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KYANITE, SILLIMANITE AND ANDALUSITE

(FINAL RELEASE)

GOVERNMENT OF INDIA
MINISTRY OF MINES
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30 Kyanite, Sillimanite and Andalusite

Kyanite, sillimanite and andalusite are unhydrous aluminosilicate minerals that have the same chemical formula Al_2O_3 but differ in crystal structure and physical properties. When calcined at high temperature around 1350 ^{0}C to 1380 ^{0}C for kyanite and slightly higher for andalusite and sillimanite, these minerals are converted to mullite, ($3 Al_2O_3.2SiO_2$) and silica (SiO_2) which are refractory minerals.

Synthetic mullite is made by heating mixtures of alumina and silica or bauxite and kaolin at around 1550 ^{0}C to 2000 ^{0}C. Refractory are heat resistant materials used in high temperature applications such as furnances, ladles, kilns, in the metallurgical, glass, chemical, cement and other industries.

RESOURCES

Kyanite

The total reserves/resources of kyanite as per NMI database, based on UNFC system as on 1.4.2015 in the country have been placed at 104.98 million tonnes. Out of these resources, only 0.68 million tonnes are the reserves and 104.29 million tonnes are the remaining resources. Out of total resources, high and medium-grade resources together account for merely 1.74%, low grade 8%, mixed grade 0.73%, quartz kyanite rock, kyanite gneiss rock and kyanite schist 87.1% and granular, others and not-known grades 2.41%. Statewise, share of Telangana is 46% of total resources followed by Andhra Pradesh 30.5%, Karnataka 12.67% and Jharkhand 7.23%. Remaining 3.60% resources are in Kerala, Maharashtra, Rajasthan, Tamil Nadu and West Bengal collectively (Table-1).

Sillimanite

The total reserves/resources of sillimanite as per NMI database, based on UNFC system in the country as on 1.4.2015 have been placed at 70.20 million tonnes. Out of these resources, the reserves are only 6.50 million tonnes, while about 63.70 million tonnes are the remaining resources. Out of total resources, more than 73.33% are granular high-grade, while quartz sillimanite rocks and sillimanite bearing rocks are about 21.64%. Resources of massive sillimanite of all grades are about 4.83%. The resources are located mainly in Odisha (25.15%), Tamil Nadu (24.87%), Uttar Pradesh (16.30%), Andhra Pradesh (12.52%), Kerala (10.17%) and Assam (6.55%). Remaining 4.44% resources are in Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Meghalaya, Rajasthan and West Bengal (Table-2).

Andalusite

The total reserves/resources of andalusite in the country as on 1.4.2015 as per NMI database, based on UNFC system have been placed at 28.20 million tonnes. Most of the resources are of reconnaissance category located in Uttar Pradesh (Table-3).

EXPLORATION & DEVELOPMENT

The detailed exploration for andalusite was carried out by the Geological Survey of India at Salaidih-Harwaria area of Sonbhadra district of Uttar Pradesh.

Details of exploration are furnished in Table-4.

Table – 1 : Reserves/Resources of Kyanite as on 1.4.2015
(By Grades/States)

(In tonnes)

Grade/State	Reserves				Remaining Resources								Total Resources (A+B)
	Proved STD111	Probable		Total (A)	Feasibility STD211	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
		STD121	STD122			STD221	STD222						
All India : Total	**639121**	**-**	**48958**	**688079**	**1505114**	**568205**	**2193427**	**579619**	**3577402**	**95869713**	**-**	**104293480**	**104981559**
By Grades													
High grade	-	-	-	-	-	4317	21867	-	297827	114689	-	438700	438700
Medium grade	212881	-	48958	261839	430490	-	276651	-	34410	381532	-	1123083	1384922
Low grade	426240	-	-	426240	234210	15930	1178813	386247	2214900	3952872	-	7982972	8409212
High & medium mixed	-	-	-	-	-	100550	53103	-	93640	106928	-	354221	354221
Medium & low mixed	-	-	-	-	-	-	-	-	-	48000	-	48000	48000
High, medium & low mixed	-	-	-	-	13097	89650	10606	-	45000	210025	-	368378	368378
Granular	-	-	-	-	-	-	-	-	167000	81359	-	248359	248359
Quartz kyanite rock	-	-	-	-	-	-	-	-	-	81105358	-	81105358	81105358
Kyanite gneiss rock	-	-	-	-	-	-	-	-	-	5370800	-	5370800	5370800
Kyanite schist	-	-	-	-	-	-	-	-	724625	4250000	-	4974625	4974625
Others	-	-	-	-	593710	23491	303166	1012	-	12530	-	933909	933909
Not-known	-	-	-	-	233607	334267	349221	192360	-	235620	-	1345075	1345075
By States													
Andhra Pradesh	-	-	-	-	-	-	399	-	-	32003829	-	32004228	32004228
Jharkhand	426240	-	-	426240	824472	524467	881313	-	1754900	3182363	-	7167515	7593755
Karnataka	-	-	-	-	637460	15930	113630	386247	1610502	10531529	-	13295298	13295298
Kerala	-	-	-	-	-	-	-	192360	-	10000	-	202360	202360
Maharashtra	212881	-	48958	261839	30085	27808	1187479	1012	45000	1684113	-	2975497	3237336
Rajasthan	-	-	-	-	13097	-	10606	-	-	-	-	23703	23703
Tamil Nadu	-	-	-	-	-	-	-	-	167000	81359	-	248359	248359
Telangana	-	-	-	-	-	-	-	-	-	48350000	-	48350000	48350000
West Bengal	-	-	-	-	-	-	-	-	-	26520	-	26520	26520

Figures rounded off.

Table – 2 : Reserves/Resources of Sillimanite as on 1.4.2015
(By Grades/States)

(In tonnes)

Grade/States	Reserves				Remaining Resources								Total Resources (A+B)
	Proved STD111	Probable		Total (A)	Feasibility STD211	Pre-feasibility		Measured STD331	Indicated STD332	Inferred STD333	Reconnaissance STD334	Total (B)	
		STD121	STD122			STD221	STD222						
All India : Total	**323231**	**5728868**	**450016**	**6502115**	**1020187**	**135278**	**20257525**	**4580083**	**17790664**	**16068690**	**3849600**	**63702027**	**70204142**
By Grades													
Massive high grade	-	-	-	-	-	-	-	-	-	11903	-	11903	11903
Massive medium grade	-	-	-	-	-	4000	-	-	-	29705	-	33705	33705
Massive low grade	44021	-	15000	59021	300	-	519	-	850000	2273786	-	3124605	3183626
Massive high & medium	-	-	-	-	-	-	-	-	-	19800	-	19800	19800
Massive medium & low	136981	-	7274	144255	-	-	-	-	-	-	-	-	144255
Massive high, medium & low	-	-	-	-	-	-	-	-	-	38	-	38	38
Granular high	128789	5728868	427742	6285399	1019887	120208	20257006	2480083	7590600	13732942	-	45200726	51486125
Quartz sillimanite rock	-	-	-	-	-	-	-	-	-	-	3748000	3748000	3748000
Sillimanite bearing rock	-	-	-	-	-	-	-	2100000	9350000	-	-	11450000	11450000
Others	-	-	-	-	-	11070	-	-	-	-	-	11070	11070
Unclassified	13440	-	-	13440	-	-	-	-	-	-	-	-	13440
Not-known	-	-	-	-	-	-	-	-	64	516	101600	102180	102180
By States													
Andhra Pradesh	2045	-	37	2082	15	11278	12	267	7430300	1346988	-	8788861	8790943
Assam	-	-	-	-	-	-	-	-	850000	6700	3748000	4604700	4604700
Jharkhand	-	-	-	-	-	-	-	-	-	83000	-	83000	83000
Karnataka	-	-	-	-	-	-	-	-	-	982725	-	982725	982725
Kerala	-	-	-	-	1015625	120000	-	2479816	160300	3369200	-	7144941	7144941
Madhya Pradesh	-	-	-	-	-	-	-	-	-	-	101600	101600	101600
Maharashtra	181002	-	22274	203276	-	-	-	-	64	15516	-	15580	218856
Meghalaya	-	-	-	-	-	-	-	-	-	55807	-	55807	55807
Odisha	-	5728868	427705	6156573	-	-	6557013	-	-	4943600	-	11500613	17657186
Rajasthan	-	-	-	-	300	-	519	-	-	-	-	819	819
Tamil Nadu	140184	-	-	140184	4246	4000	13699981	-	-	3612154	-	17320381	17460565
Uttar Pradesh	-	-	-	-	-	-	-	2100000	9350000	-	-	11450000	11450000
West Bengal	-	-	-	-	-	-	-	-	-	1653000	-	1653000	1653000

Figures rounded off.

Table – 3 : Reserves/ Resources of Andalusite as on 1.4.2015

(In '000 tonnes)

State	Total Reserves (A)	Remaining Resources			Total Resources (A+B)
		Inferred STD333	Reconnaissance STD334	Total (B)	
All India : Total	**–**	**4000**	**24201**	**28201**	**28201**
By Grades					
Unclassified	-	-	24201	24201	24201
Low	-	4000	-	4000	4000
By States					
Jharkhand	–	4000	1	4001	4001
Uttar Pradesh	–	-	24200	24200	24200

Figures rounded off

Table – 4 : Details of Exploration Activities for Kyanite, Sillimanite and Andalusite, 2015-16

Agency/ State/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage		
Andalusite							
GSI							
Uttar Pradesh							
Sonbhadra -	Salaidih Harwaria area (Mahakoshal Group)	-	-		33	22 core samples and 10 trench samples	G-2 stage exploration for andalusite was carried out in Harwaria area. The rocks of the area comprise andalusite-bearing phyllite and quartzite of Parsoi Formation, Mahakoshal Group and younger acid and basic intrusives. Andalusite occurs as porphyroblasts within the phyllite and schist. All 33 boreholes drilled show andalusite mineralisation from surface to 60 m depth. About 2% to 20% andalusite content is observed by visual estimation.

PRODUCTION & STOCKS

Kyanite

The production of kyanite at 2,901 tonnes in 2015-16, decreased by 54% as compared to the previous year due to lack of environmental clearance and less market demand. There were 5 reporting mines during the year under review as against 3 mines in the previous year. Two principal producers contributed almost the entire production of kyanite during the year (Tables- 5 to 7).

In 2015-16, 2,590 tonnes i.e. about 89% of total production of kyanite was of grade 40% Al_2O_3 and above and 311 tonnes about 11% of total production of kyanite was of grade below 40% Al_2O_3. About 93% of the total production was reported by the private sector.

Mine-head closing stocks at the end of the year 2015-16 were 14,519 tonnes as against 14,280 tonnes in 2014-15 (Table - 8).

The average daily employment of labour was 85 in 2015-16 as against 57 in the preceding year.

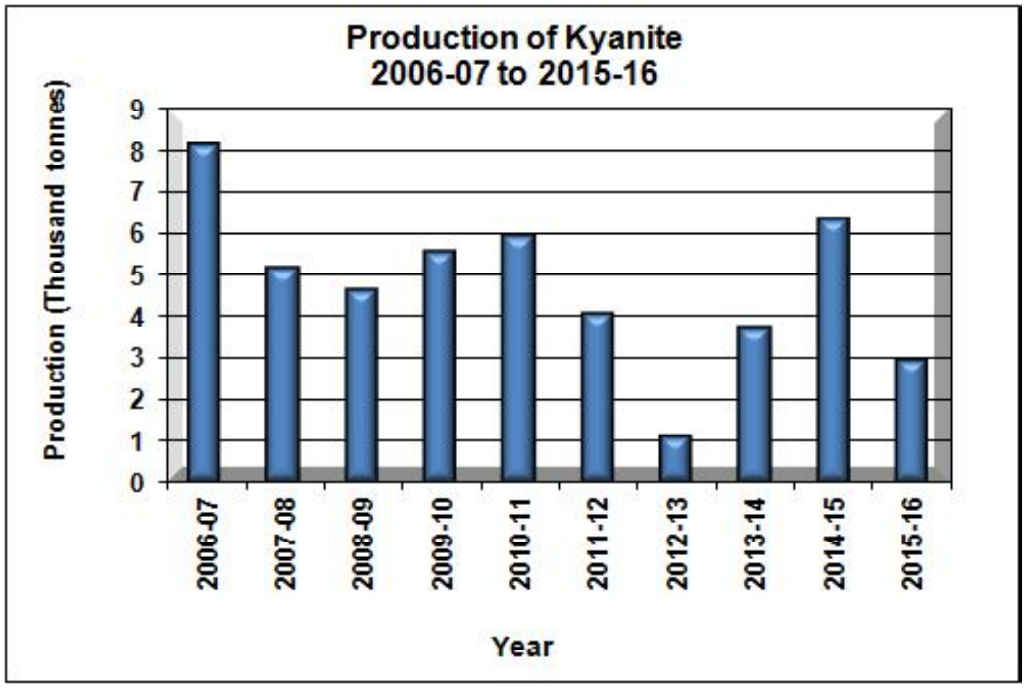

Table – 5 : Producers of Kyanite, 2015-16

Name & address of producer	Location of mine	
	State	District
Pavri Kyanite Mines, Cimmco House, A-1 Indra Sagar Apartment, Ravindranath Tagore Marg, Civil Lines, Nagpur- 440 001, Maharashtra.	Maharashtra	Bhandara
Maharashtra State Mining Corporation Ltd Plot No. 7, Ajani Chowk, Wardha Road, Nagpur - 440 015, Maharashtra.	Maharashtra	Bhandara

Table – 6 : Production of Kyanite, 2013-14 to 2015-16
(By States)

(Qty in tonnes; Value in `'000)

State	2013-14		2014-15		2015-16 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**3679**	**8071**	**6255**	**12185**	**2901**	**14029**
Karnataka	1416	708	4400	3520	-	-
Maharashtra	2263	7363	1855	8665	2901	14029

Table – 7 : Production of Kyanite, 2014-15 and 2015-16
(By Sectors/States/Districts/Grades)

(Qty in tonnes; Value in ` '000)

State/District	2014-15					2015-16 (P)				
	No. of mines	Quantity			Value	No. of mines	Quantity			Value
		40% & above Al_2O_3	Below 40% Al_2O_3	Total			40% & above Al_2O_3	Below 40% Al_2O_3	Total	
India	**3**	**6255**	**-**	**6255**	**12185**	**5**	**2590**	**311**	**2901**	**14029**
Public sector	-	-	-	-	-	1	123	78	201	322
Private sector	3	6255	-	6255	12185	4	2467	233	2700	13707
Karnataka	**1**	**4400**	**-**	**4400**	**3520**	**1***	**-**	**-**	**-**	**-**
Mysuru	1	4400	-	4400	3520	1*	-	-	-	-
Maharashtra	**2**	**1855**	**-**	**1855**	**8665**	**4**	**2590**	**311**	**2901**	**14029**
Bhandara	2	1855	-	1855	8665	4	2590	311	2901	14029

***** *: Only labour reported.*

Table – 8 : Mine-head Closing Stocks of Kyanite, 2014-15 and 2015-16
(By States/Grades)

(Qty in tonnes)

State	2014-15			2015-16 (P)		
	40% Al_2O_3 & above	Below 40% Al_2O_3	Total	40% Al_2O_3 & above	Below 40% Al_2O_3	Total
India	**6025**	**8255**	**14280**	**6204**	**8315**	**14519**
Jharkhand	-	1327	1327	-	1326	1326
Karnataka	5738	6444	12182	5738	6444	12182
Maharashtra	287	484	771	466	545	1011

Sillimanite

The production of sillimanite at 70,447 tonnes in 2015-16 recorded an increase of 6% as compared to the previous year. There were 4 reporting mines in the current and the previous year. All the four mines reported production of sillimanite as an associated mineral either with garnet or kyanite during 2015-16.

Ninety nine percent of total production during the year was contributed by three producers. About 26% of total production of sillimanite was reported by the public sector, while remaining 74% of production was reported by the private sector. Andhra Pradesh, the main producing state contributed 61% of the total production of sillimanite in 2015-16 followed by Odisha (19%), Maharashtra (13%) and Kerala (7%) (Tables - 9 to 11).

Mine-head closing stocks for the year 2015-16 were 24,287 tonnes as against 21,239 tonnes in the previous year (Table - 12).

The average daily employment of labour during 2015-16 was 1,778 as against 1,720 in the previous year.

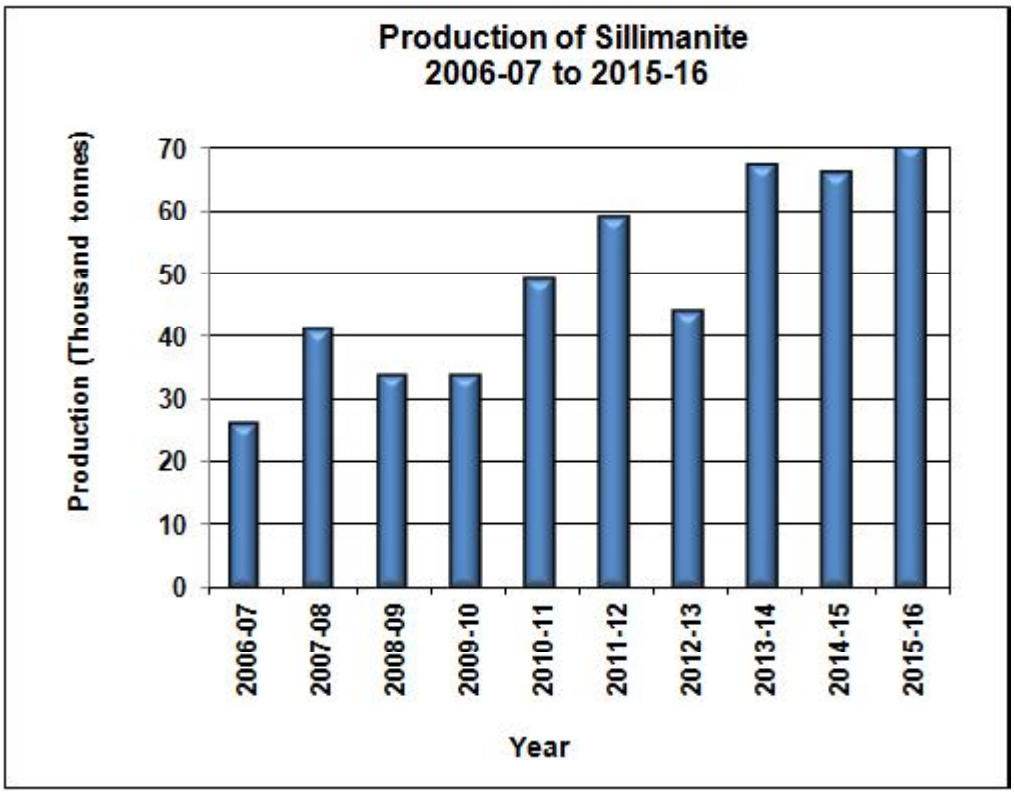

Table – 9 : Producers of Sillimanite, 2015-16

Name & address of producer	Location of mine	
	State	District
Indian Rare Earths Ltd, Plot No. 1207, Veer Sawarkar Marg, Near Siddhi Vinayak Temple, Prabhadevi, Mumbai-400 028, Maharashtra.	Odisha Kerala	Ganjam Kollam
#Trimex Sands Private Limited, 3rd Floor, Serene Tower, Banjara Hills, Hyderabad, Andhra Pradesh.	Andhra Pradesh	Srikakulam
*Pavri Kyanite Mines, A/1, Indrasagar Apartments, Ravindranath Tagore Road, Civil Lines, Nagpur- 440 001 Maharashtra.	Maharashtra	Bhandara

 # Producing as an associated mineral with garnet.
** Producing as an associated mineral with kyanite.*

Table –10 : Production of Sillimanite, 2013-14 to 2015-16
(By States)

(Qty in tonnes; Value in `'000)

State	2013-14		2014-15		2015-16 (P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	**67265**	**408247**	**66273**	**456050**	**70519**	**498992**
Andhra Pradesh	43705	277396	33801	250026	42914	341195
Kerala	5109	44635	7689	69201	5121	46158
Maharashtra	6729	9964	6472	17948	9091	20964
Odisha	11722	76252	18311	118875	13393	90675

Table – 11 : Production of Sillimanite, 2014-15 and 2015-16
(By Sectors/States/Districts)

(Qty in tonnes; Value in `'000)

State/District	2014-15			2015-16 (P)		
	No. of mines	Quantity	Value	No. of mines	Quantity	Value
India	**4(3)**	**66273**	**456050**	**4(4)**	**70447**	**498992**
Public sector	4	26275	188699	4	18514	136833
Private sector	(3)	39998	267351	(4)	51933	362159
Andhra Pradesh	**(1)**	**33801**	**250026**	**(1)**	**42914**	**341195**
Srikakulam	(1)	33801	250026	(1)	42914	341195
Kerala	**2**	**7689**	**69201**	**2**	**5121**	**46158**
Kollam	2	7689	69201	2	5121	46158
Maharashtra	**1(2)**	**6472**	**17948**	**1(3)**	**9019**	**20964**
Bhandara	1(2)	6472	17948	1(3)	9019	20964
Odisha	**1**	**18311**	**118875**	**1**	**13393**	**90675**
Ganjam	1	18311	118875	1	13393	90675

Figures in parentheses indicate the number of associated mines with garnet and kyanite

Table – 12: Mine-head Closing Stocks of Sillimanite 2014-15 & 2015-16
(By States)

(In tonnes)

State	2014-15	2015-16 (P)
India	**21239**	**24287**
Andhra Pradesh	1357	2566
Kerala	3925	1980
Maharashtra	12695	16095
Odisha	2945	3646
Rajasthan	317	-

Andalusite

There was no production of andalusite in the country since 1988.

MINING & MARKETING

Kyanite

Kyanite mines are worked by opencast manual as well as semi-mechanised methods. Generally, the mineral is marketed under three grades: 60% Al_2O_3 and above, 50-60% Al_2O_3 and less than 50% Al_2O_3. These three grades are used in the manufacture of refractories.

Sillimanite

Sillimanite mines are also worked by opencast method. Pohra mine of Maharashtra State Mining Corporation Ltd is semi-mechanised.

Granular sillimanite is obtained from beach sands in Kerala, Odisha and Tamil Nadu as a by-product along with ilmenite, rutile, zircon, garnet, etc. while recovering monazite. The Odisha Sands Complex of IREL in the coastal region of Chatrapur in Ganjam district, Odisha, has the capacity to recover 10,000 tpy granular sillimanite at present. At Chatrapur, mining is carried out by suction dredging with gravel pump. IREL's Chavara plant in Kollam district, Kerala, presently has an installed capacity of 10,000 tpy granular sillimanite.

At Chavara in Kerala, beach sand mining operations are carried out by IREL in two stages: (i) by means of bulldozers and wheel loaders, and

subsequently loading by front-end loaders, wheel loaders and belt conveyors; and (ii) upgrading it to around 93% heavy minerals at Dredge & Wet Concentration Plant and concentrate upgrading unit. The Mineral Recovery Plant (MRP) essentially consists of a dredging system to mine the deposit and a pre-concentration system to separate the valuable minerals and dispose of the waste at the same place from where it was mined. The two systems are mounted on a combined floating platform which keeps moving with the progress of mining. For details regarding mining and processing, etc. of beach sand minerals, review on 'Ilmenite and Rutile' may be referred.

USES

Kyanite, sillimanite and andalusite are mainly used in refractories and ceramic products because of their ability to form mullite phase at high temperature. Mullite is an essential component of high - alumina refractories forming the inner lining of furnaces and high temperature vessels widely used in the production of metals,ceramics, glass and cement.These are used to manufacture refractory products like dense bricks, insulating bricks, monolithic & castables. Sillimanite refractory bricks are extensively used in steel and glass industries and also in ceramics, cement kilns, heat treatment furnaces and petrochemical industries.

SPECIFICATIONS

BIS has prescribed IS:14301-1995 (reaffirmed in 2011) for kyanite used in Refractory Industry. There are two grades i.e. Grade-1 and Grade-2. Composition of kyanite under this specification is Al_2O_3 58% min for Grade-1 and 54% min for Grade-2; Fe_2O_3 1.50% max, $K_2O + Na_2O$ 1% max; other constituents as agreed between the supplier and purchaser and Pyrometric Cone Equivalent (PCE) not less than 36 (for Grade-1) and 35 (for Grade-2). Size of the material is 50 to 150 mm or 10 to 50 mm.

BIS has laid down IS:14302-1995 (reaffirmed in 2011) in respect of beach sand sillimanite for use in Refractory Industry, while IS:2045-1962 in respect of natural sillimanite blocks for glass melting tanks furnaces has been withdrawn.

CONSUMPTION

Kyanite

The consumption of kyanite in various industries was 3,100 tonnes in 2015-16 which is about 3% less than previous year. About 97% consumption of kyanite was accounted for by the Refractory Industry and rest of 3% consumption is reported by Iron & Steel Industry (Table-13).

Sillimanite

The consumption of sillimanite was 34,400 tonnes in 2015-16 which increased by about 22% over the previous year. Refractory Industry alone accounted for about 91% consumption (Table-13).

Table – 13 : Consumption* of Kyanite and Sillimanite 2013-14 to 2015-16 (By Industries)

(In tonnes)

Industry	2013-14	2014-15 (R)	2015-16 (P)
Kyanite			
All Industries	**3000**	**3200**	**3100**
Iron & Steel	Nil	300	100
Refractory	3000	2900	3000
Sillimanite			
All Industries	**20900**	**28200**	**34400**
Abrasive	100	100	100
Ceramic	1600	2400	2500
Chemicals	200	200	200
Foundry	++	++	200
Refractory	19000	25500	31400

Figures rounded off.

(Due to paucity of data, consumption may not be complete).*

WORLD REVIEW

World reserve of kyanite and related minerals is large in the USA. Andalusite is limited to only a few countries. The main producer and exporter of andalusite is South Africa. USA and India are the main producers of kyanite. India is the leading producer of sillimanite. World production of kyanite and related minerals is given in Table-14.

Table – 14 : World Production of Kyanite and Related Minerals
(By Principal Countries)

(In tonnes)

Country	2013	2014	2015
Brazil			
Kyanite[eb]	200	200	200
France			
Andalusite[e]	68000	68000	68000
India*			
Kyanite	3679	6255	2901
Sillimanite	67265	66273	70447
Madagascar	4500	4500[e]	4500[e]
Nepal			
Kyanite	19	12	7
South Africa			
Andalusite[e]	270000	270000	270000
USA			
Kyanite[(a)]	110000	110000[e]	110000[e]

Source: *World Mineral Production, 2011-2015.*
(a) Including related minerals.
(b) Including beneficiated & directly shipped material.
** India's production of kyanite during 2013-14, 2014-15 and 2015-16 was 3,679 tonnes, 6,255 tonnes and 2,901 tonnes respectively, while that of sillimanite was 67,265 tonnes, 66,273 tonnes and 70,447 tonnes, respectively.*

The irregular availability of inexpensive refractory-grade bauxite from China served to increase the demand for refractories from alternate raw materials such as andalusite. The leading andalusite producers, China, Peru and South Africa, continued to expand operations.

China

China is supposed to produce kyanite, but its production data is not available since 2003. A production capacity of 40,000 tonnes per year was reported for Yilong Andalusite Mineral Co. (a subsidiary of Imerys SA, Paris, France) in the Xinjiang Uyghur Autonomous Region of north-western China.

France

Imerys Refractory Minerals (a member of Imerys Group), which produces andalusite under the trade name Kerphalite[T] mined andalusite from three mine pits at its Glomel Mine, in Brittany, France.

Peru

Andalusita S.A. continued development and production from its mine in north-western Peru, 20 km from the deep seaport Paita in unconsolidated sand and gravel of the Tablazo Mancora flood plain. A primary andalusite product graded 59% to 60% Al_2O_3, with a maximum 0.85% iron oxide was produced for refractory consumers. Plant capacity is planned to increase between 48,000 and 60,000 tonnes per year.

Latin Resources Ltd (Perth,Western Australia, Australia) succeeded in renegotiating the purchase price of its Guadalupito andalusite and heavy-mineral-sands project in peru to slightly less than $8 million from the original $13 million.

The Los Conchales resource mineral sands deposit, which covers 1,350 hectares of the Guadalupito project was estimated to contain 1.1 billion tonnes of heavy mineral sand containing mostly andalusite (21% to 24%) and magnetite (22% to 25%) and small quantities of apatite, garnet, ilmenite, monazite, rutile and zircon. The andalusite is found mostly as individual particles in the deposit, more than 90% of which is below the water table, making it amenable to dredging. Based on testing performed in 2014, the deposit was expected to produce an andalusite product grade of greater than 60% Al_2O_3 with less than 0.2% iron oxide. The company planned to market its production to the refractory and technical ceramics industries. The company planned to use a conventional dredge mining operation and to begin production at an initial rate of 15 million metric tons per year at a minimum mine life of 15 years.

South Africa

South Africa's Competition Commission blocked the proposed takeover by Imerys of Andalusite Resources (Pty.) Ltd. The Commission determined that the merger would create an andalusite supply monopoly within South Africa, making the mineral more expensive to local consumers by removing competition in the fine-grade and medium-grade andalusite markets with no alternative domestic supplier in South Africa.

Andalusite Resources (Pty.) Ltd mined andalusite at its Maroelasfontein Mine in Thabazimbi, Limpopo Province. Development at the mine, which had a production capacity of 70,000 t/yr in 2014, continued with work aimed at increasing capacity to 90,000 t/yr by year end 2015 and to 120,000 t/yr during the next several years.

Denain-Anzin Mineraux Refractaire Ceramique (Damrec) (a subsidiary of Imerys SA) produced about 70% of the andalusite in South Africa at four mines, which had a combined capacity of 195,000 t/yr of andalusite. Damrec planned to increase output to 250,000 t/yr over the next serveral years. Rhino Minerals

(Pty.) Ltd operated three of Damrec's mines in South Africa: the Annesley, Havercroft and Rhino Mines in Limpopo Province. Samrec (Pty.) Ltd was the operator of the Krugerspost Mine near Lydenburg, Mpumalanga Province, which had been idle since 2013.

FOREIGN TRADE

Exports

Exports of kyanite during 2015-16 were 144 tonnes which increased drastically by 269% more than the previous year. Exports were mainly to China (39%), Greece (32%) and Saudi Arabia (22%). While exports of sillimanite decreased by 13% to 15,078 tonnes in 2015-16 from 17,304 tonnes in the previous year. Sillimanite was exported mainly to China (67%) and Nepal (26%). There were no exports of andalusite during 2015-16 (Tables - 15 to 17).

Imports

In 2015-16, imports of kyanite were at 478 tonnes as against 508 tonnes in the previous year. Imports of sillimanite were 214 tonnes in 2015-16 as compared to 116 tonnes in the previous year. Imports of andalusite increased to 14,072 tonnes in 2015-16 from 9,350 tonnes in the previous year. The entire imports of kyanite were from USA. France (45%) and Turkey (37%) were the main supplier of sillimanite, while South Africa (91%) was the main supplier of andalusite in 2015-16 (Tables - 18 to 20).

Table – 15 : Export of Kyanite (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**39**	**505**	**144**	**2696**
Greece	-	-	46	924
Saudi Arabia	-	-	32	842
China	++	2	56	783
UAE	-	-	++	81
Nepal	22	203	10	62
Jordan	-	-	++	2
Singapore	-	-	++	2
Iran	5	164	-	-
Kenya	12	126	-	-
UK	++	7	-	-
Other countries	++	3	-	-

Table – 16 : Exports of Sillimanite (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**17304**	**141262**	**15078**	**110846**
China	12958	105524	10160	79494
Nepal	3262	19413	3867	11671
Japan	261	5027	474	10664
Belgium	312	3518	208	2545
Thailand	75	1674	76	1368
UAE	1	59	20	1192
Netherlands	-	-	104	1192
Greece	138	2518	46	887
Germany	5	8	22	403
Sri Lanka	-	-	25	365
Other countries	292	3521	76	1065

Table – 17 : Exports of Andalusite (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries		**4**	**127**	--
UAE	2	74	-	-
Nepal	1	35	-	-
China	1	18	-	-
Other countries		-	-	--

Table – 18 : Imports of Kyanite (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**508**	**17006**	**478**	**16913**
USA	503	15988	478	16913
Nepal	2	932	-	-
China	3	86	-	-
Other countries	-	-	-	-

Table – 19 : Imports of Sillimanite (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**116**	**10754**	**214**	**9043**
France	-	-	96	3288
USA	-	-	19	2954
Japan	11	1551	19	2039
Turkey	-	-	79	527
China	-	-	++	150
Hong Kong	-	-	++	56
Taiwan	-	-	1	29
Nepal	24	7271	-	-
Peru	81	1893	-	-
Thailand	++	33	-	-
Other countries	++	6	-	-

Table – 20 : Imports of Andalusite (By Countries)

Country	2014-15		2015-16 (P)	
	Qty (t)	Value (``'000)	Qty (t)	Value (``'000)
All Countries	**9350**	**201731**	**14072**	**306082**
South Africa	8488	179375	12817	267491
France	815	21192	1127	34855
USA	20	498	120	3105
Japan	-	-	8	631
Peru	27	666	-	-
Other countries	-	-	-	-

FUTURE OUTLOOK

The demand for high quality raw and calcined sillimanite minerals is closely linked to the need for high performance refractories with increased operational lifespans. As the predominant consumer of refractory products, the steel manufacturing industry provides a reliable market indicator of the demand for sillimanite minerals. The Asia-Pacific region remains the largest market for refractories. As per the Report of the Working Group for 12th Plan (2012-17), the current demand of sillimanite is 32,000 tpy. Projected demand for next five years is 35,000 to 40,000 tpy at GDP growth rate of 8%, 9% and 10%. The production of sillimanite is likely to be increased in coming years to meet the demand. China will remain the leading market on global front.