

KYANITE AND RELATED MINERALS

(Data in thousand metric tons unless otherwise noted)

Domestic Production and Use: In Virginia, one firm with integrated mining and processing operations produced kyanite from two hard-rock open pit mines and mullite by calcining kyanite. Two other companies, one in Alabama and another in Georgia, produced synthetic mullite from materials mined from four sites. Each company sourced materials from one site in Alabama and one site in Georgia; these data are withheld to avoid disclosing company proprietary data. Commercially produced synthetic mullite is made by sintering or fusing such feedstock materials as kyanite or bauxitic kaolin. Natural mullite occurrences typically are rare and uneconomic to mine. Of the kyanite-mullite output, 90% was estimated to have been used in refractories and 10% in other uses, including abrasive products such as motor vehicle brake shoes and pads and grinding and cutting wheels; ceramic products, such as electrical insulating porcelains, sanitaryware, and whiteware; foundry products and precision casting molds; and other products. An estimated 60% to 65% of the refractory usage was consumed by the iron and steel industries, and the remainder was used by industries that manufacture chemicals, glass, nonferrous metals, and other materials. Andalusite was commercially mined from an andalusite-pyrophyllite-sericite deposit in North Carolina and processed as a blend of primarily andalusite for use by producers of refractories in making firebrick.

Salient Statistics—United States:	2012	2013	2014	2015	2016^e
Production:					
Mine	¹ 99	¹ 110	¹ 89	¹ 108	100
Synthetic mullite	W	W	W	W	W
Imports for consumption (andalusite)	3	4	4	12	2
Exports (kyanite)	36	42	40	40	35
Consumption, apparent	W	W	W	W	W
Price, average, dollars per metric ton: ²					
U.S. kyanite, raw concentrate	340	300	260	270	300
U.S. kyanite, calcined	510	450	370	410	450
Andalusite, Transvaal, South Africa	300	350	340	290	300
Employment, kyanite mine, office, and plant, number ^e	125	135	140	155	150
Employment, mullite plant, office, and plant, number ^e	230	240	260	250	240
Net import reliance ³ as a percentage of apparent consumption	E	E	E	E	E

Recycling: Insignificant.

Import Sources (2012–15): South Africa, 75%; Peru, 19%; France, 4%; and other, 2%.

Tariff: Item	Number	Normal Trade Relations 12–31–16
Andalusite, kyanite, and sillimanite	2508.50.0000	Free.
Mullite	2508.60.0000	Free.

Depletion Allowance: 22% (Domestic), 14% (Foreign).

Government Stockpile: None.

Events, Trends, and Issues: Crude steel production in the United States, which ranked fourth in the world, decreased slightly in the first 7 months of 2016 compared with that of the same period in 2015, indicating a minimal to no change in consumption of kyanite-mullite refractories if this trend continues. Total world steel production decreased slightly during the first 8 months of 2015 compared with a 2.3% decrease in the same period in 2015 from that of 2014. Of the total world refractories market, which was estimated to be approximately 40 million metric tons, crude steel manufacturing consumed more than 70% of refractories production.

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The decrease in world steel production during the first 7 months of 2016 was, in part, the result of a deceleration in growth in China from a slowing of its construction activities and in its manufacturing and automotive sectors, a continued sluggish economy in Europe, and slightly lower steel demand in the United States. Although steel production and consumption was expected to be slightly lower in 2016, gradual increases were expected in 2017. Andalusite and mullite could receive increasing consideration as alternative aluminosilicate refractory minerals to refractory bauxite; a decreasing availability of inexpensive refractory-grade bauxite from China, which accounted for about three-quarters of market share worldwide, has continued.

Although experiencing an economic slowdown, China is expected to continue to have an economic growth rate of 6% and to be the largest market for refractories, accounting for the majority of global demand. Slowing, but still above-average, growth is expected in India and other portions of Asia. Eastern Europe, North America, and Western Europe are expected to have sluggish but continuing refractory demand because of their large industrial bases. The economies of North America and Europe are expected to increase in 2017 with recovery in manufacturing and steel production, but may lag behind the worldwide average in the longer term with steel production increasing in India and shifting to less-developed countries, such as Indonesia and Vietnam. Demand for refractories in iron and steel production is expected to have greater increases in countries with higher rates of growth in steel production. Increased demand also is anticipated for refractories used to produce other metals and in the industrial mineral market because of increasing production of cement, ceramics, glass, and other mineral products.

Andalusite projects in Peru continued to progress. One facility increased production capacity by 10% and planned to increase by about 10% more in 2017. At another andalusite project in Peru, the company continued exploration and worked on construction of the processing operation as it sought a joint-venture investment partner. Production was anticipated to begin by 2017. Large resources of kyanite were discovered in 2015 in Murmansk in the Kola Peninsula region of Russia, but currently are considered uneconomic, owing to their distance from market.

World Mine Production and Reserves:

	Mine production		Reserves ⁴
	2015	2016 ^e	
United States (kyanite)	108	100	Large
India (kyanite and sillimanite)	65	65	1,600
Peru (andalusite)	35	35	NA
South Africa (andalusite)	200	190	NA
Other countries	—	—	NA
World total (rounded)	⁵ 408	⁵ 390	NA

World Resources: Large resources of kyanite and related minerals are known to exist in the United States. The chief resources are in deposits of micaceous schist and gneiss, mostly in the Appalachian Mountains and in Idaho. Other resources are in aluminous gneiss in southern California. These resources are not economic to mine at present. The characteristics of kyanite resources in the rest of the world are thought to be similar to those in the United States. Significant resources of andalusite are known to exist in China, France, Peru, and South Africa; kyanite resources have been identified in Brazil, India, and Russia; and sillimanite has been found in India.

Substitutes: Two types of synthetic mullite (fused and sintered), superduty fire clays, and high-alumina materials are substitutes for kyanite in refractories. Principal raw materials for synthetic mullite are bauxite, kaolin and other clays, and silica sand.

^eEstimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data. — Zero.

¹Source: Virginia Department of Mines, Minerals and Energy.

²Source: Average of prices reported in Industrial Minerals.

³Defined as imports – exports.

⁴See [Appendix C](#) for resource and reserve definitions and information concerning data sources.

⁵In addition to the countries listed, France continued production of andalusite and Brazil and China produced kyanite and related minerals. Output is not reported quantitatively, and no reliable basis is available for estimation of output levels.