pit and plant	Do. Pinal. Yuma.
Silver:			
American Smelting and Refining Co.	120 Broadway New York, N.Y. 10005	*See* Copper	Pima.
The Anaconda Company	Box 127 Sahuarita, Ariz. 85629	....do	Do.
Bagdad Copper Corp.	Box 245 Bagdad, Ariz. 86321	....do	Yavapai.
Cyprus Mines Corp., Bruce Mine Division.	Box 457 Bagdad, Ariz. 86321	....do	Gila.
Duval Corp.	Box 1271 Kingman, Ariz. 86401	....do	Mohave.
	Box 38 Sahuarita, Ariz. 85629	....do	Pima.
Inspiration Consolidated Copper Co.	Inspiration, Ariz. 85537	....do	Gila.
Kennecott Copper Corp., Ray Mines Division.	Hayden, Ariz. 85235	....do	Pinal.
Magma Copper Co.:			
San Manuel Division	Box M San Manuel, Ariz. 85631	....do	Do.
Superior Division	Box 37 Superior, Ariz. 85273	....do	Do.
Magma Copper Co. (McFarland & Hullinger, lessee).	Box 238 Tooele, Utah 84074	Dump	Do.
Phelps Dodge Corp.:			
Copper Queen Branch	Drawer K Bisbee, Ariz. 85603	*See* Copper	Cochise.
Morenci Branch	Morenci, Ariz. 85540	....do	Greenlee.
New Cornelia Branch	Drawer 9 Ajo, Ariz. 85321	....do	Pima.
Pima Mining Co.	Box 7157 Tucson, Ariz. 85713	....do	Do.
Cities Service Co., Miami Copper Co. Division.	Box 100 Miami, Ariz. 85539	....do	Gila.
Stone:			
American Cement Corp., Phoenix Division.	2404 Wilshire Blvd. Los Angeles, Calif. 90057	Quarry and plant	Yavapai.
New Pueblo Constructors	4115 E. Illinois St. Tucson, Ariz. 85714	Quarry	Pima.
Paul Lime Plant, Inc.	Drawer T Douglas, Ariz. 85607	Quarry and plant	Cochise.
Zinc: Cyprus Mines Corp., Bruce Mine Division.	Box 457 Bagdad, Ariz. 86321	*See* Copper	Yavapai.

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Arkansas

The rocks of the state of Arkansas are regionally affected by igneous activity in two major areas: (1) a batholith underlying the southern sedimentaries of the Ozark Region, and (2) plutonic extrusives along the southern edge of the Ouachita Mountain Region. These areas are located on the Figure A-8 by showing for (1) the areas of intense mineralization, and for (2) the major igneous outcrops. Minor outcrops of the igneous rocks occur frequently along the southern front of the Ouachita Mountains and mineralization and metamorphism is extensive. The mineral assemblage includes the fibrous amphiboles.

Near Little Rock, the Jeffrey Stone Company (P.O. Box 185, North Little Rock, Arkansas 72114) produces large tonnages of quartzitic sandstone for crushed aggregate and other uses. The quartz veins within this formation contain cookeite, chlorite, purite, galena, sphoderite, aukerite and rectorite including the mountain leather variety of rectorite. A belt of the quartz-cookeite-rectorite mineralization exists in the northeastern Frontal Ouachita Mountains believed to be emplaced in Cretaceous time.

The Granite Mountain intrusive south of Little Rock is locally quarried for a number of commodities. Metamorphosed shale and novaculite of Paleogoic age are exposed in contact with the nepheline syenite of Granite Mountain. The porphyritic syenite is called pulaskite. Some exposures of fourchite and other basic dike rocks occur nearby. Small occurrences of calcite, fluorite, chlorite and other minerals are found in association with these rocks.

To the southwest in Saline County, the Milwhite Company, Incorporated (P.O. Box 15038, Houston, Texas 77020) grinds soapstone and slage for fillers, insecticides, and roofing uses. Soapstone is obtained from open pits worked in a sill-like serpentine intrusion of probable Paleogoic age. The major operation in Saline County is the aluminum-bauxite recovery by the Aluminum Company of America, the American Cyanamid Company, the A. P. Green Refractories Company, and the Reynolds

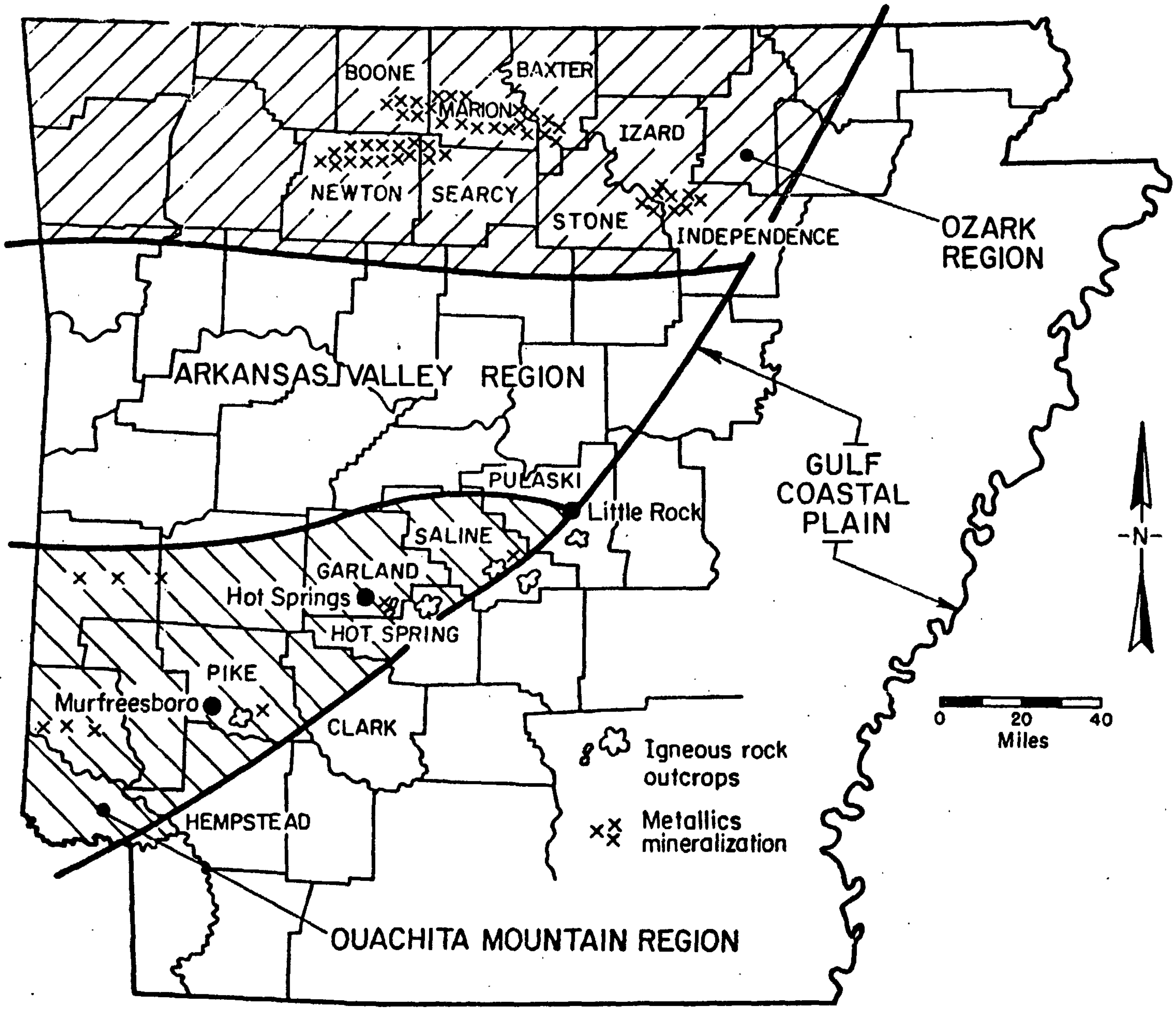

FIGURE A-8. OCCURRENCE OF IGNEOUS ROCK AND METALLIC MINERALIZATION IN ARKANSAS

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Mining Corporation. The bauxite deposits are centered around intrusives of nepheline syenite. Lateritic weathering has resulted in the alteration to bauxite. The principal mineral is gibbsite. Impurities are silica, iron, and titanium.

About 15 miles due west of Little Rock, in Saline County, there is a serpentine dike area noted for its talc-soapstone deposits and nickel mineralization. The serpentine dikes cut middle Ordivician age shale and in turn are cut by Cretaceous age smaller dikes and sills of monchiquite, ouachitite, fourchite, nepheline syenite, phonolite, syenite, trachyte, and diorite. The talc-dolomite-soapstone alteration of the serpentine body was by low-temperature hydrothermal solution. Small deposits of nickel are often found in serpentine or peridatite bodies as replacement occurrences. The nickel deposits are not now being exploited.

The Magnet Cove intrusive complex in Hot Spring County is an alkalic igneous rock assemblage where many varieties of igneous rocks, metamorphism of sedimentary rocks, and associated mineralization can be found. Sphene nepheline syenite, ijolite, carbonatite, phonolite, garnet pseudolencite syenite, and jacupirangite rocks are found in the roughly circular outcrop. The jacupirangite is cut by mafic and alkalic dikes. There are numerous titanium-bearing minerals and as the name of the place implies, there is much magnetite. The Arkansas Novaculite in the area is thermally metamorphosed. There is quarrying in this area for barite by Dresser Minerals (P.O. Box 6504, Houston, Texas 77005) and by National Lead Industries, Incorporated (P.O. Box 1675, Houston, Texas 77001).

About 4 miles to the west of the Magnet Cove complex there is a relatively small circular alkalic intrusive in Garland County which is the site of the only primary vanadium recovery operation in the United States. The outer ring of this intrusive is alkali syenite and fenite. The center is principally nepheline syenite. Numerous other basic rock types are included in the complex and the whole has been weathered to considerable depth. Locally the rocks have been intensely chloritized and close to the intrusive the metamorphics include the fibrous amphiboles (e.g., tremolite).

The Union Carbide Corporation (Route 2, P.O. Box 564, Hot Springs, Arkansas 71901) is working two open pit quarries in the area chiefly for recovery of the vancium content.

Evidence of the igneous activity along the front of the Ouachita Mountain Region is found continually to the southwest from Magnet Cove. For example, in Pike County, there is the diamond bearing intrusive near Murfreesboto which has become famous as the only site in the United States where diamonds are found. A small amount of mercury (cinnabar) is recovered from the mineralized area of Pike County.

In addition to the mineralization of the Ouachita Mountain Region there is extensive mineralization in the northern Arkansas counties as indicated in Figure A-8. Lead and zinc mineralization predominates over a five county area to the west and manganese minerals are found to the east. Currently there is no production of these commodities from the Ozark Region.

The county by county mineral production in Arkansas is tabulated in Tables A-8 and A-9.

TABLE A-8. **Value of mineral production in Arkansas, by county**[1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value,
Arkansas	$3	--	
Ashley	W	W	Sand and gravel.
Baxter	W	W	Sand and gravel, stone.
Benton	W	W	Stone, sand and gravel.
Boone	W	W	Do.
Bradley	285	W	Petroleum, sand and gravel.
Calhoun	989	$1,198	Sand and gravel, petroleum.
Carroll	327	W	Sand and gravel, stone.
Chicot	W	--	
Clark	W	W	Sand and gravel, stone.
Clay	245	170	Sand and gravel.
Cleburne	W	142	Stone.
Cleveland	W	W	Sand and gravel.
Columbia	40,179	41,507	Bromine, petroleum, natural gas, natural gas liquids, sand and gravel.
Conway	262	W	Stone, natural gas.
Craighead	W	W	Sand and gravel, clays.
Crawford	W	4,742	Natural gas, stone, sand and gravel.
Crittenden	W	W	Clays, sand and gravel.
Cross	716	W	Sand and gravel.
Dallas	W	W	Do.
Desha	W	W	Do.
Drew	W	W	Do.
Faulkner	569	W	Stone, sand and gravel.
Franklin	10,065	8,904	Natural gas, coal, stone, sand and gravel.
Fulton	208	W	Sand and gravel, stone.
Garland	W	W	Vanadium, abrasives, sand and gravel, tripoli, stone.
Grant	102	W	Sand and gravel.
Greene	194	W	Do.
Hempstead	W	W	Sand and gravel, clays.
Hot Spring	4,509	W	Barite, clays, stone, sand and gravel.
Howard	W	W	Cement, gypsum, stone, clays, petroleum.
Independence	W	3,064	Stone, lime, sand and gravel.
Izard	2,202	W	Sand and gravel, stone.
Jackson	41	W	Sand and gravel.
Jefferson	317	W	Do.
Johnson	4,931	5,355	Natural gas, coal, stone, clays.
Lafayette	16,368	15,308	Petroleum, natural gas, natural gas liquids, sand and gravel.
Lawrence	859	W	Stone, sand and gravel.
Lincoln	159	W	Sand and gravel.
Little River	W	W	Cement, stone, sand and gravel, clays.
Logan	1,721	W	Natural gas, stone, coal.
Lonoke	W	W	Clays, sand and gravel.
Madison	1	1	Sand and gravel.
Marion	115	W	Do.
Miller	W	13,927	Petroleum, sand and gravel, natural gas, clays.
Mississippi	6	7	Sand and gravel.
Monroe	(2)	--	
Montgomery	W	W	Stone.
Nevada	W	W	Petroleum, sand and gravel.
Newton	W	2	Sand and gravel.
Ouachita	8,323	8,580	Petroleum, sand and gravel, natural gas, clays.
Perry	147	20	Stone.
Phillips	75	W	Sand and gravel.
Pike	W	W	Gypsum, sand and gravel, stone, tripoli, mercury.
Poinsett	449	341	Sand and gravel.
Polk	W	W	Sand and gravel, stone.
Pope	W	2,089	Stone, natural gas, sand and gravel.
Prairie	27	--	
Pulaski	9,047	18,588	Stone, bauxite, clays, sand and gravel.
Randolph	W	32	Stone, sand and gravel.
St. Francis	W	W	Sand and gravel.
Saline	27,869	26,202	Bauxite, lime, stone, sand and gravel, clays, talc.
Scott	83	W	Natural gas.
Searcy	8	65	Stone, sand and gravel.
Sebastian	4,923	5,328	Natural gas, stone, coal, sand and gravel, clays.
Sevier	W	61	Sand and gravel.
Sharp	10	11	Do.
Stone	1	17	Stone, sand and gravel.
Union	29,476	30,597	Bromine, petroleum, sand and gravel, natural gas, clays.
Van Buren	W	W	Stone.
Washington	W	W	Stone, sand and gravel, natural gas.
White	1,046	W	Stone, sand and gravel.
Woodruff	W	3	Sand and gravel.
Yell	28	11	Natural gas.
Undistributed[3]	58,743	66,954	
Total[4]	225,625	253,219	

W Withheld to avoid disclosing individual company confidential data.
[1] Lee County is not listed because no production was reported in 1970 or 1971.
[2] Less than ½ unit.
[3] Includes mineral production that cannot be assigned to specific counties and values indicated by symbol W.
[4] Data may not add to totals shown because of independent rounding.

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TABLE A-9. PRINCIPAL MINERAL PRODUCERS IN ARKANSAS

Commodity and company	Address	Type of activity	County
Abrasives:			
Arkansas Oilstone Co., Inc.	P.O. Box 1426 Hot Springs, Ark. 71901	Mine and plant	Garland.
Norton Pike Division, Norton Co.	Littleton, N. H. 03561	Mine	Do.
Hiram A. Smith Whetstone Co.	11 Snider St. Hot Springs, Ark. 71901	do	Do.
Barite:			
Dresser Minerals	P.O. Box 6504 Houston, Tex. 77005	Mine and plant	Hot Spring.
N L Industries, Inc.	P.O. Box 1675 Houston, Tex. 77001	do	Do.
Bauxite:			
Aluminum Co. of America	1036 Alcoa Bldg. Pittsburgh, Pa. 15219	Mine	Saline.
American Cyanamid Co.	Berdan Avenue Wayne, N.J. 07470	Mine and plant	Pulaski and Saline.
A.P. Green Refractories Co.	Mexico, Mo. 65265	Mine	Saline.
Reynolds Mining Corp.	P.O. Box 398 Bauxite, Ark. 72011	do	Do.
Bromine:			
Arkansas Chemicals, Inc.	Route 6, Box 98 El Dorado, Ark. 71730	Brine wells and plant.	Union.
Bromet Co.	P.O. Box B Magnolia, Ark. 71753	do	Columbia.
The Dow Chemical Co.	Midland, Mich. 48640	do	Do.
Great Lakes Chemical Corp.	P.O. Box 2200, West Lafayette, Ind. 47901	do	Union.
Michigan Chemical Corp.	351 East Ohio St. Chicago, Ill. 60611	do	Do.
Carbon black:			
Cities Service Co., Columbian Division.	60 Wall St. New York, N.Y. 10005	Furnace	Do.
Cement:			
Arkansas Cement Corp.	P.O. Box 398 Foreman, Ark. 71836	Plant and quarry	Little River.
Ideal Cement Co., Div. of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	do	Howard.
Clays:			
Acme Brick Co.	P.O. Box 425 Fort Worth, Tex. 76101	Mine and plant	Hot Spring and Sebastian.
Arkansas Cement Corp.	P.O. Box 398 Foreman, Ark. 71836	do	Little River.
Arkansas Lightweight Aggregate Corp.	P.O. Box 99 England, Ark. 72046	do	Crittenden and Lonoke.
W.S. Dickey Clay Manufacturing Co.	P.O. Box 13125 Kansas City, Mo. 64199	do	Miller and Polk.
Eureka Brick & Tile Co.	Clarksville, Ark. 72830	do	Johnson.
A. P. Green Refractories Co.	Mexico, Mo. 65265	do	Pulaski and Saline.
Coal:			
Dixie Construction Co.	P.O. Box 477 Fort Smith, Ark. 72901	Strip mine	Johnson.
Excelsior Valley Coal Co.	Midland, Ark. 72945	do	Sebastian.
Garland Coal & Mining Co.	P.O. Box 186 Fort Smith, Ark. 72901	do	Franklin and Johnson.
Johnson Coal Co., Inc.	P.O. Box 508 Clarksville, Ark. 72830	Underground mine.	Johnson.
Prairie Coal Co., Inc.	415 Grandview Clarksville, Ark. 72830	do	Do.
Gypsum:			
Dulin Bauxite Co., Inc.	835 Valley Hot Springs, Ark. 71901	Mine and plant	Pike.
Weyerhaeuser Co.	810 Whittington Avenue Hot Springs, Ark. 71901	do	Howard.
Lime:			
Aluminum Co. of America	1501 Alcoa Bldg. Pittsburgh, Pa. 15219	Plant	Saline.
Rangaire Corp., Batesville White Lime Division.	P.O. Box 1311 Batesville, Ark. 72501	do	Independence.
Reynolds Metals Co.	6603 W. Broad Street Richmond, Va. 23226	do	Saline.
Roofing granules:			
Bird and Son, Inc.	East Walpole, Mass. 02032	do	Montgomery.
Minnesota Mng & Mfg Co.	3 M Center (220-13W) St. Paul, Minn. 55101	do	Pulaski.
Sand and gravel:			
Arkansas Rock & Gravel Co.	P.O. Box "I" Murfreesboro, Ark. 71958	Stationary	Pike.
Arkhola Sand & Gravel Co.	323 Merchants Bank Bldg. Fort Smith, Ark. 72901	do	Crawford.
Belvedere Sand & Gravel Co.	P.O. Box 243 Benton, Ark. 72015	do	Saline.

Principal producers—Continued

Commodity and company	Address	Type of activity	County
Sand and gravel—Continued			
Braswell Sand and Gravel Co., Inc.	P.O. Box 798 Minden, La. 71055	Stationary	Little River.
Gifford-Hill & Co., Inc.	P.O. Box 47127 Dallas, Tex. 75247	do	Lafayette and Miller.
Jeffrey Sand Co.	P.O. Box 5054, North Little Rock, Ark. 72114	do	Pulaski.
Malvern Gravel Co.	P.O. Box 337 Malvern, Ark. 72104	do	Hot Spring.
Mobley Construction Co., Inc.	P.O. Box 109 Morrilton, Ark. 72110	Portable	Jackson and Pope.
St. Francis Material Co.	P.O. Box 999 Forrest City, Ark. 72335	Stationary	Ashley, Calhoun, Craighead, Poinsett, St. Francis.
Silica Products Co., Inc.	P.O. Box 248 Guion, Ark. 72540	do	Izard.
Stone:			
Arkansas Cement Corp.	P.O. Box 398 Foreman, Ark. 71836	Quarry	Little River.
Arkhola Sand & Gravel Co.	323 Merchants Bank Bldg. Fort Smith, Ark. 72901	do	Crawford.
Ben M. Hogan Co., Inc.	P.O. Box 2860 Little Rock, Ark. 72203	do	Franklin, Lawrence, Lonoke, Pope, White.
Ideal Cement Co., Div. of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	do	Howard.
Jeffrey Stone Co., Inc.	P.O. Box 165, North Little Rock, Ark. 72114	do	Pulaski.
McClinton Brothers Co.	P.O. Box 790 Fayetteville, Ark. 72701	do	Madison and Washington.
McGeorge Contracting Co.	P. O. Box 7008 Pine Bluff, Ark. 71601	do	Pulaski and Van Buren.
Minnesota Mng & Mfg Co.	3 M Center 220 13W St. Paul, Minn. 55101	do	Pulaski.
Missouri City Stone Co.	1961 N. Industrial Blvd. Dallas, Tex. 75207	do	Perry.
Rangaire Corp.	P. O. Box 1311 Batesville, Ark. 72501	do	Independence and Izard.
Talc and soapstone:			
The Milwhite Co., Inc.	P.O. Box 15038 Houston, Tex. 77020	Mine and plant	Saline.
Tripoli:			
Hercules Minerals Corp.	114 National Old Line Bldg. Little Rock, Ark. 72201	Mine	Pike.
Malvern Minerals Co.	P.O. Box 1246 Hot Springs, Ark. 71901	do	Garland.
Vermiculite:			
W. R. Grace and Co.	62 Whittemore Avenue Cambridge, Mass. 02140	Exfoliating	Pulaski.
Natural gas liquids:			
Arkla Chemical Corp.	Magnolia, Ark. 71753	Plant	Columbia.
Austral Oil Co., Inc.	Stamps, Ark. 71860	do	Lafayette.
Phillips Petroleum Co.	do	do	Do.
Sun Oil Co., DX Division	do	do	Do.
Petroleum:			
American Oil Co.	El Dorado, Ark. 71730	Refinery	Union.
Berry Petroleum Co., Div. Crystal Oil Co.	Magnolia, Ark. 71753	2 Refineries	Nevada and Ouachita.
Cross Oil & Refinery Co. of Arkansas, Div. C. J. Wood Petroleum Co.	Smackover, Ark. 71762	Refinery	Union.
Lion Oil, Div. Monsanto Co.	El Dorado, Ark. 71730	do	Do.
Macmillan Ring-Free Oil Co., Inc.	Norphlet, Ark. 71759	do	Do.
Vanadium:			
Union Carbide Corp.	Route 2, Box 563 Hot Springs, Ark. 71901	Mine	Garland.

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California

Large areas of the state of California contain favorable geologic conditions for the formation of asbestiform minerals. Figure A-8 the geographic distribution of these areas. In the western part of the state, along the Sierra Nevada range, there are extensive areas of igneous intrusive rocks. Along the boundaries of the igneous rock are associated metamorphic rocks or rocks which have been altered by hydrothermal activity. The result has been the formation of asbestiform minerals. Similar areas are shown for other parts of southern California. Certain areas of the state are characterized by scattered occurrences of intrusive igneous rocks. Such an area is shown in the southern portion of the state. Along the coastal range is another elongate area of scattered intrusives which includes ultramafic bodies. These bodies characteristically alter to fibrous serpentine.

Localities in California with reported occurrences of asbestiform minerals are indicated in Figure A-9. Table A-10 gives, by county, a brief description of the asbestos occurrences, references, and the coordinates of the sites. Mining activity in each of the counties is given in Table A-11. The great majority of the individual mines or quarries in the suspect counties have no published descriptions of the minerology and the presence of asbestos can only be inferred from the presence of igneous or metamorphic rocks or from recorded occurrences in the area.

Four mines on which published literature was available are indicated on Figure A-9. These mines serve as examples of asbestos occurrences in nonasbestos mines. A description of each of the mines follows.

Mountain Pass District, San Bernardino County. The rare-earth deposits here are in Precambriam metamorphic and igneous rocks. Included in the country rock are gneisses, schists, migmatites, amphibolites, and pegmatites. The ore mineral bastnasite occurs within igneous rocks that cut metamorphic rock as numerous dikes. The common gangue minerals are calcite, dolomite, ankerite, and siderite, while a minor phase is the amphibole crocidolite. The Mountain Pass Mine is operated by the Molybdenum Corporation of America. Mining is by open-pit, with mill feed capacity 1,200 tons per day. The mine is in a sparsely populated area in the north-east portion of the county.

New Idria Mine, San Benito County. This is a hydrothermal deposit of cinnabar, pyrite, and marcasite occurring in country rock of sandstone, shale, greywacke, and serpentinites. Presumably chrysotile is present in the serpentinite and occurs in the gangue. The mine is open-pit and underground and is operated by the New Idria Mining and Chemical Company. Concentrator feed capacity is 350 tons per day. The only population center nearby is the mining town of Idria.

Bishop Tungsten District, Inyo County. In this deposit tightly folded metasedimentary and metavolcanic rocks are enclosed by intrusive igneous rocks. Along the contact of the granitic intrusive with calcareous metasedimentary (marble) rock a scheelite bearing ore deposit was formed. The Pine Creek Mine, operated by the Union Carbide Corporation, is an underground mine located along this contact. A breccia zone also exists near the contact and contains, among other phases, actinolite. The breccia must often be removed in order to mine the tungsten ore and consequently contributes actinolite to the gangue. The town of Bishop is the closest population center.

New Almaden District, Santa Clara County. This deposit was formed in silicate-carbonate by the hydrothermal alteration of serpentine which had intruded sedimentary rocks. The principal ore mineral cinnabar was deposited along fractures in the serpentine. It is expected that the mined ore will have a high content of serpentine gangue, presumably containing chrysotile.

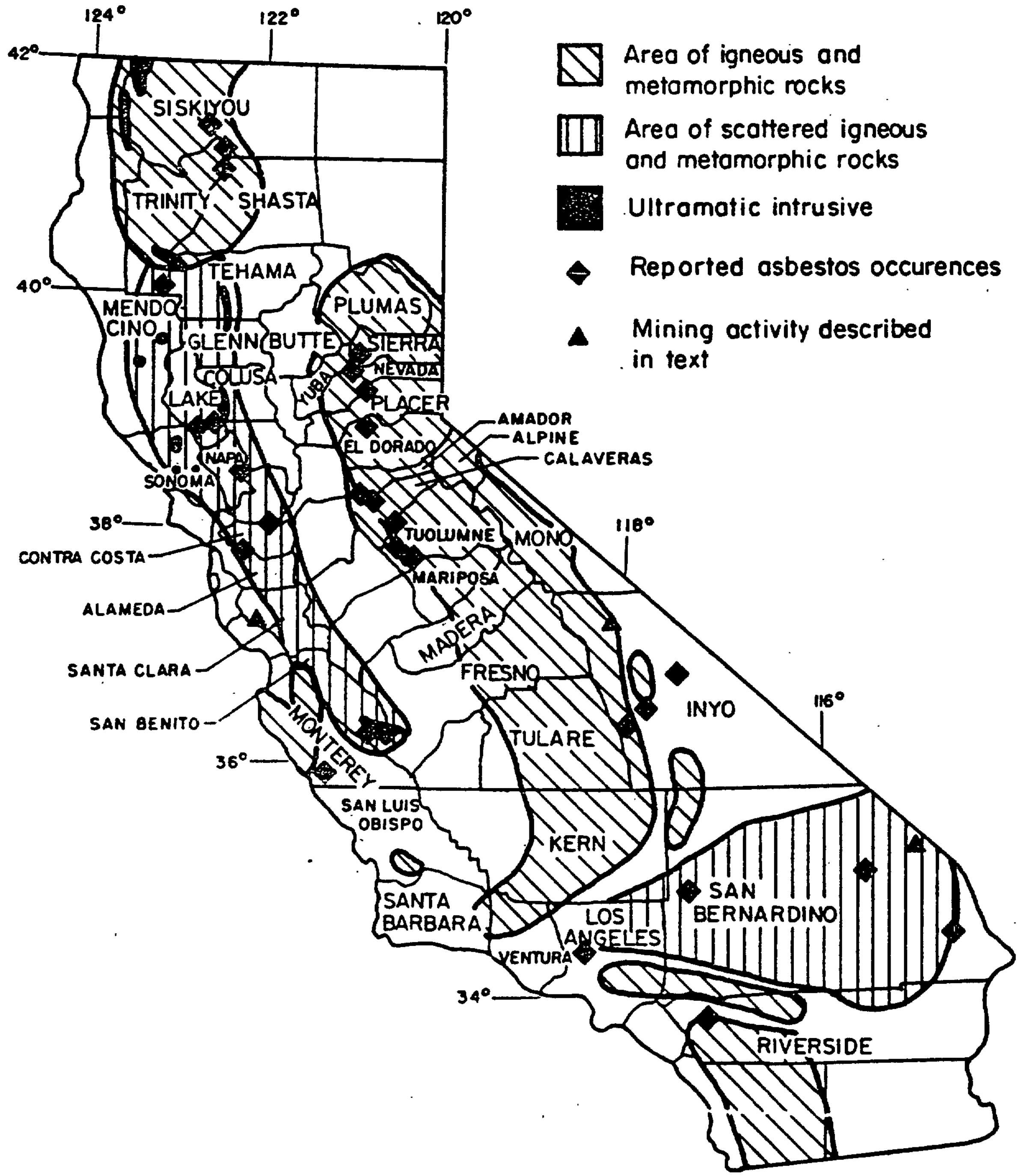

FIGURE A-9. MAP SHOWING AREAS OF CALIFORNIA WHICH HAVE FAVORABLE GEOLOGIC CONDITIONS FOR THE FORMATION OF ASBESTIFORM MINERALS

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TABLE A-10. ASBESTOS OCCURRENCES IN CALIFORNIA

Siskiyou County		
Asbestos of unknown variety. Averill, 1935.	41°55'	123°09'
Asbestos of unknown variety. Wiebelt and Smith, 1959.	41°44'	122°44'
Brittle chrysotile asbestos in serpentine. Wiebelt and Smith, 1959.	41°29'	122°34'
Chrysotile asbestos.	41°25'	122°29'
Narrow veins of chrysotile asbestos in serpentine. Wiebelt and Smith, 1959.	41°24'	122°27'
Chrysotile asbestos in peridotite. Wiebelt and Smith, 1959.	41°19'	122°28'
Type of asbestos is unknown. Averill, 1935.	41°19'	122°29'
Chrysotile asbestos in serpentine. Wiebelt and Smith, 1959.	41°17'	122°26'
Chrysotile asbestos in serpentine. Wiebelt and Smith, 1959.	41°15'	122°52'
Shasta County		
Chrysotile-bearing rock with minor amounts of amphibole asbestos in serpentine. Wiebelt and Smith, 1959.	41°06'	122°26'
Tremolite asbestos in serpentine. Wiebelt and Smith, 1959; Rice, 1957.	41°06'	122°23'
Chrysotile asbestos. Averill, 1939.	41°05'	122°30'
Chrysotile asbestos in serpentine and peridotite. Wiebelt and Smith, 1959.	41°03'	122°28'
Trinity County		
General Reference: Wiebelt and Smith, 1959		
Weathered amphibole asbestos.	41°10'	122°30'
Chrysotile asbestos in serpentine.	41°06'	122°28'
Anthophyllite asbestos in serpentine.	41°05'	122°43'
Chrysotile asbestos in serpentine.	40°03'	123°13'
Lake County		
All deposits are chrysotile asbestos in serpentine		
General Reference: Brice, 1953		
Wiebelt and Smith, 1959.	38°51'	122°40'
	38°55'	122°30'

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TABLE A-10. (continued)

Napa County		
Short-fiber chrysotile asbestos in serpentine. Wiebelt and Smith, 1959.	$38^\circ 29'$	$122^\circ 11'$
Contra Costa County		
Asbestos of unknown variety in serpentine. Wiebelt and Smith, 1959.	$37^\circ 57'$	$121^\circ 49'$
Alameda County		
Short-fiber asbestos of unknown variety in serpentine. Wiebelt and Smith, 1959.	$37^\circ 48'$	$122^\circ 09'$
Plumas County		
Amphibole asbestos. Logan, 1943.	$40^\circ 00'$	$121^\circ 09'$
Amphibole asbestos in sheared "greenstone".	$39^\circ 52'$	$120^\circ 46'$
Sierra County		
Slip-fiber amphibole asbestos in schist and serpentine		
General Reference: Wiebelt and Smith, 1959		
	$39^\circ 39'$	$120^\circ 40'$
	$39^\circ 33'$	$120^\circ 54'$
	$39^\circ 33'$	$120^\circ 38'$
Nevada County		
Cross-fiber chrysotile in ultrabasic intrusion of Jurassic age. Wiebelt and Smith, 1959.	$39^\circ 22'$	$120^\circ 49'$
Logan, 1941.	$39^\circ 09'$	$120^\circ 58'$
Yuba County		
General Reference: O'Brien, 1952		
Very small seams of asbestos of unknown variety in serpentine.	$39^\circ 33'$	$121^\circ 08'$
Small seams of asbestos of unknown variety along a serpentine-slate contact.	$39^\circ 31'$	$121^\circ 13'$
Small seams of asbestos of unknown variety in serpentine.	$39^\circ 28'$	$121^\circ 03'$
Placer County		
Chrysotile asbestos. Logan, 1927.	$39^\circ 17'$	$120^\circ 35'$
Short-fiber chrysotile asbestos in serpentine. Logan, 1927.	$39^\circ 14'$	$120^\circ 48'$
Anthophyllite in serpentine. Wiebelt and Smith, 1959.	$39^\circ 12'$	$120^\circ 47'$

TABLE A-10. (continued)

White slip-fiber tremolite. Wiebelt and Smith, 1959.	39°06'	120°51'
El Dorado County		
Asbestos of unknown variety. Clark and Carlson, 1956; Wiebelt and Smith, 1959.	38°56'	120°55'
Chrysotile (?) asbestos. Clark and Carlson, 1956; Wiebelt and Smith, 1959.	38°52'	120°49'
Amador County		
Deposits are the amphibole asbestos type		
General Reference: Wiebelt and Smith, 1959		
	38°22'	120°54'
	38°20'	120°45'
Calaveras County		
Veinlets of chrysotile asbestos associated with a chromite deposit in a schistose serpentinized saxonite. Cater, 1948.	38°14'	120°48'
Asbestos occurrence of unknown variety. Wiebelt and Smith, 1959.	38°13'	120°41'
Chrysotile asbestos veinlets in serpentine. Wiebelt and Smith, 1959.	38°14'	120°30'
Veins and veinlets of slip-fiber tremolite or actinolite. Wiebelt and Smith, 1959.	38°08'	120°30'
Short-fiber chrysotile asbestos. Wiebelt and Smith, 1959.	38°01'	120°38'
Cross-fiber chrysotile in serpentinized saxonite. Wiebelt and Smith, 1959.	37°56'	120°33'
Tuolumne County		
Chrysotile asbestos seams in serpentine		
General Reference: Wiebelt and Smith, 1959		
	37°57'	120°27'
	37°47'	120°17'
Madera County		
Amphibole asbestos. Logan, 1950.	37°19'	119°45'
Fresno County		
Short-fiber asbestos of unknown variety. Logan and others, 1951.	36°16'	120°34'

TABLE A-10 (continued)

San Benito County		
All deposits are chrysotile asbestos in sheared serpentine		
Laizure, 1926.	36°22'	120°46'
Averill, 1947.	36°20'	120°43'
California Department of Natural Resources, Division of Mines, 1957.	36°21'	120°36'
Monterey County		
Chrysotile asbestos veins in serpentine. Laizure, 1925.	35°52'	121°17'
Inyo County		
Amphibole asbestos. Norman and Stewart, 1951.	36°49'	117°27'
Cross-fiber chrysotile asbestos veins in serpentinized limestone. Bowles, 1955; Rice, 1957.	36°37'	117°31'
Slip-fiber tremolite in a fault zone in limestone and dolomite. Norman and Stewart, 1951.	36°31'	117°55'
Kern County		
Chrysotile asbestos in serpentine. Tucker, 1929.	35°20'	118°09'
Amphibole asbestos in serpentine. Tucker, 1929; Tucker and others, 1949.	34°49'	119°09'
Los Angeles County		
Short-fiber chrysotile asbestos along a shear zone in chloritized shale. Gay and Hoffman, 1954.	34°20'	118°27'
San Bernardino County		
Amphibole and chrysotile (?) asbestos in dolomitic limestone. Tucker and Sampson, 1931.	35°07'	116°00'
Cross- and slip-fiber tremolite asbestos in quartz schist. Bowen, 1954.	34°49'	117°15'
Riverside County		
General Reference: Tucker and Sampson, 1945		
Amphibole asbestos in a shear zone in granite.	33°46'	117°16'
Veins of slip-fiber tremolite in schist.	33°37'	116°29'
Narrow seams of amphibole asbestos.	33°36'	116°26'
Amphibole asbestos in belt of serpentine schist.	33°36'	116°29'

TABLE A-11. MINING ACTIVITY IN CALIFORNIA

County	Minerals produced in 1971 in order of value
Alameda	Sand and gravel, salt, stone, clays, petroleum.
Alpine	Silver, gold, stone, copper, lead, zinc, sand and gravel.
Amador	Sand and gravel, stone, clays, coal.
Butte	Natural gas, sand and gravel.
Calaveras	Cement, asbestos, stone, sand and gravel, clays.
Colusa	Natural gas, sand and gravel, stone, mercury.
Contra Costa	Stone, natural gas, petroleum, lime, sand and gravel, clays, peat, mercury.
Del Norte	Sand and gravel, clays, stone.
El Dorado	Stone, lime, sand and gravel, talc.
Fresno	Petroleum, sand and gravel, natural gas, asbestos, natural gas liquids, stone, gold, tungsten, clays, silver.
Glenn	Natural gas, sand and gravel, lime, stone.
Humboldt	Sand and gravel, natural gas, stone.
Imperial	Sand and gravel, gypsum, lime, clays, stone.
Inyo	Tungsten, talc, zinc, molybdenum, silver, stone, lead, sand and gravel, copper, boron compounds, perlite, clays, gold.
Kern	Petroleum, boron compounds, natural gas, cement, natural gas liquids, sand and gravel, stone, gypsum, sodium sulfate, clays, salt, carbon dioxide, pumice, tungsten.
Kings	Natural gas, natural gas liquids, petroleum, sand and gravel.
Lake	Sand and gravel, pumice, mercury, stone.
Lassen	Pumice, sand and gravel, stone.
Los Angeles	Petroleum, sand and gravel, natural gas, natural gas liquids, stone, clays, lime, zinc, copper.
Madera	Natural gas, sand and gravel, stone, clays, pumice.
Marin	Stone, clays, mercury.
Mariposa	Sand and gravel, stone.
Mendocino	Stone, sand and gravel.
Merced	Sand and gravel, stone, mercury, gold.
Modoc	Sand and gravel, stone, pumice.
Mono	Sand and gravel, pumice, clays, talc, gold.
Monterey	Petroleum, magnesium compounds, stone, lime, sand and gravel, feldspar, natural gas.
Napa	Salt, stone, mercury, clays, diatomite, sand and gravel, pumice.
Nevada	Sand and gravel, stone.
Orange	Petroleum, sand and gravel, natural gas, natural gas liquids, clays, lime, peat.
Placer	Sand and gravel, clays, stone, gold.
Plumas	Sand and gravel, stone, gold.
Riverside	Iron ore, cement, sand and gravel, stone, clays, petroleum, natural gas.
Sacramento	Natural gas, sand and gravel, petroleum, stone, gold, clays, silver.
San Benito	Cement, stone, asbestos, mercury, sand and gravel, petroleum, clays, natural gas.
San Bernardino	Cement, boron compounds, stone, sand and gravel, potassium salts, sodium carbonate, sodium sulfate, rare-earth minerals, salt, petroleum, clays, lime, calcium-magnesium chloride, talc, iron ore, bromine, lithium minerals, natural gas, tungsten, pumice, gypsum, silver, gold, copper.
San Diego	Sand and gravel, stone, salt, magnesium compounds, clays, lead, gold, silver, copper, zinc.
San Francisco	Sand and gravel
San Joaquin	Natural gas, sand and gravel, lime, stone, gold, silver.
San Luis Obispo	Petroleum, stone, natural gas, sand and gravel, mercury, gypsum, clays.
San Mateo	Salt, magnesium compounds, cement, stone, sand and gravel, petroleum, natural gas
Santa Barbara	Petroleum, diatomite, natural gas, natural gas liquids, sand and gravel, lime, mercury, stone.
Santa Clara	Cement, stone, sand and gravel, mercury.
Santa Cruz	Cement, stone, sand and gravel, clays
Shasta	Cement, sand and gravel, stone, pumice, clays, barite, gold, silver.
Sierra	Sand and gravel, gold.
Siskiyou	Pumice, sand and gravel, stone.
Solano	Natural gas, petroleum, stone, sand and gravel.
Sonoma	Sand and gravel, mercury, stone, clays, natural gas.
Stanislaus	Sand and gravel, clays, gold, silver, stone.
Sutter	Natural gas, sand and gravel, clays.
Tehama	Natural gas, sand and gravel, stone, pumice
Trinity	Stone, sand and gravel, mercury, gold.
Tulare	Sand and gravel, lime, natural gas, stone, petroleum, clays.
Tuolumne	Stone, sand and gravel.
Ventura	Petroleum, natural gas, natural gas liquids, sand and gravel, stone, clays.
Yolo	Sand and gravel, natural gas, lime, petroleum.
Yuba	Sand and gravel, stone, clays.
Undistributed[1]	

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[1] Includes Federal offshore petroleum and natural gas, copper, gem stones, mercury, sand and gravel, and tungsten that cannot be assigned to specific counties, and values indicated by symbol W.

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Colorado

The state of Colorado has fairly extensive regions of igneous and metamorphic which are likely sources of asbestiform minerals. These regions are shown in Figure A-10. The state is divided geologically by the Rocky Mountains into three parts. The eastern part, in the Great Plains province, is characterized geologically be relatively undisturbed, flat-lying sedimentary rocks. Here the conditions are unfavorable for the formation of asbestiform mineral phases. The middle part of the state, the mountain province has igneous, metamorphic, and sedimentary rock divided into many complex structural units. The western portion of the state, in the Plateau province, is characterized by relatively undisturbed sedimentary rocks into which are stream-cut valleys and canyons.

The eastern and western parts of the state generally possess geologic conditions unfavorable to the formation of asbestiform mineral phases and need not be dealt with further in the present study. The middle portion of the state, however, has geologic conditions favorable to the formation of asbestiform mineral phases and may provide sources of fugitive asbestos emissions. Within this area are intrusive granitic rocks of both Precombrian and Genogoic age and associated metamorphic rocks. Counties of prime interest are Routt, Jackson, Larimer, Grand, Boulder, Gilpin, Clear Creek, Jefferson, Summit, Eagle, Pitkin, Lake, Park, Douglas, Feller, Colorado Springs, Fremont, Chaffee, Gunnison, Sagusche, Custer, Pueblo, Huerfano, Costilla, Las Animos, Moffat, Hinsdal, San Juan, and La Plato.

Despite the widespread area of favorable geologic conditions, no specific mention of asbestiform mineral occurrences in mining sites has been found for the state in the general literature. Some of the mine sites investigated are indicated in Figure A-10. Mining districts investigated include the Climax molybdenum deposit in Lake County, the Gilman District zinc deposits in Eagle County, the Leadville Districts gold-silver-copper-lead-zinc mines in Lake County, and the deposits of

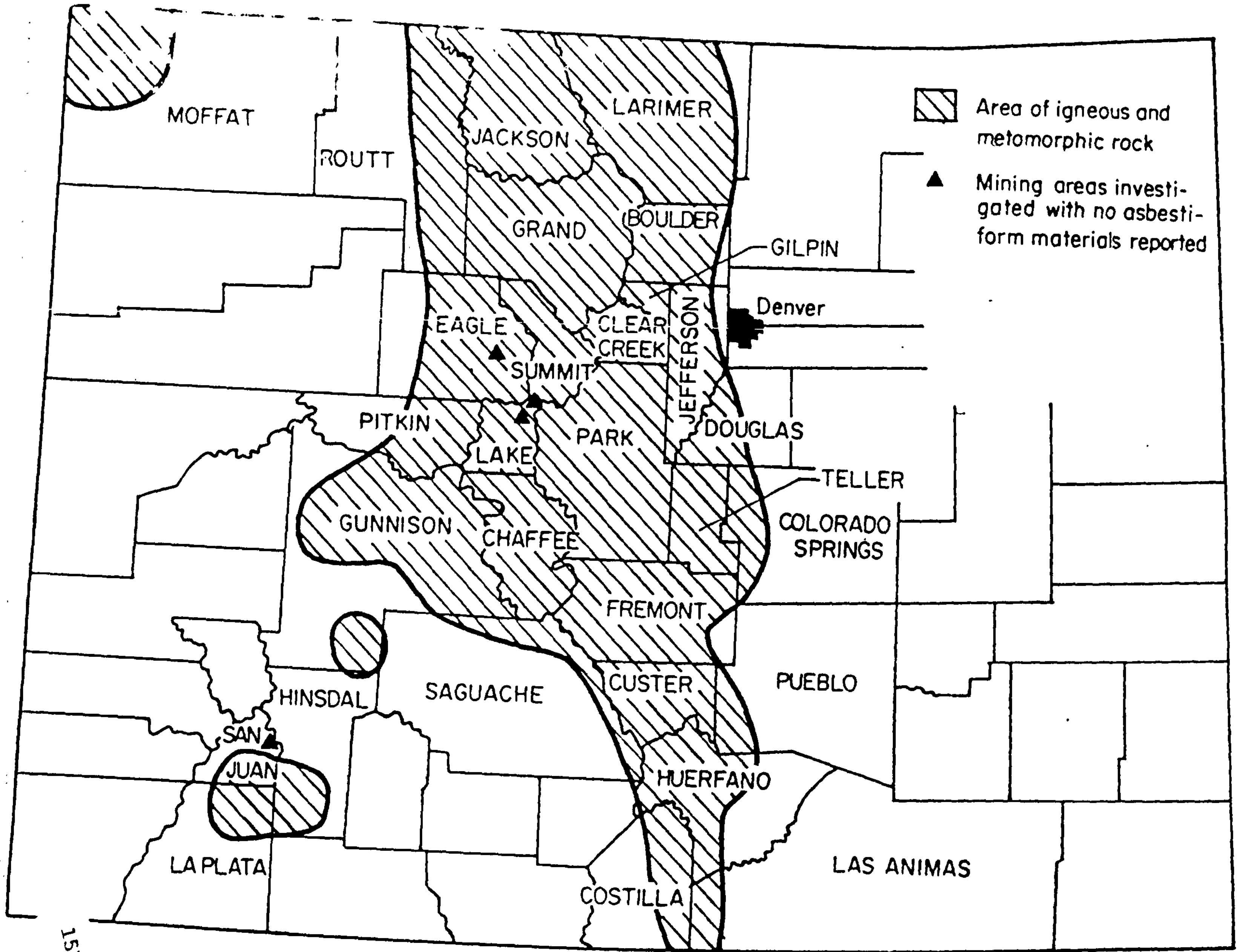

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FIGURE A-10. OCCURRENCE OF IGNEOUS AND METAMORPHIC ROCK IN COLORADO silver-copper-lead-zinc in the San Juan Mountains of San Juan and Hinsdal Counties. Though no specific mention of abestiform minerals was found in the literature searched, given the regional geology, there is little doubt of their existence in the central Colorado area.

From the population map in Figure A-10, it is seen that the area of interest is one of relatively low population density. Mining activity in this area is given in Table A-12.

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TABLE A-12. Value of mineral production in Colorado, by county
(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Adams	$7,819	$8,986	Petroleum, sand and gravel, natural gas, lime, gold, stone, lead, copper, silver, zinc.
Alamosa	W	W	Sand and gravel, stone, peat.
Arapahoe	8,798	14,178	Petroleum, sand and gravel, natural gas liquids, natural gas, stone.
Archuleta	W	W	Petroleum, sand and gravel, natural gas, stone.
Baca	1,401	1,238	Natural gas, sand and gravel, petroleum.
Bent	W	27	Sand and gravel, natural gas, petroleum, clays.
Boulder	8,592	14,739	Cement, sand and gravel, fluorspar, stone, lime, clays, peat, gold, petroleum, silver, copper.
Chaffee	W	W	Stone, sand and gravel, peat.
Cheyenne	1,954	1,380	Petroleum, sand and gravel, stone, natural gas.
Clear Creek	W	W	Molybdenum, sand and gravel, stone, mica.
Conejos	65	W	Sand and gravel, silver, gold.
Costilla	W	W	Pumice.
Crowley	W	67	Sand and gravel.
Custer	93	78	Perlite, sand and gravel, stone, clays.
Delta	5,028	4,962	Coal, sand and gravel, lime.
Denver	W	220	Sand and gravel.
Dolores	1,838	681	Zinc, lead, silver, copper, sand and gravel, stone, gold, natural gas, petroleum.
Douglas	755	2,094	Sand and gravel, stone, clays.
Eagle	11,257	11,918	Zinc, lead, silver, sand and gravel, gold, copper, pumice, stone.
Elbert	102	374	Petroleum, sand and gravel, clays, natural gas.
El Paso	2,159	4,076	Sand and gravel, stone, clays.
Fremont	12,187	14,933	Cement, stone, coal, gypsum, sand and gravel, clays, petroleum, uranium, beryllium, feldspar.
Garfield	8,400	2,779	Vanadium, sand and gravel, natural gas, pumice, stone, coal.
Gilpin	W	20	Peat, stone, silver, lead, gold, copper.
Grand	W	W	Sand and gravel, stone.
Gunnison	6,471	7,166	Coal, sand and gravel, silver, lead.
Hinsdale	60	W	Stone.
Huerfano	199	W	Coal, sand and gravel, stone.
Jackson	W	W	Fluorspar, natural gas, petroleum, sand and gravel, stone.
Jefferson	W	9,735	Uranium, sand and gravel, clays, stone, gold, silver.
Kiowa	8,713	4,546	Petroleum, natural gas, sand and gravel.
Kit Carson	W	W	Sand and gravel, petroleum.
Lake	109,820	87,174	Molybdenum, tungsten, zinc, lead, gold, silver, sand and gravel, tin, copper, pyrites, stone.
La Plata	7,515	7,103	Natural gas, natural gas liquids, sand and gravel, petroleum, coal, stone.
Larimer	8,397	9,996	Cement, stone, sand and gravel, petroleum, lime, gypsum, natural gas, natural gas liquids, mica.
Las Animas	6,186	5,410	Coal, sand and gravel, clays, stone.
Lincoln	W	40	Sand and gravel.
Logan	W	5,958	Petroleum, natural gas, natural gas liquids, sand and gravel, lime.
Mesa	W	5,907	Vanadium, uranium, sand and gravel, natural gas, natural gas liquids, coal, stone.
Mineral	W	W	Silver, zinc, lead, copper, sand and gravel, gold.
Moffat	9,822	9,190	Natural gas, petroleum, natural gas liquids, coal, sand and gravel.
Montezuma	1,081	1,372	Petroleum, sand and gravel, natural gas, carbon dioxide, stone.
Montrose	r 13,506	12,022	Vanadium, uranium, coal, sand and gravel, salt, stone.
Morgan	W	4,825	Natural gas liquids, petroleum, natural gas, lime, sand and gravel.
Otero	879	W	Lime, sand and gravel.
Ouray	W	W	Zinc, lead, copper, silver, gold, sand and gravel.
Park	163	118	Sand and gravel, peat, stone, gold.
Phillips	W	--	
Pitkin	W	W	Coal, iron ore, sand and gravel, natural gas.
Prowers	W	W	Sand and gravel, petroleum, stone.
Pueblo	32,314	33,189	Sand and gravel, lime, clays, stone.
Rio Blanco	41,254	46,843	Petroleum, natural gas, natural gas liquids, stone.
Rio Grande	W	W	Copper, sand and gravel, gold, silver, stone.
Routt	7,823	7,335	Coal, sand and gravel, petroleum, pumice, natural gas.
Saguache	57	54	Sand and gravel, stone, pumice.
San Juan	W	4,890	Zinc, lead, gold, copper, silver, natural gas, sand and gravel.
San Miguel	18,518	20,096	Vanadium, uranium, zinc, copper, lead, silver, gold, sand and gravel, natural gas, petroleum, stone.
Sedgwick	725	W	Sand and gravel, lime, stone.
Summit	855	W	Sand and gravel, zinc, lead, silver, gold.
Teller	347	248	Natural gas, peat, sand and gravel, stone.
Washington	W	12,013	Petroleum, natural gas, sand and gravel, stone.
Weld	8,295	6,817	Petroleum, coal, sand and gravel, lime, stone.
Yuma	W	W	Sand and gravel, stone.
Undistributed[1]	82,935	37,423	
Total[2]	r 389,824	392,724	

r Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes gem stones, some stone and sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

15196719

Connecticut

The occurrence of metamorphic rocks in Connecticut is extensive except in the Connecticut River Valley in the central part of the state. As can be seen in the map, Figure A-11, metamorphic rocks appear in all eight counties of the state. Many of the formations are metamorphosed basic volcanics and associated products. The metamorphic rocks in the western zone include genisses, schists, phyllites, quartzites, and marbles having local concentrations of tremolite. The metamorphic rocks in the east consist mainly of gneisses and schists. Deposits of asbestiform minerals and soapstone are present in Litchfield and New Haven counties. The geographical locations of these deposits are shown in Figure A-11 and locations and descriptions are tabulated in Table A-13.

The current mining and quarrying activities in the state by county are summarized in Table A-14. Asbestiform mineral occurrences have not been reported from these operations.

TABLE A-13. ASBESTOS DEPOSITS IN CONNECTICUT

Litchfield County		
(1) Satan's Kingdom Deposit. A large vein of pyrophyllite.	41°51'	72°59'
New Haven County		
(2) Maltby Lakes. Slip- and cross-fiber chrysotile in serpentinite.	41°18'	72°59'
Soapstone Deposits		
Litchfield County		
(1) Torrington-New Hartford area. Soapstone probably related to serpentinite. Rice and Gregory, 1906.	41°51'	73°02'
New Haven County		
(2) Maltby Lakes. Soapstone associated with serpentinite.	41°18'	72°58'

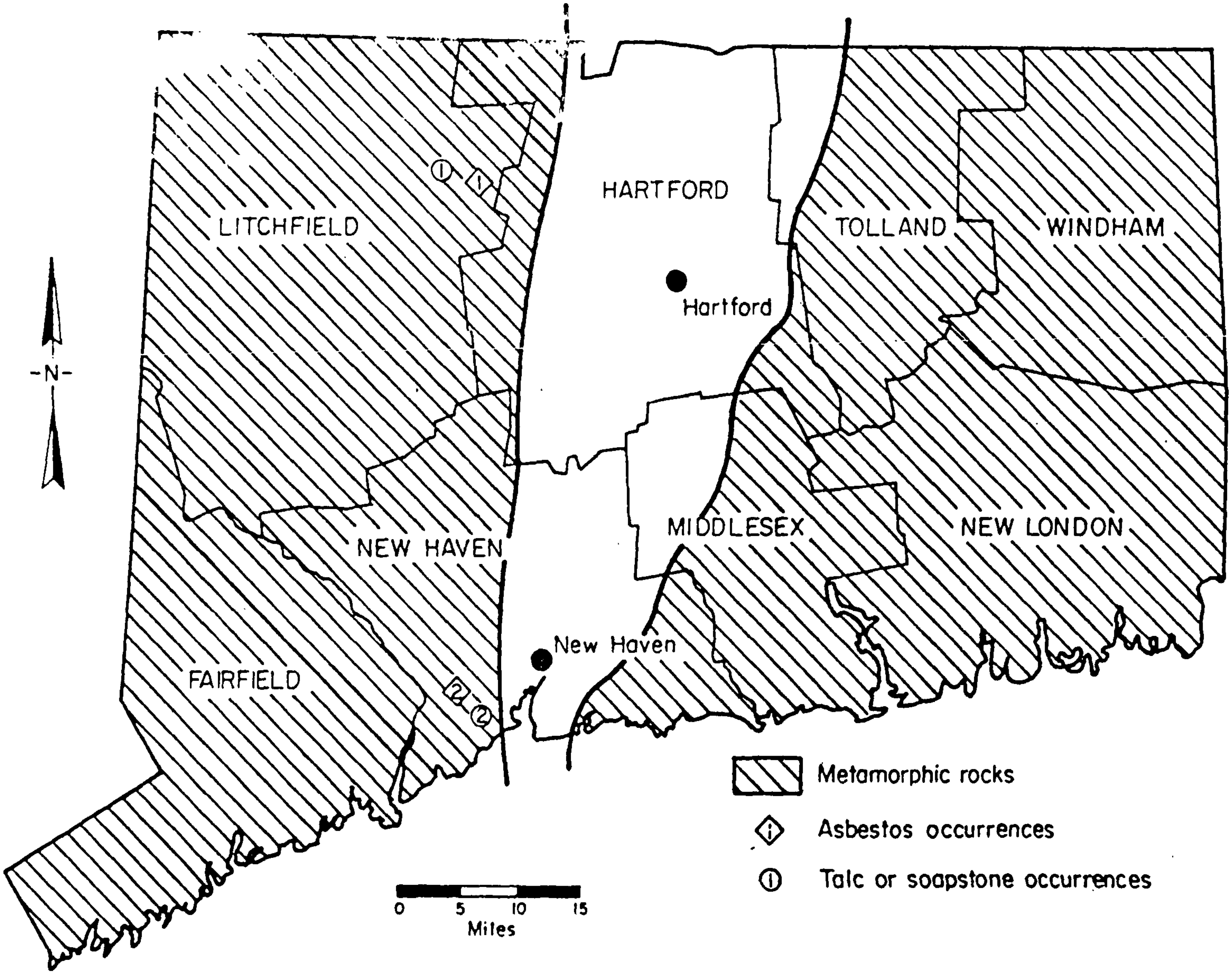

FIGURE A-11. OCCURRENCE OF METAMORPHIC ROCKS IN CONNECTICUT

TABLE A-14. MINERAL ACTIVITY IN CONNECTICUT

County	Commodity
Fairfield	Sand and gravel
Hartford	Clay Sand and gravel Crushed and dimension stone
Litchfield	Sand and gravel Crushed stone
Middlesex	Clay Feldspar Sand and gravel
New Haven	Clay Sand and gravel Crushed and dimension stone
New London	Sand and gravel Crushed quartzite
Tolland	None
Windham	Sand and gravel Crushed and dimension stone

Source References

(1) Metamorphic Map of the Appalachians
Benjamin A. Morgan, 1972
U.S.G.S. Map I-724.

(2) Asbestos in the United States
A. H. Chidester and A. F. Shride, 1962
U.S.G.S. Map MR-17.

(3) Talc and Soapstone in the United States
A. H. Chidester and H. W. Worthington, 1962
U.S.G.S. Map MR-31.

(55) Geological Map of Connecticut
J. Rodgers, et al, 1956
Connecticut Geological and Natural History Survey.

(56) Mineral Deposits and Occurrences in Connecticut Exclusive of Clay, Sand and Gravel, and Peat
N. C. Pearre, 1957
U.S.G.S. Map MR-7.

(57) The Mineral Industry of Connecticut
R. A. Clifton, 1971
U. S. Bur. Mines Minerals Yearbook.

Delaware

The band of metamorphic rocks that are a prominent geologic feature of mid-state Maryland extend into the northernmost part of Delaware (Newcastle County) as shown in Figure A-12. Within the metamorphic rock area of Newcastle County there are gneisses, gabbro, granite, amphibolite, schists, marble, and a small body of serpentine. These rocks are believed to be of Paleoyoic age. The balance of the formations in Delaware appear to be Cretaceous and younger.

There are no current mining activities in Delaware. The quarrying operations include: in Newcastle County, clay is produced by the Delaware Brick Company and seven companies recover sand and gravel. There have not been any asbestiform minerals reported in the production of these commodities. A county by county tabulation of the mineral production is given in Table A-15.

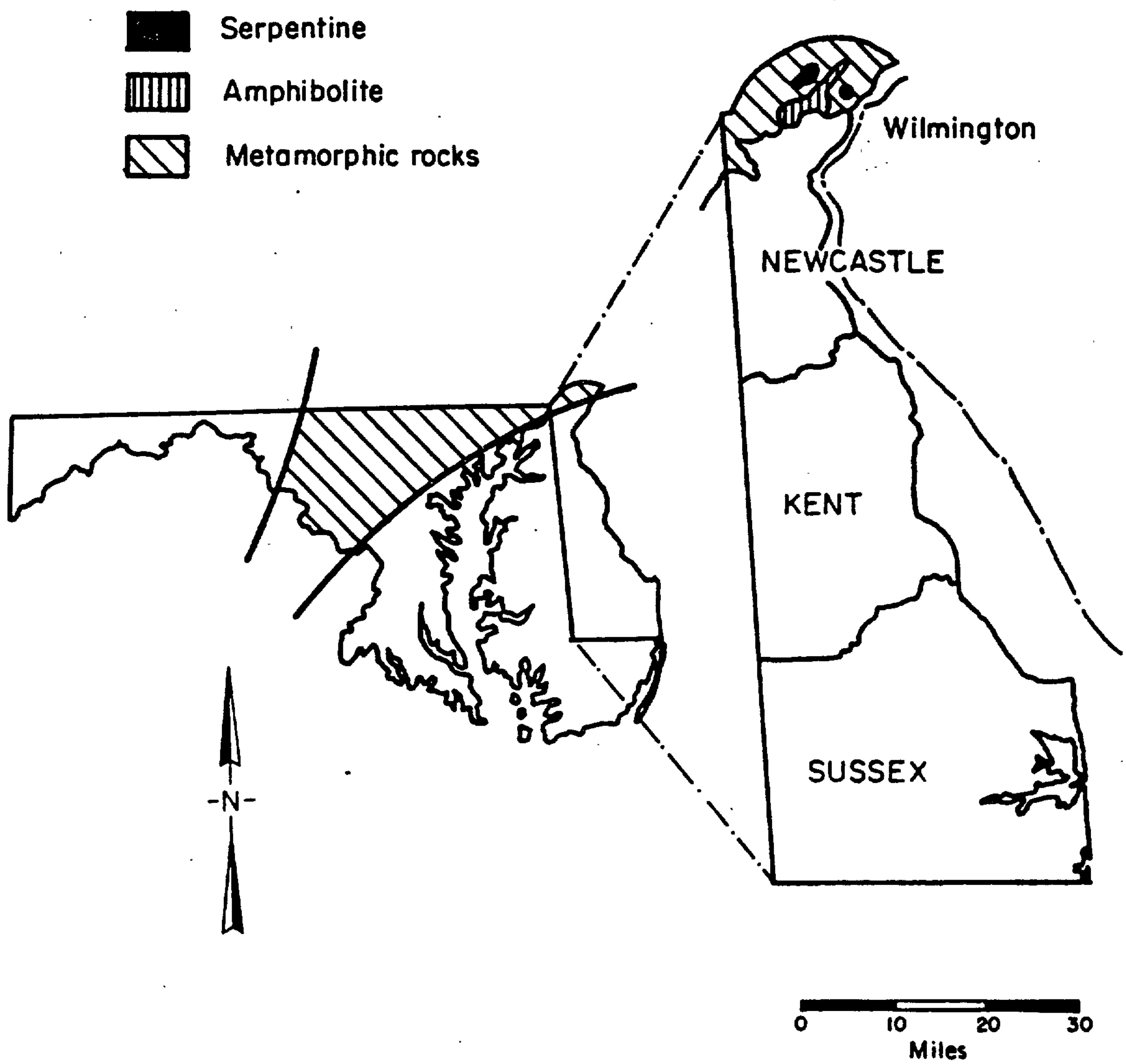

FIGURE A-12. OCCURRENCE OF METAMORPHIC ROCK IN DELAWARE

TABLE A-15. PRINCIPAL MINERAL PRODUCERS IN DELAWARE

Commodity and company	Address	Type of activity	County
Clay:			
Delaware Brick Co.	River Rd. New Castle, Del. 19720	Pit	New Castle.
Gypsum, calcined:			
Georgia-Pacific Corp.	P.O. Box 311 Portland, Oreg. 97207	Plant	Do.
Sand and gravel:			
Barber Sand and Gravel	R.F.D. 1 Harrington, Del. 19952	Pit	Kent.
Clough & Caulk Sand & Gravel.	Route 1, Box 129 Wyoming, Del. 19934	Pit	Do.
Delaware Sand & Gravel	R.D. 2, Box 286 New Castle, Del. 19720	Pit	New Castle.
George Nashold, Inc.	Box 286 Frederica, Del. 19946	Pit	Kent.
Material Transit, Inc.	Box 210 924 South Herald St. Wilmington, Del. 19800	Pit	New Castle.
Parkway Gravel, Inc.	4048 New Castle Ave. New Castle, Del. 19720	Pit	Do.
Petrillo Brothers, Inc.	Box 426 Wilmington, Del. 19809	Pit	Do.
St. Jones River Gravel Co.	Box 426 Dover, Del. 19901	Pit	Do.
Swain Construction Co	Lincoln, Del. 19960	Pit	Sussex.
Whittington's Sand & Gravel Co.	U.S. Route 40 Bear, Del. 19701	Pit	New Castle.
Woodlawn Gravel Co.	Box 2561 Wilmington, Del. 19805	Pit	Do.

Source References

(1) Metamorphic Map of the Appalachians
Benjamin A. Morgan, 1972
USGS Map I-724.

(58) Generalized Geologic Map of Delaware
N. Spoljaric and R. R. Jordan, 1966
Delaware Geological Survey, Wilmington, Delaware.

(59) The Mineral Industry of Delaware
R. T. MacMillan, 1971
U. S. Bur. Mines Minerals Yearbook.

Florida

The mineral production in Florida is not large but it is varied as indicated by the description of the county by county production given in Table A-16. The notable commodities are zirconium and titanium concentrates produced from beach sands, phosphate rock, stone, sand, and gravel, and fossil fuels. There are no activities in rocks where fibrous amphibole minerals might occur.

TABLE A-16. **Value of mineral production in Florida, by county**[1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Alachua	$1,835	$1,596	Stone.
Bay	W	94	Sand and gravel.
Bradford	--	W	Natural gas liquids.
Brevard	W	W	Stone, sand and gravel.
Broward	11,930	13,627	Stone, zirconium concentrates, sand and gravel.
Calhoun	4	W	Sand and gravel.
Charlotte	W	W	Sand and gravel, stone.
Citrus	1,941	2,274	Stone, clays, phosphate rock.
Clay	W	W	Ilmenite, sand and gravel, staurolite, clays, kyanite.
Collier	W	W	Petroleum, stone, natural gas.
Dade	35,184	55,022	Cement, stone, sand and gravel.
Duval	W	--	
Escambia	W	W	Sand and gravel, clays.
Franklin	W	4	Peat, sand and gravel.
Gadsden	W	11,803	Clays.
Gilchrist	W	W	Phosphate rock.
Glades	W	--	
Gulf	W	W	Magnesium compounds, lime.
Hamilton	W	W	Phosphate rock.
Hendry	W	W	Petroleum, sand and gravel, natural gas.
Hernando	W	W	Stone, lime.
Hillsborough	20,041	W	Cement, stone, sand and gravel, peat.
Jackson	W	W	Stone, sand and gravel.
Lake	1,437	1,600	Sand and gravel.
Lee	W	W	Stone, petroleum, natural gas.
Leon	W	409	Sand and gravel.
Levy	W	W	Stone.
Manatee	W	--	
Marion	2,562	2,634	Stone, clays, sand and gravel, phosphate rock.
Monroe	616	W	Stone.
Okaloosa	W	W	Sand and gravel.
Orange	W	W	Sand and gravel, peat.
Palm Beach	W	1,038	Stone, sand and gravel.
Pinellas	W	W	Do.
Polk	140,598	150,725	Phosphate rock, sand and gravel, peat.
Putnam	W	W	Sand and gravel, clays, peat.
Santa Rosa	W	[2] W	Petroleum, natural gas.
St. Lucie	2,444	1,589	Sand and gravel, stone, peat.
Sumter	W	W	Stone, lime, peat.
Suwannee	W	W	Stone.
Taylor	W	W	Do.
Volusia	W	--	
Walton	W	W	Sand and gravel.
Undistributed [3]	81,953	101,815	
Total [4]	300,042	343,731	

W Withheld to avoid disclosing individual company confidential data, included with "Undistributed."

[1] The following counties are not listed because no production was reported: Baker, Columbia, DeSoto, Dixie, Flagler, Hardee, Highlands, Holmes, Indian River, Jefferson, Lafayette, Liberty, Madison, Martin, Nassau, Okeechobee, Osceola, Pasco, St. John's, Sarasota, Seminole, Union, Wakulla, and Washington.

[2] Includes value of petroleum and natural gas from Escambia County.

[3] Includes value of natural gas (1970), natural gas liquids (1970), and counties indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

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Georgia

The metamorphosed region of northern Georgia is very extensive as indicated on Figure A-13 which also identifies the counties of primary interest. The counties of interest were identified from the Georgia State Mineral Resource Map and the Mining Directory. The commodities produced in the counties of primary interest are summarized in the tabulation. There is no current asbestos mining in the state of Georgia although in the past there were such activities in the counties of White (Number 10 on Figure A-13), Habersham (11), Rabun (5), Barrow (24), and Meriwether (31). Currently there is no mineral extraction operations in White, Habersham, or Meriwether counties. Sand and gravel are dredged in Barrow County by the Collins Sand Company (Route 3, Monroe, Georgia 30655). A porphyritic granite gneiss is crushed to sand and aggregate for use in portland and asphalt cement sand and gravel are produced for road construction by the Rabun Quarries, Inc. (Rabun Gap, Georgia 30568) in Rabun County. While there are dunite deposits and fibrous mineral occurrences in Rabun County there are no reports of current commercial extraction of these materials.

The northern counties of Georgia, in addition to Rabun County, are Murray, Fannin, Union, and Towns Counties, the geologic features of which may be characterized by the widespread occurrence of highly altered rock bodies. There are found talc mines and a mill in Murray County, for example, which are operated by the Southern Talc Company (P.O. Box F, Chatsworth, Georgia 30705). These are located in and around Chatsworth, Georgia (population approximately 2000), where the mineral products are ground for use in paint, crayons, rubber, roofing, insecticides, asphalt, lubricants, and dusting agents. Since in the northern counties, the talc deposits commonly contain other alteration minerals, (e.g., anthophyllite), it is likely that the mining operations of Murray County encounter considerable fibrous minerals in their production of talc. The crushed rock (quartz and quartzite) producer in Fannin County, Stone Products Corporation (P.O. Box 8, Blue Ridge, Georgia 30513), and the crushed granite (biotite gneiss) producer in

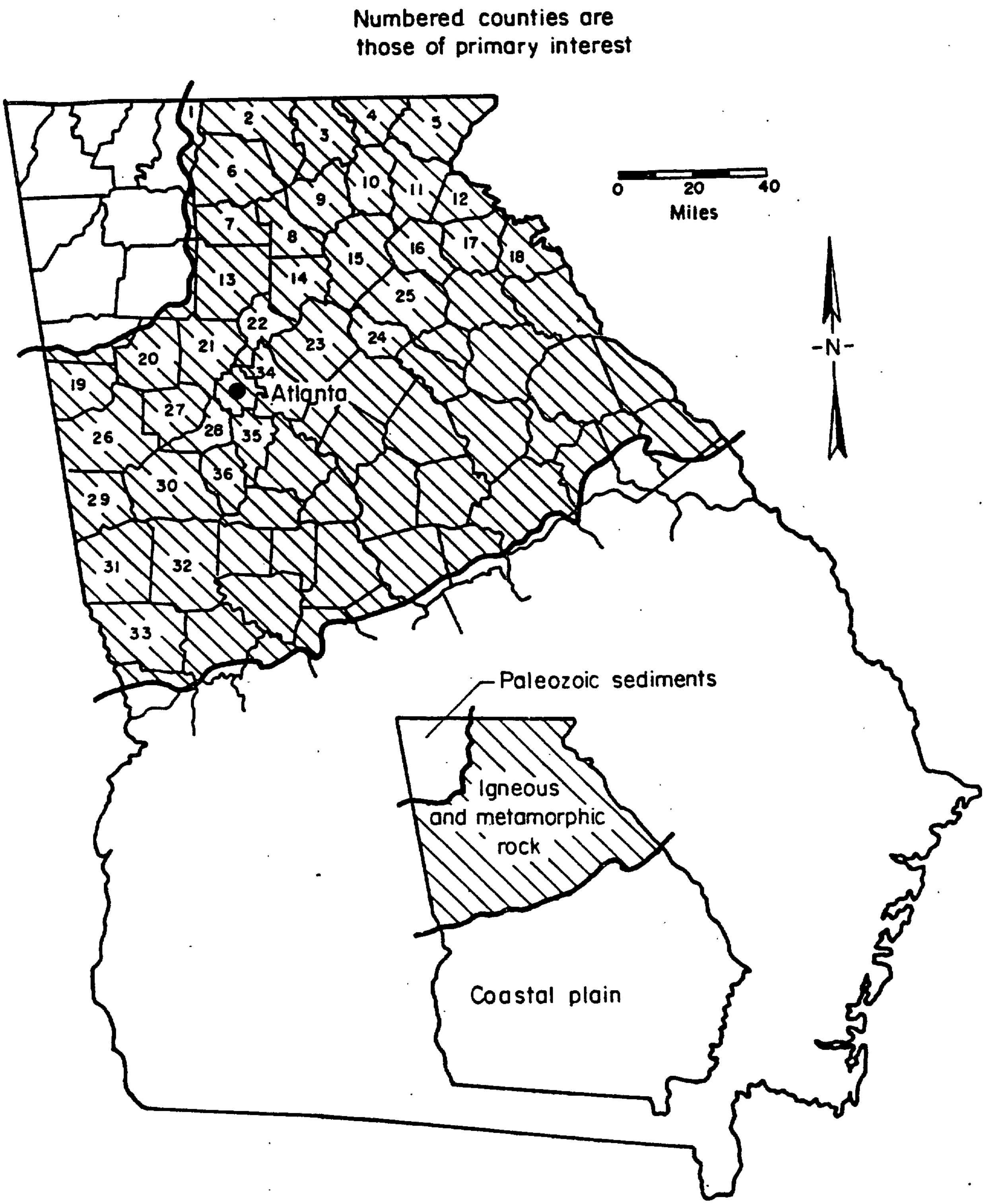

FIGURE A-13. OCCURRENCE OF IGNEOUS AND METAMPHORIC ROCK IN GEORGIA

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Union County, Colwell Construction Company (P.O. Box 6, Blairsville, Georgia 30512), might encounter fibrous minerals in their operations also. In fact, all of the operations listed in the previous tabulation, would possibly encounter fibrous minerals in their activities since the prevalence of altered metamorphic rocks in northern Georgia is widespread. The occurrence of asbestos, talc, and soapstone deposits as described in the USGS Mineral Resources Maps (MR-17 and MR-31) are given in Tables A-17, A-18, and A-19.

TABLE A-17. COUNTIES OF NORTHERN GEORGIA OF PRIMARY INTEREST

County	Commodity
Murray	Talc[a]
Fannin	Crushed Marble, Quartz, Quartznite, Chert
Union	Crushed Granite[b]
Towns	No Current Mining Activity[b,c]
Rabun	Crushed Granite[b,d]
Gilmer	Crushed Marble
Pickens	Flagstone, Crushed and Dimension Marble
Dawson	No Current Mining Activity
Lumpkin	No Current Mining Activity
White	No Current Mining Activity(e)
Habersham	No Current Mining Activity[e]
Stephens	Crushed Granite
Cherokee	Talc[f]
Forsyth	Crushed Granite, Sand
Hall	Crushed Granite, Crushed Marble
Banks	Crushed Granite
Franklin	No Current Mining Activity
Hart	Mica
Haralson	No Current Mining Activity
Paulding	No Current Mining Activity
Cobb	Crushed Granite
Fulton	Crushed and Dimension Granite, Sand, Clays
Gwinnett	Crushed Granite
Barrow	Gravel, Sand(e)
Jackson	Sand
Carroll	No Current Mining Activity
Douglas	Crushed Granite, Gravel, Sand, Clays
Heard	No Current Mining Activity
Coweta	No Current Mining Activity
Troup	No Current Mining Activity
Meriwether	No Current Mining Activity[e]
Harris	No Current Mining Activity
DeKalb	Crushed and Dimension Granite, Sand
Clayton	Crushed Granite
Fayette	Crushed Granite

(a) Four active mines.

(b) These northernmost counties of Georgia are in the Forsterite Olivine deposits belt which is located chiefly in Western North Carolina.

(c) Towns county has the Buck Creek Dunite deposite. Some of the dunite is altered to chlorite, serpentinized dunite, and talcy vermiculite.

(d) Rabun County has Ellijoy, Burton Lake, and Laurel Creek Olivine and Dunite deposits. Alteration minerals are common. The Burton Lake deposit has been prospected for slip fiber asbestos. The Laurel Creek deposit contains up to 20 percent talc and anthophyllite and other alteration minerals are common.

15196731

(e) Counties where asbestos mining has previously been accomplished.

TABLE A-18. THE OCCURRENCE OF ASBESTOS IN GEORGIA

Locality	N. Lat.	W. Long.
Rabun County		
1. Pine Mountain area (Laurel Creek, Hicks and Pig Pen Mountain). Long-fiber anthophyllite asbestos associated with peridotite (dunite). Hunter, 1941.	34°57'	83°11'
2. Mill Creek area. Anthophyllite asbestos in harzburgite.	34°59'	83°18'
3. Dillard area prospects. Amphibole asbestos in serpentinized dunite.	34°59'	83°25'
4. Andrew Gennett property. Mass-fiber amphibole asbestos.	34°53'	83°20'
5. Burton mine. Chrysotile asbestos in peridotite. Bowles, 1955.	34°51'	83°35'
Habersham County		
6. Mack Mountain deposit. Anthophyllite asbestos associated with talcose and chloritic schist. Bowles, 1955.	34°45'	83°36'
7. Hollywood mine. Mass-fiber anthophyllite asbestos associated with peridotite and pyroxenite. Bowles, 1955; Reifsneider, 1925.	34°39'	83°27'
8. Sautee Creek (Berrong). Mass-fiber amphibole asbestos associated with massive serpentine rock.	34°42'	83°38'
White County		
9. Sall Mountain-Calhoun mines. Mass-fiber anthophyllite asbestos in biotite-granite gneiss. Bowles, 1955.	39°40'	83°41'
10. Cleveland mine. Talcose asbestos near contact of granite gneiss with schists and hornblende gneiss. Bowles, 1955.	34°37'	83°45'
Barrow County		
11. Arnold mine. Cross- and mass-fiber amphibole asbestos. Bowles, 1955.	33°58'	83°35'
Coweta County		
12. Moreland area. Cross-fiber amphibole asbestos associated with biotite granite and hornblende gneiss. Bowles, 1955.	33°17'	84°46'
Meriwether County		
13. Luthersville (Camp property). Cross- and slip-fiber amphibole asbestos in talcose rock associated with granite or granite gneiss. Bowles, 1955.	33°12'	84°45'
Troup County		
14. Bryan property near West Point. Cross-fiber amphibole asbestos veins in talcose rock probably derived from peridotite. Bowles, 1955.	32°53'	84°55'

(Localities by North Latitude and West Longitude)

TABLE A-19. THE OCCURENCE OF TALC AND SOAPSTONE IN GEORGIA

1. Sweetgun area, J. L. Grey, and unnamed prospects.	34°58′	84°12′
2. Mineral Bluff area (John Harper, J. B. Dickey, and W. T. S. and G. M. Dickey mines and prospect).	34°54′	84°15′
3. Blue Ridge area, J. W. Wishon property.	34°50′	84°21′
Chatsworth district. Deposits consist of talc-carbonate and talc rock probably altered from dolomitic portions of the Cohutta Schist but possibly derived from ultramafic igneous rocks. Furcron and Teague, 1947; Hopkins, 1914.		
4. Fort Mountain, Mill Creek, Earnest, and Lindsay mines.	34°47′	84°42′
5. Southern, Cohutta, and Latch mines; Fields, Hammock, and Russell prospects.	34°46′	84°43′
6. Old Cohutta, Judge's Pit, Georgia, and Bramlet mines; Bramlet prospect.	34°44′	84°43′
7. Pickering, Rock Creek Road, and Chicken Creek mines.	34°43′	84°43′
8. Dillards area. Soapstone probably associated with ultramafic igneous rocks. Hopkins, 1914.	34°57′	83°26′
9. Mack and Wolfpit Mountains. Soapstone and talc rock probably associated with ultramafic igneous rocks. Hopkins, 1914.	34°46′	83°37′
10. Cleveland. Soapstone probably associated with ultramafic igneous rocks. Hopkins, 1914.	34°37′	83°45′
11. Cornelia. Anthophyllite probably derived from mafic igneous rocks, but parent rock unknown. Hopkins, 1914.	34°33′	83°33′
12. Soapstone Ridge. Anthophyllite probably derived from mafic igneous rocks, parent rock unknown.	34°26′	83°52′
13. Dahlonega area. Soapstone probably associated with mafic igneous rocks. Hopkins, 1914.	34°33′	83°56′
Elberton area, near Bethlehem Church. Soapstone probably associated with mafic or ultramafic igneous rocks. Hopkins, 1914.	34°03′	82°42′
Center. Soapstone probably associated with mafic or ultramafic igneous rocks. Hopkins, 1914.	34°05′	83°24′
Ballground. Talc rock associated with Murphy marble. Hopkins, 1914.	34°20′	84°25′
Holly Springs. Soapstone probably associated with mafic or ultramafic igneous rocks. Hopkins, 1914.	34°10′	84°31′
18. Dallas area, Harris property. Soapstone probably associated with mafic or ultramafic igneous rock. Hopkins, 1914.	33°59′	84°52′
19. Conley. Soapstone probably associated with mafic or ultramafic igneous rocks. Hopkins, 1914.	33°46′	84°20′
20. Phinizy area, near Appling. Soapstone probably associated with mafic or ultramafic igneous rocks. Hopkins, 1914; LeGrand and Furcron, 1956.	33°38′	82°14′
21. Villa Rica area. Soapstone probably associated with mafic or ultramafic igneous rocks. Hopkins, 1914.	33°44′	84°56′
22. Carrollton area. Soapstone probably associated with mafic or ultramafic igneous rocks. Hopkins, 1914; Maynard and others, 1923.	33°35′	85°04′
23. Centralhatchee Creek. Soapstone probably associated with mafic or ultramafic igneous rocks. Hopkins, 1914 Maynard and others, 1923.	33°24′	85°08′
24. St. Marks. Soapstone probably associated with mafic or ultramafic igneous rocks. Hopkins, 1914.	33°08′	84°50′
25. West Point area. Soapstone probably associated with mafic or ultramafic rocks. Hopkins, 1914.	32°54′	85°10′
26. Chipley area. Soapstone probably associated with mafic and ultramafic igneous rocks. Hopkins, 1914; Maynard and others, 1923.	32°52′	84°52′
27. Mountain Creek area. Soapstone associated with mafic and ultramafic igneous rocks. Hopkins, 1914.	32°48′	84°59′
28. Moore property. Soapstone probably associated with mafic or ultramafic igneous rocks. Hopkins, 1914.	33°41′	84°21′

15196733

Source References

(1) Metamorphic Map of the Appalachians
Benjamin A. Morgan, 1972
USGS Map I-724.

(2) Asbestos in the United States
A. H. Chidester and A. F. Shride, 1962
USGS Map MR-17.

(3) Talc and Soapstone in the United States
A. H. Chidester and H. W. Worthington, 1962
USGS Map MR-31.

(60) Geologic Map of Georgia
J. W. Smith and M. A. Green, 1968
Georgia Department of Mines, Mining, and Geology
Atlanta, Georgia

(62) Forsterite Olivine Deposits of North Carolina and Georgia
Charles E. Hunter, 1941
Bulletin No. 41
North Carolina Division of Mineral Resourch
Raleigh, North Carolina

(63) Mining Directory of Georgia
A. C. Martin and L. P. Stafford, 1972
Circular No. 2
Georgia Department of Natural Resources
Atlanta, Georgia

Hawaii

The Hawaiian Islands are a southeast trending line of islands about 1500 miles long. They are a part of the row of islands known as the Hawaiian Archipelago. Figure A-14 shows the location of the Hawaiian Archipelago. Each island is the summit of a great volcanic mountain rising from the ocean floor, which have been modified by stream and wave erosion. Each island consists of layers of molten rock that has issued at intervals from the interior of the earth and hardened.

The minerals present in the Hawaiian Islands are given in Table A-20. As can be seen, these minerals are igneous in origin. Very minor amounts of metamorphism have occurred in the Hawaiian Island chain. Therefore, the alterations of the sort that are considered metamorphic is very small.

Metamorphism in the broad sense includes alterations brought about by volcanic gases. This type of metamorphism has been noted to occur in the calderas of the East Molokai volcano and Koolau volcano on Oahu. This original pyroxene and olivine has been extensively altered to serpentine and talc. A considerable amount of talc has been found in the muds of Koneohe Bay. These muds were derived from the erosion of Koolau caldera. A map showing the relative of location of these talc deposits is given in Figure A-15. The presence of talc in Koneohe Bay indicates the possible occurrence of fibrous amphiboles.

The mining or quarrying activity is very small in the islands. The mining and quarrying activity is summarized in Table A-21.

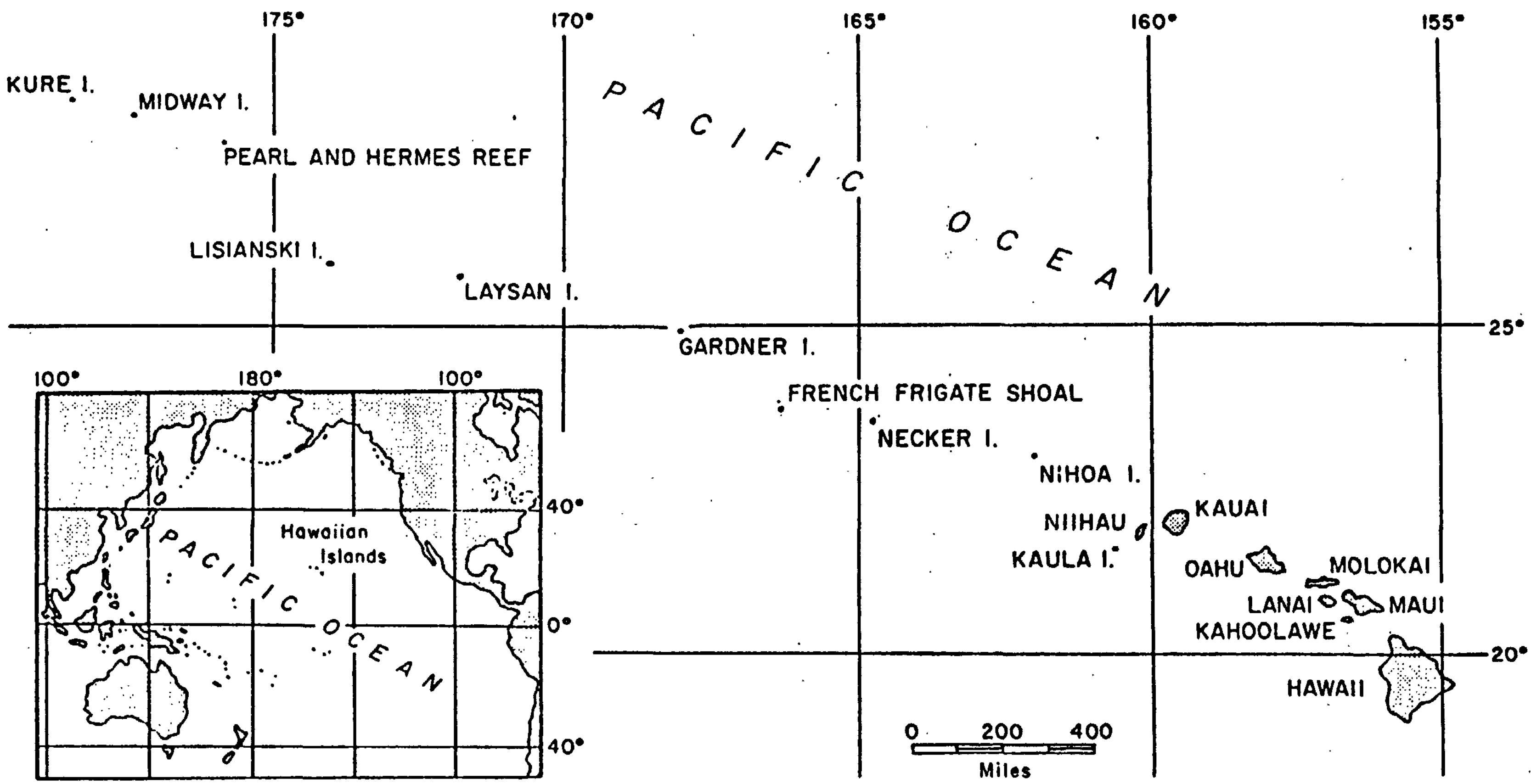

FIGURE A-14. MAP OF THE HAWAIIAN ARCHIPELAGO

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TABLE A-20. HAWAIIAN MINERALS

Quartz		SiO_2
Orthoclase feldspar		$KAlSi_3O_8$
Anorthoclase feldspar		$(K,Na)AlSi_3O_8$
Plagioclase feldspar	Albite	$NaAlSi_3O_8$
	Anorthite	$CaAl_2Si_2O_8$
Nepheline		$NaAlSiO_4$
Calcite		$CaCO_3$
Gypsum		$CaSO_4 \cdot H_2O$
Kaolinite (clay)		$Al_2Si_2O_5(OH)_4$
Gibbsite		$Al_2O_3 \cdot H_2O$
Montmorillonite		$(Al,Mg)_8(Si_4O_{10})_3(OH)_{10} \cdot 12H_2O$
Biotite (black mica)		$H_4K_2(Mg,Fe)_5Al_4Si_5O_{24}$
Olivine		$(Mg,Fe)SiO_4$
Pyroxene	Hypersthene	$(Mg,Fe)SiO_3$
	Pigeonite	$(Mg,Fe)SiO_3$
	Augite	$Ca(Mg,Fe)Si_2O_6 \cdot (Al,Fe)_2O_3$
Magnetite		Fe_3O_4
Hematite		Fe_2O_3
Ilmenite		$FeO \cdot TiO_2$
Melilite		$Ca(Mg,Fe)_2Si_2O_7$
Chlorite		$(Mg,Fe)_5(Al,Fe)_2Si_3O_{10}(OH)_8$
Limonite		$Fe_2O_3 \cdot nH_2O$

Regional Geology: Oahu

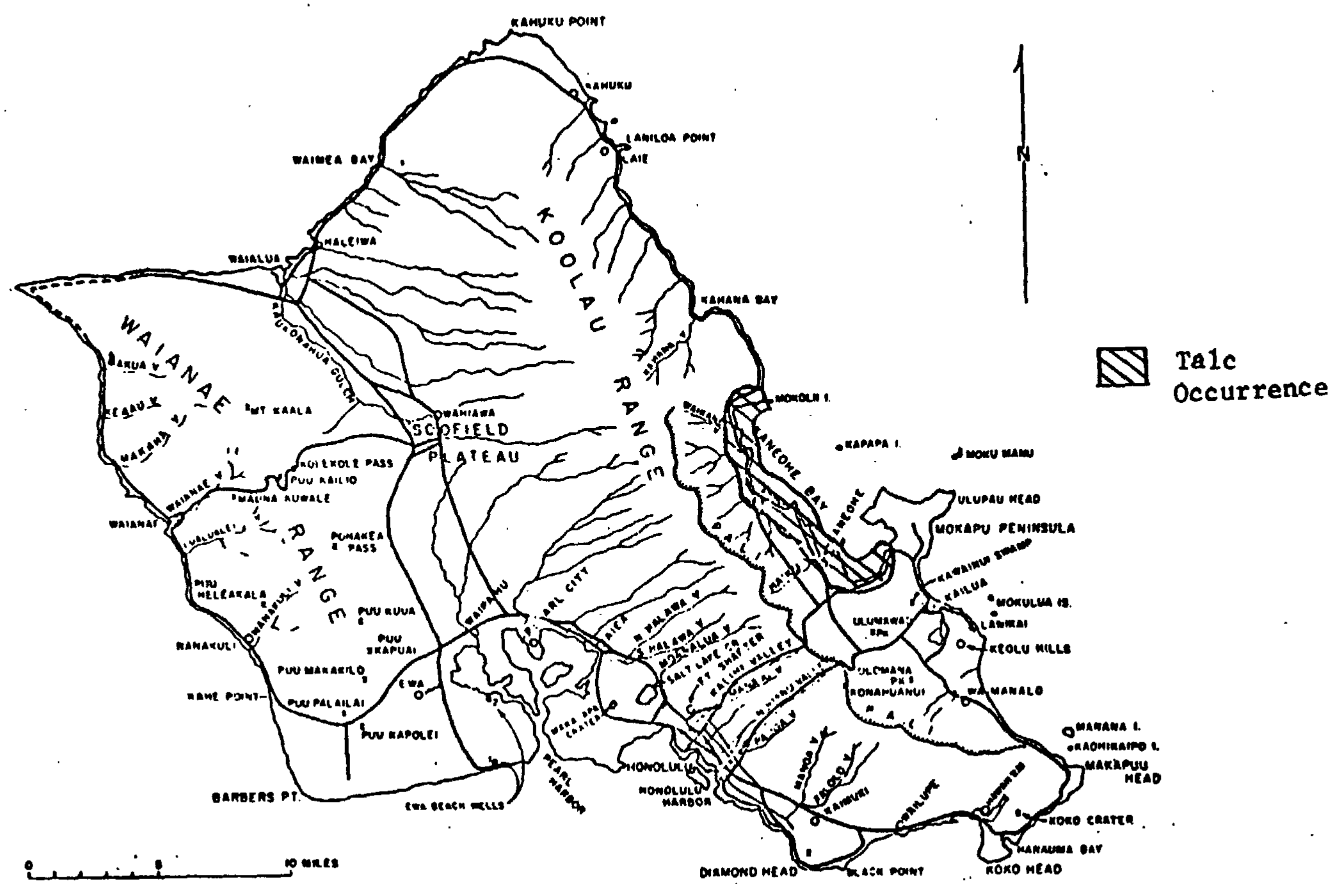

FIGURE A-15. TALC OCCURRENCE ON ISLAND OF OAHU

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TABLE A-21. PRINCIPAL MINERAL PRODUCERS IN HAWAII

Island	Company and Address	Commodity
Oahu	Hawaiian Cement Corp. 1600 Kapiolani Blvd. Suite 1200 Honolulu, Hawaii 96814	Cement
Do.	Kaiser Cement & Gypsum Corp. Permanente Rd. Permanente, Calif. 95014	Cement
Do.	Pacific Clay Corp 547 Halekauwila St. Honolulu, Hawaii 96813	Clay
Do.	GasprO, Ltd. P.O. Box 2454 Honolulu, Hawaii 96804	Lime
Maui.	Hawaiian Commercial & Sugar Co. Ltd. Puunene, Hawaii 96784	Lime
Do.	Fong Construction Co., Ltd 237 Dairy Rd. Kahului, Hawaii 96732	Pumice and volcanic cinder
Molokai	HC&D, Ltd P.O. Box 190 Honolulu, Hawaii 96810	Pumice and volcanic cinder Sand and gravel
Hawaii.	James Kuwana P.O. Box 406 Pahoa, Hawaii 96778	Pumice and volcanic cinder
Do.	Hilo Coast Processing Co Pepeekeo, Hawaii 96783	Pumice and volcanic cinder
Do.	Laupahoehoe Sugar Co Papaaloa, Hawaii 96780	Pumice and volcanic cinder
Do.	Volcanite, Ltd 8282 Fort St. Honolulu, Hawaii 96813	Pumice and volcanic cinder
Oahu	Tanaka Hawaiian Salt 968 D Akepo Lane Honolulu, Hawaii 96817	Salt
Maui	Concrete Industries, Inc P.O. Box 86 Puunene, Hawaii 96784	Sand and gravel
Kauai	Kekaha Sugar Co., Ltd Kekaha, Hawaii 96752	Sand and gravel

TABLE A-21 (continued)

Maui	Maui Concrete & Aggregates, Inc. 8 Central Ave. Wailuku, Hawaii 96793	Sand and gravel
Kauai	Louis K. Rego Trucking Lihue, Hawaii 96766	Sand and gravel
Maui	Concrete Industries, Inc. P.O. Box 86 Puunene, Hawaii 96784	Stone
Hawaii	James W. Glover, Ltd. P.O. Box 275 Hilo, Hawaii 96720	Stone
Kauai	Grove Farm Co., Inc. Puhi Rural Station Puhi, Hawaii 96766	Stone
Oahu	Hawaiian Bitumuls & Paving Co. Ltd P.O. Box 2240 Honolulu, Hawaii 96804	Stone
Do.	Hawaiian Cement Corp 1600 Kapiolani Blvd Suite 1200 Honolulu, Hawaii 96814	Stone
Do.	HC&D, ltd P.O. Box 190 Honolulu, Hawaii 96810	Stone
Do.	Kaiser Cement & Gypsum Corp. Permanente Rd. Permanente, Calif. 95014	Stone
Do.	Lone Star Industries, Pacific Region 400 Alabama St. San Francisco, Calif. 94110	Stone
Molokai Oahu	Pacific Concrete & Rock Co., Ltd. 2344 Pahounui Dr. Honolulu, Hawaii 96819	Stone
Oahu	Vermiculite of Hawaii, Inc. 842-A Mapunapuna St. Honolulu, Hawaii 96819	Vermiculite (exfoliated)

Source Reference

(64) Volcanoes in the Sea; The Geology of Hawaii, G. A. McDonald, and A. T. Abbott, University of Hawaii Press, 441 pages (including Geol. Sketch Maps), Honolulu, 1970.

(65) A Morphological and Mineralogical Study of the Gray Hydromorphic Soils of the Hawaiian Islands, M. S. Hussain and L. D. Swindale, Pac. Sci., vol 24, No. 4, p 543-553, 1970.

(66) Geol. Map Hau Desert Guad, GQ 827.

(67) Interaction Between Geol. and Urbanization in the Hawaiian Islands, D. R. Runyan, et al., Ass. Eng. Geol. Ann. Meet Program Abstr, p 22, 1970.

(68) Crystal Structure of the Island of Hawaii from Seismic Refraction Measurement, D. P. Hill, Seismal. Soc. Amer. Bull., vol 59, No. 1, p 101-102, 1970.

(69) The Mineral Industry of Hawaii, Avery H. Reed, 1972, U.S. Bureau of Mines Minerals Yearbook.

Idaho

Geologically, the state of Idaho includes parts from three distinct physiographic provinces. These are the Northern Rocky Mountain province, the Columbia Intermontane province, and the Basin and Range province. The southeastern part of the state is within the Basin and Range province and with the exception of a few extrusive volcanic flows, is underlain largely with sedimentary rocks. Large basalt flows extend from the southwest corner of the state in Owyhee County to Fremont County in the eastern side of the state. The Northern Rocky Mountain province occupies the central portion of the state and contains a large granitic rock body, the Idaho batholith, which extends northward from Elmore County and reaches as far north as Clearwater County. From Clearwater County to the northern tip of the state there is an area of metamorphic rocks, including argillites, quartzites, gneisses, and schists. The western part of the state is a part of the Columbia Intermontane province and contains volcanic extrusive rocks as well as metamorphic sequence.

From the above discussion and from the map in Figure A-13, it is seen that the majority of the state contains potentially favorable geologic settings for the occurrence of asbestiform mineral phases. Figure A-16 shows the location of known asbestos occurrences in Idaho. Table A-22 gives their precise location and describes briefly the mode of occurrence. The minerology of several mining areas, including the larger mines in the Cocur d'Alene district, was investigated in the literature with no mention of asbestiform mineral phases found. Generally, the literature covered dealt mostly with ore minerals and stru:tural features, rather than with gangue components.

Mining activity in the state of Idaho is presented in Table A-23 by county.

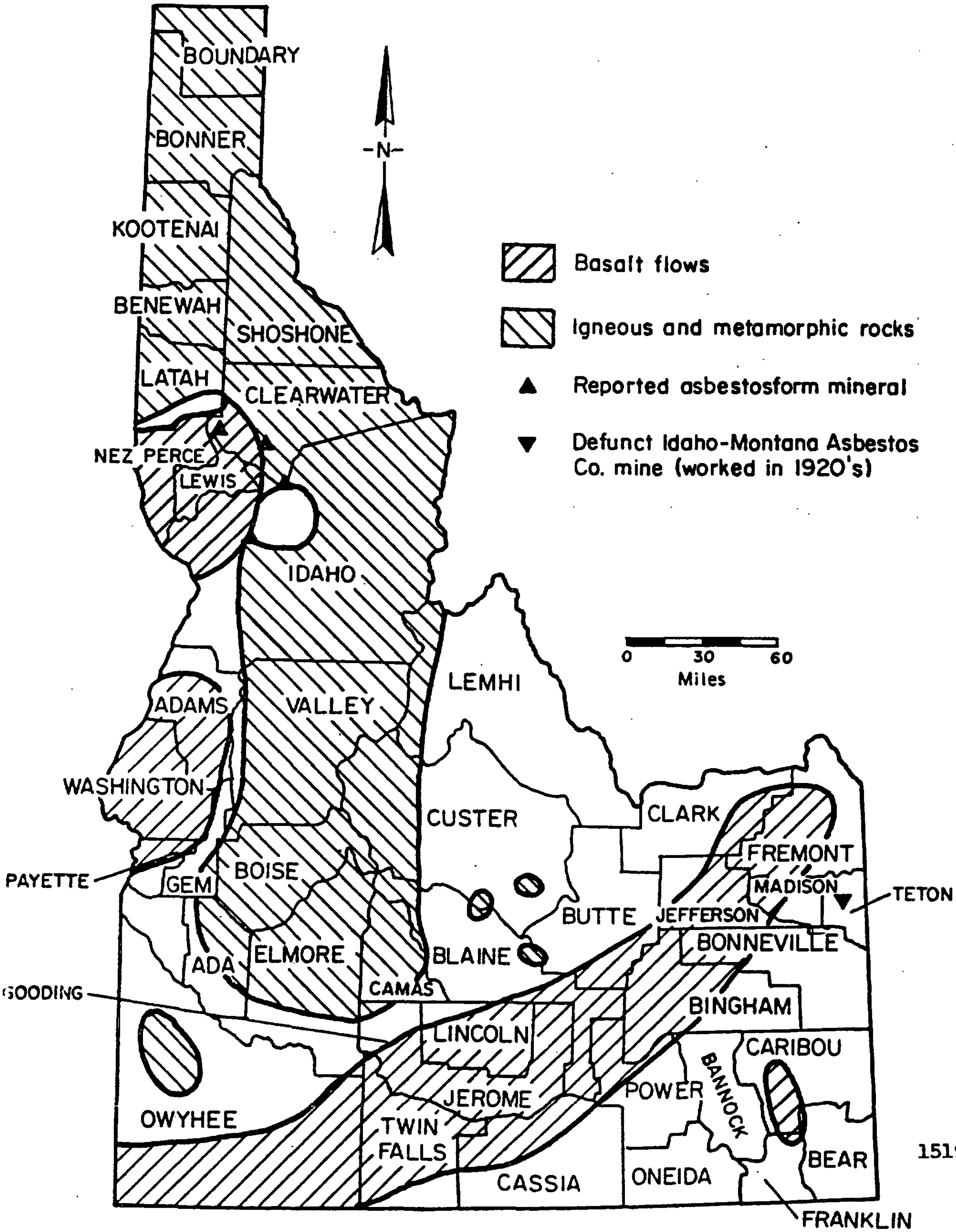
BOUNDARY
BONNER
KOOTENAI
BENEWAH
SHOSHONE
LATAH
CLEARWATER
NEZ PERCE
LEWIS
IDAHO
-N-
Basalt flows
Igneous and metamorphic rocks
Reported asbestosform mineral
Defunct Idaho-Montana Asbestos Co. mine (worked in 1920's)
0 30 60
Miles
LEMHI
ADAMS
VALLEY
WASHINGTON
CUSTER
CLARK
FREMONT
PAYETTE
GEM
BOISE
MADISON
TETON
BUTTE
JEFFERSON
BONNEVILLE
ADA
ELMORE
BLAINE
GOODING
CAMAS
BINGHAM
LINCOLN
CARIBOU
BANNOCK
POWER
JEROME
OWYHEE
TWIN FALLS
CASSIA
ONEIDA
BEAR
FRANKLIN

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TABLE A-22. Value of mineral production in Idaho, by county

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Ada	W	W	Sand and gravel, clays.
Adams	W	W	Sand and gravel, pumice.
Bannock	W	$4,399	Cement, sand and gravel, stone, peat.
Bear Lake	W	324	Sand and gravel.
Benewah	W	W	Garnet, sand and gravel.
Bingham	W	W	Phosphate rock, sand and gravel.
Blaine	$380	10	Lead, silver, zinc, copper.
Boise	W	77	Sand and gravel.
Bonner	W	W	Sand and gravel, stone.
Bonneville	755	1,281	Lime, sand and gravel, stone, pumice.
Boundary	28	90	Sand and gravel, lead, silver, zinc.
Butte	W	--	
Camas	1	W	Sand and gravel.
Canyon	710	1,655	Sand and gravel, lime, stone, pumice.
Caribou	17,798	14,204	Phosphate rock, vanadium, stone, sand and gravel.
Cassia	W	147	Sand and gravel, clays.
Clark	11	58	Stone, sand and gravel, clays.
Clearwater	W	W	Stone, sand and gravel.
Custer	W	1,344	Copper, lead, silver, zinc, tungsten, gold.
Elmore	W	W	Sand and gravel, clays.
Franklin	W	566	Sand and gravel.
Fremont	64	W	Do.
Gem	4	W	Do.
Gooding	--	W	Do.
Idaho	W	W	Stone, sand and gravel.
Jefferson	W	--	
Jerome	--	33	Sand and gravel.
Kootenai	W	W	Sand and gravel, stone.
Latah	1,164	W	Clays, stone, sand and gravel.
Lemhi	86	175	Fluorspar, sand and gravel, copper, gold, lead, silver, zinc.
Lincoln	W	W	Sand and gravel.
Madison	W	W	Sand and gravel, stone.
Minidoka	W	W	Lime, sand and gravel, clays.
Nez Perce	W	W	Sand and gravel, stone.
Oneida	116	232	Stone, perlite, pumice.
Owyhee	1	--	
Payette	W	W	Stone, sand and gravel.
Power	W	12	Sand and gravel.
Shoshone	70,185	66,073	Silver, lead, zinc, copper, antimony, gold.
Teton	281	292	Sand and gravel.
Twin Falls	887	W	Sand and gravel, lime.
Washington	W	W	Mercury, iron ore, sand and gravel.
Undistributed [2]	27,277	21,312	
Total	119,748	[1] 112,280	

TABLE A-23. MINING ACTIVITY IN IDAHO, BY COUNTY

Clearwater County

Slip-fiber anthophyllite asbestos in altered harzburgite.

1. Teakean.	46°33'	116°20'
2. Orofino Creek.	46°29'	116°02'

Idaho County

3. Kamiah mine. Brittle mass-fiber anthophyllite asbestos in altered dunite; Anderson, 1931.	46°13'	115°50'
4. Blacktail. Woodlike slip-fiber anthophyllite in narrow seams.	45°54'	115°57'

Source References

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, 1962, USGS Map MR-31.

(70) Geological Map of the State of Idaho, C. P. Ross and J. D. Forrester, U.S. Department of Interior Geological Survey, 1947.

(71) The Minerals of Idaho, F. C. Mitko, U.S. Bureau of Mines Minerals Yearbook, 1971.

(72) Mineral and Water Resources of Idaho, Committee Print, 88th Congress, 2nd Session, 1964.

(73) Mining Industry of Idaho, 68th Annual Report for 1969-1970.

Illinois

There are two areas in Illinois that merit attention with regard to mineralization and alteration of rock minerals. These areas are at opposite ends of the state: Jo Daviess County in northern Illinois and the southern counties of Saline, Gallatin, Pope, and Hardin, as shown on Figure A-17. Lead, zinc, and a little silver are mined in the western part of Jo Daviess County near Galena. Fluorspar is mined in Hardin County where some zinc also is recovered as a byproduct. There have been no reports of fibrous amphibole minerals in association with these value minerals from either location.

The dike swarms of the southern Illinois counties are believed to be of the same age and of the same intrusive system as those found across the Ohio River in western Kentucky (Livingston, Crittenden, and Caldwell Counties, Kentucky). The dikes of western Kentucky and of sourthern Illinois are mica periodotites and lamprophyres. The mineralization in association with the dikes has occurred at a later time and is believed to be of hydrothermal origin. As mentioned previously, no fibrous amphiboles have been described from this area. Currently, there is extensive fluorspar production only from Hardin County from several mines operated by the Minerva Oil Company (Eldorado, Illinois 62930) and Ozark-Mahoning Company (P.O. Box 57, Rosiclare, Illinois 62982). Both companies recover lead and zinc from the same mines.

Lead and zinc recovery by Eagle-Picher Industries, Inc (P.O. Box 1040, Galena, Illinois 61036) is from three mines in the Ordovician rock of Jo Daviess County, northern Illinois. The formations there are the Galena and Platteville dolomites and limestones which were probably mineralized at the same time as the Wisconsin Arch was uplifted. There are no reports of fibrous amphiboles in association with the mineralization.

The county-by-county mineral production in Illinois is described in Table A-24.

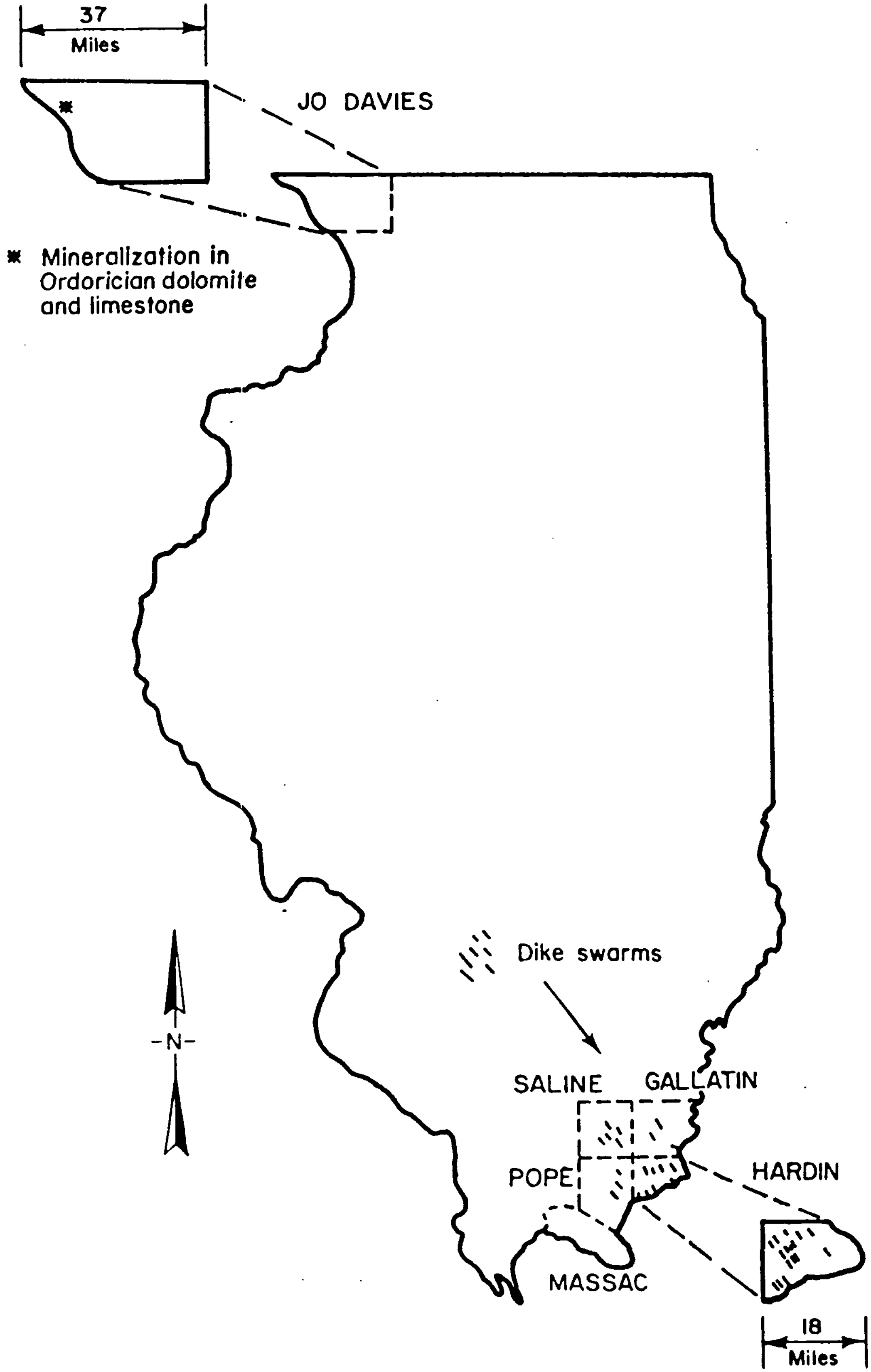

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FIGURE A-17. AREAS OF ASBESTOS OCCURRENCE IN ILLINOIS

TABLE A-24. Value of mineral production in Illinois, by county [1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Adams	W	$3,907	Stone, lime, sand and gravel, petroleum.
Alexander	$240	248	Tripoli, sand and gravel.
Bond	W	W	Sand and gravel, petroleum, clay.
Boone	W	W	Sand and gravel, stone.
Brown	W	63	Sand and gravel, petroleum, clay, stone.
Bureau	825	618	Sand and gravel.
Calhoun	W	W	Stone.
Carroll	W	407	Stone, sand and gravel.
Champaign	748	780	Sand and gravel, petroleum.
Christian	W	W	Coal, petroleum, stone.
Clark [2]	3,084	W	Stone, petroleum, sand and gravel.
Clay	W	W	Petroleum, stone.
Clinton	2,691	2,765	Petroleum, stone, sand and gravel.
Coles	W	W	Do.
Cook	39,575	45,632	Stone, lime, sand and gravel, clay, peat.
Crawford	W	7,072	Petroleum, sand and gravel, stone.
Cumberland [2]	205	W	Stone, petroleum.
De Kalb	W	W	Stone, sand and gravel.
De Witt	1,001	W	Petroleum, sand and gravel.
Douglas	W	22,671	Natural gas liquids, coal, petroleum, stone.
Du Page	W	4,008	Sand and gravel, stone, natural gas liquids, clay.
Edgar	308	357	Petroleum.
Edwards	W	2,040	Do.
Effingham	W	1,252	Petroleum, sand and gravel.
Fayette	16,239	16,829	Petroleum, stone, sand and gravel, clay.
Ford	334	W	Sand and gravel.
Franklin	44,549	45,081	Coal, petroleum.
Fulton	28,206	24,858	Coal, sand and gravel.
Gallatin	W	14,280	Coal, petroleum, sand and gravel, natural gas.
Greene	W	W	Stone.
Grundy	W	3,568	Sand and gravel, clay, stone.
Hamilton	5,320	4,857	Petroleum, sand and gravel.
Hancock	687	362	Stone.
Hardin	14,952	14,635	Fluorspar, stone, zinc, lead, silver.
Henderson	458	507	Stone.
Henry	W	W	Stone, sand and gravel.
Iroquois	W	W	Sand and gravel.
Jackson	1,255	1,211	Stone, coal, sand and gravel.
Jasper	3,434	2,882	Petroleum, sand and gravel.
Jefferson	W	46,656	Coal, petroleum.
Jersey	199	211	Stone.
Jo Daviess	2,877	2,785	Zinc, stone, lead, sand and gravel, silver.
Johnson	W	W	Stone, coal, sand and gravel.
Kane	$7,557	$8,403	Sand and gravel, stone, peat.
Kankakee	9,832	8,424	Coal, stone, clay, sand and gravel.
Kendall	W	W	Stone, sand and gravel.
Knox	W	W	Coal, stone, clay.
Lake	W	W	Sand and gravel, stone, peat.
La Salle	W	W	Stone, sand and gravel, cement, clay.
Lawrence	17,273	16,239	Petroleum, sand and gravel.
Lee	W	W	Cement, stone, sand and gravel.
Livingston	W	4,565	Stone, clay, sand and gravel.
Logan	W	W	Sand and gravel, stone.
McDonough	W	W	Stone, petroleum, clay, sand and gravel.
McHenry	6,691	W	Sand and gravel, stone.
McLean	1,256	W	Sand and gravel.
Macon	593	577	Sand and gravel, petroleum.
Macoupin	W	W	Coal, stone, petroleum.
Madison	W	W	Stone, sand and gravel, petroleum.
Marion	W	W	Petroleum, stone.
Marshall	W	W	Sand and gravel.
Mason	W	W	Sand and gravel, stone.
Massac	W	W	Cement, stone, sand and gravel.
Menard	W	W	Stone.
Mercer	415	450	Coal, stone, sand and gravel.
Monroe	W	W	Stone.
Montgomery	W	W	Coal, stone, petroleum.
Morgan	2	W	Sand and gravel.
Moultrie	W	W	Stone, sand and gravel, petroleum.
Ogle	W	W	Sand and gravel, stone.
Peoria	15,977	15,500	Coal, sand and gravel, stone.
Perry	30,517	34,037	Coal, petroleum.
Pike	W	W	Stone, sand and gravel.
Pope	69	W	Coal, sand and gravel.
Pulaski	W	W	Clay, stone, sand and gravel.
Putnam	W	W	Sand and gravel.
Randolph	W	W	Coal, stone, petroleum, sand and gravel.
Richland	5,570	4,650	Petroleum.
Rock Island	W	W	Stone, sand and gravel.
St. Clair	W	31,722	Coal, stone, petroleum.
Saline	21,600	19,095	Coal, petroleum, natural gas.
Sangamon	W	1,467	Sand and gravel, petroleum, stone, clay.
Schuyler	W	W	Sand and gravel, stone.
Scott	245	618	Stone, clay, sand and gravel.
Shelby	473	528	Sand and gravel, stone, petroleum.
Stark	W	3,351	Coal, sand and gravel.
Stephenson	770	W	Stone, sand and gravel.
Tazewell	W	W	Sand and gravel, clay.
Union	W	W	Stone, sand and gravel.
Vermilion	W	W	Stone, coal, sand and gravel, clay.
Wabash	W	W	Petroleum, sand and gravel.
Warren	W	W	Stone.
Washington	W	W	Petroleum, stone.
Wayne	15,778	14,397	Petroleum.
White	W	19,465	Petroleum, sand and gravel.
Whiteside	1,260	1,360	Peat, stone, sand and gravel.
Will	10,143	11,496	Stone, sand and gravel.
Williamson	23,101	26,611	Coal, petroleum, natural gas.
Winnebago	2,031	2,253	Stone, sand and gravel.
Woodford	W	W	Sand and gravel.
Undistributed [3]	350,355	205,073	
Total [4]	688,697	700,819	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Cass and Piatt Counties are not included because no production was reported.

[2] Value of petroleum production in Cumberland County is included with Clark County because actual source of production cannot be identified.

[3] Includes some sand and gravel and gem stones that cannot be assigned to specific counties, and values

Source References

(74) Geologic Map of Illinois
H. B. Willman, et al, 1967
Illinois State Geological Survey
Urbana, Illinois 61801.

(75) Mineral Production in Illinois in 1971
W. L. Busch, 1973
Circular 477
Illinois State Geological Survey
Urbana, Illinois 61801.

(76) The Mineral Industry of Illinois
G. N. Broderick, 1971
U. S. Bur. Mines Minerals Yearbook.

Indiana

The mineral production in Indiana consists chiefly of the fossil fuels, stone, sand and gravel as described in Table A-25. There are no activities in rocks where fibrous amphibole minerals might occur.

Source Reference

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, 1962, USGS Map MR-31.

(77) The Minerals of Indiana, B. C. Brown, U.S. Bureau of Mines Minerals Yearbook, 1971.

Table A-25. Value of mineral production in Indiana, by county [1]
(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Adams	$629	$726	Stone, clays, sand and gravel.
Allen	3,259	3,871	Stone, sand and gravel, peat.
Bartholomew	731	840	Stone, sand and gravel.
Benton	--	W	Sand and gravel.
Blackford	W	W	Stone, sand and gravel, clays.
Boone	W	W	Sand and gravel.
Brown	--	W	Do.
Carroll	W	W	Stone, sand and gravel.
Cass	W	W	Cement, stone, sand and gravel, clays.
Clark	W	W	Cement, stone, clays, sand and gravel.
Clay	W	W	Coal, clays.
Clinton	11	W	Sand and gravel.
Crawford	W	W	Stone.
Daviess	W	55	Sand and gravel.
Dearborn	W	368	Do.
Decatur	W	W	Stone.
De Kalb	254	368	Sand and gravel.
Delaware	1,355	1,467	Stone, sand and gravel, peat.
Dubois	W	W	Clays, sand and gravel.
Elkhart	W	W	Sand and gravel, stone.
Fayette	W	W	Sand and gravel.
Fountain	$604	$829	Sand and gravel, coal, clays.
Franklin	W	W	Stone, sand and gravel, clays.
Fulton	W	W	Sand and gravel, peat.
Gibson	W	W	Coal, sand and gravel.
Grant	W	W	Stone, sand and gravel, peat.
Greene	W	W	Coal, sand and gravel, clays.
Hamilton	3,957	5,215	Sand and gravel, stone.
Hancock	W	W	Sand and gravel.
Harrison	W	W	Sand and gravel, stone.
Hendricks	W	W	Sand and gravel.
Henry	W	W	Do.
Howard	W	W	Stone, sand and gravel.
Huntington	W	W	Stone, sand and gravel, clays.
Jackson	385	499	Sand and gravel, clays.
Jasper	W	W	Stone, sand and gravel.
Jay	W	W	Do.
Jefferson	W	5	Sand and gravel.
Jennings	W	W	Stone, sand and gravel.
Johnson	W	W	Sand and gravel.
Knox	543	548	Do.
Kosciusko	696	W	Sand and gravel, stone.
Lagrange	W	W	Do.
Lake	W	W	Cement, lime, sand and gravel, clays.
La Porte	W	W	Sand and gravel, stone.
Lawrence	13,834	16,833	Cement, stone, clays.
Madison	W	W	Stone, sand and gravel.
Marion	3,240	W	Sand and gravel, stone.
Marshall	W	W	Sand and gravel, stone, peat.
Martin	W	W	Gypsum, clays.
Miami	683	721	Sand and gravel, stone.
Monroe	6,169	W	Stone.
Montgomery	W	W	Sand and gravel, clays.
Morgan	W	W	Clays, sand and gravel, stone.
Newton	W	W	Stone.
Noble	242	331	Sand and gravel, stone.
Orange	W	W	Stone, abrasives.
Owen	851	857	Stone, sand and gravel.
Parke	523	846	Sand and gravel, clays, coal.
Perry	W	W	Stone, sand and gravel.
Pike	W	W	Coal, stone.
Porter	W	W	Clays.
Posey	W	W	Sand and gravel.
Pulaski	W	W	Stone, clays.
Putnam	W	W	Cement, stone, sand and gravel.
Randolph	W	W	Stone, sand and gravel.
Ripley	W	W	Stone.
Rush	236	W	Stone, sand and gravel.
St. Joseph	W	927	Sand and gravel, stone.
Scott	W	W	Stone.
Shelby	W	W	Stone, sand and gravel.
Spencer	W	W	Coal.
Starke	W	W	Sand and gravel.
Steuben	190	W	Sand and gravel, stone.
Sullivan	22,687	22,345	Coal, sand and gravel, stone.
Switzerland	W	W	Sand and gravel.
Tippecanoe	W	W	Do.
Union	21	8	Do.
Vermillion	4,944	6,206	Coal, sand and gravel, clays.
Vigo	W	1,821	Sand and gravel, coal, stone.
Wabash	840	W	Stone, sand and gravel.
Warren	W	W	Sand and gravel, peat.
Warrick	W	W	Coal, stone.
Washington	W	W	Stone.
Wayne	W	W	Sand and gravel, stone.
Wells	W	W	Stone, sand and gravel, peat.
White	W	W	Stone.
Whitley	78	W	Sand and gravel.
Undistributed[2]	189,326	215,876	
Total[3]	255,786	281,565	

W Withheld to avoid disclosing individual company confidential data, included with "Undistributed."
[1] Data for petroleum and natural gas are not available on a county basis; however, value for these commodities are included with "Undistributed.". Benton, Brown, Floyd, Ohio, Tipton and Vanderburgh Counties are not listed because no production was reported.
[2] Includes value for petroleum, natural gas and mineral production that is not assigned to specific counties plus values indicated by symbol W.
[3] Data may not add to totals shown because of independent rounding.

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Iowa

There are two small outcrops of Precambian igneous and metamorphic rocks in Iowa in the northwestern part of the state as shown on Figure A-18. Neither of these formations are mentioned as being worked in the summary of the stone, sand, and gravel recovery operations reported for Lyon and Pocahontas Counties.* In the eastern part of the state, there are several stone quarries in the Galena-Decorah-Platteville (Ordovician limestone-dolamite) Formations (notably Dubnque County) which have been mineralized (mining for lead-zinc in adjacent Wisconsin and Illinois). However, except for the stone production, there is no mineral recovery operations from these formations in Iowa. A summary of the mineral production from Iowa is given in Table A-26.

Source References

(78) Geologic Map of Iowa
H. G. Hershey, et al, 1969
Iowa Geological Survey
Iowa City, Iowa 52240.

(79) Report of the State Mine Inspector
W. D. Aubrey, 1970-1971
State of Iowa
Mines and Minerals Department
Des Moines, Iowa 50319.

(80) The Mineral Industry of Iowa
B. C. Brown, 1971
U. S. Bur. Mines Minerals Yearbook.

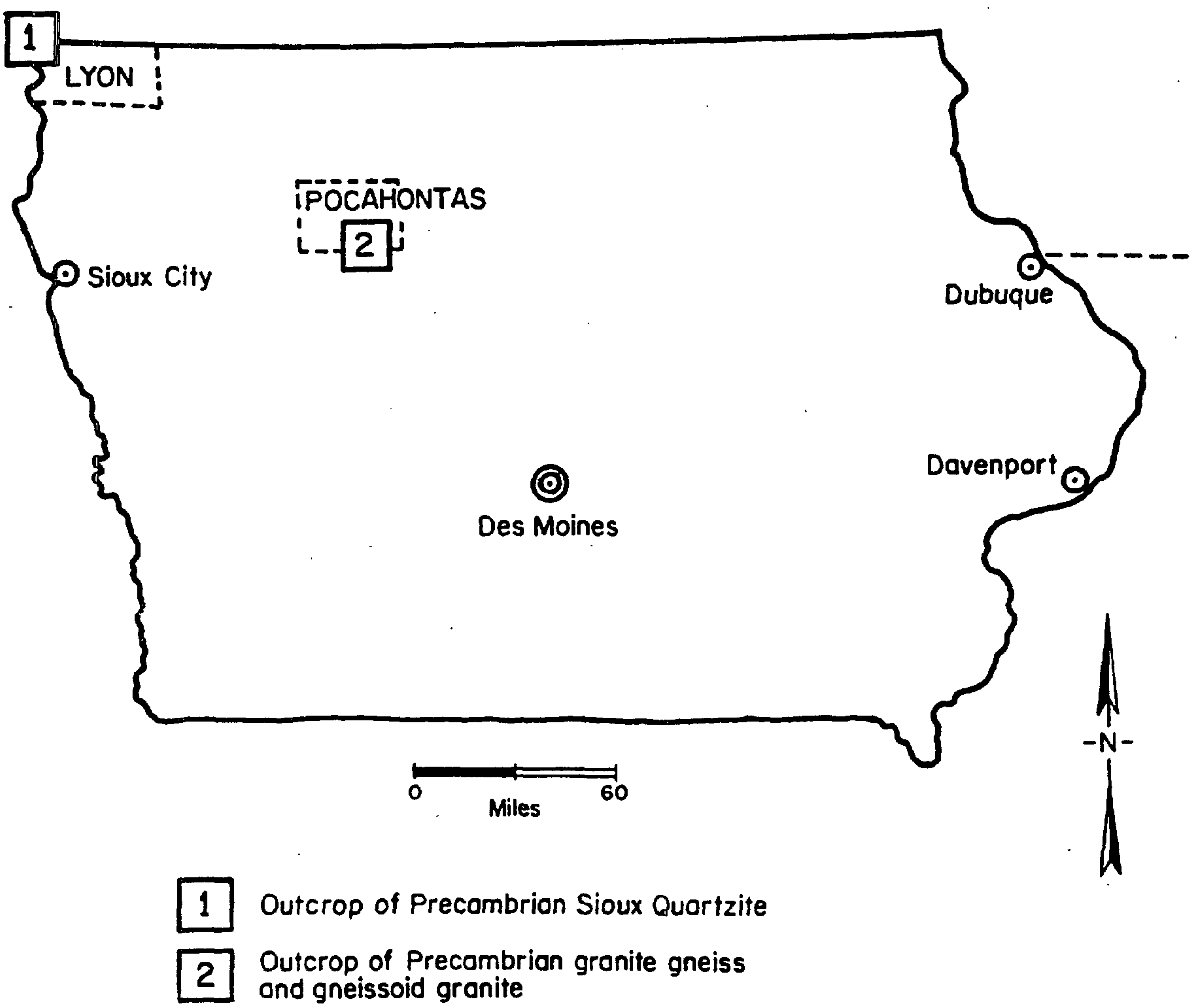

FIGURE A-18. OCCURRENCE OF IGNEOUS AND METAMORPHIC ROCK IN IOWA

TABLE A-26. **Value of mineral production in Iowa, by county**[1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Adair	W	W	Stone.
Adams	W	W	Do.
Allamakee	W	W	Stone, sand and gravel.
Appanoose	W	W	Stone, clays.
Audubon	$200	W	Sand and gravel.
Benton	W	$165	Sand and gravel, stone.
Black Hawk	W	W	Stone, sand and gravel.
Boone	W	W	Sand and gravel, clays.
Bremer	279	314	Stone, sand and gravel.
Buchanan	W	W	Do.
Buena Vista	102	33	Sand and gravel.
Butler	W	W	Stone, sand and gravel.
Calhoun	W	54	Sand and gravel.
Carroll	301	223	Do.
Cass	W	W	Stone.
Cedar	W	W	Do.
Cerro Gordo	28,334	28,734	Cement, stone, sand and gravel, clays, lime.
Cherokee	497	W	Sand and gravel.
Chickasaw	W	W	Stone, sand and gravel.
Clarke	W	W	Stone.
Clay	282	W	Sand and gravel.
Clayton	951	657	Sand and gravel, stone.
Clinton	W	W	Stone, sand and gravel.
Crawford	W	W	Sand and gravel.
Dallas	562	846	Sand and gravel, clays, stone.
Decatur	W	W	Stone.
Delaware	W	206	Stone, sand and gravel.
Des Moines	1,722	2,424	Stone, gypsum, sand and gravel.
Dickinson	354	276	Sand and gravel.
Dubuque	859	W	Stone, sand and gravel.
Emmet	208	147	Sand and gravel.
Fayette	988	915	Stone, sand and gravel.
Floyd	344	501	Stone, sand and gravel, clays.
Franklin	W	228	Sand and gravel, clays, stone.
Fremont	W	W	Stone, sand and gravel.
Greene	326	W	Sand and gravel.
Grundy	W	W	Stone, sand and gravel.
Guthrie	172	113	Sand and gravel.
Hamilton	W	W	Stone, sand and gravel.
Hancock	W	W	Sand and gravel, stone.
Hardin	W	W	Stone, sand and gravel.
Harrison	915	714	Do.
Henry	W	139	Sand and gravel, stone.
Howard	180	W	Stone, sand and gravel.
Humboldt	W	1,367	Do.
Ida	W	W	Sand and gravel.
Iowa	W	W	Do.
Jackson	W	W	Stone, sand and gravel.
Jasper	W	W	Sand and gravel, stone.
Jefferson	W	166	Stone, sand and gravel.
Johnson	1,550	W	Do.
Jones	662	W	Do.
Keokuk	W	W	Stone, clays.
Kossuth	296	129	Sand and gravel.
Lee	375	543	Stone, sand and gravel.
Linn	3,253	W	Do.
Louisa	W	W	Stone.
Lucas	686	932	Coal.
Lyon	315	156	Sand and gravel.
Madison	W	W	Stone, clays.
Mahaska	1,782	2,416	Coal, stone, sand and gravel, clays.
Marion	W	1,543	Coal, stone, sand and gravel.
Marshall	W	W	Stone, sand and gravel.
Mills	W	W	Do.
Mitchell	W	659	Do.
Monona	187	413	Sand and gravel.
Monroe	1,094	W	Coal.
Montgomery	W	W	Stone, sand and gravel.
Muscatine	W	W	Do.
O'Brien	101	W	Sand and gravel.
Osceola	881	241	Do.
Page	W	W	Stone, sand and gravel.
Palo Alto	250	431	Sand and gravel.
Plymouth	571	499	Do.
Pocahontas	W	W	Stone, sand and gravel.
Polk	16,058	17,001	Cement, sand and gravel, clays.
Pottawattamie	W	W	Stone, sand and gravel.
Poweshiek	W	W	Stone.
Sac	691	435	Sand and gravel.
Scott	14,557	14,919	Cement, stone, lime, clays, sand and gravel.
Shelby	W	W	Sand and gravel.
Sioux	$885	$762	Do.
Story	1,107	1,125	Sand and gravel, stone, clays.
Tama	W	W	Sand and gravel.
Taylor	W	W	Stone.
Union	W	W	Do.
Van Buren	808	831	Stone, coal, sand and gravel.
Wapello	W	477	Sand and gravel, coal, stone, clays.
Warren	W	W	Sand and gravel, clays.
Washington	W	W	Stone.
Wayne	W	--	
Webster	4,670	4,909	Gypsum, stone, sand and gravel, clays.
Winnebago	W	W	Peat, sand and gravel.
Winneshiek	W	W	Stone, sand and gravel.
Woodbury	370	W	Sand and gravel, clays.
Worth	765	824	Stone, sand and gravel, peat.
Wright	271	W	Sand and gravel.
Undistributed[2]	31,561	40,347	
Total	120,822	[3]127,821	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[illegible] Counties are not listed [illegible] production [illegible]

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Kansas

Kansas is a state where very little igneous activity is apparent in the surface rocks. There are small outcrops of basic intrusive rock in Riley County and peridotite and granite intrusives in Woodson County. In central and western Kansas there are volcanic ash sedimentary deposits. Except for very localized contact metamorphisin around the intrusives, there are no metamorphic rocks of any significance in Kansas. The lead-zinc mineralization in southeasternmost Kansas (Cherokee County) is currently not being exploited. The chat from these operations does not contain fibrous amphibole minerals. Stone, sand, and gravel, are taken from Riley and Woodson Counties. The three counties of interest to this study are located in Figure A-19. Kansas mineral production activities are summarized in Table A-27.

Source References

(81) Geologic Map of Kansas
J. M. Jewett, et al, 1964
State Geological Survey of Kansas
Lawrence, Kansas 66044.

(82) Inventory of Industrial, Metallic, and Solid-Fuel Minerals in Kansas
R. G. Hardy, 1970
Bulletin 199, Part 5
Kansas Geological Survey
Lawrence, Kansas 66044.

(83) Kansas Mineral Industry Report, 1971
L. L. Brady, et al, 1972
Special Distribution Publication 61
State Geological Survey of Kansas
University of Kansas
Lawrence, Kansas 66044.

(84) The Mineral Industry of Kansas
B. Michalski, 1971
U. S. Bur. Mines Minerals Yearbook.

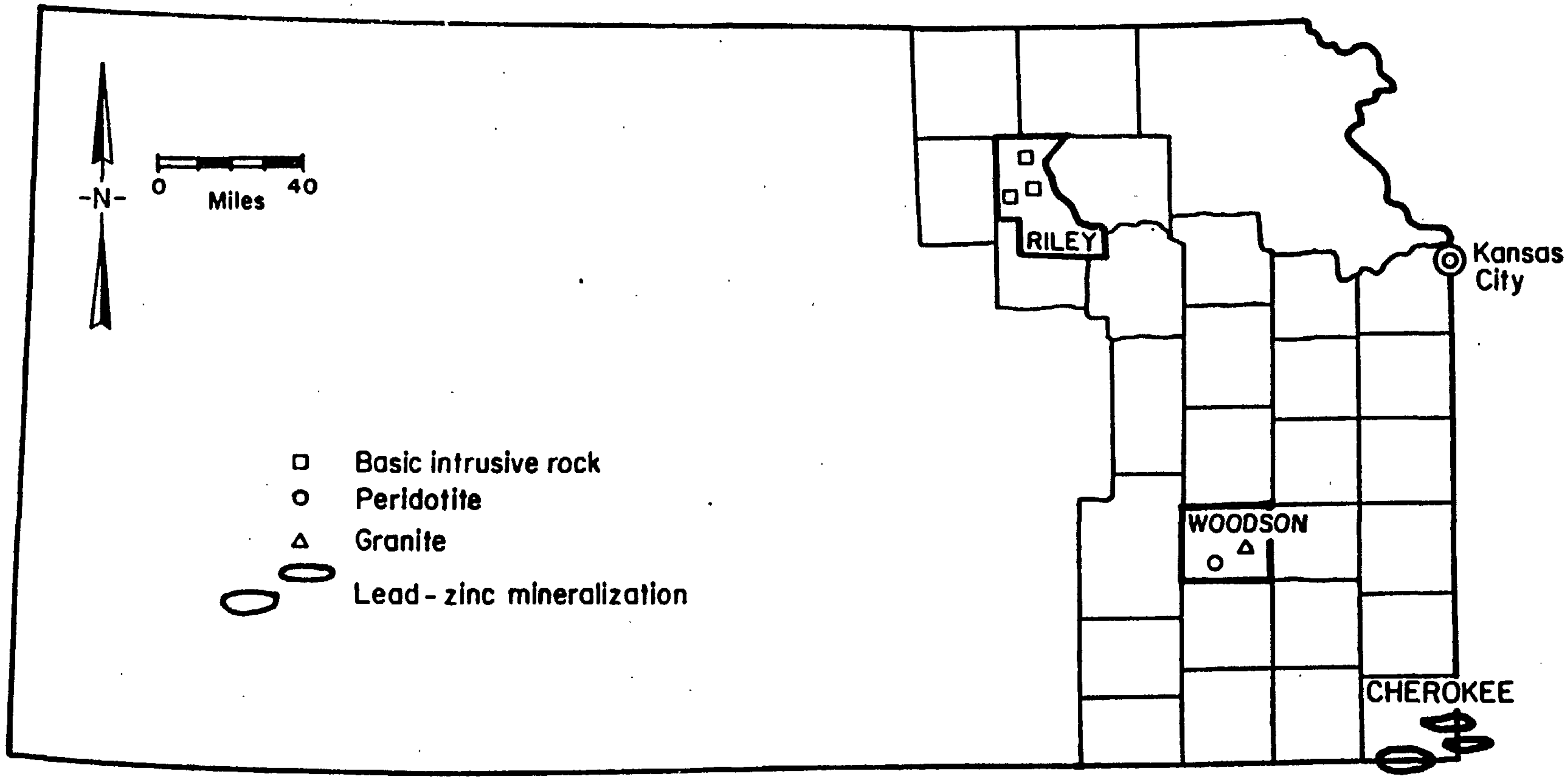

FIGURE A-19. OCCURRENCE OF IGNEOUS ROCK IN KANSAS

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TABLE A-27. Value of mineral production in Kansas, by county

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Allen	$11,519	$7,641	Cement, stone, clays, natural gas.
Anderson	982	142	Stone.
Atchison	593	W	Do.
Barber	7,784	6,957	Natural gas, petroleum, gypsum, natural gas liquids, sand and gravel.
Barton	[1]19,066	18,887	Petroleum, salt, sand and gravel, natural gas, clays.
Bourbon	W	W	Stone.
Brown	W	--	
Butler	18,052	12,995	Petroleum, stone, sand and gravel.
Chase	W	128	Stone, sand and gravel.
Chautauqua	1,999	W	Stone, natural gas.
Cherokee	7,129	4,923	Coal, clays, stone, sand and gravel.
Cheyenne	W	W	Sand and gravel.
Clark	1,494	965	Natural gas, petroleum, sand and gravel.
Clay	198	W	Sand and gravel, stone.
Cloud	W	W	Clays, sand and gravel.
Coffey	W	W	Stone.
Comanche	1,536	1,407	Petroleum, natural gas, sand and gravel.
Cowley	8,264	7,827	Petroleum, sand and gravel, stone, natural gas.
Crawford	2,910	2,629	Coal, clays, stone.
Decatur	2,191	2,248	Petroleum, sand and gravel.
Dickinson	740	687	Stone, sand and gravel, petroleum.
Doniphan	812	657	Stone, sand and gravel.
Douglas	222	W	Sand and gravel.
Edwards	1,637	2,594	Stone, natural gas, petroleum, sand and gravel.
Elk	1,695	W	Natural gas, sand and gravel.
Ellis	24,535	22,944	Petroleum, sand and gravel, stone.
Ellsworth	[1]19,447	25,365	Natural gas liquids, petroleum, salt, clays, sand and gravel, pumice, natural gas.
Finney	12,494	5,401	Petroleum, natural gas liquids, sand and gravel.
Ford	420	471	Natural gas liquids, sand and gravel, petroleum, natural gas.
Franklin	1,242	W	Stone, clays, sand and gravel.
Geary	W	W	Stone, sand and gravel.
Gove	W	1,182	Petroleum, sand and gravel.
Graham	12,813	12,229	Do.
Grant	[1]26,792	15,057	Natural gas liquids, petroleum, sand and gravel.
Gray	W	W	Sand and gravel.
Greeley	W	--	
Greenwood	7,210	W	Petroleum, natural gas.
Hamilton	2,698	1,225	Natural gas, sand and gravel, petroleum.
Harper	5,086	4,059	Petroleum, natural gas liquids, natural gas, sand and gravel.
Harvey	2,659	W	Petroleum, natural gas liquids.
Haskell	[1]20,449	12,170	Helium, petroleum, natural gas, sand and gravel.
Hodgeman	W	4,127	Petroleum, sand and gravel.
Jackson	W	90	Stone, sand and gravel.
Jefferson	867	W	Stone.
Jewell	W	W	Do.
Johnson	2,229	W	Stone, sand and gravel.
Kearny	18,297	714	Petroleum, natural gas liquids, sand and gravel, natural gas.
Kingman	14,929	10,898	Petroleum, natural gas liquids, natural gas, sand and gravel, stone.
Kiowa	5,795	9,159	Petroleum, natural gas, sand and gravel.
Labette	890	408	Stone.
Lane	128	215	Petroleum, sand and gravel.
Leavenworth	W	W	Stone, sand and gravel.
Lincoln	W	W	Stone, sand and gravel, pumice.
Linn	W	292	Stone.
Logan	16	241	Petroleum, sand and gravel.
Lyon	1,092	927	Petroleum, stone, sand and gravel.
McPherson	5,797	8,846	Petroleum, natural gas, clays, stone, sand and gravel, pumice.

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Value of mineral production in Kansas, by county—Continued

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Marion	2,061	2,114	Petroleum, stone, natural gas, sand and gravel.
Marshall	W	W	Gypsum, sand and gravel, stone.
Meade	4,415	4,213	Natural gas, petroleum, sand and gravel.
Miami	552	81	Stone.
Mitchell	W	--	Sand and gravel.
Montgomery	5,643	6,445	Cement, stone, clays.
Morris	992	1,098	Petroleum, stone, sand and gravel.
Morton	[1]22,525	20,098	Petroleum, helium, natural gas liquids, natural gas.
Nemaha	85	W	Sand and gravel, stone.
Neosho	W	10,369	Cement, stone, sand and gravel.
Ness	8,216	9,451	Petroleum, sand and gravel.
Norton	1,534	1,464	Petroleum, sand and gravel, pumice.
Osage	W	30	Stone.
Osborne	W	148	Petroleum, sand and gravel.
Ottawa	74	W	Sand and gravel.
Pawnee	$3,806	$4,010	Petroleum, natural gas, sand and gravel.
Phillips	6,550	7,022	Petroleum, sand and gravel.
Pottawatomie	W	W	Stone, sand and gravel.
Pratt	4,903	3,918	Petroleum, natural gas, sand and gravel.
Rawlins	2,206	W	Petroleum, sand and gravel.
Reno	16,385	16,563	Salt, petroleum, sand and gravel, natural gas.
Republic	W	W	Stone, sand and gravel.
Rice	[1]27,298	25,934	Petroleum, helium, salt, sand and gravel, natural gas.
Riley	993	998	Stone, petroleum, sand and gravel.
Rooks	13,525	W	Petroleum, sand and gravel.
Rush	6,706	6,496	Petroleum, helium, natural gas.
Russell	22,274	21,649	Petroleum, sand and gravel.
Saline	1,593	W	Do.
Scott	[1]7,083	9,588	Helium, natural gas liquids, petroleum, sand and gravel, natural gas.
Sedgwick	10,761	10,321	Petroleum, salt, natural gas liquids, sand and gravel.
Seward	[1]30,508	27,394	Helium, natural gas liquids, petroleum, natural gas, sand and gravel.
Shawnee	1,841	W	Stone, sand and gravel.
Sheridan	2,232	2,186	Petroleum, sand and gravel.
Sherman	278	794	Lime, sand and gravel, petroleum, stone.
Smith	W	W	Stone, sand and gravel.
Stafford	12,142	11,910	Petroleum, natural gas, sand and gravel.
Stanton	5,567	87	Petroleum, natural gas.
Stevens	26,103	3,656	Do.
Sumner	5,955	6,404	Petroleum, natural gas, sand and gravel.
Thomas	W	106	Sand and gravel, petroleum.
Trego	5,215	7,731	Petroleum, sand and gravel.
Wabaunsee	1,021	1,642	Petroleum.
Wallace	W	W	Sand and gravel.
Washington	W	W	Sand and gravel, stone.
Wichita	65	W	Sand and gravel, petroleum.
Wilson	5,164	5,553	Cement, stone, clays.
Woodson	2,974	W	Stone.
Wyandotte	9,977	10,769	Cement, sand and gravel, stone.
Undistributed[1]	24,314	160,311	
Total[2]	[1]$593,994	$599,444	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Includes sand and gravel, petroleum, stone, and natural gas which cannot be assigned to specific counties and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

Kentucky

There are two areas of igneous intrusive rocks in Kentucky, one in the eastern part of the state and one in the western part as depicted in Figure A-20. The detail maps of these areas (Figures A-21 and A-22) reveal a single occurrence in Elliott County of eastern Kentucky and a dike swarm in the western counties of Caldwell, Crittenden, and Livingston (Lyon County possibly has some also). In a study of these igneous intrusions and their surrounding geology, Koenig writes:

"Many similarities exist between the peridotites of eastern and western Kentucky. Petrographically, they are holocrystalline, porphyritic rocks, with fine-grained matrices. Serpentinized olivine is the principal mineral constituent; both contain abundant calcite or dolomite. However, the western Kentucky dikes contain a much higher percentage of phlogopite and are thus called mica peridotites. Both contain accessory pyroxene, ilmenite, magnetite, perovskite, and chromite. The Elliott County intrusion contains abundant pyrope garnet, which is almost unknown in the western Kentucky dikes.

"The Kentucky-Illinois peridotites are genetically related to the lamprophyres, both having probably formed during the Appalachian Revolution at the end of the Paleozoic Era. The Elliott County intrusion is probably of the same age ---.

"Extensive fluorite, sphalerite, and galena deposits exist in western Kentucky and southern Illinois. They post-date the igneous dikes, with which they are occasionally found, and are believed to be of hydrothermal origin. Evidence points to a genetic relationship between the igneous bodies and the ore deposits."

Although the country rock has been considerably altered locally by the intrusives and subsequent hydrothermal activity, there are no fibrous amphiboles reported from either the eastern or western sites. The only mining in Elliott County is for coal which is not done in the vicinity of the intrusive rocks. Fluorspar is mined from Crittenden County and zinc is taken from Livingston County. These mineral recovery operations and quarrying operations for stone, sand, and gravel, are the only activities in the counties of western Kentucky where the igneous rocks are located.

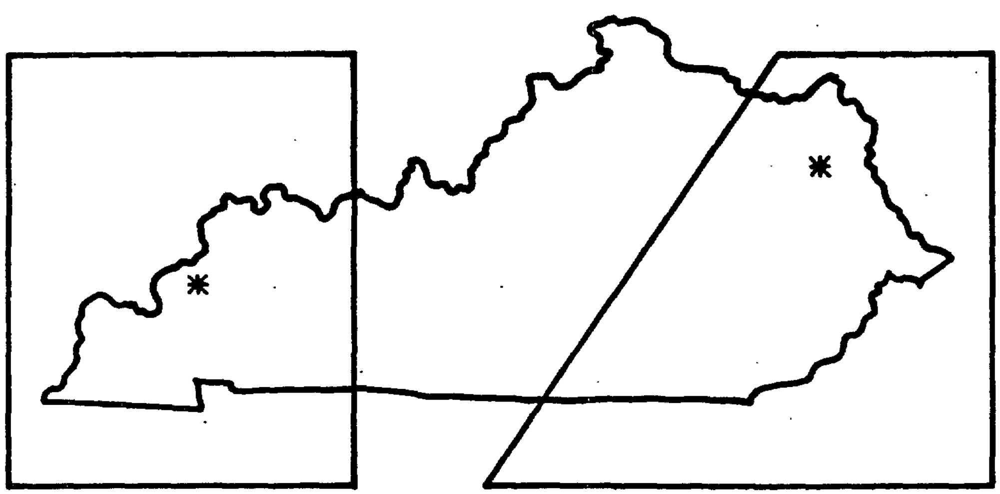

FIGURE A-20. AREAS OF KENTUCKY WHERE IGNEOUS ROCKS ARE FOUND

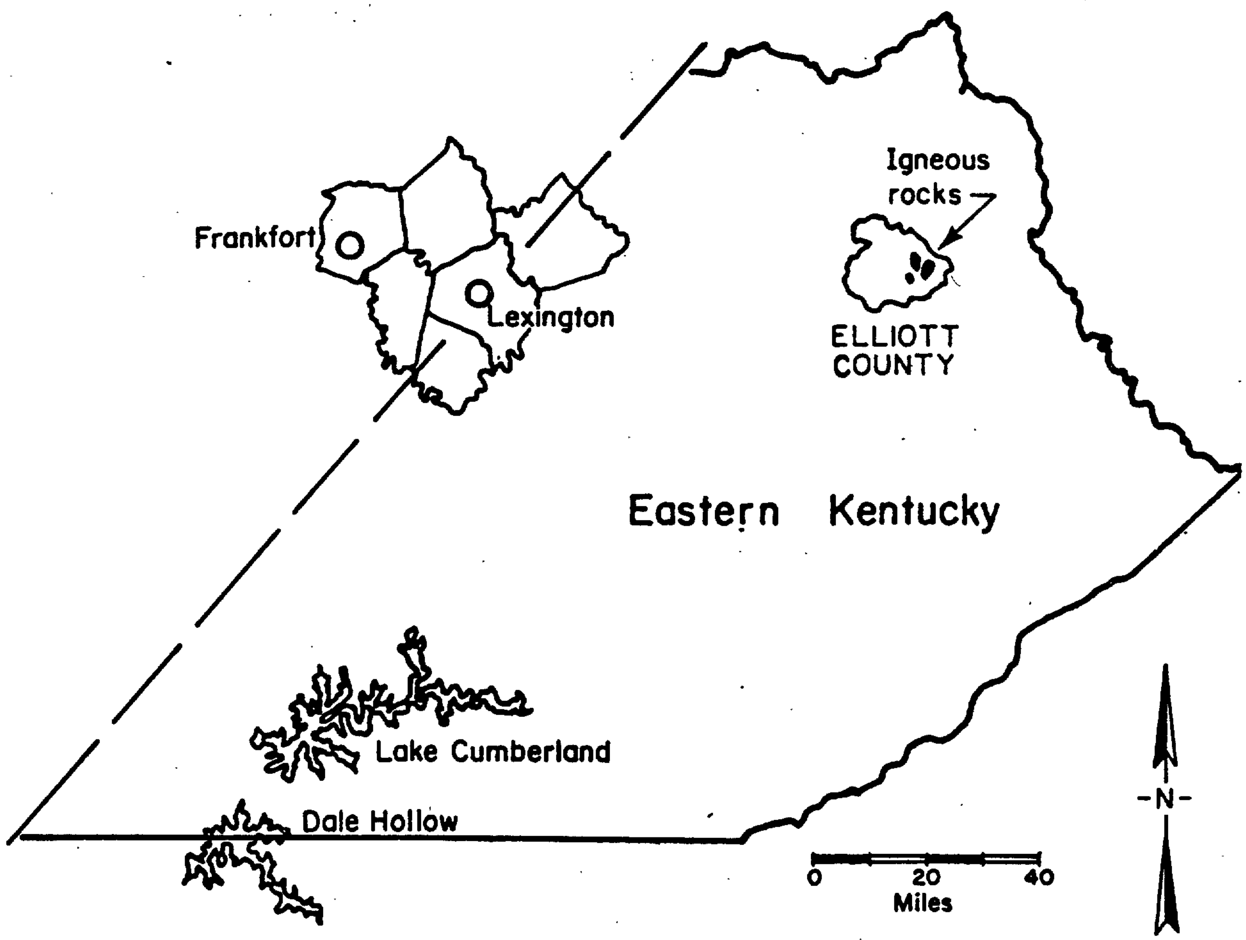

FIGURE A-21. OCCURRENCE OF IGNEOUS ROCK IN EASTERN KENTUCKY

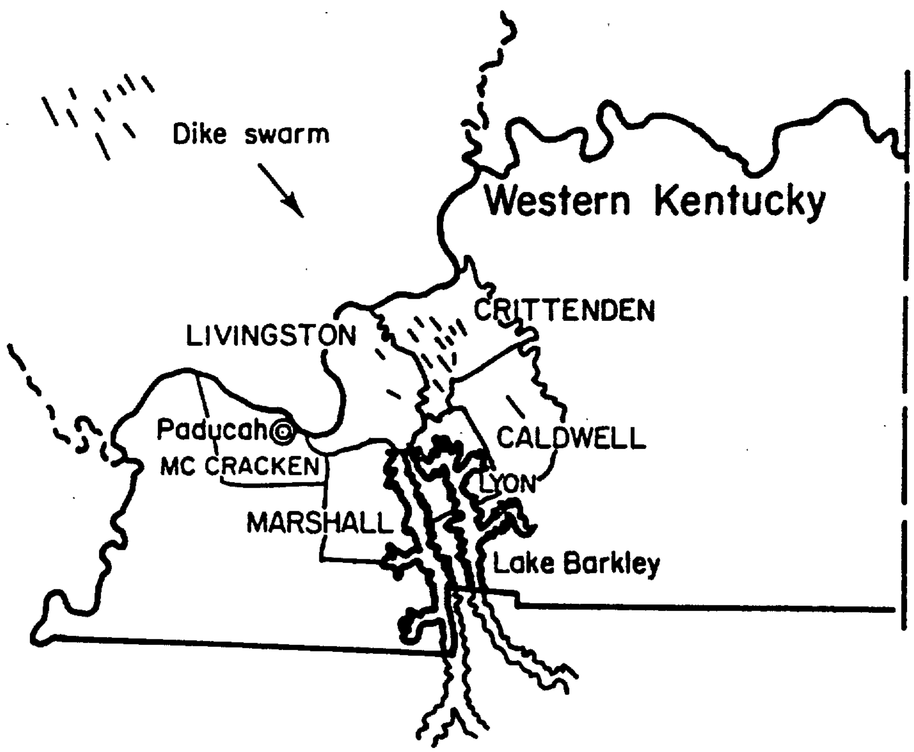

FIGURE A-22. OCCURRENCE OF IGNEOUS ROCK IN WESTERN KENTUCKY

The occurrence of fibrous amphiboles has not been described from any of these sites.

The mineral production of Kentucky is summarized in Table A-28.

Source References

(85) Geologic Map of Kentucky, Series IX, A. C. McFarlan and D. J. Jones, 1954 Kentucky Geological Survey, Lexington, Kentucky.

(86) The Petrography of Certain Igneous Dikes of Kentucky, J. B. Koenig, 1956 Bulletin No. 21, Series IX, Kentucky Geological Survey, Lexington, Kentucky.

(87) The Mineral Industry of Kentucky, H. L. Riley and P. McGrain, 1971 U. S. Bureau of Mines' Minerals Yearbook.

TABLE A-28. Value of mineral production in Kentucky, by county [1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value [2]
Adair	W	W	Petroleum, stone.
Allen	W	W	Stone, petroleum.
Anderson	W	W	Stone.
Ballard	$10	(3)	Sand and gravel.
Barren	326	W	Stone, petroleum.
Bath	12	W	Do.
Bell	16,352	$23,102	Coal, petroleum.
Boone	621	W	Sand and gravel, stone.
Bourbon	W	--	
Boyd	W	1,155	Coal, clays, petroleum.
Boyle	W	W	Stone.
Breathitt	16,870	25,249	Coal, petroleum.
Breckinridge	W	508	Stone, petroleum, sand and gravel.
Bullitt	W	W	Stone, clays.
Butler	W	1,815	Coal, stone, petroleum.
Caldwell	W	W	Stone.
Calloway	61	202	Sand and gravel.
Carlisle	18	2	Do.
Carroll	W	--	
Carter	W	2,308	Coal, stone, clays.
Casey	W	382	Stone, petroleum.
Christian	W	2,962	Stone, coal, petroleum, clays.
Clay	3,478	5,035	Coal, petroleum.
Clinton	W	W	Coal, stone, petroleum.
Crittenden	W	W	Fluorspar, stone.
Cumberland	W	W	Petroleum, stone.
Daviess	W	10,111	Coal, petroleum, sand and gravel.
Edmonson	W	W	Coal, stone, petroleum.
Elliott	110	W	Petroleum, coal.
Estill	W	W	Petroleum, stone.
Fayette	W	W	Stone.
Fleming	W	W	Do.
Floyd	W	27,951	Coal, petroleum, sand and gravel.
Franklin	795	W	Stone.
Fulton	W	137	Sand and gravel.
Gallatin	W	W	Do.
Garrard	W	165	Stone.
Graves	W	W	Clays, sand and gravel.
Grayson	W	W	Stone.
Green	W	W	Stone, petroleum.
Greenup	W	358	Clays, stone, petroleum, sand and gravel.
Hancock	W	962	Coal, clays, petroleum.
Hardin	1,250	1,244	Stone.
Harlan	71,795	81,808	Coal, stone.
Harrison	W	W	Stone.
Hart	W	W	Stone, sand and gravel, petroleum.
Henderson	W	6,099	Petroleum, sand and gravel, coal.
Henry	W	W	Stone.
Hickman	W	(3)	Sand and gravel.
Hopkins	64,355	70,323	Coal, petroleum, sand and gravel.
Jackson	W	W	Coal, stone.
Jefferson	W	W	Cement, sand and gravel, stone, clays.
Jessamine	W	W	Stone, clays.
Johnson	12,239	15,249	Coal, petroleum.
Knott	22,697	25,487	Do.
Knox	4,878	8,859	Do.
Laurel	W	3,303	Coal, stone, petroleum.
Lawrence	2,461	2,580	Coal, petroleum.
Lee	W	6,112	Petroleum, stone, coal.
Leslie	17,666	12,776	Coal, petroleum.
Letcher	W	W	Coal, stone, petroleum.
Livingston	8,467	10,460	Stone, zinc, sand and gravel.
Logan	W	W	Stone, petroleum.
Lyon	5	--	
McCracken	W	W	Sand and gravel.
McCreary	W	5,343	Coal, petroleum.
McLean	2,208	W	Do.
Madison	W	W	Stone.
Magoffin	W	5,341	Coal, petroleum.
Marion	W	238	Stone, petroleum.
Marshall	15	1,389	Stone, sand and gravel.
Martin	8,231	12,062	Coal, sand and gravel, petroleum.
Mason	W	W	Sand and gravel.
Meade	W	W	Stone.
Menifee	W	W	Do.
Mercer	W	W	Do.
Metcalfe	W	W	Petroleum, stone.
Monroe	W	308	Stone, petroleum.
Montgomery	105	172	Stone.
Morgan	W	4,960	Coal, stone, clays, petroleum.
Muhlenberg	$101,445	$103,219	Coal, petroleum, stone.
Nelson	W	W	Stone.
Nicholas	W	W	Do.
Ohio	W	28,395	Coal, stone, petroleum.
Oldham	839	1,217	Stone.
Owsley	2	W	Coal, petroleum.
Pendleton	W	W	Lime, stone.
Perry	54,668	48,923	Coal, petroleum.
Pike	W	W	Coal, stone, petroleum.
Powell	W	W	Stone, petroleum, clays.
Pulaski	W	4,181	Coal, stone, petroleum.
Rockcastle	W	W	Stone, coal.
Rowan	W	W	Stone, clays.
Russell	1	(3)	Petroleum.
Scott	W	W	Stone.
Shelby	--	34	Do.
Simpson	W	W	Stone, petroleum.
Taylor	W	W	Do.
Todd	W	W	Do.
Trigg	W	W	Stone.
Trimble	W	W	Sand and gravel.
Union	W	21,460	Coal, petroleum, sand and gravel.
Warren	991	1,399	Stone, petroleum.
Washington	W	W	Stone.
Wayne	W	W	Stone, coal, petroleum.
Webster	8,157	8,281	Coal, petroleum.
Whitley	W	6,369	Coal, clays, petroleum.
Wolfe	259	481	Stone, petroleum, coal.
Undistributed [4]	426,078	325,283	
Total	847,465	[5]925,885	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Bracken, Campbell, Clark, Grant, Kenton, Larue, Lewis, Lincoln, Owen, Robertson, Spencer, and Woodford.

[2] Excludes natural gas and natural gas liquids; included with "Undistributed."

[3] Less than ½ unit.

[4] Includes natural gas, natural gas liquids, and values indicated by symbol W.

[5] Data may not add to total shown because of independent rounding.

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Louisiana

The mineral production in Louisiana consists of petroleum, neutral gas, and other fossil fuels, and minor amounts of clays, sand, gravel, and other nonmetallic commodities. There are no activities in rocks where fibrous amphibole minerals might occur. The county by county mineral production in Louisiana is given in Table A-29.

Source Reference

(88) The Mineral Industry of Louisiana, D. A. Carleton and L. H. Hough, 1971, U.S. Bureau of Mines' Mineral Yearbook.

TABLE A-29. **Value of mineral production in Louisiana, by parish**

(Thousands)

Parish	1970	1971	Minerals produced in 1971 in order of value
Acadia	$106,904	$117,495	Natural gas, natural gas liquids, petroleum.
Allen	6,764	7,207	Petroleum, natural gas, natural gas liquids, sand and gravel.
Ascension	43,501	46,869	Natural gas liquids, petroleum, salt, natural gas.
Assumption	29,651	29,847	Natural gas, petroleum, natural gas liquids.
Avoyelles	4,420	5,810	Petroleum, natural gas liquids, natural gas, sand and gravel.
Beauregard	8,554	8,872	Petroleum, natural gas, sand and gravel, natural gas liquids.
Bienville	12,393	W	Natural gas, petroleum, sand and gravel, clays.
Bossier	19,502	19,701	Natural gas, petroleum, natural gas liquids, sand and gravel.
Caddo	24,222	W	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Calcasieu	66,168	63,506	Petroleum, natural gas, natural gas liquids, lime, salt, sand and gravel.
Caldwell	3,088	3,946	Natural gas, petroleum.
Cameron	289,105	312,357	Natural gas, petroleum, natural gas liquids, salt, shell.
Catahoula	10,949	11,809	Petroleum, sand and gravel, natural gas.
Claiborne	25,011	33,527	Petroleum, natural gas, natural gas liquids, sand and gravel.
Concordia	23,894	W	Petroleum, natural gas, natural gas liquids.
De Soto	8,516	9,265	Natural gas, petroleum, sand and gravel.
East Baton Rouge	16,074	21,616	Lime, cement, petroleum, sand and gravel, natural gas, clays.
East Carroll	7	24	Natural gas, sand and gravel.
East Feliciana	W	--	
Evangeline	9,829	10,340	Petroleum, natural gas, natural gas liquids, sand and gravel.
Franklin	2,108	2,397	Petroleum, natural gas.
Grant	845	2,763	Petroleum, sand and gravel.
Iberia	216,385	298,230	Petroleum, natural gas, salt, natural gas liquids.
Iberville	61,881	67,260	Petroleum, salt, natural gas, natural gas liquids, sand and gravel.
Jackson	1,815	1,677	Natural gas, petroleum, sand and gravel.
Jefferson	231,778	357,755	Petroleum, natural gas, sulfur, natural gas liquids, salt, sand and gravel.
Jefferson Davis	53,796	54,077	Natural gas, petroleum, natural gas liquids, sand and gravel.
Lafayette	20,887	19,578	Do.
Lafourche	515,299	470,507	Petroleum, natural gas, sulfur, natural gas liquids.
La Salle	25,075	23,840	Petroleum, natural gas, sand and gravel.
Lincoln	19,659	W	Natural gas liquids, natural gas, petroleum, sand and gravel, clays.
Livingston	512	W	Sand and gravel.
Madison	1,205	1,142	Natural gas.
Morehouse	1,907	10,011	Natural gas, petroleum.
Natchitoches	27,814	35,200	Petroleum, natural gas, natural gas liquids, sand and gravel, clays.
Orleans	18,188	19,440	Cement, shell, lime, petroleum, natural gas, sand and gravel.
Ouachita	6,461	W	Petroleum, natural gas, sand and gravel, natural gas liquids.
Plaquemines	1,244,997	1,258,074	Petroleum, natural gas, sulfur, natural gas liquids, salt, sand and gravel.
Pointe Coupee	31,162	29,427	Petroleum, natural gas, natural gas liquids, clays.
Rapides	7,003	7,804	Petroleum, sand and gravel, natural gas, clays.
Red River	3,498	456	Sand and gravel, petroleum.
Richland	18,484	22,518	Petroleum, natural gas liquids, natural gas.
Sabine	1,356	1,014	Petroleum, sand and gravel, natural gas.
St. Bernard	30,270	50,692	Natural gas liquids, natural gas, petroleum, sand and gravel, clays.
St. Charles	90,370	85,898	Petroleum, natural gas, natural gas liquids.
St. Helena	W	W	Sand and gravel, clays.
St. James	9,345	11,127	Petroleum, natural gas, natural gas liquids.
St. John the Baptist	5,930	7,755	Petroleum, natural gas.
St. Landry	48,283	42,582	Natural gas, petroleum, natural gas liquids.
St. Martin	88,187	89,672	Petroleum, natural gas, salt, natural gas liquids, sand and gravel, clays.
St. Mary	473,513	536,844	Petroleum, natural gas, natural gas liquids, salt, shell, lime, sand and gravel.
St. Tammany	6,468	8,192	Shell, sand and gravel, natural gas, petroleum, clays.
Tangipahoa	2,275	3,158	Sand and gravel, petroleum, clays.
Tensas	8,463	4,202	Petroleum, natural gas, natural gas liquids.
Terrebonne	766,968	874,853	Petroleum, natural gas, natural gas liquids, sulfur, salt.
Union	8,583	1,702	Natural gas, petroleum, sand and gravel.
Vermilion	$311,444	$312,090	Natural gas, petroleum, natural gas liquids, sand and gravel.
Vernon	308	507	Sand and gravel.
Washington	1,365	1,640	Do.
Webster	30,138	28,817	Natural gas, natural gas liquids, petroleum, sand and gravel.
West Baton Rouge	2,603	W	Petroleum, natural gas, clays.
West Carroll	40	W	Natural gas.
West Feliciana	W	W	Sand and gravel.
Winn	3,156	8,083	Petroleum, stone, gypsum, natural gas.
Undistributed	[1] 2,949	[2] 106,044	
Total [2]	5,102,321	5,553,009	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Includes some natural gas liquids that cannot be assigned to specific parishes and values indicated by symbol W.

[2] Includes some petroleum that cannot be assigned to specific parishes and values indicated by symbol W.

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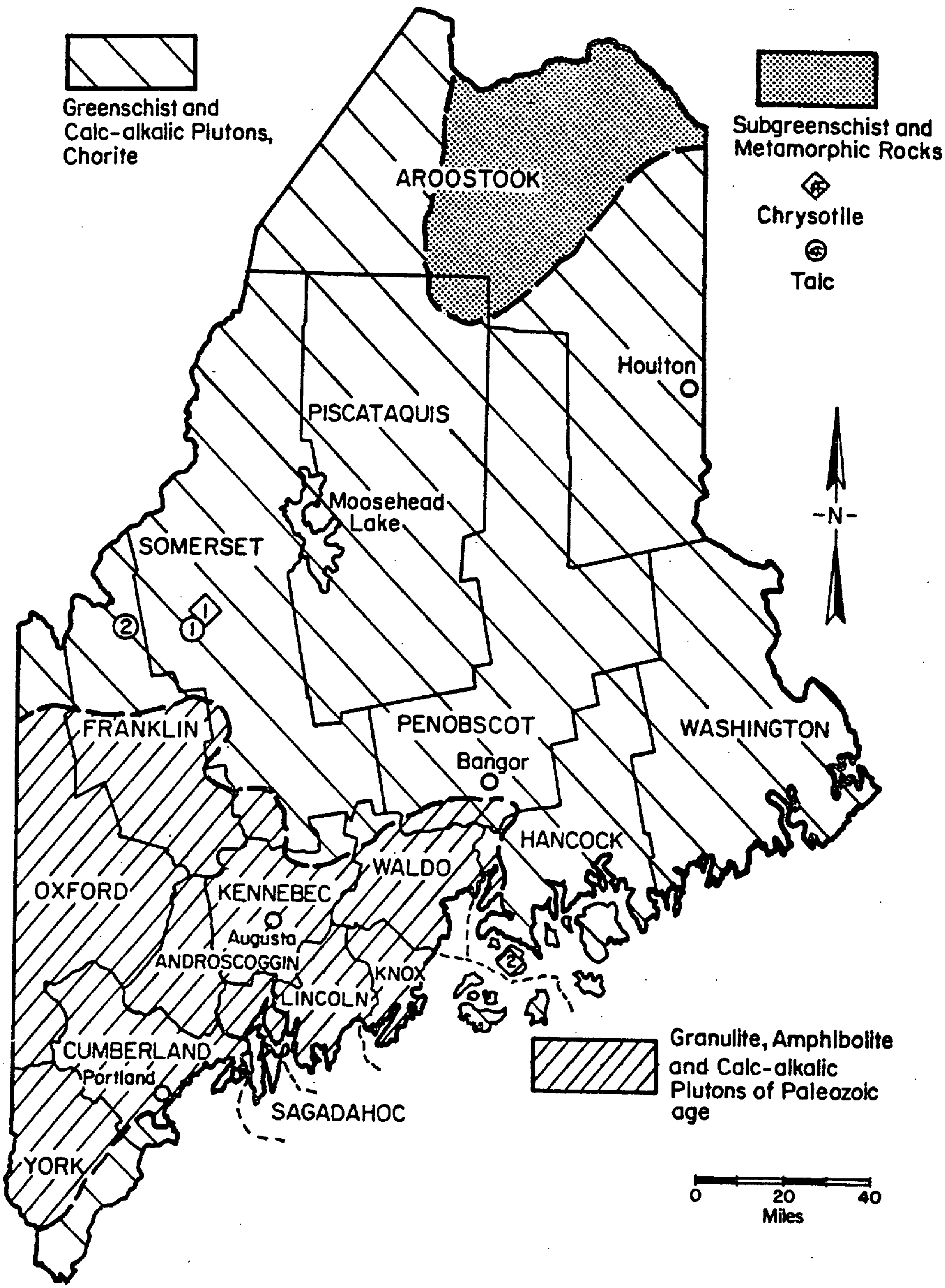
Maine

The geologic features of Maine include the extensive rock formations resulting from plutonic and metamorphic activities. The general areas distinguishable by rock types are shown in Figure A-23. There are two notable serpentinite intrustions of uncertain age, and both contain chrysotile asbestos (neither of the deposits are being exploited). These are described and located in Table A-30. Talc rocks are found in close association with one of the chrysotile occurrences also as described in the tabulation. Elsewhere in the state, fibruous mineral occurrences are not described. However, it should be understood that complete descriptions for much of the state are not available.

Metallic mineralization of Maine rocks is prevalent in the southern counties of Waldo and Hancock and in the surrounding counties of Knox, Lincoln, Kennebec, Somerset, Pemobscot, and Washington. Elsewhere there are metallic prospects in York and Aroostook Counties principally. The only current metal mining in Maine is for zinc - copper ores - in Hancock County. The Callahan Mining Company (Harborside, Maine 04642) closed out its operation in mid 1972. Kerr American, Inc., (Blue Hill, Maine) was planning to begin operations in a close-by area by late 1972. The balance of the Main mineral recovery operations are principally clay, sand, and gravel, and stone operations as described in Table A-31.



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[illegible] OCCURRENCE OF ASBESTOS ROCK IN MAINE

TABLE A-30. OCCURRENCES OF ASBESTOS AND TALC IN MAINE

Asbestos		
Somerset County:		
1. Spencer area. Slip- and cross-fiber chrysotile in serpentine. Bowles, 1955; Wing, 1951.	45° 21'	70° 14'
Hancock County:		
2. Deer Isle deposits. Chrysotile asbestos in serpentinite, Maine Geological Survey, 1957; Wing, 1951	44° 16'	68° 40'
Talc		
Somerset County:		
1. Spencer area. Talc-carbonate and talc rock associated with serpentinite. Wing, 1951	45° 21'	70° 14'
Franklin County:		
2. Kibby township. Talc rock associated with gold and silver in green and black slate, metasandstone and quartzite as well as chloritic phyllite.	45° 23'	70° 31'

(Localities are given in terms of North Latitude and West Longitude)

TABLE A-31. MINERAL PRODUCTION IN MAINE, BY COUNTY

Commodity and company	Address	Type of activity	County
Cement:			
Dragon Cement Co., Division of Martin Marietta Corp. [1]	5A Joyce Kilmer Ave. New Brunswick, N.J. 08901	Plant	Knox.
Clays:			
Dennis Brick Co., Inc	R. F.D. No. 1 33 Old Washington Rd. Auburn, Maine 04210	Pit	Androscoggin.
Lachance Bros. Brick Co	R.F.D. No. 2 Gorham, Maine 04038	Pit	Cumberland.
Fred S. Liberty & Sons, Inc	R.F.D. No. 1, Gray, Maine 04039	Pit	Do.
Morin Brick Co	Danville, Maine 04223	Pit	Androscoggin.
Royal River Brick Co., Inc	Box 191, Gray, Maine 04039	Pit	Cumberland
Peat:			
Acadia Peat Corp	Penobscot, Maine 04476	Bog	Hancock.
International Peat Moss Co., Inc.	430 Trapelo Rd. Belmont, Mass. 02178	Bog	Washington.
Perlite (expanded):			
Chemrock Corp	End of Osage Street Nashville, Tenn. 37208	Plant	Knox.
Sand and gravel:			
Blue Rock Industries	58 Main Street Westbrook, Maine 04092	Pit	Androscoggin, Cumberland.
Harry C. Crooker & Sons, Inc.	Brunswick, Maine 04011	Pit [2]	Do.
Hamlin Sand & Gravel Co., Inc.	920 Riverside St. Portland, Maine 04103	Pit [3]	Cumberland.
Lane Construction Co	965 E. Main St. Meriden, Conn. 06450	Pit	Penobscot.
Lewiston Crushed Stone Co., Inc.	South Ave. Lewiston, Maine 04240	Pit [2]	Androscoggin.
Harold C. MacQuinn, Inc	Bar Harbor, Maine 04609	Pit	Hancock.
C.M. Page Co., Inc	234 Main St. Orono, Maine 04473	Pit	Penobscot.
Leroy S. Prout Sand & Gravel	Scarborough, Maine 04074	Pit	Cumberland.
Maynard W. Robinson & Sons	R.F.D. No. 2 Cumberland Center, Maine 04021	Pit	Do.
Frank Rossi & Sons, Inc	National Bank Bldg. Gardiner, Maine 04345	Pit	Various.
Warren Bros. Company	Fairfield, Maine 04937	Pit	Kennebec.
Stone:			
Granite, dimension:			
Hocking Granite Industries Inc. [4]	Saint George, Maine 04857	Quarry	Knox.
The John Swenson Granite Co. Inc.	North State St. Concord, N.H. 03301	do	York, Knox.
Granite, crushed:			
Cook and Co., Inc	150 Causeway St. Boston, Mass. 02114	do	Cumberland.
Limestone, crushed:			
Blue Rock Industries	58 Main St. Cumberland Mills, Maine 04092	do	Kennebec.
Dragon Cement Co., Division of Martin Marietta Corp.	5A Joyce Kilmer Ave New Brunswick, N.J. 08901	do	Knox.
Lime Products Corp	P.O. Box 357 Union, Maine 04862	do	Do.
Miscellaneous, crushed:			
Blue Rock Industries	58 Main St. Cumberland Mills, Maine 04092	do	Cumberland.
Slate, dimension:			
Portland-Monson Slate Co.	Middle Granville, N.Y. 12849	Underground	Piscataquis.

[1] Portland and masonry.
[2] 2 pits.
[3] 3 pits.
[4] Also crushed.
[5] Also copper and silver.

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Source Reference

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, 1962, USGS Map MR-31.

(89) Metamorphic Map of the Appalachians, B. A. Morgan, USGS Map I-724.

(90) Preliminary Geologic Map of Maine, A. M. Hussey, II, Chief Compiler, 1967 Main Geological Survey.

(91) Mineral Resources of Maine (Reference Map Series, Bangor Sheet), (M.R.R.M.1), J. R. Rand, Main Geological Survey, Augusta, Maine.

(92) Maine Metal Mines and Prospects (Minerals Resource Index No. 3), A. M. Hussey, II, 1958, Maine Geological Survey, Augusta, Maine.

(93) The Mineral Industry of Maine, F. B. Fulkerson, 1971, U.S. Bureau of Mines' Minerals Yearbook.

Maryland

The Appalachian band of highly metamorphosed rocks is found in central Maryland as indicated in Figure A-24. The eastern portion of this region is characterized by extensive intrusives. There are numerous granitic pultons and gneiss domes, particularly around Baltimore. The metamorphosed sedimentaries are slates, marbles, and conglomerates as well as undifferential schists of Precambrian to Ordivician ages. The western Piedmont metasedmentary rocks include phyllitic slates, metasiltstone, marbles, muscovite-chloride-allite-quartz schists, interbedded quartzites, and amygdaloidal metabasalt. These formations are believed to be of late Precambrian age. Formations tend to be of younger age to the west in Washington County.

In the eastern part of the metamorphic belt there are numerous ultramatic rock bodies which are chiefly serpentinite with partly to completely altered dunite, peridotite, pyroxemite, and massive to schistose soapstone; talc-carbonate rock and altered gabbro are also found. Hypersthene gabbro, olivine gabbro, amorthositic gabbro, and metagabbros are locally prominent. Adjacent formations frequently consist of such rocks as epidote amphibolite, serpentinite, metapyroxenite, and actinolite-chloride-, and epidote-bearing schists. Mineralization is found throughout the metamorphic zone, but is especially prominent in the eastern area around the city of Baltimore. This area also contains deposits of amphibole asbestos, chiefly tremolite and amthophyllite, as well as soapstone associated with serpentinite. These sites in Baltimore and Carroll Counties are shown in Figure A-24 and described in Table A-32. To the north, in Baltimore, Harford, and Cecil Counties, there are also deposits of tremolite, talc, and soapstone, as shown on the map and described in the tabulation. Currently, only talc and soapstone are being worked on a commercial scale and from a single quarry in Harford County (Harford Talc Company, P. O. Box 527, Bel Air, Maryland, 21014). Talc was used in manufacturing toilet preparations and ceramics. Block soapstone was quarried. Nearby in Harford County, the Maryland Green Marble Corporation produced architectural serpentine and related products. Crushed serpentine is being produced in Baltimore County.

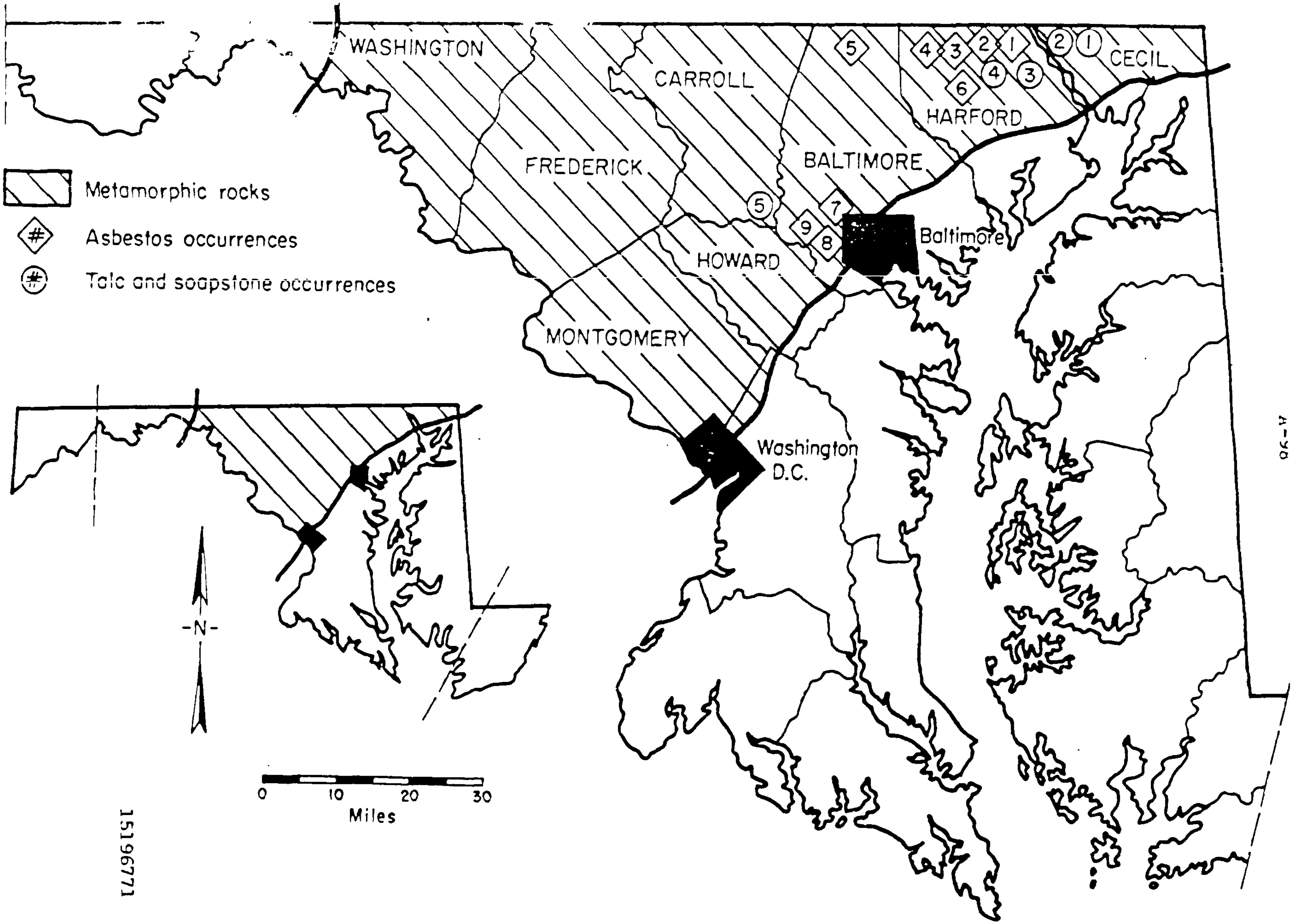

FIGURE A-24. OCCURRENCE OF METAMORPHIC ROCK IN MARYLAND

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TABLE A-32. ASBESTOS, TALC, AND SOAPSTONE DEPOSITS IN MARYLAND

Asbestos Deposits		
Harford County:		
Slip-fiber tremolite associated with basic igenous rocks		
1. Dublin area	39° 39'	76° 17'
2. Jenkins and Neikirk mines	39° 42'	76° 24'
3. Slade farm	39° 42'	76° 26'
4. Durham farm	39° 39'	76° 29'
5. Coopstown area	39° 35'	76° 27'
Baltimore County:		
6. Parkton area. Low quality amphibole asbestos	39° 40'	76° 41'
7. Powhatan area. Tremolite asbestos	39° 20'	76° 44'
8. Bok asbestos mine. Slip-fiber anthophyllite	39° 19'	76° 47'
9. Alberton mine. Anthophyllite asbestos	39° 20'	76° 49'
Talc and Soapstone Deposits		
Cecil County:		
1. Rock Springs quarries. Talc rock associated with serpentinite in contact with pegmatite.	39° 43'	76° 08'
2. Bald Friar quarry. Talc rock associated with serpentinite in contact with pegmatite.	39° 42'	76° 12'
Harford County:		
3. Dublin and Scarboro quarries. Talc-carbonate and talc rock in serpentinite in contact with pegmatites	39° 39'	76° 17'
4. Rocks (Airs) quarry. Soapstone associated with serpentinite	39° 38'	76° 25'
Carroll County:		
5. Oursler and Marriotsville quarries. Soapstone associated with serpentinite	39° 22'	76° 55'

(Locations are given in terms of North Latitude and West Longitude)

The current mining and quarrying activities in the eight-county area having metamorphic rocks are given in Table A-33. No metallics are now being produced. The extent to which the fibrous amphiboles are being encountered in the various quarrying operations is not reported.

TABLE A-33. MINING ACTIVITY IN MARYLAND

County	Commodity
Baltimore	Clays, limestone, crushed serpentine and crushed marble, sand and gravel, and quartzite.
Carroll	Cement, shale, crushed marble.
Cecil	Sand and gravel, granite building stone, crushed gneiss, crushed granite.
Frederick	Clay, cement, limestone, crushed marble, crushed quartzite
Harford	Clay, sand and gravel, architectural serpentine, crushed gneiss, crushed gabbro, talc and soapstone.
Howard	Quartzite, crushed gabbro, crushed marble.
Montgomery	Gneiss building stone, crushed serpentine.
Washington	Cement, clay, crushed limestone, potash

Source References

(1) Metamorphic Map of the Appalachians, B. A. Morgan, 1972, U.S.G.S. Map I-724.

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, U.S.G.S. Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, 1962, U.S.G.S. Map MR-31.

(94) Geologic Map of Maryland, E. G. Cleaves, et al., 1968, Maryland Geological Survey, Baltimore, Maryland.

(95) Mineral Deposits of Maryland, N.C. Pearre, U.S.G.S. Map MR-12.

(96) The Mineral Industry of Maryland in 1971, C. L. Klingman, Information Circular 15, Maryland Geological Survey in Cooperation with the U.S. Bureau of Mines (same as Md. Chapter from Minerals Yearbook).

(97) Directory of Mineral Producers in Maryland - 1971, J. Edwards, Jr., Information Circular 11, Maryland Geological Survey, Baltimore, Maryland.

Massachusetts

Metamorphic rocks are found over most of Massachusetts as shown in Figure A-25. The exceptional areas include the Connecticut River Valley in the western part of the state and Cape Cod - Barnstable County, on the Atlantic Coast. The ultramafic rocks and amphibole mineral occurrences are confined to the western counties of Massachusetts. Their areal locations are shown on the county map (Figure A-26) and are described in Table A-34. Currently, none of these sites are being worked for the exploitation of fibrous minerals. Mineral production is taking place in the several counties of interest, but most of the operations are for stone, sand, and gravel. The 1971 operating companies, their locations, and the material being produced are listed in Table A-35 (from the U.S. Bureau of Mines' Mineral Yearbook)

Sources References

(1) Metamorphic Map of the Appalachians, B. A. Morgan, 1972, U.S.G.S. Map I-724.

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, U.S.G.S. Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, 1962, U.S. Bureau of Mines' Mineral Yearbook.

(98) Mineral Deposits and Occurrences in Massachusetts and Rhode Island, Exclusive of Clay, Sand and Gravel, and Peat, N. C. Pearre, 1956, U.S.G.S. Mineral Resource Map MR-4.

(99) The Mineral Industry of Massachusetts, R. A. Clifton, U. S. Bureau of Mines' Mineral Yearbook.

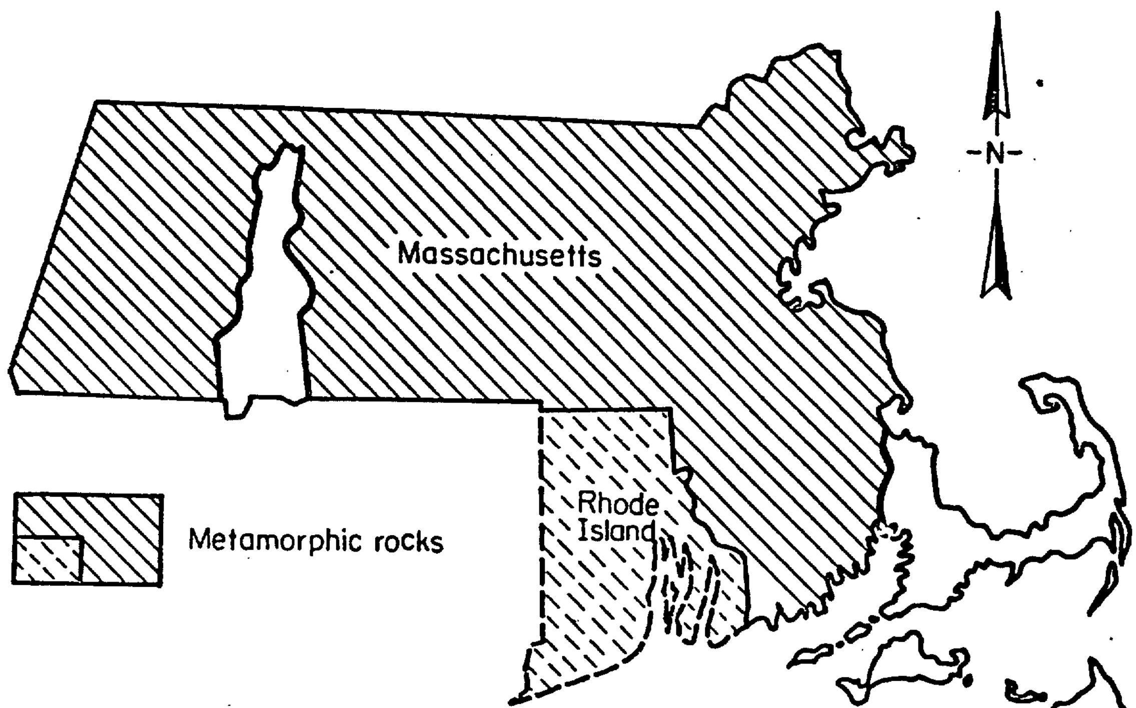

FIGURE A-25. OCCURRENCE OF METAMORPHIC ROCK IN MASSACHUSETTS

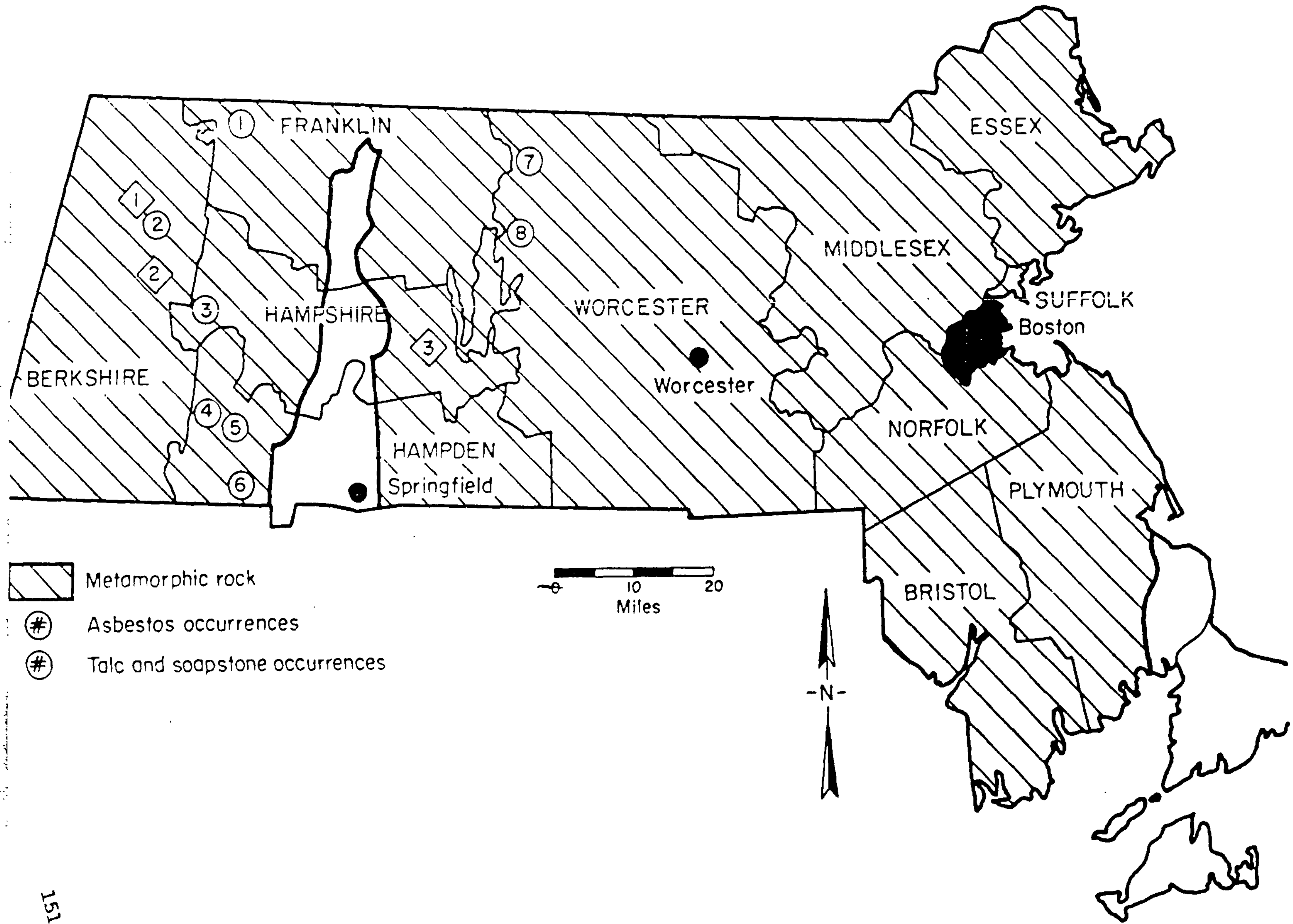

FIGURE A-26. DETAILED MAP SHOWING OCCURRENCE OF METAMORPHIC ROCK IN MASSACHUSETTS

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TABLE A-34. OCCURRENCES OF ASBESTOS, TALC, AND SOAPSTONE IN MASSACHUSETTS

Area and Description	Latitude	Longitude	County
Asbestos:			
1. North Mountain area. Chrysotile asbestos veins in large body of ultramafic rock. Herz, 1958.	42°32'	73°10'	Berkshire
2. Hinsdale mine. Amphibole asbestos. Pearre, 1956.	42°27'	73°09'	Berkshire
3. Pelham quarry. Fibrous anthophyllite veins in large block of saxonite enclosed in granite gneiss. Emerson, 1898, 1917; Pearre, 1956.	42°21'	72°27'	Hampshire
Talc and Soapstone:			
1. Rowe quarries. Talc-carbonate and talc rock derived from ultramafic igneous rocks. Pearre, 1956.	42°43'	72°55'	Franklin
2. Cummington quarry. Soapstone probably derived from mafic igneous rocks. Pearre, 1956.	42°29'	73°07'	Berkshire
3. Middlefield prospects. Soapstone probably derived from mafic igneous rocks. Pearre, 1956.	42°22'	72°59'	Hampshire
4. Unnamed quarry. Soapstone probably derived from mafic igneous rocks. Pearre, 1956	42°11'	72°58'	Hampden
5. Blandford quarry. Soapstone probably derived from mafic igneous rocks. Pearre, 1956.	42°10'	72°55'	Hampden
6. Granville quarry. Soapstone probably derived from mafic igneous rocks. Pearre, 1956.	42°03'	72°55'	Hampden
7. Tully Mountain quarry. Soapstone probably derived from mafic igneous rocks. Hadley, 1949; Pearre, 1956.	42°39'	72°15'	Worcester
8. Petersham quarries. Soapstone probably derived from mafic igneous rocks. Pearre, 1956.	42°29'	72°15'	Worcester

15196778

(Localities by North Latitude and West Longitude)

TABLE 35. MINING ACTIVITY IN MASSACHUSETTS, BY COUNTY

Commodity and company	Address	Type of activity	County
Clays:			
Susquehanna Corp., K-F Brick Co., Inc.	River St. Middleboro, Mass. 02346	Pit	Plymouth.
Plainville Corp. Mamlite Div.	Box 1747, Cross St. Plainville, Mass. 02762	Pit	Norfolk.
The Stiles & Hart Brick Co.	Box J., Bridgewater, Mass. 02324	Pit	Plymouth.
Gypsum, calcined:			
United States Gypsum Co.	101 South Wacker Dr. Chicago, Ill. 60606	Plant	Suffolk.
Lime:			
Lee Lime Corp.	Marble St., Lee, Mass. 01238	do	Berkshire.
Pfizer, Inc.	260 Columbia St. Adams, Mass. 01220	do	Do.
Peat:			
Sterling Peat Co.	Sterling Junction, Mass. 01565	Bog	Worcester.
Perlite, expanded:			
United States Gypsum Co.	101 South Wacker Dr. Chicago, Ill. 60606	Plant	Suffolk.
Whittemore Products, Inc.	85 Harrison St. Roslindale, Mass. 02131	do	Do.
Roofing granules:			
Bird & Son, Inc.	East Walpole, Mass. 02032	do	Norfolk.
Sand and gravel:			
Ashland Sand & Concrete Co.	Box 347, Chestnut St. Ashland, Mass. 01721	Pit	Middlesex.
Assonet Sand & Gravel Co., Inc.	South Main St. Assonet, Mass. 02702	Pit	Bristol.
Burlington Sand & Gravel Co., Inc.	Blanchard Rd., Box 116 Burlington, Mass. 01803	Pit	Middlesex.
Courtois Sand & Gravel Co.	Box 84 Central Falls, R. I. 02863	Pit	Bristol.
J.J. Cronin Co.	P.O. Box 176 North Reading, Mass. 01864	Pit	Middlesex.
E. L. Dauphinais, Inc.	160 Worcester Rd. North Grafton, Mass. 01536	Pit	Middlesex and Worcester.
General Sand & Stone Corp.	444 Merrill Rd. Pittsfield, Mass. 01201	Pit	Berkshire.
P. J. Keating Co.	P.O. Box 345 Fitchburg, Mass. 01420	Pit	Worcester.
Merrimack Materials, Inc.	Yemma Rd. Groveland, Mass. 01830	Pit	Essex.
Morse Sand & Gravel Co.	P.O. Box 175 Pawtucket, R. I. 02863	Pit	Bristol.
North Wilbraham Sand & Gravel & Concrete Co., Inc.	2420 Boston Rd. North Wilbraham, Mass. 01067	Pit	Hampden.
Northfield Washed Sand & Gravel Co., Inc.	Northfield, Mass. 01360	Pit	Franklin.
Pomerleau Bros., Inc.	P.O. Box 236 North Chelmsford, Mass. 01863	Pit	Middlesex.
Thomas Quinn Co., Inc.	20 Hobbs Ct. Arlington, Mass. 02174	Pit	Middlesex and Worcester.
L. Romano Const. Co.	835 Taunton Ave. East Providence, R. I. 02914	Pit	Norfolk.
Rosenfeld Washed Sand & Stone Co.	40 Cedar St. Milford, Mass. 01757	Pit	Worcester.
San-Vel Contracting Co.	Route No. 2, Ayer Rd. Littleton, Mass. 01460	Pit	Middlesex.
Stow Sand & Gravel Co.	Box 861, Acton, Mass. 01720	Pit	Do.
Tresca Bros. Sand & Gravel Inc.	66 Main St. Millis, Mass. 02054	Pit	Norfolk.
Varney Bros. Sand & Gravel, Inc.	Hartford Ave. Bellingham, Mass. 02019	Pit	Do.
Warner Bros., Inc.	Sunderland, Mass. 01375	Pit	Franklin.
A. A. Will Sand & Gravel Corp.	Turnpike St. Canton, Mass. 02021	Pit	Norfolk.
Sand and gravel—Continued			
Worcester Sand & Gravel Co.	182 Holden St. Shrewsbury, Mass. 01545	Pit	Worcester.
Wrentham Sand & Gravel Co., Inc.	Riverside Rd. Wrentham, Mass. 02093	Pit	Norfolk.
Stone:			
Basalt, crushed and broken:			
B. & M. Crushed Stone Division, Bayer & Mingolla Industries, Inc.	Spring St., Ashland, Mass. 01721	Quarry	Middlesex.
George Brox, Inc.	1471 Methuen St. Dracut, Mass. 01826	do	Do.
Essex Bituminous Concrete Corp.	Russell St. West Peabody, Mass. 01960	do	Essex.
Essex Bituminous Concrete Corp. of Dracut.	2140 Bridge St. Dracut, Mass. 01826	do	Middlesex.
Holden Trap Rock Co.	N. Main St., Holden, Mass. 01520	do	Worcester.
P. J. Keating Co.	P.O. Box 345 Fitchburg, Mass. 01420	do	Do.
John S. Lane & Son, Inc.	P. O. Box 125 Westfield, Mass. 01085	do	Hampden and Hampshire.
Lynn Sand & Stone Co.	30 Danvers Rd. Swampscott, Mass. 01907	do	Essex.
Massachusetts Broken Stone Co.	Boston Post Rd. Weston, Mass. 02193	do	Middlesex.
Rowe Contracting Co.	1500 Salem St. Malden, Mass. 02148	do	Do.
Simeone Stone Corp.	P.O. Box 218 Wrentham, Mass. 02093	do	Norfolk.
Trimount Bituminous Products Co.	1840 Parkway St. Everett, Mass. 02149	do	Essex.
Warner Bros., Inc.	Sunderland, Mass. 01375	do	Franklin.
Granite, dimension:			
Bates Bros. Seam Face Granite Co.[1]	1372 Hancock St. Quincy, Mass. 02169	do	Norfolk.
H. E. Fletcher Co.[1]	West Chelmsford, Mass. 01824	do	Middlesex.
Forrest Road Granite Co., Inc.	20 Adams St. North Chelmsford, Mass. 01863	do	Do.
Guilmette Bros. Corp.	57 Ledge Rd. North Chelmsford, Mass. 01863	do	Do.
Le Masurier Granite Quarry, Inc.	P.O. Box 71, Ledge Rd. North Chelmsford, Mass. 01863	do	Do.
Oak Hill Granite Co., Inc.	Middlesex St., Lowell, Mass. 01852	do	Do.
Plymouth Quarries, Inc.[1]	East Weymouth, Mass. 01402	do	Plymouth.
Granite, crushed and broken:			
Old Colony Crushed Stone Co.	P.O. Box 230 Quincy, Mass. 02169	do	Norfolk.
Simeone Stone Corp.	P.O. Box 218 Wrentham, Mass. 02093	do	Do.
West Roxbury Crushed Stone Co.	10 Grove St. West Roxbury, Mass. 02132	do	Suffolk.
Limestone and dolomite, crushed:			
John S. Lane & Son, Inc.	P.O. Box 125 Westfield, Mass. 01085	do	Berkshire.
Lee Lime Corp.	Marble St., Lee, Mass. 01238	do [2]	Do.
Massachusetts Broken Stone Co.	Boston Post Rd. Weston, Mass. 02193	do	Middlesex.
Pfizer, Inc.	260 Columbia St. Adams, Mass. 01220	do	Berkshire.
Miscellaneous stone, crushed:			
Berlin Stone Co.	Sawyer Hill Rd. Berlin, Mass. 01503	do	Worcester.
Dedham Sand & Gravel, Inc.	Walpole, Mass. 02081	do	Norfolk.
S. M. Lorusso & Sons, Inc.	331 West St. Walpole, Mass. 02081	do	Do.
Warren Bros. Co., Division of Ashland Oil & Refining Co.	430 Howard St. Brockton, Mass. 02402	do	Bristol.
Sandstone, dimension:			
McCormick Longmeadow Stone Co., Inc.	East Longmeadow, Mass. 01028	do [3]	Hampden.
Vermiculite, exfoliated:			
W. R. Grace & Co., Zonolite Div.	62 Whittemore Ave. Cambridge, Mass. 02140	Plant	Hampshire.

[1] Also crushed and broken granite.
[2] 2 quarries: 1 dolomite, 1 limestone.
[3] 2 quarries.

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Michigan

The bedrock of the western portion of Michigan's upper peninsula consists almost entirely of Precambrian formations. Locally there are a few outcrops of Ordivician age sediments. Within the Precambrian formations there are numerous intrusives, some of middle Precambrian age (Iron County principally), but mostly of lower Precambrian age (Gogebic, Iron, Marquette, Dickinson, and Menominee Counties). The major occurrences are shown in Figure A-27. The iron ore deposits of Michigan are sometimes closely associated with these intrusions, notably in Marquette County. The major copper occurrences of the Keeweenaw Peninsula are associated with the great Keeweenaw Fault. The copper deposit in Ontonagon County at White Pine is a sulfide. Thus, it is clear that the mineralization and metamorphism is widespread in this part of Michigan's upper peninsula. However, there is not currently an abundance of quarrying and mining activity.

There are no current mining activities for the native copper deposits of the Keesweenaw Peninsula. Copper sulfide ore is being mined in Ontonagon County at White Pine, however (White Pine Copper Company, P.O. Box 427, White Pine, Michigan 49971). Iron ores are being taken from Iron County from the Iron River - Crystal Falls District (Inland Steel Company, 30 West Monroe Street, Chicago, Illinois 60603), from the Felch District in Dickinson Country (The Hanna Mining Company, 100 Erieview Plaza, Cleveland, Ohio 44114) and from the Marquette Range in Marquette County (Cleveland-Cliffs Iron Company, 1460 Union Commerce Building, Cleveland, Ohio 44114). The latter operates at four sites from the Marquette Range as described below.

Site No.	Township & Range	Section	Town Location	Remarks
1	T 47 N, R 26 W	17	1 mile NW of Palmer	Open pit, pellets
2	T 47 N, R 27 W	1	West side of Negaunee	Open pit, pellets
3	T 46 N, R 29 W	7	1 mile S of Republic	Open pit, pellets
4	T 47 N, R 27 W	26	3 miles S of Ishpeming	Open pit, Siliceous ore

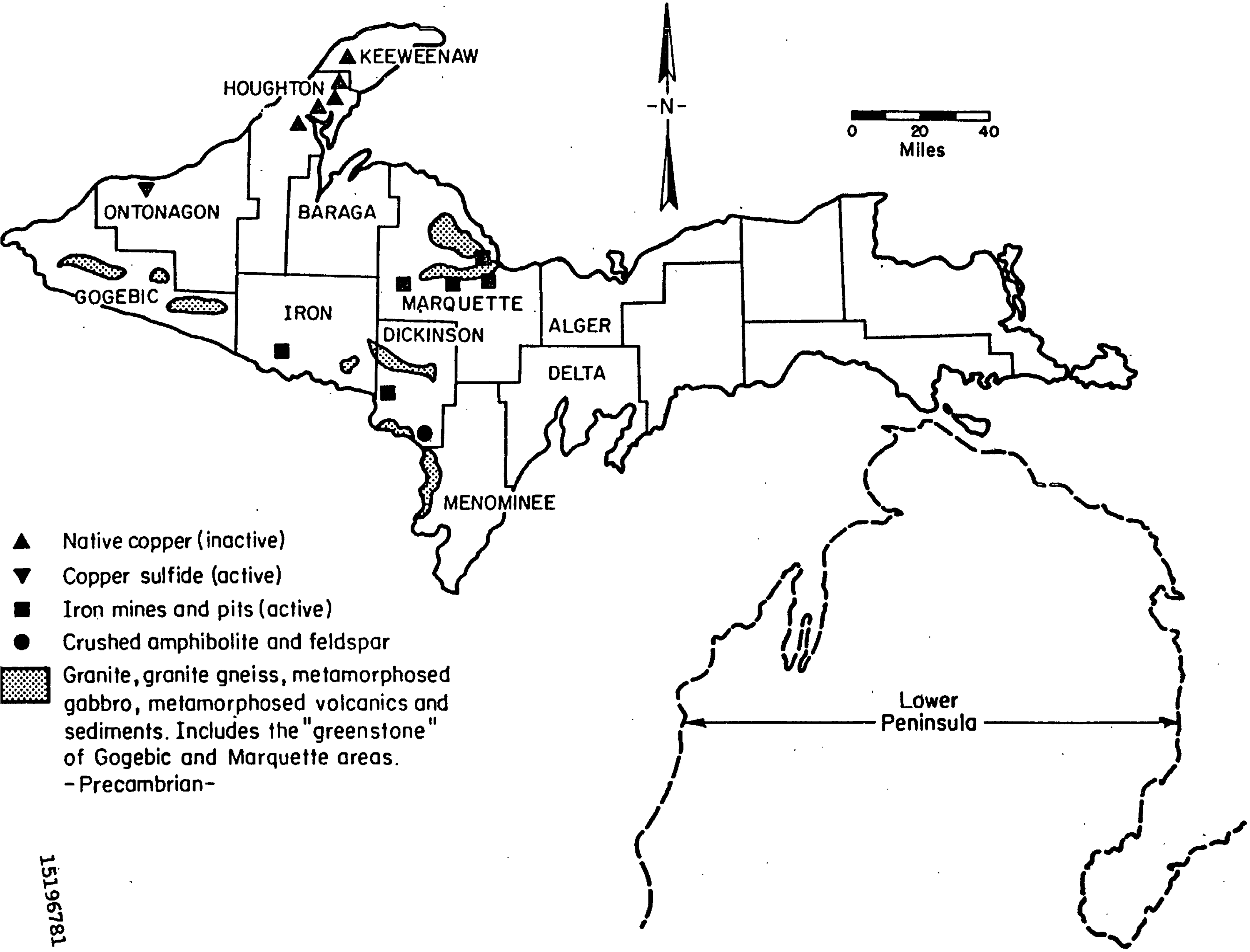

FIGURE A-27. OCCURRENCE OF ASBESTOS IN MICHIGAN

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The former iron recovery operations at Ironwood in Gogebic County, at the Amasa-Oval District in Iron County, at Gwinn in Marquette County, and in the Iron Mountain Range in Dickinson County, are currently inactive. Of interest in the same general area of Dickinson County, however, is a crushed amphibolite operation taking place in Section 26, near Randville (Aggregate Specialties, Caspian, Michigan 49915). Elsewhere in the ten-county area of western upper peninsula, Michigan, there are numerous quarrying operations for such commodities as sand, gravel, sandstone, limestone, marble, dolomite, and felspar. Asbesti form minerals have not been reported from these operations. Mineral production in Michigan is summarized in Table A-36.

Source References

(100) Bedrock of Michigan, R. W. Kelley, 1968, Small Scale Map 2, Michigan Geological Survey, Lansing, Michigan.

(101) Michigan Mineral Producers, 1972, Annual Directory 6, R. T. Segall, 1973, Michigan Geological Survey, Lansing, Michigan.

(102) Check Minerals Yearbook, Michigan, 1971.

TABLE A-36. Value of mineral production in Michigan, by county [1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Alcona	W	$334	Stone, sand and gravel.
Alger	$39	69	Sand and gravel.
Allegan [1]	W	924	Sand and gravel, petroleum, peat, stone, natural gas.
Alpena	W	W	Cement, stone, clays, sand and gravel.
Antrim	W	W	Clays, sand and gravel.
Arenac	1,048	1,055	Petroleum, stone, sand and gravel.
Baraga	120	81	Sand and gravel.
Barry	W	W	Sand and gravel, petroleum, stone.
Bay	8,738	10,805	Cement, sand and gravel, petroleum, lime.
Benzie	3	18	Sand and gravel.
Berrien	2,960	W	Sand and gravel, stone.
Branch	355	W	Do.
Calhoun [1]	W	5,061	Petroleum, sand and gravel, stone, natural gas.
Cass	W	W	Sand and gravel, stone.
Charlevoix	12,389	W	Cement, stone, sand and gravel.
Cheboygan	138	W	Stone, sand and gravel.
Chippewa	4,471	3,618	Do.
Clare [1]	W	1,331	Petroleum, sand and gravel, natural gas.
Clinton	W	807	Sand and gravel, clays.
Crawford [1]	W	W	Petroleum, sand and gravel, natural gas.
Delta	270	W	Stone, sand and gravel.
Dickinson	26,983	26,210	Iron ore, stone, sand and gravel.
Eaton	1,033	729	Sand and gravel, stone, clays, peat.
Emmet	9,342	12,882	Cement, stone, sand and gravel.
Genesee	633	975	Sand and gravel, petroleum.
Gladwin	W	912	Petroleum.
Gogebic	114	W	Sand and gravel.
Grand Traverse	W	W	Sand and gravel, petroleum.
Gratiot [1]	W	W	Magnesium compounds, calcium-magnesium chloride, salt, bromine, sand and gravel, petroleum, natural gas.
Hillsdale [1]	W	W	Petroleum, sand and gravel, stone, natural gas.
Houghton	119	W	Sand and gravel, stone.
Huron	1,105	1,276	Stone, lime, sand and gravel.
Ingham	W	1,917	Petroleum, sand and gravel, peat.
Ionia	562	319	Sand and gravel.
Iosco	4,893	5,306	Gypsum, sand and gravel.
Iron	7,020	6,635	Iron ore, sand and gravel.
Isabella [1]	W	W	Sand and gravel, petroleum, natural gas.
Jackson [1]	W	2,921	Petroleum, sand and gravel, stone, natural gas.
Kalamazoo	1,809	W	Sand and gravel, stone.
Kalkaska	521	[2] 1,007	Petroleum, sand and gravel, natural gas.
Kent [1]	4,478	5,106	Sand and gravel, gypsum, petroleum, peat, natural gas.
Keweenaw	21	5	Sand and gravel.
Lake	685	630	Petroleum, sand and gravel.
Lapeer [1]	1,840	1,231	Peat, petroleum, sand and gravel, calcium-magnesium chloride, natural gas.
Leelanau	222	609	Stone, sand and gravel.
Lenawee [1]	766	1,002	Sand and gravel, clays, petroleum, natural gas.
Livingston	3,345	2,936	Sand and gravel.
Luce	33	W	Do.
Mackinac	W	W	Stone, sand and gravel.
Macomb [1]	2,284	2,267	Sand and gravel, petroleum, natural gas.
Manistee	27,573	26,701	Salt, magnesium compounds, bromine, sand and gravel.
Marquette	135,806	128,064	Iron ore, sand and gravel, stone.
Mason	W	26,747	Magnesium compounds, calcium-magnesium chloride, lime, bromine, sand and gravel petroleum.
Mecosta [1]	W	W	Petroleum, sand and gravel, peat, natural gas.
Menominee	W	W	Lime, sand and gravel.
Midland	W	W	Bromine, salt, calcium-magnesium chloride, magnesium compounds, iodine, petroleum, sand and gravel.
Missaukee [1]	2,008	W	Petroleum, sand and gravel, natural gas.
Monroe	W	W	Cement, stone, clays, peat, petroleum, sand and gravel.
Montcalm	[2] 543	W	Petroleum, sand and gravel.
Montmorency	54	2	Sand and gravel.
Muskegon	2,260	W	Salt, sand and gravel, petroleum.
Newaygo [1]	493	W	Sand and gravel, petroleum, natural gas.
Oakland	W	13,543	Sand and gravel, peat, petroleum.
Oceana	$507	$401	Petroleum, sand and gravel.
Ogemaw [1]	1,736	1,628	Petroleum, sand and gravel, stone, natural gas.
Ontonagon	79,618	59,282	Copper, silver, sand and gravel.
Osceola [1]	2,261	W	Petroleum, sand and gravel, natural gas.
Oscoda	50	40	Sand and gravel, petroleum.
Otsego [1]	911	W	Petroleum, sand and gravel, natural gas.
Ottawa [1]	W	3,763	Sand and gravel, clays, petroleum, natural gas.
Presque Isle	W	W	Stone, sand and gravel, petroleum.
Roscommon [1]	W	W	Petroleum, sand and gravel, natural gas.
Saginaw	513	809	Sand and gravel, lime, clays, petroleum.
St. Clair [1]	19,293	18,923	Salt, petroleum, cement, clays, sand and gravel, natural gas.
St. Joseph	266	198	Sand and gravel, peat, stone.
Sanilac	1,158	1,935	Peat, sand and gravel, lime.
Schoolcraft	W	W	Stone.
Shiawassee	682	486	Sand and gravel, peat, clays, petroleum.
Tuscola	W	W	Sand and gravel, petroleum, lime.
Van Buren	174	138	Sand and gravel, petroleum.
Washtenaw	1,354	2,503	Do.
Wayne	57,189	54,028	Cement, lime, salt, sand and gravel, stone, clays, petroleum.
Wexford	121	W	Sand and gravel.
Undistributed [3]	238,321	202,467	
Total	[4] 670,729	640,636	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Values for natural gas and natural gas liquids are not available on a county basis; included with "Undistributed."

[2] Excludes value of natural gas.

[3] Includes values for natural gas, natural gas liquids, gem stones, some sand and gravel that cannot be assigned to specific counties, and values indicated by symbol W.

[4] Data does not add to total shown because of independent rounding.

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Minnesota

The general geology of Minnesota is an extension of the Canadian Precambrian Shield and has the same general rock sequences. Figure A-28 gives the general geology, with the shaded areas indicating the igneous and metamorphic horizons which are close to the surface over most of the state. The primary metamorphism is associated with Duluth Gabbro along the eastern end of the Mesabi Range. The principal minerals in this area are quartz, magnetite, amphiboles (commonly cummingtonite, actinolite, and hornblende) pyroxenes, garnet, fayalite, and biotite. The Duluth Gabbro Complex is also present in the Gunflint Range and a small section of the Vermillion Range.

The main mineral production value of Minnesota is the iron ore. Two counties (St. Louis and Itasca) account for 92 percent of the states mineral production value with St. Louis counties totaling 81 percent. The remaining mineral production is accounted for by manganiferous ore, clays, sand and gravel, stone, lime, and peat. The principal mineral producers are given in Table A-37. The value of mineral production is given in Table A-38 by county.

The iron ore coming from the northeastern end of the Mesabi Range reportedly contains asbestosform minerals as an accessory component in quantities as high as 30 percent. Currently, there is court action being taken by the EPA to stop Reserve Mining Company from dumping tailings into the lake. This action was taken upon finding fibrous amphiboles in the drinking water supply which is taken from the lake by Duluth and other communities.

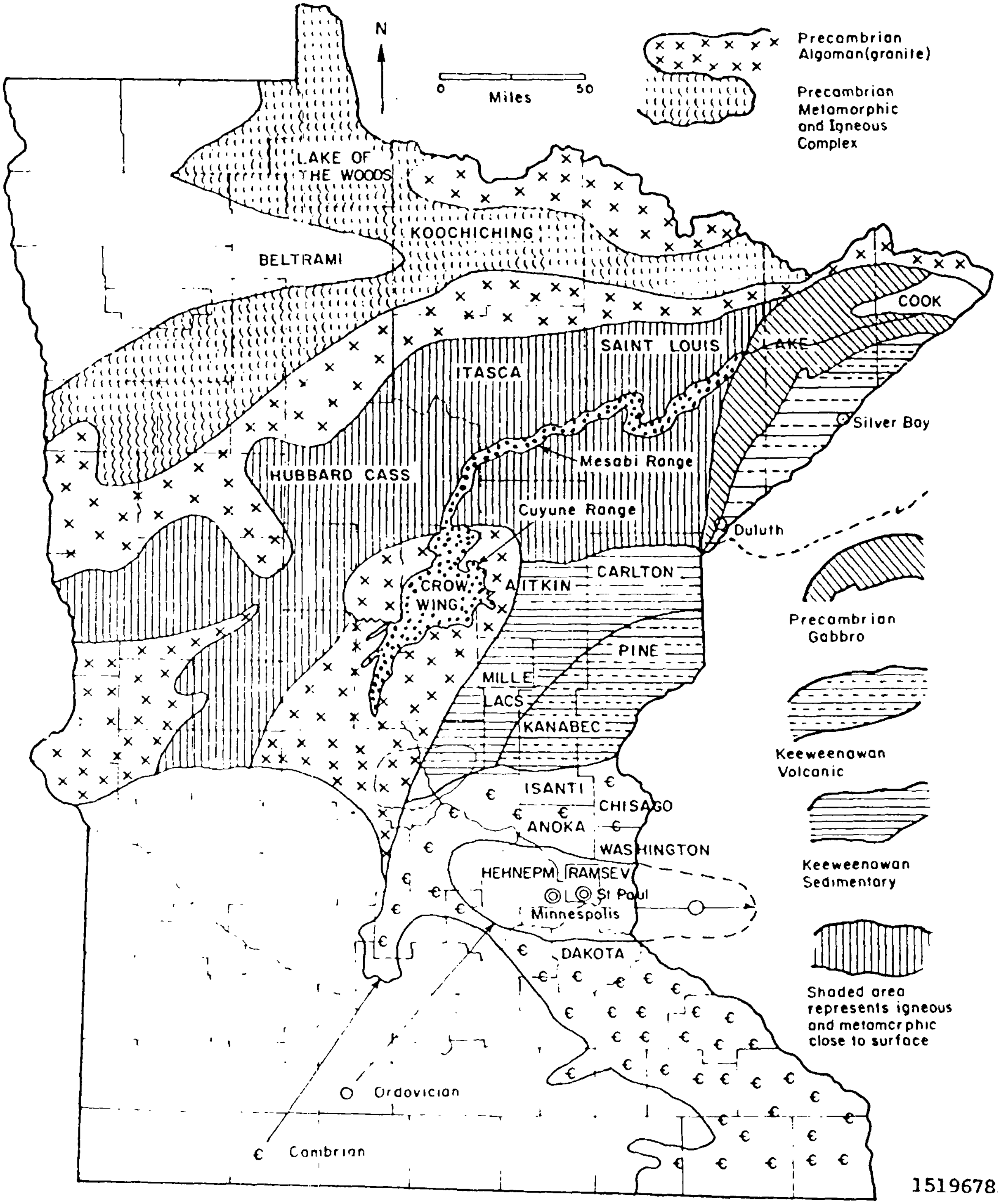

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FIGURE A-28. GEOLOGICAL FEATURES OF MINNESOTA

Minnesota

The general geology of Minnesota is an extension of the Canadian Precambrian Shield and has the same general rock sequences. Figure A-28 gives the general geology, with the shaded areas indicating the igneous and metamorphic horizons which are close to the surface over most of the state. The primary metamorphism is associated with Duluth Gabbro along the eastern end of the Mesabi Range. The principal minerals in this area are quartz, magnetite, amphiboles (commonly cummingtonite, actinolite, and hornblende) pyroxenes, garnet, fayalite, and biotite. The Duluth Gabbro Complex is also present in the Gunflint Range and a small section of the Vermillion Range.

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TABLE A-37. PRINCIPAL MINERAL PRODUCERS IN MINNESOTA

County	Company and Address	Commodity
Rock	Jasper Stone Company Box 206 Sioux City, Iowa 51102	Abrasive Stone
St. Louis	Universal Atlas Cement Div. United States Steel Corp. Chatham Center, Box 2969 Pittsburgh, Pennsylvania 15230	Cement
Hennepin	North Central Lightweight Aggregate Company, Inc. 4901 W. Medicine Lake Dr. Minneapolis, Minnesota 55427	Clays & Shale
Brown, Redwood	Ochs Brick & Tile Company Springfield, Minnesota 56087	Clays & Shale
Ramsey	Twin City Brick Company 790 Joy Avenue St. Paul, Minnesota 55118	Clays & Shale
St. Louis	American Steel & Wire Division United States Steel Corp. Morgan Park Duluth, Minnesota 55800	Coke
Ramsey	Koppers Company, Inc. 1000 Hamline Avenue, North St. Paul, Minnesota 55104	Coke
	Cleveland-Cliffs Iron Company 1460 Union Commerce Building Cleveland, Ohio 44115	Iron Ore
Itasca	Canisteo and Hill Trumbull	Iron Ore
	The Hanna Mining Company 100 Eireview Plaza Cleveland, Ohio 44114	Iron Ore
Crow Wing	Rabbit Lake	Iron Ore
Itasca	Butler Taconite Project	Iron Ore
Itasca, St. Louis	National Steel Pellet Project	Iron Ore

TABLE A-37 (continued)

County	Company and Address	Commodity
	Hanna Mining Co. (continued)	
St. Louis	Pierce Group	Iron Ore
"	South Agnew Group	"
Itasca	West Hill	"
	Jones & Laughlin Steel Corporation Minnesota Ore Division Virginia, Minnesota 55692	
"	Hill Annex and Lind-Greenway	"
St. Louis	McKinley and Schley Group	"
	Oglebay Norton Company Hanna Building Cleveland, Ohio 44115	
"	Thunderbird Mine	"
"	Fairland Plant	"
	Pickands Mather & Company 2000 Union Commerce Building Cleveland, Ohio 44115	
"	Erie Commercial	"
"	Mahoning	"
	Pittsburgh Pacific Company 2521 First Avenue Hibbing, Minnesota 55746	
"	Dunwoody, Gilbert, Lincoln West, Monroe, and Others	"
"	Julia Plant	"
	Reserve Mining Company Silver Bay, Minnesota 55614	
"	Peter Mitchell	"
Lake	E. W. Davis Works	"
	Rhude & Fryberger, Inc. Box 66 Hibbing, Minnesota 55746	
St. Louis	Gross Nelson and Hull-Rust Group	"

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TABLE A-37 (continued)

County	Company and Address	Commodity
	Snyder Mining Company Box 1106 Pittsburgh, Pa 15230	
St. Louis	Kosmerl Lease Area, Wanless, Whiteside	Iron Ore
	United States Steel Corporation Minnesota Ore Operations Box 417 Mountain Iron, Minnesota 55768	
Itasca	Plummer Group	"
St. Louis	Kosmerl	"
"	Minntac	"
"	Rouchleau Group	"
"	Sherman Group	"
"	Stephens Mine	"
"	American Steel & Wire Division U.S. Steel Corp Morgan Park Duluth, Minn 55800	Iron and steel
Dakota	Gopher Smelting and Refining Company Hwy. 49 and Hwy. 55 St. Paul, Minn 55111	Secondary Lead Smelters
Hennepin	N. L. Industries, Inc. 3650 Hamshire St Minneapolia, Minn 55426	"
Carvery, Clay, Polk	American Crystal Sugar Co Boston Building Denver, Colorado 80201	Lime
St. Louis	Cutler-Magner Company 12th Avenue & Waterfront Duluth, Minn 55802	"
	The Hanna Mining Company 100 Eireview Plaza Cleveland, Ohio 44114	15196788
Crow Wing	Lauretta	Manganiferous ore

TABLE A-37 (continued)

County	Company and Address	Commodity
	Pittsburgh Pacific Company 2521 First Avenue Hibbing, Minn 55746	
Crow Wing	Louise and Mangan No. 1	Manganiferous ore
Aitkin	Colby Pioneer Peat Company Box 8 Hanlontown, Iowa 50444	Peat
St. Louis	Power-O-Peat Company Gilbert, Minn 55741	"
Carlton	Red Wing Peat Corporation Box 3006 Houston, Texas 77001	Peat
Hennepin	Zonolite Division, W. R. Grace & Company 62 Whittemore Avenue Cambridge, Massachusetts	Expanded perlite Expanded perlite
Dakota, Hannepin, Washington	Alexander Construction Company, Inc. 4641 Hiawatha Avenue Minneapolis, Minnesota 55406	Sand and Gravel
Hennepin	Anderson Aggregates, Inc. 100 North Seventh Street Minneapolis, Minnesota 55403	Sand and Gravel
Carlton, Chisago Dakota, Hennepin Sherburne, Washington	Barton Contracting Company 10300 - 89th Avenue, North Osseo, Minnesota 55369	Sand and Gravel
Bit Stone, Carlton, Clearwater, Kandiyohi, Kittson, Marshall, Polk, Redwood, Renville, Roseau	Duininck Brothers & Gilchrist Olivia, Minnesota 56277	Sand and Gravel
Brown, Carlton Faribault, Goodhue, Jackson, Martin, Polk, Stevens,	W. Hodgman & Sons, Inc. 1100 Marcus Street Fairmont, Minnesota 56031	Sand and Gravel

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TABLE A-37 (continued)

County	Company and Address	Commodity
Itasca, St. Louis	McLean Construction Company 1288 Tower Avenue Superior, Wisconsin 54880	Sand and Gravel
Clay, Clear-water, Douglas, Grant, Mahnomen, Norman Otter Tail, Wilkin	Mark Sand & Gravel Company Box 396 Fergus Falls, Minnesota 56537	Sand and Gravel
Benton, Blue Earth, Chippewa Hennepin, Jackson, Mille, Lacs, Nicollet, Nobles, Olmsted, Pine, Polk, Pope, Red Lake, Renville, Rock, Scott, Yellow Medicine	Minnesota Valley Improvement Co. Granite Falls, Minnesota 56241	Sand and Gravel
Washington	J. L. Shiely Company 1101 North Snelling Avenue St. Paul, Minnesota 55108	Sand and Gravel
Freeborn, Mower, Olmsted, Steele	Ulland Brothers, Inc. Box 98 Austin, Minnesota 55912	Sand and Gravel
Carlton, Cook, Lake, St. Louis	Do. Box 340 Cloquet, Minnesota 55720	Sand and Gravel
Big Stone, Lac qui Parle, Mille Lacs, Renville	Cold Spring Granite Company Cold Spring, Minnesota 56320	Granite
Stearns	Do.	Granite
Lac qui Parle, Stearns	Delano Granite, Inc. Delano, Minnesota 55328	Granite
Wright	Do.	Do.
Yellow Medicine	The Green Company	Granite
Stearns	Shiely-Petters Crushed Stone Company, Inc. Box 69	Granite

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TABLE A-37 (continued)

County	Company and Address	Commodity
Le Sueur	The Babcock Company Kasota, Minnesota 56050	Limestone & dolomite
Winona	Biesanz Stone Company, Inc. 116 West 7th Street Winona, Minnesota 55987	Limestone & dolomite
Scott, Washington	Bryan Rock Products, Inc. Box 215 Shakopee, Minnesota 55379	Limestone & dolomite
Houston, Winona	Hector Construction Company, Inc. Box 410 Caledonia, Minnesota 55921	Limestone & dolomite
Dakota	Edward Kraemer & Sons, Inc. Plain, Wisconsin 53577	Limestone & dolomite
Blue Earth	Mankato Ag Lime & Rock Company Route 3 Mankato, Minnesota 56001	Limestone & dolomite
Do.	Mankato Stone Company 836 North Front Street Mankato, Minnesota 56001	Limestone & dolomite
Mower	Osmundson Brothers Adams, Minnesota 55909	Limestone & dolomite
Olmsted, Wabasha	Patterson Quarries, Div. of Mathy Construction St. Charles, Minnesota 55972	Limestone & dolomite
Dodge, Olmsted, Wabasha, Winona	Quarve & Anderson Company Route 3, Box 27 Rochester, Minnesota 55901	Limestone & dolomite
Scott	River Warren Aggregates, Inc. Lakeville, Minnesota 55074	Limestone & dolomite
Scott, Washington	J. L. Shiely Company 1101 North Snelling Avenue St. Paul, Minnesota 55108	Limestone & dolomite
Blue Earth, Le Sueur	Vetter Stone Company Route 4 Mankato, Minnesota 56001	Limestone & dolomite

TABLE A-37 (continued)

County	Company and Address	Commodity
Wadena	Richard Nanik Marl Pit Star Route Staples, Minnesota 56479	Marl
Rock	Jasper Stone Company Box 206 Sioux City, Iowa 51102	Quartzite
Nicollet	New Ulm Quartzite Quarries, Inc. New Ulm, Minnesota 56073	Quartzite
St. Louis	Arrowhead Blacktop Company 14th Avenue, West & Waterfront Duluth, Minnesota 55802	Traprock (basalt)
Dakota	Great Northern Oil Company Box 3596 St. Paul, Minnesota 55101	Sulfur (recovered)
Washington	Northwestern Refining Company P.O. Drawer 9 St. Paul Park, Minnesota 55071	Sulfur (recovered)

TABLE A-38.—Value of mineral production in Minnesota, by county

(Thousands)

County	1971	1972	Minerals produced in 1972 in order of value
Aitkin	W	$109	Sand and gravel.
Anoka	--	W	Do.
Becker	W	117	Do.
Beltrami	W	W	Do.
Benton	W	114	Do.
Big Stone	W	W	Stone, sand and gravel.
Blue Earth	$1,661	1,397	Do.
Brown	W	W	Sand and gravel, clays.
Carlton	W	W	Sand and gravel, peat, clays.
Carver	W	W	Sand and gravel, clays.
Cass	140	190	Sand and gravel.
Chippewa	250	W	Do.
Chisago	193	W	Do.
Clay	W	W	Sand and gravel, lime.
Clearwater	219	W	Sand and gravel.
Cook	W	W	Do.
Cottonwood	117	W	Do.
Crow Wing	1,706	1,494	Manganiferous ore, iron ore, sand and gravel.
Dakota	W	W	Sand and gravel, stone.
Dodge	W	W	Stone, sand and gravel.
Douglas	W	62	Sand and gravel.
Faribault	W	120	Do.
Fillmore	772	606	Stone, sand and gravel.
Freeborn	659	391	Sand and gravel.
Goodhue	W	W	Sand and gravel, stone.
Grant	W	W	Sand and gravel.
Hennepin	W	4,447	Sand and gravel, clays, stone.
Houston	W	W	Stone, sand and gravel.
Hubbard	W	--	
Isanti	8	29	Sand and gravel.
Itasca	81,585	75,527	Iron ore, sand and gravel, peat.
Jackson	255	W	Sand and gravel.
Kanabec	38	75	Do.
Kandiyohi	W	274	Do.
Kittson	W	W	Do.
Koochiching	W	116	Do.
Lac qui Parle	481	414	Stone, sand and gravel.
Lake	W	80	Sand and gravel.
Lake of the Woods	W	W	Do.
Le Sueur	W	W	Sand and gravel, stone.
Lincoln	W	W	Sand and gravel.
Lyon	W	90	Do.
McLeod	W	27	Do.
Mahnomen	6	--	
Marshall	232	212	Sand and gravel.
Martin	211	300	Do.
Meeker	W	W	Do.
Mille Lacs	W	W	Stone, sand and gravel.
Morrison	38	W	Sand and gravel.
Mower	W	W	Stone, sand and gravel.
Murray	W	7	Sand and gravel.
Nicollet	W	W	Sand and gravel, stone.
Nobles	179	W	Sand and gravel.
Norman	W	$96	Sand and gravel.
Olmsted	W	W	Stone, sand and gravel.
Otter Tail	$521	W	Sand and gravel.
Pennington	W	122	Do.
Pine	47	17	Do.
Pipestone	220	W	Do.
Polk	W	W	Sand and gravel, lime.
Pope	W	W	Sand and gravel.
Ramsey	W	W	Sand and gravel, clays.
Red Lake	W	W	Sand and gravel.
Redwood	206	87	Stone, clays, sand and gravel.
Renville	W	W	Stone, sand and gravel.
Rice	W	W	Sand and gravel, stone.
Rock	818	640	Stone, abrasives, sand and gravel.
Roseau	W	59	Sand and gravel.
St. Louis	476,053	534,260	Iron ore, cement, sand and gravel, stone, lime, peat.
Scott	W	W	Stone, sand and gravel.
Sherburne	687	931	Sand and gravel.
Sibley	34	--	
Stearns	W	W	Stone, sand and gravel.
Steele	W	W	Sand and gravel, stone.
Stevens	431	W	Sand and gravel.
Swift	W	W	Do.
Todd	W	W	Do.
Traverse	W	W	Do.
Wabasha	W	W	Stone, sand and gravel.
Wadena	W	W	Sand and gravel, stone.
Waseca	W	W	Sand and gravel.
Washington	W	W	Sand and gravel, stone.
Watonwan	W	8	Sand and gravel.
Wilkin	W	W	Do.
Winona	W	W	Stone.
Wright	430	W	Sand and gravel, stone.
Yellow Medicine	W	424	Stone, sand and gravel.
Undistributed [1]	40,577	36,832	
Total [2]	608,776	659,669	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

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Mississippi

The mineral production in Mississippi consists of fossil fuels, stone, clays, and sand and gravel principally. The county by county production is presented in Table A-39. There are no activities in rocks where fibrous amphibole minerals might occur.

Source Reference

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Source Reference:
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U. S. Bureau of Mines' Mineral Yearbook.

TABLE A-39. **Value of mineral production in Mississippi, by county[1]**

(Thousands)

County	1970	1971	Minerals produced in 1971, in order of value
Adams	$23,053	$22,014	Petroleum, sand and gravel, natural gas, natural gas liquids, clays.
Alcorn	W	W	Sand and gravel.
Amite	3,732	5,364	Petroleum, natural gas.
Attala	W	W	Clays.
Bolivar	W	W	Sand and gravel.
Carroll	W	W	Sand and gravel, clays.
Clarke	40,010	44,119	Petroleum, natural gas, natural gas liquids, sand and gravel.
Clay	477	682	Sand and gravel, stone, natural gas.
Copiah	W	W	Sand and gravel.
Covington	847	920	Petroleum, sand and gravel, natural gas.
De Soto	W	W	Sand and gravel.
Forrest	3,649	3,460	Natural gas, sand and gravel, petroleum, clays.
Franklin	12,022	9,913	Petroleum, natural gas.
Greene	313	234	Do.
Hancock	238	270	Natural gas, petroleum, sand and gravel.
Harrison	174	W	Sand and gravel.
Hinds	1,555	2,128	Petroleum, clays, natural gas, stone, sand and gravel.
Holmes	349	376	Sand and gravel, petroleum, natural gas.
Humphreys	--	49	Petroleum, natural gas.
Itawamba	W	W	Clays, natural gas.
Jackson	W	W	Magnesium compounds, lime, sand and gravel.
Jasper	25,880	26,786	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Jefferson	1,334	1,220	Petroleum, natural gas.
Jefferson Davis	5,543	5,985	Natural gas, petroleum, natural gas liquids.
Jones	10,870	11,841	Petroleum, natural gas, natural gas liquids, clays.
Lafayette	W	W	Sand and gravel.
Lamar	18,530	28,436	Petroleum, natural gas, sand and gravel.
Lauderdale	W	W	Clays, sand and gravel.
Lee	W	W	Clays, sand and gravel, natural gas.
Leflore	W	W	Natural gas, petroleum.
Lincoln	5,739	4,777	Petroleum, sand and gravel, clays.
Lowndes	W	W	Sand and gravel, clays.
Madison	1,751	1,559	Petroleum, natural gas.
Marion	W	W	Natural gas, petroleum, sand and gravel.
Marshall	W	362	Clays.
Monroe	W	3,280	Clays, sand and gravel, natural gas, petroleum.
Noxubee	W	W	Clays, sand and gravel.
Oktibbeha	--	W	Natural gas.
Panola	W	W	Clays, sand and gravel.
Pearl River	587	649	Natural gas, petroleum, clays.
Perry	W	W	Sand and gravel, petroleum.
Pike	3,127	2,045	Petroleum, natural gas liquids, natural gas.
Pontotoc	W	W	Sand and gravel.
Prentiss	W	W	Clays.
Rankin	5,074	5,344	Cement, petroleum, stone, sand and gravel, natural gas.
Scott	171	295	Petroleum, natural gas.
Simpson	2,048	2,018	Petroleum, natural gas, sand and gravel.
Smith	16,067	12,098	Petroleum, natural gas, natural gas liquids, clays, sand and gravel.
Stone	W	W	Sand and gravel.
Sunflower	W	W	Clays.
Tate	59	W	Sand and gravel.
Tippah	W	1,760	Clays.
Tishomingo	W	W	Sand and gravel.
Union	16	W	Do.
Walthall	5,599	8,180	Natural gas, petroleum, sand and gravel.
Warren	1,865	3,280	Cement, stone.
Washington	W	W	Sand and gravel.
Wayne	17,031	16,150	Petroleum, natural gas, sand and gravel.
Wilkinson	7,541	6,570	Do.
Winston	W	W	Clays.
Yalobusha	W	W	Sand and gravel.
Yazoo	8,035	9,201	Petroleum, natural gas.
Undistributed	26,685	21,031	
Total[2]	249,973	262,393	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] The following counties were not listed because no production was reported: Benton, Calhoun, Chickasaw, Choctaw, Claiborne, Coahoma, George, Grenada, Issaquena, Kemper, Lawrence, Leake, Montgomery, Neshoba, Newton, Quitman, Sharkey, Tallahatchie, Tunica, and Webster.

[2] Data may not add to totals shown because of independent rounding.

Missouri

The rocks of the Ozark Uplift dominate the geology of southern Missouri. The extent of these rocks and the three areas of interest within the uplift are located on Figure A-29. Rocks of Precambrian and Cambrian age which include igneous and metamorphic rocks outcrop in the southeast mining district notably in the St. Francois Mountain District. This area is most noted for its lead-zinc production where the mineralization is in Cambrian age rocks. The zinc-lead mineralization in the Tri-State mining district (Jasper, Lawrence, and Newton Counties) is in Mississippian age cherty limestone variably altered to dolomite. In the Central mining district (Morgan, Miller, Camden, Moniteau, Cooper, and Cole Counties) the mineralization is extensive, but not intensive and is found in rocks of late Cambrian through Pennsylvanian age. These rocks also are principally limestone or cherty dolomite with local sandstone, shale, and coal members. Lead is recovered from this area as a by-product of barite recovery operations.

The Precambrian rocks exposed in the St. Francois Mountains and the outliers are of three types: felsitic volcanic rocks ranging from rhyolite to andesite, granites and granite porphyries, and basic intrusives of gabboric composition. The location of these rocks is shown on the state map and the detail map of a fourteen county area (Figure A-30). Within the general area, dikes and diatremes of mafic and ultramafic igenous rock occur in Cambrian age brecciated sediments. The extent to which this type rock is encountered during the various mining activities of the area is not reported.

As shown on the detail map of the St. Francois Mountain area, there are numerous lead-zinc and iron mining operations surrounding the Precambrian outcrops. The operations are in a mineralized area of roughly annular pattern around the dome of Precambrian rocks. While most of the sedimentaries in the area are mineralized, the most intensive mineralization is in the Cambrian Bonneterre Formation, which is the lowermost carbonate rock of the region and is principally a dolomite. The lead-zinc ore bodies are formed by a replacement mechanism. Many of the mining operations are currently active.

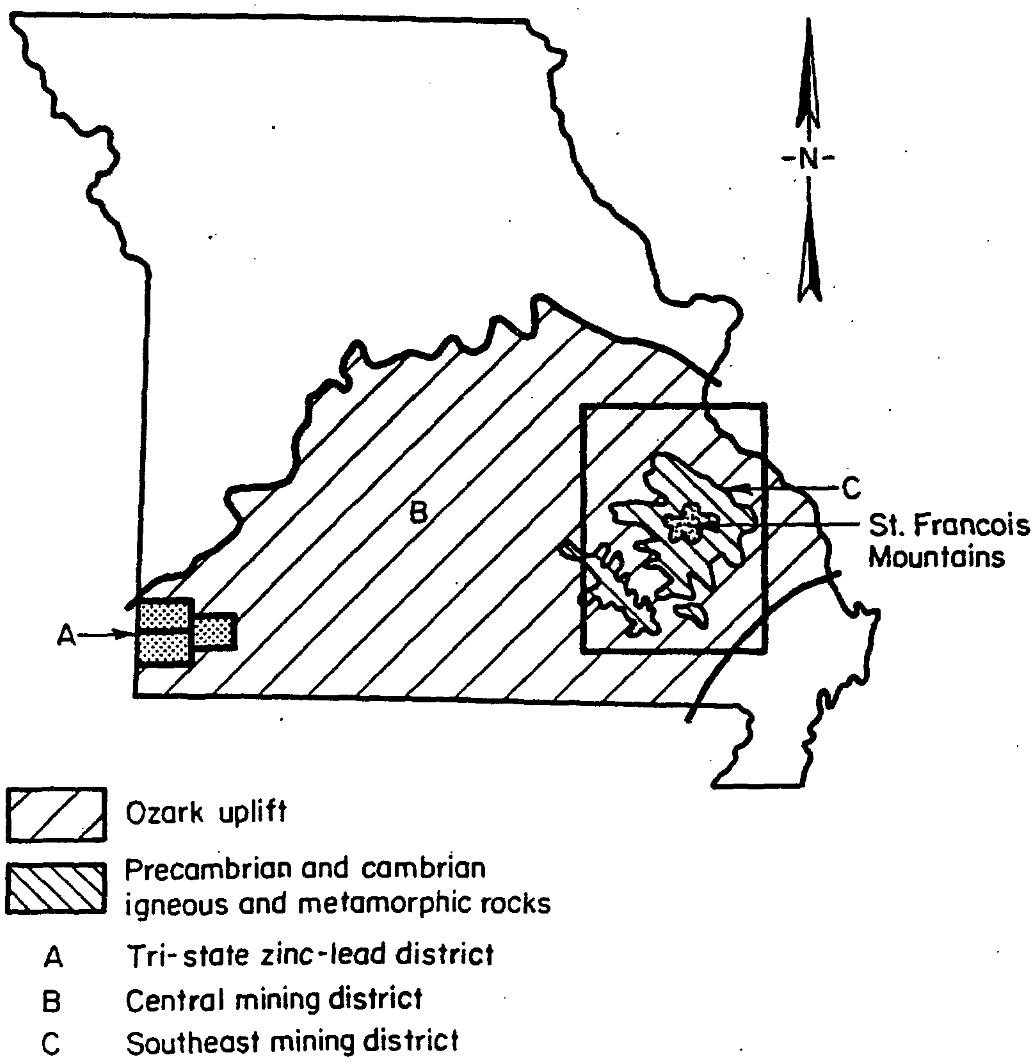

FIGURE A-29. OCCURRENCE OF IGNEOUS AND METAMORPHIC ROCK IN MISSOURI

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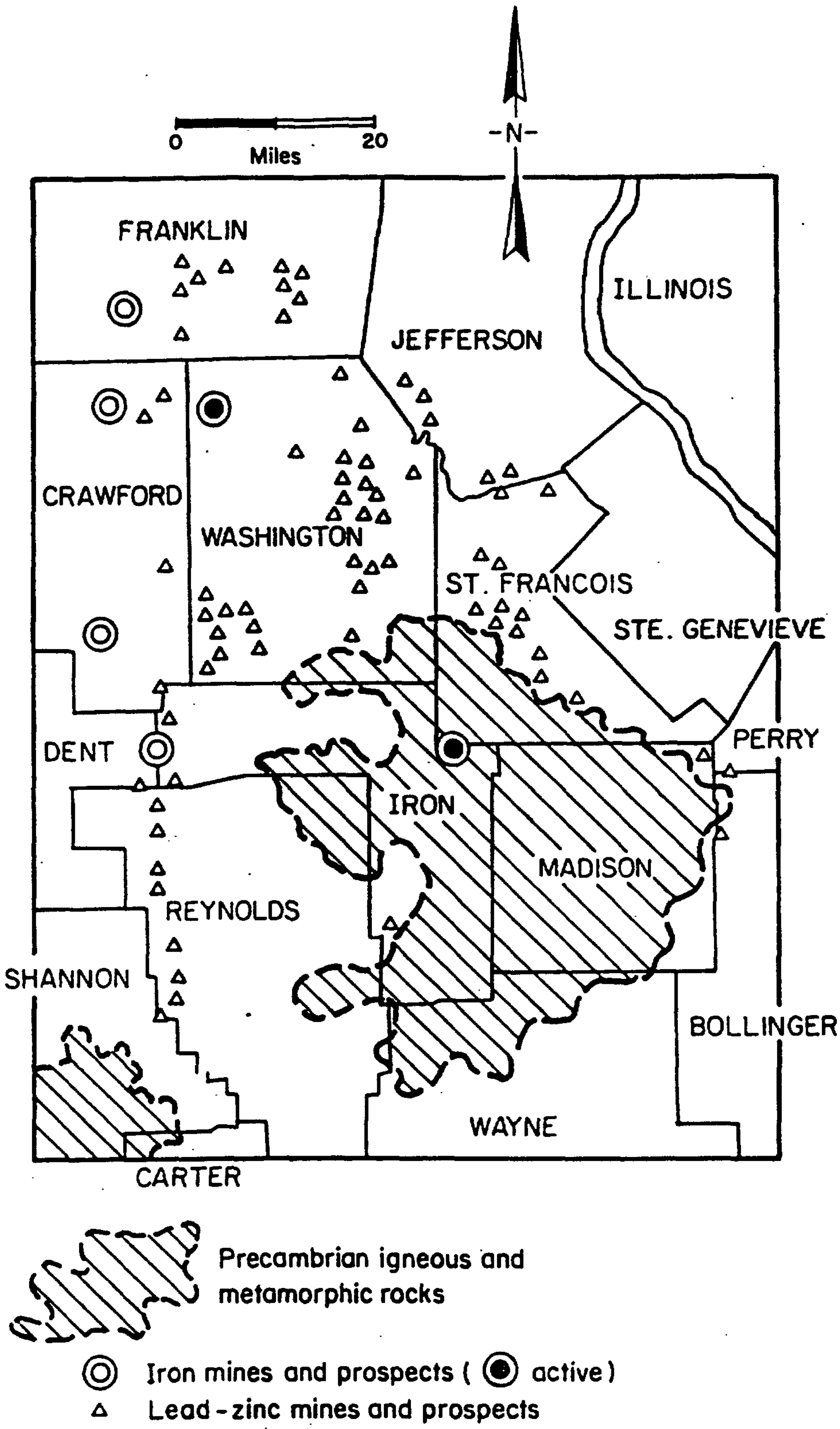

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FIGURE A-30. DETAIL MAP OF AREA OF MISSOURI WHERE IGNEOUS AND METAMORPHIC ROCKS OCCUR

The magnetite-hematite iron deposits of the southeast mining district occur as vein fillings and tabular replacement bodies in Precambrian felsites, tuffs, and tuff breccias of the St. Francis Mountains and adjacent areas. The currently active operation in Iron County at Pilot Knob (Pilot Knob Pellet Company, P.O. Box 26, Ironton, Missouri, 63650) is in a tabular body at the base of the Paleozoic rocks found locally in this area. Magnetite is the chief ore mineral. Fine grinding and magnetic separation permits concentration to about 63 percent iron with about 5 percent silica content. The trap-rock at Pilot Knob is a felsite porphyry where the minerology is chiefly quartz and feldspar phenocrysts, flurospar, and sulfides. Fibrous amphibole minerals have not been reported from this operation.

The active iron mining operation in Washington County at Pea Ridge exploits a magnetite deposit in Precambrian volcanic magnetite deposit in Precambrian volcanir rocks under 1300 feet of lower Paleozoic sedimentaries. The ore body transects the enclosing rhyolite and rhyolite porphyry flows at a low angle. Specular hematite is present in variable amounts, in places comprising most of the ore. Pyrite, apatite, and quartz are the chief impurities. Pellets averaging 68 percent iron and less than 2 percent silica are produced after concentrating and pelletizing. Fibrous amphibole minerals have not been reported from this operation.

Apart from the Precambrian iron recovery operations described above, Missouri does not have a production although there are extensive "brown ore" deposits throughout the Ozark Uplift area of the state. The deposits frequently occur in cherty clay residuum derived from weathered Ordovician dolomites. There are no reports of amphibole mineralization associated with these limonite ores.

As in numerous other midwestern states, there are numerous quarrying activities in Missouri for the recovery of sand, gravel, clay, and stone for various uses. In addition, coal, asphalt, cement, and barite are recovered from selected sites. Amphibole minerals are not reported from any of these activities. The mineral production in Missouri is summarized in Table A-40 and A-41.

TABLE A-40. **Value of mineral production in Missouri, by county**[1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Adair	W	W	Stone.
Atchison	W	W	Sand and gravel.
Audrain	$756	$1,761	Clays.
Barry	--	W	Stone.
Barton	W	W	Coal, native asphalt, stone.
Bates	176	149	Stone.
Benton	--	W	Do.
Boone	4,131	5,063	Coal, stone, sand and gravel, clays.
Buchanan	327	W	Sand and gravel, stone.
Butler	W	269	Sand and gravel, clays.
Caldwell	W	W	Stone.
Callaway	2,181	1,624	Clays, stone, coal, sand and gravel.
Camden	W	W	Stone.
Cape Girardeau	W	W	Cement, stone, sand and gravel, clays.
Cass	W	W	Stone.
Cedar	--	94	Do.
Chariton	--	W	Sand and gravel.
Christian	460	W	Stone.
Clark	W	W	Stone, sand and gravel.
Clay	W	W	Do.
Clinton	W	W	Stone.
Cole	605	391	Stone, sand and gravel, lead.
Cooper	W	W	Stone, sand and gravel.
Crawford	6,296	3,990	Lead, copper, zinc, stone, silver.
Dade	107	W	Stone.
Dallas	W	W	Do.
Daviess	585	527	Stone, sand and gravel.
De Kalb	107	125	Stone.
Douglas	W	W	Sand and gravel.
Dunklin	90	W	Do.
Franklin	W	W	Stone, clays, sand and gravel.
Gasconade	1,982	1,765	Clays, sand and gravel.
Gentry	W	W	Stone, sand and gravel.
Greene	W	W	Stone, lime.
Grundy	W	W	Stone, sand and gravel.
Harrison	W	W	Stone.
Henry	W	W	Coal, stone.
Hickory	W	W	Stone.
Holt	W	W	Do.
Howard	W	W	Stone, sand and gravel.
Howell	2,023	W	Do.
Iron	84,225	84,729	Lead, iron ore, zinc, copper, silver, stone.
Jackson	W	12,632	Cement, stone, sand and gravel, clays.
Jasper	W	W	Stone, sand and gravel.
Jefferson	W	W	Cement, stone, sand and gravel, clays, lead.
Johnson	W	W	Stone.
Knox	W	W	Do.
Laclede	W	W	Do.
Lafayette	W	W	Stone, sand and gravel.
Lawrence	W	W	Stone.
Lewis	W	W	Sand and gravel, stone.
Lincoln	486	W	Sand and gravel, stone, clays.
Linn	W	W	Stone.
Livingston	W	1,237	Stone, clays, sand and gravel.
Macon	W	W	Coal.
Madison	W	20	Stone.
Marion	W	W	Lime, stone.
Mercer	383	W	Stone.
Miller	W	W	Sand and gravel, stone.
Moniteau	85	W	Stone.
Monroe	329	271	Clays, stone, sand and gravel.
Montgomery	687	765	Do.
Newton	W	137	Stone.
Nodaway	746	W	Stone, sand and gravel.
Oregon	W	15	Stone.
Osage	W	W	Sand and gravel, clays.
Ozark	W	--	
Pemiscot	W	350	Sand and gravel.
Perry	W	W	Stone.
Pettis	W	W	Do.
Phelps	W	151	Stone, clays, sand and gravel.
Pike	W	W	Cement, stone, clays, sand and gravel.
Platte	593	1,210	Clays, stone, sand and gravel.
Polk	--	W	Stone.
Pulaski	W	176	Sand and gravel, stone.
Putnam	W	W	Coal.
Ralls	W	W	Cement, stone, clays.
Randolph	W	W	Coal, stone, sand and gravel.
Ray	920	1,710	Stone, sand and gravel.
Reynolds	58,540	45,421	Lead, zinc, copper, silver, sand and gravel, stone.
St. Charles	$2,061	$2,368	Stone, sand and gravel, clays.
St. Francois	17,337	12,734	Lead, lime, stone, copper, silver, zinc.
St. Louis	26,213	29,663	Cement, stone, sand and gravel, clays, natural gas.
Ste. Genevieve	26,661	33,211	Lime, stone, sand and gravel.
Saline	466	476	Stone.
Scotland	W	W	Do.
Scott	W	W	Clays.
Shannon	64	W	Stone.
Shelby	W	W	Do.
Stoddard	W	434	Sand and gravel.
Vernon	229	235	Stone, coal, native asphalt.
Warren	264	252	Clays, stone.
Washington	43,337	45,177	Iron ore, lead, barite, zinc, copper, silver, sand and gravel.
Wayne	W	135	Stone.
Webster	W	--	
Wright	W	W	Stone.
Undistributed[2]	109,648	111,343	
Total[3]	392,996	400,089	

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W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] *The following counties were not listed because no production was reported:* Andrew, Bollinger, Carroll, Carter, Dent, McDonald, Maries, Mississippi, Morgan, New Madrid, Ripley, St. Clair, Schuyler, Stone, Sullivan, Taney, Texas, and Worth.

[2] Includes value of sand and gravel and stone not assigned to specific counties, and value of petroleum for which county data was unavailable for 1971.

[3] Data may not add to totals shown because of independent rounding.

TABLE A-41. PRINCIPAL MINERAL PRODUCERS IN MISSOURI

Commodity and company	Address	Type of activity	County
Asphalt, native:			
Bar-Co-Roc Asphalt Co.	P.O. Box 11 Iantha, Mo. 64753	Mine	Barton.
Silica Rock Asphalt Corp.	Sheldon, Mo. 64784	do	Vernon.
Barite:			
Dresser Minerals Div.	P.O. Box 6504 Houston, Tex. 77005	do	Washington.
Milchem, Incorporated	P.O. Box 22111 Houston, Tex. 77027	Mine and mill	Do.
National Lead Co., Baroid Division	P.O. Box 1675 Houston, Tex. 77001	do	Do.
National Lead Co., DeLore Division.	P.O. Box 2808 Carondelet Sta. St. Louis, Mo. 63111	Mill	St. Louis.
Chas. Pfizer & Co., Inc.	Box 47 Mineral Point, Mo. 63660	Mine and mill	Washington.
Cement:			
Alpha Portland Cement Co.	15 South Third St. Easton, Pa. 18043	Plant and quarry.	St. Louis.
Dundee Cement Co.	P.O. Box 317 Dundee, Mich. 48131	do	Pike.
Marquette Cement Mfg. Co.	20 North Wacker Dr. Chicago, Ill. 60606	do	Cape Girardeau.
Missouri Portland Cement	7751 Carondelet Ave. St. Louis, Mo. 63105	do	Jackson, St. Louis.
River Cement Co.	Festus, Mo. 63028	do	Jefferson.
Universal Atlas Cement Div. of U.S. Steel Corp.	Chatham Center, Box 2969 Pittsburgh, Pa. 15230	do	Ralls.
Clay and shale:			
Allied Chemical Corp.	Box 70 Morristown, N.J. 07960	Mine and plant.	Gasconade.
Alton Brick Co.	Box 1025 Maryland Heights, Mo. 63042	do	St. Louis.
Carter-Waters Corp.	2440 Pennway Kansas City, Mo. 64108	do	Platte.
C-E Refractories Div. of Combustion Engineering.	101 Ferry St. St. Louis, Mo. 63147	Mine and plant.	Callaway, Monroe, Montgomery.
Dundee Cement Co.	Dundee, Mich. 48131	do	Pike.
U.S. Gypsum: A. P. Green Refractories Co.	Mexico, Mo. 65265	do	Franklin, Gasconade.
Dressers Industries Inc.: Harbison-Walker Refractories Co.	2 Gateway Center Pittsburgh, Pa. 15222	do	Audrain, Callaway, Gasconade, Lincoln, Montgomery, St. Charles, Warren.
Kaiser Refractories	P.O. Box 499 Mexico, Mo. 65265	do	Audrain, Callaway, Gasconade, Montgomery, Osage, Warren.
Marquette Cement Mfg. Co.	20 North Wacker Dr. Chicago, Ill. 60606	do	Cape Girardeau.
Midland Brick & Tile Co.	Box 428 Chillicothe, Mo. 64601	do	Livingston.
Missouri Portland Cement Co.	7751 Carondelet Ave. St. Louis, Mo. 63105	do	Jackson, St. Louis.
H. K. Porter Co., Inc.	4705 Ridgewood Ave. St. Louis, Mo. 63116	do	Callaway, Gasconade, Monroe.
Universal Atlas Cement Div., U.S. Steel Corp.	P.O. Box 2969 Pittsburgh, Pa. 15230	do	Ralls.
Wellsville Fire Brick Co.	West Highway 19 Wellsville, Mo. 63384	do	Audrain, Montgomery.
Coal:			
Clayton-Hensley Coal Co.	Route 3 Fulton, Mo. 65251	Strip mine	Callaway.
Ellis Coal Co.	Bronaugh, Mo. 64728	do	Vernon.
Kirkville Coal Co., Inc.	Box 332 Centerville, Iowa 52544	do	Putnam.
Peabody Coal Co.	301 North Memorial Dr. St. Louis, Mo. 63102	do	Boone, Henry, Macon, Randolph.
Copper: *See* Lead.			
Iodine (consumers):			
Hoffman-Taff, Inc.	West Bennett Rd. Springfield, Mo. 65800	Plant	Greene.
Interstate Chemical Co., Inc.	501 Santa Fe Kansas City, Mo. 64102	do	Jackson.
Mallinckrodt Chemical Works	3600 North Second St. St. Louis, Mo. 63147	do	St. Louis.
Iron ore:			
Meramec Mining Co.	Route 4 Sullivan, Mo. 63080	Underground mine.	Washington.
Pilot Knob Pellet Co.	Box 26 Ironton, Mo. 63650	do	Iron.
Lead:			
Cominco American, Inc.	Box 430 Salem, Mo. 65560	do	Do.
Missouri Lead Operating Co. for Amax Lead Co. and Homestake Lead Co. of Mo.	Boss, Mo. 65440	do	Do.
Ozark Lead Co.	Sweetwater, Mo. 63680	do	Reynolds.
St. Joe Minerals Corp.	Bonne Terre, Mo. 63628	do	Crawford, Iron, Reynolds, St. Francois, Washington.

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TABLE A-41. Continued)

Commodity and company	Address	Type of activity	County
Lime:			
Ash Grove Cement Co	1000 Ten Main Center Kansas City, Mo. 64105	Plant	Greene.
Marblehead Lime Co	300 West Washington Chicago, Ill. 60606	...do	Marion.
Mississippi Lime Co	7 Alby St. Alton, Ill. 62002	...do	Ste. Genevieve.
Valley Dolomite Corp	915 Olive St. St. Louis, Mo. 63101	...do	St. Francois.
Perlite:			
J. J. Brouk & Co	1367 South Kingshighway Blvd. St. Louis, Mo. 63110	Expanding plant.	St. Louis.
Roofing granules:			
GAF Corp	Box 278 Annapolis, Mo. 63620	Plant	Iron.
Sand and gravel:			
Eureka Sand & Gravel Co	Rt. 1, Box 77 Eureka, Mo. 63025	Stationary	St. Louis.
Holliday Sand & Gravel Co	6811 West 63rd St. Overland Park, Kans. 66202	Dredge	Various.
Mississippi River Sand & Matl. Co.	650 Rosedale St. Louis, Mo. 63112	Stationary and dredge.	St. Louis.
Missouri Aggregates, Inc	801 South Lindberg St. St. Louis, Mo. 63100	Stationary	Do.
Missouri Gravel Co	313 16th St. Moline, Ill. 61265	Dredge	Lewis.
Norbroco, Inc	P.O. Box 414 Hazelwood, Mo. 63042	...do	St. Louis.
PPG Industries, Inc	1 Gateway Center Pittsburgh, Pa. 15219	Stationary	Jefferson.
Pennsylvania Glass Sand Corp	Berkeley Springs, W. Va. 25411	...do	St. Louis, St. Charles.
Riverside Sand & Dredging	5000 Bussen Rd. St. Louis, Mo. 63129	Dredge	St. Louis.
St. Charles Sand Co	Rt. 1, Box 253 Bridgeton, Mo. 63042	Stationary	Do.
Stewart Sand & Material Co.	4049 Pennsylvania Ave. Kansas City, Mo. 64111	...do	Jackson.
Taylor Sand & Gravel Co	Caruthersville, Mo. 63830	Dredge	Pemiscot, New Madrid.
Welton & Gray Gravel Co	Rt. 4, Ava, Mo. 65608	Portable	Douglas.
Winter Bros. Material Co	13098 Gravois Rd. St. Louis, Mo. 63127	Stationary	St. Louis.
Silver: *See* Lead.			
Stone:			
Brown Quarries	Washington, Mo. 68090	Quarry	Various.
Bussen Quarries, Inc	5000 Bussen Rd. St. Louis, Mo. 63129	...do	Jefferson, St. Louis.
Dundee Cement Co	P.O. Box 317 Dundee, Mich. 48131	...do	St. Louis.
Gordon Bros. Quarries, Inc	Forest City, Mo. 64451	...do	Holt.
Mississippi Lime Co	7 Alby St. Alton, Ill. 62002	...do	Ste. Genevieve.
Missouri Portland Cement Co	7751 Carondelet Ave. St. Louis, Mo. 63105	...do	Jackson, St. Louis.
River Cement Company	Festus, Mo. 63028	...do	Jefferson.
Vigus Quarries, Inc	7929 Alabama Ave. St. Louis, Mo. 63111	...do	Jefferson, St. Louis
West Lake Quarry & Material Co.	Rt. 1, Box 206, Taussig Rd. Bridgeton, Mo. 63042	...do	St. Louis, Scott.
Tripoli:			
The Carborundum Co., American Tripoli Div.	Seneca, Mo. 64865	Mill	Newton.
Vermiculite:			
W. R. Grace & Co., Zonolite Div.	62 Whittemore Ave. Cambridge, Mass. 01109	Exfoliating plant.	St. Louis.
Zinc: *See* Lead.			

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Source References

(125) Geologic Map of Missouri, M. H. McCracke, 1961, Missouri Division of Geological Survey and Water Resources, Rolla, Missouri.

(126) Mineral and Water Resources of Missouri, Volume XLIII, Second Series, 1967, Senate Document No. 19 (Numerous authors), U. S. Government Printing Office, Washington, D.C.

(127) The Mineral Industry of Missouri J. P. Ryan and J. A. Martin, 1971, U. S. Bureau of Mines, Minerals Yearbook.

Montana

Montana is divisible physiographically into three roughly parallel, northwestward-trending regions. Each region comprises about one-third of the state as shown in Figure A-31. The western third of Montana forms the eastern part of the Northern Rocky Mountains and is the district of principal interest to this study. This region is characterized by deeply dissected mountain uplands separated by intermontane basins. The mountains have been carved by erosion from rocks that have been uplifted and in many places intensely folded and faulted. The southern half of the region has been invaded by granitoid igneous rocks, the two principal bodies being the Idaho batholith south of Missoula and the Boulder batholith south of Missoula and the Boulder botholith between Helena and Butte. Volcanic activity in the region has resulted in lava flows, beds of agglomerate and tuff, and small intrusive rock bodies. The eastern border of the Northern Rocky Mountains is marked by a 10- to 30-mile wide strip that is distinguished by severe deformation in consequence of overthrust faulting (called the Disturbed Belt).

The region to the east of the Rocky Mountains is known as the Great Plains Province or Missouri Plateau Region. This area is characterized by a series of isolated mountain ranges rising abruptly from the extensive plains. Some of the mountain ranges are formed as a result of block faulting; others by the intrusion of igneous stocks or laccolithic masses; still others are the remnants of volcanic piles. The eastern third of Montana is devoid of mountains and except along the west flank of the Cedar Creek anticline (Dawson, Prairie, Fallon, and Wibaux Counties along the eastern border of Montana), the strata are nearly flat-lying. The eastern third of Montana and the centrally located Great Plains Region are of less interest to the current study since the bulk of the mining activity and the chief occurrence of amphibole minerals are found in the westernmost third of Montana.

The center of the metallic and nonmetallic (exclusive of fossil fuels) mineral production in Montana is in the Rocky Mountain Region and specifically in the counties of Deer Lodge, Granite, Ravalli, Beaverhead, Silver Bow, Madison, Jefferson, Powell, and Lewis and Clark. Important

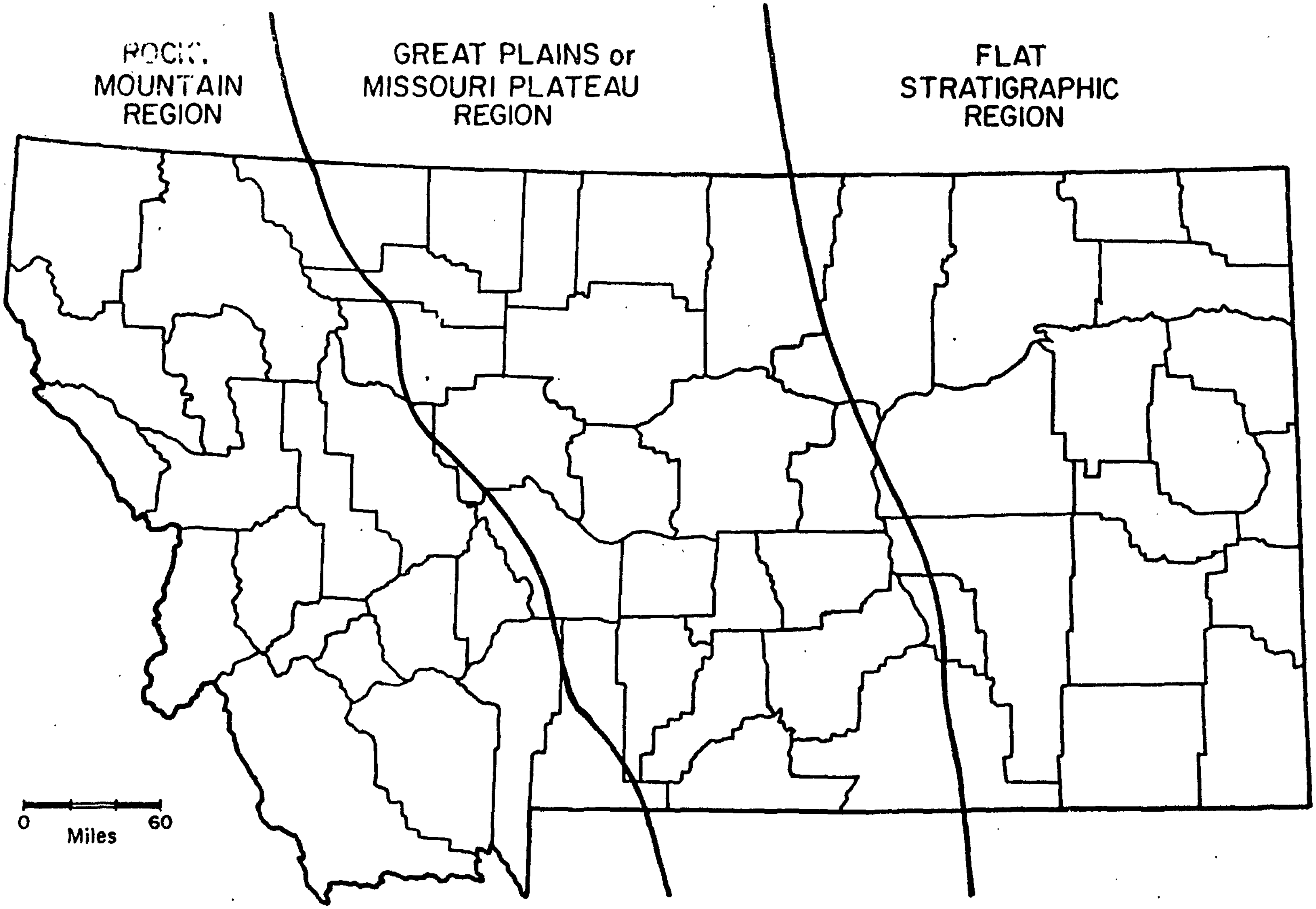

FIGURE A-31. MAJOR GEOLOGICAL REGIONS OF MONTANA

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production of selected commodities also is reported from Lincoln, Mineral, and Flathead Counties. In these counties of interest there are numerous favorable geologic formations for the occurrence of the amphibole minerals and related metamorphosed rocks. For example, the southern counties of Beaverhead, Madison, and Gallatin, have extensive deposits of talc, fibrous amphibole minerals, and chrysotile. The occurrence sites are marked on the detail map of the Rocky Mountain Region (Figures A-32) and described in Table A-42. Amphibole asbestos was formerly mined in Gallatin County. However, the current intentional production of the metamorphic minerals is confined to the talc operations of Madison County. Talc from this area is in the highly metamorphosed rocks of the Cherry Creek Group, formed from serpentinized doloimitic marble. Some of the talc occurrences are quite pure, whereas others contain impurities. Of greater importance to this study is the reported occurrence of large quantities of amphibole asbestos (tremolite) associated with the Vermiculite production near Libby, Lincoln County. The crude ore here which is milled at the open pit mine site, is the principal source of vermiculite in the United States. Consequently, considerable tonnages of ore are worked in this operation.

The occurrence of fibrous amphibole minerals in association with the metallics being produced in the Rocky Mountain mining area is not reported. The considerable production from the area as described in Table A-43. combined with the occurrence of faborable geologic conditions, would appear to make the area worthy of further specific investigation.

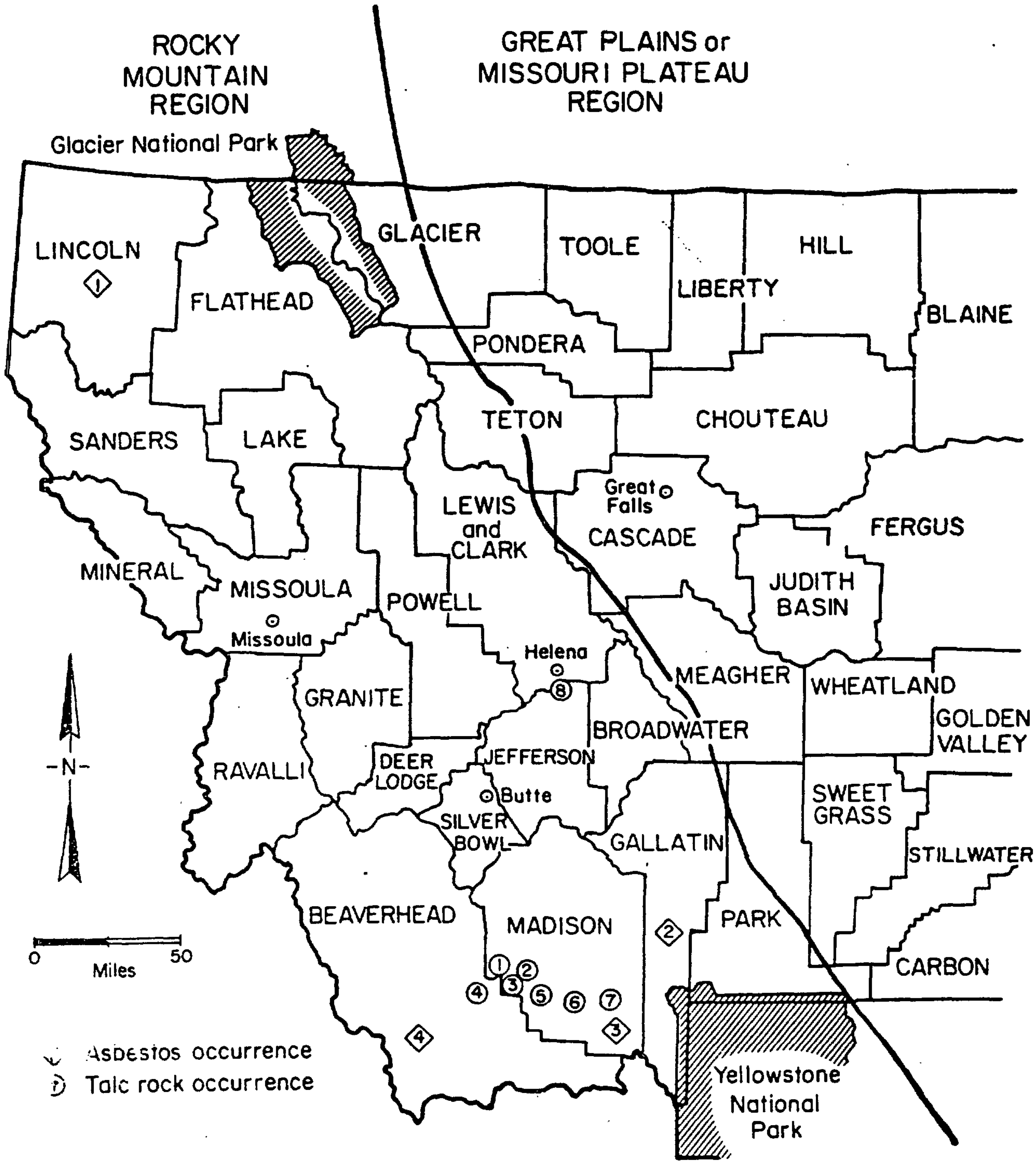

FIGURE A-32. ASBESTOS AND TALC ROCK OCCURRENCE IN WESTERN MONTANA

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TABLE A-42. THE OCCURRENCE OF ASBESTOS AND TALC IN MONTANA

Asbestos

Lincoln County		
1. Libby (Rainy Creek). Brittle tremolite asbestos associated with vermiculite in dikelike masses in pyroxenite.	48°27'	115°25'
Gallatin County		
2. Karst Resort. Woodlike fiber anthophyllite in altered peridotite dikes in Precambrian schist and gneiss.	45°21'	111°11'
Madison County		
3. Cliff Lake (Montbestos, Little Mile Creek). Chrysotile asbestos in limestone similar to Arizona deposits.	44°46'	111°25'
Beaverhead County		
4. Anderson deposit. Chrysotile asbestos in Precambrian dolomite	44° 42'	113° 01'

Talc

Dillon-Ennis district. Deposits consist of talc rock associated with and derived from dolomitic rocks of the Cherry Creek Series, of Precambrian age. Perry, 1948.

1. Lausche mine.	45°15'	112°21'
2. Treasure, Beaverhead, and Brown mines; Whitney and Ruby View prospects	45°14'	112°18'
3. Keystone and Sweetwater mines.	45°10'	112°25'
4. Smith-Dillon mine.	45°07'	112°32'
5. Estelle mine.	45°07'	112°18'
6. Petrus No. 1 and Petrus No. 2 prospect.	45°06'	112°01'
7. Yellowstone (Johnny Gulch) mine.	45°04'	111°44'
8. Helena occurrence	46° 32'	112° 02'

(Locailities are given in terms of North Latitude and West Longitude)

TABLE A-43. PRINCIPAL MINERAL PRODUCERS IN MONTANA

Commodity and company	Address	Type of activity	County
METALS			
...minum:			
Anaconda Aluminum Co	Columbia Falls, Montana 59912	Reduction plant	Flathead.
	Great Falls, Montana 59401	Rolling mill	Cascade.
...per:			
The Anaconda Company [1]	Anaconda, Montana 59711	Smelter	Deer Lodge.
	Butte, Montana 59701	Mine, concentrator, precipitating plant.	Silver Bow.
	Great Falls, Montana 59401	Refinery, rolling mill	Cascade.
...ore: R & S Iron Co	Radersburg, Montana 59641	do	Broadwater.
...d-zinc:			
American Smelting & Refining Co.	East Helena, Montana 59635	Smelter	Lewis and Clark.
The Anaconda Company	do	Slag fuming plant.	Do.
	Great Falls, Montana 59401	Zinc plant	Cascade.
John Hand [2]	Dillon, Montana 59725	Mine	Beaverhead.
J. W. Keenan [2]	Helena, Montana 59601	do	Lewis and Clark.
William Schneider [2]	Philipsburg, Montana 59858	do	Granite.
Taylor-Knapp Co. [2]	do	Mine and mill	Do.
...er:			
Frank Antonioli [4]	Butte, Montana 59701	Mine	Granite, Silver Bow.
Delbert Bullock [4]	Basin, Montana 59631	do	Jefferson.
Flathead Mines, Inc. [4]	Kalispell, Montana 59901	do	Flathead.
Harold Giulio [4]	Boulder, Montana 59632	do	Jefferson.
Joe Metesh [4]	Philipsburg, Montana 59858	do	Granite.
Moulton Mines [2]	Niehart, Montana 59465	do	Broadwater.
Pacific Mines, Inc. [4]	Virginia City, Montana 59755	do	Madison.
Tierra Explorations, Inc. [4]	2003 Wilco Bldg. Midland, Texas 79701	do	Mineral.
Dick Tunstill [4]	Philipsburg, Montana 59858	do	Deer Lodge, Granite.
Albert Walkup [4]	do	do	Granite.
James W. Young [4]	do	do	Do.
...ngsten: Minerals Engineering Co.	Glen, Montana 59732	Mine and mill	Beaverhead.
NONMETALS			
...nent:			
Ideal Cement Co	420 Ideal Cement Bldg. Denver, Colorado 80202	Plant	Gallatin.
Kaiser Cement & Gypsum Corp	Permanente Road Permanente, California 95014	do	Jefferson.
...ys:			
Hallett Minerals Co	P.O. Box 491 Forsyth, Montana 59327	Pit	Rosebud, Treasure.
Ideal Cement Co., Division of Basic Industries Inc.	420 Ideal Cement Bldg. Denver, Colorado 80202	Pit and plant	Gallatin.
Kanta Products, Inc	P.O. Box 96 Three Forks, Montana 59752	do	Do.
Kaiser Cement & Gypsum Corp	Permanente Road Permanente, California 95014	do	Jefferson.
NONMETALS—Continued			
Clays—Continued			
Lewistown Brick & Tile Co	P.O. Box 573 Lewistown, Montana 59457	Pit and plant	Fergus.
Lovell Clay Products Co	1312 Lockwood Road Billings, Montana 59101	do	Yellowstone.
Baroid Division N L Industries, Inc	P.O. Box 1675 Houston, Texas 77001	Pit	Carter.
Stauffer Chemical Co	P.O. Box 3146 Butte, Montana 59701	Pit and plant	Silver Bow.
Treasurelite, Division of Treasure State Industries, Inc.	P.O. Box 2750 Great Falls, Montana 59401	do	Cascade.
Fluorspar: Roberts Mining Co	P.O. Box 365 Darby, Montana 59829	Mine and plant.	Ravalli.
Gypsum:			
United States Gypsum Co	Lewistown, Montana 59457	Underground mine and calcining plant.	Fergus.
Lime: The Anaconda Company	Butte, Montana 59701	Plant	Deer Lodge.
Phosphate rock:			
Cominco American, Inc	Garrison, Montana 59731	Mine and plant.	Powell.
A. G. Jackson	Elliston, Montana 59728	Mine	Do.
Stauffer Chemical Co	299 Park Avenue New York, New York 10017	Plant	Silver Bow.
Sand and gravel:			
Midland Materials Co	Box 2521 Billings, Montana 59103	Pit	Yellowstone.
MS Ready Mix	Box 1501 Missoula, Montana 59801	Pit	Missoula.
Oscar J. Mortenson	Cascade, Montana 59421	Pit	Cascade.
Barry O'Leary	Box 1102 Billings, Montana 59103	Pit	Yellowstone.
Pioneer Ready Mix	Box 818 Bozeman, Montana 59715	Pit	Gallatin.
Richardson Construction Co	Box 449 Miles City, Montana 59301	Pit	Various.
Stone:			
The Anaconda Company	Anaconda, Montana 59711	Quarry and plant.	Deer Lodge.
Ideal Cement Co	420 Ideal Cement Bldg. Denver, Colorado 80202	do	Gallatin.
Kaiser Cement & Gypsum Corp	Permanente Road Permanente, California 95014	do	Jefferson.
Morrison-Knudsen Co. Inc	Seattle, Washington 98101	Pit and plant	Lincoln.
Sulfur:			
Farmer's Union Central Exchange, Inc.	P.O. Box 126 Laurel, Montana 59044	Plant	Yellowstone
Montana Sulphur & Chemical Co.	P.O. Box 1084 Billings, Montana 59103	do	Do.
Sulfuric acid:			
The Anaconda Company	Anaconda, Montana 59711	do	Deer Lodge.
Talc and soapstone:			
Pfizer, Inc	Dillon, Montana 59725	do	Beaverhead.
		Mine	Madison.
United Sierra Division of Cyprus Mines Corp.	Cameron, Montana 59720	do	Do.
	Three Forks, Montana 59752	Plant	Gallatin.
Vermiculite: W. R. Grace & Co	62 Whittemore Avenue Cambridge, Massachusetts 01109	Pit and plant	Lincoln.
Exfoliated vermiculite:			
Robinson Insulation Co	12th St. N. & River Drive Great Falls, Montana 59401	Plant	Cascade.
MINERAL FUELS *			

15196811

Coal from Musselshell, Richland, Roseland, and Powder River Counties; peat from Lake County; natural gas processing and petroleum refining from Fallon, Glacier, Lake, Toole, Yellowstone, Blaine, Garfield, Cascade, and Roosevelt counties.

Source References

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and H.W. Worthington, 1962, USGS Map MR-31.

(128) Geologic Map of Montana, C. P. Ross, et al., prepared in cooperation with Montana Bureau of Mines and Geology, USGS Map MR-2235.

(129) Reported Occurrences of Selected Minerals in Montana, B. B. Bentley and C. D. Mowatt, 1967, USGS Map MR-50.

(130) Mineral and Water Resources of Montana, Senate Document No. 98, A. E. Weissenborn, et al., 1968, USGS in cooperation with Montana Bureau of Mines and Geology, U.S. Government Printing Office, Washington, D.C.

(131) Directory of Mining Enterprises for 1972, Bulletin 88, D. C. Lawson, 1973, Montana College of Mineral Science and Technology, Butte, Montana 59701.

(132) The Mineral Industry of Montana, J. R. Welch, 1971, U.S. Bureau of Mines' Minerals Yearbook.

Nebraska

There is no mining presently being conducted in Nebraska in the metamorphic horizon. The general geology of the state is sedimentary deposits overlapping igneous bedrock as shown in Figure A-33. Much of the state is covered with unconsolidated sediments of the Pleistocene age. Most of the mining being done in Nebraska is quarrying for limestone, sand, and gravel. Some potential metallic mineral occurrence is present in the eastern part of the state. There are no reported fibrous minerals in the state.

The principal mining activity is listed in Table A-44.

Source References

(123) Mineral Resources Map, R. R. Burchett, Nebraska Geological Survey Conservation and Survey Division, University of Nebraska, Lincoln, 1973.

(134) Directory of Nebraska Quarries, Pits and Mines, R. R. Burchett, Nebraska Geological Survey Resource Report No. 5, 1971.

(135) The Mineral Industry of Nebraska, R. R. Burchett and T. C. Briggs, Bureau of Minerals Yearbook, 1972.

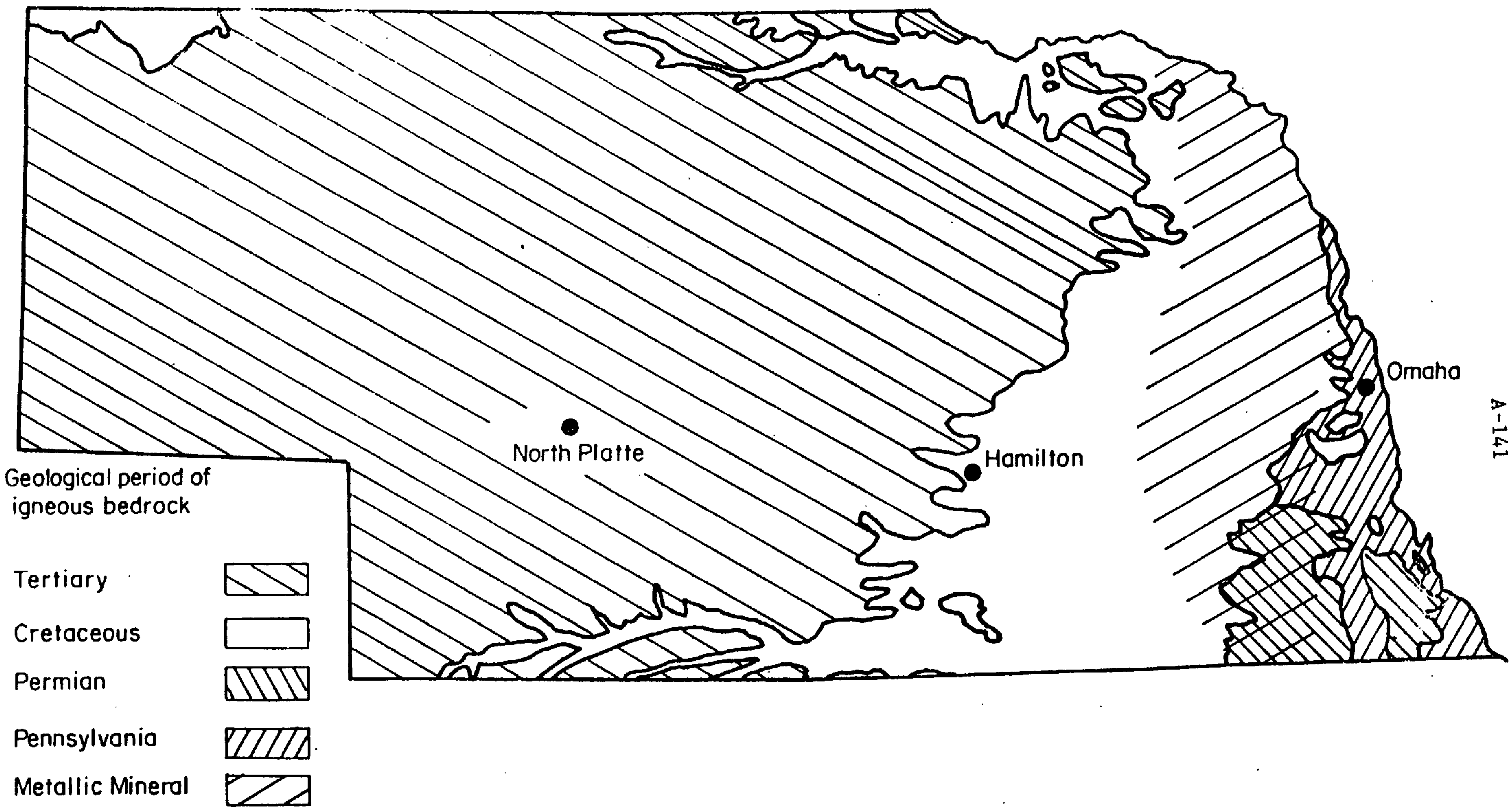

FIGURE A-33. GEOLOGIC BEDROCK MAP OF NEBRASKA

15196814

TABLE A-44. PRINCIPAL MINERAL PRODUCERS IN NEBRASKA

County	Company and Address	Commodity
Cass	Ash Grove Cement Company 1000 Tenmain Center Kansas City, Missouri 64105	Cement
Nuckolls	Ideal Cement Company Div. Ideal Basic Industries, Inc. 420 Ideal Cement Building Denver, Colorado 80202	Cement
Cass	Ash Grove Cement Company 1000 Tenmain Center Kansas City, Missouri 64105	Clays
Jefferson	Endicott Clay Products Company Endicott, Nebraska 68350	Clays
Otoe	Western Brick & Aggregate Company Box 1141 Nebraska City, Nebraska 68410	Clays
Lancaster	Yankee Hill Brick Manufacturing Co. Route 1 Lincoln, Nebraska 68502	Clays
Morrill and Scotts Bluff	Great Western Sugar Company Subsidiary of Great Western United Corporation Box 5308 Denver, Colorado 80217	Lime
Lincoln	LaRue Axtell Pumice Company Callaway, Nebraska 68825	Pumice
Butler, Hall, Pierce, Madison, Platte, and Jefferson	Central Sand & Gravel Company Box 626 Columbus, Nebraska 68601	Sand & Gravel (commercial)
Cuming	Consolidated Sand and Gravel Corp. 712 D Street Fairbury, Nebraska 68352	Sand & Gravel
Cuming	Hank Stalp Gravel Company Box 6 West Point, Nebraska 68788	Sand & Gravel
Douglas and Dodge	Hartford Sand & Gravel Company Box 571 Valley, Nebraska 68064	Sand & Gravel

TABLE A-44 (continued)

County	Company and Address	Commodity
Cass, Dodge Douglas, Morrill, Platte, Sarpy, and Saunders	Lyman-Richey Sand & Gravel Corp. 4315 Cuming Street Omaha, Nebraska 68131	Sand & Gravel
Douglas	McCann Sand & Gravel Company Valley, Nebraska 68064	Sand & Gravel
Merrick	Overland Sand & Gravel Company 22 Main Street Stromberg, Nebraska 68666	Sand & Gravel
Cass and Saunders	Western Sand & Gravel Company Box 268 Lincoln, Nebraska 68501	Sand & Gravel
Buffalo	Carl W. Whitney 1402 Ninth Avenue Kearney, Nebraska 68847	Sand & Gravel
Saunders	Wolf Sand and Gravel Company Morse Bluff, Nebraska 68648	Sand & Gravel
Cass	Ash Grove Cement Company 1000 Tenmain Center Kansas City, Mirrouri 64105	Stone
Gage	Behrens Construction Company P.O. Box 188 Beatrice, Nebraska 68310	Stone
Thurston	Fort Calhoun Stone Company 1255 South Street Blair, Nebraska 68008	Stone
Washington, Cass, Nemaha, Pawnee, and Saunders	Hopper Brothers Quarries Weeping Water, Nebraska 68483	Stone
Cass	Kerford Limestone Company Box 434 Weeping Water, Nebraska 68483	Stone
	United Rock Construction, Inc. 1117 Woodman of the World Building Omaha, Nebraska 68102	Stone

15196816

Nevada

Almost all of Nevada lies within the Basin and Range Province, a region characterized by isolated, elongate, subparallel mountain ranges and broad intervening valleys or basins. Most of the mountain ranges trend north or northeast and many are rather regularly spaced about 20 miles apart. They are 40 to 80 miles long and from 5 to 15 miles wide at their bases. The intervening basins are filled to their flatness level with the mountain wastes.

The Cordilleran geosyncline formed in Nevada in late Precambrian time. Deposition started in the central part of the trough and extended progressively eastward. The deposits tend to be clastic to the west and in the earlier deposition strata. Later deposits tend to be carbonates and are transitional to volcanics to the west. In late Devonian time, the Antler Orogemy (see the map figure for location) signaled a mountain building era in north central Nevada which culminated in the eastward movement of great thrust plates. The great Roberts Mountains thrust developed along which masses of siliceous and volcanic rocks rode eastward over limestones and dolomites. While the submerged leading edge of the plate was being blanketed by sediments, higher parts to the west were being eroded. Following the Antler Orogeny a subdued period of sedimentation followed which in turn was followed by the Sonoma Orogemy in north-central Nevada during Permian time.

During early and middle Mesozoic time, marine sediments and volcanics were again deposited to be followed by still another mountain building period characterized by great thrust faults and intricate folding. The Sierra Nevada batholith probably came near surface at this time. Cretaceous sediments indicate deposition above or near sea level. The Laramide Revolution started before the end of the Cretaceous period and this mountain building period again resulted in thrusting and folding of the Paleozoic strata.

The segmentation of the earth's crust into huge blocks which characterize the present appearance of the Basin and Range Province began with the volcanism of late Cenozoic time. Blocks of rock, bounded by normal faults, and either raised or tilted along these faults, have been sculptured to form the mountain ranges and sediments accumulated between ranges to form the flat-floored basins. In parts of Nevada, the process of block faulting is still continuing. The movement is principally vertical but lateral movement of blocks is pronounced in some localities.

The mineral deposits of Nevada are distributed in a major pattern controlled by stratigraphic and structural relationships. Most of the mineral deposits are related to intrusive rocks. Many deposits are alined along belts that trend northwestward, or east-west, or northeastward as indicated in Figure A-34. In part, ore-forming solutions probably were directly associated with the intrusive magmas and in part they may have risen along the same channelways that were earlier followed by magma. Ore bodies were formed within and around the channelways and the vicinity rock was highly altered. Sedimentary rocks adjacent to the intrusives usually show several degrees of transformation due to the various replacement and thermal efforts and depending on the nature of the intmded and intrusive rocks. In some mining districts, the fibrous amphibole minerals including tremolite and actinolite are described in the mineral suites accompanying ore minerals. However, for the most part, these minerals are not described in association with the ore minerals which seems peculiar since the conditions for the genesis of the fibrous amphiboles would appear to be extremely favorable in many mining areas.

Nevada is one of the big metallic mineral producers. Copper is the leading value metal recovered, with gold, silver, lead, zinc, iron, mercury, tungsten, and molybdenum following. Western Nevada contains the major gold, silver, tungsten, antimony, mercury, and iron deposits. Eastern Nevada contains the major lead and zinc deposits with associated gold and silver deposits. Copper deposits and the above metallics are for the most part concentrated in the central part of Nevada in the trend bands described as mining districts as illustrated on the map figure. This is not to say that production is located exclusively in such areas since almost every county has some metallic mineral production.

A variety of nonmetallic minerals also are produced in Nevada as indicated by the county by county commodity description in Table A-45. Asbestos is not found in Nevada in deposits of economic importance. Talc has been taken from Esmeralda County, in amounts up to 15,000 tons per year, from the Palmetto-Oasis area as described in the map figure and in more detail

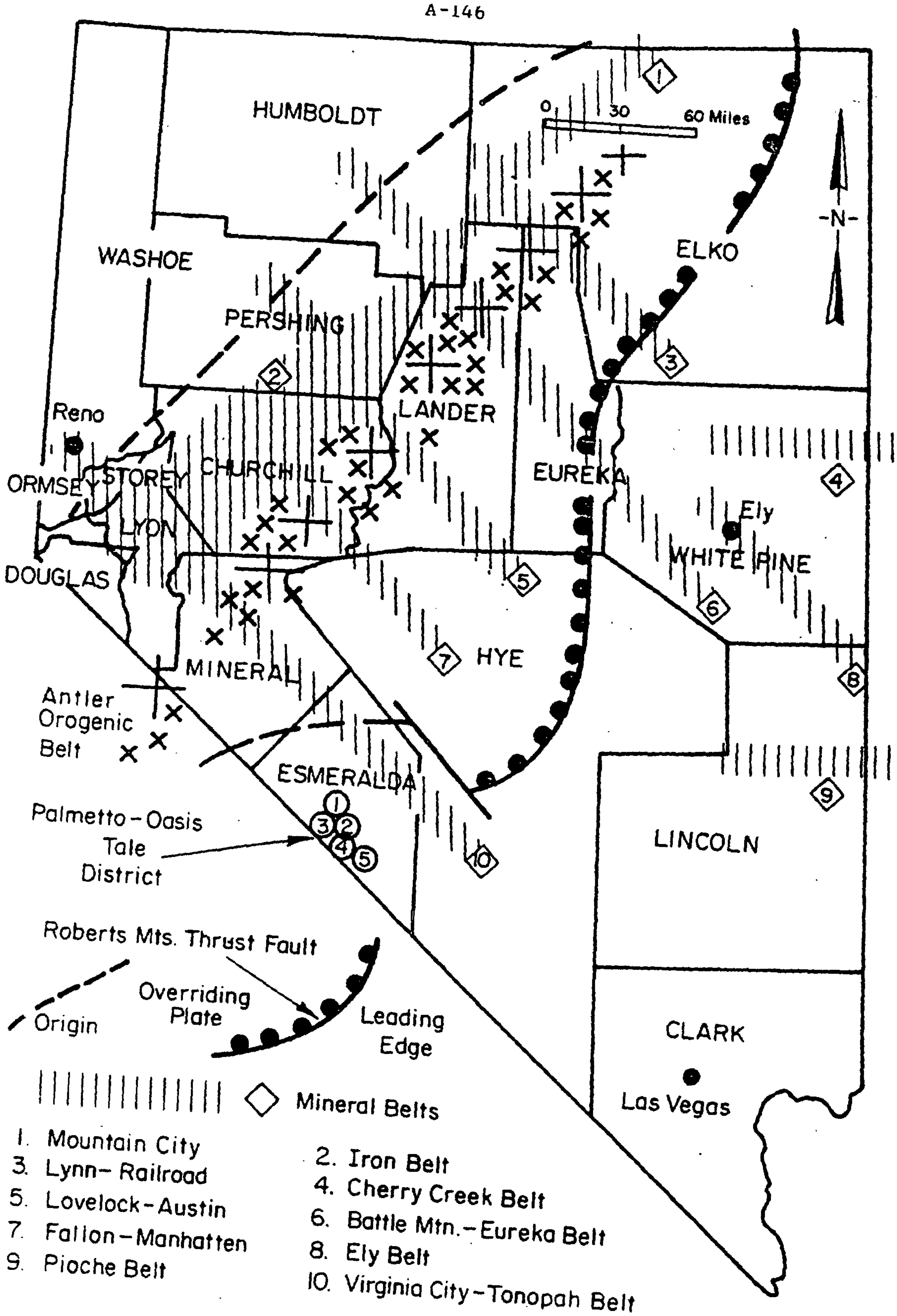

FIGURE A-34. MINERAL DEPOSITS IN NEVADA

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Table A-45. **Value of mineral production in Nevada, by county**

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Carson City [1]	W	W	Pumice, stone, sand and gravel.
Churchill	$113	$102	Sand and gravel, salt, tungsten.
Clark	13,443	16,689	Sand and gravel, lime, stone, gypsum, zinc, lead, silver, tungsten, copper.
Douglas	W	W	Iron ore, sand and gravel.
Elko	584	490	Sand and gravel, barite, gold, silver, lead, stone, tungsten, copper, zinc.
Esmeralda	2,982	2,503	Lithium, diatomite, clays.
Eureka	8,285	8,866	Gold, iron ore, sand and gravel, stone, mercury, silver, lead, copper, zinc.
Humboldt	W	816	Sand and gravel, mercury, silver, gold, tungsten, copper, lead, zinc.
Lander	25,853	23,722	Copper, gold, barite, silver, sand and gravel, antimony.
Lincoln	334	482	Stone, sand and gravel, pyrites, perlite, fluorspar, copper, silver, lead, pumice, zinc, gold.
Lyon	56,813	52,407	Copper, cement, stone, petroleum, sand and gravel, diatomite, clays.
Mineral	86	23	Sand and gravel, stone, mercury.
Nye	2,615	2,034	Magnesite, fluorspar, sand and gravel, brucite, pumice, mercury, clays, tungsten, stone.
Pershing	16,454	5,991	Diatomite, gypsum, iron ore, perlite, copper, mercury, sand and gravel, antimony, tungsten, clays.
Storey	W	W	Diatomite, pumice.
Washoe	3,193	2,911	Sand and gravel, pumice, clays, stone.
White Pine	49,283	43,992	Copper, gold, lime, silver, molybdenum, sand and gravel, stone, lead, zinc, clays.
Undistributed [2]	[r] 6,457	3,741	
Total [3]	[r] 186,345	164,774	

[r] Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Independent city; formerly listed as Ormsby County.

[2] Includes gem stones, gold (1970), lead (1970), mercury, silver (1970), tungsten, and zinc (1970) that cannot be assigned to specific counties and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

TABLE A-46. NEVADA TALC OCCURRENCE

Palmetto-Oasis district. Deposits consist of talc rock associated with and derived from sedimentary rocks, chiefly dolomite; in some deposits some of the talc is derived from quartzite. The deposits are similar to those of the Inyo Range-Panamint Range district.

1. Nevada Talc and Nevada No. 1 mines	37°31′	117°46′
2. Mae Talc, High Ridge, Shaw, White Eagle Nos. 1 and 2, Emma, Laura Bell, and Camp View mines.	37°29′	117°44′
3. Oasis, Roseamelia, Reed, White Eagle, White Swan, and Oversight mines.	37°26′	117°45′
4. White Cloud No. 1, Hideout and Cowhide, Mae Boyles Blue, White King, Sunny Side, Paramount, Alta, Lone Springs, Belle, and White Bird mines.	37°25′	117°43′
5. Tamarack and Log Spring mines	37°24′	117°39′

15196820

(Location Given in Terms of North Latitude and West Longitude) in Table A-46. The high quality talc in the Oasis mine originates as an alteration of the footwall dolomite in relation to a thrust fault. In the granitic rock of the hanging wall, are bodies of green chloritic material which is called "blue talc" by the miners. Tremolite, actinolite, and anthophylite may be associated with talc deposits. While much talc was mined from the Oasis District in the past, no production was reported in 1971. The current status of talc production from Nevada is unknown.

As mentioned previously, both metallic and nonmetallic minerals are produced in abundance from the Nevada strata. The principal producers of these commodities are described in Table A-47.

Source References

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, 1962, USGS Map MR-31.

(136) Preliminary Geologic Map of Esmeralda County, Nevada, J. P. Albers and J. H. Stewart, 1965, U.S.G.S. Field Studies Map MF-298.

(137) Geology and Mineral Deposits of Mineral County, Nevada, Bulletin 58, 1970, Nevada Bureau of Mines and Geology, Reno, Nevada, 89507.

(138) Geology and Mineral Resources of Clark County, Nevada, Bulletin 62, 1965, Nevada Bureau of Mines and Geology, Reno, Nevada, 89507.

(139) Geology and Mineral Resources of Eureka County, Nevada, Bulletin 64, 1967, Nevada Bureau of Mines and Geology, Reno, Nevada 89507.

(140) Geology and Mineral Deposits of Lyon, Douglas, and Ormsby Counties, Nevada, Bulletin 75, 1969, Nevada Bureau of Mines and Geology, Reno, Nevada 89507.

(141) Geology and Mineral Resources of Washoe and Storey Counties, Nevada, Bulletin 70, 1970, Nevada Bureau of Mines and Geology, Reno, Nevada 89507.

(142) Oxidized Zinc Districts in California and Nevada, A. V. Heyl and C. N. Boyion, 1964, U.S.G.S. Map MR-39.

143) Mineral and Water Resources of Nevada, V. A. Cammarota, Jr., 1971, U.S. Bureau of Mines' Minerals Yearbook.

TABLE A-47 PRINCIPAL MINERAL PRODUCERS IN NEVADA

Commodity and company	Address	Type of activity	County
Antimony:			
DOWCO Mining Co.	Battle Mountain, Nev. 89820	Open pit mines	Eureka and Lander.
Barite:			
Barold Division, N L Industries, Inc.	P.O. Box 1675 Houston, Tex. 77001	do	Elko.
Dresser Minerals	P.O. Box 94 Houston, Tex. 77005	do	Lander.
FMC Corp.	P.O. Box 3808 Modesto, Calif. 95352	do	Do.
Milchem, Inc., Mineral Division	P.O. Box 22111 Houston, Tex. 77027	do	Do.
Brucite:			
Basic Inc.	845 Hanna Bldg. Cleveland, Ohio 44115	do	Nye.
Cement:			
Nevada Cement Co.	Fernley, Nev. 89408	Dry-process, portland-cement plant.	Lyon.
Clays:			
Nevada Cement Co.	Fernley, Nev. 89408	Open pit mine	Washoe.
Western Talc Co.	P.O. Box 368 Yermo, Calif. 92398	do	Clark, Esmeralda, Nye, Pershing.
Copper:			
The Anaconda Company	P.O. Box 1000 Weed Heights, Nev. 89448	do	Lyon.
Duval Corp.	P.O. Box 451 Battle Mountain, Nev. 89820	do	Lander.
Kennecott Copper Corp., Nevada Mines Division.	McGill, Nev. 89318	do	White Pine.
Ranchers Exploration & Development Corp.	P.O. Box 803 Winnemucca, Nev. 89445	do	Pershing.
Diatomite:			
Eagle-Picher Industries, Inc.	P.O. Box 1869 Reno, Nev. 89505	do	Pershing and Storey.
GREFCO, Inc.	630 Shatto Place Los Angeles, Calif. 90005	do	Esmeralda.
United Sierra Division, Cyprus Mines Corp.	P.O. Box 1201 Trenton, N.J. 08606	do	Churchill.
Fluorspar:			
Carp Fluoride Co.	P.O. Box 536 Delta, Utah 84624	do	Lincoln.
J. Irving Crowell, Jr.	P.O. Box 96 Beatty, Nev. 89003	Underground mine.	Nye.
Gold:			
Carlin Gold Mining Co.	P.O. Box 672 Elko, Nev. 89801	Open pit mine	Eureka.
Cortez Gold Mines	Cortez, Nev. 89821	do	Lander.
Duval Corp.	P.O. Box 451 Battle Mountain, Nev. 89820	do	Do.
Kennecott Copper Corp., Nevada Mines Division.	McGill, Nev. 89318	do	White Pine.
Gypsum:			
The Flintkote Co.	P.O. Box 2678 Terminal Annex Los Angeles, Calif. 90054	do	Clark.
Johns-Manville Products Corp.	4301 East Firestone Blvd. South Gate, Calif. 90280	Open pit mine	Clark.
United States Gypsum Co.	101 South Wacker Drive Chicago, Ill. 60606	do	Pershing.
Iron ore:			
Nevada-Barth Corp.	P.O. Box 425 Carlin, Nev. 89822	do	Eureka.
Standard Slag Co.	P.O. Box 4400 Reno, Nev. 89501	do	Douglas.
Lead:			
Bristol Silver Mines Co.	P.O. Box 276 Pioche, Nev. 89043	Underground mine.	Lincoln.
Hal Jensen	East Ely, Nev. 89315	do	White Pine.
Lime:			
The Flintkote Co.	P.O. Box 57367 Flint Station Los Angeles, Calif. 90057	Rotary kilns, batch and continuous hydrators.	Clark.
Morrison & Weatherly Chemical Products.	P.O. Box 1105 McGill, Nev. 89318	Rotary kilns	White Pine.
Lithium:			
Foote Mineral Co.	Route 100 Exton, Pa. 19341	Dry lake brines	Esmeralda.

TABLE A-47 (continued)

Commodity and company	Address	Type of activity	County
Magnesite:			
Basic Inc.	845 Hanna Bldg. Cleveland, Ohio 44115	Open pit mine	Nye.
Mercury:			
Ruja Mining Co.	P.O. Box 31 McDermitt, Nev. 89421	Underground mine.	Humboldt.
Sierra Mineral Management	4741 E. Sunrise Drive Tucson, Ariz. 85718	do	Do.
Molybdenum:			
Kennecott Copper Corp., Nevada Mines Division.	McGill, Nev. 89318	Open pit mine	White Pine.
Perlite:			
Combined Metals Reduction Co., Panacalite Division.	218 Felt Bldg. Salt Lake City, Utah 84110	do	Lincoln.
Delamar Perlite	Pioche, Nev. 89043	Underground mine.	Do.
United States Gypsum Co.	101 South Wacker Drive Chicago, Ill. 60606	Open pit mine	Pershing.
Petroleum:			
James L. Davis	21 Boyd Road Pleasant Hill, Calif. 94523	Producing crude-oil wells.	Nye.
North American Resources Corp.	611 San Jacinto Bldg. Houston, Tex. 77002	do	Do.
Western Oil Lands, Inc.	380 Linden St. Reno, Nev. 89502	do	Do.
Pumice:			
Kaiser Industries Corp.	300 Lakeside Drive Oakland, Calif. 94612	Open pit mine	Storey.
Rillite Aggregate Co.	P.O. Box 5605 Reno, Nev. 89503	do	Washoe.
Savage Construction, Inc.	P.O. Box 970 Carson City, Nev. 89701	do	Carson City.
Salt:			
Fallon Development Co.	Harrigan Road Fallon, Nev. 89406	Dry lake brines	Churchill.
Sand and gravel:			
C. M. Brown Construction Co.	1770 North Leonard Lane Las Vegas, Nev. 89108	Open pit mine	Clark.
Frehner Trucking Service, Inc.	Las Vegas, Nev. 89101	do	Do.
R. Helms Construction Co.	3025 Mill St. Reno, Nev. 89502	do	Washoe.
Las Vegas Building Materials, Inc.	P.O. Box 530 Las Vegas, Nev. 89101	do	Clark.
Nevada Aggregates & Asphalt	P.O. Box 7424 Reno, Nev. 89502	do	Washoe.
Simplot Silica Products	P.O. Box 308 Overton, Nev. 89040	do	Clark.
Stewart Brothers Co.	P.O. Box 2775, Huntridge Station Las Vegas, Nev. 89101	do	Do.
Stock Mill & Supply Co.	3336 Cinder Lane Las Vegas, Nev. 89103	do	Do.
Wells-Cargo, Inc.	2804 West Spring Mountain Rd. Las Vegas, Nev. 89114	do	Do.
Whiting Bros.	6418A East Vegas Valley Rd. Las Vegas, Nev. 89109	do	Do.
W. M. K. Transit Mix, Inc.	1606 Industrial Rd. Las Vegas, Nev. 89102	do	Do.
Silver:			
Bristol Silver Mines Co.	P.O. Box 276 Pioche, Nev. 89043	Underground mine.	Lincoln.
Duval Corp.	P.O. Box 451 Battle Mountain, Nev. 89820	Open pit mine	Lander.
Kennecott Copper Corp., Nevada Mines Division.	McGill, Nev. 89318	do	White Pine.
Stone:			
Morrison & Weatherly Chemical Products.	P.O. Box 1105 McGill, Nev. 89318	Open quarry	Do.
Nevada Cement Co.	Fernley, Nev. 89408	do	Lyon.
U.S. Lime Division, The Flintkote Co.	P.O. Box 57367 Flint Station Los Angeles, Calif. 90057	do	Clark.
Tungsten:			
Henry C. & John Crofoot	P.O. Box 797 Lovelock, Nev. 89419	do	Churchill.
Zinc:			
Hal Jensen	East Ely, Nev. 89315	Underground mine.	White Pine.

15196822

New Hampshire

Metamorphic rocks are found to occur in every county of New Hampshire. The Devonian and older sedimentary and volcanic rocks in this site have been regionally metamorphosed. The grade of metamorphism differs considerably, from the chlorite zone at one extreme to the sillimanite zone at the other. For descriptive purposes the rocks have been assigned to five zones: the chlorite, biotite, garnet, staurolite, and sillimanite zones. These are, respectively, more or less the equivalents of the following subfacies in the facies classification: chlorite-muscovite, chlorite-biotite, chloritoid-almandite, staurolite-kyanite, and sillimanite-almandite subfacies. The regional metamorphism thus greatly complicates the description of the rocks. Conceivably, each formation might appear in all five of the metamorphic zones. For structural reasons this happens in only a few instances, and most formations appear in only a few of the zones.

The Mississippian (?) volcanic rocks are younger than the regional metamorphism. They have probably been involved in some contact metamorphism, but apparently they have not undergone much change in mineralogy.

Vast quantities of plutonic rocks have been emplaced in the sedimentary and volcanic rocks.

The metamorphic rocks typically appear in the form of slates, phyllites, schists, gneisses, quartzites, marbles, and serpentines. Soapstone has been found specifically in Grafton, Merrimack, Hillsborough, and Cheshire Counties. Refer to Table A-48 and Figure A-35 for geographical locations and nature of these deposits.

The amphibole minerals, actiholite, tremolite, anthophyllite, and occasionally crocidolite are found in widely scattered occurrences in New Hampshire although no commercial exploitation of these asbestiform materials is reported. The current quarrying activities in the state are summarized in Table A-49. There are no production activities for metallics which are found chiefly in the western counties of Grafton, Sullivan, and Cheshire.

TABLE A-48 SOAPSTONE DEPOSITS IN NEW HAMPSHIRE

Deposits consist of soapstone probably associated with ultramafic or mafic igneous rocks.

Grafton County			
1.	Page quarry	44° 07'	71° 59'
2.	Cottonstone Mountain quarry	43° 55'	72° 06'
3.	Orfordville prospects	43° 54'	72° 04'
4.	Orfordville quarry	43° 52'	72° 06'
Merrimack County			
5.	Unnamed quarry	43° 19'	71° 35'
6.	Hodgdon quarry	43° 15'	71° 45'
Hillsborough County			
7.	Hodgdon quarry	43° 03'	71° 46'
8.	Francestown Soapstone Company Quarry	43° 00'	71° 47'
Cheshire County			
9.	Richmond quarry	42° 45'	72° 13'

Source References

(1) Metamorphic Map of the Appalachians, B. A. Morgan, USGS Map I-724

(3) Talc and Soapstone in the U.S., A. H. Chidester and H. W. Worthington, 1962, USGS Map MR-31.

(144) Geologic Map of New Hampshire, M. P. Billings, 1955, New Hampshire Mines and Prospects, T. R. Meyers and G. W. Stewart, 1955, in The Geology of New Hampshire.

(145) Mineral Deposits and Occurrences in New Hampshire, Exclusive of Clay, Sand and Grave. and Peat, N.C. Pearre and J. A. Calkins, 1957, USGS Map MR-6.

(146) The Geology of New Hampshire, Part III, Minerals and Mines, 1956, T. R. Meyers and G. W. Stewart, Department of Resources and Economic Development, Concord, New Hampshire.

(147) The Geology of New Hampshire, Part II - Bedrock Geology, M. P. Billings, Department of Resources and Economic Development, Concord, N.H.

(148) The Mineral Industry of New Hampshire, A. H. Reed, U.S. Bureau of Mines' Minerals Yearbook.

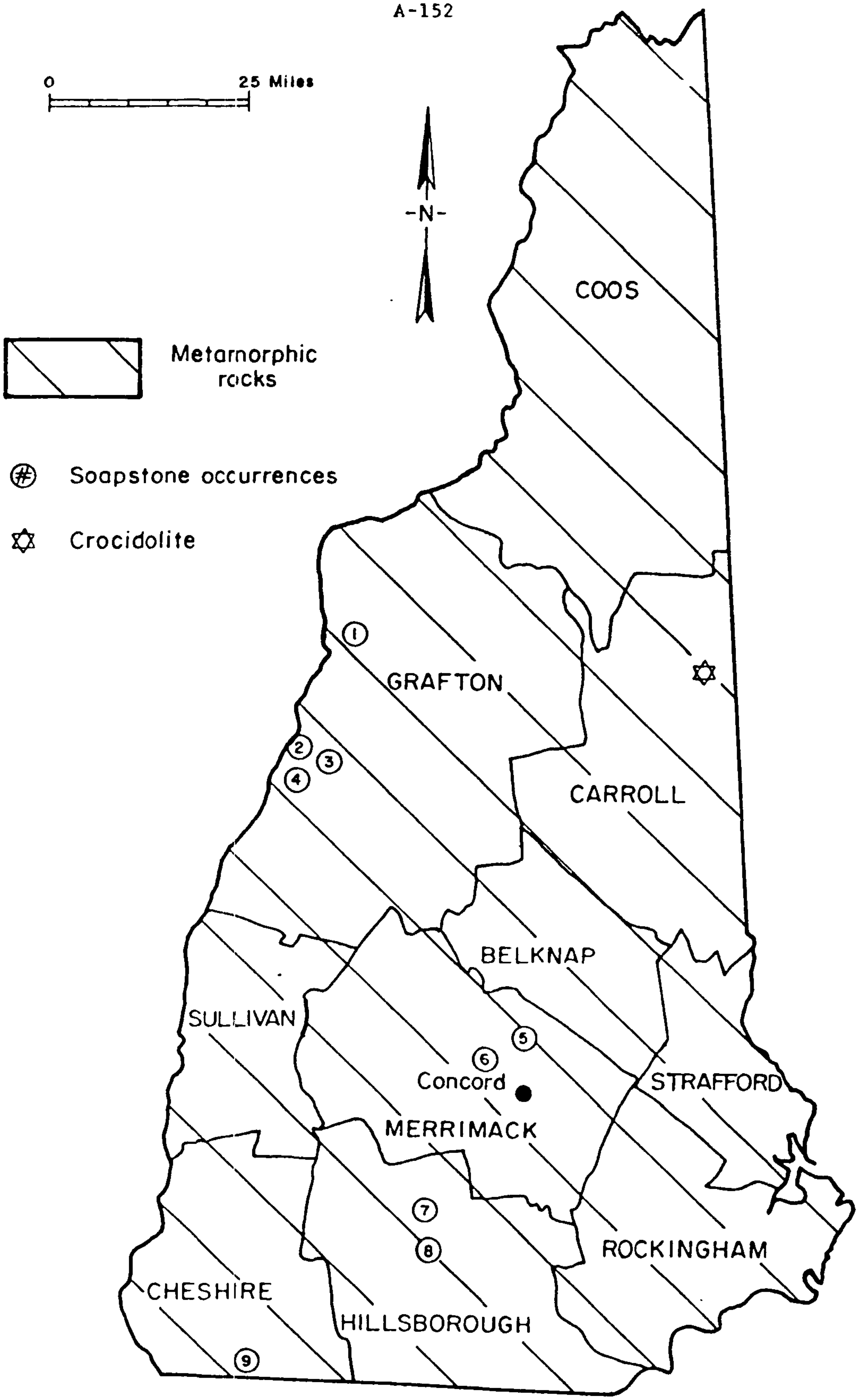

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FIGURE A-35. OCCURRENCE OF METAMORPHIC ROCK IN NEW HAMPSHIRE

TABLE A-49. CURRENT QUARRYING ACTIVITIES IN NEW HAMPSHIRE

County	Commodity
Belknap	Sand and gravel
Carroll	Sand and gravel
Cheshire	Sand and gravel
Coos	Sand and gravel
Grafton	Clay, sand and gravel, crushed stone
Hillsborough	Sand and gravel, dimension granite, crushed quartz
Merrimack	Sand and gravel, dimension granite
Rockingham	Clay, sand and gravel, crushed stone
Strafford	Clay, sand and gravel
Sullivan	None

New Jersey

In New Jersey, metamorphic rocks appear in eight counties as indicated in Figure A-36. Talc rock derived from Precambrian dolomite occurs near Phillipsburg in Warren County. Mining for zinc ore has taken place in Sussex County from the famous Franklin-Sterling Hill deposits. In this location gneisses of various origins and crystalline limestone, all of Precambrian age, are cut by minor masses of granite pegmatites and a few basic dikes. Enclosed in the limestone are the ore bodies generally ranging from 10 to 100 feet thick. The principal ores, granular franklinite. willemite, and zincite occur concentrated in bands in a calcite gangue or matrix. The altered rock is famous for its abundance of mineral species many of which are unique to the area. However, many common mineral species also are present including several of the amphiboles in asbestiform and chrysotile. The asbestiform minerals are not present in abundance in this area, however, and they have not been reported from elsewhere in the metamorphic rocks and New Jersey. The current quarrying activities in the eight-county area of New Jersey where metamorphic rocks occur are summarized in Table A-50.

Source Reference

(1) Metamorphic Map of the Appalachians, B. A. Morgan, 1972, USGS Map I-724.

(3) Talc and Soapstone in the U.S., A. H. Chidester and H. W. Worthington, 1962, USGS Map MR-31.

(149) The Minerals of Franklin and Sterling Hill, N.J., A. S. Wilkerson, 1962, (includes Geologic Map of New Jersey, 1959) Bulletin 65, New Jersey Geological Survey, Trenton, New Jersey.

(150) Geologic Map of New Jersey, J. V. Lewis and H. B. Kummel, 1912, Revised by M. E. Johnson, 1950, Atlas Sheet No. 40, New Jersey Department of Conservation and Economic Development.

(151) The mineral Industry of New Jersey, D. C. Winiger, 1971, U.S. Bureau of Mines' Mineral Yearbook.

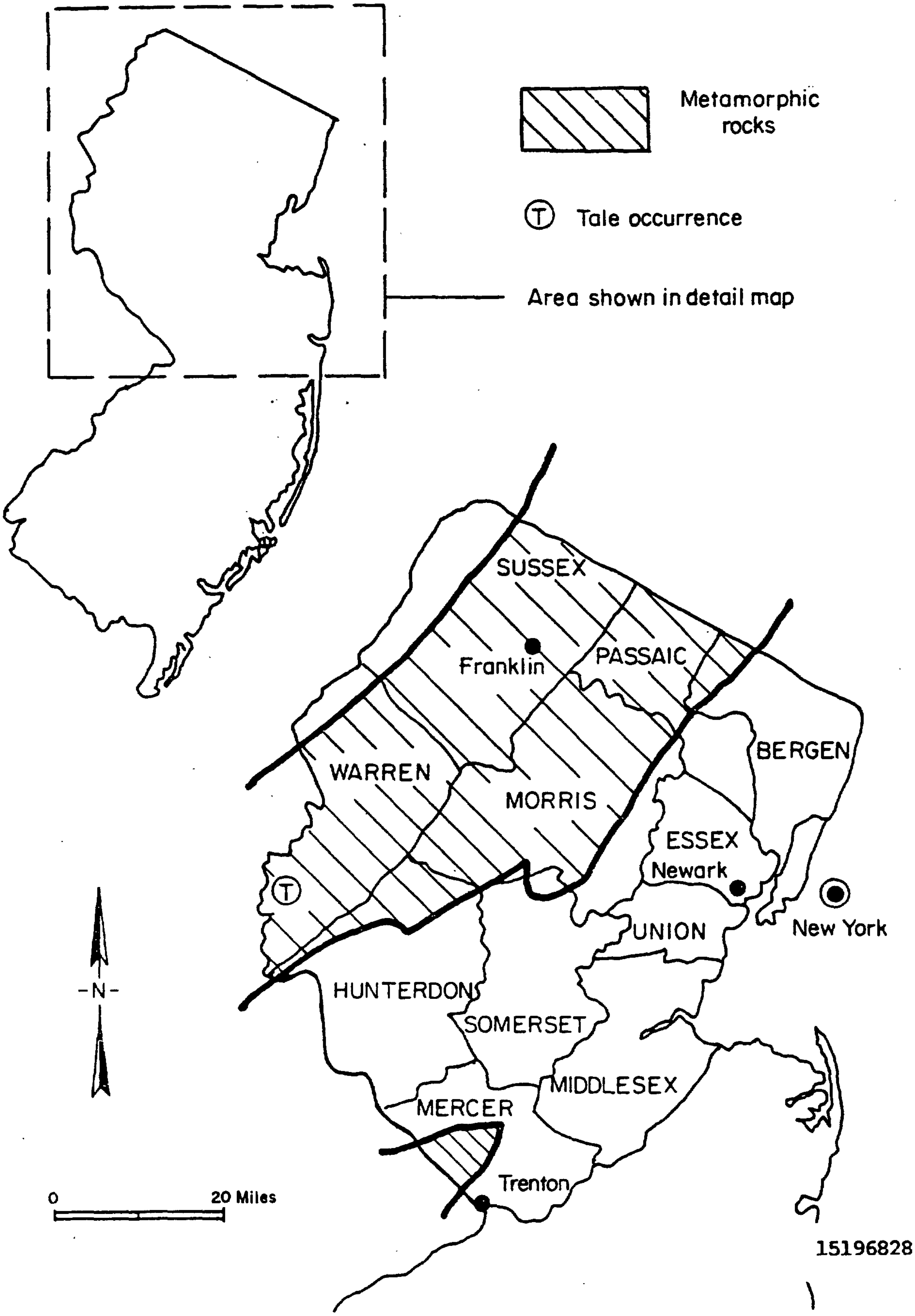

FIGURE A-36. OCCURRENCE OF METAMORPHIC ROCK IN NEW JERSEY

TABLE A-50. QUARRYING ACTIVITY IN NEW JERSEY

County	Quarrying Activity
Bergen	None
Hunterdon	Crushed and broken granite, sandstone, crushed and broken traprock (basalt)
Mercer	Crushed and broken traprock (basalt)
Morris	Sand and gravel, crushed and broken granite
Passaic	Crushed and broken granite, crushed and broken traprock (basalt)
Somerset	Clay, crushed and broken traprock (basalt)
Sussex	Crushed and broken granite, crushed limestone
Warren	Sand and gravel

New Mexico

The state of New Mexico may be divided somewhat arbitrarily into four physiographic provinces: Colorado Plateaus in the west, the southern Rocky Mountains and the Basin and Range Province in central New Mexico, and the Great Plains Province which comprises the eastern third of the state. Although not shown on Figure A-37, the provinces are further subdivided into sections on the basis of the principal land forms.

The southern Rocky Mountains Province includes only a relatively small part of New Mexico and is generally considered as terminating at the southern end of the Sangre de Christo Range (east range) and the Nacimiento Mountains (west range). However, a succession of mountain ranges of not greatly dissimilar geologic features continues southward from the Rocky Mountain ranges, in a roughly north-south alignment, to the southern border of New Mexico. These ranges, though separated by much wider deeply alleviated valleys, in the aggregate form a belt 50 to 100 miles wide from east to west that in a borad sense divides the plateau, lava, and canyon lands in the western part of the state from the plains and areas of generally lower topographic relief of the eastern part.

The rocks in New Mexico range in age from Precambrian to recent, but few Precambrian formations are exposed. The Precambrian rocks reveal that sedimentary processes were dominent in the early history of this area although there are some volcanic deposits. During Paleozoic times, New Mexico apparently was in low relief and there was intermittent encroachment of the sea. Also, there was low-grade regional warping of the strata. The uplifting during late Paleozoic time resulted in the Ancestral Rocky Mountains which highland contributed sediments from central New Mexico to adjoining basins Another quiet period followed but the uplift was rejuvenated during tertiery time.

Regional uplift accompanied by folding and local thrust faulting was th dominant tectonic activity in late Cretaceous and early Tertiary time. As early as Oligocene time, tensional stress resulted in normal faulting and widespread volcanic activity. During late Tertiary time, most of the mountains and basins that are part of the present landscape of New

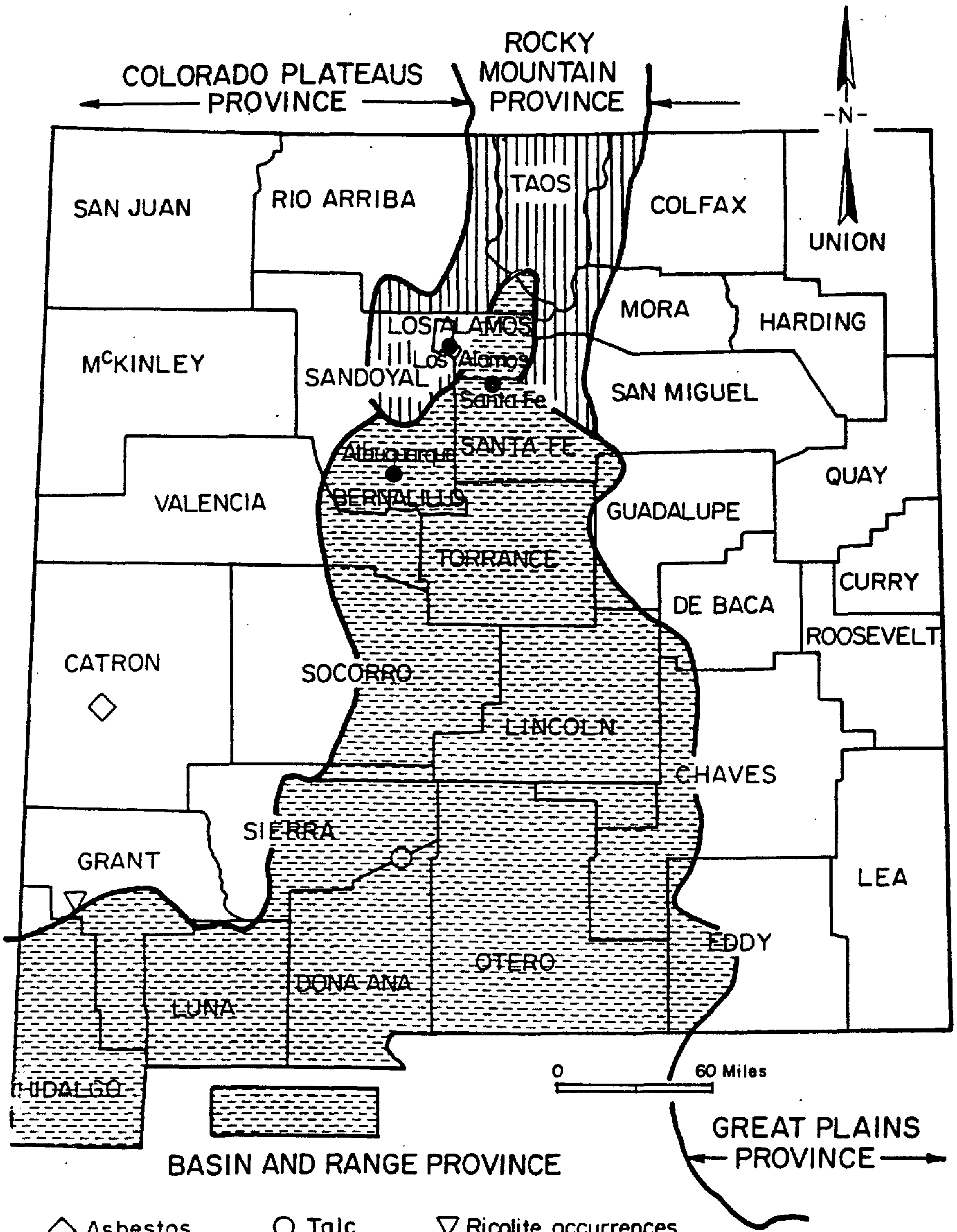

FIGURE A-37. PHYSIOGRAPHIC PROVINCES OF NEW MEXICO
AND ASBESTOS OCCURRENCE

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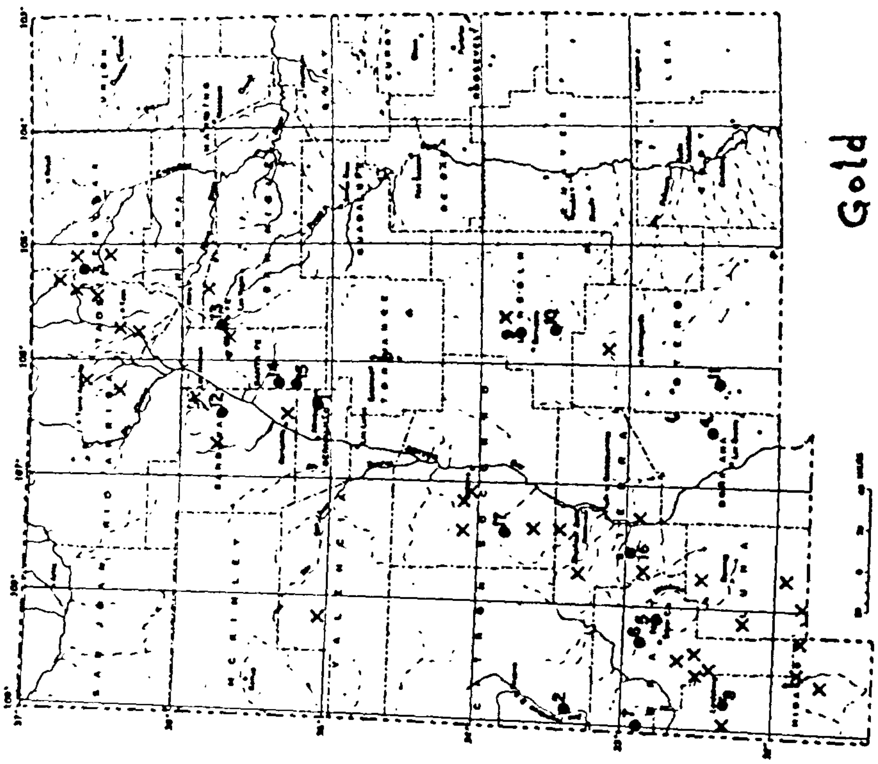
Mexico were formed. Intrusion of igneous rock from magmas formed many of the currently well-known mountains. Magmatic differentiation of the igneous rocks during igneous intrusion resulted in the formation of pegmatites and other concentrations of minerals. Contact metamorphic deposits were formed along the margins of intrusions. Faults, fissures, and folds in the strata resulted in mineral concentration. The general trend of the mineral concentration in New Mexico is from the north-central part of the state southwestward to the southwest corner, chiefly within the Basin and Range Province.

The major metallic deposits in New Mexico, copper, gold, silver, lead, and zinc, follow this general occurrence pattern as shown for copper and gold occurrences in Figure A-38. Fibrous amphibole minerals are not described as being associated with metallic minerals although in many sites, the conditions are favorable for their genesis. Minor metal production has come from the contact metasomatic deposits.

The occurrence of asbestos desposits are extremely rare in New Mexico. Asbestos deposits are reported from an area in Catron County as shown on Figure A-37. Ricolite, a banded talc serpentinite, is reported in southwestern Grant County. The Ricolite, which has been mined intermittently for decorative stone, consists of alternating bands of talc and serpentine, and has flakes of chlorite, fracture fillings of calcite, and quartz, and cross-fiber veins of chrysotile asbestos. Locally, talc predominates over serpentine with pure talc pods of several feet in thickness known. However, these are too small to be of commercial importance. Talc has been mined in both Sierra and Dona Ana Counties, however. The Hembrillo and Red Rock Mines have a talc rock derived from dolomite and phyllite at the site marked on Figure A-37. The site is not currently productive since it is within the boundaries of the White Sands Missile Range. Elsewhere in New Mexico, small occurrences of talc have been reported in Taos. Rio Arriba (talc schist), Santa Fe, Socorro, Grant, Eddy, and Lea Counties (with sylvite and halite in potash-bearing beds of Eddy and Lea Counties).

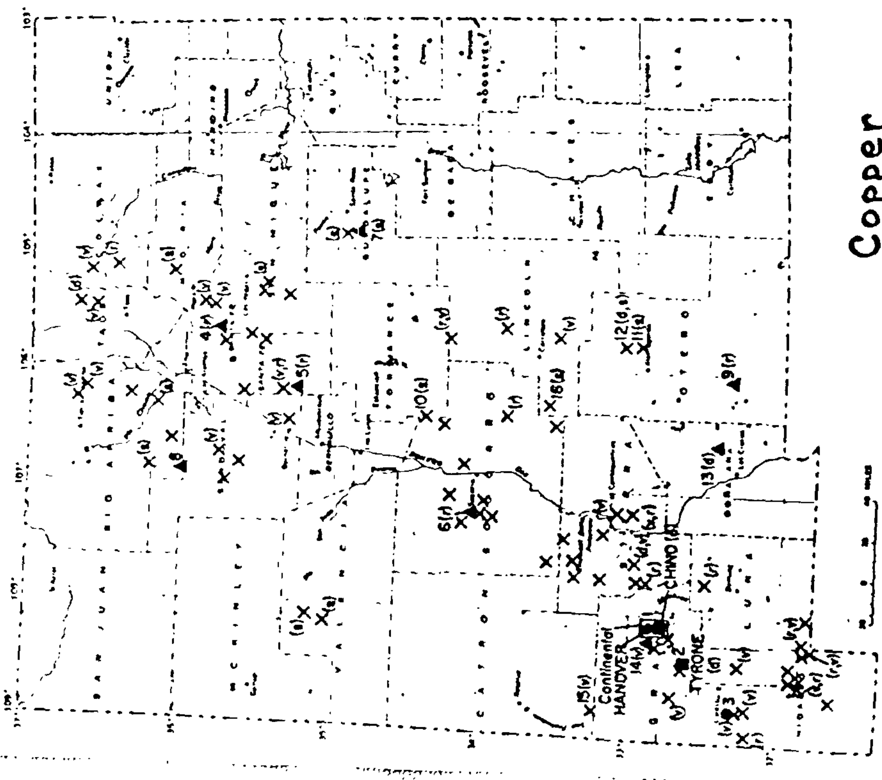
The mineral production by county and the mineral producers of New Mexico are given in Tables A-51 and A-52.



EXPLANATION

● More than 10,000 ounces total production

X Less than 10,000 ounces total production



EXPLANATION

Copper-producing districts or mines, showing relative amount of production plus estimated potential in tons

■ More than 1,000,000

● 50,000 - 1,000,000

▲ 1,000 - 50,000

X 10 - 1,000

□ Area of Central mining district

Types of deposits

(d) Disseminated (porphyry)
(v) Vein
(r) Replacement
(s) Disseminated in "Red Beds"

FIGURE A-38. OCCURRENCE OF COPPER AND GOLD IN NEW MEXICO

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Table A-51. Value of mineral production in New Mexico, by county

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Bernalillo	$8,198	$11,802	Cement, sand and gravel, stone, clay.
Catron	W	W	Sand and gravel, salt.
Chaves	16,484	12,326	Petroleum, natural gas, sand and gravel, stone.
Colfax	W	W	Stone.
Curry	W	W	Stone, sand and gravel.
De Baca	W	W	Sand and gravel.
Doña Ana	416	699	Sand and gravel, pumice, clay, stone.
Eddy	168,151	176,494	Potassium salts, petroleum, natural gas, natural gas liquids, salt, stone, sand and gravel.
Grant	199,169	168,929	Copper, zinc, silver, molybdenum, lead, lime, gold, manganiferous ore, sand and gravel, stone, fluorspar.
Guadalupe	W	W	Sand and gravel, stone.
Harding	W	W	Carbon dioxide, sand and gravel.
Hidalgo	2,695	1,575	Copper, gold, silver, clay, sand and gravel, zinc.
Lea	395,329	394,296	Petroleum, natural gas, natural gas liquids, stone, sand and gravel.
Lincoln	125	W	Stone, sand and gravel.
Los Alamos	2	--	
Luna	578	204	Sand and gravel, clay, stone.
McKinley	70,958	71,304	Uranium, natural gas liquids, petroleum, coal, stone, natural gas, molybdenum, sand and gravel.
Mora	W	W	Sand and gravel, stone.
Otero	W	W	Stone, sand and gravel.
Quay	W	W	Sand and gravel, stone.
Rio Arriba	16,052	36,563	Natural gas, petroleum, natural gas liquids, sand and gravel, stone, pumice.
Roosevelt	21,961	18,686	Petroleum, natural gas, natural gas liquids, sand and gravel.
Sandoval	829	2,836	Copper, gypsum, petroleum, natural gas, sand and gravel, silver, peat, pumice, clay, stone, zinc.
San Juan	102,934	93,571	Natural gas, coal, petroleum, natural gas liquids, sand and gravel, helium, stone, pumice, uranium, clay.
San Miguel	W	W	Sand and gravel, stone.
Santa Fe	1,584	2,045	Sand and gravel, copper, pumice, gold, silver, stone, zinc.
Sierra	W	W	Sand and gravel, copper, silver.
Socorro	225	61	Sand and gravel, iron ore.
Taos	21,796	21,105	Molybdenum, perlite, sand and gravel, mica, stone.
Torrance	W	W	Sand and gravel.
Union	W	W	Pumice, sand and gravel.
Valencia	21,826	22,477	Uranium, perlite, sand and gravel, stone.
Undistributed[1]	11,045	11,309	
Total[2]	1,060,358	1,046,284	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Includes gem stones and vanadium which cannot be assigned to specific counties; and values indicated by symbol W.

[2] Data may not add to totals shown because of independent rounding.

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TABLE A-52. PRINCIPAL MINERAL PRODUCERS IN NEW MEXICO

Commodity and company	Address	Type of activity	County
Carbon dioxide (natural):			
Schwartz Carbonic Co	Box 9737 El Paso, Tex. 79987	Well and extraction plant.	Harding.
S.E.C. Corp	....do	....do	Do.
Cement: Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Dry process, 2-rotary-kiln plant.	Bernalillo.
Clays:			
El Paso Brick Co	Box 12386 El Paso, Tex. 79912	Open pit mine	Doña Ana.
Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	....do	Bernalillo.
Kinney Brick Co., Inc	Box 1804 Albuquerque, N. Mex. 87103	....do	Do.
Coal:			
Kaiser Steel Corp	Box 1107 Raton, N. Mex. 87740	Underground mine, crushing plant, dense media-froth flotation cleaning plant.	Colfax.
The Pittsburg & Midway Coal Mining Co.	10 Main Center Kansas City, Mo. 64105	Strip mine, crushing plant, chemical and water treatment plant.	McKinley.
Utah Construction & Mining Co	Box 155 Fruitland, N. Mex. 87416	Strip mine, crushing plant, dust suppression detergent treatment plant.	San Juan.
Copper:			
Federal Resources Corp.[1]	1370 South Third West Salt Lake City, Utah 84115	3 underground mines and mill.	Hidalgo.
Kennecott Copper Corp., Chino Mines Division.[1]	Hurley, N. Mex. 88043	Open pit mine, flotation mill, precipitation plant, smelter, and refinery.	Grant.
Phelps Dodge Corp., Tyrone Branch.[1]	Tyrone, N. Mex. 88065	Open pit mine and mill.	Do.
United States Smelting Refining and Mining Co.[1]	136 East South Temple St. Salt Lake City, Utah 84111	Underground mine, open pit-underground mine, and flotation mill.	Do.
Fluorspar: Southwest Fluorspar Co	Box 1168 Demming, N. Mex. 88001	Open pit mine	Doña Ana.
Gypsum: White Mesa Gypsum Co	124 Jackson NE. Albuquerque, N. Mex. 87108	....do	Sandoval.
Iron ore: Dotson Minerals Corp	Box 115 Socorro, N. Mex. 87801	....do	Socorro.
Lime: Kennecott Copper Corp., Chino Mines Division.	Hurley, N. Mex. 88043	Rotary-kiln plant	Grant.
Manganiferous ore: Luck Mining Co	215 Market St. San Francisco, Calif. 94105	Open pit mine	Do.
Mica: Mineral Industries Commodities of America, Inc.	Box 2408 Santa Fe, N. Mex. 87501	....do Dry grinding plant	Taos. Santa Fe.
Molybdenum:			
Kennecott Copper Corp., Chino Mines Division.	Hurley, N. Mex. 88043	*See* Copper	Grant.
Kerr-McGee Corp	Kerr-McGee Bldg. Oklahoma City, Okla. 73102	By product of uranium mining.	McKinley.
Molybdenum Corporation of America, Questa Division.	280 Park Ave. New York, N.Y. 10017	Open pit mine and flotation mill.	Taos.
Natural gas and petroleum:[2]			
Peat: Humus Organic Products	506 Rosemont NE. Albuquerque, N. Mex. 87107	Humus bog	Sandoval.
Perlite:			
Grefco, Inc., Dicalite Division	333 North Michigan Ave. Chicago, Ill. 60601	Open pit mine; crushing, screening, and air-separation plant.	Taos.
Johns-Manville Perlite Corp	2500 Miguelito Road Lompoc, Calif. 93436	....do	Do.
Potash:			
AMAX Chemical Corp	Box 279 Carlsbad, N. Mex. 88220	Underground mine and refinery.	Eddy.
Duval Corp., Potash Division	Box 511 Carlsbad, N. Mex. 88220	2 underground mines and refinery.	Do.
International Minerals & Chemical Corp.	Box 71 Carlsbad, N. Mex. 88220	Underground mine and refinery.	Do.
Kerr-McGee Chemical Corp	Kerr-McGee Bldg. Oklahoma City, Okla. 73102	....do	Lea.
National Potash Co	Box 731 Carlsbad, N. Mex. 88220	....do	Eddy.
Potash Co. of America, a division of Ideal Basic Industries, Inc.	Box 31 Carlsbad, N. Mex. 88220	....do	Do.
United States Potash & Chemical Co.	Box 101 Carlsbad, N. Mex. 88220	....do	Do.
Pumice:			
General Pumice Corp	Box 449 Santa Fe, N. Mex. 87501	Open pit mine and crushing and screening plant.	Rio Arriba.
Twin Mountain Rock Co	Box 1009 Sheridan, Wyo. 82801	....do	Union.
Volcanic Cinder Co	Box 9977 El Paso, Tex. 79990	....do	Doña Ana.
Salt:			
New Mexico Salt Co	Box 303 Carlsbad, N. Mex. 88220	Potash tailing recovery and plant.	Eddy.
The Salt Supply Co., Inc	Drawer SS Carlsbad, N. Mex. 88220	....do	Do.

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TABLE A-52. (Continued)

Commodity and company	Address	Type of activity	County
Sand and gravel (commercial):			
Albuquerque Gravel Products Co.	Box 829 Albuquerque, N. Mex. 87103	Stationary plant	Bernalillo.
Armstrong & Armstrong	Box 1873 Roswell, N. Mex. 88201	Pit and portable plant.	Chaves.
Springer Corp	Box 572 Albuquerque, N. Mex. 87103	Pit and stationary crushing and screening plant.	Bernalillo.
Universal Constructors, Inc.	Box 6008, Station B Albuquerque, N. Mex. 87107	Pits and portable plants.	Bernalillo, Colfax, Mora, Rio Arriba.
Silver:			
American Smelting and Refining Co.	120 Broadway New York, N.Y. 10005	*See* Zinc	Grant.
Thomas Consolidated Mines, Inc.	637 Peyton Bldg. Spokane, Wash. 99201	Underground mine	Catron.
Stone:			
Ideal Cement Co., a division of Ideal Basic Industries, Inc.	420 Ideal Cement Bldg. Denver, Colo. 80202	Quarry and plant	Bernalillo.
Lea County Highway Department.	Lovington, N. Mex. 88260	do	Lea.
New Mexico State Highway Dept., various contractors.	P.O. Box 1149 Santa Fe, N. Mex. 87501	Quarries	Curry, Eddy, Guadalupe, Lea, Lincoln, McKinley, Otero, Quay, Rio Arriba, Santa Fe, Valencia.
Uranium:			
The Anaconda Company, New Mexico Operations.	Box 638 Grants, N. Mex. 87020	Open pit mine and acid-leach process mill.	Valencia.
Kerr-McGee Corp	Box 218 Grants, N. Mex. 87020	6 underground mines and acid-leach process mill.	McKinley.
United Nuclear Corp	Box 199 Grants, N. Mex. 87020	4 underground mines	Do.
		Underground mine	Valencia.
United Nuclear-Homestake Partners.	Box 98 Grants, N. Mex. 87020	6 underground mines and alkaline-leach process mill.	McKinley.
Zinc:			
American Smelting and Refining Co.[3]	120 Broadway New York, N.Y. 10005	Underground mine and mill.	Grant.
United States Smelting Refining and Mining Co.[1]	136 East South Temple St. Salt Lake City, Utah 84111	*See* Copper	Do.

[1] Also gold and silver.
[2] Most of the major oil and gas companies and many smaller companies operate in New Mexico and several commercial directories contain complete lists of them.
[3] Also lead.

Source References

(3) Talc and Soapstone in the U.S., A. H. Chidester and H. W. Worthington, 1962, U.S.G.S. Map MR-31.

(152) Geologic Map of New Mexico, C. H. Dane and G. O. Bachman, 1965, U.S.G.S.

(153) Mining Districts and Mineral Deposits of New Mexico (exclusive of oil and gas), C. A. Mardirosian, Consulting Geologist, 1971, Salt Lake City, Utah.

(154) Reported Occurrence of Selected Minerals in New Mexico, L. B. Haigler and H. L. Sutherland, 1965, U.S.G.S. Map MR-45.

(155) County, Township, and Range Locations of New Mexico's Mining Districts, L. File and S. A. Northrop, 1966, Circular 84, New Mexico Institute of Mining and Technology, Socorro, New Mexico.

(156) Mineral and Water Resources of New Mexico, G. O. Bachman, 1965, Senate Document, prepared as Bulletin 87, New Mexico Institute of Mining and Technology, Socorro, New Mexico.

(157) The Mineral Industry of New Mexico, R. V. Sondermeyer, 1971, U. S. Bureau of Mines' Minerals Yearbook.

New York

The metamorphic rocks of New York state are confined to the eastern region as shown in Figure A-39. Metamorphic rock occurrences stretch along the Hudson River to the southern tip of Lake Champlain, and the Adirondack Mountain Region. The Adirondack regional metamorphism was of Precambrian age whereas the Hudson River regional metamorphism includes some of Precambrian age, but mostly of Paleozoic age. The Hudson River rocks are Greenschist, Subgreenschist, and Amphibolites. There is metallic mineralization in both rock bodies although there are no current metallic recovery operations in the Hudson River regional rocks. Iron, Titanium, Zinc, Lead, and Silver (Associated with zinc) are currently being produced from the Adirondack region. There are localized occurrences of asbestiform minerals in both rock bodies.

Chrysotile asbestos is described from four localities (Warren, Putnam, and Richmond Counties) and talc in association with tremolite and authophyllite from three localities (Lewis and St. Lawrence Counties) as shown in the regional county map of New York (Figure A-40) in Table A-53. There is no active recovery operations for the chrysotile asbestos although there are four active mines for the talc-amphibole rocks (three in St. Lawrence County and one in Lewis County) as shown in Figure A-40.* The four zinc mines shown on Figure A-41 are in close proximity to the talc operations--all within a highly mineralized area.** Dr. James F. Davis (New York State Geologist) describes the talc-amphibole ore as follows:

> "The ore is a mixture of the talc, tremolite, anthophyllite, and serpentine.---The ore in the Natural Bridge location includes about 30 percent calcium carbonate in addition to the minerals mentioned above.---The proportion of fiberous minerals to flaky mineral varies even within a deposit.---Thus, production from different portions of a mine may be milled in different

* Company names for these operations are given in a separate tabulation.

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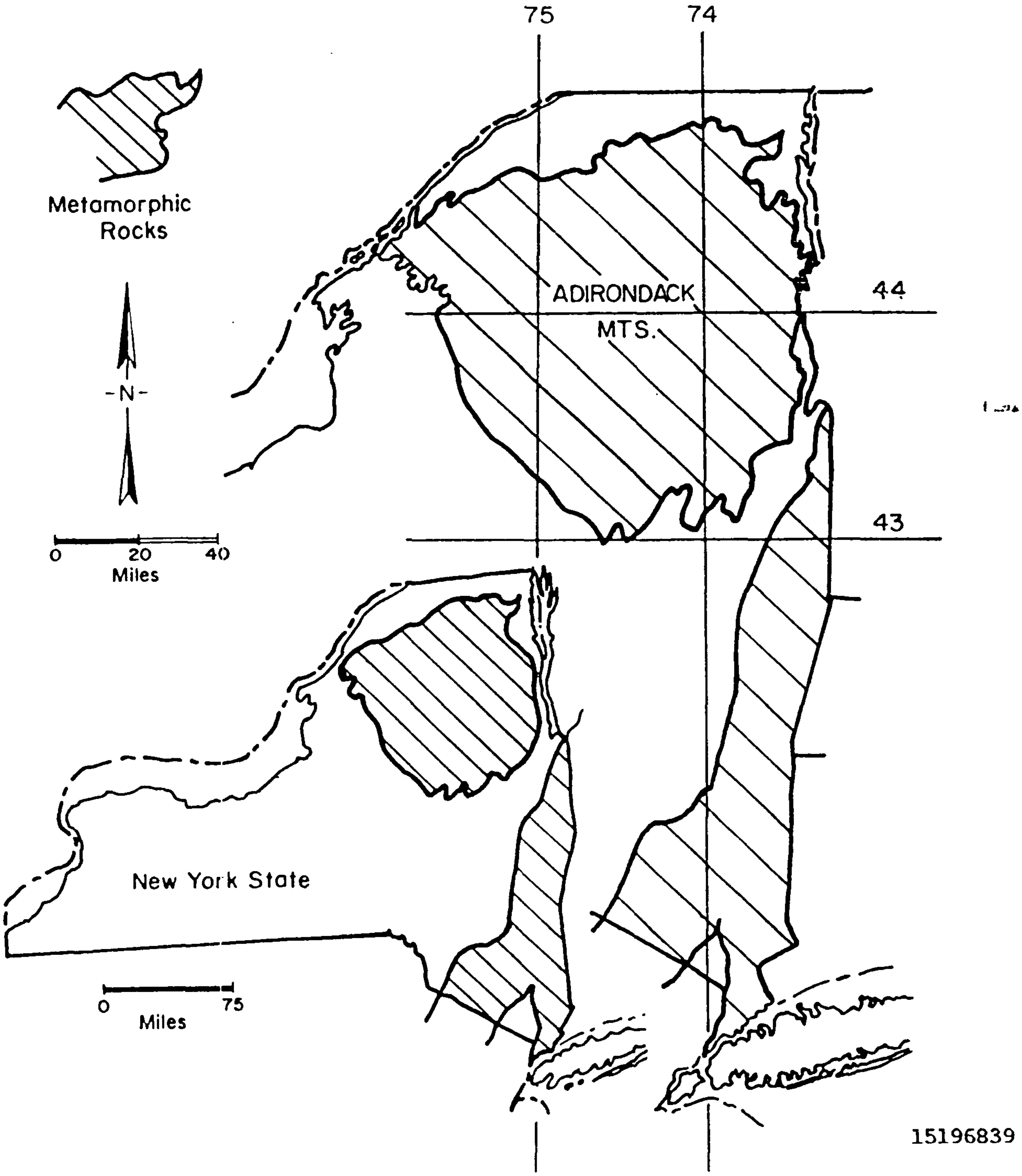

FIGURE A-39. OCCURRENCE OF METAMORPHIC ROCK IN NEW YORK

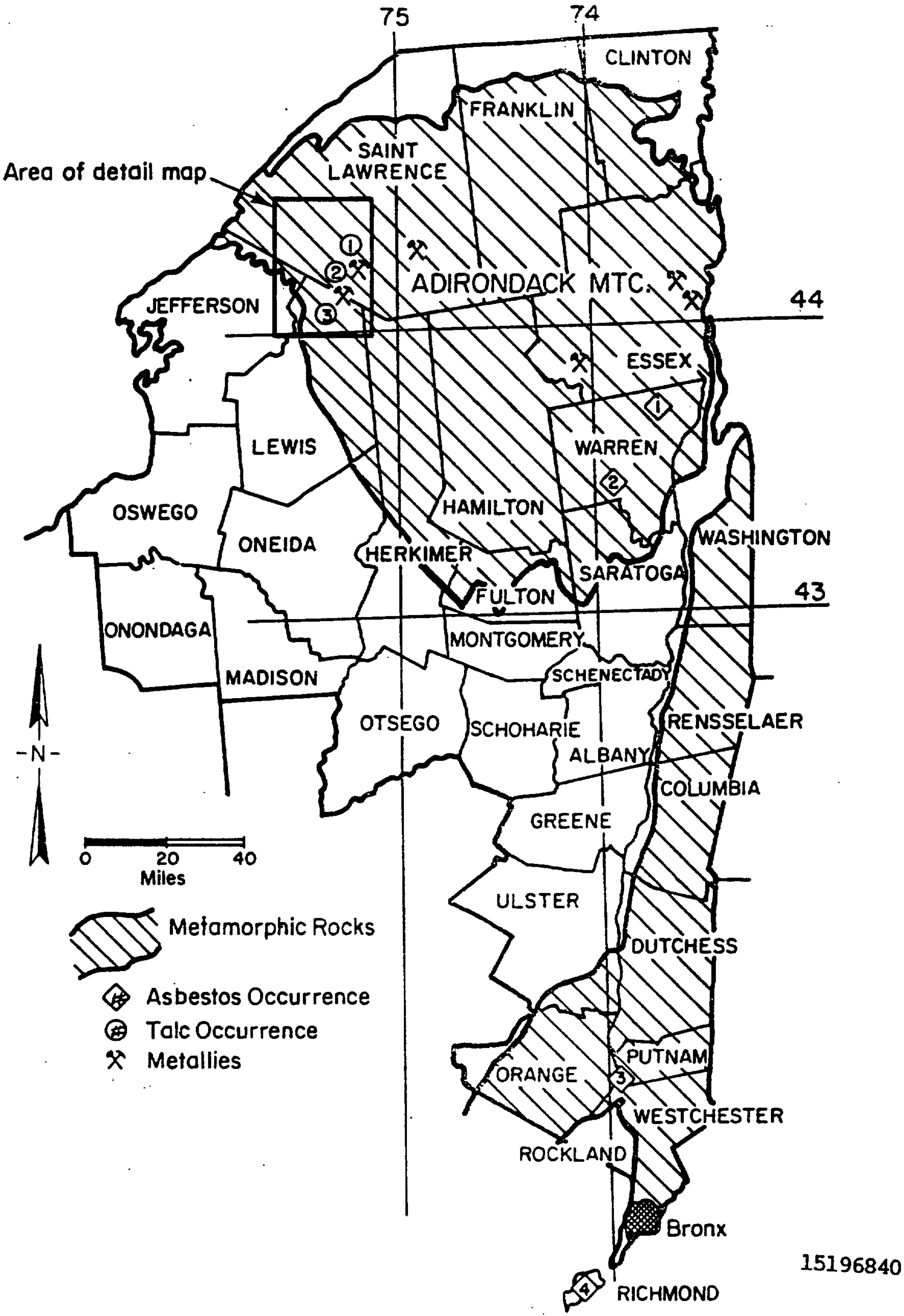

FIGURE A-40. DETAILED MAP OF METAMORPHIC ROCK OCCURRENCE IN NEW YORK

TABLE A-53. OCCURRENCE OF ASBESTOS AND TALC IN NEW YORK

Asbestos

	Warren County		
	Chrysotile asbestos veins in serpentinized zones in dolomite. General reference: Bowles, 1955.		
1.	Brant Lake prospect.	43°45'	73°39'
2.	Thurman prospect.	43°31'	73°55'
	Putnam County		
3.	Cold Spring area. Chrysotile asbestos veins in serpentinized zones in dolomite.	41°26'	73°55'
	Richmond County		
4.	Staten Island. Slip- and cross-fiber chrysotile in serpentinite.	40°35'	74°09'

Talc

Balmat-Edwards (Gouverneur) district. Deposits consist of talc rock, tremolite, and anthophyllite derived from dolomites of the Precambrian Grenville Series. Engel, 1949; Gilluly, 1945; Luedke and others, 1959.

1.	Talcville area.	44°19'	75°18'	Saint Lawrence County
2.	American, Woodcock (Loomis), Wright, and Arnold mines and nearby deposits.	44°16'	75°24'	Saint Lawrence County
3.	Natural Bridge area. Tremolite, talc rock, and anthophyllite, derived from dolomite and granitic rocks. Newland, 1921.	44°05'	75°28'	Lewis County (the deposit extends into Jefferson County)

(Localities by North Latitude and West Longitude)

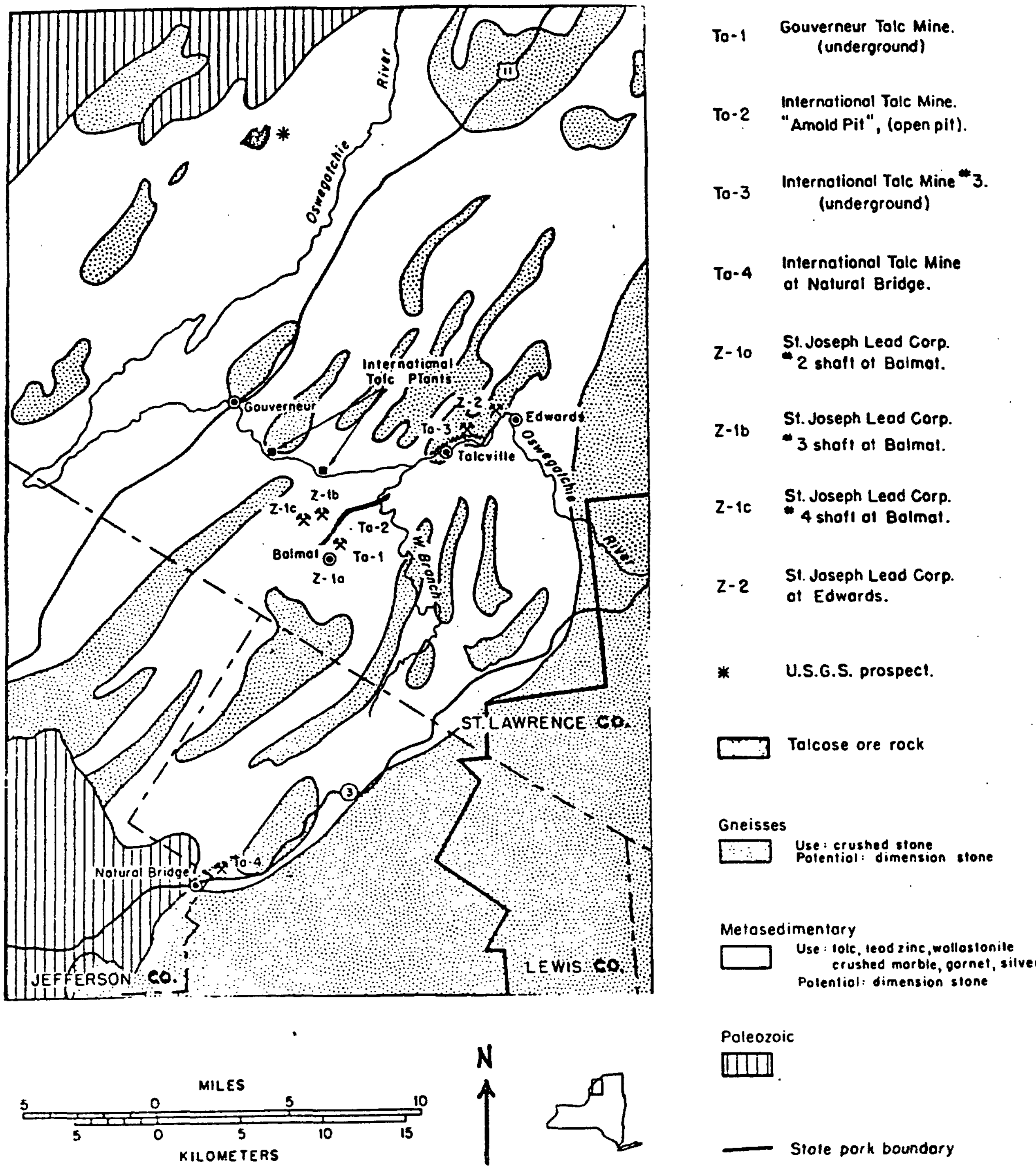

FIGURE A-41. DETAILED MAP OF AREA AROUND GOUVERNEUR, NEW YORK SHOWING TALC AND ZINC MINING ACTIVITY users.---The comparatively hard tremolite and anthophyllite make New York talc unsuitable for cosmetic purposes.---Anthophyllite-rich ore is used to dust molds to prevent sticking.---Smaller volumes of New York talc are used as a filler in rubber products and insecticides and to polish rice and peanuts.---Ceramic and paint uses are high in the fibrous minerals."

The gaugne minerals from the zinc mining operations are not completely described. It is mentioned, however, that the zinc deposits are associated with metamorphosed marbles and are in close proximity to talcose rocks.

Elsewhere in the Adirondacks there are stone quarries (crushed and dimension stone in both granitic and marble formations), the world's largest garnet mine (Warren County)***, a mine which supplies mot of the U.S. demand for Wollastonite (garnet byproduct),**** Magnetite mines in Essex and St. Lawrence Counties,***** and the largest ilmenite mine in the world (magnetite byproduct) in Essex County.****** The magnetite-ilmenite operations are in the High Peaks-anorthosite area of the Adirondacks.

Quarrying operations for the recovery of crushed and dimension stone, cement, sand and gravel, clays, and slate, predominate in the metamorphic rocks of the Hudson River area. The operations are enumerated by county in Table A-54.

Company Names

*	Gouverneur Talc Company Gouverneur, New York 13642
	International Talc Company 420 Lexington Avenue New York, New York 10006
**	St. Joseph Lead Corporation 250 Park Avenue New York, New York 10017
***	Barton Mines Corporation North Creek, New York 12853
****	Interpace Corporation Willsboro, New York 12996
*****	Jones & Laughlin Steel Corporation Star Lake, New York 13690
	Republic Steel Corporation 1629 Republic Building Cleveland, Ohio 44101
******	National Lead Company 100 Chevalier Avenue South Amboy, New Jersey 08879

TABLE A-54. QUARRYING ACTIVITY IN NEW YORK

County	Commodity
Columbia	Cement, stone, sand and gravel, clays
Dutchess	Stone, sand and gravel
Orange	Sand and gravel, stone, peat
Putnam	Sand and gravel
Rensselaer	Stone, sand and gravel
Richmond	Sand and gravel
Ulster	Cement, stone, clays, sand and gravel
Washington	Stone, sand and gravel
Westchester	Stone, emery, sand and gravel, peat

Source References

1. Metamorphic Map of the Appalachians, Benjamin A. Morgan, 1972, USGS Map I-724.

2. Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

3. Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, 1962, USGS Map I-31.

158. Mineral Resources of New York State, John A. Graham, 1952, New York State Science Service.

159. The Future of the Adirondacks, Vol. II, The Technical Report, "Mineral Resources", J. F. Davis, pp 37-58, The Reports of the Temporary Study Commission, The Adirondack Museum, 1971.

160. The Mineral Industry of New York, R. G. Clarke, 1969, U.S. Bureau of Mines' Mineral Yearbook.

North Carolina

While the eastern half of North Carolina consists of unconsolidated sedimentary deposits of fairly recent origin (Upper Cretaceous to Recent) the western half of the state may be characterized as composed of much older rocks most of which have been metamorphosed. The extent of the metamorphic rock occurrence in North Carolina is shown in Figure A-42. Within the metamorphosed rocks of western North Carolina there is a southwest-northeast trending belt of ultramafic igneous rocks that contain numerous peridotite bodies which vary greatly in size. Most of these have been extensively altered. The peridotite belt lies chiefly west of the Blue Ridge in the mountainous section of the state although a few isolated bodies occur in the Piemont section of Burke, Caldwell, Polk, Wilkes and (as far east as) Wake Counties. The map of western North Carolina (Figure A-43) shows the extent of the ultramafic rock areas.

Many of the intrusive rock bodies consist almost entirely of forsterite olivine -- thus the deposits have been described in the literature as the Forsterite-Olivine belt. However, most of these rock bodies have been greatly altered by metamorphism and hydration to result in the widespread occurrence of talc, soapstone, serpentine, amphiboles, chlorite, vermiculite, and varying amounts of carbonate. The amphibole minerals, such as tremolite and actinolite, often form bunches and radiating clusters as soapstone. Anthophyllite asbestos is the most abundant assestiform amphibole occurring chiefly in Jackson, Transylvania, Yancey, and Avery Counties, although also widespread in other counties of the peridotite belt.

Based on fiber arrangement relative to the rock wall and to each other, three types of anthophyllite asbestos ore are recognized. These types are: cross-fiber veins, slip-fiber veins, and mass-fiber deposits. Cross-fiber and slip-fiber asbestos are common, but the mass-fiber deposits have been the most worked in North Carolina. The past production areas and prospects for both the amphibole and chrysotile types of asbestos are shown in Figure A-44 which also locates the talc and soapstone operations and prospects. The location of these deposits by latitude and longitude are given in Tables A-55 and A-56. The principal producers of these commodities are listed in Table A-57, which also summarizes the other rock-mineral operations in

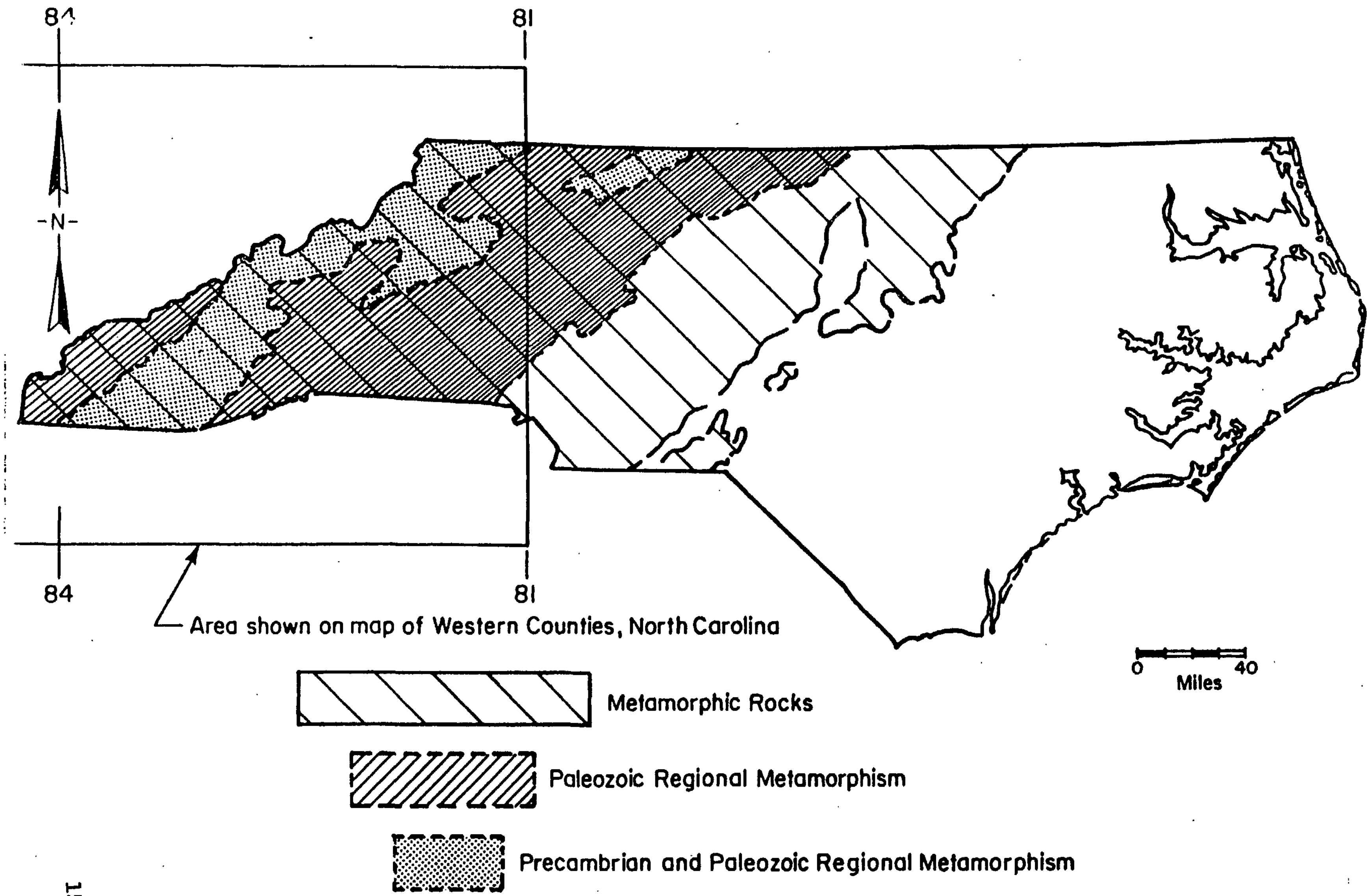

FIGURE A-42. METAMORPHIC ROCK OCCURRENCE IN NORTH CAROLINA

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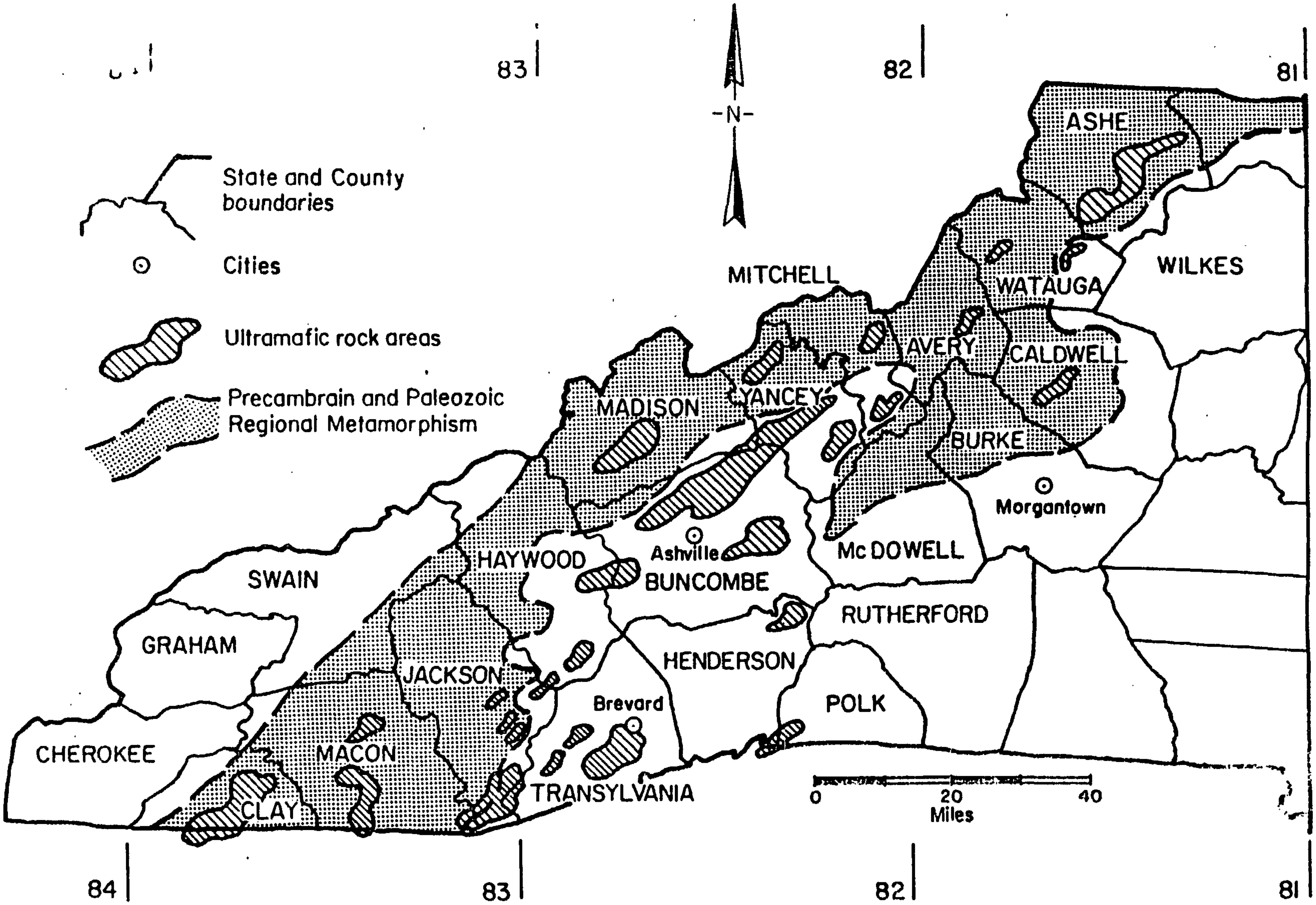

FIGURE A-43. GEOGRAPHIC DISTRIBUTION OF ULTRAMAFIC ROCK BODIES IN NORTH CAROLINA

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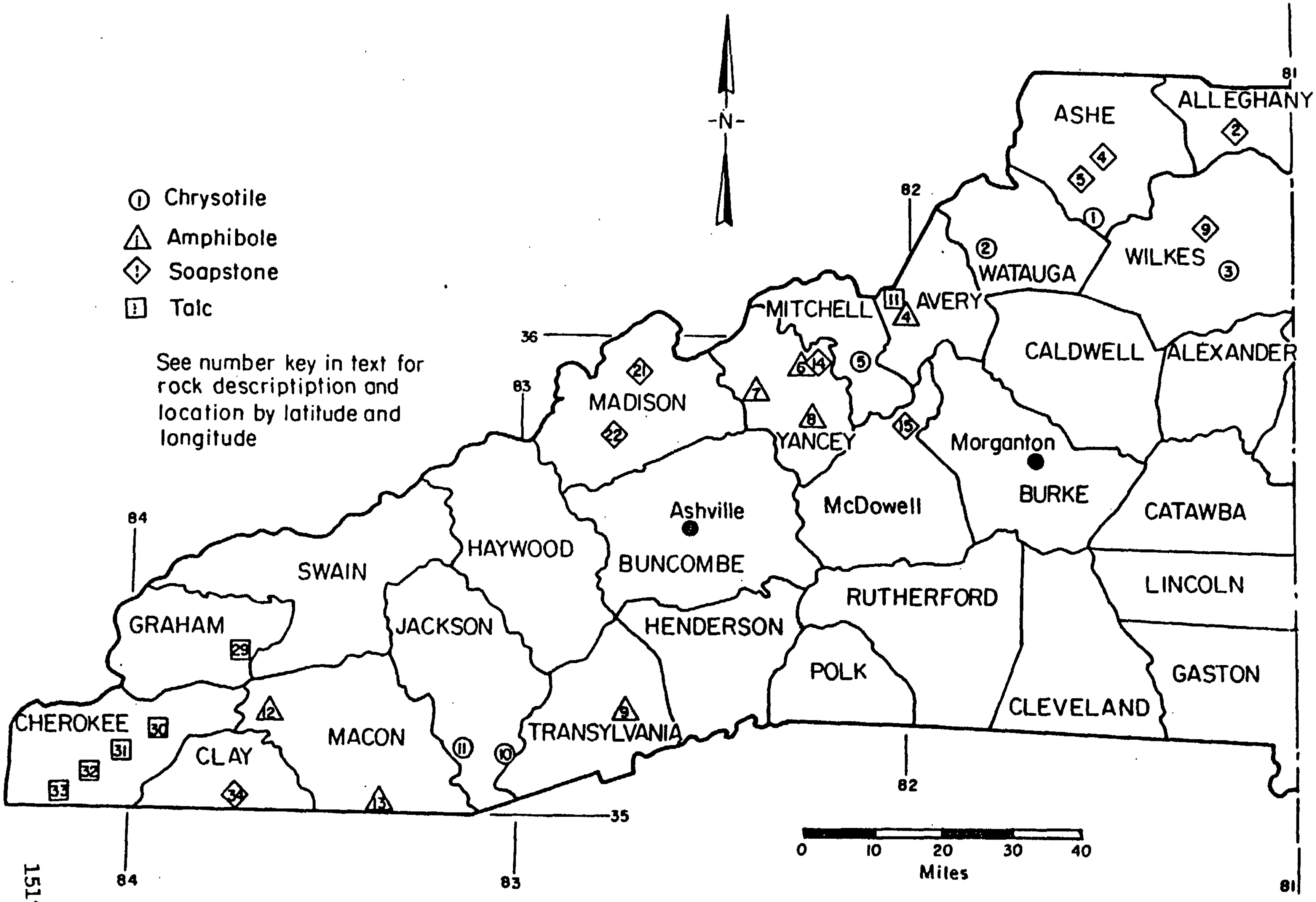

FIGURE A-44. GEOGRAPHIC DISTRIBUTION BY COUNTIES OF ASBESTOS, TALC, AND SOAPSTONE IN WESTERN NORTH CAROLINA

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TABLE A-55. THE OCCURRENCE OF ASBESTOS BY COUNTY IN WESTERN NORTH CAROLINA

Ashe County		
1. Todd area. Chrysotile asbestos associated with ultramafic igneous rocks. Bowles, 1955; Pratt and Lewis, 1905.	36°20'	81°35'
Watauga County		
2. Rich Mountain deposit. Chrysotile asbestos associated with ultramafic igneous rocks. Pratt and Lewis, 1905.	36°14'	81°44'
Wilkes County		
3. North Wilkesboro area. Chrysotile asbestos associated with ultramafic igneous rocks. Pratt and Lewis, 1905.	36°11'	81°09'
Avery County		
4. Frank area (Squirrel Creek). Slip-fiber anthophyllite asbestos in serpentinized dunite. Bowles, 1955; Hunter, 1941; Murdock, 1950; Pratt and Lewis, 1905.	36°04'	82°00'
Mitchell County		
5. Bakersville. Seams of chrysotile asbestos in dunite. Bowles, 1955; Hunter, 1941.	36°00'	82°08'
Yancey County		
6. Green Mountain. Anthophyllite asbestos. Murdock, 1950.	35°59'	82°15'
7. Cane River deposit. Mass-fiber anthophyllite asbestos. Bowles, 1955.	35°54'	82°24'
8. Bluerock-New Dale mines. Anthophyllite asbestos probably derived from altered dunite. Bowles, 1955; Hunder, 1941; Murdock, 1950; Norton, 1943.	35°53'	82°11'
Transylvania County		
9. Brevard area. Anthophyllite asbestos. Bowles, 1955.	35°16'	82°45'
Jackson County		
10. Sapphire ("Asbestus mine"). Chrysotile asbestos in a large mass of enstatite. Pratt and Lewis, 1905.	35°07'	83°00'
11. Glenville area. Chrysotile asbestos in peridotite. Pratt and Lewis, 1905.	35°11'	83°09'
Macon County		
12. Nantahala area. Anthophyllite asbestos. Bowles, 1955.	35°14'	83°38'
13. Norton dunite. Anthophyllite asbestos associated with chlorite in an amphibolite. Hopkins, 1914; Hunter, 1941.	35°00'	83°22'

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TABLE A-56. THE OCCURRENCE OF TALC AND SOAPSTONE BY LATITUDE AND LONGITUDE IN WESTERN NORTH CAROLINA

Northwestern North Carolina. Deposits consist of soapstone and talc rock principally derived from and associated with ultramafic igneous rocks, peridotite and serpentinite; some are derived from gabbro and other mafic igneous rocks. Pratt and Lewis, 1905.

1. Crab Creek near Edmonds.	36°33'	81°00'
2. Sparta.	36°30'	81°09'
3. Phoenix Gap	36°27'	81°26'
4. Jefferson area.	36°24'	81°28'
5. Bee Ridge.	36°20'	81°32'
6. Black Mountain.	36°19'	81°35'
7. Green Knob area.	36°17'	81°40'
8. Rocky Mountain-Cook Gap area.	36°12'	81°36'
9. Oak Grove Church, near Reddies River. Hunter and Gildersleeve, 1946.	36°15'	81°14'
10. Bayleaf area. Conley, 1958; Stuckey and George, 1940.	35°58'	78°38'
11. Frank deposit. Hunter, 1941; Hunter and Gildersleeve, 1946.	36°02'	81°59'
12. Bellvue.	36°01'	82°02'
13. Cane Creek Church.	36°01'	82°04'
14. Micaville area. Hunter, 1941.	35°56'	82°12'
15. Gillespie Gap area. Hunter and Gildersleeve, 1946.	35°50'	82°01'
16. Day Book deposit. Hunter, 1941.	35°59'	82°16'
17. Caney River.	35°56'	82°24'
17a. Burnsville deposit.	35°55'	82°19'
18. Possumtrot Creek.	35°53'	82°25'
19. Holcombe Branch deposit, Carter mine. Hunter, 1941.	35°50'	82°27
20. Democrat deposit. Hunter, 1941.	35°47'	82°29'
21. Laurel Creek area. Hunter and Gildersleeve, 1946; Murdock, 1950.	35°55'	82°40'
22. Marshall area. Murdock, 1950; Stuckey and Conrad, 1958.	35°48'	82°43'
23. Weaverville area.	35°41'	82°36'
24. Newfound Gap-Newfound Creek area.	35°36'	82°46'
25. Newfound Mountain.	35°36'	82°52'
26. Middleton deposit. Conley, 1958; Hunter, 1941.	35°26'	83°05'
27. Addie deposit. Conley, 1958; Hunter, 1941.	35°23'	83°10'
28. Wolf Mountain.	35°15'	83°00'

Murphy Marble belt. Deposits consist of talc rock derived from a dolomite zone near the stratigraphic center of the Murphy Marble. Van Horn, 1948.

29. Nantahala mine.	35°19'	83°39'
30. Maltby and Biltmore mines.	35°10'	83°56'
31. Moore, Regal, and Hayes mines.	35°08'	84°00'
32. Nancy Jordan Nos. 1-3 and Cold Springs mines.	35°05'	84°03'
33. Kinsey, Carolina, and Mineral and Metals mines.	35°05'	84°06'

Southwestern North Carolina. Deposits consist of talc rock and soapstone associated with ultramafic and mafic igneous rocks. Pratt and Lewis, 1905.

34. Elf area. Hunter and Gildersleeve, 1946.	35°02'	83°44'
35. Franklin area.	35°11'	83°23'
36. Ellijay area. Hunter, 1941.	35°11'	83°18'
37. Terrapin Mountain.	35°04'	83°04'
38. Otto area.	35°05'	83°23'
39. Mulberry Creek.	35°00'	83°24'

TABLE A-57. MINING ACTIVITY IN NORTH CAROLINA, BY COUNTY

County	Commodity
Alleghany	Granite
Ashe	Granite, sand and gravel
Avery	Mica, sand and gravel, kaolin, iron ore, granite
Buncombe	Granite, sand and gravel
Burke	Granite, sand and gravel
Caldwell	Granite, sand and gravel
Cherokee	Marble, sand and gravel, talc[a]
Clay	Granite, sand and gravel
Graham	Sand and gravel
Haywood	Granite, sand and gravel
Henderson	Limestone, granite, clay
Jackson	Asbestos, granite, sand and gravel[b] [c]
McDowell	Sand and gravel
Macon	Granite
Madison	Granite, Feldspar
Mitchell	Felspar, mica, sandstone, granite[b]
Polk	Granite, sand and gravel
Rutherford	Sand and gravel, clay
Swain	Limestone
Transylvania	Granite, sand and gravel[b]
Watanga	Sand and gravel
Wilkes	Granite, sand and gravel
Yancey	Asbestos, olivine, mica, sand and gravel[c]

(a) Hitchock Corporation.
(b) In 1970, 6 quarries in these 5 counties produced more than 500,000 short tons of crushed granite.
(c) Powhatan Mining Company, Woodlawn, Baltimore, Maryland.

Source References

(1) Metamorphic Map of the Appalachians, B. A. Morgan, 1972, USGS Map I-724.

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, 1962, USGS Map MR-31.

(161) Geologic Map of North Carolina, Compiled by Division of Mineral Resources, Department of Conservation and Development, Raleigh, North Carolina, 1958.

(162) Explanatory Text for Geologic Map of North Carolina, J. L. Stuckey and Stephen G. Conrad, 1958, North Carolina Division of Mineral Resources, Department of Conservation and Development Raleigh, North Carolina.

(163) Geology and Mineral Resources of North Carolina, J. L. Stuckey and W. G. Steel, Education Series No. 3, 1953, North Carolina Division of Mineral Resources.

(164) Anthophyllite Asbestos in North Carolina, S. G. Conrad, W. F. Wilson, Eldon P. Allen, and T. J. Wright, North Carolina Division of Mineral Resources.

(165) An Introduction to the Topography, Geology and Mineral Resources of North Carolina, S. D. Broadhurst, 1952, Revised by Eldon P. Allen, 1973, Educational Series No. 2, North Carolina Division of Mineral Resources.

(166) Mineral Industries of North Carolina from 1946 through 1953, S. D. Broadhurst, 1955, Economic Paper No. 66, North Carolina Division of Mineral Resources.

(167) Mineral Industries of North Carolina from 1954 through 1959, J. L. Stuckey and S. G. Conrad, 1961, Economic Paper No. 67, North Carolina Division of Mineral Resources.

(168) Mineral Industries of North Carolina from 1960 through 1967, J. L. Stuckey, 1970, Economic Paper No. 68, North Carolina Division of Mineral Resources.

(169) Forsterite Olivine Deposits of North Carolina and Georgia, C. E. Hunter, 1941, Bulletin No. 41, North Carolina Division of Mineral Resources.

(170) The Mineral Industry of North Carolina, R. W. Merwin and S. G. Conrad, 1971, U.S. Bureau of Mines' Mineral Yearbook.

North Dakota

Precambrian metamorphosed bedrock is found along the eastern border of North Dakota as shown in Figure A-45. To a very large extent the Precambrian bedrock is covered with glacial debris as is the major area of North Dakota as illustrated in the map figure. The unglaciated portion of the state is roughly the area to the southwest of the Missouri River.

The mineral industry of North Dakota is largely confined to the production of fossil fuels and the quarrying of stone, sand and gravel. Salt production from brine wells is reported in Williams County. There are no deep mines in North Dakota and no metallic mineral recovery operations. The mineral production of the state is summarized in Table A-58.

Source References

(171) Bedrock Geologic Map of North Dakota, C. G. Carlson, North Dakota Geological Survey, Miscellaneous Map No. 10, North Dakota Geological Survey, Grand Forks, North Dakota 58202.

(172) The Mineral Industry of North Dakota, J. B, Huvos, United States Bureau of Mines' Mineral Yearbook.

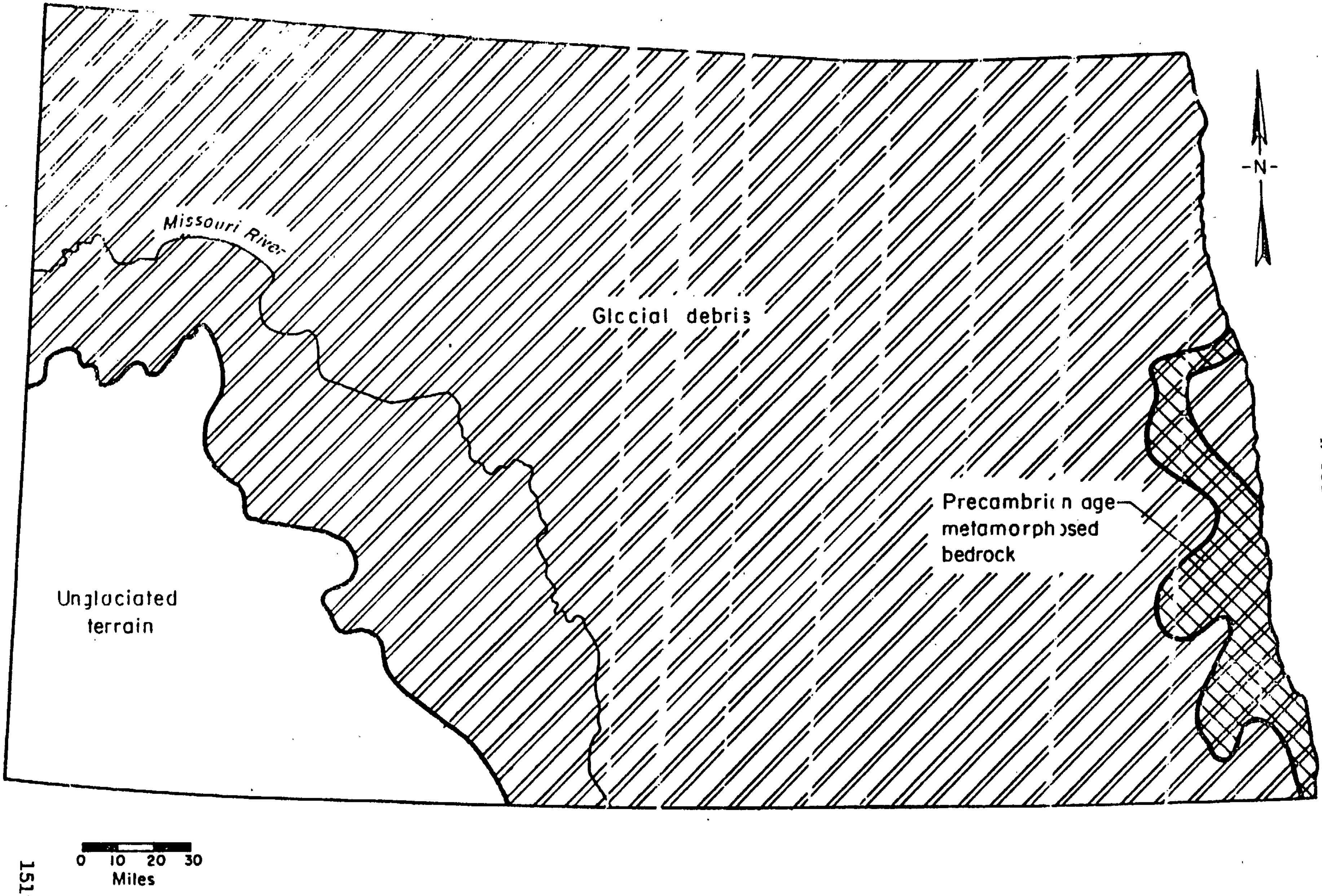

FIGURE A-45. GEOLOGICAL MAP OF NORTH DAKOTA

Table A-58. **Value of mineral production in North Dakota, by county**

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Adams	$18	$61	Sand and gravel, coal.
Barnes	227	42	Sand and gravel.
Benson	69	56	Do.
Billings	W	5,477	Petroleum.
Bottineau	8,730	9,337	Petroleum, sand and gravel, peat.
Bowman	2,729	3,494	Petroleum, coal, sand and gravel.
Burke	W	7,021	Do.
Burleigh	439	W	Sand and gravel.
Cass	146	W	Do.
Cavalier	87	W	Do.
Dickey	W	43	Do.
Divide	W	879	Petroleum, sand and gravel, clays.
Dunn	37	49	Petroleum.
Eddy	W	W	Sand and gravel.
Emmons	W	27	Do.
Foster	W	55	Do.
Golden Valley	W	220	Petroleum, sand and gravel, stone.
Grand Forks	568	334	Sand and gravel.
Grant	W	33	Coal, sand and gravel.
Griggs	93	7	Sand and gravel.
Hettinger	W	W	Do.
Kidder	W	W	Do.
LaMoure	W	--	
Logan	33	W	Sand and gravel.
McHenry	224	W	Petroleum, sand and gravel.
McIntosh	27	W	Sand and gravel.
McKenzie	12,402	14,136	Petroleum, sand and gravel, stone.
McLean	273	W	Sand and gravel, coal.
Mercer	6,286	5,515	Coal, sand and gravel.
Morton	132	348	Stone, sand and gravel, clays.
Mountrail	2,113	W	Petroleum, sand and gravel.
Nelson	W	W	Sand and gravel.
Oliver	1,458	W	Coal, sand and gravel.
Pembina	W	W	Lime, sand and gravel.
Pierce	W	80	Sand and gravel.
Ramsey	61	W	Do.
Ransom	195	136	Do.
Renville	5,189	5,581	Petroleum, sand and gravel.
Richland	W	371	Sand and gravel.
Rolette	W	W	Do.
Sargent	W	--	
Sheridan	W	W	Sand and gravel.
Sioux	W	--	
Slope	W	W	Petroleum, sand and gravel.
Stark	6,656	6,346	Petroleum, coal, sand and gravel.
Steele	W	W	Sand and gravel.
Stutsman	W	W	Sand and gravel, stone.
Towner	168	W	Sand and gravel.
Traill	242	133	Do.
Walsh	$307	$183	Sand and gravel.
Ward	2,761	3,537	Petroleum, coal, sand and gravel.
Wells	W	W	Sand and gravel.
Williams	18,264	17,266	Petroleum, salt, sand and gravel, coal.
Undistributed [1]	26,134	19,184	
Total [2]	96,047	99,901	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes gem stones, some sand and gravel, natural gas, and natural gas liquids that cannot be assigned to specific counties and values indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

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Ohio

The mineral production in Ohio consists of fossil fuels, stone, clay, sand and gravel, principally as described in the county by county production tabulation (Table A-59). There are no activities in rocks where fibrous amphibole minerals might occur.

Source Reference

(173) The Mineral Industry of Ohio, J. A. Sutton, 1971, U.S. Bureau of Mines' Minerals Yearbook.

Table A-59. Value of mineral production in Ohio, by county [1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Adams	$1,571	W	Stone.
Allen	W	$1,627	Stone, sand and gravel.
Ashland	W	W	Sand and gravel, clays.
Ashtabula	W	3,172	Lime, sand and gravel.
Athens	W	W	Stone, sand and gravel, coal.
Auglaize	W	W	Stone, sand and gravel, clays.
Belmont	69,900	72,142	Coal, stone.
Brown	W	W	Sand and gravel, stone.
Butler	3,281	3,467	Sand and gravel.
Carroll	2,960	2,215	Coal, clays, sand and gravel, stone.
Champaign	W	W	Sand and gravel, peat.
Clark	W	W	Sand and gravel, stone.
Clermont	W	W	Stone, sand and gravel.
Clinton	W	W	Do.
Columbiana	6,404	6,838	Coal, clays, sand and gravel.
Coshocton	W	14,119	Coal, stone, sand and gravel, clays.
Crawford	W	W	Stone, sand and gravel.
Cuyahoga	W	13,381	Salt, lime, sand and gravel, clays, peat.
Darke	W	W	Sand and gravel, clays.
Defiance	W	W	Sand and gravel.
Delaware	W	W	Stone, lime, clays.
Erie	W	W	Lime, stone, sand and gravel.
Fairfield	458	495	Sand and gravel.
Fayette	592	W	Stone.
Franklin	W	10,198	Sand and gravel, stone, lime, clays, peat.
Gallia	W	2,068	Coal, stone, sand and gravel.
Geauga	2,469	2,933	Sand and gravel, stone.
Greene	W	21,473	Cement, stone, sand and gravel, clays.
Guernsey	365	W	Coal, stone.
Hamilton	4,975	W	Sand and gravel, stone.
Hancock	1,134	W	Stone, lime.
Hardin	W	W	Stone.
Harrison	W	51,391	Coal, stone, clays.
Henry	80	W	Sand and gravel, clays.
Highland	W	W	Stone.
Hocking	W	W	Coal, clays, sand and gravel.
Holmes	W	4,587	Coal, clays, stone, sand and gravel.
Huron	210	249	Sand and gravel, stone.
Jackson	5,382	7,527	Coal, clays, stone.
Jefferson	24,131	27,986	Coal, clays.
Knox	W	W	Sand and gravel, stone.
Lake	W	30,104	Salt, lime, sand and gravel, stone.
Lawrence	7,724	7,051	Cement, coal, clays, sand and gravel, stone.
Licking	W	1,287	Sand and gravel, clays, stone.
Logan	W	W	Stone, sand and gravel, peat.
Lorain	W	W	Lime, stone, sand and gravel, abrasives.
Lucas	W	W	Cement, stone, sand and gravel, clays.
Madison	705	775	Stone, sand and gravel.
Mahoning	W	8,284	Stone, coal, clays, sand and gravel, peat.
Marion	W	W	Stone, sand and gravel, clays.
Medina	W	W	Sand and gravel, clays.
Meigs	W	1,604	Sand and gravel, salt, coal.
Mercer	W	W	Stone.
Miami	W	W	Stone, sand and gravel.
Monroe	W	W	Coal, stone, sand and gravel.
Montgomery	W	W	Sand and gravel, stone.
Morgan	W	3,642	Coal, sand and gravel, stone.
Morrow	W	73	Sand and gravel.
Muskingum	W	44,885	Coal, cement, stone, sand and gravel, clays.
Noble	11,824	W	Coal, stone.
Ottawa	W	W	Stone, lime, gypsum.
Paulding	W	12,174	Cement, stone, clays.
Perry	W	W	Coal, stone, clays.
Pickaway	W	W	Sand and gravel, stone.
Pike	1,207	1,103	Stone, sand and gravel.
Portage	4,416	4,127	Sand and gravel.
Preble	W	W	Do.
Putnam	W	W	Stone, sand and gravel, clays.
Richland	W	W	Sand and gravel, clays, peat.
Ross	W	W	Sand and gravel, stone.
Sandusky	W	25,119	Lime, stone.
Scioto	2,429	1,962	Stone, clays, sand and gravel, coal.
Seneca	W	W	Lime, stone, clays.
Shelby	W	W	Sand and gravel, stone.
Stark	W	14,557	Cement, coal, sand and gravel, stone, clays, peat.
Summit	W	27,862	Salt, lime, stone, cement, sand and gravel.
Trumbull	W	W	Sand and gravel.
Tuscarawas	14,239	15,393	Coal, clays, sand and gravel, stone.
Union	369	W	Stone, sand and gravel.
Van Wert	W	W	Stone, clays.
Vinton	W	W	Coal, stone, clays.
Warren	$1,657	$2,054	Sand and gravel.
Washington	W	W	Coal, sand and gravel, stone.
Wayne	W	13,154	Salt, sand and gravel, stone, coal, clays.
Williams	W	W	Sand and gravel, peat.
Wood	2,169	2,074	Stone.
Wyandot	W	W	Stone, lime, sand and gravel, clays, peat.
Undistributed [2]	441,517	189,500	
Total	612,166	[3] 652,151	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Fulton County is not listed because no production was reported. Natural gas and petroleum values are not listed by counties as data are not available; included with "Undistributed."
[2] Includes natural gas, petroleum, and gem stones that cannot be assigned to specific counties and values indicated by symbol W.
[3] Data may not add to total shown because of independent rounding.

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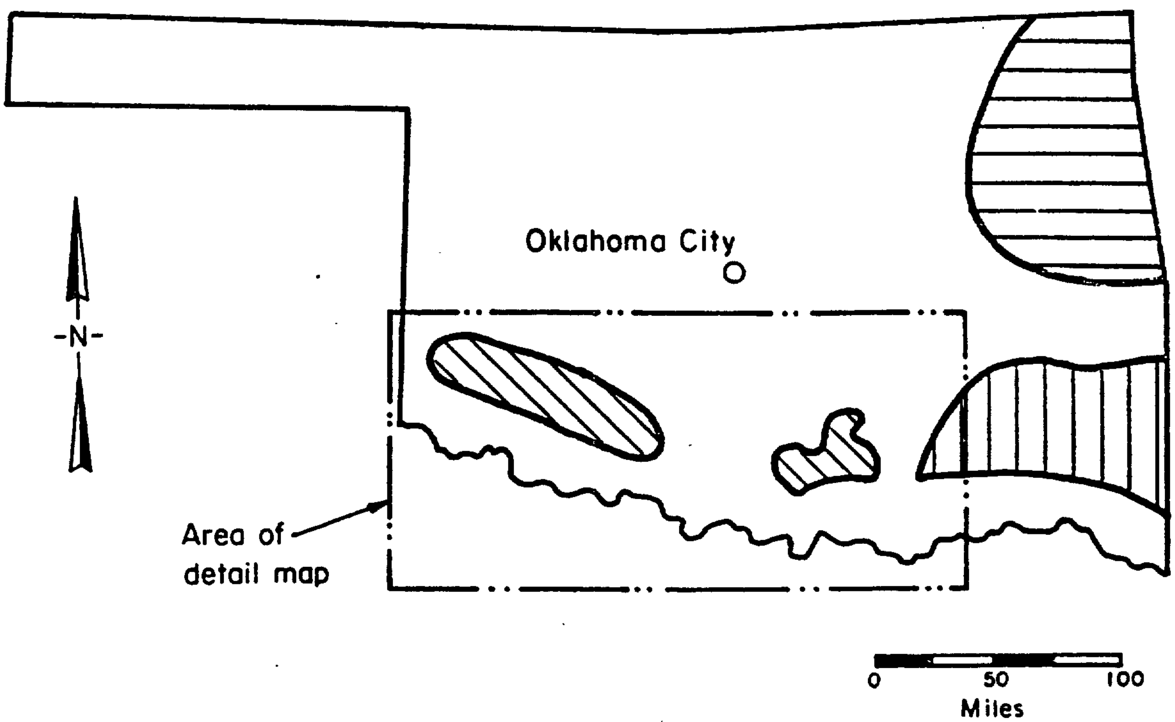
Oklahoma

There are four major regions in Oklahoma where igneous rock intrusion, metamorphism, mineralization of economic importance, or combinations of these events can be found. The Ozark Mountain uplift extends into the northeastern part of Oklahoma, for example. In the southern counties, the Wichita Mountain uplift, the Arbuckle Mountain uplift, and the Ouachita Mountain uplift resulted in the geologic regions bearing these names. Their locations are shown in Figure A-46. The detail map (Figure A-47) shows the geographic extent and the general lithology of the Wichita Mountain and Arbuckle Mountain regions as well as their relationship to other geological regions of southern Oklahoma.

There are numerous and prominent outcrops of igneous rocks in the Wichita and Arbuckle Mountain regions. There are a few quartz-orthoclase pegmatite bodies exposed in the Ouachita Mountain region (McCurtain County in the southeasternmost part of the state) and no igneous rock exposures in the Ozark uplift region. In the extreme western county of the panhandle (Cimarron County) there is a remnant of a Tertiary age basaltic lava flow.

The igneous rocks of the Arbuckle Mountain region are believed to be Precambrian in age and principally coarse-grained biotite-plagioclase-microcline granites. The Wichita Mountain granites and other intrusive rocks of this province are believed to be Middle and Late Cambrian age. The other major intrusive rock of the Wichitas is a biottie-olivine-gabbro, actually composed of a layered rock series in part, wherein rhythmic layering is conspicuous due to abrupt changes in proportions of feldspar and ferromagnesian minerals. Layers or bands of anorthosite, gabbro, olivine gabbro, and troctolite can be observed in some outcrops. Minerals of the layered series are plagioclase, monoclinic, pyroxene, orthorhombic pyroxene, olivine, titaniferous magnetite, hornblende, and locally apatite.

Mineralization of the uplift provinces is extensive although the current production of metallic and nonmetallic (exclusive of stone, clay, sand and gravel) commodities is quite limited. For example, there is no longer any lead and zinc production from Ottawa County (extreme northeastern Oklahoma) which is the Oklahoma part of the famour Tri-State Lead-Zinc Mining District in the Ozark uplift region. Similarly, there is no production



Wichita and Arbuckle Mountains

Ouachita Mountain Uplift

Ozark Mountain Uplift

FIGURE A-46. OCCURRENCE OF IGNEOUS ROCK IN OKLAHOMA

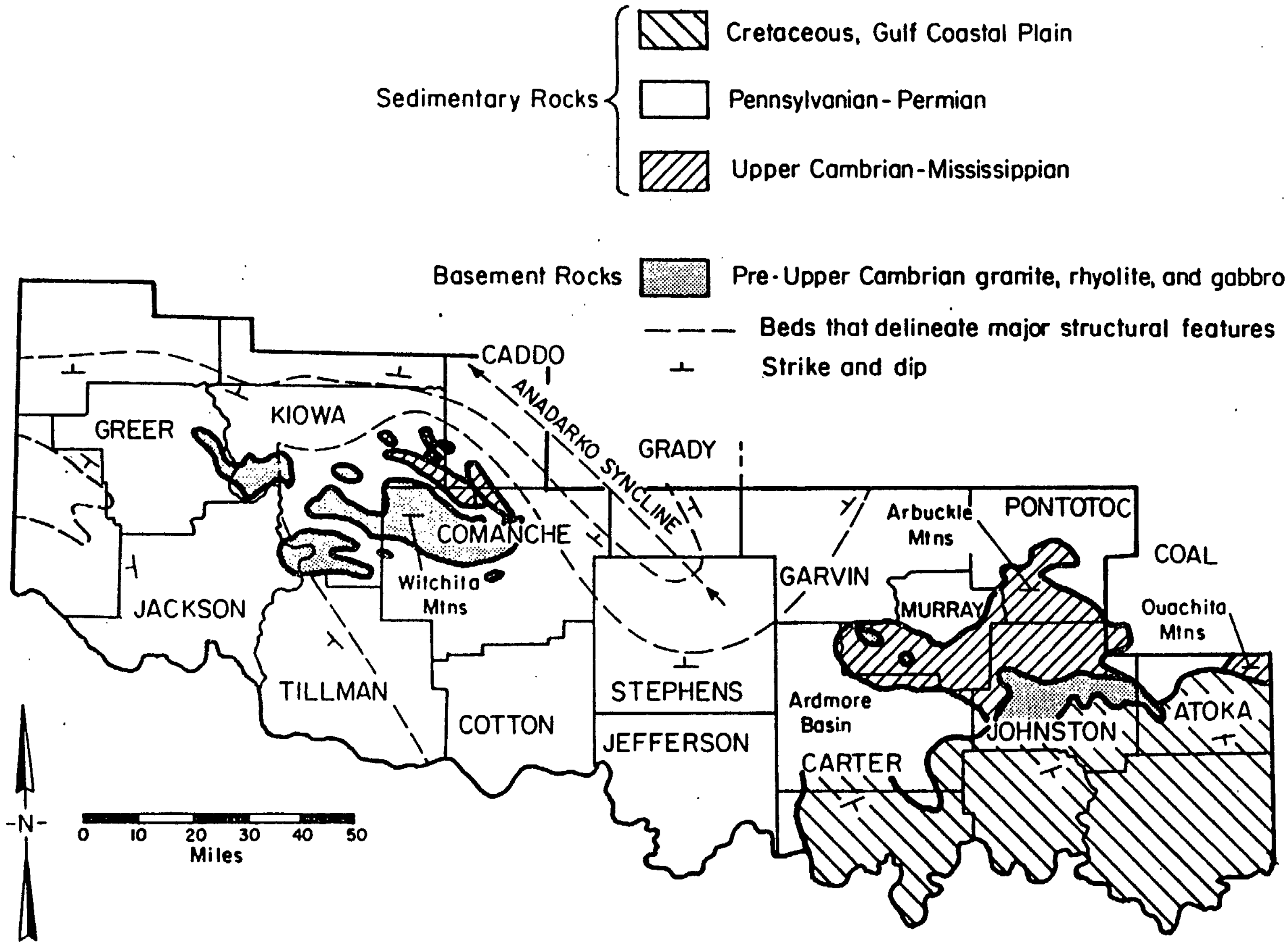


FIGURE A-47. DETAILED MAP SHOWING GEOLOGICAL FEATURES OF SOUTH CENTRAL OKLAHOMA

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Table A-60. Value of mineral production in Oklaho... ... county[1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Alfalfa	$6,903	$7,033	Petroleum, natural gas, natural gas liquids, sand and gravel.
Atoka	W	W	Stone, natural gas, petroleum, sand and gravel.
Beaver	57,440	53,906	Natural gas, petroleum, natural gas liquids, pumice.
Beckham	[r]8,425	9,467	Natural gas, natural gas liquids, petroleum.
Blaine	20,745	18,903	Natural gas, petroleum, gypsum, natural gas liquids.
Bryan	2,370	3,010	Petroleum, stone, natural gas, sand and gravel.
Caddo	22,116	22,136	Petroleum, natural gas, stone, gypsum, natural gas liquids.
Canadian	6,435	7,017	Natural gas, petroleum, sand and gravel, clays, gypsum.
Carter	74,577	81,588	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Cherokee	W	W	Stone.
Choctaw	W	W	Sand and gravel, stone.
Cimarron	[r]18,039	16,994	Helium, petroleum, natural gas, natural gas liquids, stone.
Cleveland	16,378	15,426	Petroleum, natural gas, natural gas liquids.
Coal	2,790	2,021	Petroleum, natural gas, stone, sand and gravel.
Comanche	W	3,800	Stone, gypsum, petroleum, natural gas.
Cotton	W	W	Petroleum, sand and gravel, natural gas.
Craig	W	W	Coal, stone, natural gas, petroleum.
Creek	35,550	34,731	Petroleum, natural gas liquids, stone, natural gas, sand and gravel, clays.
Custer	5,744	5,636	Natural gas, petroleum, clays, volcanic ash.
Dewey	24,429	28,818	Natural gas, petroleum, natural gas liquids, clays.
Ellis	9,390	9,435	Natural gas, petroleum.
Garfield	32,935	30,373	Petroleum, natural gas, natural gas liquids, sand and gravel.
Garvin	71,187	77,748	Petroleum, natural gas liquids, natural gas, stone, sand and gravel.
Grady	22,512	36,211	Petroleum, natural gas, natural gas liquids.
Grant	5,723	4,941	Do.
Greer	486	252	Stone, petroleum, clays, natural gas liquids.
Harmon	W	W	Salt.
Harper	23,608	23,968	Natural gas, natural gas liquids, petroleum, sand and gravel.
Haskell	W	11,290	Natural gas, coal, stone.
Hughes	6,395	15,791	Natural gas, petroleum, sand and gravel.
Jackson	3,566	4,372	Copper, sand and gravel, petroleum, gypsum, silver, natural gas, zinc.
Jefferson	2,426	2,270	Petroleum, natural gas, sand and gravel.
Johnston	W	W	Sand and gravel, stone.
Kay	15,921	15,383	Petroleum, natural gas liquids, natural gas, sand and gravel.
Kingfisher	62,205	70,873	Petroleum, natural gas, natural gas liquids, sand and gravel.
Kiowa	1,910	1,709	Stone, petroleum, sand and gravel, natural gas.
Latimer	24,660	W	Natural gas, petroleum.
Le Flore	10,591	8,058	Natural gas, coal, clays.
Lincoln	10,110	10,028	Petroleum, natural gas, natural gas liquids.
Logan	7,401	7,749	Petroleum, natural gas, natural gas liquids, sand and gravel.
Love	8,027	6,029	Petroleum, natural gas liquids, natural gas.
McClain	23,761	25,477	Petroleum, natural gas, natural gas liquids, sand and gravel.
McCurtain	W	W	Stone, sand and gravel.
McIntosh	W	W	Natural gas, stone, petroleum.
Major	28,432	41,206	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Marshall	6,808	6,543	Petroleum, natural gas liquids, natural gas, sand and gravel.
Mayes	W	W	Cement, stone, clays, sand and gravel, petroleum.
Murray	6,982	6,939	Petroleum, stone, natural gas.
Muskogee	1,828	1,575	Petroleum, sand and gravel, stone, coal.
Noble	6,083	6,089	Petroleum, natural gas, natural gas liquids.
Nowata	2,238	1,625	Petroleum, stone, natural gas liquids.
Okfuskee	4,558	4,227	Petroleum, natural gas, natural gas liquids.
Oklahoma	20,462	20,912	Petroleum, natural gas liquids, natural gas, sand and gravel, clays, stone.
Okmulgee	3,831	3,615	Petroleum, natural gas.
Osage	45,766	43,581	Petroleum, natural gas, stone, sand and gravel.
Ottawa	2,321	W	Stone, tripoli.
Pawnee	5,149	5,910	Petroleum, stone, sand and gravel, natural gas.
Payne	7,781	10,010	Petroleum, stone, natural gas, sand and gravel.
Pittsburg	8,664	8,315	Natural gas, stone, clays, sand and gravel.
Pontotoc	21,198	23,296	Petroleum, cement, stone, sand and gravel, natural gas, clays, natural gas liquids.
Pottawatomie	9,905	8,692	Petroleum, natural gas.
Pushmataha	..	1	Sand and gravel
Roger Mills	3,089	W	Natural gas, petroleum.
Rogers	$16,521	$14,431	Cement, coal, stone, petroleum, clays.
Seminole	31,214	32,714	Petroleum, natural gas liquids, stone, natural gas, sand and gravel, clays.
Sequoyah	W	5,267	Lime, natural gas, stone, sand and gravel.
Stephens	98,530	100,440	Petroleum, natural gas liquids, natural gas, sand and gravel.
Texas	89,064	90,657	Petroleum, natural gas, natural gas liquids, sand and gravel, stone.
Tillman	918	2,178	Petroleum, sand and gravel.
Tulsa	8,620	7,562	Petroleum, stone, clays, sand and gravel, natural gas.
Wagoner	347	392	Petroleum, sand and gravel, stone, natural gas.
Washington	4,149	3,769	Petroleum, stone, natural gas
Washita	630	W	Natural gas, petroleum, gypsum.
Woods	12,301	11,702	Natural gas, petroleum, sand and gravel, stone, salt.
Woodward	10,837	11,931	Natural gas, natural gas liquids, petroleum, sand and gravel, stone.
Undistributed[2]	36,294	43,494	
Total	[r]1,138,272	1,189,616	

[r] Revised. W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Adair and Delaware Counties are not listed because no production was reported.

[2] Includes some stone, sand and gravel, and petroleum that cannot be assigned to specific counties and values indicated by symbol W.

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TABLE A-61. PRINCIPAL MINERAL PRODUCERS IN OKLAHOMA

Commodity and company	Address	Type of activity	County
Carbon Black: Continental Carbon Co.	P.O. Box 22085 Houston, Texas 77027	Furnace	Kay.
Cement:			
Dewey Rocky Mountain Cement Co.[1]	1210 Fourth Nat'l. Bank Tulsa, Okla. 74119	Quarry and plant.	Rogers.
Ideal Cement Co., Div. Ideal Basic Industries, Inc.[1]	420 Ideal Cement Bldg. Denver, Colo. 80202	do	Pontotoc.
Oklahoma Cement Co. Div. OKC Corp[1]	P.O. Box 68 Pryor, Okla. 74361	do	Mayes.
Clays:			
Acme Brick Co.	P.O. Box 425 Fort Worth, Tex. 76101	Mine and plant.	Custer, Oklahoma, Tulsa.
Chandler Materials Co.	Box 627 Tulsa, Okla. 74101	do	Rogers, Oklahoma.
Filtrol Corp.	3250 East Washington Los Angeles, Calif. 90023	do	Dewey.
Mangum Brick Co.	Box 296 Mangum, Okla. 73554	do	Greer.
Oklahoma Brick Corp.	Box 87 Union City, Okla. 73090	do	Canadian.
Sapulpa Brick & Tile Corp.	[illegible] Sapulpa, Okla. 74066	do	Creek.
Superior Clay Products, Inc.	Box 1501 Ada, Okla. 74820	do	Pontotoc.
United Clay Pipe Co.	Box 552 Seminole, Okla. 74868	do	Seminole.
Wewoka Brick and Tile Co.	415 West 10th Street Wewoka, Okla. 74884	do	Do.
Coal:			
Bills Coal Co., Inc.	Route 1 Welch, Okla. 74369	Strip mine.	Craig.
Evans Coal Co.	Box 126 McCurtain, Okla. 74944	Strip and auger mine.	Haskell.
Garland Coal & Mining Co.	Box 186 Fort Smith, Ark. 72901	Strip mine.	Do.
[illegible] Co.	Box 99 Heavener, Okla. 74937	Underground mine.	Le Flore.
Kerr-McGee Corp.	Kerr-McGee Bldg. Oklahoma City, Okla. 73102	do	Haskell.
McNabb Coal Co.	Box C Catoosa, Okla. 74105	Strip mine	Rogers.
Peabody Coal Co.	301 North Memorial Drive St. Louis, Mo. 63102	do	Do.
Copper and silver: Eagle-Picher Industries Inc.	P.O. Box 910 Miami, Okla. 74354	do	Jackson.
Gypsum:			
Republic Gypsum Co.	1100 Mercantile Bank Bldg. Dallas, Tex. 75201	Quarry and plant.	Do.
United States Gypsum Co.	[illegible] Drive Chicago, Ill. 60606	do	Blaine.
Universal Atlas Cement, Div. of United States Steel Corp.	600 Grant St. Box 2969 Pittsburgh, Pa. 15230.	Quarry	Do.
Lime: St. Clair Lime Co.	Box 894 Oklahoma City, Okla. 73101	Plant and quarry.	Sequoyah.
Salt:			
Blackmon Salt Co.	Freedom, Okla. 73842	[illegible] evaporation	Woods.
Western Salt Co.	Route 2 Erick, Okla. 73645	do	Harmon.
Sand and gravel:			
Bagby-Harris Sand Co.	P.O. Box 926 Jenks, Okla. 74037	Dredge	Tulsa.
Joe Brown Sand & Gravel Co.	Box 102 Sulphur, Okla. 73086	Stationary	Murray.
The Dolese Co.	13 Northwest 13th St Oklahoma City, Okla. [illegible]	do	Canadian, McClain, Kingfisher, Logan, [illegible]
McMichael Concrete Co.	Box 9486 Tulsa, Okla. 74107	Dredge	Tulsa.
Midcontinent Glass Sand Co.	Roff, Okla. 74865	Stationary.	Pontotoc.
Mohawk Rock & Sand Co.	1310 East 16th St Tulsa, Okla. 74120	Dredge	Tulsa.
Pennsylvania Glass Sand Corp. of Okla.	Berkeley Springs, W. Va. 25411	Stationary	Johnston.
Sand Products, Inc.	3405 East Reno Oklahoma City, Okla. 73117	Stationary and dredge.	Oklahoma.
Tulsa Sand Co.	Box 1954 Tulsa, Okla. 74101	Stationary	Pawnee, Tulsa.
[illegible] Sand & Gravel Co.	323 Merchants Bank Bldg. Ft. Smith, Ark. 72901	do	Muskogee.
Stone:			
Anchor Stone Co.	Box 1630 Tulsa, Okla. 74106	Quarry	Tulsa
Arkhola Sand & Gravel Co.	323 Merchants Bank Bldg. Ft. Smith, Ark. 72901	do	Cherokee.
Dolese Brothers Co.	13 Northwest 13th St. Oklahoma City, Okla., 73103	do	Caddo, Carter, Coal, Comanche, Kiowa, Murray, Pittsburg, Seminole.
Eagle-Picher Industries, Inc.	P.O. Box 910 Miami, Okla. 74354	do	Ottawa.
The Quapaw Company	Box 72 Drumright, Okla. 74030	do	Creek, Okmulgee.
[illegible] Rock and Sand Co.	2845 Northeast 23rd Oklahoma City, Okla. [illegible]	do	Murray.
Standard Industries, Inc.	P.O. Box 15670 Admiral Station Tulsa, Okla. 74115	do	Osage, Tulsa.
Trinity Concrete Products Co.	Box 1290 Dallas, Tex. 75221	do	Atoka.
Tulsa Rock Co.	Box 15691 Admiral Station Tulsa, Okla. 74115	do	Tulsa.
Tripoli: The Carborundum Co., American Tripoli Div.	Seneca, Mo. 64865	Open pit	Ottawa.
Volcanic ash: Axtell Mining Corp.	Laverne, Okla. 73848	do	Beaver.

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from the southeastern counties (Atoka, Pushmataha, McCurtain, LeFlore, and Latimer) in the Ouachita region, although there is widespread lead-zinc-manganese mineralization in the rocks of the state boundary counties. A limited amount of germanium is being produced in Ottawa County.

The production of commodities from the counties containing the Arbuckle Mountain region consists chiefly of the fossil fuels, stone, sand and gravel. There is no available report containing information on the mineralization of the rocks being worked in this area. Similarly, there are no descriptions of the rock minerals being worked in the counties containing the Wichita Mountain region where the fibrous amphibole minerals are most likely to be found. In Jackson County of the Wichita Mountain region there is an extensive production of copper-silver-zinc bearing shale (Permian) via a strip mining operation (Eagle-Picher Industires, Incorporated, P.O. Box 910, Miami, Oklahoma 74354). A similar copper production from Greer County was not reported in the latest communique. A summary of the mineral production for all counties of Oklahoma is given in Tables A-60 and A-61.

Source References

(174) Geologic Map of Oklahoma, H. D. Miser, 1954, Oklahoma Geological Survey, Norman, Oklahoma, 73069.

(175) Mineral Map of Oklahoma (exclusive of oil and gas fields), K. S. Johnson, 1969, Map GM-15, Oklahoma Geological Survey, Norman, Oklahoma 73069

(176) Geology and Earth Resources of Oklahoma, (an Atlas of Maps and Cross Sections) K. S. Johnson, et. al., Educational Publication No. 1, 1972, Oklahoma Geological Survey.

177) The structure and Igneous Rocks of the Wichita Mountains, Oklahoma (Field Trip Guidebook), edited by G. T. Stone, 1967, The University of Oklahoma (Norman, Oklahoma); First Annual Meeting of the South-Central Section of G.S.A.

78) Sixty-fourth Annual Report, Oklahoma Department of Mines, W. Padgett, Chief Mine Inspector, 1972, Oklahoma City, Oklahoma 73105.

(179) Directory of Mineral Producers in Oklahoma, J. F. Roberts, 1970, Oklahoma Geological Survey, University of Oklahoma, Norman, Oklahoma 73069.

(180) The Mineral Industry of Oklahoma, L. G. Southard, et. al., United States Bureau of Mines' Minerals Yearbook.

Oregon

Oregon can be divided into twelve geomorphic regions of which four are of interest to this study. The four units, the Coast Range, the Cascade Range, the Klamath Mountains, and the Blue Mountains are approximately located on Figure A-48. Of principal interest to this investigation are the Klamath and Blue Mountain Regions since in these areas there are considerable occurrences of the amphibole minerals and the regions are the centers of the Oregon mining activities. Mineralization and metamorphism of the rock bodies are, of course, also present in the Coast Range and the Cascades. Also, the Basin and Range Province lying between the Klamath-Cascade and Blue Mountains is of some interest. The Basin and Range Province is an arid region characterized by fault block mountains and broad graben valleys. Somewhat localized areas of mineralization are found in this region. Elsewhere in Oregon there are high lava plains, plateaus, and uplands, which feature distinct geological characteristics leading to some favorable sites for mineral production although these areas are not of prime interest in this study.

The Klamath Mountains in southwest Oregon and the Blue Mountains in eastern Oregon contain formations which are extensively mineralized. Although currently there is little or no production from many of the known deposits, the Klamath and Blue Mountain Regions are the locations for most of the Oregon metallics. The counties of Curry, Josephine, Douglas, and Jackson in the Klamath Mountains, and Baker, Grant, Union, and Wallowa in the Blue Mountains are noted for their metallic occurrences. Table A-62 gives a partial list of the metallic occurrences by counties as reported in Bulletin No. 64 of the Oregon Survey. Only the counties having the principal deposits are listed.

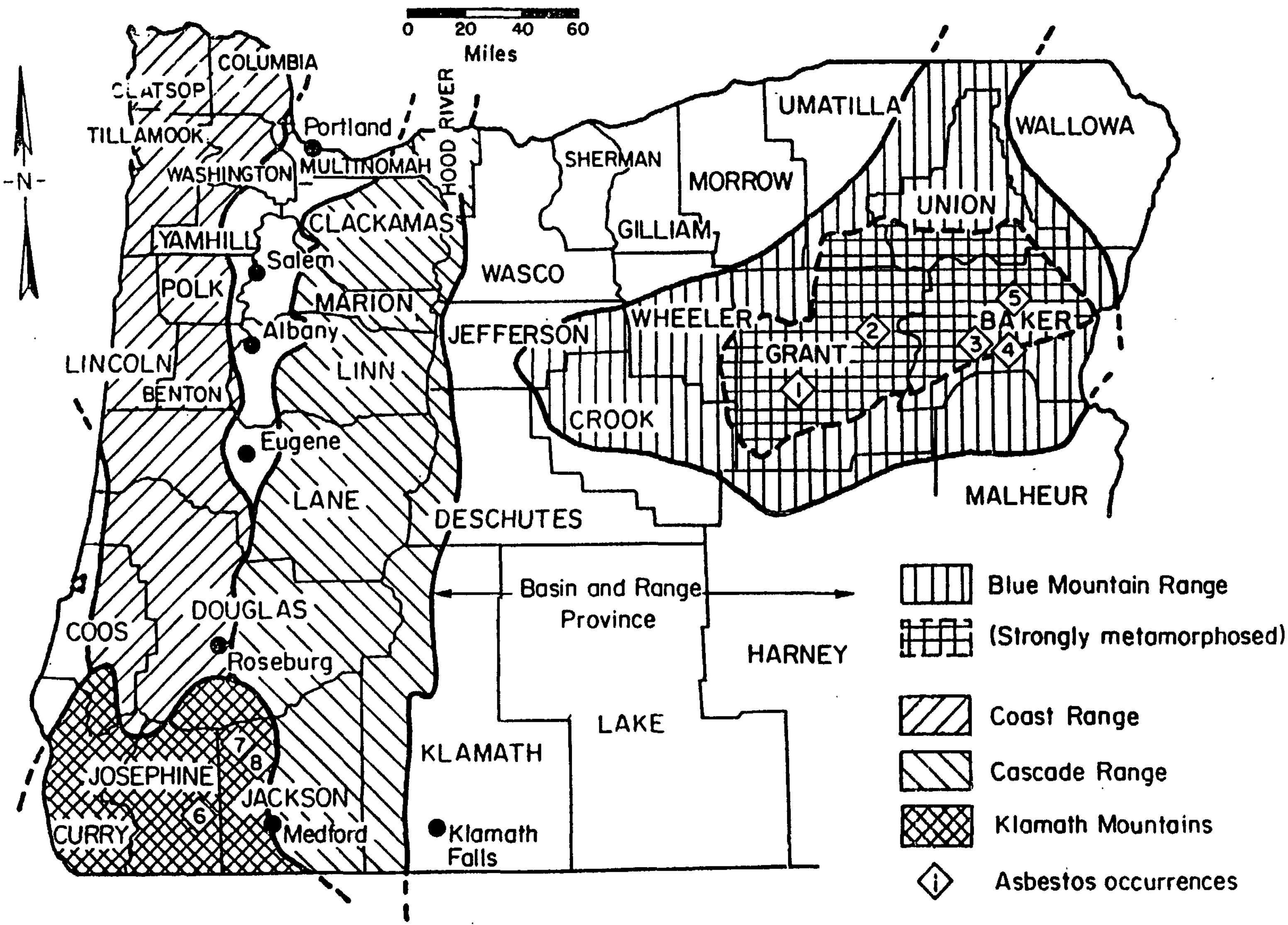

FIGURE A-48. GEOMORPHIC REGIONS OF OREGON

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Coincidental with the metallic occurrences are the asbestiform mineral occurrences. These occurrences are located on the state map figure which marks the major geological regions of interests and are located more precisely by means of Figure A-49 and Table A-63. It is readily apparent from the detail maps presented that the asbestiform minerals are frequently present in the mineralized rocks that are worked for their metallic content. It should be noted that neither of the major occurrence areas are highly populated areas. None of the asbestos deposits are currently being worked for production of fibrous minerals. A single mine in Josephine County is producing talc and soapstone; however, (Operator: J. H. Pugh, 2891 Elk Lane, Grants Pass, Oregon 97526). Elsewhere in the county, gold, sand and gravel, and stone are being produced in relatively small quantities. Oregon's mineral recovery operations are chiefly limited to the production of stone, sand and gravel, with metallics in a secondary position as indicated by the county by county mineral production tabulation from the 1971 Minerals Yearbook, as listed in Table A-64.

Source References

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, 1962, USGS Map MR-31.

(181) Geologic Map of Oregon, G. W. Walker and P. B. King. 1969, USGS Map I-595.

(182) Geologic Map of Oregon West of the 121st Meridian, F. G. Wells and D. L. Peck, 1961, USGS Map I-325.

(183) Preliminary Geologic and Tectonic Maps of Oregon East of the 121st Meridian, G. W. Walker, 1973, USGS Map MF-495, Sheets 1 and 2.

(184) Mineral and Water Resources of Oregon, P. L. Weis, et al., 1969, Bull. No. 64 (Senate Document) issued by the Oregon Department of Geology and Mineral Industries, Portland, Oregon, 97201.

(185) The Mineral Industry of Oregon, J. D. Gorrick, 1971, U.S. Bureau of Mines' Minerals Yearbook.

TABLE A-62. METALLIC OCCURRENCES IN OREGON, BY COUNTIES

Metals	Counties
Antimony	Baker, Grant, Jackson, Lane, Umatilla
Chromium	Baker, Grant, Jackson, Josephine, Curry, Goos, Douglas
Cobalt and Nickel	Baker, Grant, Jackson, Josephine, Curry, Goos, Douglas
Copper, Lead, Zinc	Baker, Grant, Jackson, Josephine, Jefferson, Douglas, Lane, Marion, Linn, Wallowa
Gold and Silver	Baker, Grant, Jackson, Josephine, Curry, Goos, Douglas, Jefferson, Marion, Lime, Crook, Lane, Wheeler
Iron	Baker, Jackson, Curry, Cook
Mercury	Baker, Grant, Jackson, Josephine, Crook, Douglas
Molybdenum	Grant, Jackson, Josephine, Curry, Douglas, Wallowa
Platinum	Baker, Grant, Josephine, Curry, Coos
Tungsten	Baker, Grant, Jackson, Josephine, Curry, Douglas, Union, Wallowa

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TABLE A-63. ASBESTOS, OLIVINE, SERPENTINE, AND DIOPSIDE OCCURRENCES IN OREGON

		Location			County
		Sec.	T.	R.	
	CHRYSOTILE ASBESTOS				
C-1	Forster Asbestos	33, 36	38 S.	9 W.	Josephine.
C-2	Mount Vernon	12, 13, 14	13 S.	30 E.	Grant
C-3	Spare Time claims	7, 18	14 S.	32 E.	do
C-4	Big Butte Creek	17, 18, 19, 20	11 S.	34 E.	do
C-5	Rock Creek Butte	22	13 S.	38 E.	Baker
C-6	Towell claims	7	14 S.	43 E.	Malheur
C-7	Bear Valley	1, 2, 3, 11	16 S.	31 E.	Grant
	AMPHIBOLE ASBESTOS				
A-1	L.E.J. Asbestos	9	37 S.	6 W.	Josephine.
A-2	Liberty Asbestos	[illegible]	[illegible]	4 W.	Jackson.
A-3	Raspberry Creek	15	34 S.	3 W.	do
A-4	Pine Creek Asbestos	34, 35	11 S.	39 E.	Baker

Grant County

1. Oregon asbeston mine. Chrysotile asbestos veins in serpentine. Oregon Department of Geology and Mineral Industries, 1941. 44°27' 119°03'
2. Stithem. Short cross-fiber chrysotile asbestos in serpentinite. Bowles, 1955. 44°36' 118°39'

Baker County

2. Pine Creek prospects. Harsh weak slip- and cross-fiber anthophyllite asbestos along shear zones in schists and greenstones. Moore, 1937. 44°33' 117°55'
4. Bald Mountain. Anthophyllite asbestos. Gilluly, 1937. 44°31' 117°48'
5. West Fork. Chrysotile asbestos. Gilluly, 1937. 44°40' 117°44'

Josephine County

6. L. E. J. Slip-fiber tremolite asbestos in dunite. 42°22' 123°25'

Jackson County

General reference: Staples, 1942.

7. Graves Creek. 42°39' 123°12'
8. Liberty. Iron-free tremolite asbestos. 42°38' 122°59'

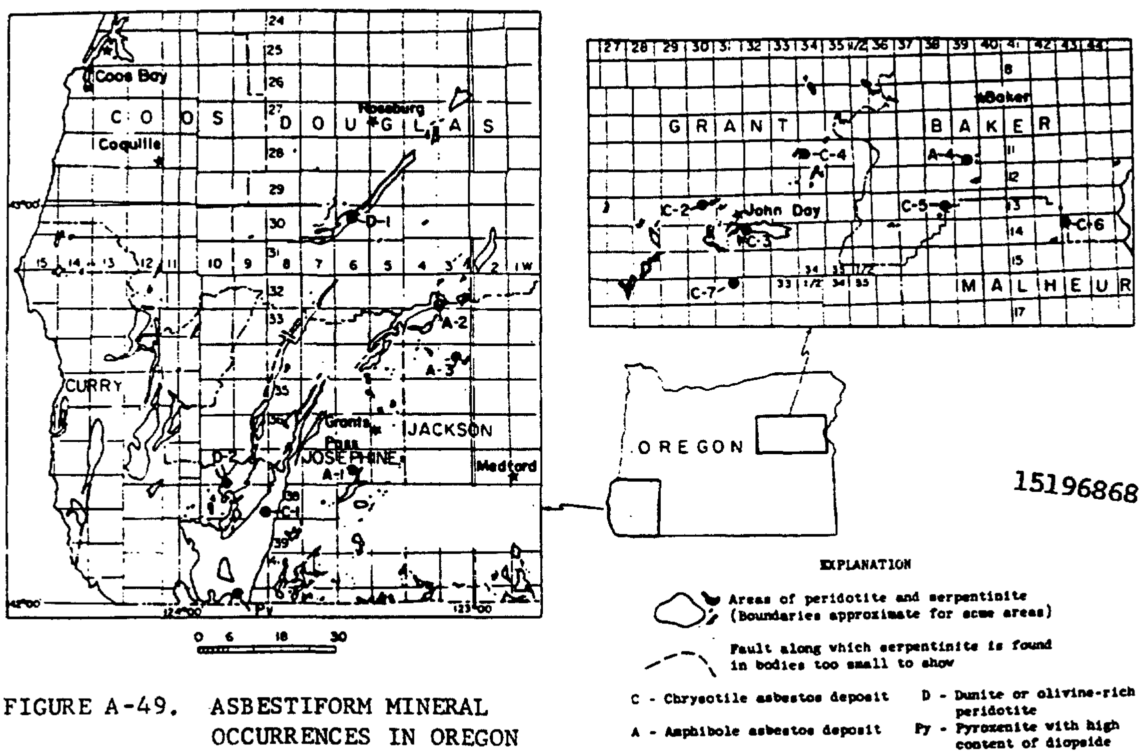

FIGURE A-49. ASBESTIFORM MINERAL OCCURRENCES IN OREGON

TABLE A-64. VALUE OF MINERAL PRODUCTION IN OREGON, BY COUNTY (thousands)

County	1970	1971	Minerals produced in 1971, in order of value
Baker	[r] $6,211	$8,249	Cement, stone, sand and gravel, pumice, clays, gold, silver, copper, tungsten.
Benton	1,030	434	Sand and gravel, stone, clays.
Clackamas	11,433	12,495	Cement, sand and gravel, stone, clays.
Clatsop	505	W	Stone, sand and gravel.
Columbia	W	W	Sand and gravel, stone.
Coos	814	634	Stone, sand and gravel.
Crook	196	353	Stone, sand and gravel, clays.
Curry	582	W	Stone, sand and gravel.
Deschutes	[r] 772	852	Pumice, stone, sand and gravel.
Douglas	W	10,294	Nickel, stone, sand and gravel, mercury.
Gilliam	W	W	Stone, sand and gravel.
Grant	638	1,011	Stone, sand and gravel, gold.
Harney	W	W	Stone.
Hood River	W	W	Stone, sand and gravel.
Jackson	975	1,700	Sand and gravel, stone.
Jefferson	W	W	Do.
Josephine	799	2,076	Sand and gravel, stone, talc, gold.
Klamath	[r] 2,855	2,228	Stone, sand and gravel, pumice, clays.
Lake	239	656	Stone, pumice, sand and gravel, diatomite.
Lane	8,046	5,288	Sand and gravel, stone, clays.
Lincoln	701	1,033	Stone, sand and gravel.
Linn	1,238	833	Sand and gravel, stone, emery.
Malheur	W	1,360	Stone, lime, sand and gravel.
Marion	650	1,120	Sand and gravel, clays, stone.
Morrow	W	W	Stone, sand and gravel.
Multnomah	7,402	7,940	Lime, sand and gravel, stone, clays.
Polk	709	422	Sand and gravel, stone.
Sherman	612	46	Stone.
Tillamook	409	308	Stone, sand and gravel, clays.
Umatilla	598	2,008	Stone, sand and gravel.
Union	632	1,676	Do.
Wallowa	613	474	Do.
Wasco	869	W	Sand and gravel, stone.
Washington	2,276	2,131	Stone, sand and gravel, clays.
Wheeler	W	60	Sand and gravel.
Yamhill	580	456	Sand and gravel, stone, clays.
Undistributed [1]	[r] 21,002	11,746	
Total [2]	[r] 68,081	77,885	

[r] Revised. W Withheld to avoid disclosing individual company confidential data.
[1] Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

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Pennsylvania

The areal extent of the metamorphic rocks in Pennsylvania is depicted in Figure A-50 where it can be seen that these rock belts trend southwest-northeast in the same general direction as the metamorphic belts in surrounding and nearby states. The metamorphic rocks are confined to the southeastern quadrant of the state being found in Adams, Berks, Bucks, Chester, Cumberland, Dauphin, Delaware, Franklin, Lancaster, Lebanon, Lehigh, Montgomery, Northampton, Perry, Philadelphia, Schuylkill, and York Counties as shown in Figure A-51. There are Greenschists, Subgreenschiests, Amphibolites, and relict Granulite facies as well as Calc-alkalic plutons in the metamorphosed region. Asbestiform mineral occurences have been reported from several localities within the region but the chief belt appears to be in the southeastern most counties of Chester, Delaware, and Montgomery. One major occurrence of asbestos and four occurrences of talc-soapstone are located on Figure A-51 and Table A-65. One of the talc occurrences is the northern part of the metamorphic belt -- Northampton County. Dr. A. A. Socolow, Director of the Pennsylvania Geological Survey, suggests that there may be considerable asbestiform amphibolite worked in the Cedar Hill Quarry located in Lancaster County on the Maryland border. The D. M. Stolzfus and Son, Inc., company (of Talmage, Pennsylvania 17580) is quarrying and crushing Serpentinite in the Cedar Hill operation for use as concrete aggregate and road ballast.

The metallic prospects and proven occurrences of southeastern Pennsylvania are shown on Figure A-51 to be largely within the principal metamorphosed formations. Currently, there are only two mines operating: the Friedensville zinc mine in southeastern Lehigh County (the New Jersey Zinc Company, 160 Front Street, New York, New York 10038, or Friedensville, Pennsylvania 18103) and the Grace magnetite mine near Morgantown in the southern tip of Berks County (Morgantown Division, Bethlehem, Pennsylvania 18016). There is no record of amphibole minerals at the Friedensville zinc mine where the host rock is limy dolomite of Ordovician age. The gangne minerals at the Grace magnetite mine near Morgantown are mainly actinolite, chlorite, serpentine, and various other calc-silicates as well as ferromagnesian

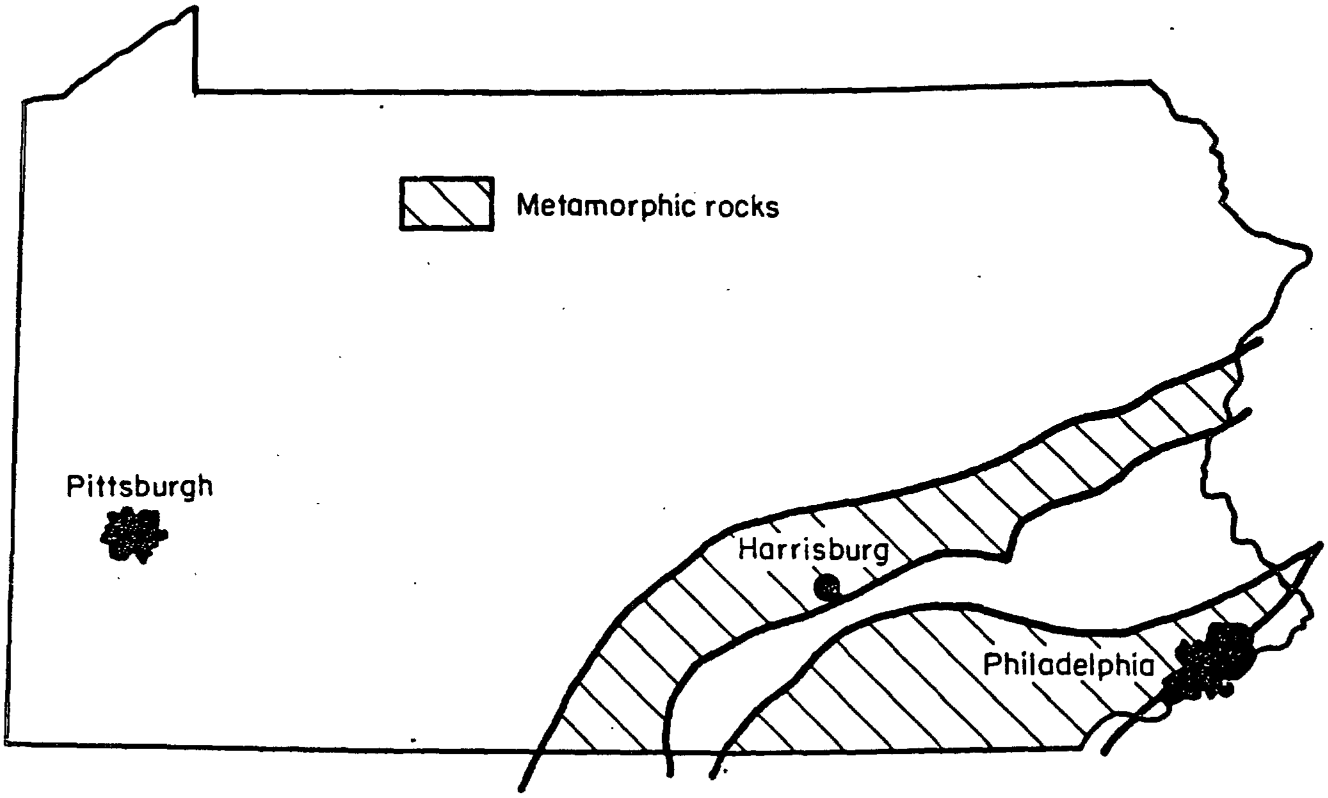

FIGURE A-50. OCCURRENCE OF METAMORPHIC ROCK IN PENNSYLVANIA

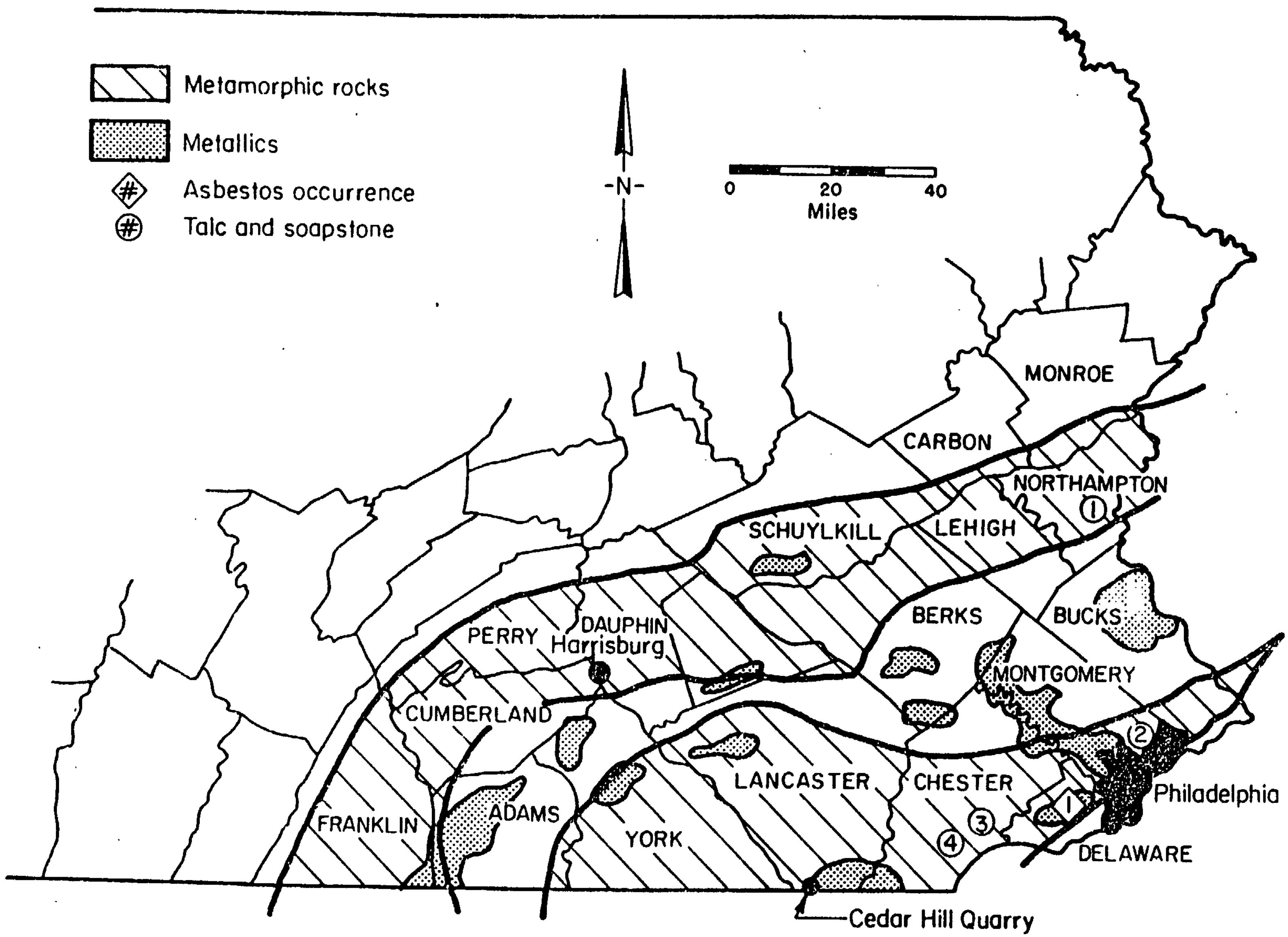

FIGURE A-51. DETAIL MAP SHOWING OCCURRENCE OF METAMORPHIC ROCK IN SOUTHEASTERN PENNSYLVANIA

TABLE A-65. OCCURRENCE OF ASBESTOS, TALC, AND SOAPSTONE IN PENNSYLVANIA

Location and Description	Latitude	Longitude (a)	County
Asbestos			
1. Media area (Village Green, Rockdale, and Smedley) mines. Unknown variety of asbestos associated with untramafic igneous rocks.	39° 53'	75° 23'	Delaware
Talc and Soapstone			
1. Easton area. Talc rock derived from and associated with Precambrian dolomite similar to the Grenville Formation Ladoo, 1923.	40° 42'	75° 12'	Northampton
2. Gladwyne and Princess quarries. Soapstone associated with serpentinite. Pearre and Heyl, 1960	40° 03'	75° 16'	Montgomery
3. West Goshen prospect. Soapstone and talc rock associated with serpentinite. Pearre and Heyl, 1960.	39° 59'	75° 36'	Chester
4. Indian Soapstone prospect. Soapstone associated with serpentinite. Pearre and Heyl, 1960.	39° 56'	75° 43'	Chester

(a) Localities by North Latitude and West Longitude.

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silicates. Elsewhere in the magnetite prospects or prior mining sites of Berks, Chester, and Lebanon Counties, the asbestiform amphiboles are commonly cited. Actinolite is the most common. Amphibole minerals are not reported from similar prospects in York County, but frequently all of the gangue materials are not described from the sites.

The nonmetailic mineral recovery operations in the counties traversed by the metamorphic belt are chiefly quarrying operations for stone, sand and gravel, and clays. The commodities produced in the various counties of interest are given in Table A-66. There is no readily available description of any asbestiform minerals that might be associated with the nonmetallic mineral recovery operations.

Source References

(1) Metamorphic Map of the Appalachians, 1:2,500,000, B. A. Morgan, Map I-724, US Geological Survey, 1972.

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, Resource Map MR-17, 1:3,168,000, U.S. Geological Survey, 1962.

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, Resource Map MR-31, 1: 3,168,000, U.S. Geological Survey, 1962.

(186) Geologic Map of Pennsylvania, 1:250,000, Carlyle Gray (ed.) Commonwealth of Pennsylvania Geologic Survey, 1960.

(187) Atlans of Pennsylvania Mineral Resources, Part 3, Metal Mines and Occurrences in Pennsylvania, A. W. Rose, Bulletin No. M50, Pennsylvania Geologic Survey, 1970.

(188) Directory of the Mineral Industry in Pennsylvania, K. V. Hoover, Information Circular 54, Commonwealth of Pennsylvania Geologic Survey, Second Edition, 1973.

(189) The Mineral Industry of Pennsylvania, F. D. Cooper, U.S. Bureau of Mines' Minerals Yearbook, Preprint from 1971.

TABLE A-66. PRINCIPAL MINERALS PRODUCED IN PENNSYLVANIA, BY COUNTIES

County	Commodities Produced
Adams	Stone, lime, clays
Berks	Magnetite, cement, stone, clays, sand and gravel, pyrites
Bucks	Stone, sand and gravel, clays
Chester	Stone, lime, clays
Cumberland	Stone, sand and gravel, clays
Dauphin	Stone, coal
Delaware	Stone
Franklin	Stone, sand and gravel
Lancaster	Stone, sand and gravel, clays
Lebanon	Stone, lime, pyrites (metallics prior to 1973)
Lehigh	Zinc, stone, cement
Montgomery	Stone, lime, cement, clays
Northhampton	Stone, cement, sand and gravel
Perry	Stone, sand and gravel
Schuylkill	Stone, coal, clays
York	Stone, lime, cement, mica, sand and gravel, clays

Rhode Island

All of the bedrock in Rhode Island has been metamorphosed, as indicated in Figures A-52. There are numerous plutonic rocks as well as metamorphosed, sedimentaries. Most of the formations are of Paleozoic age - Pennsylvanian or older - although at least some of the plutonics are younger - possibly Cretaceous in age. Typically, there are gneisses, schists, quartzites, gabbros, granites, and metamorphosed conglomerates. Both fibrous and massive amphibole alteration minerals are found in many formations in several parts of the state. The occurrences of the fibrous amphiboles, actnolite and tremolite (some crocidolite has been reported also), are shown to be in each of the five counties of Rhode Island on Figure A-53 with most occurrences in the northern part of the state (Providence County). Chrysotile asbestos (very rare) has been reported from both Providence and Newport Counties and talcose rock in northeastern Providence County (Table A-67). Currently, there are no recovery operations for metallics or for the talc or the asbestiform minerals. However, these mineral forms are undoubtedly present in the stone, sand and gravel recovery operations that constitute the mineral industry of Rhode Island. The operators and the commodities being worked are given in Table A-68.

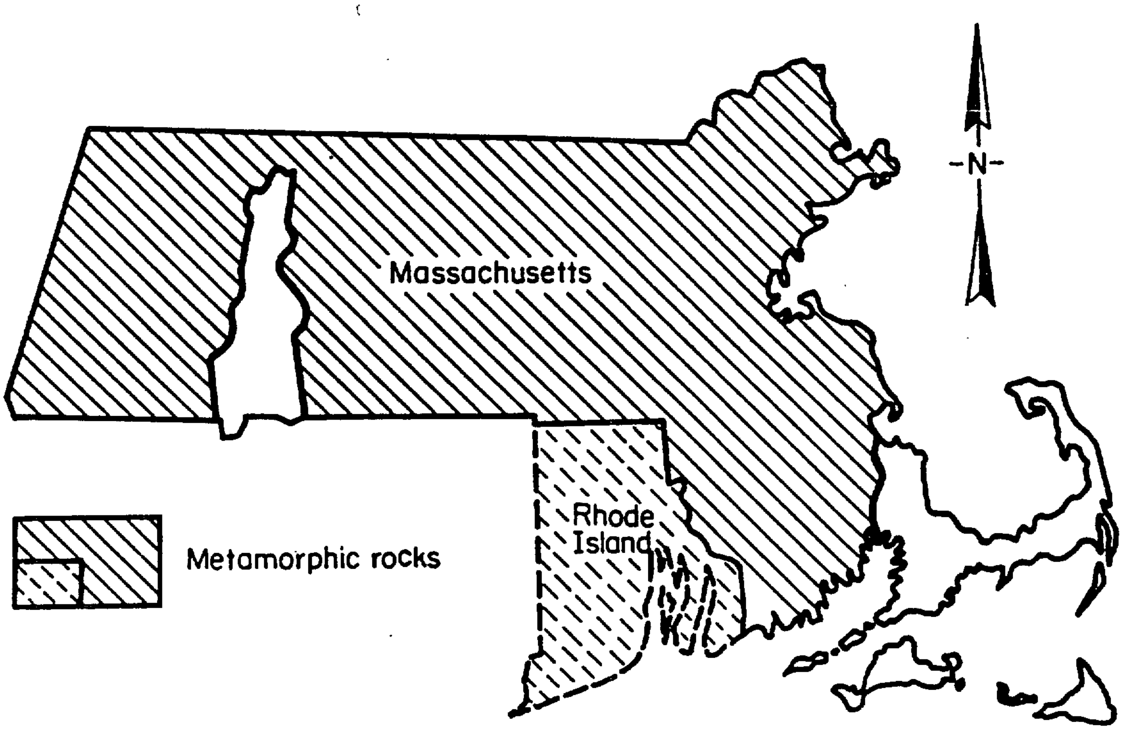

FIGURE A-52. METAMORPHIC ROCK OCCURRENCE IN RHODE ISLAND

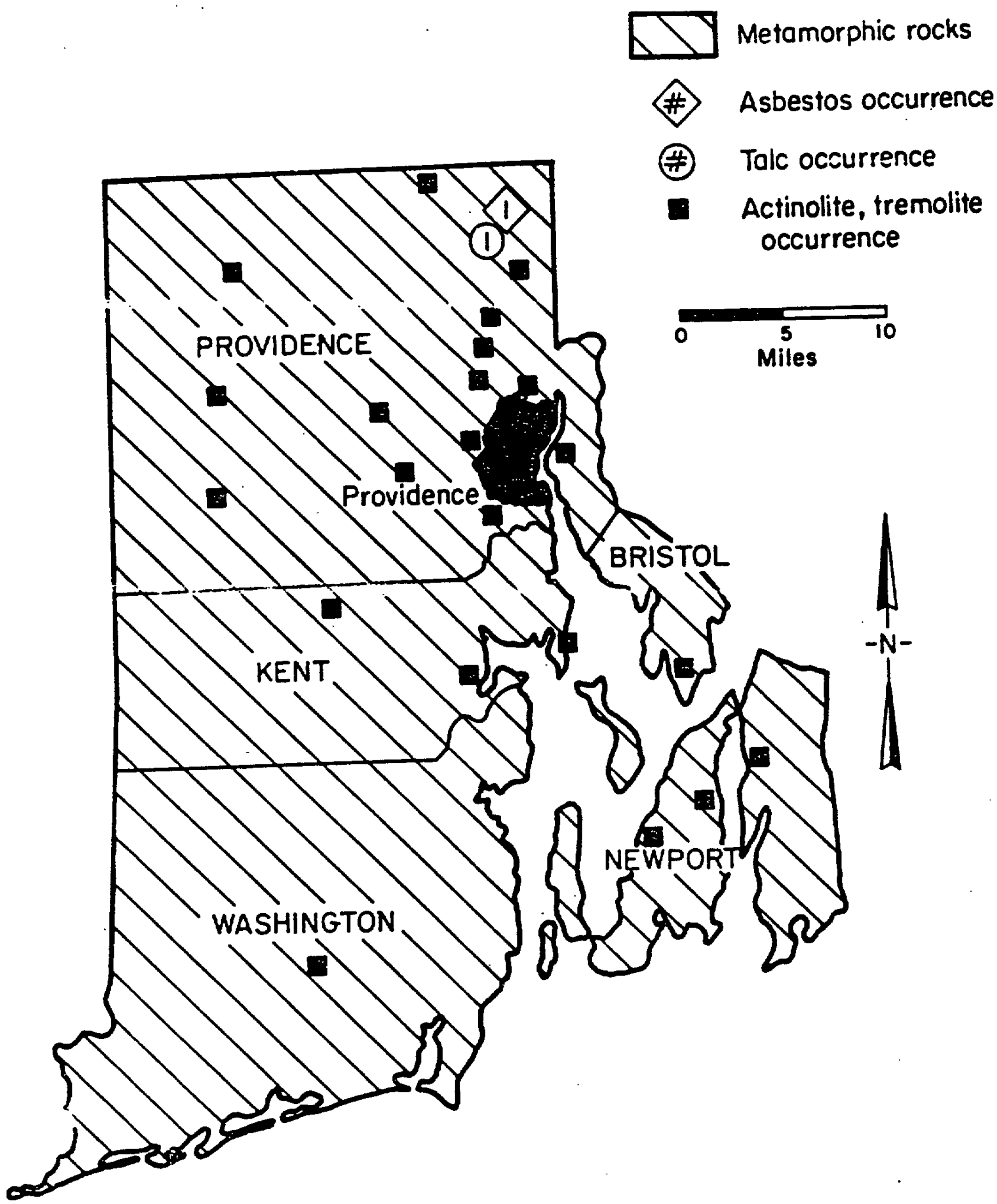

FIGURE A-53. DETAILED MAP OF METAMORPHIC ROCK IN RHODE ISLAND

TABLE A-67. OCCURRENCES OF ASBESTOS AND TALC IN RHODE ISLAND

Area and Description	Latitude, Longitude		County
Asbestos			
1. Beacon Pole Hill deposit. Crocidolite asbestos. Bowles, 1955; Quinn and others, 1949.	41° 58'	71° 28'	Providence
Talc			
1. Limerock area. Talc-carbonate and talc rock associated with serpentinite. Quinn and others, 1949.	41° 56'	71° 28'	Providence

TABLE A-68. MINING OPERATIONS IN RHODE ISLAND

Commodity and company	Address	Type of activity	County
Sand and gravel:			
A. Cardi Construction Co., Inc.	451 Arnold Road Coventry, R.I. 02816	Pit............	Kent.
Coventry Sand & Gravel Co...	Reservoir Road Coventry, R.I. 02816	Pit............	Do.
Del Bonis Sand & Gravel Co...	950 Phenix Ave. Cranston, R.I. 02920	Pit............	Providence.
Forte Brothers, Inc............	14 Whipple St. Berkeley, R.I. 02900	Pit............	Do.
Lapham Sand & Gravel Co....	R.F.D. 2, Greenville Rd. Woonsocket, R.I. 02895	Pit............	Do.
Mack Construction Co.........	Pawtucket, R.I. 02860...........	Pit............	Do.
Peckham Bros. Co., Inc........	Paradise Ave. Middletown, R.I. 02840	Pit............	Newport.
Rhode Island Sand & Gravel Co., Inc.	Kilvert St. Hillsgrove, R.I. 02886	Pit............	Kent.
J. Romanella & Sons Inc.......	Box 646, Westerly, R.I. 02891....	Pit............	Washington.
J. Santoro, Inc.................	11 Herbert Street Providence, R.I. 02909	Pit............	Providence.
South County Sand & Gravel Co., Inc.	North Rd. Peace Dale, R.I. 02883	Pit............	Washington.
Tasca Sand & Gravel Co.......	Box 113, R.F.D. 4 Esmond, R.I. 02917	Pit............	Providence.
Town Line Sand & Gravel Inc.	Victory Highway Slatersville, R.I. 02876	Pit............	Do.
Whitehead Bros. Co...........	60 Hanover Road Florham Park, N.J. 07932	Pit............	Kent.
Stone:			
Granite, dimension:			
Providence Granite Co....	210 Kingsley Ave. Providence, R.I. 02903	Quarry........	Washington.
Limestone, crushed:			
The Conklin Limestone Co., Inc.	R.F.D. 1 Lincoln, R.I. 02865	....do........	Providence.
Other stone, crushed and broken:			
M.A. Gammino Construction Co.	876 Phenix Ave. Cranston, R.I. 02920	....do........	
Peckham Brothers Co., Inc.	Paradise Ave. Newport, R.I. 02840	....do........	Newport.

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Source References

(1) Metamorphic Map of the Appalachians, B. A. Morgan, USGS Map I-724.

(2) Asbestos in the US., A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

(3) Talc and Soapstone in the U.S., A. H. Chidester and H. W. Worthington, 1962, USGS Map MR-31.

(190) Bedrock Geologic Map of Rhode Island, A. W. Quinn, 1965, USGS Bulletin No. 1295, Plate 1.

(191) Mineral Deposits and Occurrences in Massachusetts and Rhode Island, Exclusive of Clay, Sand and Gravel, and Peet, N.C. Pearre, 1956, USGS Mineral Resource Map MR-4.

(192) Minerals of Rhode Island, G. E. Miller and O. D. Hermes, 1972, Department of Geology, University of Rhode Island, Kingston.

(193) The Mineral Industry of Rhode Island, F. B. Fulkerson, 1972, U.S. Bureau of Mines' Minerals Yearbook.

South Carolina

The northern half of South Carolina is composed of metamorphic rocks as indicated in Figures A-54 and A-55. The Carolina Slate Belt and The Charlotte Belt of highly metamorphosed rocks extend across the state in a northeast-southwest trend line as shown in the map of the northern counties encompassing part or all of 16 counties. Within the Carolina Slate Belt, Amphibolite zones have been identified in York, Union, Chester, Newberry, Fairfield, and Richland counties, also as depicted in the figure. The description of this formation from the Geologic Map by Overstreet and Bell is as follows:

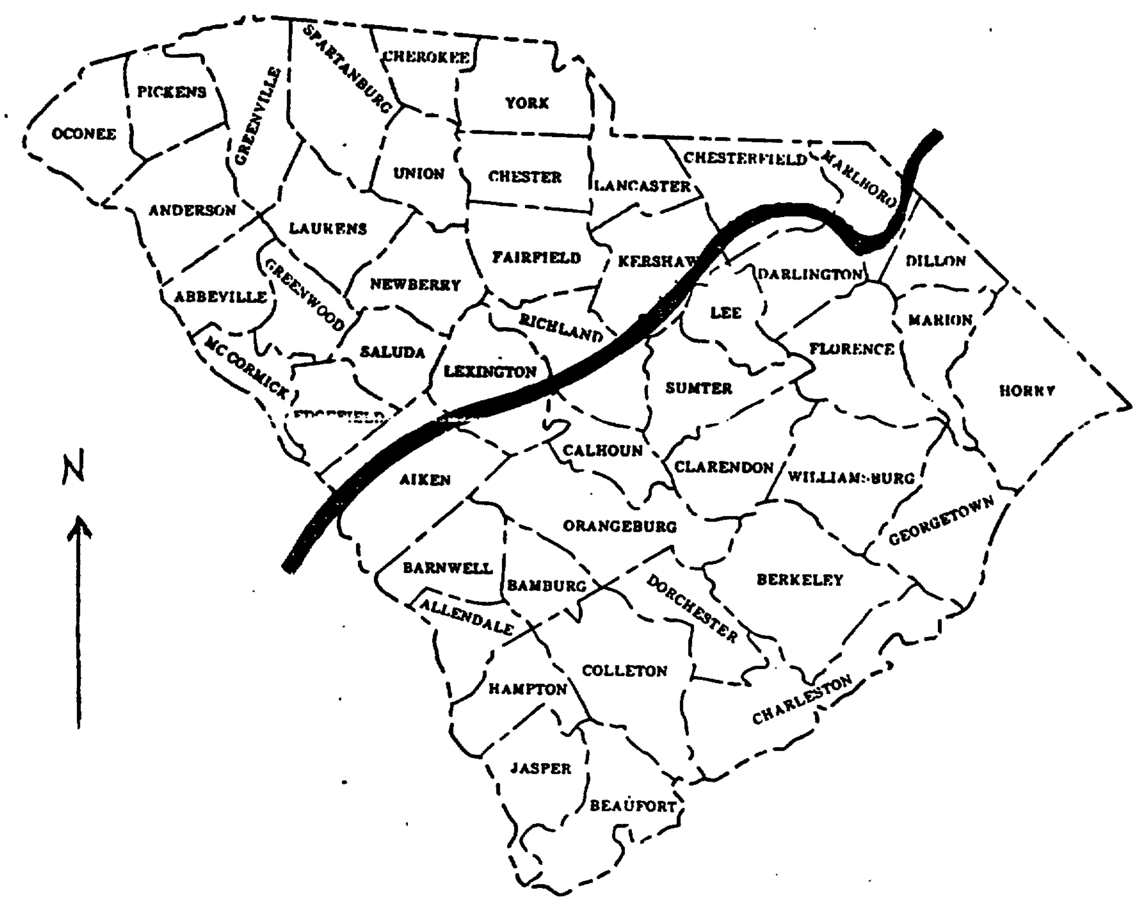
Amphibolite

"Dark green, gray, and black, fine to coarse-grained amphibolite, hornblende schist, hornblende gneiss, actinolite schist, and chlorite schist; includes some diorite, metagabbro, biotite gneiss, and numerous basic dikes of several ages and relations."

The mineral industry of the counties in which the amphibolite formation occurs is confined to the extraction of clays, sand and gravel, and granite (both crushed and dimension stone) as shown in Table A-69.

TABLE A-69. MINERAL PRODUCING ACTIVITIES IN AMPHIBOLITE FORMATIONS IN SOUTH CAROLINA

Oounty	Commodity	Company and Address
Fairfield	Clays	Richtex Corporation P.O. Box 3307 Columbia, South Carolina 29203
	Crushed granite	Martin-Marietta Corporation P.O. Box 2568 Raleigh, North Carolina 27602



Shaded Northern Part of South Carolina State
Consists Entirely of Metamorphic Rocks

FIGURE A-54. METAMORPHIC ROCK OCCURRENCE IN SOUTH CAROLINA

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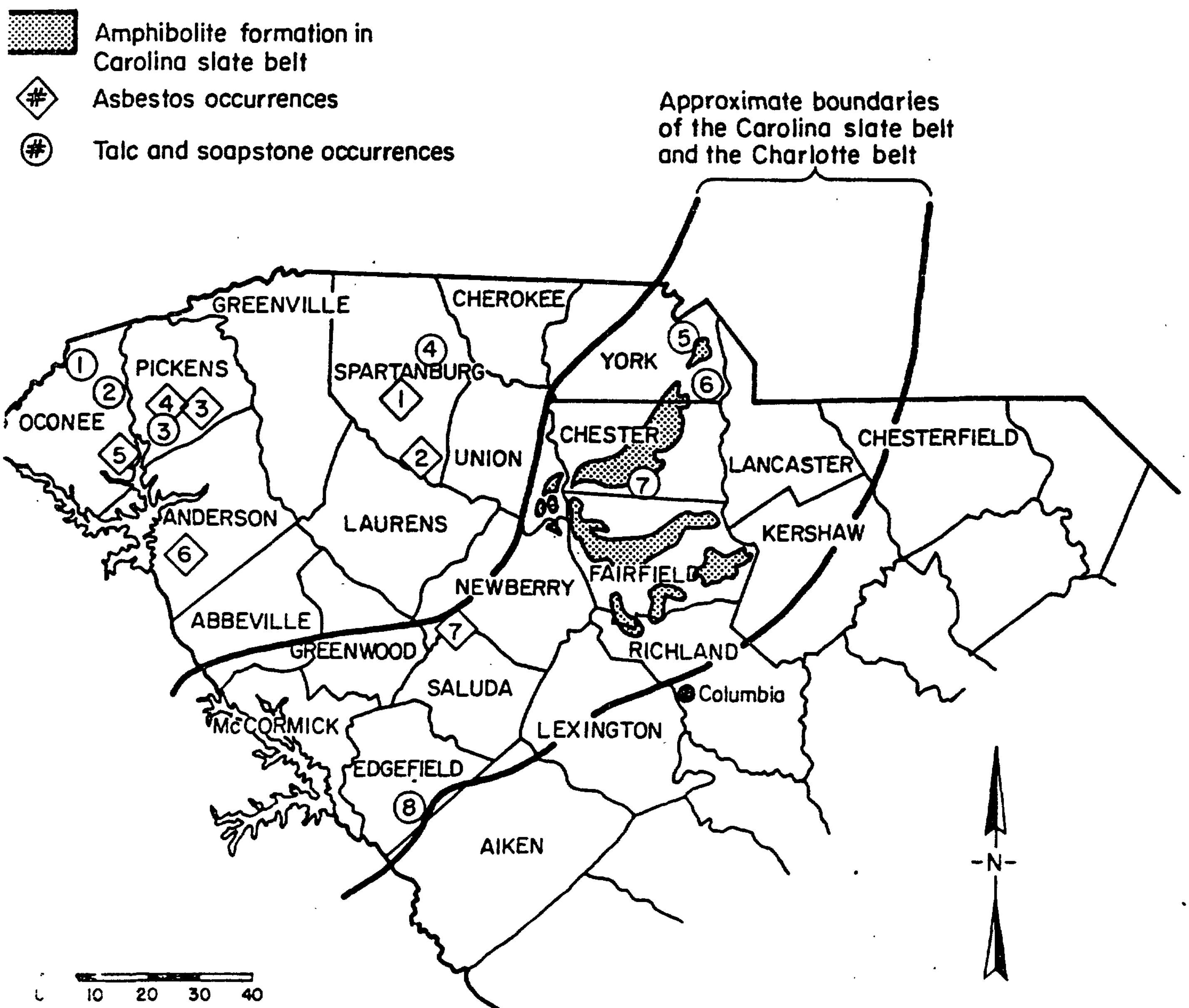

FIGURE A-55. OCCURRENCE OF ASBESTOS, TALC, AND SOAPSTONE IN SOUTH CAROLINA

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The total extent of the mining and quarrying industry in these counties is unknown since, except for Richland County, the value of the mineral production has not been published. The mineral production value for Richland County was $2.629 million in 1970 and $2.843 million in 1971. The exact quarrying and mining locations are not given and neither are the details of the operations.

Elsewhere throughout the metamorphosed zone of South Carolina asbestiform minerals occur at several localities in the northermost counties including Oconee, Pickens, Anderson, Greenville, Spartanburg, Cherokee, Abbeville, and Laurens Counties. There are numerous mining and quarrying operations in these areas as summarized in Table A-70.

The asbestiform minerals of the areas are associated with chlorite schists, talc schists, steatite, and serpentine, all of which represent alteration products of the peridotites, pyroxenite, and other magnesian silicates, both foliated and undeformed. The asbestos, frequently with the composition of crysotile, extends its bunches of crystal fibers from wall to wall of the numerous small fissures (rarely exceeding 8 inches in diameter) in the compact magnesian rocks, the separation of which in mining imposes burdensome cost. Intense metamorphism in some instances has resolved the original magnesian rock to chlorite schist, magnetite, and large clustered masses of true asbestos, with lustrous long white fibers. In some cases asbestos appears to have resulted from metasomatic action, in others from aqueo-igneous segregation. The metasomatic asbestos veins do not appear to extend to great depths and are generally too localized for economical asbestos mining activities.

Oconee and Pickens Counties in the western tip of the state, are notable for amphibole occurrences although in scattered and localized sites. A single quarry in Pickens County is worked for a crushed granite product by the Vulcan Materials Company (P.O. Drawer 8834, Greenville, South Carolina 29604) and the W. F. Thomas Sand Company (Route 1, Old Farrs Bridge Road, Greenville, South Carolina 29611) recovers sand. The Caldwell Engineering Company (P.O. Box 159, Walhallo, South Carolina 29691) crushes stone from two mines in Oconee County. A recent South

Carolina State Development Board publication describes numerous chlorite-actinolite schist occurrences in Oconee County drill-hole logs and an asbestos prospect along the Seneca River seven miles northeast of Seneca. It is believed that other asbestos occurrences might be found elsewhere within the hornblende gneiss injection zone and the Brevard belt where amphibolitic gneisses occur in Oconee County. Mr. Norman K. Olson, State Geologist, provided the following description of one of the most recent asbestos prospects - "An asbestos prospect about 2 miles northeast of the fish hatchery along Route 197 in Oconee County was found to be a weathered dunite with an outcrop area of slightly less than 1/4 mile by 1/8 mile, containing an upper weathered zone of anthophyllite [Mg, Fe)$_7$ (Si_8O_{22}) $(OH)_2$] of at least 4 feet in depth. The entire dunite was found to contain chromite ($FeCr_2O_4$) in unknown quantities. Olivine [MgFe)$_2SiO_4$] was found in an outcrop along the southern end of the intrusion's outcrop area. Anthophyllite occurs in layers up to 12 inches wide and in massive areas as short (1/2 cm) fibers, constituting probably as much as 90 percent of much of the rock. The other common mineral is talc]Mg_3 (Si_4O_{10}) $(OH)_2$] and this occurs widely disseminated throughout the body. The total amount of anthophyllite was not estimated."

The occurrences of asbestos, talc, and soapstone, as described in the USGS Mineral Resources Maps (MR-17 and MR-31) are given in Table A-71 and are marked in Figure A-55.

A county-by-county summary of the mineral production in South Carolina is given in Tables A-72 and A-73.

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TABLE A-70. MINERAL PRODUCING ACTIVITIES IN METAMORPHOSED ZONES OF SOUTH CAROLINA

County	Commodity	Company and Address
Cherokee	Clay	Bennett Brick & Tile Company P.O. Box 29 Kings Mt., North Carolina 28086
	Clay, Sericite, and Manganese	Broad River Brick Company P.O. Box 550 Gaffney, South Carolina 29340
	Sand	L. G. Chapman Sand Pit, Inc. Route 1 Spartanburg, South Carolina 29302
	Sericite and Colemanite	Industrial Minerals, Inc. P.O. Box 454 York, South Carolina 29745 or Kings Creek, South Carolina 29719
	Sand	Jobe Sand Company, Inc. No. Magnolia Street Forest City, North Carolina 28043
	Limestone and Crushed stone	Vulcan Materials Company P.O. Box 188 Blacksburg, South Carolina 29702
Greenville	Sand	E. C. Cooper Sand Company Route 7 Easley, South Carolina 29640
Greenville	Vermiculite	W. R. Grace & Company Route 1 Enoree, South Carolina 29335
	Crushed stone	Vulcan Materials Company P.O. Box 188 Blacksburg, South Carolina 29702
	Sand	Zupan Sand Company Route 3 Greenville, South Carolina 29609

TABLE A-70 (continued)

County	Commodity	Company and Address
Laurens	Vermiculite	W. R. Grace & Company Route 1 Enoree, South Carolina 29335
	Vermiculite	Patterson Vermiculite Company Route 1 Enoree, South Carolina 29335
	Crushed stone	Lone Star Industries, Inc. P.O. Box 5185 Columbia, South Carolina 29205
	Crushed stone	Vulcan Materials Company P.O. Box 188 Blacksburg, South Carolina 29702
Oconee	Crushed stone	Caldwell Engineering Company P.O. Box 159 Walhalla, South Carolina 29691
Pickens	Sand	W. F. Thomas Sand Company Route 1 Old Farrs Bridge Road Greenville, South Carolina 29611
	Crushed stone	Vulcan Materials Company P.O. Box 188 Blacksburg, South Carolina 29702
Spartanburg	Sand	L. G. Chapman Sand Pit, Inc. Route 1 Spartanburg, South Carolina 29302
	Vermiculite	W. R. Grace & Company Route 1 Enoree, South Carolina 29335
partanburg	Feldspar	Spartan Minerals Company Pacolet, South Carolina 29372
	Crushed stone	Vulcan Materials Company P.O. Box 188 Blacksburg, South Carolina 29702

TABLE A-70 (continued)

County	Commodity	Company and Address
Fairfield	Crushed granite	Lone Star Industries P.O. Box 5185 Columbia, South Carolina 29205
	Dimension granite	Winnsboro Granite Co., Inc. Rion, South Carolina 29132
	Clays	Southern Brick Company P.O. Box 208 Ninety Six, South Carolina 29666
Newberry	Dimension granite	Kershaw Granite Co., Inc. P.O. Box 250 Elberton, Georgia 30635
		Coggins Granite Industries, Inc. P.O. Box 250 Elberton, Georgia 30635
Richland	Clays	Richtex Corporation P.O. Box 3307 Columbia, South Carolina 29203
		Caroline Ceramics, Inc. RFD 3, Box 266 Columbia, South Carolina 29206
		Duncon Kaolin Mine 3515 Devereaux Road Columbia, South Carolina 29205
	Sand and Gravel	Palmetto Quarries Company P.O. Drawer 5185 Columbia, South Carolina 29205
		Lone Star Industries, Inc. P.O. Box 5185 Columbia, South Carolina 29205
	Crushed granite	Martin-Marietta Corporation P.O. Box 2568 Raleigh, North Carolina 27602
		Lone Star Industries P.O. Box 5185 Columbia, South Carolina 29205
York	Crushed granite	Martin-Marietta Corporation P.O. Box 2568 Raleigh, North Carolina 27602

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TABLE A-71. OCCURRENCE OF ASBESTOS, TALC, AND SOAPSTONE IN SOUTH CAROLINA

Asbestos

Spartanburg County

1. Landrum area. Unknown variety of asbestos in dikes of pyroxenite altered to amphibolite.	34°54'	81°54'
2. Enoree area. Unknown variety of asbestos in magnesian rocks.	34°39'	81°55'
Pickens County		
3. Pickens area. Asbestos of unknown variety formed by alteration of magnesian rock in aphanitic hornblende slates.	34°54'	82°43'
4. Woodall Mountain (Hagood property). Asbestos of unknown variety in narrow belt of partly metamorphosed rock in aphanitic hornblende slate.	34°53'	82°49'
Oconee County		
5. Ramsay place. Asbestos of unknown variety in partly metamorphosed amphibolite.	34°46'	82°52'
Anderson County		
6. Anderson area. Asbestos of unknown variety in amphibolite.	34°26'	82°45'
Newberry County		
7. Saluda Old Town. Asbestos of unknown variety in basic igneous rock.	34°13'	81°52'

Talc and Soapstone

1. Soapstone Hill.	34°55'	83°06'
2. Fair View Church.	34°46'	82°56'
3. Central.	34°44'	82°49'
4. Cedar Springs.	34°56'	81°52'
5. Catawba River, near Nation Ford	34°58'	81°00'
6. Catawba Junction.	34°55'	80°58'
7. Halselville.	34°34'	81°15'
8. Edgefield.	33°41'	81°55'

(Localities by North Latitude and West Longitude)

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Table A-72. Value of mineral production in South Carolina, by county [1]
(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Aiken	$7,403	$7,935	Clays, sand and gravel.
Anderson	80		
Berkeley	W	W	Stone.
Cherokee	W	1,657	Stone, clays, sand and gravel.
Chesterfield	669	717	Sand and gravel.
Colleton	W	W	Peat.
Dorchester	W	W	Cement, stone, clays, sand and gravel.
Edgefield	W	W	Clays.
Fairfield	W	W	Stone, clays.
Florence	W	W	Sand and gravel.
Greenville	W	1,748	Stone, clays, sand and gravel.
Greenwood	W	W	Stone.
Horry	W	W	Sand and gravel, clays.
Jasper	W	W	Sand and gravel.
Kershaw	860	818	Sand and gravel, clays, stone.
Lancaster	W	W	Mica, clays, sand and gravel.
Laurens	W	W	Vermiculite, stone.
Lexington	4,827	4,920	Stone, sand and gravel, clays.
Marion	W	W	Sand and gravel, clays.
Marlboro	W	W	Do.
Newberry	W	W	Clays, stone.
Orangeburg	W	W	Cement, stone, clays.
Pickens	W	W	Stone, sand and gravel.
Richland	2,623	2,843	Stone, clays, sand and gravel.
Spartanburg	W	W	Stone, feldspar, sand and gravel.
Sumter	W	W	Sand and gravel, clays.
York	W	W	Stone.
Undistributed	39,894	46,348	
Total [2]	56,365	66,888	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] The following counties are not listed because no production was reported: Abbeville, Allendale, Bamberg, Barnwell, Beaufort, Calhoun, Charleston, Chester, Clarendon, Darlington, Dillon, Georgetown, Hampton, Lee, McCormick, Oconee, Saluda, Union, and Williamsburg.
[2] Data may not add to totals shown because of independent rounding.

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TABLE A-73. PRINCIPAL MINERAL PRODUCERS IN SOUTH CAROLINA

Commodity and company	Address	Type of activity	County
Cement:			
Giant Portland Cement Co.	150 Strafford Ave. Wayne, Pa. 19087	Plant	Dorchester.
Santee Portland Cement Co.	Box 698 Holly Hill, S.C. 29059	do	Orangeburg.
Clays:			
Kaolin:			
Cyprus Mines Corp	Box 1201 Trenton, N.J. 08606	Mine	Aiken.
Dixie Clay Co.	230 Park Ave. New York, N.Y. 10017	2 mines	Do.
J. M. Huber Corp	630 Third Ave. New York, N.Y. 10017	4 mines	Do.
National Kaolin Products Co.	Box 431 Aiken, S.C. 29801	Mine	Do.
Southeastern Clay Co.	Box 1022 Aiken, S.C. 29801	6 mines	Do.
Common clay and shale:			
Ashe Brick Co.	Van Wyck, S.C. 29744	Mine	Lancaster.
Broad River Brick Co.	Box 550 Gaffney, S.C. 29340	do	Cherokee.
Giant Portland Cement Co.	150 Strafford Ave. Wayne, Pa. 19087	do	Dorchester.
Guignard Brick Co.	Box 568 Cayce, S.C. 29033	3 mines	Lexington.
Palmetto Brick Co.	Box 430 Cheraw, S.C. 29520	Mine	Marlboro.
Richtex Corp	Box 3307 Columbia, S.C. 29203	6 mines	Fairfield, Lexington, Richland.
Santee Portland Cement Co.	Box 698 Holly Hill, S.C. 29059	Mine	Orangeburg.
Southern Brick Co.	Box 208 Ninety Six, S.C. 29666	2 mines	Greenwood and Newberry.
Feldspar, crude:			
Spartan Minerals Co.	Route 1, Box 14A Pacolet, S.C. 29372	Plant	Spartanburg.
Mica, flake and scrap:			
The Mineral Mining Corp.	Kershaw, S.C. 29067	Mine	Lancaster.
Peat:			
United States Peat Corp	Box 568 Walterboro, S.C. 29488	Bog	Colleton.
Sand and gravel:			
Becker Sand & Gravel Co.	Box 848 Cheraw, S.C. 29520	5 mines	Chesterfield, Dorchester, Marlboro, Sumter.
Columbia Silica Sand Co.	Box 1519 Columbia, S.C. 29202	2 mines	Lexington.
Palmetto Quarries Co.	Drawer 5185 Columbia, S.C. 29205	Mine	Richland.
Pennsylvania Glass Sand Corp.	Gen. Operations Dept. Berkeley Springs, W. Va. 25411	do	Lexington.
Wilson Bros. Sand Co., Inc.	Box 945 Greenwood, S.C. 29646	do	Do.
Stone:			
Granite, crushed:			
Martin-Marietta Corp.	Box 2568 Raleigh, N.C. 27602	4 quarries	Fairfield, Lexington, Richland, York.
Lone Star Industries, Inc.	Drawer 5185 Columbia, S.C. 29205	3 quarries	Fairfield, Greenwood, Richland.
Vulcan Materials Co.	Drawer 8834 Greenville, S.C. 29604	4 quarries	Greenville, Laurens, Pickens, Spartanburg.
Granite, dimension:			
Comolli Granite Co.	Box 898 Elberton, Ga. 30635	Quarry	Kershaw.
Kershaw Granite Co., Inc.	Box 250 Elberton, Ga. 30635	3 quarries	Kershaw and Newberry.
Winnsboro Granite Co.	Rion, S.C. 29132	Quarry	Fairfield.
Limestone, crushed:			
Martin-Marietta Corp.	Box 2568 Raleigh, N.C. 27602	do	Berkeley.
Vulcan Materials Co.	Drawer 8834 Greenville, S.C. 29604	do	Cherokee.
Marl, crushed:			
Giant Portland Cement Co.	150 Strafford Ave. Wayne, Pa. 19087	do	Dorchester.
Santee Portland Cement Co.	Box 698 Holly Hill, S.C. 29059	do	Orangeburg.
Vermiculite:			
Crude:			
W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 02140	Several mines	Laurens.
Patterson Vermiculite Co.	Route 1 Enoree, S.C. 29335	Mine	Do.
Exfoliated:			
W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 02140	2 plants	Greenville and Laurens.
Patterson Vermiculite Co.	Route 1 Enoree, S.C. 29335	Plant	Laurens.

Source References

(1) Metamorphic Map of the Appalachians, Benjamin A. Morgan, 1972, USGS Map I-724.

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, 1962, USGS Map MR-31.

(194) Geologic Map of the Crystalline Rocks of South Carolina, W. C. Overstreet and Henry Bell, III, 1965, USGS Map I-413.

(195) Catalogue of the Mineral Localities of South Carolina, Earle Sloan, 1958, South Carolina Division of Geology.

(196) Geology and Mineral Resources of Oconee County, South Carolina, Charles J. Cayeau, 1967, Bulletin No. 34, South Carolina Division of Geology.

(197) South Carolina Mineral Producers Directory, 1972, South Carolina Division of Geology (Circular 2).

(198) The Mineral Industry of South Carolina, R. G. Clarke, and A. J. Lehocky, 1971, U.S. Bureau of Mines Mineral Yearbook.

South Dakota

The igneous and metamorphic rocks of South Dakota are found in both the eastern and western parts of the state as shown in Figure A-56. As illustrated, only a very small area of the state has the Milbank Granite exposure (Grant County) which is of Precambrian age. This granite is noted for its value as monument stone and is currently quarried for that purpose. To the south in eastern South Dakota, a younger Precambrian rock, Sioux Quartzite, is exposed in several counties. This formation was deposited on an extremely irregular surface of older plutonic and other rocks. The quartzite is locally interbedded with pipestone. While the Sioux Quartzite was at one time quarried for building stone, it is very little used for this purpose now. Quarrying in the counties where the Sioux Quartzite is exposed is chiefly confined to the recovery of sand and gravel, with limited stone production.

County	Commodity
Hanson	Stone, sand and gravel
Hutchinson	Sand and gravel
McCook	Sand and gravel
Minnehaha	Sand and gravel, stone
Moody	Sand and gravel
Turner	Sand and gravel

There are no reports of amphibole minerals in association with either the Milbank Granit or the Sioux Quartzite quarrying operations.

The Black Hills uplift in the western part of South Dakota is a complex of igneous and metamorphic rocks which include abundant amphibole minerals.

The rocks are predominantly of Precambrian age. In the northern part of the uplift, there are extensive tertiary igneous intrusive rocks. Figure A-57 shows the position of these intrusives and gives a generalized description of the rock types found in the Black Hills area. The current mining activities in the counties encompassing the Black Hills formations are as follows:

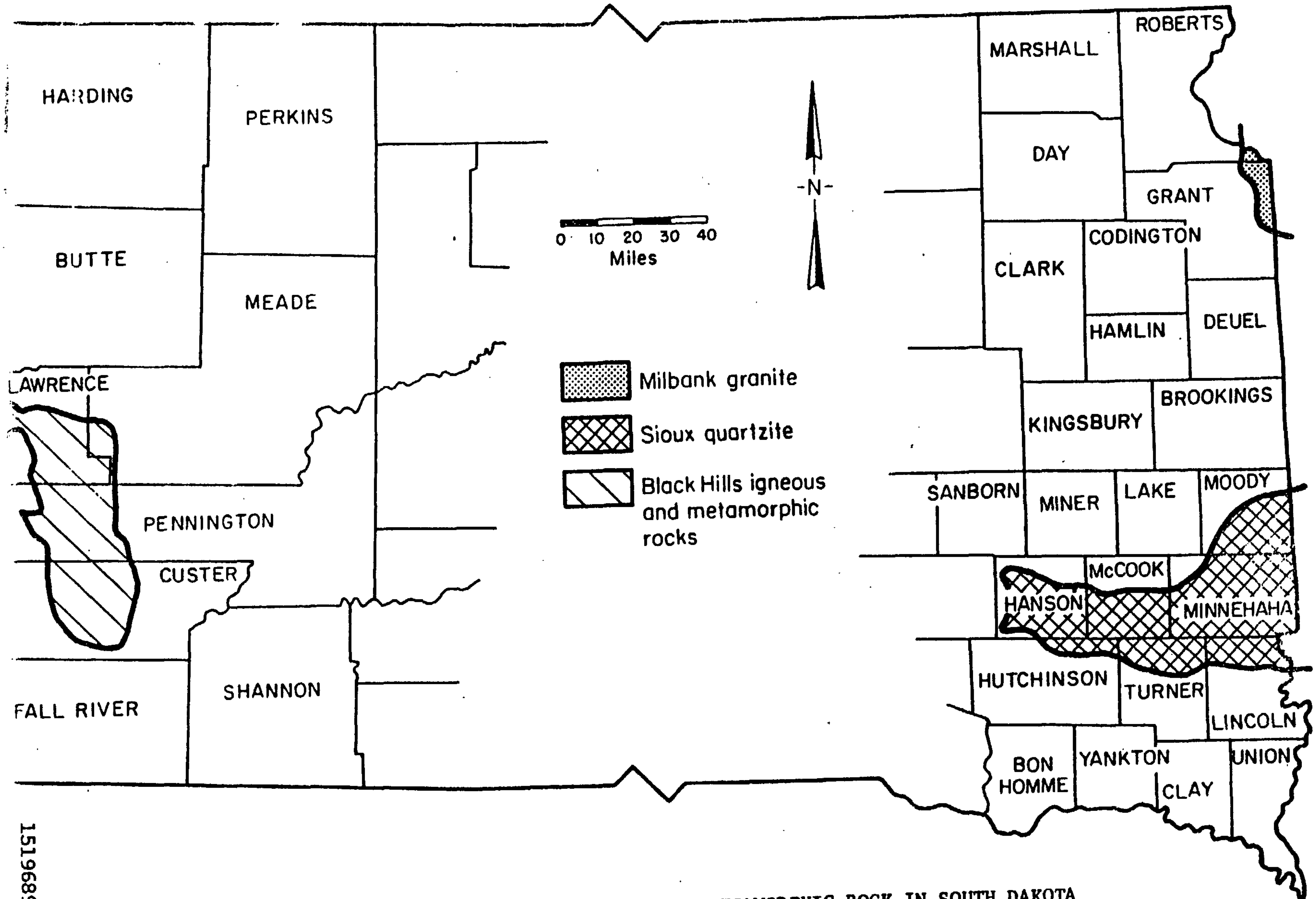

FIGURE A-56. OCCURRENCE OF IGNEOUS AND METAMORPHIC ROCK IN SOUTH DAKOTA

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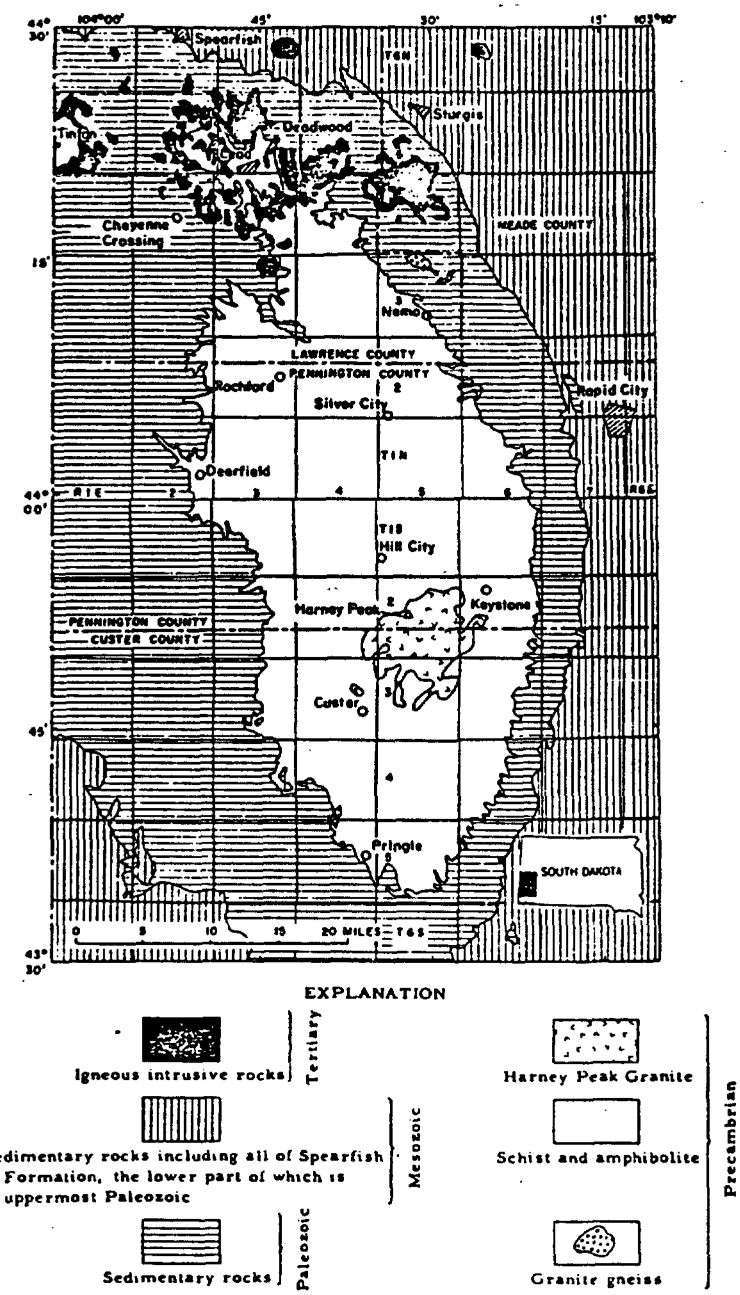

FIGURE A-57. GEOLOGICAL FEATURES OF THE BLACK HILLS AREA OF SOUTH DAKOTA

County	Commodities
Custer	Feldspar, sand and gravel, lime, stone
Lawrence	Gold, sand and gravel, silver, stone
Meade	Sand and gravel, gypsum
Pennington	Cement, stone, sand and gravel, lime, clays, mica (scrap), beryllium, and feldspar

The feldspar mica, and beryllium concentrates are chiefly hand cobbled from numerous pegmatites. Of principal interest to this study is the gold mining operation of Lawrence County where silver is recovered in the refining activities. This operation is being conducted by the Homestake Mining Company (Lead, South Dakota 57754). Rocks in the Lead district are Precambrian in age and consist of six formations with a total thickness of about 20,000 feet. The Homestake Mining Company recently has sunk new shafts to the 7189 level to develop ore in the "Nineteen" and "Twenty-one" Ledges of the formation.

Igneous rocks in the Lead area are of two ages: amphibolite bodies derived from Precambrian abbroic rocks, and small stocks, plugs, and dikes of Tertiary porphyries that range in composition from granite to syenite. The Precambrian rocks are dominantly iron-magnesium schistose rocks in the lower part of the sequence and argillaceous phyllites and schists in the upper part. They were isoclinally folded in Precambrian time and deformed further during the Teriary uplift and igneous intrusive activity. All of the major ore bodies occur in the Homestake Formation, which is a sideroplesite schist containing many bands of recrystallized chert. Where the metamorphism reached the garnet grade of progressive metamorphism, the schist of the Homestake Formation is a cummingtonite schist. The ore bodies are chloritized portions of the formation with the following suits of minerals: quartz, pyrrhotite, pyrite, arsenopyrite, ankerite, cummingtonite, biotite, garnet, albite, calcite, sericite, fluorite, galena, sphalerite, chalcopyrite, specularite, magnetite, gypsum, and gold. Mineralization of the deposists being worked has been postulated as both Precambrian and Tertiary. Almost 2 million tons of ore were mined in 1971 (down a bit from previous years because of the effort expended in sinking the new shafts) from which 513,400 ounces of gold and 107,000 ounces of silver were recovered. With approximately

11 million tons of ore in reserve, mining could continue at the 1971 rate until about 1976. Information on the disposition of the gangne rock was not reported.

A summary of the principal mineral production of South Dakota is given in Tables of A-74 and A-75.

Sources of References

(199) Geologic Map of South Dakota, N. H. Darton, 1951, U.S.G.S.

(200) Mineral and Water Resources of South Dakota, N. M. Denson and W. J. Mapel et. al., 1964, Bulletin No. 16, (Senate Resource Report), South Dakota State Geological Survey, Science Center, University of South Dakota, Vermillion South Dakota.

(201) The Mineral Industry of South Dakota, J. M. West, 1971, U. S. Bureau of Mines' Minerals Yearbook.

Table A-74. Value of mineral production in South Dakota, by county [1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Aurora	W	W	Sand and gravel.
Beadle	$317	W	Do.
Bon Homme	85	$42	Do.
Brookings	321	779	Sand and gravel, stone.
Brown	302	181	Sand and gravel.
Brule	105	W	Do.
Buffalo	W	W	Do.
Butte	W	W	Clays, sand and gravel.
Campbell	188	303	Sand and gravel, stone.
Charles Mix	125	140	Sand and gravel.
Clark	W	155	Do.
Clay	W	W	Do.
Codington	681	840	Do.
Corson	W	W	Do.
Custer	200	685	Feldspar, sand and gravel, lime, stone.
Davison	130	W	Sand and gravel.
Day	223	W	Do.
Deuel	123	W	Do.
Dewey	W	W	Sand and gravel, petroleum.
Douglas	95	W	Sand and gravel.
Edmunds	W	318	Do.
Fall River	W	W	Uranium, sand and gravel, petroleum.
Faulk	W	140	Sand and gravel.
Grant	W	W	Stone, sand and gravel.
Gregory	W	154	Sand and gravel.
Hamlin	107	260	Do.
Hand	385	524	Do.
Hanson	W	W	Stone, sand and gravel.
Harding	W	605	Petroleum, sand and gravel.
Hughes	94	W	Sand and gravel.
Hutchinson	W	W	Do.
Hyde	W	(2)	Do.
Jerauld	29	48	Do.
Jones	W	--	Do.
Kingsbury	108	22	Do.
Lake	120	W	Do.
Lawrence	21,499	21,558	Gold, sand and gravel, silver, stone.
Lincoln	237	W	Sand and gravel.
Lyman	W	W	Do.
McCook	W	W	Do.
McPherson	234	W	Do.
Marshall	189	433	Do.
Meade	W	363	Sand and gravel, gypsum.
Mellette	154	W	Sand and gravel.
Miner	W	7	Do.
Minnehaha	W	W	Sand and gravel, stone.
Moody	166	157	Sand and gravel.
Pennington	8,503	12,313	Cement, stone, sand and gravel, lime, clays, mica (scrap), beryllium concentrate, feldspar.
Perkins	155	294	Sand and gravel.
Potter	W	W	Do.
Roberts	91	257	Do.
Sanborn	4	4	Do.
Shannon	34	35	Do.
Spink	W	W	Do.
Stanley	W	W	Do.
Sully	60	W	Do.
Todd	11	69	Do.
Tripp	W	138	Sand and gravel, stone.
Turner	W	W	Sand and gravel.
Union	W	134	Do.
Walworth	14[illegible]	W	Do.
Washabaugh	W	W	Do.
Yankton	176	W	Do.
Ziebach	--	65	Do.
Undistributed[3]	26,173	21,982	
Total[4]	61,676	62,988	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Haakon, Bennett, and Jackson Counties not listed because no production was reported.

[2] Less than ½ unit.

[3] Includes sand and gravel, and stone that cannot be assigned to specific counties, gem stones, and values indicated by symbol W.

[4] Data may not add to totals shown because of independent rounding.

15196898

TABLE A-75. PRINCIPAL MINERAL PRODUCERS OF SOUTH DAKOTA

Commodity and company	Address	Type of activity	County
Beryllium:			
Jack Pendleton	Custer, S. Dak. 57730	Open pit	Pennington.
John Carter	608 St. Cloud Rapid City, S. Dak. 57701	do	Do.
L. W. Judson	Hermosa, S. Dak. 57744	*See* Mica	Do.
Merle Chase	do	Open pit	Do.
Cement:			
South Dakota Cement Commission.	Drawer 351 Rapid City, S. Dak. 57701	Wet-process, 3-rotary-kiln plant.	Do.
Clays:			
American Colloid Co.	5100 Suffield Ct. Skokie, Ill. 60076	Open pit mine and plant	Butte.
Light Aggregates, Inc.	Box 1922 Rapid City, S. Dak. 57701	do	Pennington.
South Dakota Cement Commission.	Drawer 351 Rapid City, S. Dak. 57701	Open pit mine	Do.
Feldspar:			
George Bland	Custer, S. Dak. 57730	2 open pit mines	Custer.
International Minerals & Chemical Corp., Industrial Minerals Division.	Administration Center Old Orchard Rd. Skokie, Ill. 60079	4 open pit mines and dry-grinding plant.	Do.
Gold:			
Homestake Mining Co.	Lead, S. Dak. 57754	Underground mine, cyanidation mill, and refinery.	Lawrence.
Gypsum:			
South Dakota Cement Commission.	Drawer 351 Rapid City, S. Dak. 57701	Open pit mine	Meade.
Lime:			
Pete Lien & Sons	Box 3124, P.O. Annex Rapid City, S. Dak. 57703	1-rotary-kiln, 1-vertical-kiln, continuous-hydrator plant.	Pennington.
Mica (scrap):			
L. W. Judson	Hermosa, S. Dak. 57744	Open pit mine	Do.
Northwest Beryllium Corp.	218-219 American National Bank Bldg. Rapid City, S. Dak. 57701	Stockpile	Do.
Petroleum:			
The Ozark Corp.	Box 2491 Casper, Wyo. 82601	Crude oil wells	Custer (Barker Dome field).
Pennzoil United, Inc.	900 Southwest Tower Houston, Tex. 77002	do	Harding (Buffalo field).
Phillips Petroleum Co.	Frank Phillips Bldg. Bartlesville, Okla. 74003	do	Do.
Sand and gravel (commerical):			
Aggregates, Inc.	Selby, S. Dak. 57472	Pit and plant	Lawrence.
Concrete Materials Co.	3000 West Madison St. Sioux Falls, S. Dak. 57104	Pit and 2 plants	Minnehaha.
F. J. McLaughlin Co.	Watertown, S. Dak. 57201	do	Codington.
Floyd Oberg & Sons Construction Co.	Colton, S. Dak. 57018	Pit	Minnehaha.
		Pit	Spink.
Hallett Construction Co.	Crosby, Minn. 56441	2 pits and plants	Codington.
L. G. Everist, Inc.	302 Paulton Bldg. Sioux Falls, S. Dak. 57102	Pit and plant	Brookings.
		do	Pennington.
Pickus Construction Co.	Box 1414 Aberdeen, S. Dak. 57401	do	Brown.
Tom Luke Construction	Kimball, S. Dak. 57335	3 pits	Brule.
		3 pits and plant	Davison.
		2 pits	Douglas.
		3 pits	Lyman.
Silver:			
Homestake Mining Co.	Lead, S. Dak. 57754	*See* Gold	Lawrence.
Stone:			
Cold Spring Granite Co.	Cold Spring, Minn. 56320	2 quarries	Grant.
Concrete Materials Co.	3000 West Madison Street Sioux Falls, S. Dak. 57104	Quarry and plant	Minnehaha.
Dakota Granite Co.	Box 269 Milbank, S. Dak. 57252	2 quarries	Grant.
Delano Granite Works, Inc.	Delano, Minn. 55328	Quarry	Do.
Hills Materials Co.	Box 1392 Rapid City, S. Dak. 57701	Quarry and plant	Pennington.
L. G. Everist, Inc.	302 Paulton Bldg. Sioux Falls, S. Dak. 57102	Quarry and plant	Minnehaha.
		do	Pennington.
Pete Lien & Sons	Box 3124, P.O. Annex Rapid City, S. Dak. 57703	do	Do.
Robert Hunter Granite Co., Inc.	Milbank, S. Dak. 57252	Quarry	Grant.
South Dakota Cement Commission.	Drawer 351 Rapid City, S. Dak. 57701	Quarry and plant	Pennington.
Spencer Quarries, Inc.	Spencer, S. Dak. 57374	Quarry	Hanson.
Steiner-Rausch Granite Co., Inc.	Ortonville, Minn. 56278	do	Grant.
Uranium:			
Susquehanna-Western, Inc.	Edgemont, S. Dak. 57735	Underground mine	Fall River.
Mines Development, Inc.	do	Acid-leach mill	Do.

Tennessee

The Unaka Mountains on the eastern border of Tennessee and the Valley and Ridge province immediately to the west of the Unakas contain abundant metamorphosed formations. These metamorphosed sedimentaries are of Cambrian and Precambrian age and originally were conglomerates, sandstones, shales, and occasional limestone or dolomite formations. Locally, there are intrusive igneous rock bodies which are metadiorite and metagabbro in the Polk County area. The intrusives are possibly Paleozoic. Considerable mineralization is apparent in the metamorphic rock zone of eastern Tennessee in the counties ad identified on Figures A-58 and A-59. The important metal mines in the area are located in Polk (principally copper, with zinc, silver, and gold associated recovery - also, sulfur recovery from the smelter off gas and from pyrite), and Hancock, Knox, and Jefferson Counties (principally zinc with associated sulfur recovry operations). Mineralization has occurred also to the west of the metamorphosed region. For example, an important new zinc prospect is being developed in Smith county. Fluorite prospects also are associated with the zinc prospects of Smith County, as well as in localized sites to the east - into the metamorphic zone. Fibrous amphiboles are not reported from the mineralized sitesin Tennessee. The commodities being recovered in the numerous counties of Tennessee are summarized in Table A-76.

Source References

(1) Metamorphic Map of the Appalachians, B. A. Morgan, 1972, U.S.G.S. Map I-724.

(202) Geologic Map of Tennessee, East-Central Sheet, G. D. Swingle, et. al, 1966.

(203) Mineral Resources and Mineral Industries of Tennessee, W. D. Hardeman and R. A. Miller, 1959, Tennessee Department of Conservation and Commerce, Division of Geology.

(204) Tennessee Mineral Producers Directory, S. J. Hunter, 1973, Tennessee Division of Geology, Nashville, Tennessee 37219.

(2[illegible]5) The Mineral Industry of Tennessee, H. R. Babitzke et. al., U. S. Bureau of Mines' Minerals Yearbook.

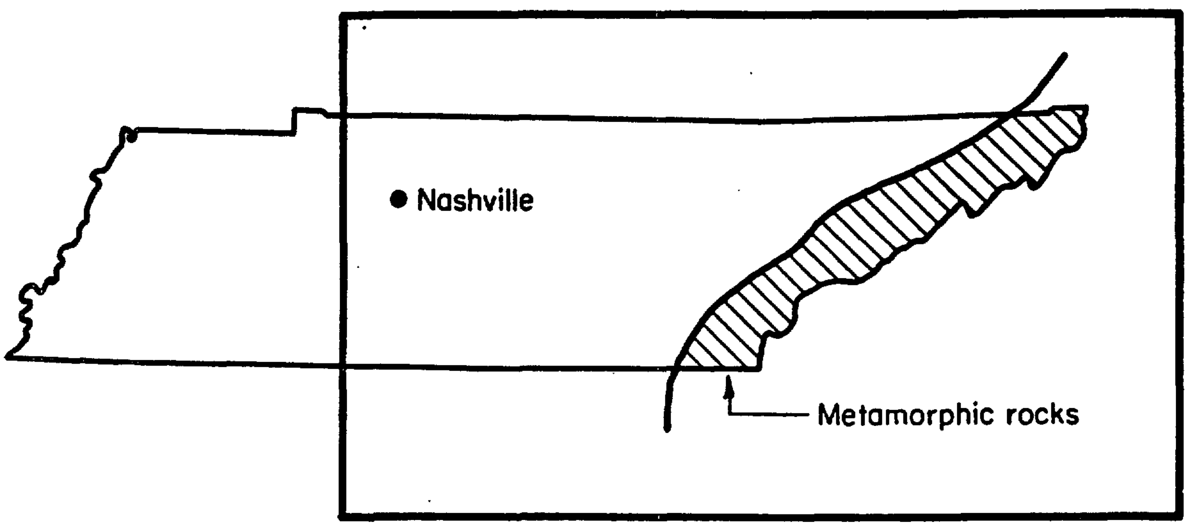

FIGURE A-58. OCCURRENCE OF METAMORPHIC ROCK IN TENNESSEE

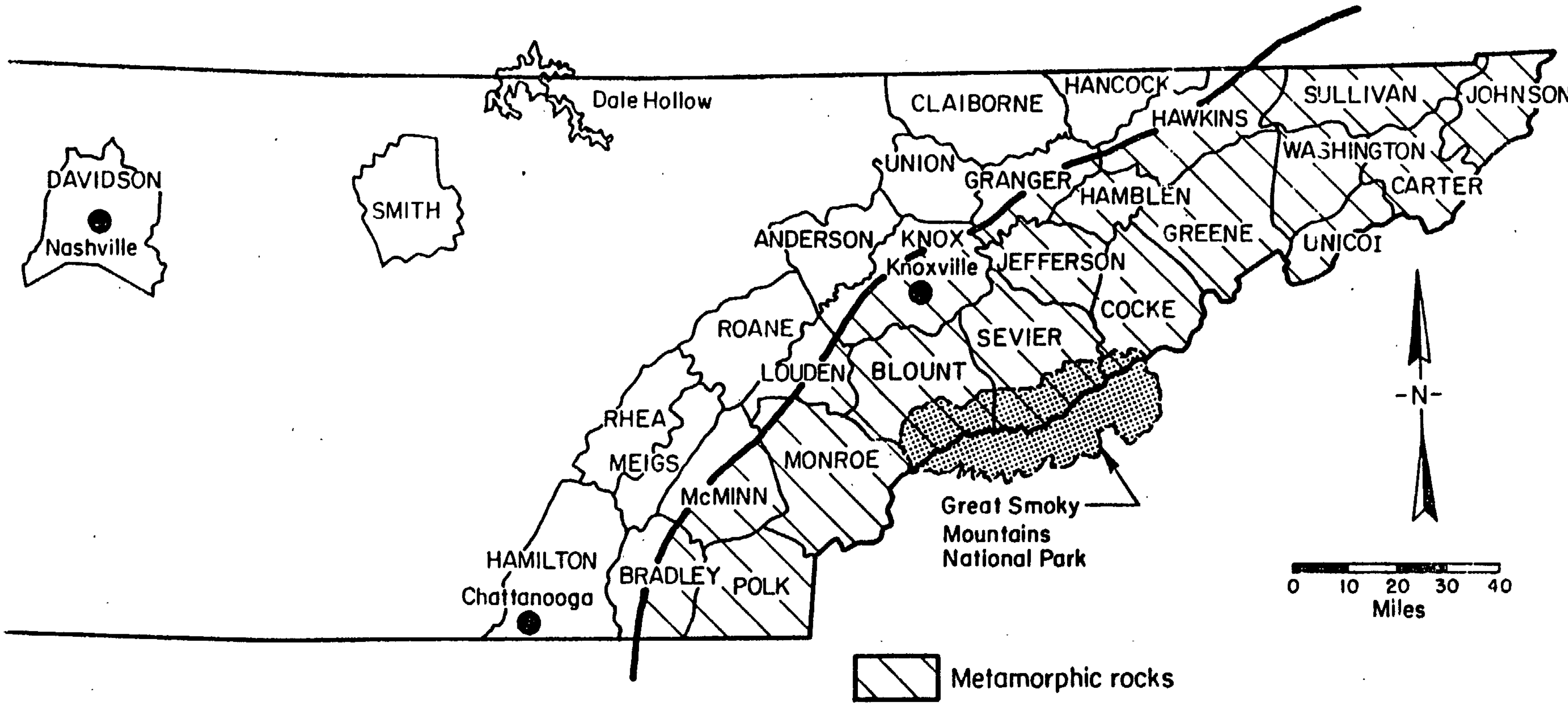

FIGURE A-59. METAMORPHIC ROCK DISTRIBUTION IN EASTERN TENNESSEE

Table A-76. Value of mineral production in Tennessee, by county [1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Anderson	W	W	Coal, stone.
Bedford	W	$420	Stone.
Benton	W	W	Sand and gravel, stone.
Bledsoe	W	216	Coal.
Blount	W	W	Stone.
Bradley	$1,697	W	Do.
Campbell	8,981	15,437	Coal, stone, sand and gravel.
Cannon	W	W	Stone.
Carter	W	W	Do.
Claiborne	W	12,826	Coal, stone, petroleum.
Clay	W	W	Stone, petroleum.
Cocke	W	--	
Coffee	W	W	Stone.
Cumberland	1,716	1,942	Stone, sand and gravel, coal.
Davidson	9,580	11,195	Cement, stone, clay.
Decatur	W	W	Stone, sand and gravel.
De Kalb	135	224	Stone.
Dickson	451	W	Do.
Fayette	55	W	Stone, sand and gravel.
Fentress	418	1,032	Coal, stone, petroleum.
Franklin	4,720	4,466	Cement, stone, sand and gravel, clay.
Gibson	W	W	Sand and gravel.
Giles	1,519	1,224	Phosphate rock, stone, sand and gravel.
Grainger	146	143	Stone.
Greene	W	W	Stone, sand and gravel.
Grundy	W	W	Coal, sand and gravel, stone.
Hamblen	W	W	Stone.
Hamilton	18,745	16,087	Cement, stone, sand and gravel, coal, clay.
Hancock	W	W	Zinc, stone.
Hardeman	W	W	Sand and gravel.
Hardin	W	W	Sand and gravel, stone.
Hawkins	W	W	Stone.
Haywood	--	7	Sand and gravel.
Henderson	W	W	Do.
Henry	3,564	W	Clay.
Hickman	W	W	Phosphate rock.
Humphreys	W	W	Stone, sand and gravel.
Jefferson	25,040	26,911	Zinc, stone.
Johnson	W	W	Stone.
Knox	23,966	20,132	Cement, zinc, stone, lime, sand and gravel, clay.
Lauderdale	W	74	Sand and gravel.
Lincoln	W	W	Stone.
Loudon	421	408	Barite, clay, stone, sand and gravel.
McMinn	726	444	Sand and gravel, stone, barite.
McNairy	W	W	Sand and gravel.
Macon	W	W	Stone.
Marion	W	W	Coal, cement, stone.
Marshall	W	W	Stone.
Maury	6,679	W	Phosphate rock, stone.
Meigs	W	W	Stone.
Monroe	W	W	Stone, barite, sand and gravel.
Montgomery	W	W	Stone.
Moore	W	W	Do.
Morgan	2,312	2,820	Coal, petroleum, natural gas.
Obion	W	W	Sand and gravel.
Overton	78	W	Stone, petroleum.
Perry	W	W	Sand and gravel.
Pickett	24	71	Stone, petroleum.
Polk	W	23,782	Copper, pyrites, zinc, silver, sand and gravel, gold.
Putnam	1,720	2,097	Stone, coal, sand and gravel.
Rhea	W	W	Stone, clay.
Roane	W	W	Stone, coal.
Robertson	W	W	Stone, petroleum.
Rutherford	1,097	946	Stone.
Scott	3,473	4,516	Coal, petroleum, natural gas.
Sequatchie	W	W	Coal, stone.
Sevier	606	W	Stone, sand and gravel.
Shelby	810	2,178	Sand and gravel.
Smith	W	81	Stone.
Stewart	W	W	Do.
Sullivan	W	W	Cement, stone, clay.
Sumner	W	W	Stone.
Tipton	W	W	Sand and gravel.
Unicoi	W	W	Sand and gravel, stone.
Union	135	1,140	Stone.
Van Buren	1,858	1,095	Coal.
Warren	W	W	Stone, natural gas.
Washington	W	W	Stone, sand and gravel, clay.
Wayne	W	W	Sand and gravel, stone.
Weakley	W	W	Clay.
White	W	W	Stone, coal.
Williamson	W	W	Stone, phosphate rock.
Wilson	W	W	Stone.
Undistributed	$104,793	$87,723	
Total [3]	220,465	[2] 239,662	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] The following counties are not listed because no production was reported: Carroll, Cheatham, Chester, Crockett, Dyer, Houston, Jackson, Lake, Lawrence, Lewis, Madison, and Trousdale.

[2] Includes values indicated by symbol W.

[3] Data does not add to total shown because of independent rounding.

15196903

Texas

There are two areas in Texas wherein igneous and metamorphic rocks may be found: west Texas and central Texas as shown in Figure A-60. Precambrian igneous rocks and metamorphosed rock of several ages are locally exposed. There is considerable mineral wealth in both the West Texas and the Central Mining Districts, although exploitation of the wealth is at a moderately slow pace. The commodities being produced in the two districts are given in Table A-77. Talc is the principal value mineral in Hudspeth County of the West Texas Mining District.

Talc, soapstaone, and asbestos are found in both the West and Central Texas Mining Districts. The principal localities for the occurrences are marked on the map figure and are described in Table A-78.

TABLE A-77. PRINCIPAL MINERAL PRODUCTION IN ASBESTIFORM AREAS OF TEXAS

County	Commodities
West Texas Mining District	
Culberson	Fossil fuels, sulfur, stone, talc
Hudspeth	Talc, gypsum, stone, fossil fuels
Jeff Davis	None produced
Presidio	Mercury (inactive mine)/gold
Brewster	Clays, fluorspar, mercury (inactive mine)
Central Mining District	
Blanco	Sand and gravel
Burnet	Stone, graphite, sand and gravel
Gillespie	Gypsum, soapstone, stone, sand and gravel
Lampasas	Sand and gravel
Llano	Stone, sand and gravel
Mason	Sand and gravel
Sam Sabamn	Stone

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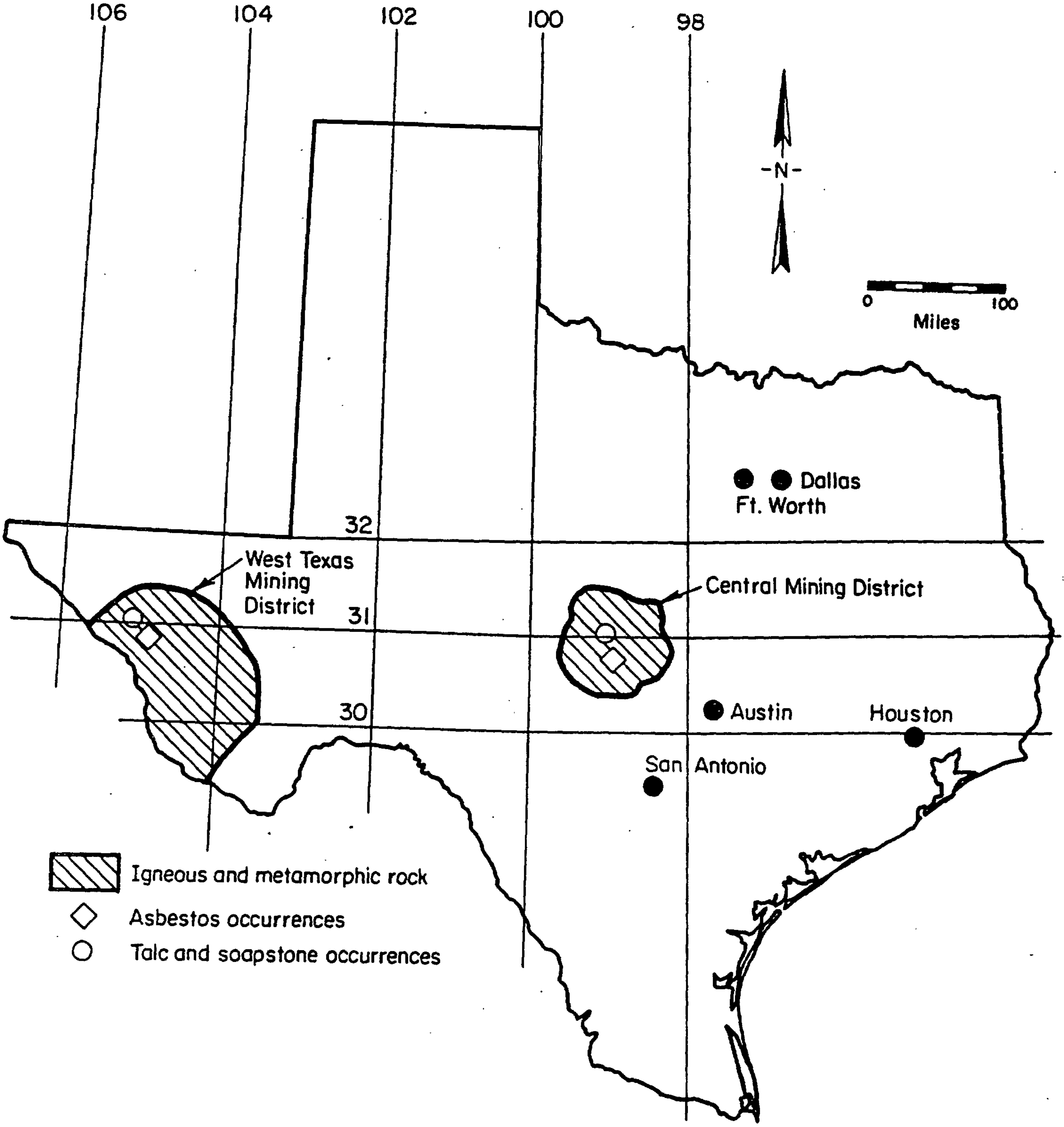


FIGURE A-60. OCCURRENCE OF IGNEOUS AND METAMORPHIC ROCK IN TEXAS

15196905

TABLE A-78. ASBESTOS, TALC, AND SOAPSTONE OCCURRENCES IN TEXAS

Asbestos

Llano County		
1. Rode. Long brittle fibers of tremolite asbestos in vein in shear zone between hornblendite and mica-quartz schist.	30°30'	98°56'
2. Crab Apple Creek. Small deposit of tremolite (?) asbestos.	30°30'	98°46'
3. Oxford. Small deposit of amphibole asbestos.	30°37'	98°42'
Blanco County		
4. Coal Creek. Several small deposits of tremolite asbestos in serpentine.	30°29'	98°33'

Talc and Soapstone

Allamoore district. Deposits consist of talc rock in interbedded phyllites, volcanic rocks, and carbonate rocks of Precambrian age. The deposits were probably derived from dolomitic beds or magnesium-rich volcanic rocks. Flawn, 1958; King and Flawn, 1953.

1. Southwestern No. 4 and Rossman mines.	31°09'	105°10'
2. Glen Ray prospect.	31°10'	105°07'
3. Milwhite mine and Escondido prospects.	31°09'	105°05'
4. Section 18 prospect.	31°08'	105°01'
5. Lone Star, Texas Talc, and Southern Clay mines.	31°07'	105°00'
6. Buck Spring prospect.	31°06'	104°57'

Llano district. Deposits consist of soapstone associated with serpentinite derived from ultramafic igneous rocks, but many small bodies are isolated in schist or gneiss near serpentinite bodies. Barnes, 1952; Barnes and others, 1950; Dietrich and Lonsdale, 1958.

7. Bratton Ranch area.	30°56'	99°20'
8. Esbon School and Rough Mountain areas.	30°50'	98°54'
9. Llano area.	30°46'	98°42'
10. Graphite area	30°45'	98°32'
11. Oxford area	30°36'	98°42'
12. Sandy Mountain area.	30°37'	98°28'
13. Keener Brook and Crabapple Creek West areas.	30°31'	98°47'
14. Crabapple Creek East and Legion Creek areas.	30°29'	98°44'
15. Cedar Mountain and Comanche Creek areas.	30°31'	98°35'
16. Youngblood Creek, Coal Creek, and Big Branch areas.	30°26'	98°36'

15196906

(Localities are given in terms of North Latitude and West Longitude)

The Allamore District, chiefly in Hudspeth County, but extending eastward into Culberson County (west Texas) is worked for the recovery of talc rock by several companies as described below.

Texas Talc Company, Allamoore, Texas 79829

Pioneer Talc Company, Chatsworth, Georgia 30705

Southern Clay Products, Inc., P.O. Box 44, Gonzales, Texas 78629

The United Sierra Division, Cyprus Mines Corporation, P. O. Box 1201, Trenton, New Jersey 08606

Westex Talc Company, P. O. Box 15038, Houston, Texas 77020

Milwhite Company, Inc., Houston, Texas 77020

Collectively, the talc producers of this area had an annual production of over 160,000 tons in 1968 (increasing annually) and tens of millions of tons are in near-surface reserves. The talc rock is locally ground and shipped for use in products such as roofing material and fillers for insecticides, paint, rubber, and plastics.

Fibrous amphibole asbestos (variety called richterite which may be considered the alkali-rich [3.54 percent K_2O] analog of tremolite) is found in the same area and is locally present with talc. Some crocidolite also is found. Mafic igneous rocks which are probably diabase sills are plentiful in the area. The main richterite deposit is in a low hill of dolomite. Asbestos content ranges from a trace to up to about 75 percent. Slip-fiber asbestiforms generally predominate, but cross-fiber and bent-fiber forms are also common. Variable amounts of other minerals are closely associated with the richterite deposits. These include talc, tremolite, mica, actinolite, quartz dolomite, and a poorly crystallized layer of silicate. A company was formed in early 1971 by Albert Gregory (Van Horn Soapstone and Talc Corporation, Van Horn, Texas) to exploit the asbestos deposites of west Texas.

Asbestos, talc, and soapstone also are found in metamorphosed rock of the Central Mining District, chiefly in Gillespie, Blanco, and Llano Counties. The asbestos is principally tremolite and other asbestiform amphiboles although some chrysotile asbestos occurs locally. Soapstone is much more abundant than talc but most of the soapstone deposits contain intermixed talc and amphibole minerals among other diluents. Currently, the only production of any of these minerals appears to be minor amounts of a serpentine-soapstone type rock crushed for use as terrazzo chips.

The asbestiform minerals, talc and soapstone of the Central Mining District are closely related to the numerous serpentine rock bodies of the area. Originally, the serpentine bodies were mostly olivine. The serpentine masses lie within the Valley Spring gneiss and Packsaddle schist. It has been suggested that the olivine masses were emplaced after the Valley Spring and Packsaddle formations (middle Precambrian) but before the Big Branch gneiss (also Precambrian). There is a wide variation in mineral suites from location to location within the known occurrences of the serpentine masses.

Elsewhere in Texas, no occurrences of the fibrous amphibole minerals in association with any of the mining or quarrying activities of the state, are reported.

Source References

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-31.

(206) Geological Highway Map of Texas, H. B. Renfro, 1962, Map. No. 7 The American Association of Petroleum Geologists and USGS, AAPG, P.O. Box 979, Tulsa, Oklahoma 74101.

(207) Asbestos in the Allamoore Talc District, Hudspeth and Culbertson Counties, Texas, R. G. Rohrbacher, 1973, Geological Circular 73-1, Bureau of Economic Geology, The University of Texas, Austin, Texas 78712.

(208) Utilization of Texas Sperpentine, V. E. Barnes, et. al., 1950, Publication No. 5020, Bureau of Economic Geology, University of Texas, Austin, Texas 78712.

(209) Building Stones of Central Texas, V. E. Barnes, et al., Publication No. 4246, Bureau of Economic Geology, University of Texas, Austin, Texas 78712.

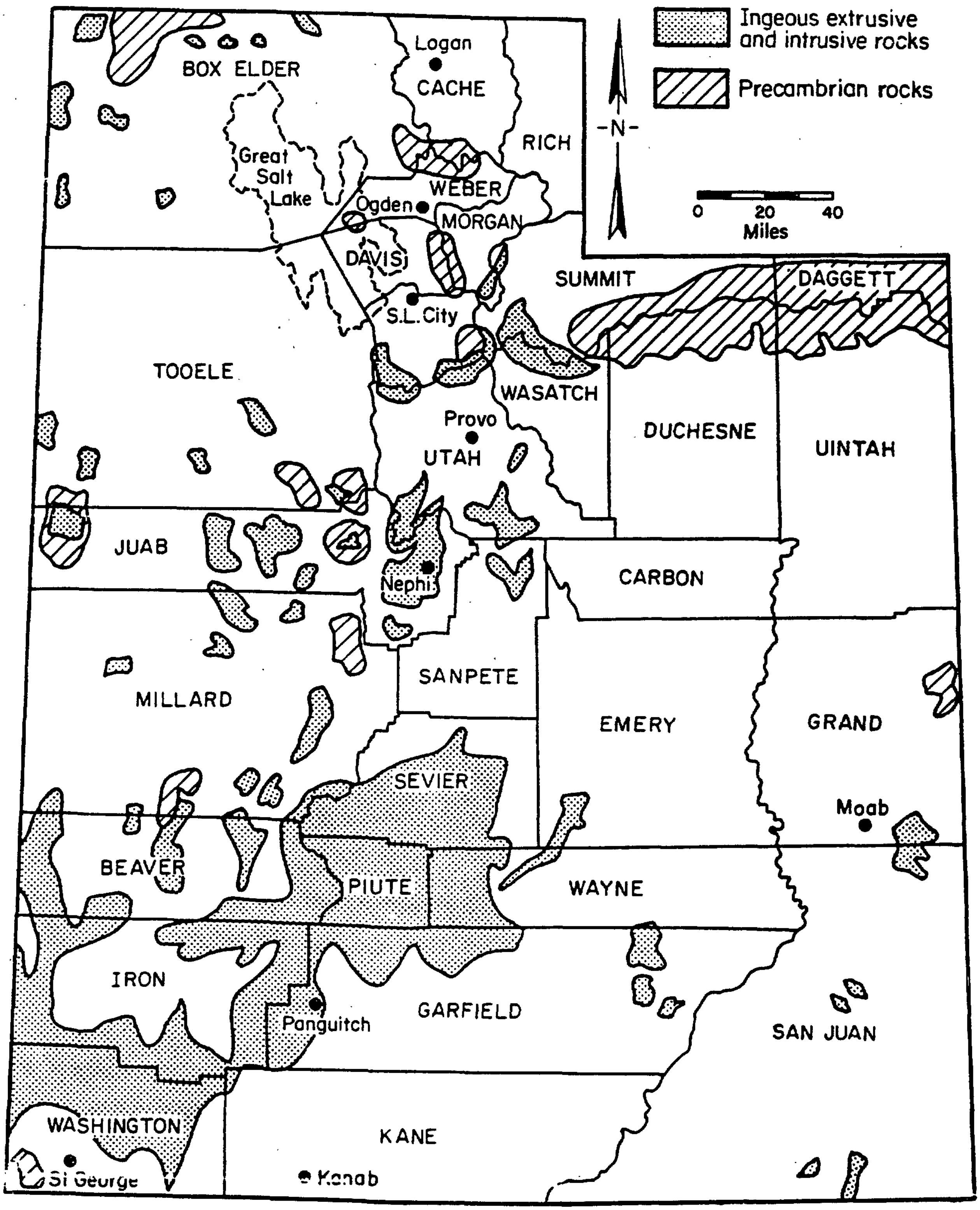
(210) The Mineral Industry of Texas, S. O. Wood, Jr., and R. Girard, 1971, U.S. Bureau of Mines' Minerals Yearbook.

Utah

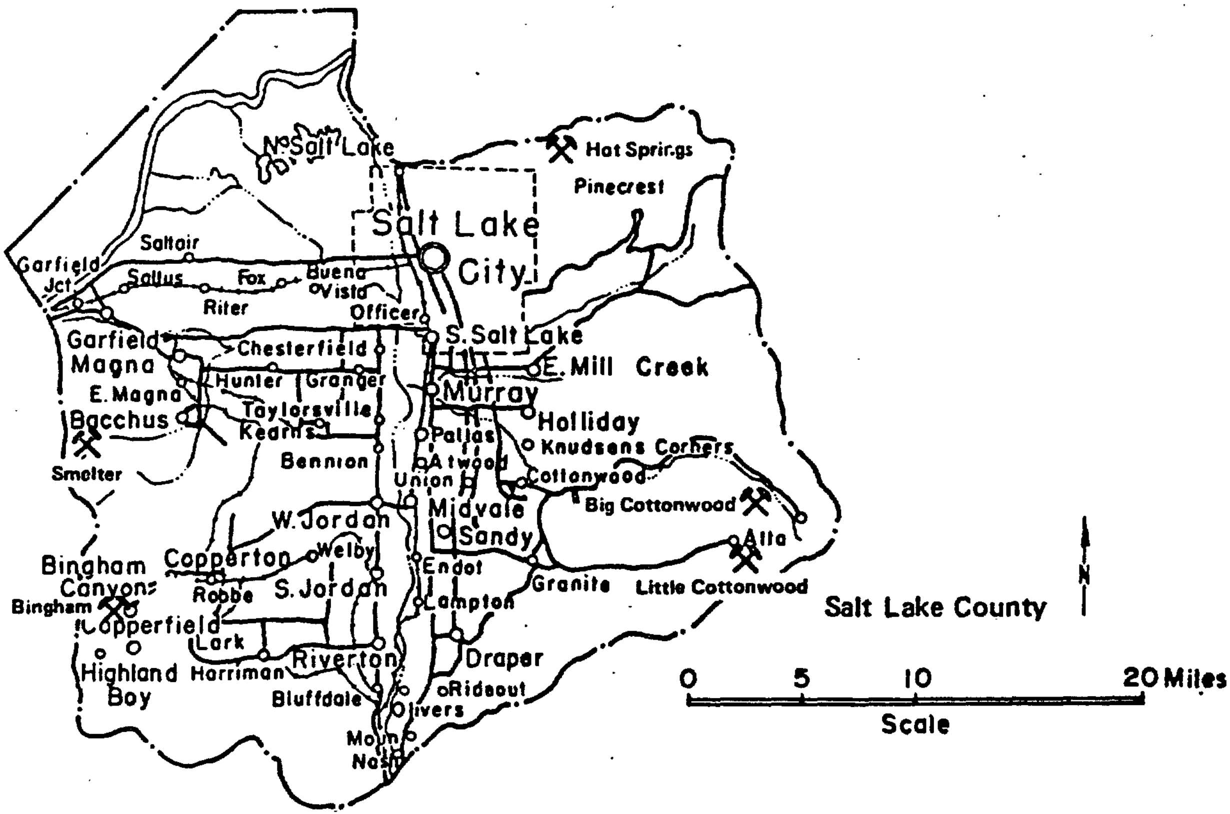
Numerous counties in the state of Utah are marked by the geologic occurrence of intrusive and extrusive igneous rocks. The major rock bodies of this type are located on Figure A-61. The occurrence of the Precambrian formations also are shown in the map figure. As shown in the figure, several of the igneous rock bodies occur within or adjacent to these rocks that have been metamorphosed to various degrees. Thus, most of the counties in Utah have extensive areas characterized by the presence of ancient metamorphic rocks or by younger metamorphism resulting from the igneous rock invasions. Further, there is not a single couny in Utah that does not have widespread mineralization of their rock formations. Somewhat surprisingly, however, mineralization is often found to be marginally concentrated so that economical mining activity is not as profuse in Utah as might be surmized from a general geologic assessment.

The center of the mining activity in Utah is in Salt Lake County. Production is chiefly of the metallics, copper, molybdenum, gold, silver, lead, and zinc. Nonmetallic operations are extensive also, chiefly cement, sand and gravel, lime, and stone, since these domestic industrial minerals are required by the large number of people in this county. A detail map of Salt Lake County (Figure A-62 is presented which shows the areal extent of the operations. This map is keyed to the tabulation of commodities and operations of Salt Lake County, as listed in Table A-79.

The counties adjacent to Salt Lake County, Tooele, Utah, Wasatch, Summit, Morgan, and Davis are mineral producers also. The small production from Davis and Morgan Counties is limited to the recovery of stone, sand and gravel. A large production of the metallic minerals occurs in the other adjacent counties of Tooele, Utah, Wasatch, and Summit. However, the associate minerals from these operations are not reported. Elsewhere, there is considerable mineral production from the counties of Juab, Iron, Garfield, Emery, Uintah (principally fossil fuels), Grand, and San Juan. A summary of the principal producers in Utah except for the fossil fuel processes, is given in Table A-80.


Ingeous extrusive and intrusive rocks
Precambrian rocks
-N-
0 20 40
Miles
BOX ELDER
Logan
CACHE
RICH
Great Salt Lake
WEBER
Ogden
MORGAN
DAVIS
SUMMIT
DAGGETT
S.L.City
TOOELE
WASATCH
Provo
UTAH
DUCHESNE
UINTAH
JUAB
Nephi
CARBON
MILLARD
SANPETE
EMERY
GRAND
SEVIER
Moab
BEAVER
PIUTE
WAYNE
IRON
Panguitch
GARFIELD
SAN JUAN
WASHINGTON
St George
KANE
Kanab

15196910



Location and Operators

Big Cottonwood Mining District
- International Pipe & Ceramics
- Big Cottonwood Sand & Gravel Co.
- A. J. Dean & Sons
- Dan R. Fogle
- Harris Bethers Constr. Co.
- Walker Sand & Gravel Co.

Bingham Mining District
- U-V Industries Co.
- Kennecott Copper Corp.

Draper
- Draper Sand & Gravel

Holladay
- A & L Concrete
- Harper-Jackson Sand & Gravel
- South East Sand & Gravel

Hot Springs Mining District
- Portland Cement Co.
- Merrico Inc.

Kearns
- Breitling Bros. Constr. Co.
- D. W. Brimhall Co.

Location and Operators

- Pioneer Sand & Gravel
- Sorensen Sand & Gravel
- Utah Sand & Gravel Products
- Snider Rock Products

Little Cottonwood Mining District
- J. J. Beeson

Midvale
- Armin A. Rosenhan

Murray
- White Concrete Products, Inc.
- Beehive Sand & Gravel

North Salt Lake City
- Chapman & Chapman
- Gibbons & Reed Co.
- P. C. Kimball
- Utah Sand & Gravel Products

Salt Lake City
- Filtrol Corporation
- Acme Lite Wate Products, Inc.
- Morton Salt Company
- W. W. Clyde

Location and Operators

- Cox Bros. Constr. Co.
- Gardner, Inc.
- Geneva Rock Products
- Prince Block Co.
- Utah Sand & Gravel Products
- Vermiculite-Intermountain Inc.

Sandy
- Wilford H. Hansen
- R. Whitmore
- Asphalt Products, Inc.

Smelter Mining District
- International Smelting & Refining
- Kennecott Copper Corp.
- England Constr. Co.
- M & M Constr. Co.

South Salt Lake City
- Geneva Rock Products

West Jordan
- Salt Lake Valley Sand & Gravel

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FIGURE A-62. MINERAL OPERATIONS IN SALT LAKE COUNTY, UTAH.

TABLE A-79. Mineral Commodities and Operators, Salt Lake County, Utah
(From: Utah Mineral Industry Operator Directory)

Commodity	Name of property	Location	Operator/address	Production *
Cement rock	Parley's Canyon quarry	Sec. 24, T1S–R1E Hot Springs mining district Parley's Canyon limestone quarry and cement plant	Portland Cement Co. 615 W. 8th S. Salt Lake City, Utah 84104	NC
Cement rock	White Concrete products	Murray	White Concrete Products, Inc. 219 W. Central Ave. Murray, Utah 84107	NW
Clay, fireclay, quartzite	Cottonwood Clay pits Circle "M" Nos. 1 and 2	Sec. 24, T2S–R1E Big Cottonwood mining district	International Pipe and Ceramics Corp. c/o Interpace Corp. 260 Cherry Hill Road Parsippany, New Jersey 07054	NW
Copper, gold, lead, silver	Wasatch mine	SW Sec. 6, T3S–R3E Little Cottonwood mining district	Beeson Exploration Joseph J. Beeson, Pres. 875 Donner Way Salt Lake City, Utah 84108	A
Copper, lead, silver	Cleanup	Midvale	Armin A. Rosenhan 750 E. 6400 S. Midvale, Utah 84047	O
Copper, lead, silver, zinc	Murray [illegible] dump	SE Sec. 12, T2S–R1W SW Sec. 7, T2S–R1W Smelter mining district	International Smelting and Refining Co., L. J. Eliason, Pres. R. F. D. No. 1 Tooele, Utah 84074	NW
Copper, lead, silver, zinc	Butterfield mine	SW Sec. 29, T3S–R2W West Mountain (Bingham) mining district	U-V Industries Co. (U. S. Smelting, Refining and Mining Co.) University Club Bldg., Salt Lake City, Utah 84110	C
Gold, silver, copper, lead, zinc	Cardiff mine	T3S–R3E Little Cottonwood mining district	Beeson Exploration Joseph J. Beeson, Pres. 875 Donner Way Salt Lake City, Utah 84108	W
Gold, silver, copper, molybdenite, molybdic oxide, ammonium perrhenate, sulfuric acid, platinum, palladium, bismuth, selenium, lead, nickel	Utah Copper mine	SW Sec. 26, T3S–R3W Bingham district West Mountain (Bingham)	Kennecott Copper Corp. Utah Copper Division P. O. Box 11299 Salt Lake City, Utah 84111	C
Gold, silver, copper, lead, zinc, pyrites	U. S. and Lark mine	SW Sec. 29, T3S–R2W West Mountain (Bingham)	U-V Industries Co. (U. S. Smelting, Refining and Mining Co.), University Club Bldg., Salt Lake City, Utah 84111	O
Granite (dimension)	Peoa Stone quarry	T3S–R1W 8809 S 600 W Sandy	Wilford H. Hansen Stone Quarries, Inc. P. O. Box 86 Sandy, Utah 84070	NO
Granite	Temple granite quarry and plant	SE NE Sec. 12, T3S–R1E Wasatch Resort Sandy	R. Whitmore 430 E. South Temple Salt Lake City, Utah 84110	NW
Halloysite	Halloysite Process plant	Salt Lake City	Filtrol Corp. 2580 Andrew Ave. Salt Lake City, Utah 84115	NW
Limestone	Chapman pits	SW SW Sec. 13, T1S–R1E North Salt Lake	Chapman and Chapman 535 S. 2nd E. No. 515 Salt Lake City, Utah 84111	NO

* See [illegible] key to production symbols.

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TABLE A-79.(continued)

Commodity	Name of property	Location	Operator/address	Production
Limestone, lime, stone (dimension)	Salt Lake City limekiln	SW Sec 17, T1S–R3W Smelter mining district	Kennecott Copper Corp. Utah Copper Division P. O. Box 11299 Salt Lake City, Utah 84110	NB
Perlite	UTCO	Salt Lake City	Acme Lite Wate Products, Inc. 330 Hartwell Ave. Salt Lake City, Utah 84111	NW
Salt	Saltair plant	Secs. 5 and 6, T1S–R2W Saltair Salt Lake City	Morton Salt Company 110 N. Wacker Dr. Chicago, Ill. 60606 *Also:* 1545 S. 1100 E. Salt Lake City, Utah 84105	NC
Sand, gravel	A and L gravel pits	Sec. 23, T2S–R1E 6400 S. 3010 E. Holladay	A and L Concrete Co. 67 E. 8000 S. Sandy, Utah 84047	NW
Sand, gravel	Asphalt Products pits	Sec. 1, T3S–R1E Sandy	Asphalt Products, Inc. 1820 Beck St. Salt Lake City, Utah 84116	NO
Sand, gravel	Beehive sand and gravel pits	Sec. 28, T2S–R1E 15th E. 70th S. Murray	Beehive Sand and Gravel P. O. Box 7253 Murray, Utah 84117	NC
Sand, gravel	Big Cottonwood gravel pits	SE Sec. 14, T2S–R1E Cottonwood Big Cottonwood mining district	Big Cottonwood Sand and Gravel Co. 6695 S. Wasatch Blvd. Salt Lake City, Utah 84121	NC
Sand, gravel	Kearns gravel pits	SW Sec. 4, T2S–R1W 4537 S. 3200 W. Kearns	Breitling Bros. Constr. Co. 3645 S. Wasatch Blvd. Salt Lake City, Utah 84104	NC
Sand, gravel	Brimhall gravel pits	NE Sec. 17, T2S–R1W 3200 W. 5600 S. Kearns	D. W. Brimhall Co. 17 E. 6150 S. Murray, Utah 84107	NO
Sand, gravel	Clyde pits	Salt Lake City	W. W. Clyde North Main P. O. Box 350 Springville, Utah 84663	NW
Sand, gravel	CPC Valley pits	2200 N. 1200 W., Salt Lake City 9400 S. 1125 E., Salt Lake City 3200 W. 5400 S., Salt Lake City 8000 S. 700 W., Bountiful 6901 Wasatch Blvd. Salt Lake City	Concrete Products Co. Divison of G and R Co., Hobusch Walker Whitehill and Tehem 41 West Central Ave. P. O. Box 7356 Murray, Utah 84107	NW
Sand, gravel	Cox Bros. pits	Salt Lake City	Cox Bros. Constr. Co. 50 E. 1 N. Manti, Utah 84642	NW
Sand, gravel	Dean and Sons pits	Big Cottonwood mining district	A. J. Dean and Sons 6695 S. Wasatch Blvd. Salt Lake City, Utah 84121	NW

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Table A-79. (continued)

Commodity	Name of property	Location	Operator/address	Production
Sand, gravel	Draper pits	Draper	Draper Sand and Gravel 11900 S. 1000 E. Draper, Utah 84020	NW
Sand, gravel	England Constr., sand and gravel pits	Smelter mining district	England Construction Co. P. O. Box 488 Tooele, Utah 84074	NB
Sand, gravel	Fogle gravel pit	Sec. 14, T2S–R1E 665 Big Cottonwood Canyon Road Big Cottonwood mining district	Dan R. Fogle Sand and Gravel Products 7817 S. 2000 E. Salt Lake City, Utah 84115	NW
Sand, gravel	Gardner pits	Salt Lake City	W. W. and W. B. Gardner, Inc. 1399 S. 7th E. Salt Lake City, Utah 84110	NW
Sand, gravel	Geneva rock products	South Salt Lake City	Geneva Rock Products Co. 350 W. 3900 S. Salt Lake City, Utah 84115	NC
Sand, gravel	North Salt Lake gravel pits	SE Sec. 23, T1N–R1W North Salt Lake City	Gibbons and Reed Co. Concrete Products Division P. O. Box 2429 Salt Lake City, Utah 84110	ND
Sand, gravel	Harper–Jackson gravel pits	SW SE Sec. 14, T2S–R1E ½ mile east 5800 Holladay Blvd. Holladay	Harper–Jackson Sand and Gravel 5909 Tolcate Lane Salt Lake City, Utah 84121	NW
Sand, gravel	Bethers Constr.	Big Cottonwood mining district	Harris Bethers Constr Co. P. O. Box 26 Heber, Utah 84032	NW
Sand, gravel	Kimball gravel pit	N Salt Lake City	P. C. Kimball 22 E. 400 S. North Salt Lake, Utah 84054	NW
Sand, gravel	M and M pit	Smelter mining district	M and M Construction Co. P. O. Box 981 Tooele, Utah 84074	NW
Sand, gravel	Pioneer sand and gravel pits	3200 W. 5600 S. Kearns	Pioneer Sand and Gravel Richard M. Savage, Pres. P. O. Box 18457 Salt Lake City, Utah 84118	NC
Sand, gravel	Prince gravel pit and plant	Salt Lake City	Prince Block Co. 170 W. 17th S. Salt Lake City, Utah 84115	NW
Sand, gravel	Welby pit	Salt Lake County gravel pit 165 Sugar St. Midvale 9000 S 5600 W. West Jordan	Salt Lake County Dept. of Roads and Bridges Rm. 205, City and Co. Bldg. Salt Lake City, Utah 84101	NW
Sand, gravel	valley [illegible] pit	Jordan Narrows Bluffdale	Salt Lake Valley Sand and Gravel Box E Sandy, Utah 84070	NW

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TABLE A-79.(continued)

Commodity	Name of property	Location	Operator/address	Production
Sand, gravel	Kearns gravel pits	SE SW Sec. 8, T2S-R1W 3616 W. 5400 S. Kearns	Sorensen Sand and Gravel Co. Leon G. Sorensen, Pres. Box 18545 Kearns, Utah 84118	NC
Sand, gravel	Key Industries, Inc. pits	NW Sec. 23, T2S--R1E 6500 Holladay Blvd. Holladay	South East Sand and Gravel Co. Box 17345 Salt Lake City, Utah 84117	NW
Sand, gravel	Kearns pit	6000 S. 5400 W. Kearns	Utah Sand and Gravel Products 1730 Beck Street P. O. Box 537 Salt Lake City, Utah 84116	NB
Sand, gravel	Stauffer pit	NE Sec. 23, T1N–R1W N Salt Lake	Utah Sand and Gravel Products 1730 Beck Street P. O. Box 537 Salt Lake City, Utah 84116	NC
Sand, gravel	Cottonwood Heights pit	NW Sec. 23, T2S–R1E 6637 S. 2300 E. Salt Lake City	Utah Sand and Gravel Products 1730 Beck Street P. O. Box 537 Salt Lake City, Utah 84116	NC
Sand, gravel	Walker gravel pits	SE Sec. 23, T2S–R1E 6950 S. Wasatch Blvd. Big Cottonwood mining district	Walker Sand and Gravel Co. Walker, J. B., Inc. 21 S. 10th W. Salt Lake City, Utah 84121	NC
Sand, gravel	Kearns pit	Kearns	George A. Wood Snider Rock Products 393 W. 48th S. Kearns, Utah 84118	NW
Stone (crushed)	Ute White quartzite quarry	Parleys Bluff Hot Springs mining district	Merrico, Inc. 5200 S. Main St. Salt Lake City, Utah 84107	NW
Vermiculite	Regional	Salt Lake City	Vermiculite–Intermountain Inc. 333 W. 1 S. Salt Lake City, Utah 84101	NW

Key to production symbols:

A 1-5000 tons

B 5000-50,000 tons

C 50,000-500,000 tons

D 500,000 tons or more

O No production

W Data withheld

N Prefixed to distinguish nonmetallic mineral data.

TABLE A-80. UTAH MINERAL COMMODITIES AND PRODUCERS (EXCEPT FOSSIL FUELS AND RELATED PRODUCTS)

Commodity and company	Address	Type of activity	County
Beryllium: Brush Wellman, Inc.	67 W. 2950 S. Salt Lake City, Utah 84115	Open pit mine; Chemical processing plant	Juab. Millard.
Carbon dioxide (natural):			
Equity Oil Co.	806 American Oil Bldg. Salt Lake City, Utah 84101	Well and plant, Farnham Dome field.	Carbon.
Cement:			
Ideal Cement Co., Div. of Ideal Basic Industries, Inc.[1]	420 Ideal Cement Bldg. Denver, Colo. 80202	Wet process, 2-rotary-kiln plant.	Morgan.
Portland Cement Co. of Utah.	Box 1469 Salt Lake City, Utah 84110	Wet process	Salt Lake.
Clays:			
Filtrol Corp	3250 E. Washington Blvd. Los Angeles, Calif. 90023	Open pit-underground mine.	Juab.
Interstate Brick Co	Box 6239 Salt Lake City, Utah 84106	Open pit mines	Sevier, Summit, Tooele, Utah.
Utelite Corp	R.F.D. Coalville, Utah 84017	Open pit mine and expanding plant.	Summit.
Western Clay & Metals Co.	1200 S. Atlantic Blvd. Alhambra, Calif. 91803	2 open pit mines	Sevier.
Copper:			
Hecla Mining Co	Box 320 Wallace, Idaho 83873	*See* Gold	Wasatch.
Kennecott Copper Corp., Utah Copper Division.	Box 11299 Salt Lake City, Utah 84111	Open pit mine, crusher, 2 flotation mills, precipitation plant, smelter, and electrolytic refinery.	Salt Lake.
United States Smelting Refining and Mining Co.	136 E. South Temple St. Salt Lake City, Utah 84111	*See* Lead	Do.
Fluorspar:			
Centennial Development Co.	Eureka, Utah 84628	Open pit and underground mines.	Juab.
Chesley & Black, Inc	Delta, Utah 84624	Open pit mine	Do.
Spor Bros	Box 276 Delta, Utah 84624	Open pit and underground mines.	Do.
Willden Fluorspar Co	Box 536 Delta, Utah 84624	Underground mine	Do.
Gold:			
Hecla Mining Co	Box 320 Wallace, Idaho 83873	Underground mine and flotation mill.	Wasatch.
Kennecott Copper Corp., Utah Copper Division.	Box 11299 Salt Lake City, Utah 84111	*See* Copper	Salt Lake.
United Park City Mines Co.	Star Route 1, Box 40 Heber City, Utah 84032	*See* Zinc	Summit.
United States Smelting Refining and Mining Co.	136 E. South Temple St. Salt Lake City, Utah 84111	*See* Lead	Salt Lake.
Gypsum:			
Georgia Pacific Corp., Gypsum Division.	P.O. Box 311 Portland, Oreg. 97207	Open pit mine and calcining plant.	Sevier.
United States Gypsum Co.	101 S. Wacker Drive Chicago, Ill. 60606	....do	Do.
Iron ore:			
CF&I Steel Corp	Box 1920 Pueblo, Colo. 80201	3 open pit mines	Iron.
United States Steel Corp., Western Ore Operations.	Lander, Wyo. 82520	Open pit mine	Do.
Utah Construction & Mining Co.	Box 649 Cedar City, Utah 84720	2 open pit mines, mobile crushing and screening plant, and beneficiation plant.	Do.
Lead:			
Deer Trail Mines & Arundel Mining Co.	1834 S. Woodside Dr. Salt Lake City, Utah 84172	*See* Zinc	Piute.
Hecla Mining Co	Box 320 Wallace, Idaho 83873	*See* Gold	Wasatch.
Kennecott Copper Corp., Tintic Division.	Box 250 Eureka, Utah 84628	*See* Zinc	Utah.
United Park City Mines Co.	Star Route 1, Box 40 Heber City, Utah 84032	....do	Summit.
United States Smelting Refining and Mining Co.	136 E South Temple St. Salt Lake City, Utah 84111	Underground mine and custom flotation mill.	Salt Lake.
United States Smelting Refining and Mining Co. (McFarland & Hullinger, lessee).	....do	Underground mine	Tooele.
Lime:			
The Flintkote Co., U.S. Lime Division.[1]	2244 Beverly Blvd. Los Angeles, Calif. 90057	2-shaft-kiln plant	Do.
Kennecott Copper Corp	Box 11299 Salt Lake City, Utah 84111	Lime kiln	Salt Lake.
Utah Marblehead Lime Co.[1]	300 W. Washington St. Chicago, Ill. 60606	Rotary-kiln plant	Do.
Magnesium chloride: Kaiser Aluminum & Chemical Corp., Bonneville, Ltd., Division.	300 Lakeside Drive Oakland, Calif. 94612	Solar evaporation	Do.
Molybdenum: Kennecott Copper Corp., Utah Copper Division.	Box 11299 Salt Lake City, Utah 84111	*See* Copper	Do.

TABLE A-80. (continued)

Commodity and company	Address	Type of activity	County
Phosphate rock:			
Stauffer Chemical Co.	636 California St. San Francisco, Calif. 94119	Open pit-underground mine.	Rich.
		Open pit mine and beneficiation plant.	Uintah.
Potassium salts:			
Great Salt Lake Minerals & Chemicals Corp.	Box 1190 Ogden, Utah	Brine processing plant.	Weber.
Kaiser Aluminum & Chemical Corp.	300 Lakeside Drive Oakland Calif. 94604	----do.	Tooele.
Texas Gulf Sulphur Co.	200 Park Ave. New York, N.Y. 10017	Underground mine and flotation refinery.	Grand.
Pumice: Thompson Block Co.	620 N. 400 W. Cedar City, Utah 84720	Open pit mine and crushing and screening plant.	Beaver.
		----do.	Iron.
Salt:			
Great Salt Lake Minerals & Chemicals Corp.	Box 1190 Ogden, Utah	Solar evaporation.	Weber.
Hardy Salt Co.	P.O. Drawer 449 St. Louis, Mo. 63166	----do.	Salt Lake.
Morton Salt Co. a division of Morton International, Inc.	110 N. Wacker Drive Chicago, Ill. 60606	Lake brine processing plant.	Do.
Solar Salt Co.	270 Crossroad Square Salt Lake City, Utah 84115	----do.	Tooele.
Sand and gravel:			
Breitling Bros. Construction, Inc.	3645 S. 500 W. Salt Lake City, Utah 84104	Pit and plant.	Salt Lake.
Construction Materials Corp., Savage Bros., Inc., Division.	R.F.D. 4, Box 611 American Fork, Utah 84003	----do.	Davis.
Dan R. Fogle Sand & Gravel Products.	350 Hartwell Ave. Salt Lake City, Utah 84115	Pit and 3 plants.	Salt Lake.
Gibbons & Reed Co., Concrete Products Co. Division.	41 W. Central Ave. Murray, Utah 84107	Pit and plant.	Davis.
		----do.	Salt Lake.
		----do.	Weber.
Pioneer Sand & Gravel.	3200 W. 6400 S. Granger Dr. Salt Lake City, Utah 84118	Pit and plant.	Salt Lake.
Sorensen Sand & Gravel.	Box 18545 Kerns, Utah 84118	----do.	Do.
Utah Sand & Gravel Products Corp.	Box 537 Salt Lake City, Utah 84110	3 pits and plants.	Do.
Selenium: Kennecott Copper Corp., Utah Copper Division.	Box 11299 Salt Lake City, Utah 84111	*See* Copper.	Do.
Silver:			
Deer Trail Mines & Arundel Mining Co.	1834 S. Woodside Dr. Salt Lake City, Utah 84172	*See* Zinc.	Piute.
Hecla Mining Co.	Box 320 Wallace, Idaho 83873	*See* Gold.	Wasatch.
Kennecott Copper Corp., Tintic Division	Box 250 Eureka, Utah 84628	*See* Zinc.	Utah.
Kennecott Copper Corp., Utah Copper Division.	Box 11299 Salt Lake City, Utah 84111	*See* Copper.	Salt Lake.
Kennecott Copper Corp. (Ben Dixon & Christie, lessee.)	----do.	Underground mine.	Do.
United Park City Mines Co.	Star Route 1, Box 40 Heber City, Utah 84032	*See* Zinc.	Summit.
United States Smelting Refining and Mining Co.	136 E. South Temple St. Salt Lake City, Utah 84111	*See* Lead.	Salt Lake.
United States Smelting Refining and Mining Co. (McFarland & Hullinger, lessee).	----do.	----do.	Tooele.
Stone:			
Le Grand Johnson Corp.	Box 248 Logan, Utah 84321	Quarry and plant.	Cache.
Portland Cement Company of Utah.	Box 1469 Salt Lake City, Utah 84110	----do.	Salt Lake.
Southern Pacific Railroad Co.	65 Market St. San Francisco, Calif. 94105	Quarry.	Box Elder.
United States Steel Corp., Western Ore Operations.	Lander, Wyo. 82520	Quarry and plant.	Utah.
Utah Marblehead Lime Co.	300 W. Washington St. Chicago, Ill. 60606	----do.	Tooele.
Uranium:			
Atlas Corp., Atlas Minerals Division.	Box 1207 Moab, Utah 84532	Underground mine.	Emery.
		Moab custom mill.	Grand.
		14 underground mines.	San Juan.
Homestake Mining Co.	Box 663 Moab, Utah 84532	Underground mine.	Do.
Lake Washburn Mining	720-26 Road Grand Junction, Colo. 81501	2 underground mines.	Do.
Zinc:			
Deer Trail Mines & Arundel Mining Co.	1834 S. Woodside Dr. Salt Lake City, Utah 84172	Underground mine.	Piute.
Hecla Mining Co.	Box 320 Wallace, Idaho 83873	*See* Gold.	Wasatch.
Kennecott Copper Corp., Tintic Division.	Box 250 Eureka, Utah 84628	2 underground mines.	Utah.
United Park City Mines Co.	Star Route 1, Box 40 Heber City, Utah 84032	----do.	Summit.
United States Smelting Refining and Mining Co.	136 E. South Temple St. Salt Lake City, Utah 84111	*See* Lead.	Salt Lake.
United States Smelting Refining and Mining Co. (McFarland & Hullinger, lessee).	----do.	----do.	Tooele.

The occurrence of asbestiform minerals in Utah is not well documented. Certainly there are a number of localities where the regional or contact metamorphism of a preferred country rock would favor the transformation to asbestiforms although not much is reported on such occurrences. One occurrence of asbestos is reported from a Mineral Resources document as being located in Millard County in the Autelope Mountain district (no current exploitation), but not even the type asbestos is described. Elsewhere, talc rock is mined at Ogden in Weber County (believed to be a minor recovery operation), and amphibole minerals are reported in association with a copper deposit in eastern Daggett County (not currently exploited). In view of the relative lack of information or lack of asbestiform mineral reporting and widely dispersed nature of the mining operations in sparsely populated localities, it would appear that the state of Utah is not of prime consideration in a further investigation of the present type. An area of possible exception is Salt Lake County.

Source Reference

(211) Geologic Map of Utah, Map No. 23, W. L. Stokes, et. al. (1961-1964), D. A. Andres and C. B. Hunt, (1948), Utah Geological and Mineralogical Survey, Salt Lake City, Utah, 84112.

(212) Mining Districts and Mineral Deposits of Utah, C. A. Hardirosian, 1966, Consulting Geologist, 521 Fifth Avenue, Salt Lake City, Utah.

(213) Industrial Minerals of Utah, H. H. Doelling, 1969, Utah Geological and Mineralogical Survey, Salt Lake City, Utah, 84112.

(214) Utah Mineral Industry Operator Directory, C. H. Stowe, [illegible], Bulletin No. 101, Utah Geological and Mineralogical Survey, Salt Lake City, Utah 84112

(215) The Mineral Industry of Utah, F. C. Mitko, 1971, U. S. Bureau of Mines' Minerals Yearbook.

Vermont

Metamorphism of the rocks found in Vermont is found in several stages of development. The metamorphic map (Figure A-63) shows the general zones of development. The local intensity of metamorphism, for example, in localities affected by localized plutonic activity, is not shown. Formations and zones generally trend north-south as indicated on the map. The rocks range in age from Precambrian to possibly middle triassic (some of the plutonic rocks). The rock types found include granites, gneisses, schists, slates, and marbles with a large assemblage of minerals characteristic of all stages of metamorphism.

Figure A-64, identifying counties, shows the approximate locations of the chrysotile asbestos, talc, and soapstone occurrences in Vermont. Table A-81 gives the locations of the talc and chrysotile asbestos occurrences by latitude and longitude. The occurrence pattern is seen to lie in a north-south trend line, generally aligned with the principal fold axes in formations of moderate degree of metamorphism. The mafic rocks in these areas are mainly greenstone schists with an actinolite amphibole constituent while the carbonate rocks contain talc, phlogopite, and tremolite amphibole. The fibrous amphibole minerals are commonly found in many of the Vermont rock formations.

Vermont is not known as a major mining state although some important production of talc and asbestos takes place there. Asbestos is produced from Orleans County (northern Vermont) and talc is produced in Lamoille (northern Vermont), Windham, and Windsor (southern Vermont) Counties. The balance of the mineral production is chiefly confined to recovery of stone, sand and gravel. These operations take place from all the counties of Vermont except Crand Isle County (Lake Champlain district). The principal producers of mineral commodities in Vermont are given in Table A-82, which also gives company addresses, descriptions of activity, and counties of operation. The extent to which the fibrous amphibole minerals are encountered in these various operations is not reported.

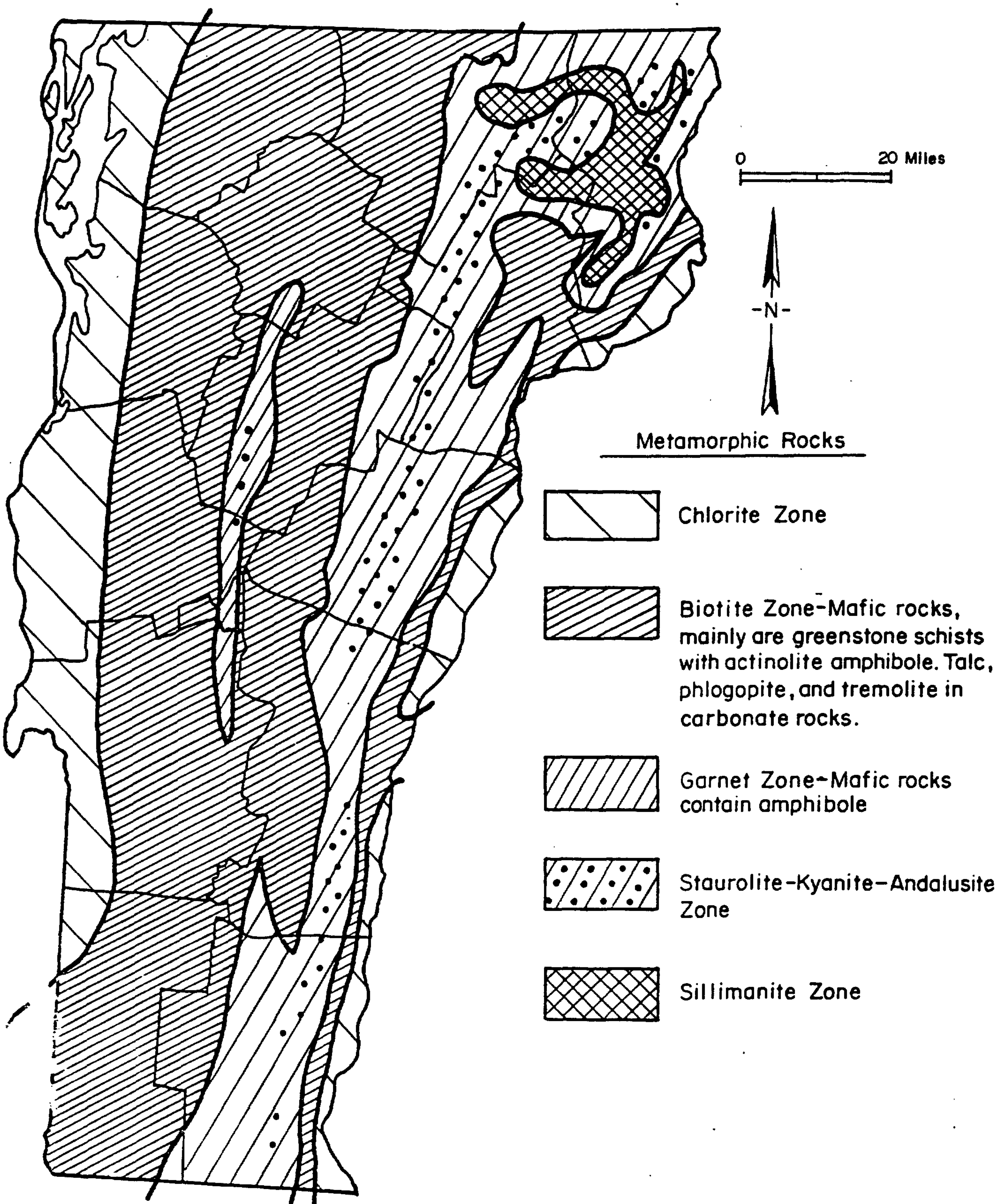

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FIGURE A-63. OCCURRENCE OF METAMORPHIC ROCK IN VERMONT

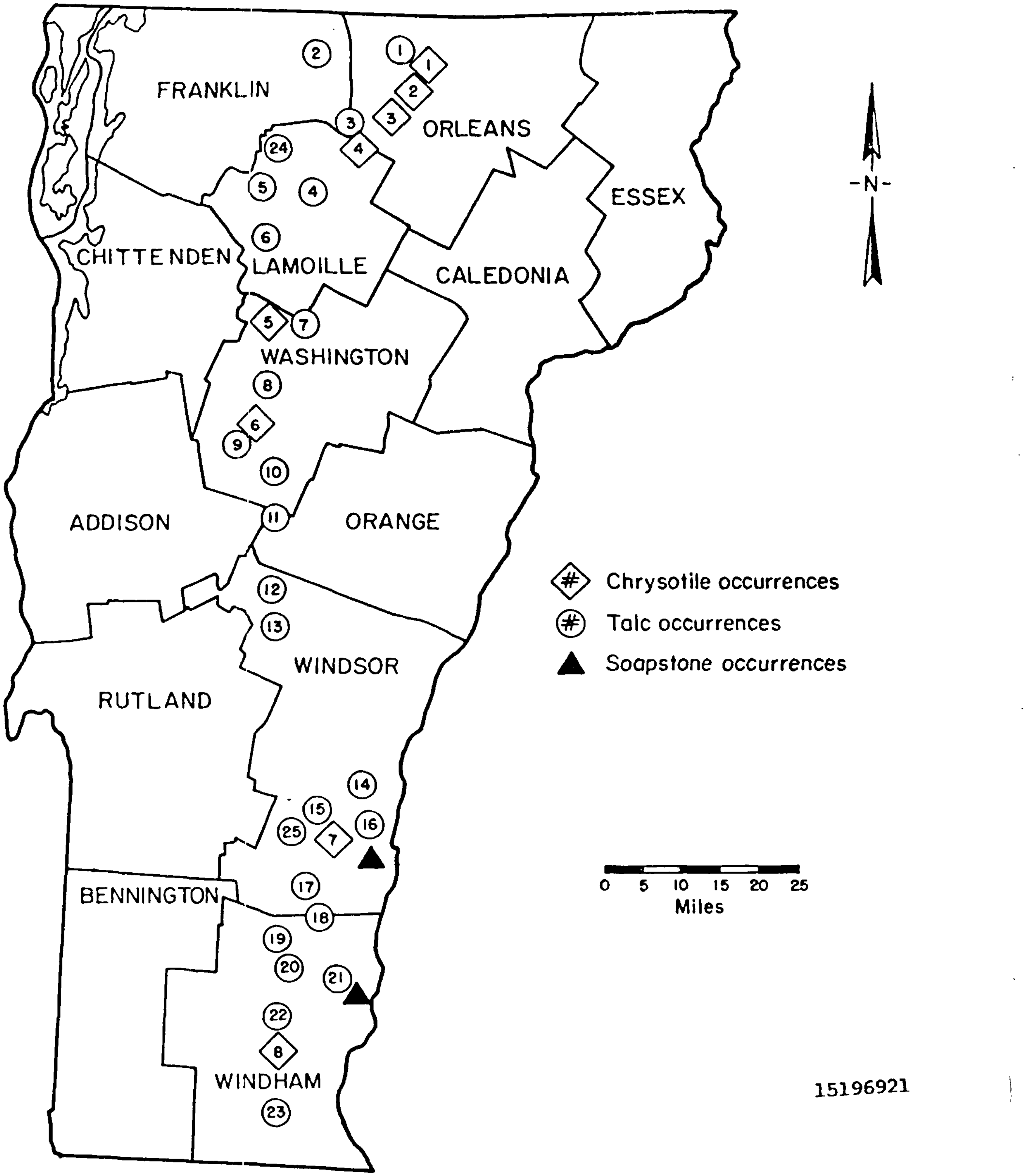

FIGURE A-64. OCCURRENCE OF CHRYSOTILE, TALC, AND SOAPSTONE IN VERMONT

TABLE A-81. ASBESTOS AND TALC DEPOSITS IN VERMONT

Asbestos

Orleans County

General references: Chidester and others, 1951; Pearre and Calkins, 1957.

1.	East Hill prospect. Cross- and slip-fiber chrysotile asbestos in serpentinite.	44°56'	72°23'
2.	Westfield prospects. Slip- and cross-fiber chrysotile in serpentinite.	44°53'	72°25'
3.	Lowell prospects. Slip- and cross-fiber chrysotile in serpentinite and relatively unserpentinized dunite and peridotite.	44°49'	72°27'

Lamoille and Orleans Counties

4.	Ruberoid-Belvidere Mountain area. Slip- and cross-fiber chrysotile in serpentinite and relatively unserpentinized dunite and peridotite. Bain, 1942; Chidester and others, 1951; Marsters, 1904, 1905; Pearre and Calkins, 1957.	44°46'	72°32'

Washington County

5.	Barnes Hill locality. Slip- and cross-fiber chrysotile in serpentinite. Chidester and others, 1952.	44°24'	72°41'
6.	Mad River locality. Slip- and cross-fiber chrysotile in serpentinite. Chidester and others, 1951.	44°14'	72°48'

Windsor County

7.	Ludlow area. Slip- and cross-fiber chrysotile in serpentinite and relatively unserpentinized dunite and peridotite. Chidester and others, 1951.	43°23'	72°39'

Windham County

8.	Dover area. Slip- and cross-fiber chrysotile in serpentinite and relatively unserpentinized dunite and peridotite. Chidester and others, 1951.	42°58'	72°46'

Talc

All deposits are associated with and chiefly derived from serpentinite. The deposits consist principally of talc-carbonate rock bordered by thin shells of talc rock. Bain, 1942; Chidester and others, 1951, 1952; Pearre and Calkins, 1957a.

1.	Troy-East Hill deposits.	44°54'	72°23'
2.	Montgomery Center prospect.	44°53'	72°38'
3.	Belvidere Mountain area.	44°46'	72°32'
4.	Johnson mines and nearby deposits.	44°40'	72°38'
5.	Rousseau prospect.	44°40'	72°47'
6.	Sterling Pond deposits.	44°33'	72°46'
7.	Barnes Hill prospect.	44°25'	72°43'
8.	Waterbury mine.	44°19'	72°44'
9.	Mad River mine.	44°14'	72°48'
10.	Roxbury deposits.	44°05'	72°44'
11.	East Granville mine.	44°01'	72°45'
12.	Williams and McPherson mines and nearby deposits.	43°52'	72°46'
13.	Greeley mine.	43°48'	72°46'
14.	Hammondsville quarry.	43°29'	72°33'
15.	Proctorsville deposits.	43°23'	72°39'
16.	Perkinsville quarry.	43°22'	72°32'
17.	Carleton quarry and Chester Reservoir mine.	43°16'	72°38'
18.	Davis (Holden) and Barton quarries	43°14'	72°38'
19.	Windham quarry and nearby deposit	43°12'	72°43'
20.	South Windham deposits.	43°08'	72°42'
21.	Grafton prospects.	43°08	72°36'
22.	Dover-Newfane deposits.	43°00'	72°45'
23.	Marlboro deposits.	42°52'	72°46'
24.	Waterville quarry.	44°44'	72°45'
25.	Valentine mine.	43°24'	72°41'

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(Localities are given by North Latitude and West Longitude)

TABLE A-82. VERMONT MINERAL PRODUCERS

Commodity and company	Address	Type of activity	County
Asbestos:			
GAF Corporation, Bldg. & Industrial Floor Products Division.[1]	140 West 51st St. New York, N.Y. 10020	Pit	Orleans.
Peat:			
Kirks Green Mountain Peat	P.O. Box 456 Woodstock, Vt. 05091	Bog	Windsor.
Sand and gravel:			
Brattleboro Sand & Gravel, Inc.	P.O. Box 358 Brattleboro, Vt. 05301	Pit	Windham.
Caledonia Sand & Gravel Co. Inc.	Box 428 St. Johnsbury, Vt. 05819	Pit	Washington.
Calkins Construction, Inc.	Danville, Vt. 05828	Pit	Orleans.
J. P. Carrara & Sons, Inc.	N. Clarendon, Vt. 05759	Pit	Rutland.
William E. Dailey, Jr.	N. Bennington, Vt. 05257	Pit	Bennington.
S. T. Griswold, Inc.	P.O. Box 8 Williston, Vt. 05495	Pit	Chittenden.
Albert S. Nadeau	Johnson, Vt. 05656	Pit	Lamoille.
Lawrence Sangraveo, Inc.	138 Portland St. Johnsbury, Vt. 05819	Pit	Essex.
Vermont Sand & Gravel Corp.	Box 429 Bellows Falls, Vt. 05101	Pit	Rutland.
Stone:			
Granite (dimension):			
Rock of Ages Corp.	Barre, Vt. 05641	Quarry	Orange, Washington, Windsor.
Wells-Lamson Quarry Co., Inc.	102 N. Main St. Barre, Vt. 05641	do	Washington.
Granite (crushed):			
Wells-Lamson Quarry Co., Inc.	Framingham, Mass. 01701	do	Washington.
Limestone (crushed and broken):			
L.A. Demers Crushed Rock Co.	Upper Main St. Winooski, Vt. 05404	do	Chittenden.
Perini Corp.	Framingham, Mass. 01701	Crushing plant, quarry.	Windsor.
Swanton Lime Works, Inc.	Swanton, Vt. 05488	Quarry	Franklin.
Vermarco Ground Products Division of Vermont Marble Co.	W. Rutland, Vt. 05777	do	Rutland.
Marble (dimension):			
Vermont Marble Co.[2]	Proctor, Vt. 05765	do	Rutland, Windsor.
Marble (crushed):			
F. W. Whitcomb Const. Corp.	Box 429 Bellows Falls, Vt. 05101	do	Rutland.
Slate (dimension):			
Green Mountain Slate Corp.	Granville, N.Y. 12832	do	Do.
John G. Hadeka	25 College St. Poultney, Vt. 05764	do	Do.
Hilltop Slate Co.	Middle Granville, N.Y. 12849	do	Do.
Rising & Nelson Slate Co., Inc.	West Pawlet, Vt. 05775	do	Do.
Somich Brothers	Granville, N.Y. 12832	do	Do.
Taran Brothers, Inc.	No. Poultney, Vt. 05764	do	Do.
Tatko Brothers Slate Co.	Middle Granville, N.Y. 12849	do	Do.
Vermont Structural Slate Co., Inc.	Prospect St. Fair Haven, Vt. 05743	do	Do.
Talc:			
Eastern Magnesia Talc Co.	Johnston, Vt. 05656	Underground	Lamoille.
Vermont Talc Co.	Chester, Vt. 05143	do	Windham.
Windsor Minerals, Inc.	P.O. Box 680 Windsor, Vt. 05089	do	Windsor.

[1] Also miscellaneous stone.
[2] Also crushed marble.

Source References

(1) Metamorphic Map of the Appalachians, B. A. Morgan, USGS Map I-724.

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Worthington, 1962, USGS Map MR-31.

(216) Geologic Map of Vermont, C. G. Doll, et al., 1961, Vermont Geological Survey, University of Vermont, Burlington, Vermont 05401.

(217) Mineral Deposits and Occurrences in Vermont Exclusive of Clay, Sand and Gravel, and Peat, N.C. Pearre and J. A. Calkins, 1957, USGS Map MR-5.

(218) The Mineral Industry of Vermont, F. B. Fulkerson, 1971, U. S. Bureau of Mines' Minerals Yearbook.

Virginia

The state of Virginia has approximately three-fourths metamorphic rock, as shown in Figure A-65. As in the other eastern states of the Appalachian and Piedmont Regions, the general trend of formations is southwest-northeast. The occurrence of the ultramafic rocks in Virginia not surprisingly follows the same trend-line as shown in the county map of the metamorphosed areas. The features of this ultramafic rock belt include the occurrence of amphibole asbestiform minerals, chiefly anthophyllite, and extensive soapstone formations sometimes of talcy type alteration products. Figure A-66 and Table A-83 pinpoint the principal occurrences of these alteration minerals.

Currently, there are no commercial operations for the recovery of the amphibole asbestiform minerals although amphibolite rocks are produced in Floyd and Patrick Counties. The Pine Creek Stone Corporation (Route 4, P. O. Box 778, Floyd, Virginia) produces crushed stone from Floyd County and the operation of Wade and Griffith (Route 1, Floyd, Virginia, produces dimension stone from Patrick county. Similarly, there are very limited operations for the recovery of the related minerals, talc, and soapstone. It is reported that the Blue Ridge Talc Company, Inc., operates a soapstone quarry in Franklin County and a crushing and grinding mill in Henry County. Dimension soapstone was produced by Alberene Stone, a division of Georgia Marble Company, in Albermarle and Nelson Counties. Most of the rock recovery operations in the ultramafic belt consist of quarrying for the production of stone, sand and gravel as shown in Table A-84, a listing of mineral production by the counties of primary interest.

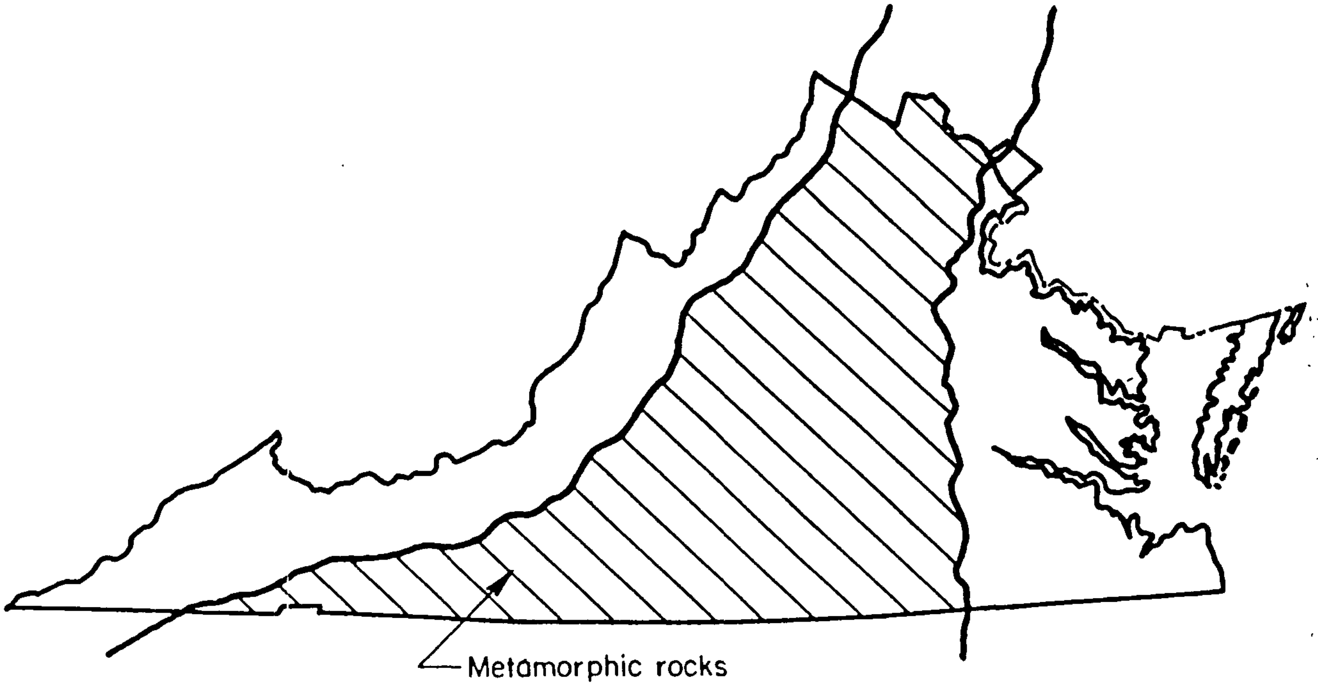

FIGURE A-65. OCCURRENCE OF METAMORPHIC ROCK IN VIRGINIA

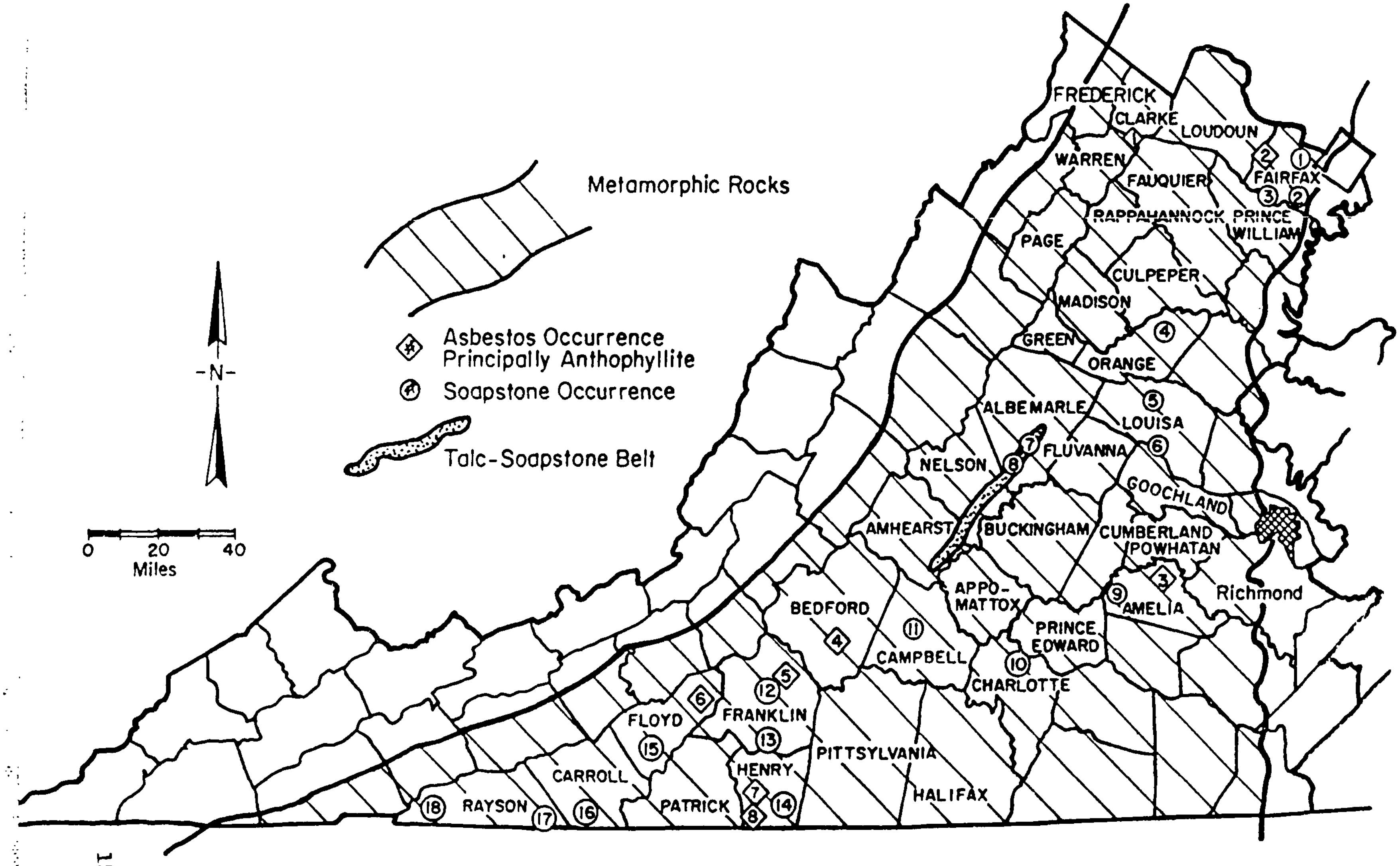

FIGURE A-66. THE OCCURRENCE OF AMPHIBOLC ASBESTIFORM MINERALS, TALC, AND SOAPSTONE WITHIN THE METAMORPHIC ROCK BODIES OF VIRGINIA

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TABLE A-83. OCCURRENCE OF ASBESTOS, TALC, AND SOAPSTONE IN VIRGINIA

Asbestos

Clarke County		
1. Boyce deposits. Asbestos of unknown variety associated with ultramafic rocks. Bowles, 1955.	39°03'	78°04'
Fairfax County		
2. Centerville area. Asbestiform anthophyllite occurring with tremolite. Dietrich, 1955.	38°50'	77°24'
Amelia County		
3. Chula-Mattox Station area. Amphibole asbestos. Dietrich, 1953.	37°24'	77°57'
Bedford County		
4. Bedford area. Slip-fiber anthophyllite asbestos in veinlike masses associated with hornblende and olivine. Bowles, 1955; Dietrich, 1953, 1955.	37°10'	79°30'
Franklin County		
5. Rockymount mine. Slip-fiber amphibole asbestos. Bowles, 1955; Dietrich, 1953.	36°58'	79°50'
Floyd County		
6. Floyd area. Asbestiform anthophyllite. Dietrich, 1955.	36°53'	80°17'
Henry County		
General reference: Dietrich, 1955.		
7. Axton. Asbestiform anthophyllite.	36°39'	79°42'
8. Ridgeway. Fine white asbestiform anthophyllite.	36°36'	79°50'

Talc and Soapstone

All deposits are associated with ultramafic and mafic igneous rocks. They are mostly of the soapstone variety. The Schuyler deposits, which are soapstone chiefly suitable for dimension stone, are derived from metagabbros and metapyroxenites.

1. Falls Church	38°53'	77°11'
2. Annandale Dietrich, 1953.	38°50'	77°12'
3. Clifton Dietrich, 1953.	38°48'	77°25'
4. Rhoadesville Dietrich, 1953.	38°17'	77°55'
5. Louisa Burfoot, 1930.	38°01'	77°59'
6. Ferncliff Burfoot, 1930.	37°56'	78°03'
7. Alberene area quarries. Burfoot, 1930; Hess, 1933; Hopkins, 1957.	37°52'	78°35'
8. Schuyler area quarries. Burfoot, 1930; Hess, 1933; Hopkins, 1957.	37°47'	78°42'
9. Walnut Creek Dietrich, 1953.	37°18'	78°10'
10. Cullen Dietrich, 1953.	37°07'	78°40'
11. Otter River Dietrich, 1953.	37°14'	79°07'
12. Rocky Mount Dietrich, 1953.	36°59'	79°54'
13. Henry Dietrich, 1953.	36°53'	79°58'
14. Axton Burfoot, 1930.	36°40'	79°43'
15. Floyd Dietrich, 1953.	36°53'	80°22'
16. Blue Ridge Mill Dietrich, 1955; Stose and Stose, 1957.	36°37'	80°52'
17. The Glades Dietrich, 1955; Stose and Stose, 1957.	36°37'	80°55'
18. Troutdale Dietrich, 1953.	36°42'	81°25'

TABLE A-84. MINERAL PRODUCTION BY COUNTIES IN VIRGINIA

County	Commodity
Albermarle	Soapstone, stone, sand and gravel
Amherst	Sand and gravel, titanium concentrate
Amelia	No current production
Bedford	Feldspar
Campbell	Stone
Carroll	Stone
Charlotte	No current production
Clarke	Stone
Fairfax	Stone, sand and gravel
Floyd	Stone (Amphidolite)
Franklin	Soapstone
Henry	Stone
Louisa	Stone
Nelson	Stone, Aplite
Orange	Clays
Patrick	Stone (Amphibolite)
Ranson	No current production

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Source References

(1) Metamorphic Map of the Appalachians, B. A. Morgan, 1972, USGS Map I-724.

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and H. Worthington, 1962, USGS Map MR-31.

(219) Geologic Map of Virginia, 1963, R. C. Milici, et al., J. L. Calver and C.R.B. Hobbs, Jr. Eds., Virginia Division of Mineral Resources, Charlottesville, Virginia.

(220) Mineral Resources of Virginia, D. C. LeVan and W. B. Harris, 1971, Virginia Division of Mineral Resources, Charlottesville, Virginia.

(221) Directory of the Mineral Industry in Virginia, D. C. LeVan, 1973, Virginia Division of Mineral Resources, Charlottesville, Virginia.

(222) The Mineral Industry of Virginia, F. D. Cooper, 1970, U.S. Bureau of Mines' Minerals Yearbook.

Washington

The state of Washington may be discussed in terms of geological areas which are distinct from one another in geological characteristics. For example, the northeastern part of Washington is known as the Okanogan Highlands, eastern and western sections. Another area which has been described is the Columbia Basin. It has distinct physiography as does the Blue Mountain region in the southeastern corner of Washington. The rugged Cascade Mountains form a north-south spine separating eastern from western Washington not only in geological characteristics but also in climate. Western Washington is strongly influenced by the Coast Range, known as the Willapa Hills to the south and climaxing in the Olympic Mountains along the northwest coast. The Puget Sound Lowlands separate the coast mountains from the extensive Cascade Mountain system. These provinces and sections are delineated on the map figure and are important to this study as a means of identifying areas where mineral production occurs or might occur and where fibrous amphibole minerals might be found in association with such activity.

Perhaps the most interesting area of Washington is the Cascade Mountain Range. In the mountains of this provice there is a grand assortment of rocks and the geologic history includes marine sedimentary periods as well as several stages of mountain building with its accompanying igneous and metamorphic activity. In Washington, the Cascades consist of two geologically contrasting areas: the southern part dominated by Tertiary volcanic rocks with relatively simple structures and the northern part where most of the exposed rocks are structurally complex pre-Tertiary igneous and metamorphic rock types. The Okanogon Highlands to the east of the northern part of the Cascade Range is in some respects much like the Cascades, although the easterr mountains are lower and less rugged than those found in the Cascade spine. The two areas, the northern Cascades and the Okanogan Highlands, may be considered together for purposes of describing certain aspects f the mineral industry of Washington. Within these rocks which occupy the northeast quadrant of the state, mineralization is far greater than in other sectors. Northeastern Washington, including only the counties of Pend Oreille, Stevens, Ferry, eastern Okanogan, and northern Spokane, comprises less than 15 percent of the state's area, but accounts for over

90 percent of the metallic mineral production. The counties of Pend, Oreille, Stevens, and Ferry, are particularly noteworthy for their metal production. This is readily apparent from the following county by county tabulation of Washington State's mineral production. The tabulation also shows that except within these counties and King County (Cascade mines east of Seattle) there is currently no metal mining activity in Washington. There are metallic mineral prospects elsewhere (eg. manganese and mercury occurrences in the Olympich Mountains) which have not been and are currently not being exploited.

The nonmetallic mineral extraction in Washington is from every county and as shown in Table A-85, is principally stone, sand and gravel. Of greatest interest to this study, however, is the olivine and talc production from Skagit County. As shown on Figure A-67, the northeast quadrant of Washington has many occurrences of the metamorphosed minerals -- the several asbestiform minerals, talc, soapstone, etc. -- and those in Skagit County are commercially exploited. The tabulations of Table A-86, which are number keyed to Figure A-67, describe the locations and the mineral occurrence for selected sites. In Skagit County, the olivine production is from relatively fresh and massive dunite, alteration to serpentine being observed only at the edges of the deposit. A very little chrysotile asbestos is known from this area although it is believed to not be much encountered in the production of the olivine rock. The talc and soapstone production is from deposits in a complex of greenschist derived from mafic volcanic rocks, and of serpentine. Both the schist and the serpentine have been metamorphosed by intrusive granodiorite of pre-Carboniferous age. Undoubtedly, some of the talc produced is intermixed with amphibole minerals (e.g. tremolite) from this site which is mineralogically favorable for its occurrence.

Areas which are favorable for the genesis and occurrence of the asbestiform minerals are widely found in the northeast quadrant of Washington. As previously mentioned, they occur in association with the olivine (some extent) and talc (to a greater extent) production in Skagit County. Elsewhere in the metallic mineral-producing counties, they are likely to be encountered in association with the mineralized rock bodies wherever contact metamorphosed rock is being worked, commonly in King, Ferry, Stevens, and Pend Oreille Counties.

The principal mineral producers in the state of Washington are listed in Table A-87.

Source References

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

(3) Talc and Soapstone in the United States, A. H. Chidester and H. W. Washington, 1962, USGS Map MR-31.

(223) Geologic Map of Washington, M. T. Hunting, et al., 1961, Washington Department of Conservation, Division of Mines and Geology, Olympia. Washington 98501.

(224) Geologic Map of Washington, A. E. Weissenborn, 1969, USGS Map I-583.

(225) Inventory of Washington Minerals, Part I, Nonmetallic Minerals, Vol. 1 Text, Vol. 2 maps, G. M. Valentine and M. T. Hunting, 1960; Part II, Metallic Minerals, Vol. 1 text, Vol. 2 Maps, M. T. Hunting, 1956, Washington Department of Conservation, Division of Mines and Geology, Olympia, Washington 98501.

(226) Mineral and Water Resources of Washington, A. E. Weissenborn, et al., 1966, Senate Document, Washington Division of Mines and Geology Reprint No. 9, Olympia, Washington 98501.

(227) The Mineral Industry of Washington, R. A. Whitman, 1971, U.S. Bureau of Mines'-Minerals Yearbook.

Table A-85. **Value of mineral production in Washington, by county**

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Adams	W	W	Sand and gravel, stone.
Asotin	$13	$2	Sand and gravel.
Benton	W	W	Sand and gravel, stone.
Chelan	W	340	Sand and gravel.
Clallam	659	1,360	Stone, clays, sand and gravel.
Clark	W	W	Stone, sand and gravel, clays.
Columbia	W	W	Stone.
Cowlitz	883	449	Stone, sand and gravel, clays.
Douglas	W	W	Sand and gravel, clays.
Ferry	W	W	Gold, silver, stone, copper, lead.
Franklin	W	W	Sand and gravel, stone.
Garfield	630	W	Stone.
Grant	2,702	2,789	Diatomite, lime, stone, sand and gravel.
Grays Harbor	1,308	1,049	Sand and gravel, stone.
Island	W	W	Do.
Jefferson	W	W	Stone, sand and gravel.
King	24,363	21,729	Cement, sand and gravel, stone, coal, clays, peat, copper, silver, gold.
Kitsap	W	W	Sand and gravel, stone, peat.
Kittitas	W	226	Stone, clays, sand and gravel.
Klickitat	483	W	Sand and gravel, stone.
Lewis	W	W	Coal, sand and gravel, stone, clays.
Lincoln	148	W	Stone, sand and gravel.
Mason	326	217	Sand and gravel, stone, peat.
Okanogan	489	W	Stone, sand and gravel, gypsum.
Pacific	321	766	Stone.
Pend Oreille	W	9,090	Cement, zinc, lead, stone, sand and gravel, silver, copper, gold.
Pierce	W	6,255	Sand and gravel, lime, stone, clays, peat.
San Juan	W	W	Sand and gravel.
Skagit	1,432	1,913	Olivine, sand and gravel, stone, talc.
Skamania	W	W	Stone, sand and gravel, pumice.
Snohomish	5,375	3,299	Sand and gravel, stone, peat, clays.
Spokane	W	2,955	Sand and gravel, stone, clays, peat.
Stevens	W	5,619	Uranium, stone, sand and gravel, clays, lead, gold, silver, copper, zinc, abrasives.
Thurston	W	W	Sand and gravel, stone, peat.
Wahkiakum	W	1	Sand and gravel.
Walla Walla	453	407	Sand and gravel, stone.
Whatcom	W	W	Cement, sand and gravel, stone, clays.
Whitman	1,375	1,458	Stone, sand and gravel.
Yakima	W	2,257	Stone, sand and gravel, lime.
Undistributed[1]	49,964	32,421	
Total[2]	90,922	94,601	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes value of mineral production that cannot be assigned to specific counties and values indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

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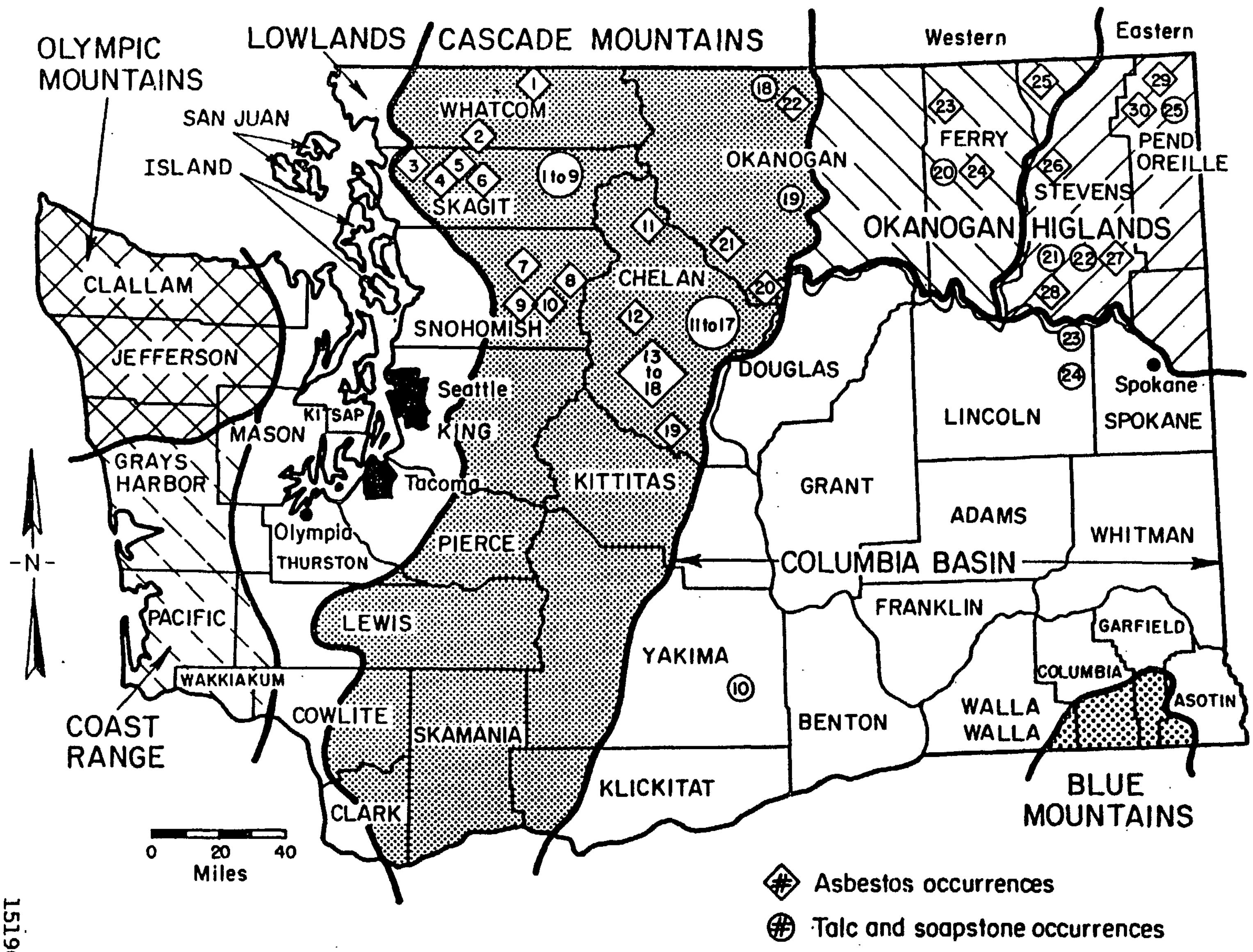

FIGURE A-67. METAMORPHIC ROCK OCCURRENCE IN WASHINGTON

TABLE A-86. METAMORPHIC ROCK OCCURRENCE IN WASHINGTON

Asbestiform Materials

WHATCOM COUNTY

1. Name: Skyline Ridge. Loc: Asbestos is reported on Skyline Ridge between Mount Shuksan and Twin Lakes. Details unknown.

2. Name: Twin Sisters. Loc: NE¼SW¼ sec. 36, (37-6E). Descr: Veinlets of cross-fiber serpentine asbestos less than ¼ in. thick. Value: Commercial quantity not obvious.

SKAGIT COUNTY

3. Name: Oyster Creek. Loc: Irregular zone extends from near mouth of Oyster Creek to vicinity of Samish Lake. Descr: Schists lying just S. of boundary of Chuckanut formation are reported to contain amphibole asbestos. Value: Not known.

4. Name: Burlington. Loc: Hill just N. of Burlington in N½ sec. 32, (35-4E). Descr: Somewhat fibrous soapstone-actinolite mixture developed in shear zones cutting greenstone. Value: Asbestos-Talc Products Co. mined this material. It was ground, mixed with imported asbestos, and used in special cements.

5. Name: Scott. Loc: W½E½ sec. 27, (36-5E). Descr: Amphibole asbestos having fine white silky fibers up to 3 in. long, which are particularly flexible and strong for this kind of asbestos. Value: Possibly commercial; occurrence small.

6. Name: Lyman. Loc: Near Hamilton, across Skagit River from Lyman. Descr: Said to be long fibered and of good quality. Value: A small amount has been shipped.

SNOHOMISH COUNTY

7. Name: Clear Creek. Loc: Near headwaters of Clear Creek in sec. 3, (30-9E). Descr: Serpentine dike, 30 to 150 ft. wide, exposed to depth of 75 ft., contains talcose asbestos. Value: Further investigations warranted.

8. Name: Bedal Creek. Loc: On Bedal Creek in sec. 35, (30-11E). Descr: Slip-fiber asbestos of low grade reportedly occurs as stringers and lenses, 1 in. or less in thickness, cutting quartz diorite, gneiss, and schist. Value: Not known

9. Name: Florence Rae prospect. Loc: On Florence Rae property in sec. 27, (29-10E). Descr: Veins of cross-fiber asbestos, ¼ in. or less thick, cutting through a body of peridotite. Value: Observed quantity below commercial grade.

10. Name: Mackinaw prospect. Loc: At Mackinaw prospect in sec. 19, (29-11E). Descr: Small amount of slip-fiber asbestos in serpentine of nickel prospect. Value: Quantity small.

CHELAN COUNTY

11. Name: Stehekin River. Loc: In bed of a tributary to the Stehekin River, 5 mi. upstream from Lake Chelan. Descr: Reportedly a "ledge" of blue-white, long-fiber asbestos 5 to 25 ft. wide. Value: Unknown.

12. Name: Williams Creek. Loc: On Williams (Raging) Creek, 9 mi. by trail from Chiwawa River road, a showing of asbestos is reported high on the mountain. Another report states that asbestos is exposed in two tunnels, one at an altitude of 3,400 ft. and the other at 4,200 ft. Descr: Said to occur along hanging walls of veins of siliceous asbestiform material. Probably amphibole asbestos. Value: Unknown.

13. Name: Goose Creek. Loc: NW¼ sec. 18, (27-17E), at Goose Creek camp ground. Descr: Anthophyllite in felty masses and veins in a ledge 50 ft. square on N. bank of Goose Creek. Value: Unknown.

13A. Name: Deep Creek. Loc: Sec. 19, (27-18E), between Deep Creek and Goose Creek. Descr: Chrysotile asbestos reported. Value: Unknown.

13B. Name: Nason Ridge. Loc: In road cut in S½N½ sec. 32, (27-17E), on SE. slope of Nason Ridge. Descr: Anthophyllite in boulders as large as 10 ft. by 20 ft., not in place but probably have not traveled far. Value: Unknown.

13C. Name: Trout Creek. Loc: Near center sec. 6, (24-16E), at intersection of Trout Creek and Jack Creek trails. Descr: Chrysotile reported. Value: Unknown.

13D. Name: Trout Lake. Loc: Sec. 19, (24-16E), near Trout Lake. Descr: Anthophyllite in serpentine. Chrysotile reported nearby. Value: Unknown.

13E. Name: Mill Creek. Loc: SE¼ sec. 30, (24-18E). Descr: Anthophyllite in serpentine. Value: Unknown.

14. Name: Chumstick Mountain. Loc: On Chumstick Mountain in sec. 27, (15-19E). Descr: Anthophyllite occurs as a vein less than 1 ft. wide in biotite gneiss. Value: Exposed by shallow pit. Insufficient quantity for commercial development.

15. Name: Swakane Canyon (may be same as Chumstick Mountain occurrence). Loc: In Swakane Canyon on property of Rafter and Bousquet Logging Co. Descr: Short-fiber anthophyllite. Value: Quantity and quality not known.

TABLE A-86 (continued)

16. Name: Burch Mountain. Loc: Reported on W. slope Burch Mountain. Descr: Said to be in three "ledges" from 1 to 11 in. wide and of good fiber. Value: Unknown.

17. Name: Icicle Creek. Loc: Said to occur on Icicle Creek near Leavenworth. Descr: Unknown. Value: No production reported, but some development work done.

18. Name: Ingalls Creek. Loc: Reported on high ridge N. of Ingalls Creek a few miles from its mouth. Descr: Said to be of long fiber. Value: Unknown.

19. Name: Peshastin Creek. Loc: Sec. 14, (22-17E). Descr: Networks of tiny veinlets of cross-fiber asbestos in serpentine. Value: Low grade and short fibered.

OKANOGAN COUNTY

20. Name: Alta Lake. Loc: 6 mi. SW. of Pateros and 1 mi. from Alta Lake. Descr: Large lenses of short-fiber amphibole asbestos. Value: Was formerly mined and shipped to Asbestomine Co. in Wenatchee, where it was used in the manufacture of cold-water paint.

21. Name: Twisp. Loc: Old report mentions asbestos 14 mi. SW. of Twisp. Descr: Said to be large deposit of silky white long-fiber asbestos 400 ft. wide and traceable for 2,500 ft. Value: Unknown.

22. Name: Ivanhoe prospect. Loc: Reported at Ivanhoe prospect in SW¼ sec. 16, (39-26E). Descr: Said to be "20 ft. down on 60-ft. ledge." Value: Unknown.

FERRY COUNTY

23. Name: Hardscrabble Mountain. Loc: Reported on Hardscrabble Mountain in NW¼ T. 38 N., R. 32 E. Descr: Said to be a 4-ft. vein of radiating tremolite. Value: Unknown.

24. Name: California prospect. Loc: Reported at California prospect in SW¼SW¼ sec. 20, (36-34E). Descr: Serpentine asbestos. Value: Unknown.

STEVENS COUNTY

25. Name: Laurier. Loc: E. of Laurier in secs. 1 and 12, (40-36E) and secs. 6 and 7, (40-37E). Descr: Thin masses of white asbestos along fractures in serpentine. Value: Low grade and of short fiber.

26. Name: Stranger Creek. Loc: NW¼NE¼ sec. 35, (34-38E). Descr: Fibrous radiating tremolite interbedded with dolomite throughout a thickness of 1,000 ft. Value: Warrants investigation.

27. Name: Chewelah. Loc: 8 mi. E. of Chewelah. Descr: Said to be a 5-ft. vein. Value: Unknown.

28. Name: Boundary Butte. Loc: Prospect hole in SW¼NW¼ sec. 21, (29-37E). Descr: Fibrous radiating tremolite occurs in a bed of altered dolomite 4 ft. thick. Value: Warrants investigation.

PEND OREILLE COUNTY

29. Name: Metaline area. Loc: Mines in Metaline district. Descr: Paligorskite occurs as sheets along joints associated with the lead and zinc ores. Value: Quantity small.

30. Name: Coffin prospect. Loc: Sec. 16, (38-42E). Descr: Small veinlets of serpentine asbestos less than ¼ in. thick cut across diopside and serpentine. Value: Fibers too short to be of value.

TABLE A-86 (continued)

Talc and Soapstone

SKAGIT COUNTY

*1. Name: Skagit Talc Products. Loc: NW¼NW¼ sec. 14, (36-11E). Descr: Large tonnage of excellent soapstone containing some high-grade talc. Value: Formerly used extensively for furnace blocks. Currently ground for insecticide base and cut into dimension blocks for carving, etc. Steel-marking pencils are made on demand. Certain portions of the deposit have been found to be usable as steatite or lava talc.

2. Name: Alvard. Loc: Near SW. cor. sec. 15, (36-11E). Descr: Large quantity of soapstone and reportedly a large quantity of talc. Quality lowered somewhat by ankerite inclusions. Value: Recently operated by Skagit Mineral Products Co., Inc. Later leased by William Soren, owner of Skagit Talc Products.

*2A. Name: Rainbow. Loc: Sec. 15, (36-11E). Descr: Soapstone. Value: Current limited production by Scheel Olivine, Inc., Mount Vernon.

*3. Name: McMyrl-Wilson. Loc: NE¼ sec. 21, (36-11E). Descr: Pale green soapstone and talc in bodies as much as 10 ft. wide. Value: Dimension soapstone cut for refractory use at one time. Recently quarried by Northwest Talc & Magnesium Co., Clearlake, Wash.

*3A. Name: Dad's Girl claim. Loc: N½ sec. 21, (36-11E), on hill above McMyrl-Wilson adit. Descr: Soapstone body 20 ft. wide exposed for 75 ft. Talc itself is good grade but contains ankerite inclusions. Value: Currently operated by Skagit Talc Products, Sedro Woolley, Wash.

4. Name: Scott. Loc: SW¼SE¼ sec. 27, (36-5E). Descr: Largely serpentinized schists, but some are talcose. One lens of soapstone 3 to 4 in. thick. Value: Exposed quantity too small for commercial use.

5. Name: Alger. Loc: Reported in SE¼NE¼ sec. 15, (36-4E). Descr: Unknown. Value: Unknown.

6. Name: Lyman. Loc: S½ sec. 30, (35-6E). Descr: Rubbery bluish-white talcose clay. Value: Talc content and peculiar physical properties might prove to be of value.

*7. Name: Londonderry. Loc: SW¼SE¼SE¼ sec. 16, (35-11E). Descr: Soapstone deposit, in part nearly pure talc, exposed in body 70 to 100 ft. wide for a length of 200 ft. Enclosed in schist. Value: Recently operated by National Talc Co., Seattle, and currently operated by Herman Smith, Marblemount, Wash.

*8. Name: Sadie Cudworth. Loc: Near SE. cor. sec. 21, (35-12E). Descr: Soapstone crops out for 1,000 ft. along the road, thickness unknown. Value: Quarried in 1953-1954 by J. L. Pape, Rockport, Wash.

*9. Name: Clear Lake. Loc: Secs. 16 and 17, (34-5E). Descr: Serpentine and schist in which are lenses of high-quality talc. Value: Currently quarried by Northwest Talc & Magnesium Co., ground in its plant at Clearlake, and sold for agricultural use and as a diluent in insecticides.

YAKIMA COUNTY

10. Name: Miller. Loc: Unknown. Descr: Sample of good talc sent to the Division of Mines and Geology by George Miller, Granger, Wash. Value: Unknown.

CHELAN COUNTY

11. Name: White River. Loc: Soapstone reported on White River NW. of Wenatchee Lake. Descr: Sample from there of fair quality. Value: Unknown.

12. Name: Williams Creek. Loc: On Williams (Raging) Creek, 9 mi. by trail from the Chiwawa River road. Descr: Soapstone associated with asbestos. Value: Warrants investigation.

13. Name: Ruth. Loc: Sec. 2, (26-15E). Descr: A 5-to 8-ft. ledge of soapstone in biotite gneiss. Value: Not promising.

14. Name: Entiat. Loc: Sec. 32, (26-20E). Descr: Talc zone in gneiss 20 to 30 ft. wide, 2,000 ft. long, and 500 ft. high. Value: Warrants investigation.

15. Name: Tumwater Canyon. Loc: On a hillside close to the highway about 5 mi. NW. of Leavenworth, probably in sec. 21, (25-17E). Descr: Steeply dipping thick tabular body of soapstone in contact with biotite schist. Value: Warrants investigation.

16. Name: Roaring Creek. Loc: Sec. 8, (25-20E). Descr: Soapstone 50 ft. wide, 500 ft. long, and 500 ft. high. Value: Warrants investigation.

17. Name: Lockwood & Cole. Loc: Sec. 24, (25-20E) and sec. 18, (25-21E). Descr: Soapstone 30 to 50 ft. wide, 1,000 ft. long, and 500 ft. high. Value: Warrants investigation.

TABLE A-86 (continued)

OKANOGAN COUNTY

18. **Name:** Kaaba-Texas mine. **Loc:** Secs. 15 and 23, (40-25E). **Descr:** Reportedly crystalline talc as much as 18 in. thick on the hanging wall of the vein. **Value:** Unknown, but should be investigated.
19. **Name:** Johnson Creek. **Loc:** S. center sec. 32, (35-26E). **Descr:** Basic igneous rock has altered to serpentine, talc, and associate minerals. A 1-in. vein of high-grade talc exposed in an old open cut. **Value:** Exposed quantity not commercial.

FERRY COUNTY

20. **Name:** Republic. **Loc:** Road cut in sec. 20, (36-34E). **Descr:** Shear zone in schist carries considerable talc. In the same cut talc is 3 to 4 ft. thick along a felsite-serpentine contact. **Value:** Warrants investigation.

STEVENS COUNTY

21. **Name:** Firmenhac. **Loc:** W½SW¼ sec. 15, (30-38E). **Descr:** Slate, quartzite, and dolomite cut by basic dikes. Dolomite has altered to good-quality talc, which forms a 3-ft. vein exposed for 50 ft. **Value:** Several tons mined, but none known to have been shipped.
22. **Name:** C. F. Allen. **Loc:** NW¼ sec. 21, (30-38E). **Descr:** Talcose serpentinized schist. **Value:** Warrants investigation.

LINCOLN COUNTY

23. **Name:** C. W. Capps (Mondovi). **Loc:** W½NW¼ sec. 34, (27-38E). **Descr:** Talc of fair grade occurs in calcareous schist. It averages 5 ft. in width over a distance of several hundred feet. **Value:** Talc formerly ground and shipped to paper mills.
24. **Name:** Travis farm. **Loc:** NE¼ sec. 6, (24-39E). **Descr:** Argillaceous quartzite and talc schist near granite intrusives. **Value:** Warrants investigation.

PEND OREILLE COUNTY

25. **Name:** Totem Gulch. **Loc:** Sec. 23 or 26, (39-44E), in Totem Gulch on Sullivan Mountain. **Descr:** Deposit of exceptionally pure talc reported in road cut. **Value:** Unknown.

TABLE A-87 PRINCIPAL MINERAL PRODUCERS IN WASHINGTON

Commodity and company	Address	Type of activity	County
NONMETALS			
Cement:			
Columbia Cement Co	Marietta Road, P.O. Box 37 Bellingham, Wash. 98225	Plant	Whatcom.
Ideal Cement Co., Div. of Ideal Basic Industries, Inc	420 Ideal Cement Bldg. Denver, Colo. 80202	do	King.
Lehigh Portland Cement Co.[1]	718 Hamilton St. Allentown, Pa. 18105	do	Pend Oreille.
Lone Star Cement Corp	P.O. Box 2047 Seattle, Wash. 98111	do	King.
Clays:			
Chehalis Brick & Tile Co	P.O. Box 868 Chehalis, Wash. 98532	Pit and plant	Lewis.
Cle Elum Cement Products, Inc	P.O. Box 336 Cle Elum, Wash. 98922	do	Kittitas.
R. L. Fleshman	2804 Spirit Lake Highway Castle Rock, Wash. 98611	Pit	Cowlitz.
Hidden Brick Co	2610 Kauffman Ave. Vancouver, Wash. 98660	Pit and plant	Clark.
Jim Hoy Co	1757 W. Bakerview Road Bellingham, Wash. 98225	Pit	Whatcom.
Ideal Cement Co., Div. of Ideal Basic Industries, Inc	420 Ideal Cement Bldg. Denver, Colo. 80202	Pit and plant	Clallam.
Interpace Corp	2901 Los Feliz Blvd. Los Angeles, Calif. 90039	3 pits and plants. 2 pits and plants. Pit and plant	King. Spokane. Stevens.
Lind Gravel Co	1530 State St. Bellingham, Wash. 98225	Pit	Whatcom.
Lowell Brick Co	Box 3005 Everett, Wash. 98201	Pit and plant	Snohomish.
Mutual Materials Co	P.O. Box 3547 Seattle, Wash. 98124	do	King, Pierce.
Wenatchee Silica Sand	Box 1668 Wenatchee, Wash. 98801	Pit	Douglas.
Diatomite:			
Kenite Corp	2 Overhill Road, Overhill Building Scarsdale, N.Y. 10583	Mine and plant	Grant.
Gypsum:			
Kaiser Gypsum Co., Inc	300 Lakeside Drive Oakland, Calif. 94612	Plant	King.
Lime:			
Domtar Chemicals Ltd	Tacoma, Wash. 98421	do	Pierce.
Olivine:			
Northwest International	329 Kincaid Mount Vernon, Wash. 98273	Mine and plant	Skagit.
Olivine Corp	1015 Hilton Bellingham, Wash. 98225	do	Do.
Pumice and pumicite:			
W. L. Marenakos Co	Rt. 1, Box 921 Issaquah, Wash. 98027	Plant	Kittitas.
Weyerhaeuser Co	Longview, Wash. 98632	do	Skamania.
Roofing granules:			
Northwest Talc & Magnesium Co	P.O. Box 324 Clear Lake, Wash. 98235	do	Skagit.
Sand and gravel:			
Ace Concrete Co	N. 302 Park Road Dishman, Wash. 99206	Pit and plant	Spokane.
Associated Sand & Gravel Co. Inc.	6300 Glenwood Ave. Everett, Wash. 98202	do	Snohomish.
Cadman Gravel Co	Redmond, Wash. 98052	do	King.
Central Pre-Mix Concrete	805 N. Division St. Spokane, Wash. 99202	do	Spokane, Adams, Franklin.
DeAtley Corp.[2]	Box 648 Lewiston, Idaho 83501	do	Various.
Friday Harbor Sand & Gravel	Box 8 Bellingham, Wash. 98225	do	San Juan.
Glacier Sand & Gravel Co	5975 E. Marginal Way Seattle, Wash. 98134	do	King, Pierce.
Klineline Sand & Gravel Co	1112 N.E. Hazel Dell St. Vancouver, Wash. 98665	do	Clark.
Lakeside Gravel Co., Inc	Box 7, Bellevue, Wash. 98004	do	King.
Miles Sand & Gravel	Box 130, Auburn, Wash. 98002	do	Do.
North Kitsap Gravel Asphalt Co.[1]	Rt. 2, Box 306 Poulsbo, Wash. 98370	do	Kitsap.
North Star Sand & Gravel Corp	Box 398, Everett, Wash. 98036	do	Snohomish.
Olympia Oil & Wood	State and Washington Sts. Olympia, Wash. 98501	do	Thurston.
Pacific Sand & Gravel Co	Box 699, Centralia, Wash. 98531	do	Lewis.
Quigg Bros. McDonald, Inc	1600 Riverside Ave. Hoquiam, Wash. 98550	do	Grays Harbor.
Reid Sand & Gravel Co	Box 922 Bellevue, Wash. 98004	do	King.
Stoneway Concrete, Inc	Box 509, Renton, Wash. 98005	do	Do.
D. A. Sullivan Co.[2]	Parkwater Station, Box 37 Spokane, Wash. 99211	do	Various.
S & S Sand & Gravel Co.[2]	Box 938 Ephrata, Wash. 98823	do	Do.
Ray Weist Construction Co.[1]	Box 191, Yakima, Wash. 98901	do	Yakima.
Woodworth & Co., Inc	1200 East D St. Tacoma, Wash. 98421	do	Pierce.
Yakima Cement Products Co	1202 S. First St. Yakima, Wash. 98901	do	Yakima.
Silicon carbide:			
The Carborundum Co	P.O. Box 423 Niagara Falls, N.Y. 14302	Plant	Clark.

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TABLE A-87 (continued)

Commodity and company	Address	Type of activity	County
Stone:			
Associated Sand & Gravel Co., Inc.	6300 Glenwood Ave. Everett, Wash. 98202	Quarry and plant.	Skagit, Snohomish.
Carl Carbon, Inc.	Box 5153 N. Central Station Spokane, Wash. 99205	do	Spokane, Whitman.
Cascade Asphalt Paving Co.[1]	6328 S. Tacoma Way Tacoma, Wash. 98409	do	Pierce.
Columbia Cement Co.	Marietta Road Bellingham, Wash. 98225	do	Whatcom.
Crow Rock Products	1384 Walenia Drive Moscow, Idaho 83843	do	Whitman.
General Construction Co.	Box 3845 Seattle, Wash. 98124	do	Jefferson.
Roy L. Houck Sons	1158 Chemeketa N.E. Salem, Oreg. 97301	do	Lewis, Various.
Lehigh Portland Cement Co.	718 Hamilton St. Allentown, Pa. 18105	do	Pend Oreille.
Lockheed Shipbuilding & Construction.	12020 E. Marshall Way Seattle, Wash. 98168	do	King.
Materne Bros.	Box 0—Rosewood Station Spokane, Wash. 99208	do	Various.
Stoen Construction Co.	2210 E. 95th St. Seattle, Wash. 98115	do	Snohomish.
Umpqua River Navigation Co.	2280 Oakmont Way Eugene, Oreg. 97401	do	Clark.
Vinnell-Mannix-Fuller-Dillingham.	Star Route Pomeroy, Wash. 99347	do	Whitman.
R. Wamberg Construction Co.	7404 S. Tacoma Way Tacoma, Wash. 98408	do	Grays Harbor.
Weyerhaeuser Co.	Longview, Wash. 98632	do	Cowlitz, Lewis, Pacific.
Sulfuric acid:			
American Smelting and Refining Co	Box 1605 Tacoma, Wash. 98401	Smelter	Pierce.
Talc and soapstone:			
Northwest Talc & Magnesium Co.	Clearlake, Wash 98235	Quarry	Skagit.
Herman Smith	Marblemount, Wash. 98267	do	Do.
Vermiculite (exfoliated):			
Vermiculite-Northwest, Inc.	P.O. Box A Auburn, Wash. 98002	Plant	Spokane.
METALS			
Aluminum:			
Aluminum Company of America	Vancouver, Wash. 98600	do	Clark.
	Wenatchee, Wash. 98801	do	Chelan.
Intalco Aluminum Corp.	Bellingham, Wash. 98225	do	Whatcom.
Kaiser Aluminum & Chemical Corp	Spokane, Wash. 99200	do	Spokane.
	Tacoma, Wash. 98400	do	Pierce.
Reynolds Metals Co.	Longview, Wash. 98632	do	Cowlitz.
Copper:			
American Smelting and Refining Co	Box 1605 Tacoma, Wash. 98401	Smelter	Pierce.
Pend Oreille Mines & Metals Co.	923 Old National Bank Bldg. Spokane, Wash. 99201	Mine and mill	Pend Oreille.
Ferroalloys:			
Foote Mineral Co.	Wenatchee, Wash. 98801	Plant	Douglas.
Ohio Ferro-Alloys Corp.	Tacoma, Wash. 98400	do	Pierce.
Gold:			
Knob Hill Mines, Inc.	160 Sansome St. San Francisco, Calif. 94104	Mine and mill	Ferry.
Lead-zinc:			
Pend Oreille Mines & Metals Co.	923 Old National Bank Bldg. Spokane, Wash. 99201	do	Pend Oreille.
Steel:			
Bethlehem Steel Co., Pacific Coast Division.	Seattle, Wash. 98134	Plant	King.
Northwest Steel Rolling Mills, Inc.	do	do	Do.
Zinc:			
American Smelting and Refining Co	Wallace, Idaho 83873	Mine and mill	Stevens.
MINERAL FUELS			
Coal:			
Black Prince Coal Co.	Rt. 2, Box 59 Centralia, Wash. 98531	Mine	Lewis.
Palmer Coking Coal Co., Inc.	P.O. Box 8 Black Diamond, Wash. 98010	do	King.
Peat:			
Cunningham Sand & Gravel Co., Inc.	N. 6315 Cedar St. Spokane, Wash. 99208	Bog	Spokane.
Harbor Heights Humus Co.	Gig Harbor, Wash. 98335	Bog	Pierce.
Maple Valley Humus	Renton, Wash. 98055	Bog	King.
Plant Food Co.	Bothell, Wash. 98011	Bog	Snohomish.
Petroleum refining:			
Mobil Oil Corp.	Ferndale, Wash. 98248	Refinery	Whatcom.
Shell Oil Co.	Anacortes, Wash. 98221	do	Skagit.
Sound Refining, Inc.	Tacoma, Wash. 98400	do	Pierce.
Texaco, Inc.	Anacortes, Wash. 98221	do	Skagit.
Union Oil Co. of California	Edmonds, Wash. 98020	do	Snohomish.
U.S. Oil & Refining Co.	Tacoma, Wash. 98400	do	Pierce.

[1] Also clay.
[2] Also traprock.
[3] Also sand and gravel.

15196941

West Virginia

Cambrian, Ordovician, and a few Silurian age formations are regionally metamorphosed in the far eastern counties of West Virginia as shown in Figure A-68. The two counties where the metamorphic rocks are exposed are Berkeley and Jefferson Counties. The mineral extraction activities of these counties are confined to the quarrying of clays and limestone - limestone only in Jefferson County. Sandstone, sand and gravel are recovered in adjacent Morgan County.

Dolomites, limestones, shales, and sandstones predominate in the Siburian Ordovician, and upper Cambrian formations of Berkeley and Jefferson Counties. Along the Maryland border, the Cambrian Catoctin Formation is predominantly a greenstone. Basic lava flows, schist and gneiss, containing chlorite, plagioclose, amphibolite, and epidote are found as well as minor quantities of arkose and thin calstics. Fibrous amphibole minerals are not reported. Precambrian crystalline rocks form the basement beneath the Paleozoic sedimentary section in this area. The mineral production of West Virginia is summarized in Table A-88.

Reference Sources

(1) Metamorphic Map of the Appalachians, USGS Map I-724.

(228) Mineral Industry of West Virginia, R. E. Harris, 1971, Preprint Minerals Yearbook.

(229) West Virginia Mineral Producer's Directory, 1973.

(230) Geologic Map of West Virginia, D. G. Cardwell, et al., 1968.

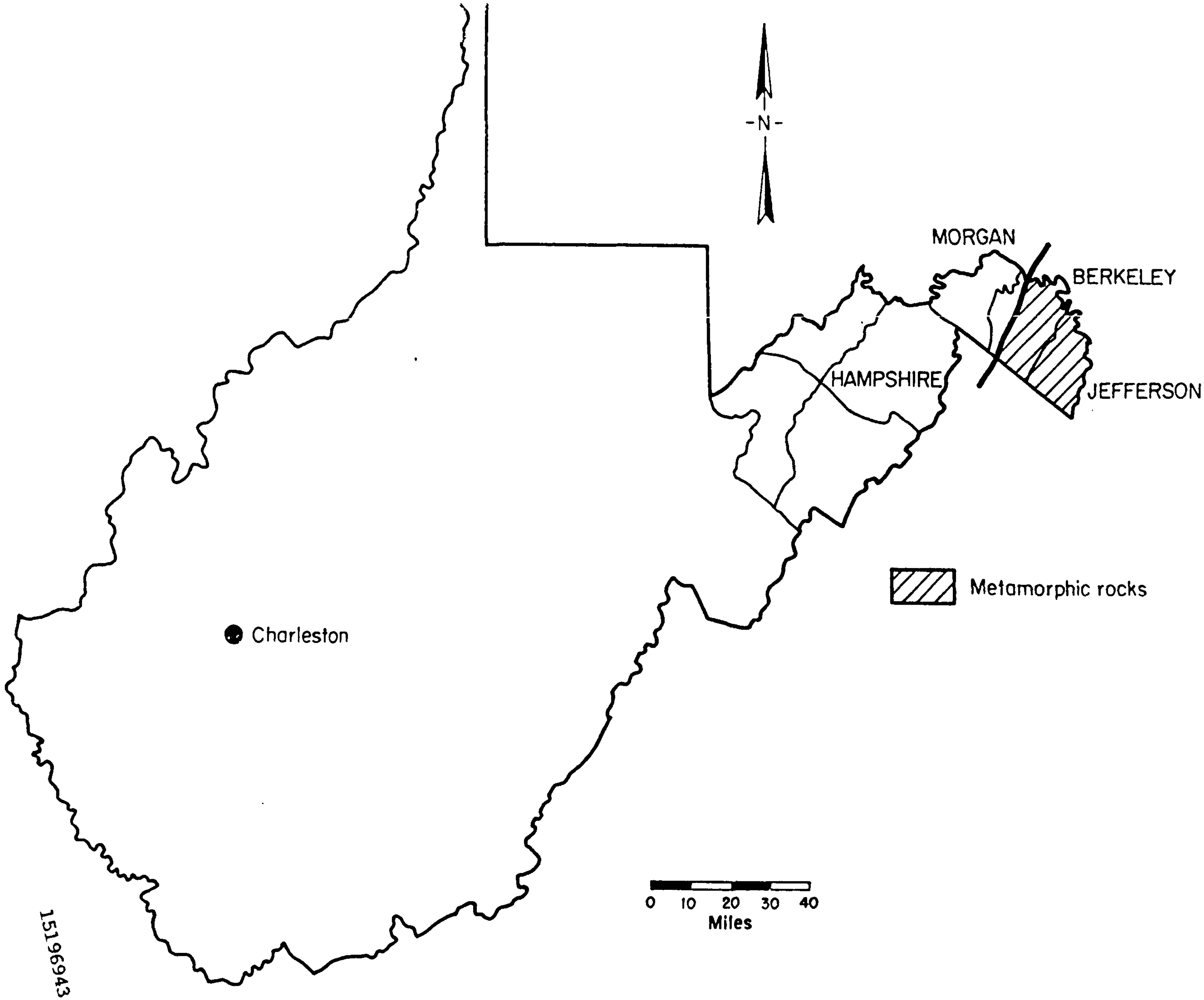

FIGURE A-68. OCCURRENCE OF METAMORPHIC ROCK IN WEST VIRGINIA

Table A-88. **Value of mineral production in West Virginia, by county**[1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Barbour	$27,839	$25,171	Coal.
Berkeley	W	W	Cement, stone, lime, clays.
Boone	W	85,972	Coal.
Braxton	W	W	Stone, coal.
Brooke	W	W	Coal, sand and gravel.
Cabell	W	W	Clays.
Clay	W	883	Coal.
Fayette	W	46,790	Do.
Gilmer	498	620	Do.
Grant	W	14,523	Coal, stone.
Greenbrier	5,244	7,360	Do.
Hancock	5,173	W	Sand and gravel, clays.
Hardy	43	43	Stone.
Harrison	W	W	Coal, stone.
Jackson	W	W	Stone.
Jefferson	W	W	Stone, lime.
Kanawha	W	W	Coal, stone.
Lewis	2,272	W	Do.
Lincoln	W	W	Stone, clays.
Logan	118,303	113,177	Coal.
McDowell	191,149	192,372	Do.
Marion	61,428	54,983	Do.
Marshall	W	W	Coal, salt.
Mason	W	W	Coal, sand and gravel.
Mercer	W	11,052	Coal.
Mineral	W	W	Coal, stone.
Mingo	16,823	28,514	Coal.
Monongalia	W	W	Coal, stone.
Monroe	--	W	Sand and gravel.
Morgan	W	W	Do.
Nicholas	W	W	Coal, sand and gravel.
Ohio	W	W	Coal.
Pendleton	W	W	Stone, lime.
Pleasants	W	W	Sand and gravel.
Pocahontas	W	W	Stone, coal.
Preston	W	W	Coal, stone.
Raleigh	W	W	Do.
Randolph	W	W	Do.
Roane	W	W	Stone.
Summers	209	--	
Taylor	1,329	W	Coal, clays.
Tucker	W	W	Coal, stone.
Tyler	W	W	Sand and gravel, salt.
Upshur	4,884	7,845	Coal.
Wayne	W	W	Coal, stone.
Webster	2,448	1,622	Coal.
Wetzel	W	W	Sand and gravel.
Wirt	--	W	Stone.
Wood	W	2,525	Sand and gravel.
Wyoming	110,569	W	Coal, sand and gravel.
Undistributed[2]	737,150	680,505	
Total[3]	1,285,364	1,273,960	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."

[1] Calhoun, Doddridge, Hampshire, Putnam, and Ritchie Counties are not listed because no production was reported.

[2] Includes gem stones, natural gas, natural gas liquids, and petroleum that cannot be assigned to specific counties, and values indicated by symbol W.

[3] Data may not add to totals shown because of independent rounding.

15196944

Wisconsin

The northern counties of Wisconsin have extensive Precambrian rock exposures as shown in Figure A-69. The map also shows the location of the more intense metamorphism within the Precambrian age formations. In the northern counties of Douglas, Bayfield, Ashland, and Iron, Keeweenawan rocks of middle to late Precambrian age are mainly sedimentary and volcanics in contact with intrusive and extrusive rocks. The Gogelic Iron Range is the southern extent of this rock division. Further to the south, the rock districts are named Barron, Butternut-Conover, Rhinelander, Florence, and Mountain-Amberg areas. These contain metasedimentary rocks and granite of early to maybe late Precambrian age. The most southern rocks of Precambrian age (Black River Falls - Neillsville, Wausau-Wisconsin Rapids, and Tigerton districts) are mainly a complex of extrusive and intrusive rocks with metasedimentary rocks present locally. These rocks also are believed to be of middle Precambrian age.

The Keeweenawan rocks are notabale for their copper prospects, chiefly in Polk, Burnett, Douglas, and Bayfield Counties. The Keeweenawan rocks contain both native copper and copper sulphides at many places but their economic potential is not known. Elsewhere in the Precambrian districts, copper prospects occur in Rusk, Marathon, and Marinette Counties -- Kennecott Copper Corporation is actively evaluating their prospect in Rusk County.

Currently, there are no iron recovery operations from the Gogebic Range. Extensive iron formations occur in these rocks and to the south in the Butternut-Conover district, (southern Ashland and Iron Counties as well as northern Price County). However, the only iron now being worked in Wisconsin is from the Black River Falls-Neillsville district in Jackson County. Here the Jackson County Iron Company (30 West Monroe Street, Chicago, Illinois 60603), a subsidiary of Inland Steel Company, is outputting considerable tonnages of taconite pellets. The mine, about 6 miles east of Black River Falls, is in a quartz-hematite-magnetite formation associated with a quartz-biotite-chlorite-garnet schist. Nearby, there are outcrops of Precambrian granite, granite gneiss, gabbro, and other rocks. The fibrous amphibole minerals are not reported from this operation but it is a likely site for their occurrence.

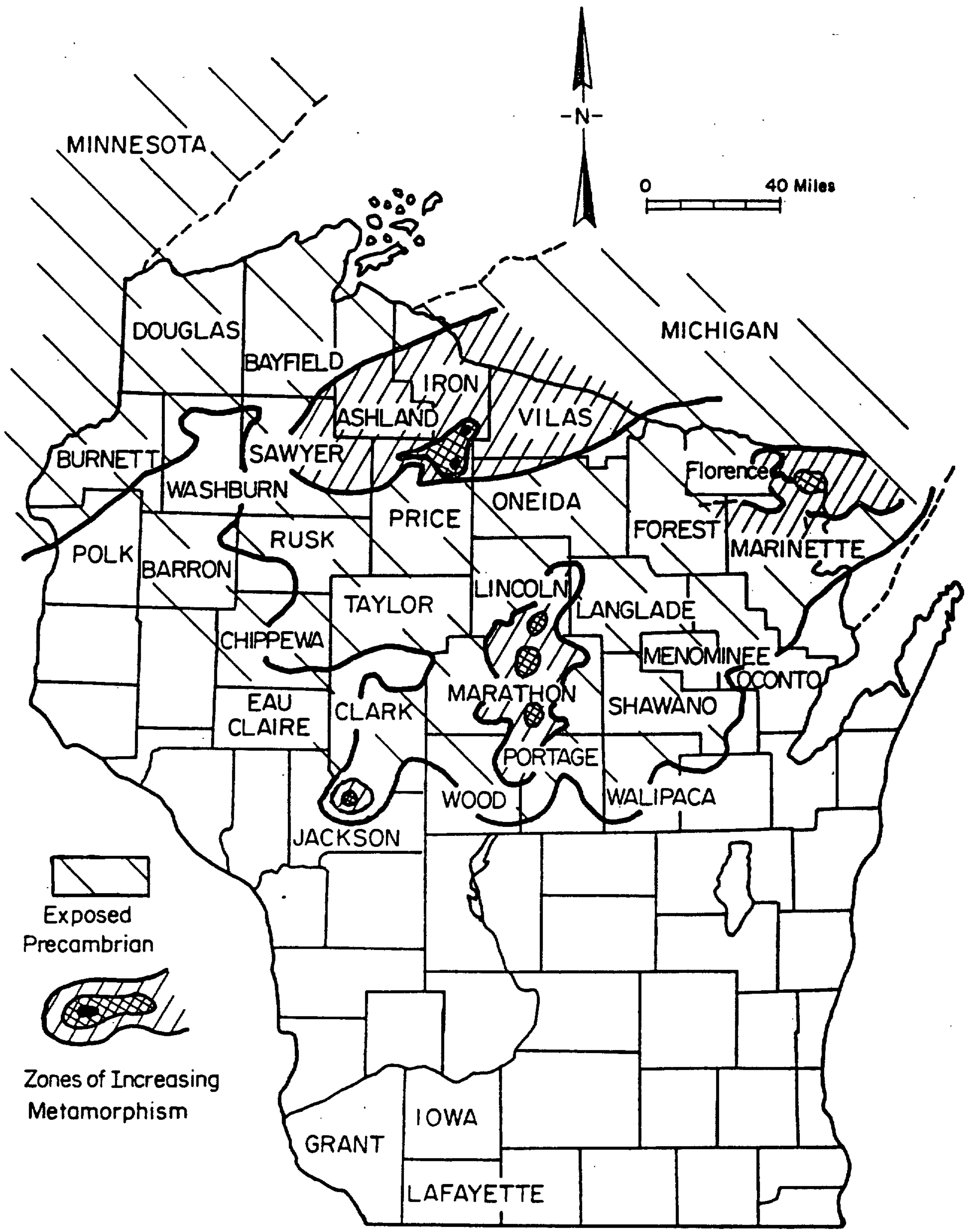

FIGURE A-69. OCCURRENCE OF METAMORPHIC ROCK IN WISCONSIN

15196946

The Shullsberg mine in Lafayette County is the single remaining zinc-lead producer in Wisconsin. This mine is owned and operated by Eagle-Picher Industries, Incorporated (P.O. Box 406, Galena, Illinois 61036). The zinc mineralization in Lafayette, Grant, and Iowa Counties is of course, a part of the same mineralization occurring in the Ordovician rock of Jo Davies County, northern Illinois. The rock formations in these southern Wisconsin counties are limestones and dolomites which were probably mineralized at the time of the Wisconsin Arch uplift.

The nonmetallics being produced in Wisconsin are principally stone, sand and gravel. Production of these commodities is virtually from every county. Details of the rock types being worked are not available. Presumably there may well be operations from the metamorphic rock areas, since these are so widespread. There are no reports of production from rock containing the fibrous amphibole minerals although it is believed that these minerals could be encountered since ultramafic rocks are prevalent in several areas. In Marinette County (in the Mountain-Amberg rock district), there is a local occurrence of short fiber crysotile asbestos (along fractures in small knobs of serpentine) which is not being worked commercially. The location is known as the Herriman Prospect at 45° 35' North Latitude and 87° 50' West Longitude.

A summary of the mineral production in Wisconsin is given in Tables A-89 and A-90.

Source References

(231) "Lithologic, Geophysical, and Mineral Commodity Maps of Precambrian Rocks in Wisconsin", C. E. Dutton and R. E. Bradley, 1970, U.S.G.S. Map I-631.

(232) The Mineral Industry of Wisconsin, G. N. Broderick, U.S. Bureau of Mines' Minerals Yearbook.

Table A-89. Value of mineral production in Wisconsin, by county [1]

(Thousands)

County	1970	1971	Minerals produced in 1971 in order of value
Adams	W	W	Sand and gravel.
Ashland	$292	$220	Do.
Barron	485	480	Do.
Bayfield	257	W	Do.
Brown	W	W	Stone, lime, sand and gravel.
Buffalo	W	W	Stone, sand and gravel.
Burnett	W	W	Sand and gravel.
Calumet	W	W	Stone, sand and gravel.
Chippewa	546	316	Sand and gravel.
Clark	757	W	Sand and gravel, stone.
Columbia	2,226	2,132	Do.
Crawford	W	W	Stone, sand and gravel.
Dane	3,974	3,065	Sand and gravel, stone.
Dodge	W	W	Sand and gravel, lime, stone.
Door	W	W	Sand and gravel, stone.
Douglas	W	W	Lime, sand and gravel, stone.
Dunn	W	175	Stone, sand and gravel.
Eau Claire	W	W	Sand and gravel.
Florence	W	52	Do.
Fond du Lac	W	W	Stone, sand and gravel, lime, clays.
Forest	209	W	Sand and gravel.
Grant	3,169	2,019	Zinc, stone, sand and gravel, lead.
Green	W	W	Stone, sand and gravel.
Green Lake	554	W	Sand and gravel, stone.
Iowa	W	332	Stone.
Iron	W	W	Sand and gravel.
Jackson	W	W	Iron ore, sand and gravel.
Jefferson	W	W	Sand and gravel, stone.
Juneau	W	W	Stone, sand and gravel.
Kenosha	388	503	Sand and gravel.
Kewaunee	637	628	Sand and gravel, stone.
La Crosse	197	W	Do.
Lafayette	4,556	3,309	Zinc, stone, lead, sand and gravel.
Langlade	W	467	Sand and gravel.
Lincoln	W	468	Do.
Manitowoc	2,295	2,445	Cement, stone, lime, sand and gravel.
Marathon	2,407	3,066	Stone, sand and gravel.
Marinette	1,194	1,696	Do.
Marquette	W	W	Do.
Milwaukee	W	5,560	Cement, stone, sand and gravel.
Monroe	304	W	Stone, sand and gravel.
Oconto	W	W	Sand and gravel, stone.
Oneida	255	W	Do.
Outagamie	1,243	W	Stone, sand and gravel.
Ozaukee	578	W	Sand and gravel, stone.
Pepin	W	W	Stone, sand and gravel.
Pierce	W	W	Sand and gravel, stone.
Polk	W	W	Do.
Portage	W	447	Sand and gravel.
Price	148	W	Do.
Racine	W	W	Stone, sand and gravel, clays.
Richland	443	215	Stone, sand and gravel.
Rock	2,039	1,105	Sand and gravel, stone.
Rusk	W	W	Sand and gravel.
St. Croix	W	W	Stone, sand and gravel.
Sauk	W	1,419	Do.
Sawyer	149	W	Sand and gravel.
Shawano	W	W	Sand and gravel, stone.
Sheboygan	626	W	Do.
Taylor	695	243	Sand and gravel.
Trempealeau	W	W	Stone, sand and gravel.
Vernon	W	481	Do.
Vilas	228	W	Sand and gravel.
Walworth	W	W	Sand and gravel, stone.
Washburn	W	W	Sand and gravel.
Washington	1,766	1,130	Do.
Waukesha	W	7,468	Sand and gravel, stone, peat.
Waupaca	W	W	Sand and gravel, stone.
Waushara	128	86	Do.
Winnebago	W	2,481	Stone, sand and gravel.
Wood	454	187	Do.
Undistributed [2]	54,572	41,841	
Total [3]	87,670	84,036	

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] No production reported for Menominee County.
[2] Includes gem stones, quantities of sand and gravel, and stone that cannot be assigned to specific counties, and values indicated by symbol W.
[3] Data may not add to totals shown because of independent rounding.

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TABLE A-90. PRINCIPAL MINERAL PRODUCERS IN WISCONSIN

Commodity and company	Address	Type of activity	County
Cement:			
Marquette Cement Mfg. Co.	20 N. Wacker Dr. Chicago, Ill. 60606	Portland and masonry, dry process.	Milwaukee.
Medusa Portland Cement Co.	Box 5668 Cleveland, Ohio 44101	White, dry process	Manitowoc.
Clays and shale:			
Oakfield Shale Brick & Tile Co.	Oakfield, Wis. 53065	Pit and plant	Fond du Lac.
Union Grove Drain Tile Co.	Box 848 Union Grove, Wis 53182	do	Racine.
Coke:			
Milwaukee Solvay Coke Div., Pickands Mather & Co.	311 E. Greenfield Ave. Milwaukee, Wis. 53204	Coke ovens	Milwaukee.
Iron ore:			
Jackson County Iron Co. Inland Steel Co.: Black River Falls.	30 W. Monroe St. Chicago, Ill. 60603	Mine, concentrator, agglomerator.	Jackson.
Lead and zinc:[1]			
Eagle-Picher Industries, Inc.: Shullsburg	Box 406 Galena, Ill. 61036	Mine and mill	Lafayette.
Lime:			
Cutler-LaLiberte-McDougall Corp.	12th Ave. & Waterfront Duluth, Minn. 55802	Quick and hydrated, two rotary kilns, one continuous hydrator.	Douglas.
Mayville White Lime Works.	Box 25 Mayville, Wis. 53050	Quicklime, one shaft kiln.	Dodge.
Rockwell Lime Co.	228 N. LaSalle St. Chicago, Ill. 60601	Quick and hydrated, one rotary kiln, one continuous hydrator.	Manitowoc.
The Western Lime & Cement Co.:			
Green Bay plant	Box 2076 Milwaukee, Wis. 53201	Quick and hydrated, five shaft kilns, one batch hydrator.	Brown.
Knowles plant		Hydrated, five shaft kilns, one continuous hydrator.	Dodge.
Eden plant		Quick and hydrated, five shaft kilns, one batch hydrator.	Fond du Lac.
Peat:			
Demilco, Inc	3101 W. Custer Ave. Milwaukee, Wis. 53209	Bog, processing plant.	Waukesha.
Expanded perlite:			
Midwest Perlite Co	912 College Ave. Appleton, Wis. 54911	Processing plant	Outagamie.
Zonolite Division, W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 02140	do	Milwaukee.
Sand and Gravel:			
Eau Claire Sand & Gravel Co.	104 Gibson St. Eau Claire, Wis. 54701	Pits; portable and stationary plants.	Chippewa, Dunn, Eau Claire.
Genessee Sand & Gravel Co. Inc., Jaeger Sand & Gravel Co., Inc.	8532 W. Schlinger Ave. Milwaukee, Wis. 53214	Pit; portable and stationary plants.	Waukesha.
Janesville Sand & Gravel Co.	1110 Harding St. Janesville, Wis. 53545	Pit; stationary plant.	Rock.
Johnson Sand & Gravel Inc.	22750 W. Bluemound Rd. Waukesha, Wis. 53186	Pits; portable plants.	Waukesha.
Edward Kraemer & Sons, Inc.	Plain, Wis. 53577	do	Brown, Barron, Chippewa, Eau Claire, Forest, Oconto, Ozaukee, Polk, Portage, Racine, Sauk, Sawyer, Sheboygan, Walworth, Washington, Waukesha.
C. C. Linck, Inc	1226 N. Center St. Beaver Dam, Wis. 53916	do	Calumet, Columbia, Dane, Dodge, Fond du Lac, Green Lake, Racine, Waushara.
Manley Sand Division, Martin Marietta Corp.	Rockton, Ill. 61072	Pit; stationary plant; industrial sand.	Columbia.
Plautz Brothers, Inc	Route 1 Willard, Wis. 54493	Pit; portable plants.	Chippewa, Clark.
Rein, Schultz & Dahl, Inc.	6217 Nesbitt Rd. Madison, Wis. 53711	do	Dane, Jackson, Jefferson, Waukesha.
State Sand & Gravel Co.	10833 W. Watertown Plank Rd. Milwaukee, Wis. 38326	Pits; stationary plants.	Waukesha.
Wissota Sand & Gravel Co.	313 One Half Eau Claire Eau Claire, Wis. 54701	do	Barron, Bayfield, Eau Claire, Washington.

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TABLE A-90.(continued)

Commodity and company	Address	Type of activity	County
Stone:			
Granite:			
Anderson Bros. & Johnson Co.	Box 26 E. Manson St. Wausau, Wis. 54401	Quarries; stationary plant.	Marathon.
Lawrence Ladick, Inc.	Route 1 Vesper, Wis. 54489	Quarry	Do.
Lake Wausau Granite Co.	Box 397 Wausau, Wis. 54401	Quarry; stationary plant.	Do.
Limestone and dolomite:			
Courtney & Plummer, Inc.	Box 351 Neenah, Wis. 54956	Quarries; stationary and portable plants.	Calumet, Waupaca, Winnebago.
Daanen & Janssen	124 S. Huron St. De Pere, Wis. 54115	Quarries; portable plants.	Brown.
Franklin Stone Products, Inc.	7220 S. 68th St. Hales Corners, Wis. 53130	Quarry; stationary plant.	Milwaukee.
Halquist Lannon Stone Co.	Sussex, Wis. 53089	Quarries; stationary plant.	Waukesha.
Edward Kraemer & Sons, Inc.	Plain, Wis. 53577	Quarries; portable plants.	Buffalo, Columbia, Crawford, Douglas, Dunn, Green, Juneau, La Crosse, Marquette, Monroe, Pierce, Richland, St. Croix, Sauk, Trempealeau, Vernon.
Arthur Overgaard, Inc.	Box 87 Elroy, Wis. 53929	Quarries; stationary and portable plants.	Juneau, Various counties.
Vulcan Materials Co., Midwest Division.	29 N. Wacker Dr. Chicago, Ill. 60606	Quarries; stationary plants.	Milwaukee, Racine, Waukesha, Winnebago.
Waukesha Lime & Stone Co.	Box 708 Waukesha, Wis. 53186	Quarry; stationary and portable plants.	Waukesha.
Wingra Stone Co., Inc., Stewart Watson Construction Co.	Route 2, Box 4284 Madison, Wis. 53711	Portable plants	Dane.
Quartzite:			
Foley Bros., Inc	450 Endicott Bldg. on 4th St. Paul, Minn. 55101	Quarry; stationary plant.	Sauk.
Minnesota Mining & Mfg. Co.	2501 Hudson Rd. St. Paul, Minn. 55119	Quarries; stationary plant.	Marathon.
Sandstone:			
Ellis Quarries, Inc	Stevens Point, Wis. 55481	Quarries; stationary plant.	Marathon, Wood.
Traprock (basalt):			
Bryan Rock Products Inc.	Box 215 Shakopee, Minn. 55379	Quarry; stationary and portable plants.	Polk.
GAF Corp	Pembine, Wis. 54156	Quarry; stationary plant.	Marinette.
McLean Construction Co.	314 Ogden Ave. Superior, Wis. 54880	Quarry; portable plant.	Douglas.
Vermiculite, exfoliated			
Zonolite Div., W. R. Grace & Co.	62 Whittemore Ave. Cambridge, Mass. 02140	Processing plant	Milwaukee.

[1] All lead-zinc mining was by underground methods.

15196950

Wyoming

The Division of Wyoming into regular physiographic units is difficult due to the diversity of the rock structures and to their irregularity of occurrence in geographic pattern. Nevertheless, the vast area of Wyoming is essentially basin and range and a conventional division into provinces has been suggested as follows:

Mountain cores of Precambrian crystalline rock,

Basin areas of Paleozoic, Mesozoic, and Tertiary sedimentaries,

Absaroka Mountain volcanic area and the

Yellowstone Plateau of the northwest corner of Wyoming,

Belts of folded and thrust faulted Paleozoic and Mesozoic sediments in the West and Southwest,

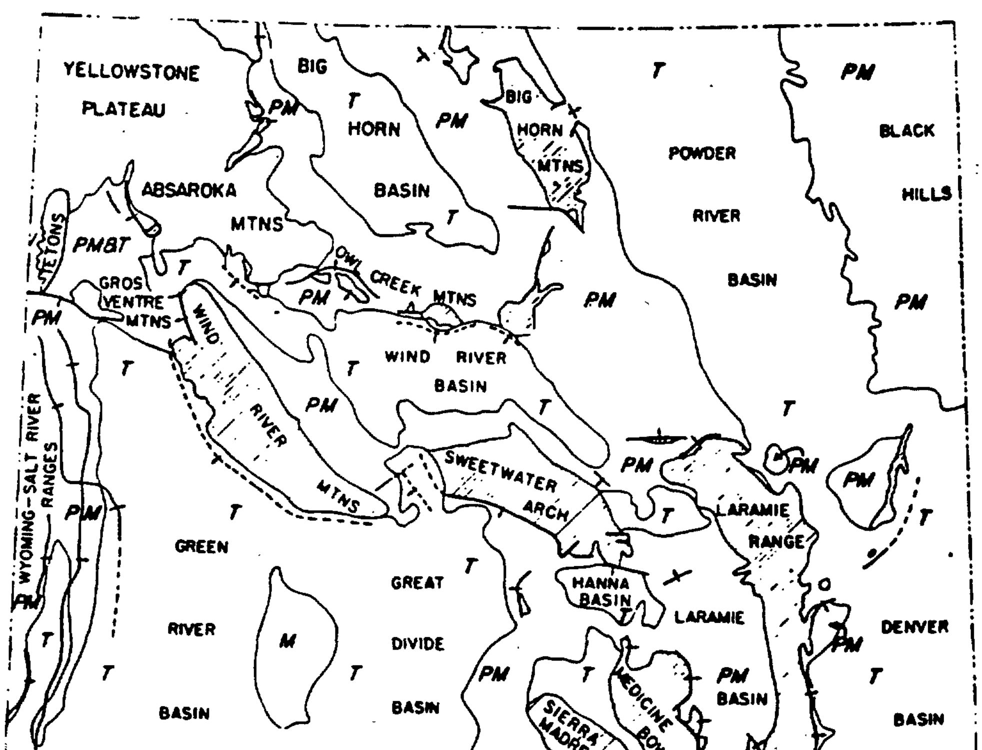
Areas of scattered volcanic stocks and necks.

Figure A-70 shows the various mountain ranges and basins and particularly mark the Precambrian mountain cores which consist of igneous and metamorphosed complex rock systems.

Not surprisingly, the occurrence of the asbestiform minerals, both chrysotile and amphibole types, and the genetically related minerals, talc and soapstone, is closely associated with the igneous and metamorphic formations of the Precambrian mountain cores. This relationship is apparent in the map figure which illustrates the locations of specific mineral occurrences. The nature of the specific occurrences is described in Tables A-91 and A-92 which are number keyed to the locations identified on Figure A-71.

Generally, the metallic mineralization of Wyoming also is located in or adjacent to the mountain ranges as might be expected. However, many of Wyomings metallic mineral deposits are undeveloped. Except for uranium, there is little metal mining in Wyoming. Many valuable deposits remain to be commercially exploited. Similarly, the nonmetallic minerals are not a large part of the Wyoming production either, compared to the fossil fuel mineral production. The fossil fuels account for most of the Wyoming mineral values produced. Stone, sand and gravel are abundantly worked to rank second to fossil fuels in degree of mineral recovery activity. Other nonmetallics and metallics, notably uranium, make up the bulk of the production. The county by county production and the principal mineral producers of Wyoming are given in Tables A-93 and A-94. There are no reports of the fibrous amphibole minerals being encountered in the Wyoming production.

NOTE: The jade deposits in the Red Desert/South Pass area are known to contain fibrous material (which could conceivably be asbestiform). There is some hard-rock mining for jade going on in addition to exploitation of surface material. Also the western flank of the Tetons contain considerable (variety Bowenite).



Generalized geological index map of Wyoming showing major structural features. Pre-Cambrian areas are cross hatched. Paleozoic and Mesozoic areas are indicated by the symbol M. Tertiary areas are indicated by the symbol T. Tertiary volcanics are shown by coarse stipple. Major faults are shown as heavy lines with arrows showing direction of movement of hanging wall of thrust faults (555).

FIGURE A-70. GEOLOGICAL MAP OF WYOMING

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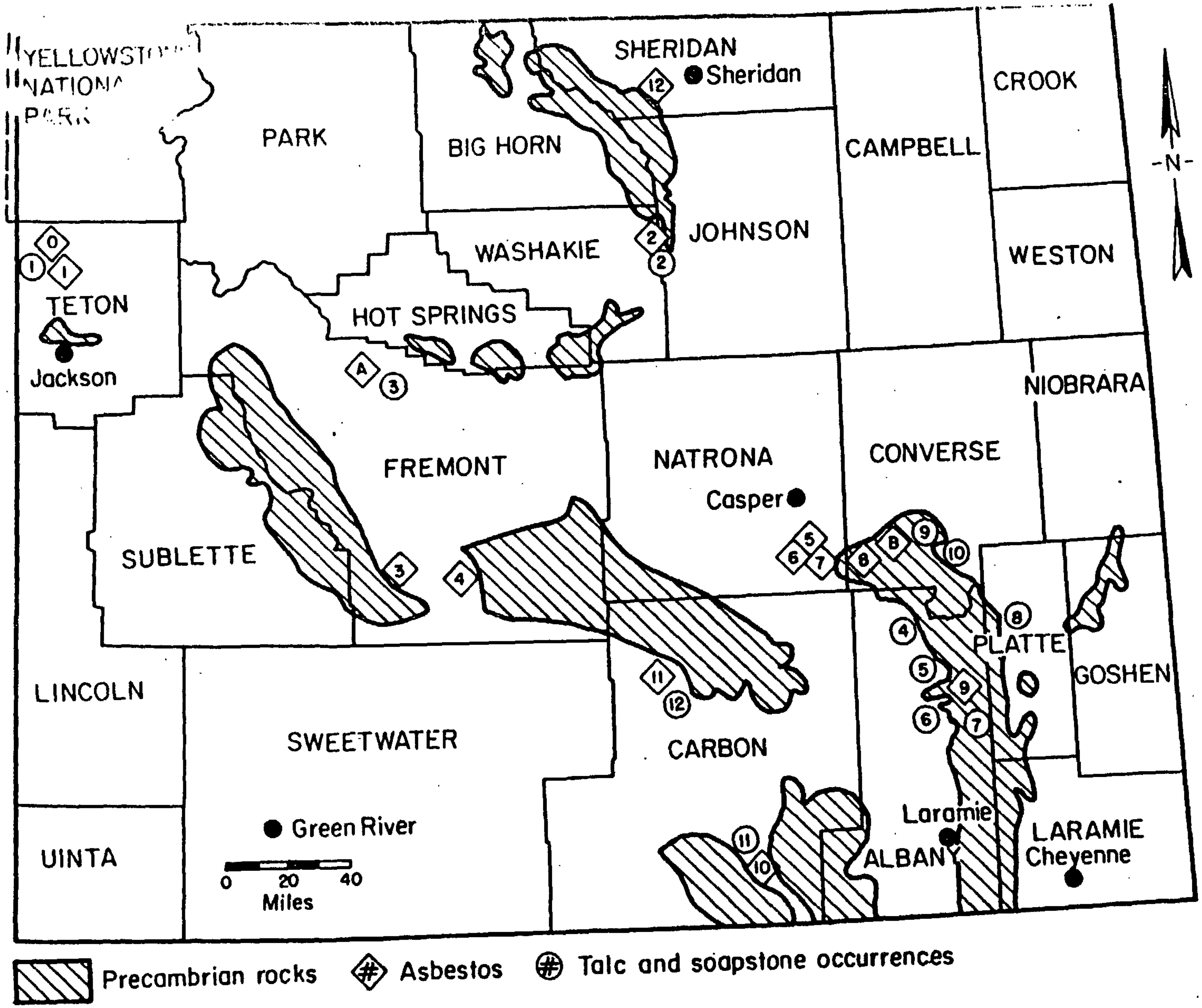

FIGURE A-71. OCCURRENCE OF IGNEOUS AND METAMORPHIC ROCK IN WYOMING

TABLE A-91. ASBESTOS OCCURRENCES IN WYOMING

Teton County

1 *Berry Creek Deposit;* at head of Berry Creek approximately 2 mi. east of the Teton range watershed and 6 mi. south of Yellowstone National Park. A tabular, vertical body of altered peridotite strikes east, has a maximum width of 50 ft., and can be traced for 400 ft. along the strike. The peridotite is surrounded by granite gneiss. "Several fractures in altered peridotite contains slip-fiber chrysotile and amphibole less than 1 in. long. Much of the fiber has been destroyed by later replacement."

Brown Bear Deposit; secs. 19 or 20, T. 47 N., R. 116 W., has a 400 ft. serpentine dike or sill with stringers of slip-fiber chrysotile and amphibole which strikes north-south, and stands vertically. Some fibers are more than 1 in. long but many fibers have been destroyed by later quartz replacement. A mill was built, but there has been no production

Washakie County

2 *Canyon Creek Claim;* sec. 25, T. 48 N., R. 86 W. A series of metamorphics (greenstone, hornblende schist, metadiabase) strike N. 15° E. and disappear under [illegible] sediments about 1 [illegible] of the claim. These pre-Cambrian metamorphics contain a very small amount of brittle, [illegible] asbestos and talc. No chrysotile has been found

Fremont County

3 *Fire King Deposit;* SE¼ sec. 26, T. 30 N., R. 100 W., about 4 mi. due north of Atlantic City. A pre-Cambrian serpentine body strikes northeast and stands vertical; it is associated with chlorite and magnetite schist, quartzite, and gneiss. Later granites cut and invade the metamorphics. Asbestos is found in small lenses in one zone 150 ft. wide and 900 ft. long Cross-fiber chrysotile (average ½-in. long) for spinning was produced prior to 1921. A mill was built in 1919

4 *Beaver Creek Deposit;* sec. 19, T. 30 N., R. 96 W., 5 mi. south of Beaver Hill. Five lenticular serpentine masses, surrounded by granite are well exposed. The western lens is 600 ft. long and 250 ft. wide, the central lens is 800 ft. long and 130 ft. wide. The other lenses are much smaller. Small amounts of cross-fiber chrysotile veinlets (¼ to ½-in. long) in the serpentine strike parallel to the serpentine mass. Vermiculite, talc and anthophyllite also are associated with the serpentine

A *Abernathy Deposit;* sec. 5, T. 7 N., R. 5 W., sec. 32, T. 8 N., R. 5 W., (Wind River Meridian) and sec 7, T. 42 N., R. 104 W. at the west end of the Owl Creek mountains. Amphibole asbestos follows cleavage planes and fractures in a thick diabase dike. The fibers are weedy and brittle, but are longer than the Casper Mountain fibers

Natrona County

5 *Casper Mountain Asbestos Deposits;* sec. 16, 17, T. 39 N., R. 79 W., 8 mi. from Casper. A mill was built in 1910, but there has been little production since that time. A serpentine body, several thousand feet wide trends east-west through the north-central half of secs. 16 and 17. The serpentine is surrounded and cut by granite gneiss, hornblende schist, and metadiabase. Small, parallel cross-fiber chrysotile veins about ⅛- to ¼-in. wide are separated by layers of serpentine. Locally many fractures are filled with cross-fiber chrysotile. Some fibers up to 4 in. long have been reported

6 *Smith Creek Deposit;* SE¼ sec. 19, SW cor. sec. 20, NW cor. sec. 29, NE cor. sec. 30, T. 31 N., R. 78 W. Three pre-Cambrian serpentine lenses, one barren

of asbestos, contain vertical veins of yellowish-green cross fiber chrysotile, mostly ½ in. in length. The central lens is 650 ft. by 300 ft. The western lens shows fiber ¼ in. long in a zone 75 ft. to 150 ft. in length

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7 *Green Hill Deposit;* sec. 23, T. 31 N., R. 78 W., 3 mi. east of the Smith Creek asbestos mill. One serpentine lens 1,700 ft. long and 500 ft. wide surrounded by granite has a 1 in. veinlet of harsh, coarse chrysotile. A small amount of harsh, slip-fiber chrysotile was found on the dump

TABLE A-91 (continued)

Converse County

8 *Koch Deposit;* sec. 15, T. 31 N., R. 77 W., on the north side of the West Fork of Deer Creek. A serpentine lens 1,500 ft. by 500 ft. trends northeast. There are several smaller lenses; all are surrounded by granite. A small amount of amphibole asbestos, one chrysotile veinlet, ¼-in. wide, and two vermiculite lenses have been reported

B *Stardust Claim;* sec. 20, T. 32 N., R. 75 W. A small amount of chrysotile is associated with a vermiculite deposit

Albany County

9 *Halleck Canyon area;* approx. sec. 18, T. 22 N., R. 71 W. Chrysotile cross-fiber veinlets up to 2 inches in width occur in two small areas of serpentine. The cross-fibers are up to one inch in length and are not excessively brittle. Minor amounts of slip-fibers are developed in other fracture systems which are flat dipping and trend obliquely to the regional foliation

Carbon County

10 A deposit of amphibole asbestos is reported to be located about 1½ mi. southwest of *Encampment*

11 *Seminoe Mountains area;* secs. 21, 22, T. 26 N., R. 85 W. Two narrow anthophyllite asbestos veins occur in amphibole schist. The veins vary from 2 inches to 1.6 feet in width and are intermittently exposed in several prospect pits along an east-west strike parallel to a regional foliation of vertical dip. The asbestos occurs mainly as mass fibers and some soft and brittle cross fibers up to 2½ inches long

Sheridan County

12 Asbestos is reported in the mountains west of Sheridan

TABLE A-92. TALC AND SOAPSTONE OCCURRENCES IN WYOMING

Teton County

1 *Badger Creek Deposit;* sec. 5, T. 6 N., R. 117 W. Massive soapstone and fibrous talc are found in an olivine diabase that has been intruded by granite and quartz (32, p. 816).

Washakie County

2 *Canyon Creek Talc Deposit;* sec. 25, T. 48 N., R. 86 W. Talc schist and fibrous talc are associated with folded hornblende schist, olivine metadiabase, and a small amount of brittle amphibole asbestos. The rocks strike N. 15° E. (32, p. 857).

Fremont County

3 *Abernathy Deposit;* (See VERMICULITE).
Soapstone was found by Aughey on "north side of Rattlesnake Mountains, on headwaters of S. Powder" (16, p. 61).

Albany County

4 *Halleck Canyon Area;* approx. sec. 13, T. 22 N., R. 72 W. Talc, approximately 100 feet long by 5 to 7 feet wide, occurs in a steatized serpentine zone. The deposit is well foliated, steeply dipping unit that strikes approximately due north. The deposit grades into a steatized chlorite-rich rock to the north. The talc-rich layer contains numerous zones of tremolite which makes it brittle and of poor quality (635).

5 *Nipper No. 1 Claim;* SE¼ sec. 32, T. 25 N., R. 73 W. Talc schist strikes N. 55° W. and dips 65° N. Apparently a hornblende schist altered along a zone of weakness to talc. Sericite and quartz are associated with the talc schist (344).

5 *Nipper No. 2 Claim;* W½ NE¼ and E½ NW¼ sec. 32, T. 25 N., R. 73 W. A contorted talc schist body trends N. 25° to 45° W. and stands vertically (344).

5 *Nipper No. 3 Claim;* NE¼ sec. 32, T. 25 N., R. 73 W. A talc schist, actinolite schist and anthophyllite schist strike N. 45° E. and dip 65° S. The talc schist is about 20 ft. wide at the prospect pit, but narrows to several inches (344).

5 *Nipper No. 4 Claim;* S½ SE¼ sec. 29, and N½ NE¼ sec. 32, T. 25 N., R. 75 W. A talc schist contacts hornblende schist along the northeast slope of a hill. The schists strike N. 25° E. and dip 65° E. (344).

6 *Palmer Canyon;* sec. 1, T. 24 N., R. 71 W. A talc lens has formed between hornblende schist and granite. The lens of good quality talc is 6 ft. thick at the surface, but narrows with depth; it is a very small deposit. Anthophyllite has altered to vermiculite (296).

7 In sec. 3, T. 25 N., R. 71 W. a lens of talc-like mineral, "Mg-amphibole schist" is about 1½ mi. long and 1/3 mi. wide. The foliated type of schist is a mass of interwoven acicular pseudomorphs of Mg-amphibole after hornblende (468); (See GARNET, MICA).

Platte County

8 *Collins Deposit;* 500 ft. from south quarter corner, sec. 15, T. 27 N., R. 70 W. Country rocks at this prospect are hornblende schist, granite, and quartz veins. Good grade crumpled and metamorphosed talc is found in the main pit but the quantity is small as the talc pinches and swells (297).

Converse County

9 *Badger Prospect;* (See VERMICULITE).

10 *Smith Prospect;* (See VERMICULITE).

Carbon County

11 A deposit 1 mi. south of Encampment consists of high-grade chlorite mica that grades into talc (217).

15196956

Carbon County

12 Foliated talc was reported from the Deserted Treasure Mine in the Seminoe Mountains (16, p. 61).

TABLE A-93. MINERAL PRODUCTION IN WYOMING, BY COUNTY

County	1970	1971	Minerals produced in 1971, in order of value
Albany	$7,317	$6,877	Cement, stone, petroleum, sand and gravel, gypsum, iron ore.
Big Horn	23,346	27,790	Petroleum, clays, sand and gravel, gypsum, natural gas, lime, stone.
Campbell	142,193	128,441	Petroleum, natural gas, natural gas liquids, coal, sand and gravel.
Carbon	26,397	35,601	Uranium, coal, petroleum, natural gas, natural gas liquids, sand and gravel, natural gas.
Converse	20,704	22,293	Petroleum, coal, natural gas liquids, sand and gravel, natural gas.
Crook	22,954	21,693	Petroleum, clays, natural gas, sand and gravel.
Fremont	82,688	83,175	Petroleum, uranium, iron ore, natural gas, natural gas liquids, sand and gravel, feldspar.
Goshen	588	458	Sand and gravel, lime, petroleum.
Hot Springs	36,932	33,811	Petroleum, coal, natural gas, sand and gravel.
Johnson	17,804	16,870	Petroleum, clays, natural gas, natural gas liquids, sand and gravel.
Laramie	3,104	2,739	Petroleum, stone, sand and gravel.
Lincoln	12,122	14,135	Coal, natural gas liquids, phosphate rock, natural gas, petroleum, sand and gravel, stone.
Natrona	51,222	51,014	Petroleum, uranium, natural gas, natural gas liquids, clays, sand and gravel, stone.
Niobrara	W	1,916	Petroleum, natural gas, sand and gravel, natural gas liquids.
Park	112,090	109,934	Petroleum, natural gas, natural gas liquids, sand and gravel, gypsum, stone.
Platte	4,820	4,727	Iron ore, stone, sand and gravel.
Sheridan	6,685	8,026	Coal, petroleum, sand and gravel, stone.
Sublette	22,047	24,581	Petroleum, natural gas, sand and gravel, natural gas liquids.
Sweetwater	86,457	97,076	Sodium carbonate, petroleum, natural gas, coal natural gas liquids, sand and gravel, stone.
Teton	W	209	Sand and gravel, stone.
Uinta	2,435	1,674	Natural gas, natural gas liquids, sand and gravel, clays, stone.
Washakie	10,046	11,020	Petroleum, natural gas, natural gas liquids, sand and gravel, lime.
Weston	11,834	12,452	Petroleum, clays, sand and gravel, natural gas stone.
Yellowstone National Park	W		
Undistributed [1]	2,250	1,424	
Total [2]	705,533	717,937	------Value in $ thousands

W Withheld to avoid disclosing individual company confidential data; included with "Undistributed."
[1] Includes gem stones, some stone, and sand and gravel that cannot be assigned to specific counties and values indicated by symbol W.
[2] Data may not add to totals shown because of independent rounding.

15196957

TABLE A-94. PRINCIPAL MINERAL PRODUCERS IN WYOMING

Commodity and company	Address	Type of activity	County
Cement:			
Monolith Portland Midwest Co.	3326 San Fernando Road Los Angeles, Calif. 90065	Plant	Albany.
Clays:			
American Colloid Co.	5100 Suffield Court Skokie, Ill. 60076	Open pit mine and plant.	Big Horn.
		Open pit mine	Crook.
		Open pit mine and plant.	Weston.
Black Hills Bentonite Co.	Box 1, Mills, Wyo. 82644	do	Johnson.
Dresser Industries, Inc., Greybull Dresser Minerals Division.	Box 832 Greybull, Wyo. 82426	do	Big Horn.
		Open pit mines and plant.	Do.
International Minerals & Chemical Corp., Eastern Clay Products Dept.	Administration Center Old Orchard Road Skokie, Ill. 60079		
NL Industries Inc., Baroid Division.	Box 1675 Houston, Tex. 77001	do	Do.
		Open pit mines	Weston.
Wyo-Ben Products, Inc.	Box 1979 Billings, Mont. 59103	Open pit mine and plant.	Big Horn.
Youghiogheny & Ohio Coal Co., Federal Bentonite Co. Division.	4614 Prospect Ave. Cleveland, Ohio 44103	do	Crook.
		do	Weston.
Coal:			
The Kemmerer Coal Co.	Frontier, Wyo. 83121	2 strip mines, crushing and oil treatment plant.	Lincoln.
Pacific Power & Light Co.	920 S.W. 6th Avenue Portland, Oreg. 97204	Strip mine	Converse.
Gypsum:			
Big Horn Gypsum Co.	Box 590 Cody, Wyo. 82414	Open pit mine and wallboard plant.	Park.
Iron Ore:			
CF & I Steel Corp.	Box 316 Pueblo, Colo. 81002	Underground mine and beneficiation mill.	Platte.
United States Steel Corp., Western Ore Operations.	Lander, Wyo. 82520	Open pit mine and agglomerator.	Fremont.
Lime:			
The Great Western Sugar Co.	Box 5308 Denver, Colo. 80217	Pot kiln at beet-sugar plant.	Big Horn.
Holly Sugar Corp.	Holly Sugar Bldg. Colorado Springs, Colo. 80902	Shaft kiln at beet-sugar plant.	Goshen.
Natural gas and petroleum: [1]			
Phosphate rock:			
Stauffer Chemical Company of Wyoming.	636 California Street San Francisco, Calif. 94108	Open pit mine and beneficiation plant.	Lincoln.
Sand and gravel (commercial):			
Boatright-Smith	Box 1129 Casper, Wyo. 82602	Pits and plants	Natrona.
Gilpatrick Construction Co., Inc.	Box 978 Riverton, Wyo. 82501	Pit	Sublette.
		Pit	Sweetwater.
		Pit	Washakie.
Teton Construction Co.	Box 3248 Cheyenne, Wyo. 82001	Pit	Carbon.
		Pit	Johnson.
		Pit	Laramie.
Union Pacific Railroad Co.	1416 Dodge Street Omaha, Nebr. 68102	Pit	Albany.
Sodium Carbonate:			
Allied Chemical Corp., Industrial Chemicals Div.	Box 70 Morristown, N.J. 07960	Underground mine and refinery.	Sweetwater.
FMC Corp., Inorganic Chemicals Division.	Box 872 Green River, Wyo. 82935	do	Do.
Stauffer Chemical Company of Wyoming.	Box 513 Green River, Wyo. 82935	do	Do.
Stone:			
The Great Western Sugar Co.	Box 5308 Denver, Colo. 80217	Quarry and plant	Laramie.
Guernsey Stone Co.	Box 337 Guernsey, Wyo. 82214	do	Platte.
Monolith Portland Midwest Co.	Box 40 Laramie, Wyo. 82070	2 quarries and plants	Albany.
Union Pacific Railroad Co.	1416 Dodge Street Omaha, Nebr. 68102	Quarry and plant	Laramie.
Uranium:			
Federal American Partners	Box 991 Riverton, Wyo. 82501	3 open pit mines and mill.	Fremont.
Petrotomics Co.	Drawer 2450 Casper, Wyo. 82601	Open pit mine and mill.	Carbon.
Utah Construction & Mining Co.	Box 911 Riverton, Wyo. 82501	2 open pit mines, leaching operation.	Do.
		2 open pit mines, 2 under-ground mines, and mill.	Fremont.
Western Nuclear, Inc.	1700 Broadway, Suite 1900 Denver, Colo. 80202	5 underground mines, 1 open pit mine, leaching operation, and mill.	Do.

[1] Most of the major oil and gas companies and many smaller companies operate in Wyoming, and several commercial directories contain complete lists of them.

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Source References

(2) Asbestos in the United States, A. H. Chidester and A. F. Shride, 1962, USGS Map MR-17.

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15. SUPPLEMENTARY NOTES

16. ABSTRACT The report describes work directed at defining the potential seriousness of asbestos emissions that result from man's disturbing geological formations in which asbestos occurs as an accessory mineral. An extensive literature search yielded a catalog of all known and probable occurrences of asbestos in the United States. These locations were screened to identify large mining activities which could cause release of asbestos to the atmosphere. Sixteen such sites were identified. Emissions were estimated for these sites, based on production figures and the nature of the operations. Two sites were selected from this group for further characterization based on probable emissions and population density considerations. Ambient air samples were taken at the two sites, using high volume samplers; the samples were analyzed, using electron microscope techniques. The analysis of these samples did not support the hypothesis that a public health hazard exists because of asbestos emissions from the two sources tested; however, because of the limited sampling and analysis, it would not be valid to apply these findings to all possible sources.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Air Pollution	Air Pollution Control	13B
Asbestos	Stationary Sources	08G, 11E
Mining		08I
Gangue		

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