

## KYANITE AND RELATED MINERALS

(Data in metric tons unless otherwise specified)

**Domestic Production and Use:** In Virginia, one firm with integrated mining and processing operations produced an estimated 85,000 tons of kyanite worth \$36 million from two hard-rock open pit mines and 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 were 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 not economical 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 70% of the refractory use was by the iron and steel industries, and the remainder was by industries that manufacture cement, 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. Another company mined mineral sands in the southeastern United States; product blends that included kyanite and (or) sillimanite were marketed to the abrasive, foundry, and refractory industries.

<b>Salient Statistics—United States:</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>	<b>2023<sup>e</sup></b>
Production:					
Kyanite, mine	191,300	167,100	1105,000	185,900	85,000
Synthetic mullite	W	W	W	W	W
Imports for consumption (andalusite)	6,960	714	1,390	7,630	6,500
Exports (kyanite)	40,100	37,400	48,000	51,800	52,000
Consumption, apparent <sup>2</sup>	W	W	W	W	W
Price, average unit value of exports (free alongside ship), <sup>3, 4</sup> dollars per metric ton	358	369	369	382	420
Employment, number: <sup>e, 5</sup>					
Kyanite, mine, office, and plant	150	140	140	140	140
Synthetic mullite, office and plant	200	200	200	200	200
Net import reliance <sup>6</sup> as a percentage of apparent consumption	E	E	E	E	E

**Recycling:** Insignificant.

**Import Sources (2019–22):**<sup>4</sup> South Africa, 48%; Peru, 24%; France, 21%; United Kingdom, 7%; and other, <1%.

<b>Tariff:</b>	<b>Item</b>	<b>Number</b>	<b>Normal Trade Relations 12–31–23</b>
	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 8 months of 2023 compared with that in the same period in 2022, indicating a similar change in consumption of kyanite-mullite refractories. Global crude steel production was unchanged during the first 8 months of 2023 compared with that in the same period in 2022. Global crude steel production during the first 8 months of 2023 was disrupted by ongoing logistical issues and high input costs. The steel industry continued to be the leading consumer of refractories.

A company in South Africa that accounted for nearly one-third of global andalusite output was transferred to its new owner following the conclusion of business rescue proceedings in 2022. In mid-2019, the company entered business rescue proceedings attributed to financial problems in preparation to be transferred to a new owner. In January 2021, the company announced that a new investor and owner had been approved.

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Andalusite production in 2023 remained constrained by challenging market conditions, such as availability of ore supply and increasing costs. In 2022, andalusite mines in South Africa were adversely affected by electricity supply disruptions, flooding, and shipping problems. In Peru, andalusite production in 2023 was estimated to have decreased from that in 2022 and output was not expected to meet demand. Andalusite exports from France were greater than those from Peru but exports from China were less than those reported from other andalusite-producing countries. In India, mining of new groups of minerals, including andalusite, was approved, but some sillimanite mines had previously been reclassified as beach sand minerals mines and, as a result, those mines were no longer considered sillimanite-producing mines. Some sillimanite was produced in association with kyanite-producing mines. If andalusite producers are unable to meet demand, market participants may consider alternatives such as bauxite and mullite. Development of and production from new refractory-grade bauxite sources in Brazil and Guyana continued to progress in 2023.

**World Mine Production and Reserves:** Reserves estimates for China were revised based on Government reports.

	Mine production <sup>e</sup>		Reserves <sup>7</sup>
	2022	2023	
United States (kyanite)	185,900	85,000	Large
China (andalusite, crude ore)	100,000	100,000	5,000,000
France (andalusite)	65,000	65,000	NA
India (kyanite and sillimanite)	12,000	10,000	7,200,000
Peru (andalusite)	43,000	40,000	NA
South Africa (andalusite)	170,000	170,000	NA
World total (rounded)	<sup>8</sup> NA	<sup>8</sup> NA	NA

**World Resources:**<sup>7</sup> 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 economical 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 Energy.

<sup>2</sup>Defined as production + imports – exports.

<sup>3</sup>Calculated from U.S. Census Bureau export data.

<sup>4</sup>Includes data for the following Harmonized Tariff Schedule of the United States code: 2508.50.0000.

<sup>5</sup>Estimated based on data from the U.S. Department of Labor, Mine Safety and Health Administration.

<sup>6</sup>Defined as imports – exports.

<sup>7</sup>See Appendix C for resource and reserve definitions and information concerning data sources.

<sup>8</sup>In addition to the countries and (or) localities listed, Brazil and Iran may have produced kyanite and related minerals and China may have produced kyanite in addition to andalusite, but information was not available to make reliable estimates of output.