

## 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 a synthetic 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. Synthetic mullite production data are withheld to avoid disclosing company proprietary data. Commercially produced synthetic mullite is made by sintering or fusing such feedstock materials as kyanite, kaolin, bauxite, 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.

<b><u>Salient Statistics—United States:</u></b>	<b><u>2013</u></b>	<b><u>2014</u></b>	<b><u>2015</u></b>	<b><u>2016</u></b>	<b><u>2017<sup>e</sup></u></b>
Production:					
Mine	<sup>1</sup> 110	<sup>1</sup> 89	<sup>1</sup> 109	<sup>1</sup> 79.7	90
Synthetic mullite	W	W	W	W	W
Imports for consumption (andalusite)	4	4	12	3	8
Exports (kyanite)	42	40	40	37	40
Consumption, apparent	W	W	W	W	W
Price, average, dollars per metric ton: <sup>2</sup>					
U.S. kyanite, raw concentrate	300	260	270	270	270
U.S. kyanite, calcined	450	370	410	410	420
Andalusite, Transvaal, South Africa	320	340	330	330	340
Employment, kyanite mine, office, and plant, number <sup>e</sup>	140	150	155	150	150
Employment, mullite plant, office, and plant, number <sup>e</sup>	210	230	220	210	210
Net import reliance <sup>3</sup> as a percentage of apparent consumption	E	E	E	E	E

**Recycling:** Insignificant.

**Import Sources (2013–16):** South Africa, 74%; Peru, 19%; France, 5%; United Kingdom 1%, and other, 1%.

<b><u>Tariff:</u></b>	<b><u>Item</u></b>	<b><u>Number</u></b>	<b><u>Normal Trade Relations</u></b>
			<b><u>12–31–17</u></b>
	Andalusite, kyanite, and sillimanite	2508.50.0000	Free.
	Mullite	2508.60.0000	Free.

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

**Government Stockpile:** None.

## KYANITE AND RELATED MINERALS

**Events, Trends, and Issues:** Crude steel production in the United States, which ranked fourth in the world, increased by about 2.4% in the first 8 months of 2017 compared with that of the same period in 2016, indicating a similar change in consumption of kyanite-mullite refractories. Total world steel production increased by nearly 5% during the first 8 months of 2017 compared with the same period in 2016. The increase in world steel production during the first 8 months of 2017 was the result of incremental to small increases in production, both in developed and developing countries, especially in Asia. Despite a continuing deceleration in growth, China still led with the largest increase in steel production; increases also took place in the Philippines and Vietnam. Of the total world refractories market, which was estimated to be approximately 40 million tons, crude steel manufacturing consumed more than 70% of refractories production.

The availability of inexpensive refractory-grade bauxite from China, which accounted for about three-quarters of the refractories market share worldwide, continued to decrease. Andalusite and mullite could receive increasing consideration as alternative aluminosilicate refractory minerals to refractory bauxite, but the availability of andalusite may have been hampered by heavy rains and flooding that took place during the first quarter of 2017 in major andalusite-producing areas in South Africa and Peru. China was expected to have an economic growth rate approaching 7% in 2017 and continue to be the largest market for refractories. Slowing, but still above-average, growth is expected in most other portions of Asia. The economies of North America and Europe are expected to increase in 2018 with continued 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, the Philippines, and Vietnam. Demand for refractories in iron and steel production is expected to have larger 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.

Although slowed somewhat by adverse weather conditions, andalusite projects in Peru continued to progress. One facility increased production capacity by 10% and, at another andalusite project, the company continued exploration and construction of the processing facility as it sought a joint-venture investment partner, deemed necessary to proceed with production.

### **World Mine Production and Reserves:**

	Mine production		Reserves <sup>4</sup>
	2016	2017 <sup>e</sup>	
United States (kyanite)	80	90	Large
India (kyanite and sillimanite)	73	75	1,600
Peru (andalusite)	40	40	NA
South Africa (andalusite)	180	180	NA
World total (rounded)	<sup>5</sup> NA	<sup>5</sup> NA	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 identified 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.

<sup>e</sup>Estimated. E Net exporter. NA Not available. W Withheld to avoid disclosing company proprietary data.

<sup>1</sup>Source: Virginia Department of Mines, Minerals and Energy.

<sup>2</sup>Source: Average of prices reported in Industrial Minerals.

<sup>3</sup>Defined as imports – exports.

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

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