KYANITE AND RELATED MATERIALS

By Michael J. Potter

Kyanite, andalusite, and sillimanite are anhydrous aluminum silicate minerals that have the same chemical formula, Al_2SiO_5, but differ in crystal structure and physical properties. When calcined at high temperatures, these minerals are converted to mullite, $3Al_2O_3 \cdot 2SiO_2$, and silica, SiO_2, which are refractory materials. Andalusite and sillimanite are not mined in the United States, except for a pyrophyllite/andalusite/sericite deposit that is mined by Piedmont Minerals Co., Inc., near Hillsborough, NC. In processing the ore, andalusite is not separated but remains in various combinations with the pyrophyllite and sericite to produce blends of products.

Production

Kyanite was mined in 1997 by Kyanite Mining Corp. at two openpit locations in Buckingham County, VA. The company also operated beneficiation plants and calcining facilities for the conversion of kyanite to mullite. High-temperature sintered synthetic mullite was produced by C-E Minerals near Americus, GA. Production data were obtained for the kyanite and synthetic mullite producers but cannot be published because they are proprietary.

Consumption

The U.S. Geological Survey does not publish data on end uses of kyanite and synthetic mullite because of company proprietary data. However, refractories were a major end use, including monolithics such as ramming mixtures, castables, gunning mixes, and plastics. Other end uses included whitewares, kiln furniture, acoustical tiles, catalytics, electrical insulators, shell castings, foundry uses, and investment casting procedures.

Foreign Trade

U.S. kyanite, mullite, and synthetic mullite were shipped to worldwide locations including Europe, Latin America, and the Pacific Rim. In recent years, imports of andalusite have been largely from South Africa. There were no known U.S. imports of kyanite or sillimanite in 1997.

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In South Africa, Hernic Exploration Pty.'s andalusite plant in Pietersburg-Burgersfort was shut down for a period to allow upgrading of the process and grade of the output. The renewed capacity of the plant is 30,000 metric tons per year of andalusite, with product grading 58% to 59.5% alumina, and a maximum of 0.9% iron oxide. Hernic acquired the plant in the first half of 1996 from Hoogenoeg Andalusite Pty., (Industrial Minerals, 1997b).

Outlook

Raw materials for low-, medium-, and high-alumina refractories include high-purity kaolinitic or bauxitic clays, kyanite, andalusite, sillimanite, mullite, bauxite, fused alumina, or tabular alumina aggregates. High-alumina bricks and monolithics are growing in demand for most high-temperature applications and are projected to be growth sectors in refractories globally (Jarvis, 1997).

The trend toward increased usage of monolithic refractories in general is continuing. Developments during the past 20 years in monolithics, especially castables (refractory concrete), have resulted in products with properties that are equivalent to, or better than, fired bricks. Improved installation and lining removal techniques are providing a further boost to the trend in using monolithic refractories (Semler, 1997a).

The iron and steel industry is a major end user of refractories. Other user industries include nonferrous metals, glass, cement, and lime. Changes, such as in process operating conditions, furnace lining design, and refractory selection have resulted in refractories that are higher quality and longer lasting. As a result, there also has been reduced refractory consumption.

U.S. steel production has increased gradually during the past few years (Semler, 1997b). Although the European steel industry has been a mature market in recent years, the iron and steel industries of East Asia are seen to have growth potential (Bolger, 1997). Dominant producers of refractories in general in this region are China, Japan, and the Republic of Korea. China's refractories industry has been the largest by volume with Japan second (O'Driscoll, 1997).

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TABLE 1
PRICE OF KYANITE AND RELATED MATERIALS

(Dollars per metric ton)

1997	Price
Andalusite, South Africa, 57.5% alumina, 2,000 metric ton bulk, f.o.b. 1/	180 - 200
Andalusite, South Africa, 59.5% alumina, 2,000 metric ton bulk, f.o.b. 1/	220 - 240
Kyanite, USA (VA), 54% to 60% alumina, 35-325 mesh, 18 ton lots, explant:	
Raw	154 - 185
Calcined	273 - 304
Sillimanite, South Africa, 70% alumina, bags, c.i.f. 2/ main European port	314 - 330

1/ "Free-on-board."
2/ "Cost, insurance, and freight."

Source: Industrial Minerals (London), December 1997, no. 363, p. 79.

TABLE 2
U.S. IMPORTS FOR CONSUMPTION OF ANDALUSITE 1/ 2/ 3/

Year	Quantity (metric tons)	Value 4/ (thousands)
1996	11,300	$2,310
1997	8,170	1,680

1/ Most material is from South Africa.
2/ Harmonized Tariff System (HTS) code: 2508.50.0000.
3/ Data are rounded to three significant digits.
4/ Customs value.

Source: Bureau of the Census.

TABLE 3
KYANITE: WORLD PRODUCTION, BY COUNTRY 1/ 2/

(Metric tons)

Country 3/ and commodity	1993	1994	1995	1996	1997 e/
Australia: e/					
Kyanite	800	800	800	800	800
Sillimanite 4/	100	100	100	100	100
Brazil: Kyanite e/	600	600	600	600	600
China: Unspecified e/	2,500	2,500	2,500	2,500	2,500
France: Andalusite e/	50,000	50,000	45,000	45,000	45,000
India:					
Kyanite	11,359	6,265	6,772 r/	6,715 r/	6,700
Sillimanite	14,895	10,378	9,687 r/	7,521 r/	7,500
Kenya: Kyanite e/	(5/)	(5/)	(5/)	(5/)	--
Korea, Republic of: Andalusite	18	--	--	--	--
South Africa:					
Andalusite	187,708	206,291	206,378 r/	228,010 r/	220,000
Sillimanite	569	525	317	303 r/	300
Spain: Andalusite e/	3,000	3,500	3,500	3,500	3,500
United States:					
Kyanite	W	W	W	W	W
Mullite, synthetic	W	W	W	W	W
Zimbabwe: Kyanite	878	567	875 r/	141 r/	50

e/ Estimated. r/ Revised. W Withheld to avoid disclosing company proprietary data.
1/ Estimated data are rounded to three significant digits.
2/ Owing to incomplete reporting, this table has not been totaled. Table includes data available through March 20, 1998.
3/ In addition to the countries listed, a number of other nations produce kyanite and related materials, but output is not reported quantitatively, and no reliable basis is available for estimation of output levels.
4/ In addition, about 7,000 metric tons of sillimanite clay (also called kaolinized sillimanite) is produced annually containing 40% to 48% Al_2O_3.
5/ Less than 1/2 unit.