DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

TO ACCOMPANY MAP MR-18

PYROPHYLLITE, AND KYANITE AND RELATED MINERALS IN THE UNITED STATES

(Exclusive of Alaska and Hawaii)

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Introduction

The important deposits of pyrophyllite, and of kyanite and the related minerals (sillimanite, andalusite, dumortierite, and topaz) in the United States (exclusive of Alaska and Hawaii) are shown on the accompanying map. These minerals, all aluminum silicates, are grouped together because they occur in similar geologic environments. Their high aluminum content makes them particularly useful in the manufacture of ceramic articles that must withstand high temperatures as well as abrupt temperature change. Pyrophyllite has important non-ceramic uses also; because of its soft flaky nature it is used in insecticides, asphalt filler, paints, and rubber.

Only the principal deposits are shown on the map, although these minerals occur in minor amounts at numerous other localities. Many of these are listed by Grametbaur (1959).

Three types of deposits containing these minerals are distinguished on the map: micaceous schist or gneiss deposits, quartzose deposits, and placer deposits. Inasmuch as information is meager about the size and mineral content of many deposits of micaceous schist and gneiss which contain these minerals, most of these deposits are shown on the map either by a square or by heavy dashes to indicate the general trend of an extensive deposit. More information is available for quartzose deposits, and such deposits that are known to be of large size are distinguished from those that are of moderate, small, or unknown size.

The deposits are numbered consecutively by states and identified in the Locality Index on the following pages, which also gives the principal literature references used in the compilation. The full references are cited in the concluding section. Unpublished material in the files of the Geological Survey was also consulted.

Production

Pyrophyllite is currently produced, or has been produced in the past, from practically every pyrophyllite deposit in California and North Carolina that is shown on the map. All domestic production of kyanite in the United States since 1950 has come from the deposits at Willis Mountain and Baker Mountain, Va., and Henry Knob., S. C.; kyanite was formerly produced from Ogilby, Calif., the Clarkesville district, Ga., the Petaca district, N. M., and Celo Mountain in the Burnsville-Swannanoa district, N. C. Andalusite is now produced with pyrophyllite at Hillsboro, N. C.; it was formerly produced at White Mountain, Calif., and Hawthorne district, Nev. Dumortierite was once mined at Oreana, Nev.; topaz has been produced from the Brewer deposit, S. C.

Geologic features

These minerals characteristically occur in certain types of metamorphic rocks or hydrothermally altered rocks in some mountain systems. Principal deposits of these minerals in the United States are in the Appalachian Mountain and Rocky Mountain systems and in California and Nevada.

Kyanite, sillimanite, and andalusite are the most abundant and widespread of this group of six minerals; these three have the same chemical composition--Al_2SiO_5--but have different physical properties. Kyanite, sillimanite, and andalusite commonly occur in two rather distinct types of deposits--micaceous schists and gneisses, and quartzose deposits. In many places only one of the Al_2SiO_5 minerals is present, but in a few places two or all three of them occur together. Micaceous schists and gneisses with sufficiently high aluminum content usually have kyanite or sillimanite in areas of regional metamorphism, and andalusite or sillimanite in areas of thermal metamorphism. The Al_2SiO_5 minerals may be present in these schists and gneisses over large areas, but the average content of these minerals usually does not exceed 10 percent, except in thin beds or layers that are particularly high in aluminum. Within the areas of micaceous schist and gneiss, the Al_2SiO_5 minerals commonly occur also in quartz veins and pegmatites, but such deposits are small and are not shown on the map. In the quartzose deposits, kyanite is the most common Al_2SiO_5 mineral; andalusite, sillimanite, pyrophyllite, and other aluminous minerals are also present in some quartzose deposits. The origin of the quartzose deposits is not clear in all cases, but some definitely appear to be of metamorphic origin, and other deposits seem to have been formed by hydrothermal alteration. These quartzose deposits are generally not so large as the schist or gneiss deposits, but the content of Al_2SiO_5 minerals in many quartzose deposits is between 10 and 30 percent; because of their higher grade, these deposits have been more productive than the deposits in schist and gneiss. The Al_2SiO_5 minerals tend to accumulate in placer deposits; kyanite and sillimanite occur with ilmenite and other heavy minerals in large deposits of sand in Florida.

Pyrophyllite, $Al_2Si_4O_{10}(OH)_2$, occurs in quartzose deposits of probable hydrothermal origin in California, North Carolina, and South Carolina. Geologic

features characteristic of these deposits are the occurrence of pyrophyllite with other aluminous minerals in lenticular deposits or schistose zones within silicified zones in volcanic rocks.

Dumortierite, $8Al_2O_3.B_2O_3.6SiO_2.H_2O$, and topaz, $Al_2SiO_4(F,OH)_2$, also occur with other aluminous minerals in quartzose deposits of probable hydrothermal origin. However, they are found in abundance only in a very few localities in the conterminous United States.

Locality Index

	Lat. N.	Long. W.
ARIZONA		
1. Quartzsite. Dumortierite occurs with kyanite, andalusite, sillimanite, and pyrophyllite in schist. Wilson, 1929.	33°38'	114°15'
CALIFORNIA		
1. Pacific and Colton mines. Three deposits of pyrophyllite schist occur in silicified volcanic and sedimentary rocks. Wright, 1957b.	37°38'	118°20'
2. Champion or White Mountain mine. Andalusite and other high-alumina minerals occur as podlike masses in quartzite. Kerr, 1932; Lemmon, 1937; Wright, 1957a.	37°37'	118°18'
3. Imus mine. Poorly exposed body of pyrophyllite schist. Wright, 1957b.	37°05'	118°17'
4. Victorite mine. Pyrophyllite occurs in altered zone in andesite and dacite tuff. Bowen, 1954; Wright and others, 1953.	34°40'	117°08'
5. Pioneer mine. Pyrophyllite schist and pyrophyllite-quartz schist occur in altered zones in andesitic to rhyolitic flows, breccias and tuffs. Jahns and Lance, 1950.	33°02'	117°10'
6. Ogilby or Vitrefax mine, Cargo Muchacho Mtns. Kyanite quartzite. Henshaw, 1942; Wright, 1957a.	32°50'	114°47'
COLORADO		
1. Jamestown district. Biotite-sillimanite schist of Idaho Springs formation (Precambrian). Lovering and Goddard, 1950.	40°05'	105°25'
2. Holy Cross quadrangle. Biotite-sillimanite-quartz-feldspar schist in Idaho Springs formation (Precambrian). Heinrich and Bever, 1957.	39°22'	106°20'
FLORIDA		
1. Starke ilmenite mine. Kyanite and sillimanite occur with ilmenite and other heavy minerals in quartz sand deposit. Browning and others, 1956; Engineering and Mining Journal, 1952.	29°55'	82°01'

GEORGIA		
1. Towns, Union, and Fannin Counties. Kyanite-graphite schist and kyanite-garnet schist. La Forge and Phalen, 1913; Prindle and others, 1935.	34°57'	84°03'
2. Clarkesville district. Kyanite-graphite-mica schist, 30-60 feet thick, crops out on circumference of gneissic dome. Espenshade and Potter, 1960; Prindle and others, 1935; Teague and Furcron, 1948.	34°38'	83°32'
3. Madison, Ebert, and Hart Counties. Sillimanite-quartz-mica schist. Espenshade and Potter, 1960; Furcron and Teague, 1945; Grant, 1958; Hudson, 1946; Teague, 1950.	34°03' to 34°25'	83°08' to 82°50'
4. Graves Mountain. Kyanite-quartz rock occurs as large irregular lenses. Espenshade and Potter, 1960; Johnston, 1935; Watkins, 1942.	33°44'	82°32'
IDAHO		
1. Boehls Butte. Kyanite, andalusite, and sillimanite occur together in cordierite-biotite schist and gneiss. Abbott and Prater, 1954; Hietanen, 1956.	46°59'	115°50'
2. Troy deposit. Sillimanite-biotite-quartz schist and gneiss. Forrester, 1942; Skinner and Kelly, 1947.	46°43'	116°37'
MAINE		
1. Lake Onawa region. Andalusite occurs in contact metamorphosed rocks around a large igneous intrusion. Philbrick, 1936.	45°22'	69°25'
2. Squaw Mountain. Andalusite occurs in contact metamorphosed rocks around gabbro. Philbrick, 1940.	45°29'	69°42'
3. Moxie Pond. Andalusite occurs in contact metamorphosed rocks around gabbro.	45°16'	69°54'
MASSACHUSETTS		
1. Oak Hill. Andalusite-quartz-sericite schist. Jahns, 1942.	42°32'	71°32'
MONTANA		
1. Jack Creek Ridge. Dumortierite	46°22'	112°19'

MONTANA (cont'd.)

occurs in quartz latitic welded tuff. U. S. Geol. Survey, 1955.

2. Elk Creek deposit. Sillimanite and corundum occur in biotite gneiss and pegmatitelike rock. Clabaugh and Armstrong, 1950. 45°34' 111°20'
3. Bear Trap deposit. Sillimanite and corundum occur in biotite gneiss and pegmatitelike rock. Clabaugh and Armstrong, 1950. 45°31' 111°31'
4. Dillon region. Sillimanite-biotite schist. Heinrich, 1950. 45°10' 112°27'

NEVADA

1. Oreana or Champion mine. Lenses of dumortierite and andalusite occur in quartz-sericite schist (altered rhyolitic and trachytic tuffs). Kerr and Jenney, 1935. 40°20' 118°13'
2. Green Talc, Bismark, and Deep Mines claims, Hawthorne district. Andalusite, corundum, and diaspore occur in silicified zones in metavolcanics and schist. 38°37' 118°30'

NEW HAMPSHIRE

1. Signal Hill. Kyanite-quartz-muscovite schist, interbedded with volcanics and mica schist. Bannerman, 1941; Chapman, 1939. 43°39' 72°14'
2. Mt. Monadnock. Sillimanite-quartz-mica schist. Fowler-Billings, 1944. 42°52' 72°07'

NEW MEXICO

1. Big Rock deposit, Petaca district. Irregular bodies of kyanite-quartz rock occur in kyanite-quartz-mica schist. Barker, 1958; Corey, 1954. 36°33' 106°05'
2. Picuris Range. Kyanite-sillimanite quartzite and andalusite-quartz-mica schist. Montgomery, 1953. 36°17' 105°44'

NEW YORK

1. Dutchess County. Kyanite schist and sillimanite gneiss. Barth, 1936. 41°35' 73°35'

NORTH CAROLINA

1. Hagers Mountain. Irregular lenses of kyanite-quartz rock. Espenshade and Potter, 1960. 36°28' 78°58'
2. Bowlings Mountain. Pyrophyllite and other high-alumina minerals occur in silicified zones in altered volcanics. Broadhurst and Councill, 1953; Stuckey, 1928. 36°14' 78°45'
3. Hillsboro. Andalusite-pyropnyllite-quartz deposit. Broadhurst and Councill, 1953; Espenshade and Potter, 1960. 36°04' 79°08'
4. Bradshaw mine. Pyrophyllite deposit. 35°59' 79°14'
5. Snow Camp (Holman's Mill) mine. Irregular body of pyrophyllite-quartz rock in sericite schist. Broadhurst and Councill, 1953. 35°52' 79°24'
6. Staley mine. Pipelike (?) body of pyrophyllite-quartz rock in sericite schist. Broadhurst and Councill, 1953; Burgess, 1936; Stuckey, 1928. 35°48' 79°36'
7. Corbett or Smithfield deposit. Kyanite and some pyrophyllite and topaz in irregular bodies of quartzose rock. Espenshade and Potter, 1960. 35°35' 78°24'
8. Phillips and Womble mines. Pyrophyllite schist in altered zones in acidic volcanic tuff. Stuckey, 1928. 35°30' 79°25'
9. Hemp (Robbins) mine. Pyrophyllite schist in acidic volcanic tuff. Stuckey, 1928. 35°25' 79°37'
10. Steeds deposit. Lenticular bodies of pyrophyllite-quartz rock. 35°30' 79°46'
11. Clubb Mountain. Lenticular bodies of kyanite-quartz rock. Espenshade and Potter, 1960. 35°24' 81°05'
12. Reese Mountain. Sillimanite-quartz deposit. Espenshade and Potter, 1960. 35°25' 81°07'
13. Crowder's Mountain. Kyanite quartzite and mica schist. Espenshade and Potter, 1960; Keith and Sterrett, 1931. 35°14' 81°17'
14. Knox deposit. Sillimanite quartzite and schist. Espenshade and Potter, 1960. 35°12' 81°16'
15. The Pinnacle and Carolina mines. Kyanite quartzite and mica schist. Espenshade and Potter, 1960; Keith and Sterrett, 1931. 35°12' 81°19'
16. Cliffside - Elkin belt. Sillimanite-quartz-biotite-muscovite schist. Hash and Van Horn, 1951. 35°11' to 36°02' 81°48' to 81°00'
17. Burnsville-Swannanoa area. Kyanite-quartz-feldspar-biotite gneiss. Espenshade and Potter, 1960. 35°53' to 36°02' 82°17' to 82°03'
18. Warne-Sylva belt. Sillimanite- 35°00' 83°57'

NORTH CAROLINA (cont'd.)

quartz-biotite-muscovite schist. Hash and Van Horn, 1951.	to 35°22'	to 83°13'

PENNSYLVANIA

1. Coatesville-West Chester district. Kyanite and sillimanite-mica schists. McKinstry, 1949.	39°55'	75°45'

SOUTH CAROLINA

1. Henry Knob. Kyanite quartzite. Espenshade and Potter, 1960; Keith and Sterrett, 1931; Smith and Newcome, 1951.	35°08'	81°17'
2. Brewer mine. Topaz, andalusite, kyanite, and pyrophyllite occur in silicified schistose volcanic rocks. Fries, 1942; Peyton and Lynch, 1953; Espenshade and Potter, 1960.	34°39'	80°25'
3. Little Mountain. Lenses of kyanite-quartz rock in mica schist. Espenshade and Potter, 1960.	34°12'	81°24'
4. Boles or Strom Mountain deposit. Andalusite and pyrophyllite and other high alumina minerals occur in quartzose rock. Espenshade and Potter, 1960.	33°57'	82°02'
5. Piedmont belt. Sillimanite-quartz-biotite- muscovite schist. Hudson, 1946; Overstreet and Griffitts, 1955; Smith, 1945.	34°35' to 34°57' 34°54' to 35°11'	82°29' to 82°14' 82°00' to 81°48'

SOUTH DAKOTA

1. Southern Black Hills. Sillmanite-garnet schist. Connolly and O'Harra, 1929; Page and others, 1953.	43°45'	103°30'

VIRGINIA

1. Willis Mountain. Kyanite quartzite. Espenshade and Potter, 1960; Jonas, 1932; Watkins, 1932.	37°28'	78°28'
2. Woods Mountain. Kyanite-muscovite quartzite. Espenshade and Potter, 1960; Jonas, 1932.	37°24'	78°35'
3. Baker Mountain. Kyanite-muscovite quartzite. Espenshade and Potter, 1960; Jonas, 1932; Watkins, 1932.	37°12'	78°39'
4. Leigh Mountain. Kyanite quartzite. Espenshade and Potter, 1960; Jonas, 1932.	37°12'	78°21'
5. Madisonville. Kyanite-muscovite quartzite. Espenshade and Potter, 1960.	37°11'	78°42'
6. Halifax County. Kyanite-muscovite quartzite. Espenshade and Potter, 1960.	36°48'	79°04'

WASHINGTON

1. Silver Hill. Sillimanite-biotite schist and andalusite-graphite schist; sillimanite and andalusite also in cassiterite-bearing pegmatite. Page, 1942.	47°33'	117°20'

WISCONSIN

1. Manitowish Range. Kyanite-garnet-biotite-plagioclase-quartz gneiss. Allen and Barrett, 1915; Fries, 1939.	46°15'	90°00'

WYOMING

1. Laramie Range. Kyanite and sillimanite occur in cordierite-mica schist. Hagner, 1953.	42°00'	105°31'

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