

BAUXITE



Indian Minerals Yearbook 2015 (Part- III : Mineral Reviews)

54th Edition

BAUXITE

(FINAL RELEASE)

**GOVERNMENT OF INDIA
MINISTRY OF MINES
INDIAN BUREAU OF MINES**

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4 Bauxite

Bauxite is basically an aluminous rock containing hydrated aluminium oxide as the main constituent and iron oxide, silica and titania in varying proportions. Hydrated aluminium oxides present in the bauxite ore are diaspore and boehmite, $Al_2O_3 \cdot H_2O$ (Al_2O_3 -85%; Al-45%); gibbsite or hydrargillite, $Al_2O_3 \cdot 3H_2O$ (Al_2O_3 -65.4%; Al-34.6%), and bauxite (containing colloidal alumina hydrogel), $Al_2O_3 \cdot 2H_2O$ (Al_2O_3 -73.9%; Al-39.1%). The iron oxide in bauxite ore is present as haematite or goethite, silica as clay and free quartz and titania as leucosene or rutile. Bauxite is a principal ore of aluminium which is one of the most important non-ferrous metals used in the modern industry. It is also an essential ore for Refractory and Chemical industries. The country has abundant resources of bauxite which can meet both domestic and export demands.

RESOURCES

Resources of bauxite in the country as on 1.4.2013, as per UNFC system are placed at 3,739 million tonnes. These resources include 830 million tonnes reserves and 2,909 million tonnes remaining resources. By grades, about 81% resources are of metallurgical grade. The resources of refractory and chemical grades are limited and together account for about 3%. By States, Odisha alone accounts for 53% of country's resources of bauxite followed by Andhra Pradesh (16%), Gujarat (8%), Jharkhand (5%), Madhya Pradesh, Maharashtra and Chhattisgarh (4% each). Major bauxite resources are concentrated in the East Coast bauxite deposits in Odisha and Andhra Pradesh (Table-1).

EXPLORATION & DEVELOPMENT

Details of exploration carried out for bauxite by State Directorates of Geology & Mining, Government of Chhattisgarh and Maharashtra during 2014-15 are given in Table- 2.

PRODUCTION, STOCKS & PRICES

The production of bauxite at 22,226 thousand tonnes in 2014-15 decreased marginally as compared to the previous year.

There were 152 reporting mines in 2014-15 as against 177 in the previous year. Besides production of bauxite was reported as associate mineral by 7 mines during the year. In all, 67 producers reported production of bauxite in 2014-15. Ten principal producers having 35 mines contributed 79% of the total production. Fifty three (53) major mines, including two associ-

ate mines each producing more than 50 thousand tonnes per annum, together accounted for 94% of the total production.

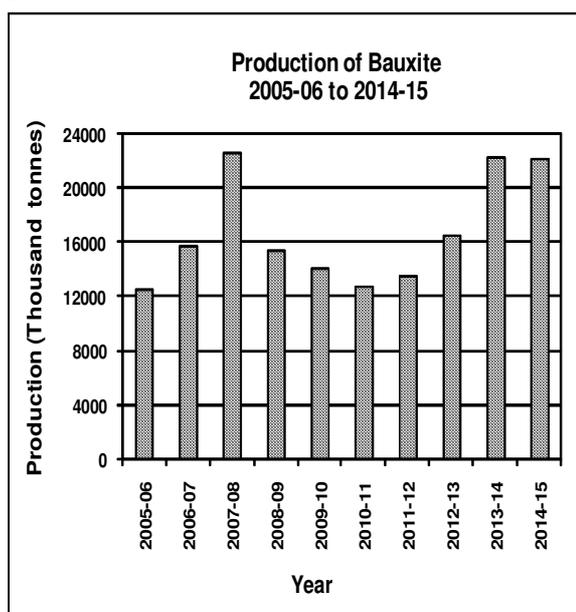
The contribution of the Panchpatmali bauxite mine of NALCO was 26% of the total production. The share of public sector mines was about 29 % of the total production in 2014-15, as against 30 per cent in the previous year.

About 34 % each of the total production of bauxite was of 45-50% Al_2O_3 grade and 40-45% Al_2O_3 grade, 25% was of cement grade, 5% was of below 40% Al_2O_3 grade, 1% was of Refractory grade and remaining production was reported in 50-55% Al_2O_3 abrasive and chemical grades during the year under review.

Odisha emerged as the leading producing state accounting for about 42% of the total production. Next in the order of production were Gujarat (25%), Maharashtra (12%), Jharkhand (9%), Chhattisgarh (7%) Madhya Pradesh (4%) and the remaining 1% was produced by Goa, Karnataka and Tamil Nadu (Tables -3 to 6).

Mine head closing stocks of bauxite in 2014-15 was 10,043 thousand tonnes as compared to 12,084 thousand tonnes in the previous year. About 86% of total stock was held in Gujarat at the end of the year (Tables- 7 'A' & 'B').

The average daily employment of labour in bauxite mines was 6048 in 2014-15 as against 6854 in the previous year.



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Table – 1 : Reserves/Resources of Bauxite as on 1.4.2013
(By Grades/States)

(In '000 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	401993	52254	375948	830195	134706	131749	348925	653773	431524	1161536	46644	2908856	3739051
By Grades													
Chemical	7240	0	52	7292	167	4584	411	3018	182	4922	0	13284	20576
Refactory	26752	173	831	27755	2289	4561	45406	6828	720	10938	364	71108	98864
Chemical/Refractory Mixed with others	4316	150	742	5207	511	2218	205	3149	427	8484	0	14995	20203
Metallurgical-1	260494	39892	344556	644942	76913	60766	237281	448395	292594	638503	14573	1769026	2413968
Metallurgical-2	40623	11	3705	44339	30807	21848	36757	105382	67769	306726	4440	573729	618068
Metallurgical mixed	11714	26	5072	16812	4672	3020	2518	53969	0	28799	16630	109608	126420
Low Grade	23221	11575	9898	44693	13192	3913	19019	23366	54837	105335	0	219663	264356
Mixed grade Excluding Chem./Refrac.	18485	232	2001	20718	5319	7529	6824	7619	4370	13366	0	45028	65746
Abrasive	667	0	70	737	28	805	123	92	56	961	0	2066	2803
Others	5867	0	8989	14856	110	952	296	1949	4848	10997	1545	20696	35552
Unclassified	2013	196	32	2241	543	21540	85	0	5720	11039	8954	47881	50122
Not - Known	601	0	0	601	153	12	0	5	0	21465	138	21772	22373
By States													
Andhra Pradesh	0	0	0	0	0	0	0	188971	138120	288176	0	615267	615267
Bihar	0	0	0	0	0	0	0	0	0	4114	0	4114	4114
Chhattisgarh	12594	2958	4793	20344	9796	4511	45865	33764	11792	23041	18747	147516	167860
Goa	15169	0	1207	16376	14133	1097	10121	6820	0	8646	0	40817	57193
Gujarat	122060	9932	20627	152619	16339	25679	3925	29733	22107	58778	0	156561	309180
Jammu & Kashmir	0	0	0	0	0	0	0	1323	182	520	0	2025	2025
Jharkhand	57931	1508	11534	70972	13991	4807	13802	15760	17474	53983	0	119817	190789
Karnataka	126	1474	3403	5003	2550	864	10	0	2220	35567	0	41210	46213
Kerala	0	0	0	0	29	0	24	2037	9284	2722	0	14096	14096
Madhya Pradesh	11735	1037	2923	15695	9451	10296	1174	14255	56153	50796	0	142125	157820
Maharashtra	15787	12350	3512	31649	13161	6115	13312	38918	8354	50291	0	130149	161798
Odisha	166026	22996	327950	516971	55256	77240	257128	310842	155253	567994	27897	1451611	1968582
Rajasthan	0	0	0	0	0	0	0	0	0	528	0	528	528
Tamil Nadu	565	0	0	565	0	1141	3564	960	10084	8363	0	24112	24677
Uttar Pradesh	0	0	0	0	0	0	0	10390	500	8018	0	18908	18908

Figures rounded off.

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Table – 2 : Details of Exploration Activities for Bauxite, 2014-15

Agency/ State/ District	Location Area/ Block	Mapping		Drilling		Sampling (No.)	Remarks Reserves/Resources estimated
		Scale	Area (sq km)	No. of boreholes	Meterage drilled		
Geological Survey of India							
Chhattisgarh							
Balrampur	Jawaharnagar- Khajri-Barpat- Chandadarhi area	1:12500	50	-	-	145	Reconnaissance stage (G-4) investigation for bauxite was carried out in Chilpi area. Aluminous laterite occurs as irregular pockets and lenses. Pockets of massive bauxite extends up to 200-300 m was reported from west of Karundha village. In the east of Damchuan village, massive bauxite of 200 m length and 2 to 3.5 m thickness was observed. The Pisolithic/Oolitic bauxite of size 2 mm to 1 cm was also reported. Aluminium laterite observed in the south of Damchuan village and excavation/pitting of 97.61 m ³ of rocks shows the pocketed nature of bauxite. In South of Chandadarhi village, pocket types of ore body extends up to 1.5 km underlain by laterite. Thickness varies from 0.5 to 1.5 m and excavation of 15 pits shows pocketing nature of bauxite in Chandadarhi plateau. Laterite observed to the east of Premnagar, Bijatoli and Mahuatoli villages contains few lenses of bauxite. Chemical analysis of bauxite samples of 22 BRS, 34 channel and 20 pit shows Al ₂ O ₃ ranges from 47.81 to 54.17%, 30.31 to 58.42% and 30.75 to 58.21%, respectively and SiO ₂ ranges from 1.21 to 4.95%. In Laterite samples Al ₂ O ₃ ranges from 24.46 to 37.98% and SiO ₂ 6.59 to 10.85%.
		1:5000	2				
Meghalaya							
West Khasi Hills	Around Rambrai area	1:5000	1.5	-	-	105	Reconnaissance stage (G-4) investigation for laterite bauxite was carried out. Four main bodies of lateritic bauxite having dimension of 900 x 400 m, 260 x 150 m, 280 x 100 m and 620 x 350 m were identified in the area. The thickness of laterite bauxite is about 8 to 10 m. A total 78 no. of samples were collected and Al ₂ O ₃ content varies from 15.33% to 60.88% with average value of 38.5%. Cr and V also showed encouraging values up to a maximum of 1230 ppm and 875 ppm, respectively.
DMG, /Chhattisgarh							
Surguja	Dandkeshra Mainpat Plateau	1:50000 1:4000	150 2.11	137	1483.6	1498	Pitting - 128 m ³ Estimated 6 lakh tonnes of metal grade bauxite.
Kabirdham	Darai Area	1:50000 1:4000	153 1.79	174	1594	969	Pitting - 116.8 m ³ Estimated 5 lakh tonnes of bauxite under (333) category. Pitting (3 Nos.) - 24 m ³
Raigarh	Kindha area	-	-	-	-	-	
Maharashtra							
Ratnagiri	Guhaghar	-	40	-	-	30	-

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Table – 3 : Principal Producers of Bauxite, 2014-15

Name & address of producer	Location of mine	
	State	District
National Aluminium Co. Ltd, NALCO Bhawan, P/1, Nayapali Bhubaneshwar-751 061, Odisha.	Odisha	Koraput
Utkal Alumina International Ltd, J-6, Jayadev-Vihar, Bhubaneshwar-751 013, Odisha.	Odisha	Raygada
Hindalco Industries Ltd, Century Bhawan, Dr. Annie Beasant Road, Worli, Mumbai-400 025, Maharashtra.	Chhattisgarh Jharkhand	Surguja Gumla Latehar Lohardaga Kolhapur
Bombay Minerals Ltd, Okha, Jamnagar Highway Jam-Khambalia-361 305, Jamnagar, Gujarat.	Gujarat	Devbhoomi Dwarka
Bharat Aluminium Co. Ltd, BALCO Nagar Township, Korba-495 684, Chhattisgarh.	Chhattisgarh	Kabirdham

(Contd.)

Table- 3 (Concl'd.)

Name & address of producer	Location of mine	
	State	District
Prabhudas Vithaldas, Mayur Pankh Society, Opp. Circuit Villa, Chopati Road, Porbandar-360 575, Gujarat.	Gujarat	Jamnagar
Bharat Abrasives & Chemical Industries,1, Prabhu Chamber, Shreeji Palace, Porbandar-360 575, Gujarat.	Gujarat	Devbhoomi Dwarka
Ashapura Minechem Ltd, 278, 3 rd Floor, D.N. Road, Jeevan Udyog Building, Fort, Mumbai-400 001.	Maharashtra	Ratnagiri
Panditrao Mines & Minerals Pvt. Ltd, Anant Bld C, Vasant Vishwas Park, B1, Nale Colony, Devkar Paland Corner, Karveer, Kolhapur-416 007, Maharashtra.	Maharashtra	Kolhapur
Carborundum Universal Ltd, Post Box No. 02, Port Okha, Jamnagar-361 350 Gujarat.	Gujarat	Devbhoomi Dwarka

**Table – 4 : Production of Bauxite, 2012-13 to 2014-15
(By States)**

(Qty in tonnes; Value in ₹'000)

States	2012-13		2013-14		2014-15(P)	
	Quantity	Value	Quantity	Value	Quantity	Value
India	16507960	7960767	22319148	9996894	22226062	10769338
Chhattisgarh	1818169	1117536	1314129	859657	1565562	1048811
Goa	104200	10420	220400	53420	235000	32850
Gujarat	3429903	1632905	7309743	2726039	5507566	2091034
Jharkhand	1977575	939283	2282428	1302079	2040519	1039554
Karnataka	81200	28420	74500	24064	127500	31920
Madhya Pradesh	913106	581525	775508	458732	807697	474183
Maharashtra	2628328	926330	2606349	945574	2630715	1179604
Odisha	5460037	2693761	7635196	3578360	9233131	4826823
Tamil Nadu	95442	30587	100895	48969	78372	44559

(P) Provisional

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Table – 5 (A) : Gradewise Production of Bauxite, 2013-14
(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹'000)

State/District	No. of Mines	For use in Alumina & Aluminium extraction : Al ₂ O ₃ content							For use in other than Alumina & Aluminium extraction				Total
		55-60%	50-55%	45-50%	40-45%	Below 40%	Cement	Abrasive	Refractory	Chemical	Quantity	Value	
India	177(10)	-	118260	4574703	8049789	1898106	7228001	121089	249444	79756	22319148	9996894	
Public Sector	20	-	-	3414100	3186033	-	28186	-	6178	56037	6690534	3141653	
Private Sector	157(10)	-	118260	1160603	4863756	1898106	7199815	121089	243266	23719	15628614	6855241	
Chhattisgarh	12	-	-	477156	836973	-	-	-	-	-	1314129	859657	
Kabirdham	2	-	-	472672	-	-	-	-	-	-	472672	290182	
Surguja	10	-	-	4484	836973	-	-	-	-	-	841457	569475	
Goa	1	-	-	-	208400	-	12000	-	-	-	220400	53420	
South Goa	1	-	-	-	208400	-	12000	-	-	-	220400	53420	
Gujarat	95	-	14760	106132	377452	50	6414490	120760	219062	57037	7309743	2726039	
Amreli	1	-	-	-	-	50	-	-	-	-	50	23	
Devbhoomi Dwarka	79	-	14760	-	350953	-	6195631	120760	212884	-	6894988	2470584	
Kutch	8	-	-	106132	26499	-	28186	-	6178	56037	223032	170902	
Porbandar	5	-	-	-	-	-	131608	-	-	-	131608	58077	
Sabarkantha	2	-	-	-	-	-	59065	-	1000	-	60065	26453	
Jharkhand	19	-	-	3989	1210780	1067659	-	-	-	-	2282428	1302079	
Gumla	9	-	-	-	1009145	56595	-	-	-	-	1065740	630073	
Latehar	1	-	-	3989	48940	-	-	-	-	-	52929	40491	
Lohardaga	9	-	-	-	-	-	-	-	-	-	1163759	631515	
Karnataka	2	-	-	-	152695	1011064	74500	-	-	-	74500	24064	
Belagavi	1	-	-	-	-	-	74500	-	-	-	74500	24064	
Dakshin Kannada*	1	-	-	-	-	-	-	-	-	-	-	-	
Madhya Pradesh	24(9)	-	-	91921	377345	190392	62749	-	30382	22719	775508	458732	
Anuppur	1	-	-	-	49910	-	-	-	-	-	49910	40128	
Jabalpur	1(1)	-	-	-	-	-	37310	-	-	2987	40297	19105	
Katni	6(4)	-	-	91921	95170	180901	4508	-	3352	-	375852	190965	
Rewa	4	-	-	-	57375	96	-	-	-	-	57471	29207	
Sana	7(4)	-	-	-	-	9395	20931	-	12407	19732	62465	54126	
Shahdol	2	-	-	-	174890	-	-	-	-	-	174890	98880	
Sidhi	3	-	-	-	-	-	-	-	14623	-	14623	26321	
Maharashtra	16	-	103500	575530	1229973	133650	563696	-	-	-	2606349	945574	
Kolhapur	6	-	103500	575530	569838	34300	563696	-	-	-	1846864	618817	
Raigarh	6	-	-	-	94300	92000	-	-	-	-	186300	52164	
Ratnagiri	4	-	-	-	565835	7350	-	-	-	-	573185	274593	
Odisha	5(1)	-	-	3319975	3808866	506355	-	-	-	-	7635196	3578360	
Koraput	2	-	-	3307968	2985159	-	-	-	-	-	6293127	2883358	
Raigada	1	-	-	-	823707	506355	-	-	-	-	1330062	687642	
Sundergarh	2(1)	-	-	12007	-	-	-	-	-	-	12007	7360	
Tamil Nadu	3	-	-	-	-	-	100566	329	-	-	100895	48969	
Namakkal *	2	-	-	-	-	-	-	-	-	-	-	-	
Salem	1	-	-	-	-	-	100566	329	-	-	100895	48969	

Figures in parentheses indicate number of associated mines with fireclay, kaolin, manganese ore and ochre.
* Only labour reported.

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Table - 5 (B) : Gradewise Production of Bauxite, 2014-15
(By Sectors/States/Districts)

(Qty in tonnes; Value in ₹000)

State/District	For use in Alumina & Aluminium extraction : Al ₂ O ₃ content					For use other than Alumina & Aluminium extraction					Total
	No. of Mines	50-55%	45-50%	40-45%	Below 40%	Cement	Abrasive	Refractory	Chemical	Quantity	
India	152(7)	26248	7617993	7468200	1107772	5590068	122375	193039	100367	22226062	10769338
Public Sector	18	-	5864298	387539	-	5716	-	7084	85242	6349879	3359778
Private Sector	134(7)	26248	1753695	7080661	1107772	5584352	122375	185955	15125	15876183	7409560
Chhattisgarh	13	-	933009	632553	-	-	-	-	-	1565562	1048811
Kabirdham	3	-	886781	16494	-	-	-	-	-	903275	632071
Surguja	10	-	46228	616059	-	-	-	-	-	662287	416740
Goa	1	-	-	50000	-	185000	-	-	-	235000	32850
South Goa	1	-	-	50000	-	185000	-	-	-	235000	32850
Gujarat	71	26248	125178	397374	1650	4562475	122375	176139	96127	5507566	2091034
Anreli	1	-	-	357985	1650	-	-	-	-	1650	743
Devbhoomi Dwarka	58	26248	-	357985	-	4378984	122375	169055	10885	5065532	1794465
Junargarh*	1	-	-	-	-	-	-	-	-	-	-
Kutch	6	-	125178	39389	-	5716	-	7084	85242	262609	188274
Porbandar	3	-	-	-	-	103000	-	-	-	103000	74575
Sabarkantha	2	-	-	-	-	74775	-	-	-	74775	32977
Jharkhand	23	-	28182	1243220	769117	-	-	-	-	2040519	1039554
Gumla	12	-	28182	1132367	-	-	-	-	-	1160549	573141
Latehar	1	-	-	75631	-	-	-	-	-	75631	41580
Lohardaga	10	-	-	35222	769117	-	-	-	-	804339	424833
Karnataka	2	-	-	-	-	127500	-	-	-	127500	31920
Belagavi	1	-	-	-	-	127500	-	-	-	127500	31920
Dakshin Kannada*	1	-	-	-	-	-	-	-	-	-	-
Madhya Pradesh	21(7)	-	70387	421360	154817	139993	-	16900	4240	807697	474183
Anuppur	1	-	-	49925	-	-	-	-	-	49925	36196
Jabalpur	(1)	-	-	-	-	18000	-	1100	-	19100	10650
Kami	5(4)	-	70387	142375	119450	120939	-	-	-	453151	265294
Rewa	6	-	-	54135	107	285	-	-	-	54527	23994
Satna	4(2)	-	-	-	35260	769	-	-	4240	40269	8571
Shahdol	2	-	-	174925	-	-	-	-	-	174925	97652
Sidhi	3	-	-	-	-	-	-	15800	-	15800	31826
Maharashtra	14	-	722117	1229682	182188	496728	-	-	-	2630715	1179604
Kolhapur	7	-	722117	594618	-	481428	-	-	-	1798163	785302
Raigarh	4	-	-	45000	83500	15300	-	-	-	143800	40227
Ratnagiri	3	-	-	590064	98688	-	-	-	-	688752	354075
Odisha	4	-	5739120	3494011	-	-	-	-	-	9233131	4826823
Koraput	2	-	5739120	-	-	-	-	-	-	5739120	3011987
Raigada	1	-	-	3494011	-	-	-	-	-	3494011	1814836
Sundergarh*	1	-	-	-	-	-	-	-	-	-	-
Tamil Nadu	3	-	-	-	-	78372	-	-	-	78372	44559
Namakkal *	2	-	-	-	-	-	-	-	-	-	-
Salem	1	-	-	-	-	78372	-	-	-	78372	44559

Figures in parentheses indicate number of associated mines. * Only labour reported.

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**Table – 6 : Production of Bauxite, 2013-14 and 2014-15
(By Frequency Groups)**

(Qty in tonnes)

Production group	No. of mines		Production for the group		Percentage to total production		Cumulative percentage	
	2013-14	2014-15(P)	2013-14	2014-15(P)	2013-14	2014-15(P)	2013-14	2014-15(P)
Total	177(10)	152(7)	22319148	22226062	100.00	100.00	-	-
Up to 1000	57(1)	30(2)	3693	2822	0.02	0.01	0.02	0.01
1001 - 3000	4(2)	10	15209	22970	0.07	0.10	0.09	0.11
3001 - 5000	6	6(1)	27022	30395	0.12	0.14	0.21	0.25
5001 - 10000	16(1)	12	118119	89871	0.53	0.40	0.74	0.65
10001 - 25000	21(2)	25(2)	359513	455853	1.61	2.05	2.35	2.70
25001 - 50000	15(3)	18	724356	690632	3.25	3.11	5.60	5.81
50001 and above	58(1)	51(2)	21071236	20933519	94.40	94.19	100.00	100.00

Figures in parentheses indicate number of associated mines.

**Table – 7 (A) : Mine-head Stocks of Bauxite, 2013-14
(By States & Grades)**

(Qty in tonnes)

State	For use in alumina & aluminium metal						For use other than alumina & aluminium metal extraction				Total
	Extraction Al ₂ O ₃ Content						Cement	Abrasive	Refractory	Chemical	
	60% & above	55-60%	50-55%	45-50%	40-45%	Below 40%					
India	-	20	13399	620295	1070903	262565	9956435	55339	89762	14924	12083642
Chhattisgarh	-	-	-	2595	23	336	-	95	-	-	3049
Goa	-	-	-	-	-	-	10299	-	-	-	10299
Gujarat	-	20	1701	573154	589747	450	9613302	51924	84579	1975	10916852
Jharkhand	-	-	-	491	9352	54897	-	-	-	-	64740
Karnataka	-	-	-	-	19296	-	15344	-	-	-	34640
Madhya Pradesh	-	-	-	7582	233470	87910	51751	-	5183	12949	398845
Maharashtra	-	-	11698	23283	197100	75527	255734	-	-	-	563342
Odisha	-	-	-	13190	21915	27010	-	-	-	-	62115
Tamil Nadu	-	-	-	-	-	16435	10005	3320	-	-	29760

BAUXITE

**Table – 7 (B) : Mine-head Stocks of Bauxite , 2014-15
(By States & Grades)**

(In tonnes)

State	for use in alumina & aluminium metal extraction Al ₂ O ₃ Content						For use other than alumina & aluminium metal extraction				
	60% & above	55-60%	50-55%	45-50%	40-45%	Below 40%	Cement	Abrasive	Refractory	Chemical	Total
India	-	20	8465646399	1488849	435279	7231192	69205	90775		72959	10043143
Chhattisgarh	-	-	-	7286	6192	337	-	95	-	-	13910
Goa	--	-	-	-	50000	-	18166	-	-	-	68166
Gujarat	-	20	5519	512929	920851	145	6945829	65790	84309	62389	8597781
Jharkhand	-	-	-	807	20725	61796	-	-	134	-	83462
Karnataka	-	-	-	-	19296	-	17137	-	-	-	36433
Madhya Pradesh	-	-	-	16407	335320	98569	73961	-	6332	10570	541159
Maharashtra	-	-	2946	95781	114550	246787	166094	-	-	-	626158
Odisha	-	-	-	13189	21915	11210	-	-	-	-	46314
Tamil Nadu	-	-	-	-	-	16435	10005	3320	-	-	29760

MINING & TRANSPORT

The mining of bauxite is carried out by opencast method. The mines are classified in the following three categories depending upon the level of mechanisation:

- (i) Manually operated mines
- (ii) Semi-mechanised mines
- (iii) Mechanised mines

Manually operated Mines

Many bauxite mines are small and produce less than 25,000 tpy. The entire work of overburden removal, extraction of bauxite and loading of bauxite in trucks is carried out manually and the bauxite is transported to respective railway siding or plants by road.

Semi-mechanised Mines

In semi-mechanised mines, mining operations are carried out by jack hammer drilling and normally ANFO mixture is used as an explosive for blasting in mineralised zone as well as in overburden, if required. Loading of mineral in trucks or dumpers is done by payloaders or manually. Since bauxite occurs as small lenses or pockets or boulders or as segregations in murrum and laterite, it is difficult to mechanise the mining operations.

Mechanised Mines

Mechanised mining operations are carried out in a few captive mines of the alumina/aluminium

plants. These mines use compressed-air drills for drilling blastholes. Sometimes, compressed-air jack hammer drills are also used for drilling blastholes for secondary blasting of boulders and also for toe drilling in irregular bauxite faces caused due to improper fragmentation of bauxite. The blasted overburden/ore materials are handled and transported separately by using shovels or excavators and trucks/dumpers. Separate benches are maintained for the overburden and ores. The height of benches in ore varies from 1.5 to 7.5 m. Hindalco has done away with drilling and blasting at its Durgmanwadi mines in Maharashtra by using state-of-the-art ripper dozer which is regarded as "Miner's Plough". Use of ripper dozer silently ploughs the mine surface to extract the mineral. It eliminates ground vibrations and air pollution normally caused by dust, gases and noise.

In Bagru Hill mines of Hindalco in Jharkhand, the blasted bauxite is transported with the help of dumpers to the crusher. The 4-inch crushed bauxite is then transported to Lohardaga railway station by a monocable aerial ropeway. BALCO also has monocable ropeway for transporting bauxite from its captive mines to the alumina plant at Korba in Chhattisgarh.

Computerised mine planning, use of mobile crusher, simultaneous land reclamation, restricting operations to small portions of mining area at a time, etc. have greatly helped in conserving energy and faster land rehabilitation.

BAUXITE

In Odisha, NALCO has adopted the mechanised 'Trench method' of opencast mining at Panchpatmali mine. In this method, a pilot trench is driven through the middle of the deposit and several other trenches are opened on both the sides in a staggered pattern exposing and creating more number of working faces. Transportation of ore to alumina refinery at Damanjodi has been done through a 14.6 km long single-flight, multi curve cable belt conveyor of 1800 TPH capacity. The fertile top soil is preserved by dozing aside and hard laterite of 3 m thickness is drilled and blasted. The overburden is removed using higher capacity mobile equipment like dumpers and wheel loaders to expose the bauxite bed.

The top slice of bauxite having 8–10 m thickness is loosened by drilling and blasting and the bauxite of 3-4 m thickness at the bottom contact is removed selectively using backhoe shovels. The mine has achieved overall capacity of 6.3 million tonnes per year bauxite after expansion. Accordingly, higher capacity mobile equipment like dumpers, wheel loaders, ripper dozers and faster drills have been introduced. NALCO has plans in place to further increase bauxite mining capacity to 6.825 million tonnes per year.

CONSUMPTION

In 2014-15, consumption of bauxite was estimated at 13.63 million tonnes as compared to 14.08 million tonnes in the previous year. Alumina/aluminium industry was the principal consumer of bauxite and accounted for 94% consumption in 2014-15 followed by cement (4%) and refractory (2%) (Table-8).

Gujarat was the main supplier of abrasive and refractory grade bauxite. Besides, M.P. also produces refractory grade bauxite. Alumina plants draw supplies mostly from their captive mines. Hindalco sources bauxite from other suppliers too (Table- 9).

USES & SPECIFICATIONS

Bauxite is primarily used to produce alumina through the Bayer process. Aluminium industry normally uses bauxite containing minimum 38% Al_2O_3 . However, slightly inferior grades with a suitable blend are also used, depending upon other characteristics, such as, solubility in caustic soda and absence of silica. The IS : 5953-1985 (Reaffirmed 2008 & 2014) specifications for metallurgical grade bauxite are listed in Table-10. Details of the industries are provided in a separate review named 'Aluminium and Alumina'.

**Table – 8 : Consumption* of Bauxite#
2012-13 to 2014-15
(By Industries)**

(In tonnes)			
Industry	2012-13(R)	2013-14(P)	2014-15(E)
All Industries	13235800	14077200	13625300
Abrasives	3400(3)	3400(3)	3400(3)
Alumina ^{1/}	12385300(5)	13216900(5)	12743100(5)
Cement	535000(29)	561100(32)	591000(33)
Ceramic	1200(3)	1200(3)	1200(3)
Chemical	5900(3)	5900(3)	5900(3)
Ferro-alloys	11200(7)	7100(7)	7100(7)
Iron & steel	1200(6)	1200(6)	1200(6)
Refractory ^{2/}	292600(54)	280400(55)	272400(55)

Figures rounded off.

Figures in parentheses denote the number of units in organised sector reporting consumption.

#Excludes industrial end-use consumption of laterite which was 4368600 tonnes, 4334400 tonnes and 5346500 tonnes during 2012-13, 2013-14 and 2014-15, respectively.

^{1/} Includes about 11338 thousand tonnes, bauxite equivalent of alumina estimated to have been consumed in the production of aluminium metal.

^{2/} Includes consumption of calcined bauxite.

* Paucity of data, hence consumption may not be complete.

**Table – 9 : Domestic Sources of Supplies of
Bauxite to Alumina Plants**

Producer	Plant	Source of supply
NALCO	Damanjodi, Koraput (Odisha)	Captive mines at Panchpatmali Hills, Koraput distt. Odisha.
BALCO	Korba (Chhattisgarh)	Captive mines in Surguja & Bodai-Daldali in Kabirdham (Kawardha) distt. Chhattisgarh.
Hindalco Industries	Renukoot (Uttar Pradesh)	Captive mines in Shahdol distt. Madhya Pradesh; Gumla & Lohardaga distts. Jharkhand and Surguja distt. in Chhattisgarh. Also other suppliers include suppliers from Odisha, Madhya Pradesh and Jharkhand; Katni Bauxite Pvt. Ltd, Satna, Laxmidasji Ramji, Katni; and Minerals & Minerals Corp., Gujarat.
	Belagavi (Karnataka), Muri, Ranchi (Jharkhand)	Captive mines in Chandgad & Durgmanwadi, Kolhapur distt. Maharashtra and Lohardaga distt. Jharkhand. Udgeri, Guddeghar, Kolhapur distt. Bhoomi Resources Pvt Ltd Maharashtra.
Vedanta Aluminium	Lanjigarh (Odisha)	GMDC, Gujarat, Ashapura Minechem, Maharashtra, BALCO, Bagmar Resources Pvt Ltd, Chhattisgarh; LDR, M.P.

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Table – 10 : Specifications for Metallurgical Grade Bauxite (IS : 5953-1985; Reaffirmed 2008 & 2014)

(In % by weight)

Constituent	Gr. I	Gr. II *
	(essentially gibbsite or trihydrate)	(mixture of gibbsite, boehmite and diaspor or trihydrate & monohydrate)
Total Al ₂ O ₃ (min.)	40	47
Total available alumina (min.)	36	43
Total SiO ₂ (max.)	4	4
Module Al ₂ O ₃ /SiO ₂ (min.)	12	12
Fe ₂ O ₃ /TiO ₂ (max.)	30	30
P ₂ O ₅ (max.)	0.20	0.20
V ₂ O ₅ (max.)	0.20	0.20
Loss on ignition at 1100° C	20	20

* Normally, 1 to 20% diaspor and 5 to 7% boehmite.

In Steel Industry, bauxite is used as a slag corrector in place of fluorite and generally bauxite, containing 45 to 54% Al₂O₃ and 5% SiO₂ (max.) is consumed. Size preference is 25 to 125 mm with a tolerance of 5% (max.) for -25 mm & +100mm fractions.

BIS has prescribed the following specifications for bauxite in Refractory Industry (Table-11):

Table – 11 : IS Specifications of Bauxite for Refractory Industry (IS : 10817-1984; Reaffirmed 2008 & 2014)

Constituent	Percent
Al ₂ O ₃	58 min.
Fe ₂ O ₃	3 max.
TiO ₂	3 max.
CaO	0.5 to 0.6
LOI	27 to 30

The refractory manufacturers use bauxite of the following specifications:

Specifications of Bauxite used by Refractory Industry

Constituent	Percent
Al ₂ O ₃	55-60
Fe ₂ O ₃	4-6
TiO ₂	5-8
SiO ₂	2
Others	25-40
PCE	33-36 (Ortan)

The IS specifications of bauxite for consumption in chemical and petroleum industries are given in Table-12.

Table – 12 : IS Specifications of Bauxite for Chemical and Petroleum Industries (IS : 3605-1984; Reaffirmed 2010)

Constituent	Requirement
Alumina (as Al ₂ O ₃), % by mass (min.)	58.0
Silica (as SiO ₂), % by mass (max.)	3.0
Iron oxide (as Fe ₂ O ₃), % by mass (max.)	2.0
Titania (as TiO ₂), % by mass (max.)	4.0
Phosphorus pentoxide (as P ₂ O ₅), % by mass (max.)	0.3
Manganese dioxide (as MnO ₂), % by mass (max.)	0.1
Calcium and magnesium (as CaO), % by mass (max.)	2.0
Loss on ignition, % by mass (max.)	32.0

Apart from the chemical specifications, the physical requirements are that the material passing through 90-micron IS sieve but retained on 212-micron IS sieve should be 90% maximum; that passing through 300-micron IS sieve shall be 1% by mass maximum; and that passing through 212- micron IS sieve but retained on 300-micron IS sieve should be 10% maximum.

The other specifications laid down by BIS are IS:8228-1976 (Reaffirmed 2008) for bauxite sand and IS:8988-1978 (Reaffirmed 2008) for bauxite powder for foundry washes.

SUBSTITUTION

There is no substitute for bauxite in aluminium metal extraction carried out on a large scale. However, calcined clay can be substituted for refractory bauxite but only with reduction in time and stock resistance. Sillimanite, alumina, silicon carbide, magnesite-chromite and carbon-magnesite refractories are the other alternatives for high-alumina material but these would entail higher cost. Silicon carbide and diamonds can substitute for fused aluminium oxide in abrasive use but these would entail again at higher cost. Synthetic mullite is a probable substitute for bauxite-based refractories. Silicon carbide and alumina-zirconia are costlier substitutes for bauxite-based abrasives. The raw material like alunite, anorthosite, coal wastes and oil shales are other potential sources of alumina. The extraction, however, would require new plants with different technology. These non-bauxitic materials could satisfy the demand for primary metal, refractories, aluminium chemicals and abrasives.

TRADE POLICY

As per the Foreign Trade Policy for 2015-2020 and policy on export and import, imports of aluminium ores and concentrates including natural bauxite, whether calcined or not, and others are permitted freely. There are no policy restrictions on the export of bauxite.

WORLD REVIEW

The world bauxite reserves are estimated at 28 billion tonnes and are located mainly in Guinea (26%), Australia (22%), Brazil (9%), Vietnam (8%), Jamaica (7%), Indonesia (4%), Guyana & China (3% each). Countrywise reserves of bauxite are given in Table- 13.

The world production of bauxite was estimated at 260 million tonnes in 2014. Australia continued to be the major producer and accounted for about 30% share in total production, followed by China (25%), Brazil (14%), India (8%) and Guinea (7%) (Table-14).

**Table – 13 : World Reserves of Bauxite
(By Principal Countries)**

(In '000 tonnes)

Country	Reserves
World: Total (rounded)	2800000
Australia	6200000
Brazil	2600000
China	830000
Greece	250000
Guinea	7400000
Guyana	850000
India*	590000
Indonesia	1000000
Jamaica	2000000
Kazakhstan	160000
Malaysia	40000
Russia	200000
Suriname	580000
USA	20000
Venezuela	320000
Vietnam	2100000
Other countries	2400000

Source: Mineral Commodity Summaries, 2016.

* India's total resources of bauxite as per UNFC system are placed at 3.74 billion tonnes as on 1.4.2013.

Australia

Alumina & Bauxite production decreased by about 5% and 3% mainly due to shut down of one refinery. Rio Tinto shut down Gove refinery in northern territory owing to low alumina prices, high fuel cost, etc. Production of bauxite continued at adjacent bauxite mine 6 Mt/year for sale to third party customers and its capacity was envisaged to increase to 8 Mt/year by the end of 2015. Altech Chemicals Ltd (formerly Australia Minerals and Mining Group Ltd) built a refinery in Johor Bahru, Malaysia to produce high-purity alumina from a high-alumina clay deposit in western Australia.

China

New capacity expansion of China were limited owing to concern about availability of bauxite and financing restrictions by the Govt. In anticipation of Indonesia's ban on exporting of bauxite and other un-processed minerals, many refineries in China increased imports of bauxite from other countries. Between 2011 to 2013, about 280 million tonnes of bauxite reserves were discovered mostly in Guangxi, Guizhou, Henan and Shanxi Provinces. Exploration for new bauxite deposits were continued with discoveries being made in Guangxi Zhuang Autonomous Region and Guizhou Province.

Shanxi Province

A 2 million tonnes per annum bauxite mine was being developed to cater need of 1.4 million tonnes per annum alumina refinery (Shanxi Tongde Aluminium Co. Ltd) in Xinzhou, Baode county.

Guizhou Province

Aluminium Corp of China (Chinalco) permanently shut down 1.2 million tonnes per year capacity alumina refinery in Guiyang. Chinalco and Hangzhou Jinjiang Group Ltd planned to build a new refinery adjacent to mine that was the principal source of bauxite for the Guiyang refinery.

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The alumina refinery of China Power Investment Corp was under construction and will have capacity of 8 lakh tonnes per annum and raw material bauxite will be supplied from Dazhuyuan and Wachangping mines.

Henan Province

Chinalco obtained an underground mining permit to operate Sanmenxia mine in Jiayi area. It will supply bauxite to the Zhongzhou alumina refinery.

Guinea

Owing to strong demand from third party customer, Sangaredi mine had a record production of about 15.8 million tonnes in 2014. The mine was a joint venture among the Government (49%), Alcoa (22.95%), Rio Tinto (22.95%) and Dadco Group (5.1%). Kindia mine of RUSAL also reported higher production.

RUSAL started construction of the Dian-Dian mine of capacity 3 million tonnes per annum and slated for completion in 2016.

Indonesia

Bauxite production decreased by about 95% as compared to 2013 as mines that had exported bauxite closed after a ban on exporting bauxite and other unprocessed minerals ores. The mining law was aimed to increase economic development in the country through investment in mineral processing facilities. Although number of companies have invested in alumina refineries in Indonesia, the same are yet to start production.

Tayan refinery of PT Indonesia Chemical Alumina, is on trial runs of 3 lakh tpa and it will draw bauxite from nearby deposits from West Kalimantan.

Malaysia

Since Indonesia implemented an export ban on bauxite & unprocessed minerals, bauxite production in Malaysia increased to 3.26 million tonnes in 2014, as existing mines increased production and new mines were opened to supply bauxite to refineries in China.

Russia

The first stage of a new shaft at the Cheryomukhovskaya Glubokaya section of the North Urals mine was completed. The expansion would enable mining from the deposit to continue when reserves in the Krasnaya Shapochka are exhausted.

FOREIGN TRADE

Exports

Exports of bauxite increased drastically to 6,809 thousand tonnes in 2014-15 from 3,493 thousand tonnes in 2013-14. Exports were mainly to China (92%), Qatar (4%), Kuwait (2%), Oman and UAE (1% each) (Tables-15 to 17).

Imports

In 2014-15, imports of bauxite increased to 1800 thousand tonnes from 422 thousand tonnes in the previous year. Imports were mostly from Guinea (77%), Australia (7%), China & Pakistan (4% each) and Malaysia (2%) (Tables - 18 to 20).

**Table – 14 : World Production of Bauxite
2012 to 2014
(By Principal Countries)**

	(In '000 tonnes)		
Country	2012	2013	2014
World: Total	256330	298174	259585
Australia	76281	81119	78632
Brazil	34988	33849	35410
China	44052	50339	65000 ^e
Greece	1816	1844	1876
Guinea	17326	18331	18743
Guyana	2214	1713	1564
India*	16612	21666	20201
Indonesia ^e	31443	51024	2556
Jamaica	9339	9435	9677
Kazakhstan	5170	5193	4516
Russia	5166	5322	5589
Saudi Arabia	760	1044	1965
Suriname	2905	2671	2708
Turkey	1521	796	800 ^e
Venezuela	2286	2341	2316
Other countries	4450	5487	8033

Source: World Mineral Production, 2010-2014.

* India's production of bauxite during 2012-13, 2013-14 and 2014-15 was 16,508 thousand tonnes, 22,319 thousand tonnes and 22,226 thousand tonnes, respectively. e - estimated

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**Table – 15 : Exports of Bauxite
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	3492546	6736457	6808588	14050663
China	2942784	5243081	6239885	12547289
Qatar	52	99282	253304	444579
Kuwait	173850	284822	120200	231441
Slovenia	15370	183764	16499	220712
Oman	9516	60005	85872	194436
Austria	125	1054	3725	56549
UAE	62500	141479	57200	52292
UK	1149	24978	2235	43992
France	2100	51761	1600	40602
Nepal	21263	45413	17177	34703
Other countries	263837	600818	10891	184068

**Table – 16 : Exports of Bauxite : Other
Aluminium Ores & Concentrates
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	1022	4771	55970	115793
Qatar	-	-	54253	97538
USA	16	391	373	8294
Thailand	75	1528	275	5573
Nepal	762	1540	895	1930
Saudi Arabia	17	401	66	1539
Bangladesh	27	241	108	919
Other countries	125	670	-	-

**Table – 17 : Exports of Bauxite : Other
Aluminium Ores & Concentrates
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	3491524	6731685	6752618	13934869
China	2942664	5242763	6239885	12547289
Qatar	52	99282	199051	347041
Kuwait	173850	284822	120200	231441
Slovenia	15370	183764	16499	220712
Oman	9516	60005	85872	194436
Austria	125	1054	3725	56549
UAE	62500	141479	57200	52292
UK	1149	24978	2235	43992
France	2100	51761	1600	40602
Nepal	20501	43873	16282	32773
Other countries	263697	597904	10069	167742

**Table – 18 : Imports of Bauxite
(By Countries)**

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	421612	3662474	1800690	8560886
Guinea	326707	1784461	1394291	5579257
China	77229	1760452	67151	1540078
Brazil	3	467	99321	466413
Australia	1	57	129473	449757
Pakistan	17186	102341	72912	400092
Malaysia	-	-	37282	114235
Netherlands	196	9071	225	9911
Hong Kong	275	4918	26	708
USA	2	88	5	324
Chinese Taipei/ Taiwan	-	-	1	63
Other countries	13	619	3	48

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Table – 19 : Imports of Bauxite : Other Aluminium Ores & Concentrates (By Countries)

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	16808	101078	72313	396420
Pakistan	16779	99717	72312	396356
Chinese Taipei/				
Taiwan	-	-	1	63
Other countries	29	1361	++	1

Table – 20 : Imports of Bauxite : Other Aluminium & Concentrates (By Countries)

Country	2013-14		2014-15 (P)	
	Qty (t)	Value (₹'000)	Qty (t)	Value (₹'000)
All Countries	404804	3561396	1728376	8164466
Guinea	326707	1784461	1394291	5579257
China	77229	1760452	67151	1540078
Brazil	3	467	99321	466413
Australia	1	57	129473	449757
Malaysia	-	-	37282	114235
Netherlands	171	7987	225	9911
Pakistan	407	2624	600	3736
Hong Kong	275	4918	26	708
USA	2	88	5	324
Italy	-	-	2	46
Other countries	9	342	++	1

FUTURE OUTLOOK

India has large resources of bauxite. The resources of metallurgical grade bauxite are adequate while those of the chemical and refractory grade bauxite are relatively limited considering the future requirements. As per the Report of the Working Group for the 12th Five Year

Plan, the abundance of bauxite resources in Eastern Ghat regions of Odisha and Andhra Pradesh is likely to metamorphose the region into a hub for bauxite mining activities in future.